Clinical Approaches and Procedures in Cosmetic Dermatology

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Maria Claudia Almeida Issa
Bhertha Tamura *Editors*

Chemical and Physical Procedures

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Clinical Approaches and Procedures in Cosmetic Dermatology

Series Editors
Maria Claudia Almeida Issa
Department of Clinical Medicine – Dermatology
Fluminense Federal University
Niterói, RJ, Brazil

Bhertha Tamura
Clínicas Hospital of São Paulo of the University of São Paulo
São Paulo, SP, Brazil

Barradas and Bourroul's Ambulatório de Especialidades in São Paulo
São Paulo, SP, Brazil

Sorocaba's Ambulatório de Especialidade in Sorocaba
São Paulo, SP, Brazil

The series “Clinical Approach and Procedures in Cosmetic Dermatology” intends to be a practical guide in Cosmetic Dermatology. Procedures in cosmetic dermatology are very popular and useful in medicine, indicated to complement topical and oral treatments not only for photodamaged skin but also for other dermatosis such as acne, rosacea, scars, etc. Also, full-face treatments using peelings, lasers, fillers and toxins are increasingly being used, successfully substituting or postponing the need for plastic surgeries. Altogether, these techniques not only provide immediate results but also help patients to sustain long-term benefits, both preventing/treating dermatological diseases and maintaining a healthy and youthful skin. Throughout this series, different treatments in Cosmetic Dermatology will be discussed in detail covering the use of many pharmacological groups of cosmeceuticals, the new advances in nutraceuticals and emerging technologies and procedures.

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With 165 Figures and 23 Tables

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Foreword

When I received the invitation from Maria Claudia Issa, M.D., Ph.D., and Bhertha Tamura, M.D., Ph.D., to write one of the chapters of this marvelous book, I was very happy. Later, upon receiving the mission to write the prologue of this book, whose editors, with numerous publications in the international scientific field of cosmetic dermatology, dignify the Brazilian dermatology, left me extremely honored. In this book, some of the leading medical doctors and research scientists from Brazil and from all over the world present their professional experience in the cosmetic dermatology area.

Cosmetic dermatology is constantly evolving. Procedures for rejuvenating the skin are actively sought by people, nowadays. As dermatology grows as a specialty, an increasing proportion of dermatologists will become proficient in the delivery of different procedures. Even those who do not perform cosmetic procedures must be well versed in the details to be able to guide their patients.

Numerous major advances in the field of the cosmetic dermatology area, including botulinum exotoxin, soft tissue augmentation, chemical peels, cutaneous lasers, light source–based procedures, and the state of the art of dermatologic and cosmetic prescriptions, have been developed and enhanced by dermatologists and plastic surgeons.

Cryotherapy and electrosurgery are routinely used to remove unaesthetic lesions, contributing with skin rejuvenation. Peelings are still a very important tool in the armamentarium of the dermatology. Very interesting results in the treatment of photoaging can be obtained with relatively low cost. However, accuracy in its management as well as the knowledge of possible complications and their management are of extreme importance. In this volume, the different types of peelings are thoroughly scattered as well as innovations in this well-established area.

The series Clinical Approach and Procedures in Cosmetic Dermatology offers a wonderful and embracing text. It was a pleasure to contribute in this unique book with so many well-renowned authors.

This work project is a text certainly of inestimable value for those who wish to deepen their knowledge in the field of cosmetic dermatology.

Hoping that you will enjoy learning a lot from this book!

Mônica Manela Azulay

Preface

Nowadays, life expectation had increased and for a better quality of life, people are looking for beauty, aesthetics, and health. Dermatologists and plastic surgeons who work with cosmetic dermatology can help patients to maintain a healthy and youthful skin. Topical and oral treatments associated with full-face procedures using peelings, lasers, fillers, and toxins are increasingly being used, successfully substituting or postponing the need for plastic surgeries.

This series of book is very special among other ones already published as it encompasses all subjects related to this area of dermatology. All authors are experts in the field of cosmetic dermatology. Literature review and its correlation with authors' experience is a differential feature of this work.

This work had been divided into four volumes due to the breadth of the subjects, which cover skin anatomy and histopathology, physiology, patient's approaches, common cosmetic dermatosis, topical and oral treatments, and cosmetic procedures.

In *Chemical and Physical Procedures*, Prof. Maria Issa, Prof. Bhertha Tamura, and collaborators provide the applicability and benefits of physical and chemical procedures in cosmetic dermatology. Here, the use of superficial, medium, and deep peelings; cryotherapy; and electrosurgery are discussed in detail. These procedures are commonly used to treat unaesthetic lesions, which cannot be treated with topical or oral approaches, offering a rejuvenated appearance. Indications, contraindications, complications, and its management are also reported.

The *Clinical Approach and Procedures in Cosmetic Dermatology* was prepared to be a guide in cosmetic dermatology. It can be considered a complete encyclopedia in the field of cosmetic dermatology and, for this reason, it is extremely useful for those who already work with cosmetic dermatology as well as for beginners in this field. This is a new reference work project, and we are delighted to have you on board.

Maria Claudia Almeida Issa
Bhertha Tamura

Acknowledgments

When we were invited to write a book about cosmetic dermatology, we could not imagine the dimension of this work project.

After drawing the program content, we realized that a comprehensive handbook series in this field would be built. Nevertheless, it would not be possible without the efforts and experience of our invited partners. They deserve our acknowledgment and our deep appreciation.

To all collaborators, our very special thanks.

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About the Editors

Maria Claudia Almeida Issa is among the leading dermatologists in Brazil and Latin America, especially in what regards to cosmetic dermatology. Dr. Issa holds a Ph.D. in Dermatology from the Federal University of Rio de Janeiro (2008) and an M.Sc. in Dermatology from the Fluminense Federal University (1997). Dr. Issa is currently an Associate Professor within the Department of Clinical Medicine – Dermatology, at the Fluminense Federal University, Brazil. Her research focuses on photodynamic therapy, non-melanoma skin cancer, lasers, photoaging, and dermal remodeling. Finally, Dr. Issa has an extensive clinical experience in cosmetic dermatology, being registered as a dermatologist at the Brazilian Society of Dermatology since 1995 and member of the American Academy of Dermatology.

Bhertha Tamura has M.Sc. and Ph.D. degrees in Dermatology from the Hospital das Clínicas de São Paulo – Universidade de São Paulo. Specialist in general surgery and dermatology. Counselor for the Brazilian Society of Dermatologic Surgery and for the Brazilian Society of Dermatology. Member of the Scientific Commission of the Brazilian Society of Dermatology. Chief of the Department of Dermatology at the Complexo Hospital Heliopolis (São Paulo, Brazil). Member of several international dermatological societies.

Contributors

André Ricardo Adriano Instituto de Dermatologia Professor Rubem David Azulay/Santa Casa da Misericordia do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Chinobu Chisaki Department of Dermatology, Hospital do Servidor Público Municipal de São Paulo, São Paulo, SP, Brazil

Katleen Conceição Instituto de Dermatologia Professor Rubem David Azulay/Santa Casa da Misericordia do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Izelda Maria Carvalho Costa Department of Dermatology, University of Brasilia, Brasília, DF, Brazil

Patrick Silva Damasceno Department of Dermatology, University of Brasilia, Brasília, DF, Brazil

Lilian Mathias Delorenze Department of Medicine (Dermatology), Hospital Universitário Antonio Pedro, Niterói, RJ, Brazil

Luiza Soares Guedes Brazilian Society of Dermatology, Rio de Janeiro, RJ, Brazil

Heloisa Hofmeister Pontificia Universidade Católica do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Gabriela Horn Department of Dermatology, Hospital do Servidor Público Municipal de São Paulo, São Paulo, SP, Brazil

Maria Claudia Almeida Issa Department of Clinical Medicine – Dermatology, Fluminense Federal University, Niterói, RJ, Brazil

Marcio Martins Lobo Jardim Department of Dermatology, Iamps/SP, São Paulo, SP, Brazil

Bogdana Victoria Kadunc Pontifícia Universidade Católica de Campinas, São Paulo, SP, Brazil

Maria Paulina Villarejo Kede Brazilian Society of Dermatology, Rio de Janeiro, RJ, Brazil

Emerson Lima Santa Casa de Misericórdia do Recife, Recife, Brazil

Mariana Lima Santa Casa de Misericórdia do Recife, Recife, Brazil

Tiago Silveira Lima Hospital Universitário Clementino Fraga Filho, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Sarita Martins Santa Casa de Misericórdia do Recife, Recife, Brazil

Joaquim Mesquita Filho Instituto de Dermatologia Professor Rubem David Azulay da Santa Casa, Rio de Janeiro, RJ, Brazil

Marcelo Cabral Molinaro Policlínica Geral do Rio de Janeiro – (PGRJ), Rio de Janeiro, RJ, Brazil

Leandro Fonseca Noriega Department of Dermatology, Hospital do Servidor Público Municipal de São Paulo, São Paulo, SP, Brazil

Francine Papaiordanou Instituto de Dermatologia Professor Rubem David Azulay da Santa Casa, Rio de Janeiro, RJ, Brazil

Mirella G. Pascini Private Practice, São Paulo, SP, Brazil

Keila Gabrielle Pati Gomes Department of Dermatology, University of Brasilia, Brasília, DF, Brazil

Jane Marcy Neffá Pinto Department of Medicine (Dermatology), Hospital Universitário Antonio Pedro, Niterói, RJ, Brazil

Fátima Pires de Freitas Instituto de Dermatologia Prof. Rubem David Azulay - Santa Casa de Misericórdia do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

João Carlos Lopes Simão Division of Dermatology, Department of Internal Medicine, Ribeirão Preto Medical School, University of São Paulo, São Paulo, SP, Brazil

Denise Steiner University of Mogi das Cruzes, São Paulo, SP, Brazil

Clínica Denise Steiner, São Paulo, SP, Brazil

Paulo S. Torreão Hospital Federal dos Servidores do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

Wellington Vasques Department of Medicine (Dermatology), Hospital Universitário Antonio Pedro, Niterói, RJ, Brazil

Carlos Gustavo Wambier Department of Medicine, State University of Ponta Grossa, Ponta Grossa, PR, Brazil

Part I

Superficial, Medium, and Deep Peels

Retinoic Acid Peel

Heloisa Hofmeister

Abstract

Chemical Peels may be defined as "controlled wounds" of the skin made by the dermatologist to multiple purposes. They are classified as superficial, medium, and deep according to the depth of penetration of the chemical solution. The deepest the peelings, the best results and the greatest range of complications. Superficial chemical peels are useful procedures to enhance the appearance of the skin with fast results and little or no downtime. They are appropriate to all skin phototypes. Retinoic acid is a well-established agent in the treatment of acne from the 1960s and photoaged skin, and it has been used for this purpose since the 1980s. Photoaged skin is characterized by wrinkles, hyperpigmentation, enlarged pores, laxity, and loss of brightness, among other alterations. For the last decades, retinoic acid has been used in higher concentrations for superficial peelings as an effective and safe tool for the dermatologist. This chapter will drive you through the stages and techniques of this peeling step by step based on my 30 years of personal experience and medical literature.

Keywords

Superficial peeling • Tretinoin • Retinoic acid • Collagen enhancing • Rejuvenation

Contents

Introduction

The development for the treatment of photodamaged skin has been enormous in the last decades. New concepts and better understanding of the aging process caused huge changes in the way dermatologists can treat their patients. Better equipments of lasers and lights, radiofrequency, ultrasound, 3D rejuvenation and volumization, botulinum toxin and their new targets, lifting sutures, and collagen enhancers among others are new tools always being renewed and reinvented. But one

H. Hofmeister (✉)
Pontificia Universidade Católica do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
e-mail: hah@uol.com.br

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procedure remains unchanged, always the same since ancient times. Peelings actually have been increasing in number as a procedure in the last years. According to the Plastic Surgery Statistic Report (2014) of the American Society of Plastic Surgery, 1.2 million chemical peelings were performed in 2014 in the USA with an increase of 7% from 2013 to 2014. It is becoming more and more popular. It can renovate layers of cells and cause neocollagenesis. Superficial peels can bring back bright and clear skin in just few days. They are relatively simple procedures and inexpensive for dermatologists. Best results are achieved with a series of applications at short intervals.

History of Retinoic Acid Peels

Retinoic acid or tretinoin has been used for the treatment of acne for many years because of its comedolitic effect. It was been used for the treatment of actinic comedones (Kligman et al. 1971), for naevus comedonicus (Decherol et al. 1972), and for acne aestivalis (Mills and Kligman 1975). In 1983, Cordero published the first South American paper after observing unexpected improvement of periorbital wrinkles in patients that were been treating actinic comedones (Cordero 1983). The dosages he used at that time were 0.005–0.01%, with good and reproducible results and without the so-called "retinoic effect" that became so popular years after. In 1986, Kligman published the histopathological evidences of its rejuvenating effects in an article and in a special supplement of our Blue Journal, the *Journal of the American Academy of Dermatology* (Kligman et al. 1986). It became the best and the most popular agent for rejuvenation of the skin and for the treatment of solar damage, and it is still the best agent for those treatments. In the 1990s, it began to be used as a peeling agent when associated with 35% trichloroacetic acid medium peel resulting in a more uniform frosting of the skin and shortening the post-peeling recovery time (Brody et al. 2000). At that time emerges the retinoic acid peels for various indications.

Mechanism of Action

> "The mechanical action of the peeling, even when limited to the epidermis, is able to stimulate regeneration via pathways in the dermis that are not totally understood" (Fischer et al. 2010)

We do know that the mechanism of action is characterized by thinning and compression of the stratum corneum, reversal of epidermal cells atypias, dispersion of melanin in the epidermis, stimulation of dermal deposition of collagen, increased deposition of glycosaminoglycans, and neovascularization (Yokomizo et al. 2013).

Retinoic acid has the property of making neocollagenesis and cellular renovation accelerating the cellular turnover of keratinocytes. It is comedolitic and a depigmenting agent, as it inhibits tyrosinosis and TIRP-1. There are also other mechanisms associated with the activation of nuclear retinoic acid receptors (RARα, RARβ, and RARγ) (Baldwin et al. 2010).

Indications

The retinoic peelings can improve photodamaged skin, skin texture, actinic keratosis, actinic melanosis, freckles, Civatte's poikiloderma, striae, acne, follicularis keratosis, and melasma, among others.

Contra-Indications

Retinoic acid peelings should be avoided at pregnancy, lactancy, if the patient does have previous hypersensitivity episodes, telangiectasia, and rosacea.

Classification of the Superficial Peels

Superficial peels will exfoliate epidermal layers without going beyond the basal layer (Fischer et al. 2010).

They can be classified as very superficial, removing the stratum corneum (depth = 0.06 mm), and superficial, causing epidermal

exfoliation of the granular layer until the basal layer (depth = 0.45 mm) (Yokomizo et al. 2013). The depth of the superficial peel, as of any peelings, will depend on the type of skin, pretreatment preparation of the skin, concentration of the retinoic acid, vehicle, and the technique of the application of the retinoic acid on the skin. The depth of the peeling will determine the post-peel healing with no downtime, little erythema, and mild desquamation, or, if exfoliating until the basal layer, a little downtime with darkening of the treated area and more desquamation. The post-peel reaction and recovery time must be discussed previously with the patient and an informed consent must be signed.

Preparation of the Patient, Use, and Dose

The ideal patient has had a previous home routine treatment given by the dermatologist. The purpose of the pretreatment phase is to prepare the skin for the peeling process and for the following regeneration phase. To achieve this, tretinoin is usually applied for 1 month before hand because its action on the skin facilitates a more homogeneous penetration of the peel, leading to a more consistent result. Moreover, preparation with tretinoin also facilitates to accelerate the post-procedure healing process. To prevent postinflammatory hyperpigmentation, the epidermal melanogenesis needs to be inhibited by the daily use of sunscreens (Fischer et al. 2010).

Darker skin individuals, Fitzpatrick's phototype 3 to more, are prone to develop a post-peeling hyperpigmentation. They must be treated with hydroquinone or other approved substance at least for 3 weeks before the procedure. It may be used at daylight, even at the beach or at the pool with proper skin sun protection. It rarely causes contact allergy, but it will frequently cause primary irritant dermatitis if the patient uses it in a thick layer. So, it must be used in a minimal amount, "almost nothing" as I tell my patients. In melasma, it may be used as much as three times a day. The results are outstanding, and we think it is a golden standard for melasma! The treatment with hydroquinone prepares the skin to the peeling, making it safer. However, be sure you trust the pharmacist who will manipulate your formula. A wrong manipulated hydroquinone formula as monobenzylether may cause disasters such as permanent hypopigmentation, even far from the treated area. Be sure to refer your patient to the pharmacist you trust!

The patient must understand what is going to happen during and after the procedure and the importance of daily sun protection.

Even in superficial peels, herpes infection must be prevented. Perform a careful anamnesis and, if the patient has a herpes history, the prophylactic antiviral therapy with valacyclovir 500 mg 12/12 h for 5 days is given right before the peeling.

By the time of the procedure, the room must be silent and calm, relaxing music is welcome and the environment must be friendly. The room temperature should be as nice as possible. The patient must use a disposable cap and gown and must be wearing comfortable clothes. The dermatologist must wear gloves. It should be a pleasant time for the patient.

The concentrations of retinoic acid as a peeling agent vary from 3% to 12%. The most common and probably safer concentration is 5%. Published in 2011, a study found no difference in treatment results for melasma between 5% and 10% concentrations (Magalhães et al. 2011). The solution can be prepared in tinted gel, lotion, or cream of propilenoglycol. The most common vehicle is propylenoglycol, and the color of the solution is yellowish. The retinoic acid peeling solution may be formulated by the pharmacist with a skin-colored tone to make up the strong yellow natural color of the retinoic acid. It may be applied with a silk disposable brush, gently and evenly in the entire area to be treated. The application of the solution is completely painless, although in some sensible skin patients it may prickle a little. The patient must keep the solution on the skin for at least 6 h and then wash it out. At the next day there might be a mild to a strong erythema, depending upon the depth of action of the superficial peel.

The depth of the peeling depends on the thickness of the epidermis, the density of the follicles, the degree of photodamage, the gender (male skin is oilier, hampering penetration), skin phototype, the integrity of the epidermal barrier, and the skin's previous preparation (Yokomizo et al. 2013).

Degreasing the skin is the key to control the depthness and uniformity of any peeling, and it is not different for retinoic acid peel. The skin can be degreased by vigorous rubbing using gauze embedded with Hoffman solution and it will cause erythema immediately after the peel. If the skin is thicker, it can be a good method to apply the peel. It will cause much more scaling after the procedure, and just before peeling begins, the skin will be darker. The patient must be aware of these posttreatment details as though as that this procedure can worsen telangiectasia and rosacea. The skin can also be degreased with gauze and alcohol with no rubbing, and then the retinoic acid is applied in the same way described above.

If treating striae distensae, rubbing is very important to provoke a deeper action of the retinoic acid. For this indication and even for photodamaged skin, the peel may be preceded by microdermabrasion or even fractional lasers to enhance the results. For striae, the area treated with the solution can be also occluded with a PVC film to improve the effect of the peeling.

Postpeeling

At home, at least 6 h with the retinoic acid, the patient is instructed to wash out the retinoic acid solution peel with water and a soft soap. During the week after the procedure, sunscreen and/or sunscreen and/or sun blocks are mandatory. After a superficial peeling, hydration may be very important for a better outcome.

Side Effects and Their Managements

Retinoic acid peel can cause strong erythema specially in very thin and degreased skin. In this case, the prescription of a mild topical corticosteroid like desonide cream for a couple of days will minimize the problem. Prolonged erythema is rare and if happens, a halogenated corticosteroid must be used under strict dermatological supervision as inflammation may lead to postinflammatory hyperchromia.

If postinflammatory hyperchromia occurs, it will be easily controlled with formulas containing hydroquinone and sunscreens.

Take Home Messages

1. Retinoic acid peels are precious for the dermatologist routine.
2. If you do not have experience with this procedure, start with caution.
3. Always take before and after pictures and ask your patient to return to daily visits to check them until you feel comfortable with the procedure.
4. It is a relatively easy and safe treatment and the patient, if well oriented by the doctor with a good medical-patient relationship, will be pleased and grateful.

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Glycolic Acid Peel

Denise Steiner and Mirella G. Pascini

Abstract

Peelings are among the oldest and widespread procedures used in aesthetic dermatology worldwide. Chemical peels are classified as superficial, medium, and deep according to the depth of penetration of the peeling solution. The glycolic acid (GA) peel is the most used alpha hydroxy acid peel, producing a very superficial, superficial, or even a medium-depth peel, all of them usually well tolerated by patients and without systemic toxicity. GA peels have been used as an adjunctive therapy in a variety of skin disorders because of its anti-inflammatory, keratolytic, and antioxidant effects. The depth of glycolic acid peel depends on the concentration of the acid used, time of exposure, and skin condition. Acne (inflammatory and non-inflammatory), acne scars, melasma, photoaging, and post-inflammatory hyperpigmentation can be treated with GA peel, but the most common indication has been skin rejuvenation. As other AHA peels, it needs to be neutralized to end its action, and it should be repeated several times to achieve the desirable cosmetic result. They have practically no downtime, and results vary significantly from patient to patient, but with proper patient selection and correct technique, GA has great skin improvement potential. In addition, the GA peel can be used or combined with other techniques, such as botulinum toxin injections and dermal fillers to promote the rejuvenation of the aging face.

Keywords

Glicolic acid peel • Alpha hydroxy acid peel • Chemical peeling • Superficial depth peel • Medium depth peel • Acne • Fine wrinkles • Epidermal melasma

Contents

D. Steiner (✉)
University of Mogi das Cruzes, São Paulo, SP, Brazil

Clínica Denise Steiner, São Paulo, SP, Brazil
e-mail: steiner@uol.com.br

M.G. Pascini
Private Practice, São Paulo, SP, Brazil
e-mail: mgpascini@hotmail.com

M.C.A. Issa, B. Tamura (eds.), *Chemical and Physical Procedures*, Clinical Approaches and Procedures in Cosmetic Dermatology 2, https://doi.org/10.1007/978-3-319-16805-0_2

Introduction

Chemical peeling (chemexfoliation) is the application of a chemical agent to the skin, which causes controlled destruction of a part of or the entire epidermis, with or without the dermis, leading to exfoliation and removal of superficial lesions, followed by regeneration of new epidermal and dermal tissues (Khunger 2008). Chemical peels are classified as very superficial, superficial, medium, and deep according to the depth of penetration of the peeling solution.

In a very superficial light peel, there is necrosis up to the level of stratum corneum. A superficial light peel will reach the entire epidermis up to the basal layer. A medium peel is characterized by necrosis up to the upper reticular dermis. According to Rubin, who developed a classification of photodamaged skin based on the histologic depth of the damage, the peel must be as deep as the deepest skin problem to achieve the best results, which means that the proper selection of the patient and sort of lesion to be treat is a key determinant for achieving the desired result (Ditre 2006; Fabbrocini et al. 2009). Chemical peels can be used to treat acne, acne scars, dyschromias, and photoaging which includes wrinkles, actinic keratoses, and senile lentigines.

Chemical peels have stood the test of time, and today, a great number of peel preparations are available. Various chemicals have been used as peeling agents, of which the most used are the alpha hydroxy acids, such as glycolic acid, or beta hydroxy acids, such as salicylic acid (Fabbrocini et al. 2009). In this chapter we will specifically approach the use of the glycolic acid as peeling agent, which has a keratolytic, germinative layer, and a fibroblast stimulating action (Fabbrocini et al. 2012). Before dealing with GA specifically, a brief introduction to alpha hydroxy acids (AHAs) is warranted.

The alpha hydroxy acids were developed by Van Scott and Yu as more superficial peels for hyperkeratosis in the early 1980s. Subsequently, peeling with glycolic acid was developed (Fischer et al.2010). AHAs represent a group of organic acids, which share the same hydroxyl in the alpha position. They are naturally found in foods such as fruits, sugarcane, and yoghurt. Among the alpha hydroxy acids are glycolic acid (derived from sugarcane), lactic acid (derived from sour milk), citric acid (derived from lemon and orange), malic acid (derived from apples), and tartaric acid (derived from grapes).

The natural source of glycolic acid is sugarcane, but the glycolic acid used in practice is created in laboratories from chemical reagents. The simplest and most used among the AHAs is glycolic acid (GA), with a two-carbon structure with a highly hydrophilic feature, allowing for better cutaneous penetration.

GA peels are usually performed in a 30%–70% concentration, inducing epidermolysis and desquamation. AHAs are weak acids that cause rejuvenation by their metabolic and caustic effect and need to be neutralized with basic solutions like sodium bicarbonate, sodium hydroxide, or water in order to end its action (Murad et al. 1995).

In this section we will consider the strengths and doses for GA peel, followed by the appropriate mechanisms of action. This leads into a discussion of what GA is used for, proper patient selection, and mechanism of action. We will then discuss prepeel assessment, how to safely perform the procedure, and how to deal with post-peel care. Potential complications for the procedure and combination therapies are also discussed.

Glycolic Acid Peel

Peel Strengths and Doses

GA is a versatile peeling agent and can be administered in various peel strengths, with resulting implications for dosage and the extent of skin exposure. Glycolic acid concentration ranges from 20% to 70%, and the pH varies between 1 and 3. They are commercially available as free

acids, partially neutralized (higher pH), buffered, or sterified solutions. When buffered preparations are used, the necessary exposure time should be longer. The absorption of glycolic acid in human skin is pH-, strength-, and time dependent (Fabbrocini et al. 2012). The formulation varies from solution and gel, which is preferred since it has a slower penetration and is easier to control. Free acid solutions have lower pH values than the partially neutralized, allowing a more deep chemoexfoliation. Also, the risk of uneven penetration is higher with very low pH solutions, leading to deeper peeling areas.

Dermis penetration risk and pH values are inversely correlated; the lower the pH value, the higher the penetration risk and the more intense the peeling will be, which can cause scarring. Otherwise, the higher the pH value, the more neutralization takes place, and there is less free acid available (less bioavailability) and lower penetration. Formulations with lower pH value cause more burning, stinging, and erythema and are less tolerable than solutions with a higher pH (Kede and Guedes. 2012).

It is important to have in mind that the depth of the peel should be adjusted to the depth of the pathological process to be treated; thereby superficial peels can improve acne, fine wrinkles, and epidermal melasma, but will not improve deep wrinkles, dermal melasma, or postinflammatory pigmentation, for example. It is also recommended to start with low concentration of the acid (20–30%) and to increase its concentration and contact time in the next sessions (Landau 2007). Neutralization is a crucial part of the procedure and should be done promptly with sodium bicarbonate or plain water as soon as the end point is achieved. If the GA peel is left on the skin unneutralized for too long, it can cause dermal wounds (Monheit and Chastain 2012).

Indications

GA can be used to treat postinflammatory pigmentation, solar lentigines, epidermal melasma (Fig. 1), seborrhea, and fine wrinkling (Fig. 2) (Monheit and Kayal 2003). Acne (Fig. 3) of varying severity has also been one of the well-evaluated indications for GA peels. In these patients glycolic acid is more widely used than Jessner's solution, considering the equal treatment effect but a reduced exfoliation in glycolic acid (Fabbrocini et al. 2012; Kim et al. 1999). The number and frequency of the applications depended on the degree of the clinical response, and it is usually well tolerated by the patients. Considering the use of GA peels to treat melasma, it can result in a more uniform distribution of melanin and the elimination of melanin accumulations, being useful in the treatment of epidermal

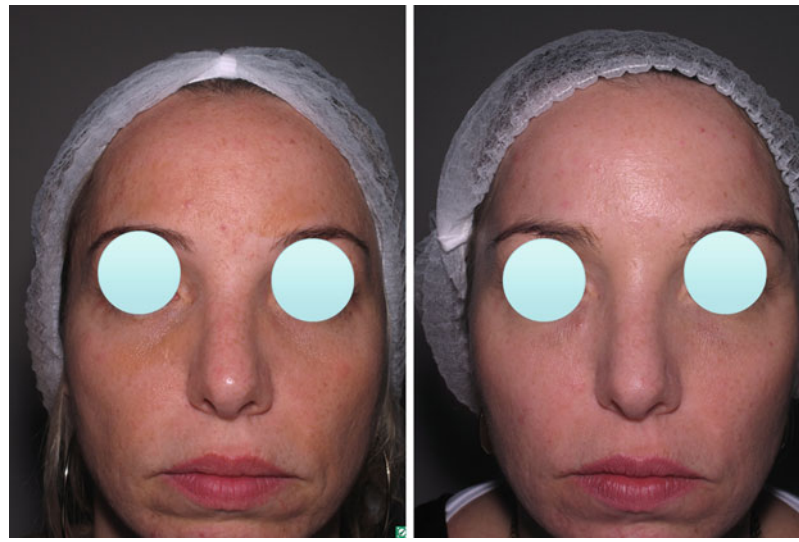

Fig. 1 Before and after glycolic acid peel (six sessions, 4 weeks of interval) for melasma with a sucessful result

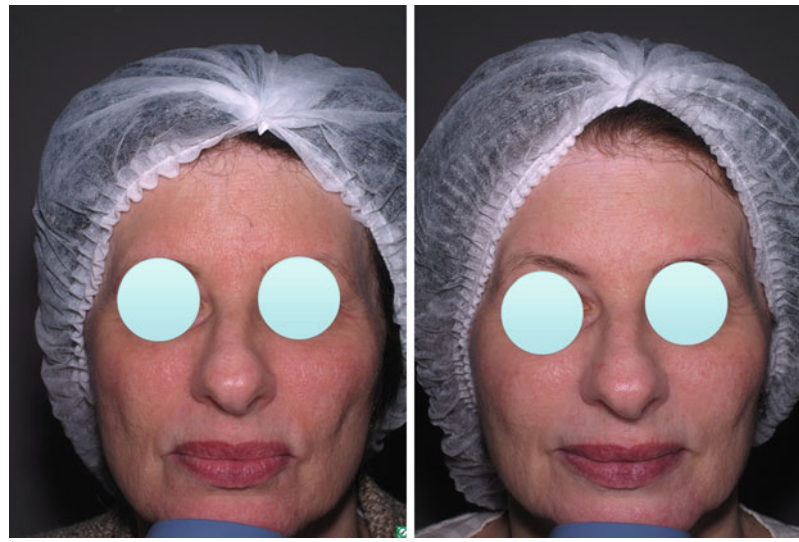

Fig. 2 Before and after glycolic acid peel (six sessions, 4 weeks of interval) for photorejuvenation with a good result (improvement in texture, fine wrinkles, and melanoses)

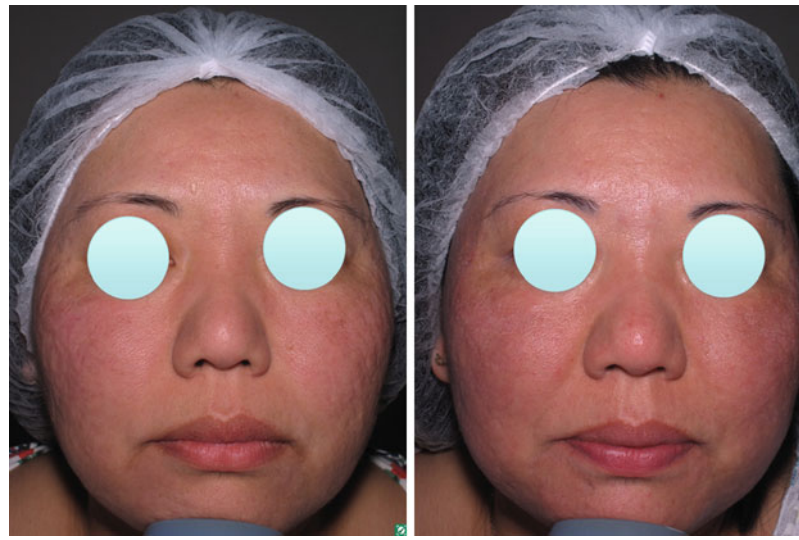

Fig. 3 Before and after glycolic acid peel (six sessions, 4 weeks of interval) for acne scars

melasma. However, the studies comparing the efficacy of chemical peels have mixed results when it comes to melasma, and the use of non-inflammatory peeling agents such as salicylic acid is preferred for such a disorder as there is less propensity to cause postinflammatory hyperpigmentation (Monheit and Chastain 2012).

Glycolic acid can also be used in combination with 5-fluorouracil for the treatment of pre-skin cancer conditions, such as actinic keratosis and actinic cheilitis, as a so-called fluorouracil-hydroxy pulse peel (Jackson 2014).

All skin type patients are eligible for a superficial GA peel; however, a medium-depth GA peel should be avoided in Fitzpatrick skin types IV and V patients because they have a greater risk of developing hyperpigmentation or hypopigmentation.

Contraindications

Glycolic acid peels are contraindicated in certain conditions such as pregnancy, nursing patients, active herpes simplex, contact dermatitis, and

patients with glycolate hypersensitivity. Furthermore, they may enhance skin sensitivity to ultraviolet light (Fabbrocini et al. 2012; Fischer et al. 2010).

Mechanism of Action

Glycolic acid aims the corneosome, increasing damage and decreasing cohesiveness, leading to desquamation (Fartasch et al. 1997). AHA superficial peels also increase epidermal activity of enzymes, causing epidermolysis and exfoliation (Fischer et al. 2010). The epidermis becomes thinner, and the multiplication of the epidermal cells results in regeneration and remodeling, with improvement of texture and surface abnormality. Stimulation of the epidermis also leads to the production of cytokines, which activates the fibroblasts to produce collagen type I and type IV and elastin fibers, improving the appearance of photoaged skin. Deeper peels result in a greater deposition of collagen and glycosaminoglycans (Murad et al. 1995).

Concerning acne, it is effective in treating non-inflammatory lesions and inflammatory eruptions because of its antibactericidal effects on *Propionibacterium acnes* and antioxidant action. It may also improve penetration of topical acne therapies, and thus it may be used as an adjuvant treatment for acne. However, it has very few effects on atrophic or hypertrophic scars (Atzori et al. 1999). By causing epidermolysis, dispersing basal layer melanin and epidermal dermal hyaluronic acid, they can also correct altered keratinization seen in these cases, in addition to improving collagen gene expression through an elevated secretion of IL-6 (Bernstein et al. 2001).

The provider and the patient should keep in mind that multiple peels are usually necessary to obtain optimal results, in average once every 15 days for 4–6 months, until the expected outcome is observed.

Prepeel Assessment

The patient should be interrogated about the degree of sun exposure, history of herpes simplex, recent isotretinoin treatment in the last 6 months (for medium-depth GA peel), and tendency for postinflammatory hyperpigmentation. Patients with darker skin type have a tendency to develop postinflammatory hyperpigmentation. Also, a complete medical history and current medications should be informed by the patient.

Informed consent and also photographic record and standard good-quality photographs are highly recommended for all types of peelings.

Written information about the type of the peeling they will be subjected to, what they should expect, and post-care peel is a necessity.

The physician should also explain to the patient the need for multiple procedures to achieve the expected outcome and evaluate the patient's expectations and motivation. The patient should be advised about the recovery time, importance of maintenance regimens after the peel, and possible side effects and complications (Khunger 2008).

Required Materials

- Gloves
- Disposable hair cap
- Alcohol to clean the skin
- Acetone to degrease the skin
- Cotton-tipped applicators or gauze pads
- A timer
- Neutralizing solution

Performing the Peel

Performing the peel requires consideration of the following steps: skin preparation, cleansing, application, and neutralization.

Skin Preparation

It is imperative that the patient maintain a rigorous skin care regimen during the immediate preoperative and postoperative periods in order to obtain the most favorable results. The physician should be prepared to provide guidance, sources, and examples that help formulate this regimen.

The patients should have their skin treated with products like retinoic acids, AHAs, and sometimes bleachers for 2–4 weeks prior to the peel and discontinue 3–5 days before the procedure. Thus, patients may be primed at home by using mild topical peeling agents such as tretinoin 0.025%, adapalene 0.1%, glycolic acid 6–12%, kojic acid, or azelaic acid (Khunger 2008).

The use of tretinoin prior to chemical peeling amplifies the procedure's effects. By decreasing the stratum corneum's thickness, it increases the peel's depth. Tretinoin is also known to reduce healing time after resurfacing.

Hydroquinone (2–4%) is useful in patients with skin type III or higher, as it blocks the tyrosine enzyme and decreases epidermal melanin production during preoperative and healing periods, even without history of pigmentary abnormalities (Monheit and Chastain 2012).

The choice of the primer agent will depend on the need of each patient and risk of complications. The same primer agent may be used for maintenance afterward.

Cleansing Procedures

Cleansing the skin before a chemical peel is extremely important to obtain a homogeneous penetration of the peel and thus a uniform result. First, the patient is asked to wash the face with soap and water. Then, the skin surface must be mildly cleansed to remove any remaining traces of makeups or oils. Isopropylic alcohol is used to clean the skin and acetone for degreasing.

Application

The patient should be seated in a comfortable position, wearing a hair cap, and must keep their eyes closed during the entire procedure. The acid can be applied with gauze pads, fan brush, gloved fingers, or a cotton-tipped applicator, depending on the formulation of the peel. In general, gel formulations have a slower penetration time and are easier to control (Fabbrocini et al. 2009).

It is better to start applying the glycolic acid on the forehead and then to the rest of the face since the forehead is less sensitive and can tolerate a little more exposure to the acid than other parts of the face can. Very sensitive areas, like the corners of the nose and lips, should be protected with Vaseline. Training is necessary for the application of this peel, since the whole skin should be exposed to the acid in the same amount of time, and the risk of excessive penetration is high when the provider is not familiar with the procedure (Ditre et al. 2006). The depth of penetration of the peeling agent can be observed and controlled by the changes in the skin color:

- Diffuse homogeneous erythema indicates epidermal penetration.
- White frost means coagulative necrosis of the papillary dermis.
- Gray-white frost indicates coagulative necrosis of the reticular dermis (Fabbrocini et al. 2009).
- There is no determinable end point for this peeling, which should be decided based on the depth of the skin problem. Usually a uniform erythema is seen by 3–5 min, when it should be neutralized. If frosting is observed in any area before the set time or end point, it should be neutralized at the same time. This is specially important at some areas with a thinner stratum corneum, like the alar groove or nasolabial fold, which absorb the acid faster than others, and may need to be neutralized before the rest of the face (Sharad 2013).

Neutralization

GA peels need to be neutralized to have their action stopped. Neutralizing agents for AHA peels are basic solutions, such as ammonium salts, sodium bicarbonate, sodium hydroxide, or water. The most used is a 10–15% sodium bicarbonate solution, and as it produces carbon dioxide in the process of neutralizing the acid, bubbling is seen on the surface of the skin, which is important as it assures the physician that they have neutralized the acid (Rubin

1992). After that, the patient should wash his or her face with a large amount of cool water.

Failing to neutralize the peel at the proper moment can lead to dermal wound and scarring. Therefore, the neutralization agent should be close by at the moment of the procedure.

The strength of the GA peel will be determined by the concentration of the solution and time of contact; therefore, neutralization is determinative. For example, 30%–50% GA, applied for 1–2 min, is a very superficial peel; a 50%–70% GA peel, applied for 2–5 min, is considered a superficial peel. A medium-depth peel would be 70% GA, applied for 3–15 min (Fabbrocini et al. 2009).

It is essential to recall that more important than painstaking monitoring of the peel clock is to watch the patient closely, observing the reaction of the skin and looking for any area of frosting that should be neutralized before any others. With this peeling in particular, uneven penetration is common, and the provider should pay close attention to this fact when performing it. Also, the increasing discomfort reported by the patient is associated with an area of deeper penetration. The majority of the patients will refer symptoms like stinging, itching, or tingling, and it should stop rapidly after the neutralization.

Post-Peel Care

Preventing or reducing the risk of complications and assuring prompt recuperation of the skin are the purposes of the post-peel care. The patient should be asked to interrupt the use of his or her daily products for a few days, until the skin is completely recovered, and apply only the prescribed agents.

Bland topical steroid cream can be used for 2 or 3 days in the case that significant inflammation occurs, in order to accelerate resolution. Although infection is a rare complication, antibactericidal ointment should be used in case of crusting, to assure no infections develop. For those with normal skin, but experience high skin sensitivity, the use of emollients is enough.

The daily routine of skin care should be suspended during the postoperative period, and the normal maintenance regimen (AHAs, retinoic acid, bleaching creams, moisturizers) should be started as soon the skin looks and feels normal again.

The patient should be aware of the need to avoid sun exposure for at least 6 weeks after the peel and use broad-spectrum sunscreen since the new skin is fragile and more susceptible to injury.

Complications

GA is an established, widely accepted peeling agent, and it was found to be quite safe, but side effects and complications may occur. These complications of chemical peel can be prevented by proper patient selection, patient counseling, and adequate priming and with good intra-peel and post-peel care. Compliance to the post-peel care is essential to ensure success of a series of GA peels and to avoid complications.

Immediate complications are undesirable reactions like erythema, desquamation, and sensation of pulling of facial skin that take place within minutes or hours after the peeling. These reactions are expected and depend on the depth on the peel.

Delayed complications, which develop within a few days to weeks, include scarring, infection, postinflammatory hyperpigmentation, persistent erythema, and herpetic infection.

Herpes labialis: Antiviral therapy is recommended in all patients subjected to a medium GA peel, regardless of whether there is a history of herpes simplex infection. It should be started 2 days before the procedure and continued for 7–10 days, until full reepithelialization. The recommended regimen consists of acyclovir 400 mg, three times a day; valacyclovir 500 mg, twice daily; or famciclovir 250 mg twice daily. Patients who undergo a superficial GA peel do not need prophylaxis against herpes infection, because this injury is not enough to reactivate the virus. However, the prophylaxis should be considered in patients with a history of repeating herpetic infection (Monheit and Chastain 2012).

Persistent erythema: In a few cases, some degree of erythema remains many weeks after the peel and should not concern the provider.

This kind of erythema worsens with increasing blood flow to the area, which can occur in simple daily activities such as exercise. Low-potency corticosteroid creams may be helpful, besides the use of sunscreens (Tung and Rubin 2010).

Postinflammatory hyperpigmentation: This is usually not a problem with very superficial and superficial GA peeling but may become a significant problem to patients with Fitzpatrick skin type III or higher and to all patients subjected to a medium-depth peel. The use of hydroquinone (2–4%) may reduce the risk in patients prone to postinflammatory pigmentation since the hydroquinone blocks the enzyme tyrosinase, and patients may benefit from using it during the pre- and postoperative period (Monheit and Chastain 2012).

Infection: This is a rare complication that can be seen mainly with medium-depth GA peels and combined peels, caused by loss of cutaneous barrier and tissue injury followed by inappropriate wound care. Delayed healing and persistent redness are early warning signs. For viral, bacterial, or fungal infection, culture of the area and empiric antimicrobial therapy should be readily initiated to minimize scarring.

Scarring: Scarring is extremely uncommon, but GA peels can cause dermal wounds in case of poor technique during application or use of excessively concentrated solution. To avoid this complication, the provider should watch constantly the face during the procedure and neutralize the acid rapidly in case of frosting, which indicate dermal injury (although the correlation with the depth of injury is not always complete).

Combined Therapies

The foundation of combined peels is to use two superficial peels to reach the same depth of the skin you could reach with only one agent, increasing safety and reducing the risk of scarring. This helps in enhancing the depth of penetration of both agents while decreasing the toxicity and morbidity associated with deeper peels.

GA and TCA Peel

Dr. Coleman proposed the use of GA and trichloroacetic acid (TCA). Since the glycolic acid causes a debridement at the stratum corneum, it favors a uniform penetration of TCA, producing a medium-depth peel (Coleman and Futrell 1994). Beyond that, the combination of 70% glycolic acid gel, rather than solution, and 35% TCA has been used to treat nonfacial skin, for example, lentigines, actinic keratoses on the neck, and balding scalp, arms, and hands (Tung and Rubin 2010).

Performing the peel: After degreasing the skin, apply a uniform layer of 70% GA and neutralize it in 2 min. Then apply the 35% TCA following the usual procedure. This will result in a more even and deeper peel than the use of TCA alone. GA and TCA peels are performed as a single procedure to remove mild rhytides, actinic keratosis, or pigmented dyschromias. They can be repeated in every 6 months or yearly depending on the actinic damage (Fabbrocini et al. 2012; Kadunc 2012).

Jessner's Solution and GA Peel

The combination of Jessner's solution and GA (Monheit peel) results in a more uniform peel, because the Jessner's solution has a keratolytic effect, allowing an even permeation of the GA (Monheit 1989). However, the use of Jessner's solution followed by a GA peel may increase the risk of overpeel and scarring, since the end point of the GA peel may be difficult to observe, especially in dark-skinned patients. Actinic keratosis, rhytides, and photoaged skin may be treated with this combined peel.

Performing the peel: After cleansing and degreasing the skin, two or three layers of Jessner's solution should be applied to the skin with a gauze pad, until a mild erythema is seen. Then the 70% GA is applied, which penetrates more rapidly, evenly, and deeply than if applied alone.

Advantages and Disadvantages of Glycolic Acid Peel:

Advantages	Disadvantages
Very mild erythema	Burning sensation and erythema during application
Mild desquamation	No uniformity of application
Short postoperative period	Neutralization is mandatory
Useful in photodamage	Necrotic ulcerations if time of application is too long and/or skin pH is reduced

Fabbrocini et al. (2009)

Take Home Messages

- The success of any peel is crucially dependent on the physician's understanding of the chemical and biological processes, safety profile and efficacy, as well as of indications and side effects of the peeling agent.
- The GA peels always need to be neutralized, and the neutralizing agent should be close by.
- GA peels can create dermal wounds and post-inflammatory hyperpigmentation.
- GA peels need to be repeated several times for their best effect.
- There is great variability between patients in terms of results.
- The perfect choice of patient for a GA peel is one with moderate skin damage and dyschromia, who is disposed for a series of treatment, and cannot bear out a downtime.

Cross-References

- ▶ Combining Superficial Chemical Peels
- ▶ Combining Trichloroacetic Acid Peel
- ▶ Jessner's Peel
- ▶ Trichloroacetic Acid Peel

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Denise Steiner Residency in Dermatology at Hospital das clínicas- University of São Paulo, Doctorated in Dermatology at UNICAMP, president of the Brazilian Society of Dermatology 2013–2014

Mirella Pascini Residency in Internal Medicine and Dermatology at Irmandade Santa Casa de Misericórdia de São Paulo, member of the Brazilian Society of Dermatology

Salicylic Acid Peel

Maria Paulina Villarejo Kede and Luiza Soares Guedes

Abstract

Chemical peels, also known as chemical exfoliation, consist of the application of one or more exfoliating skin agents, leading to the destruction of some layers of the epidermis or dermis, followed by regeneration of the skin. Each patient should be evaluated to decide which exfoliating agent will produce the best outcome with the least morbidity, according to the indication of the chemical peeling, the patient's lifestyle, the depth of the lesions to be treated, and their skin type. Salicylic acid (SA) is a β-hydroxy acid that is keratolytic in concentrations of 3–5% and facilitates the topical penetration of other agents. In concentrations under 3%, SA has a keratoplastic effect. It is more frequently used in a 20% or 30% concentration alcohol solution and has a low incidence of complications. The mild exfoliation starts 3–5 days after the peel and lasts for up to 10 days. SA is efficient for the treatment of initial photoaging, melasma, acne with or without inflammation, superficial acne scars, and disorders in darker skin phototypes.

Keywords

Salicylic acid • Chemical peel • Exfoliation • Acne • Melasma • Photoaging

M.P.V. Kede (✉) • L.S. Guedes
Brazilian Society of Dermatology, Rio de Janeiro, RJ, Brazil
e-mail: paulinakede@globo.com; lsguedes@gmail.com

Contents

Introduction

Chemical peels, also known as chemical exfoliation, consist of the application of one or more exfoliating skin agents, leading to the destruction of some layers of the epidermis or dermis, followed by regeneration of the skin (Fischer et al. 2010).

Use of an appropriate chemical peel application technique causes programmed and controlled damage, resulting in rejuvenation of the skin (Butler et al. 2001). The first reported use of chemical peels was 1941, when Eller and Wolf used the technique for the treatment of acne scars. American interest in this particular field increased with the first reports from the European in 1930 and 1940. Ayres (1960) and Baker and Gordon (1961) introduced what is known as the 'modern age of the chemical peels'. In 1986, Brody and Hailey used the

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combination of two superficial chemical peel agents to perform a medium-depth peel. Monheit reported another technique for the combination of different chemical peels in 1989 (Brody 2000).

Salicylic Acid (SA) Peel

Definition

The hydroxy acids (HAs) were initially described by Van Scott and Yu when they discovered that HA with a hydroxyl group at the α or β position applied on the skin would lead to an improvement of hyperkeratosis. They found that keratinization was affected, causing a thinning of the stratum corneum (Van Scott and Yu 1984). The use of HAs in cosmetics happened years later, with the observation that they would also improve the clinical aspect and texture of photodamaged skin (Tung et al. 2000; Van Scott et al. 1996).

The HAs are classified as organic carboxylic acids as they are composed of carbon and hydrogen molecules. In dermatology there are four different groups of HA, classified according to the hydroxyl group position at the molecule: α-HA, β-HA, poly-HA, and bionics.

Salicylic acid (SA) is a β-HA because it has a hydroxyl radical connected to a β position of the carboxylic molecule. The main physical–chemical difference between SA and the α-HAs is that SA is not water soluble, while the α-HAs are (Guedes 2012).

In concentrations under 3%, SA has a keratoplastic effect, regulating the keratinization process, improving the photodamaged epidermis, and increasing the dispersion of melanin granules. In concentrations of 3–5%, SA is keratolytic and facilitates the topical penetration of other agents. It can be used as a peel agent in concentrations from 10 to 30%.

SA has an antiseptic effect and has a high penetration capacity in the lipophilic skin and sebaceous glands, which makes it very useful in acne treatment. In addition, it has a low incidence of complications. The formulation vehicle is very volatile and evaporates fast, which prevents deeper penetration of the acid.

Indications and Contraindications

SA can be indicated in the treatment of initial photoaging, melasma, acne with or without inflammation, superficial acne scars, and disorders in darker skin phototypes.

An SA peel can also be used in combination with other peeling agents such as trichloroacetic acid and retinoic acid. It is important to keep in mind that when we use an SA peel first, penetration of the second agent will be faster and deeper because of the keratolytic effect of the SA peel, increasing the risk of complications.

SA can be used on any body area, making it a useful tool for treating dorsal acne and the 'V' neck area. However, the use of SA on extensive areas should be avoided because of the risk of salicylism, although this is actually very unusual with the liquid formulation. In addition, it should not be used in patients who are allergic to SA.

SA Peel Formulations

In our practice we use an alcohol solution of salicylic acid (SA) as described in literature (Yokomizo et al. 2013). We usually formulate SA at a concentration of 20 or 30% 20% with ethanol. The acrylate copolymer works by forming a film over the skin, allowing the SA to remain on the skin and the ethanol to evaporate. It can also be prepared in a formulation as a cream (Kede 2015): SA (powder) USP (United States Pharmacopeia) 40 or 50%, sodium methyl salicylate 16 drops, and solid petrolatum 112 g.

More recently, a new compound derived from SA with the addition of one lipid chain, the lipo HA, has been used. It is more lipophilic than SA, leading to a more specific mechanism of action and a greater keratolytic effect.

A new vehicle, polyethylene glycol, has also been evaluated. It causes fewer symptoms of burning, stinging, and the erythema provoked by SA. This new vehicle has a high affinity for the acid, remaining bound to it, and slowly releases smaller amounts at the epidermis. This fact might explain why it causes less burning.

Pre-Procedure

Preparation of the skin should start 1 month before the SA peel. It is important to prepare the skin with retinoids or HAs to help penetration of the peel and to promote dispersion of the melanin granules. In addition, the regular use of sunscreen with high UVA and UVB protection and ferric oxide in the formulation should always be recommended.

Herpes virus prophylaxis is indicated if patient has a history of herpes simplex virus infection.

Procedure

- Remove make-up with a non-soap lotion and cotton.
- Clean the skin with gauze and alcohol, to remove oil and improve penetration.
- Apply one or two layers of the SA peel using gauze (Fig. 1). A cotton swab is used to apply SA over only a single lesion (such as an inflamed acne lesion).
- After few seconds the patient will feel a mild burning sensation, which lasts 3–4 min. During this period light and homogenous erythema are observed in Caucasian patients.
- When the SA agent dries, it produces a white color that is not a true frosting but rather a precipitation of SA crystals. It is more intense above inflammatory lesions (Fig. 2a, b).
- SA peel is neutralized like α-HA peels. Despite this, after 5 min, a gauze pad embedded with water can be used to clean the peel area. Cold water can be used to relieve the burning sensation.
- The procedure can be repeated every 2–4 weeks. Three to six sessions are indicated to achieve good clinical results.

Post-Procedure

Post-procedure, mild exfoliation occurs after 3–5 days and lasts for 7–10 days (Fig. 3).

During this period, moisturizing agents can be prescribed for skin dryness, sunscreens must be used, and no other treatment should be applied, such as retinoic acids or glycolic acids, until the skin is completely recovered. It is important to prescribe the correct healing agent, as oily topical medications should be avoided if SA peeling was performed to treat acne-prone skin. In cases of acne, we frequently advise only to apply oil-free sunscreen. Acne medications should be started as soon as the skin recovers.

Complications and Management

Penetration of the SA peel is usually superficial and is safe for most skin types. Nevertheless, care must be taken with higher phototypes or non-prepared skin because of the risk of post-

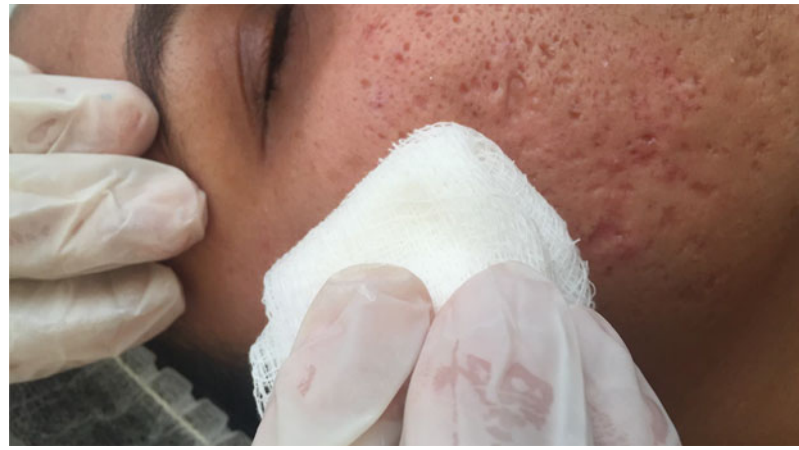

Fig. 1 Application of a salicylic acid peel using gauze

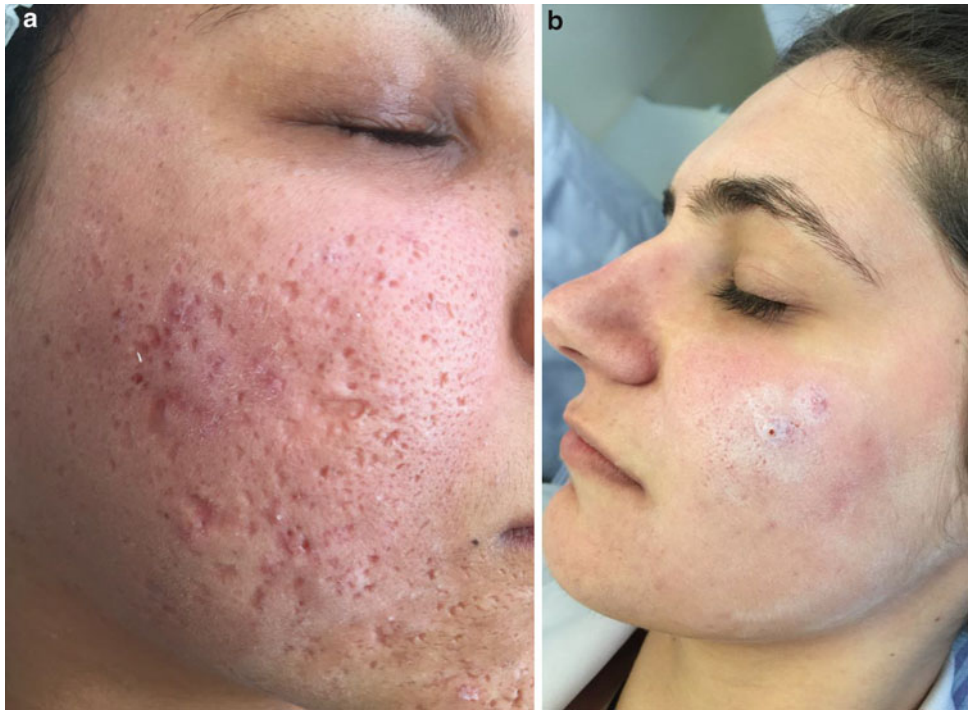

Fig. 2 White color of the skin caused by salicylic acid (SA) precipitation a few minutes after application: (**a**) after one layer of SA peel; (**b**) after three layers of SA peel

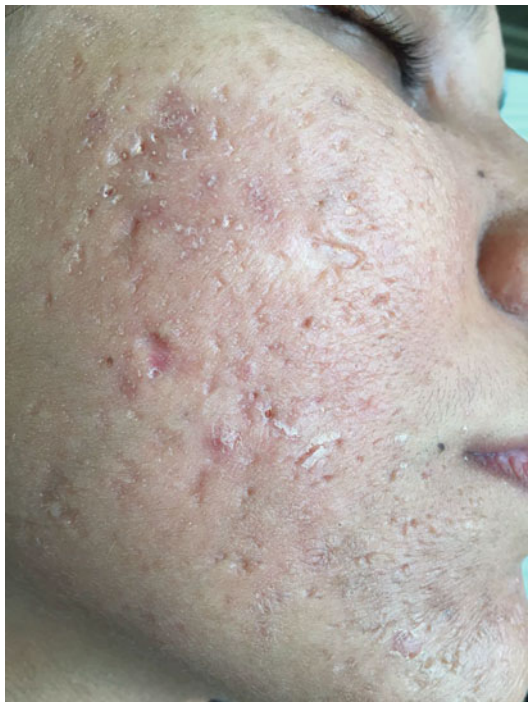

Fig. 3 Mild exfoliation after 4 days

inflammatory hyperpigmentation. For this reason, we always advise patients to avoid sun exposure for at least 1 month before the peel and for an additional month after the procedure.

A short period (3–5 days) of topical steroids might be helpful if a significant inflammatory reaction occurs just after the procedure. This can occur due to irritants or allergic reactions.

If hyperpigmentation occurs, bleaching agents and sunscreens should be prescribed according to the patient's skin type.

Although there is a risk of salicylism, it is actually very unusual with the liquid formulation of SA. Toxicity occurs when serum concentrations rise from 200 to 400 μg/ml (Guedes 2012). Symptoms of salicylism are as follows:

- Mild salicylism: shortness of breath, tinnitus, decreased hearing, dizziness, nausea, vomiting, abdominal pain.
- Severe salicylism: central nervous system disorders, mental disorders (simulating alcohol toxicity).

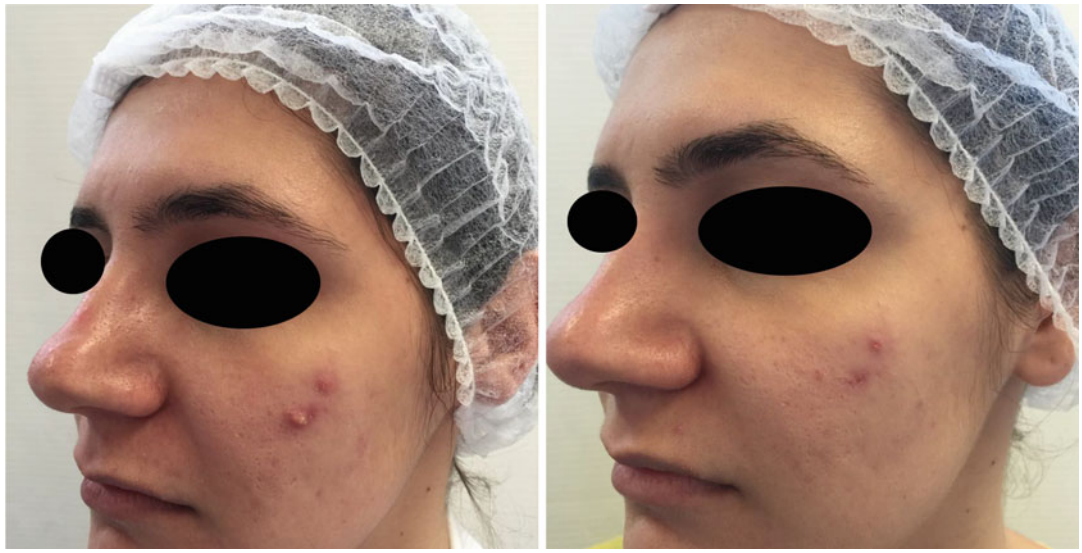

Fig. 4 Before and after one session. Clinical improvement after 10 days

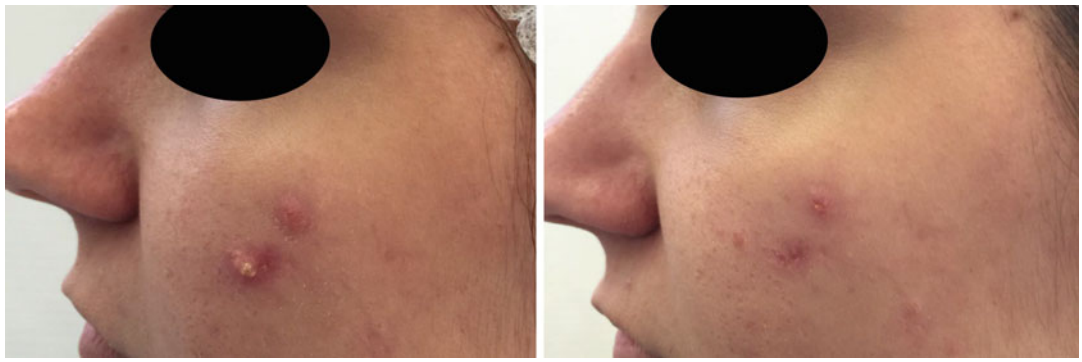

Fig. 5 Closer view of the same patient before and after one1 session. Clinical improvement after 10 days

Conclusion

SA peels are safe and useful for the treatment of acne, melasma, and photoaged skin. They can be used to treat the face and extra-facial region.

SA is commonly very well-tolerated, with only thin desquamation Three to six sessions can be performed every 2–4 weeks. SA can be used in conjunction with other superficial peeling in the same procedure to increase second-agent penetration, improving clinical results.

When treating acne, it is helpful to reduce inflammatory lesions (Figs. 4 and 5) as well as to improve acne post-inflammatory pigmentation and skin texture.

Take Home Messages

- Chemical peels are easy to perform and very useful for the treatment of different dermatologic disorders.
- SA peels are safe and useful in the treatment of acne, melasma, and photoaged skin.
- When treating acne, SA is helpful to reduce inflammatory lesions as well as to improve the

post-inflammatory pigmentation and texture of acne.
- SA can be used to treat the face and extra-facial region.
- SA can be given in association with other superficial peeling to increase the second-agent penetration, improving clinical results.
- SA is commonly very well-tolerated, with thin desquamation.
- The patient should know the limits of this procedure and have real expectations.

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Pyruvic Acid Peel

Carlos Gustavo Wambier

Abstract

Pyruvic acid peels can be classified as an intermediate peel, for possessing qualities of both superficial and medium-strength peelings. The depth of penetration depends on the pyruvic acid concentration, friction, vehicle, passes, and exposure time. Pyruvic acid may be added to croton oil for achieving deep peels; however, this modality remains to be further investigated to reach full clinical application. This chapter describes how to better indicate different modalities of pyruvic acid peels. Specific limitations, contra-indications, preparation and postpeeling regimens are described.

Keywords

Photodamage • Photoaging • Chemical peels • Pyruvic acid • Croton oil • Trichloracetic acid • Acne • Acne scars

Contents

Introduction

With a wide range of resurfacing treatments such as LASERs, radiofrequency, microdermabrasion, and the classical chemical peels such as trichloracetic acid (TCA), salicylic acid, retinoic acid, lactic acid, glycolic acid, carbolic acid, and their combinations and modified formulas, even an experienced dermatologist would hesitate to try a different, less common chemical peel, unless it covered some aspects that all the other chemical peels would not attend so well.

Although pyruvic acid peels have gained significant attention in the last decade, it is still an "exception peel." This small dimension alpha-keto-acid presents low pKa and penetrates rapidly and deeply through the skin and may be considered a potent chemical peel agent. Although, it is usually classified as a superficial or medium depth peel. I prefer the term "intermediate peel," because it can achieve greater results than common superficial peels but is usually extremely lighter than common medium-depth peels. However, in higher concentrations and in alcoholic solutions this peeling may have deep peeling effects (Coleman and Brody 1997). Scaling is usually virtual because this peel causes

C.G. Wambier (✉)
Department of Medicine, State University of Ponta Grossa, Ponta Grossa, PR, Brazil
e-mail: cwambier@uepg.br

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mild dermal edema and hydration along with mild keratolytic, antimicrobial, anti-inflammatory, and sebostatic properties, added to the ability to stimulate new production of collagen and elastin. By possessing undisputed biochemical properties that act directly on energy metabolism in mitochondria of all aerobic organisms, pyruvate is converted to acetyl coenzyme A before being oxidized completely to CO_2. When oxygen levels are not enough, pyruvate is metabolized to lactate. Thus, its fundamental biochemical energy transferring potential may affect intracellular metabolism, and its effects may not depend only on chemical coagulation or damage.

Pyruvic acid is very unstable, so formulas should be kept air-tight in the refrigerator (2–8 °C). It is volatile, with a strong bitter smell of burned wine with seasonings. Its vapors may irritate airways and eyes, so it is mandatory to have a fan during the procedure and the patient should refrain from opening the eyes during the procedure. If there is no refrigerator available in the office, formulas and even the dry salt cannot be safely kept stable. Office delivery of the formulas by pharmacies may represent a concerning issue, so the author would recommend having the formulas you desire to use being carefully supervised by a compounding pharmacist experienced on pyruvic acid solutions.

Indications and Limitations

Major indications for pyruvic acid peels are: acne (grades I-IV) (Cotellessa et al. 2004; Marczyk et al. 2014), oily skin (Marczyk et al. 2014), folliculitis, mild photodamage with superficial wrinkles (Glogau I-II) (Ghersetich et al. 2004), and superficial scarring and mottled pigmentation (Berardesca et al. 2006). As an alternative agent, it may provide benefit for melasma on phototype I-III patients, especially those with associated acne scars or hydroquinone-induced pigmentary changes, such as spotted leucoderma or mild post-inflammatory hyperpigmentation.

This agent has the limitation of superficial dermal penetration, so it presents no effect on deeper dermal disorders, such as deep wrinkles, deep acne scars, and dermal pigmentation. The addition of croton oil for better collagen stimulus is experimental, with need of better formulas and treatment protocols. For thicker epidermal conditions, it is frequently ineffective. Thus, combined treatment with TCA provides better results for treatment of actinic keratoses.

Patient Selection and Skin Preparation

The selection of patients is mandatory when choosing pyruvic acid peels. Warning: this peel may penetrate fast and furiously on a skin with disrupted barrier such as ongoing dermatitis, such as retinoid irritation, seborrheic dermatitis, atopic dermatitis, and perioral dermatitis. If frosting occurs during pyruvic acid peels, the affected area is certainly to develop severe postinflammatory hyperpigmentation (PIH). Over degreasing the skin prior to treatment is not recommended.

Phototype I-III healthy patients are the ideal candidates for such procedure. The penetration is usually uniform even on unprepared skin. In some cases with extreme oiliness and comedos, it is advisable to start agents with mild keratolytic properties, which the patient may continue as a maintenance treatment after the series of peels sessions, such as glycolic acid 10%, pyruvic acid 8%, azelaic acid 15%, or adapalene 0.1% for at least 1 month prior to the first peeling session, to allow time for the patient to adapt to his home regimen, which usually irritates the skin in the first week. It is advisable to stop topical medications 48–72 h before the peeling day to avoid excessive irritation in areas prone to hot spots such as perioral or periocular areas. PIH is a dangerous side effect if the patient presents hot spots. Patients should be aware of this risk and that they may experience temporary pigmentary side-effects for up to 6 months.

Application Method

Degreasing is done to ensure even penetration by removing excess sebum of the skin. Since pyruvic acid has good penetration in oily skin, degreasing is done in a soft manner, with 70% ethanol, in a soft cotton pad (Fig. 1).

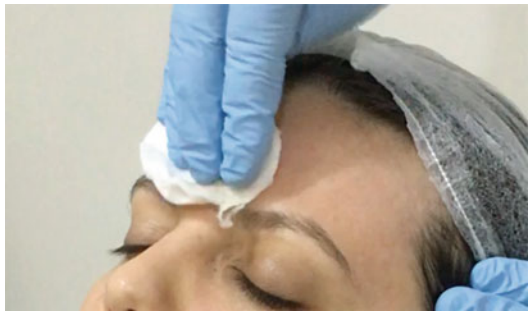


Fig. 1 Soft degreasing with 70% ethanol with a cotton pad

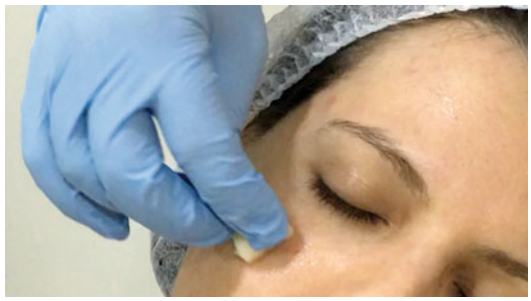


Fig. 2 Peeling procedure with 40% pyruvic acid in balanced water-ethanol solution. First session with cotton ball, with an even thin layer of the solution, without friction. A fan is held by the patient to prevent airway irritation. Her eyes are closed during the whole procedure to prevent ocular irritation by volatizaton

If any area of dermatitis is found red and pain is produced during alcohol degreasing, it is advisable to postpone the peeling procedure or, if the main area to be treated is sound and healthy for the peel, this peeling can be done on localized areas, without pass over the irritated areas, to prevent hot spots and PIH.

This peel may be applied with a soft cotton (Fig. 2), a soft brush, or a folded 4 × 4 gauze sponge, in a crescent order of penetration. The soft cotton application delivers a thin layer of solution and has no increased penetration by friction. The soft brush, such as sable-hair brush or goat-hair brush, is delicate but delivers a thicker layer of the solution onto the skin. This subtle difference occurs because hair has limited liquid absorbing properties, while a cotton ball acts as a sponge. The use of gauze sponges is indicated for increased penetration by mild to moderate friction. If heavy friction is performed, it may be advisable to consider switching to a mild deep peel, such as phenol 30–35% with croton oil 0.4%, which will provide better penetration to the dermis.

Pyruvic acid must be neutralized or washed once it produces erythema, which usually occurs after 3–5 min, so the solution must be applied in a fast manner, full face, or applied in each cosmetic unit and neutralized at a time, which usually produces more controllable uniformity of penetration, because perioral, periocular, and cheeks present faster penetration than the forehead. So if a full-face procedure is intended, I usually start on the forehead and nose. Then the peeling solution is applied on the lateral cheeks, medial cheeks, perinasal area, perioral area, and then periocular area/neck.

For safety reasons, this peel is typically neutralized with 10% sodium bicarbonate solution or face washing in a sink with copious amounts of water. This neutralization may prevent superficial damage. The neutralization starts at the most erythematous area, which is usually periocular or perioral, but in some well-prepared patients, the forehead may achieve erythema by the end of the application and must be neutralized first. In exceptional cases, no neutralization is chosen for stronger effects.

Full medical control of the neutralization is advisable; therefore, a 10% bicarbonate solution is prepared in a plastic disposable water cup where dry cotton wipes are soaked before the application on each area of the skin for neutralization (Fig. 3). Bicarbonate spray may be used and rinsed with a soft cotton ball or cotton wipe. If water is used as a neutralization solution with a wipe, it is advisable to have more wipes soaked in the water and to use them in a series of new fresh-water wipes. After complete removal of the solution, it is advisable to ask the patient wash the face in a sink to ensure maximum removal of the acid. (Fig. 4).

Choosing the Strength of Pyruvic Acid Solutions

Before choosing the concentration of pyruvic acid solution, it is mandatory to be aware of the solution vehicle. Although ethanol solutions may

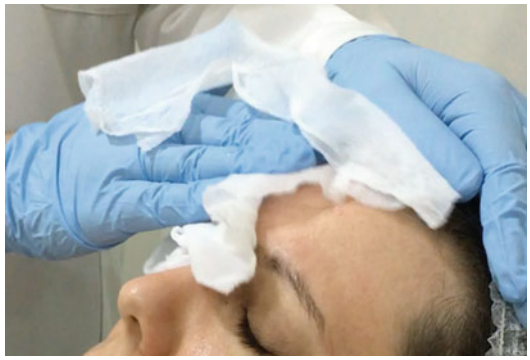


Fig. 3 Neutralization with 10% sodium bicarbonate solution with a large and soft cotton wipe

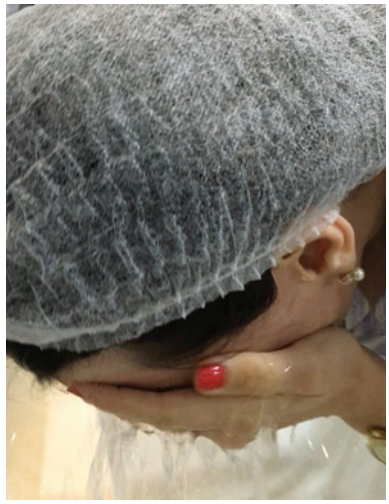


Fig. 4 Face wash in a sink to remove excess pyruvic acid. Note that this method does not neutralize the solution but causes dilution of the solution

provide stronger peeling, aqueous solutions are more stable, less volatile, but with formation of lactic acid. Lactic acid may present some benefits on hydration and depigmenting the skin. So the author recommends the use of formulas in "balanced" hydroalcoholic solutions (40–60% ethanol).

It is advisable to always start with 40% pyruvic acid solution, which is safe and also effective. Increasing the concentration to 50% is advisable only if the patient had no complaints during the first peel and would like stronger results.

Figures 5, 6, 7, and 8 show expected results with pyruvic acid peeling for acne, acne scars, and oily skin.

Combining Treatments

Retinoic Acid

For better effects on oiliness, some patients may be candidates to combining 5% retinoic acid in a similar way that these combining procedure may be done following salicylic acid peels or Jessner's peels. Retinoic acid solution or cream is applied to the treatment areas and is allowed to act on the skin for 2–6 h before being washed with a baby soap at home.

The addition of retinoic acid improves results reducing the size of sebaceous glands. However, retinoic acid peels usually cause significant irritation and dry skin in the first 3 days. Figures 9, 10, 11, and 12 show results of pyruvic and retinoic acid combo peels.

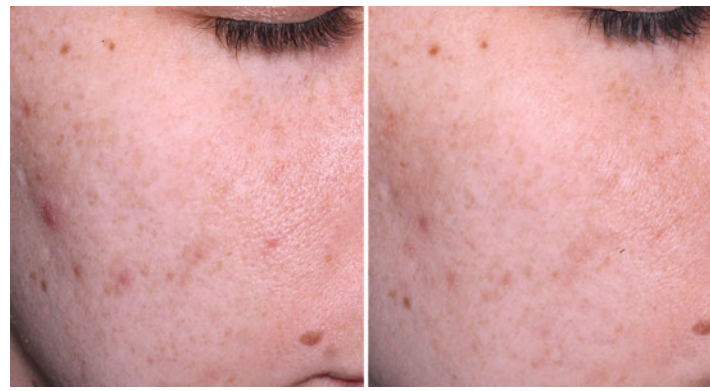


Fig. 5 Usual result after 10 days of one session of 40% pyruvic acid. Note the anti-inflammatory effect on acne papules and pore reduction

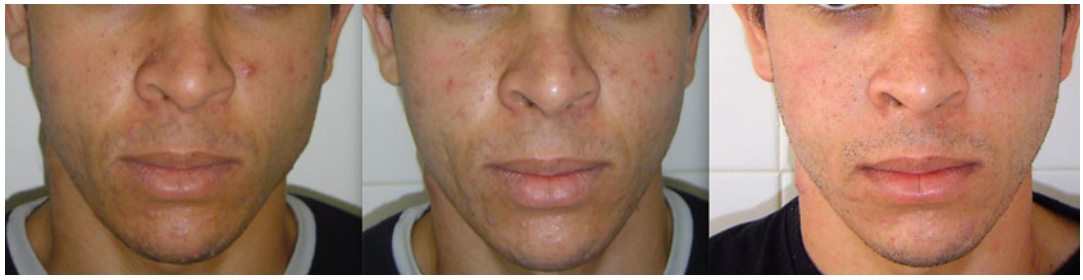


Fig. 6 Series of weekly pyruvic acid peels. First session was performed with 40%. Second session was performed with 50% pyruvic acid

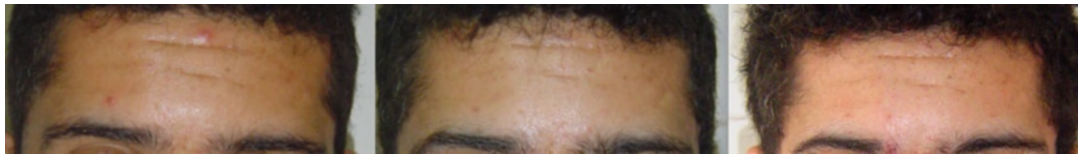
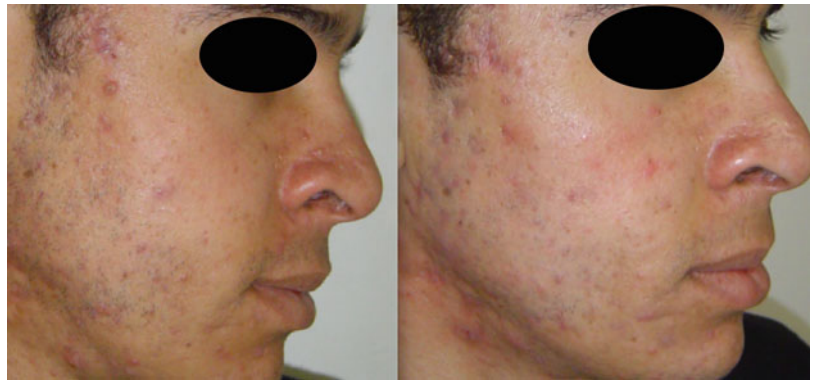


Fig. 7 Series of weekly pyruvic acid peels. First session was performed with 40%. Second session was performed with 50% pyruvic acid

Fig. 8 Results of first session of pyruvic 40% peel for inflammatory acne



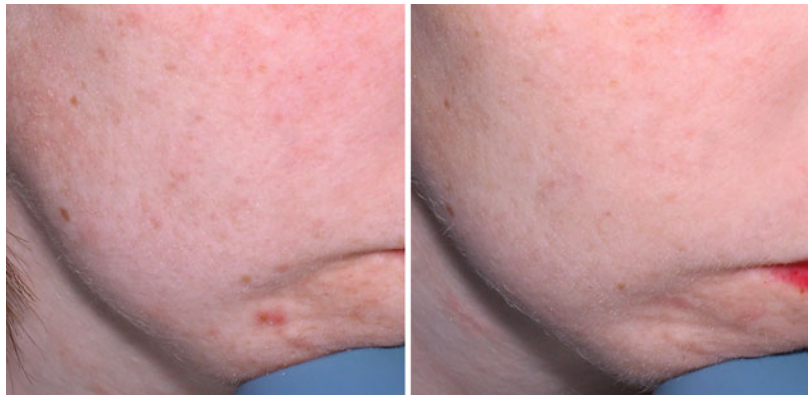


Fig. 9 Results of first session of pyruvic 40% peel, combined with 5% retinoic acid peel

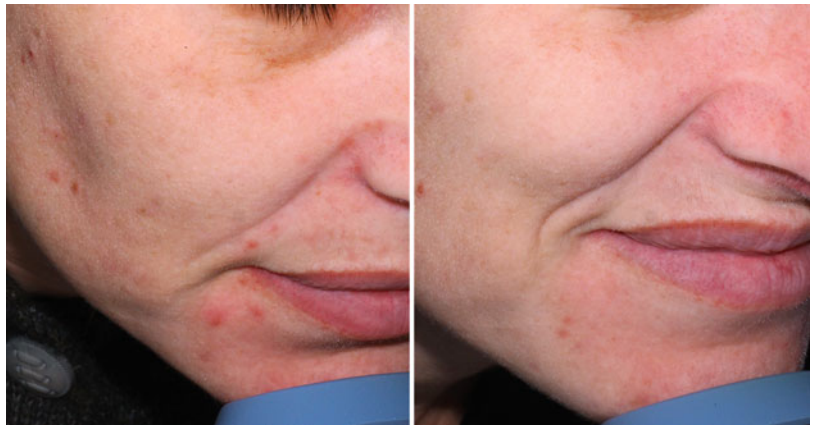


Fig. 10 Results of three sessions of Q-switched 1064 nm LASER toning combined with 40% pyruvic acid and 5% retinoic acid peels

Q-Switched 1064 nm LASER Toning

For better effects on PIH or other pigmentary changes, pyruvic acid may be applied immediately after laser toning. For this indication it is not advisable to exceed 40% pyruvic acid concentration, because of increased risk of penetration. Some patients with active acne may benefit from a triple combination of Q-switched + pyruvic acid + retinoic acid, with excellent results after 2–5 sessions every 14 days. Figures 10, 11, 12, 13, and 14 show results of the combination with LASER toning.

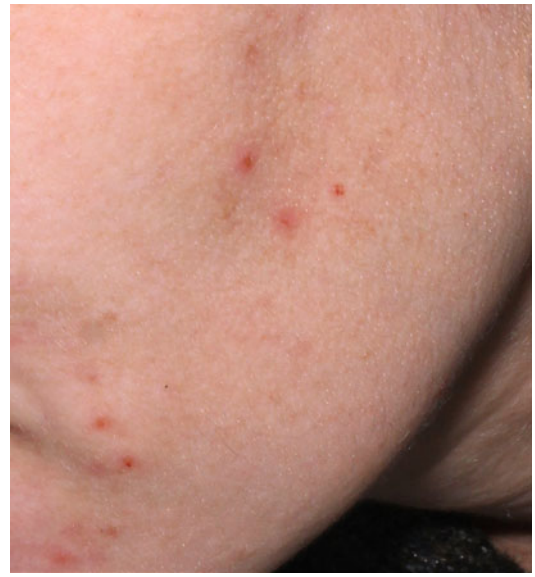


Fig. 11 Before three sessions of Q-switched 1064 nm LASER toning combined with 40% pyruvic acid and 5% retinoic acid peels

TCA

For treatment of multiple actinic keratoses with peeling, Pyruvic acid can be used at 50%, followed, after 5 min, by application of 35–40% TCA, which usually causes a deeper peel in the keratosis than using TCA alone. Pyruvic acid may be neutralized (Figs. 15 and 16) or not neutralized for increased chemical damage (Fig. 17).

Croton Oil

For treatment of dermal problems. The main issue is the solubility of croton oil in hydroalcoholic solution of pyruvic acid 50%. The author has tried this combination of 50% pyruvic acid in hydroalcoholic solution in some patients in restricted areas of treatment such as scars or deep wrinkles, without improvement after 3 months of follow-up and no additional benefits to pyruvic acid 50% with friction alone. However, the author has noticed that croton oil is not mixable with this specific solution. It is possible that 100% ethanol solution or adding a surfactant to the solution may increase solubility; however, this is still to be reported on clinical experiments.

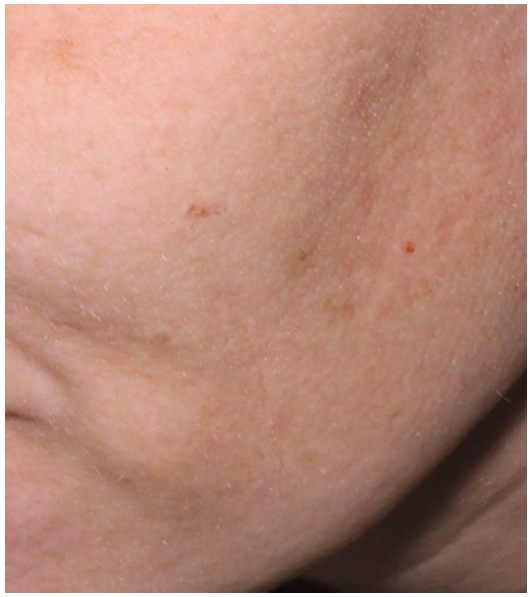


Fig. 12 After three sessions of Q-switched 1064 nm LASER toning combined with 40% pyruvic acid and 5% retinoic acid peels

The doctoral thesis of Dr. Bogdana Kadunc in 1998 described the effects in porcine skin of 60–100% pyruvic acid. The experiments demonstrated that pyruvic acid can be used for superficial depth, medial depth, or deep depth peelings. When admixed with 1 drop per 5 ml of croton oil, the solution had absolute alcohol (ethanol) as the vehicle. The results showed increased chemical depth of the action with not neutralized peels, with increased concentrations of pyruvic acid, and with addition of croton oil and methyl salycilate. Methyl salycilate showed to be a stronger additive to chemical damage at 10% than croton oil at 1 drop per 5 ml (0.8%). Some combinations such as 80–100% pyruvic acid with croton oil 0.8% and metyl salycilate 10% not neutralized and occluded, as well as 100% pyruvic acid alone applied with increased friction by a hard brush to have similar deep level of depth (reticular dermis) but with more inflammation and necrosis in the brush

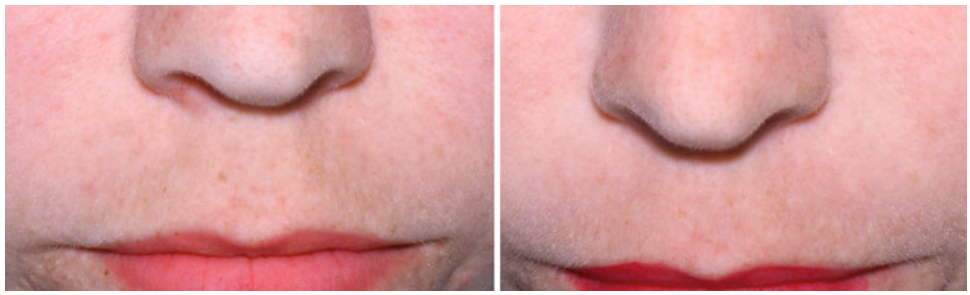


Fig. 13 Results of a single session of Q-switched 1064 nm LASER toning and pyruvic acid 40% peel combo. Reduction of pigmentation

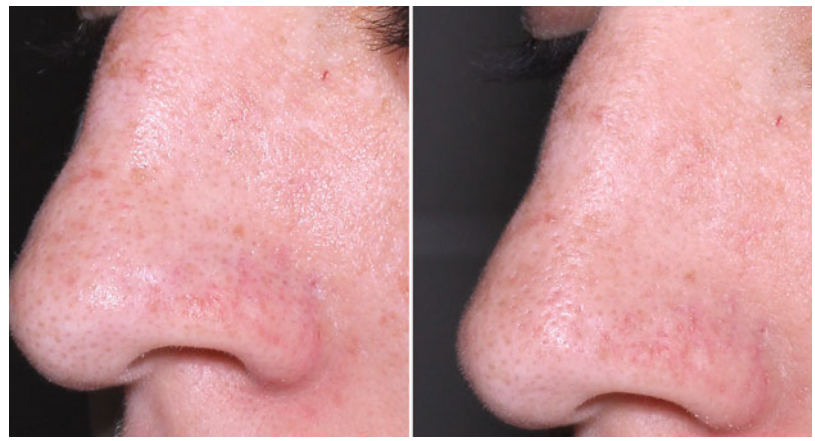


Fig. 14 Results of a single session of Q-switched 1064 nm LASER and pyruvic acid 40% peel combo. Reduction of pores and pigmentation

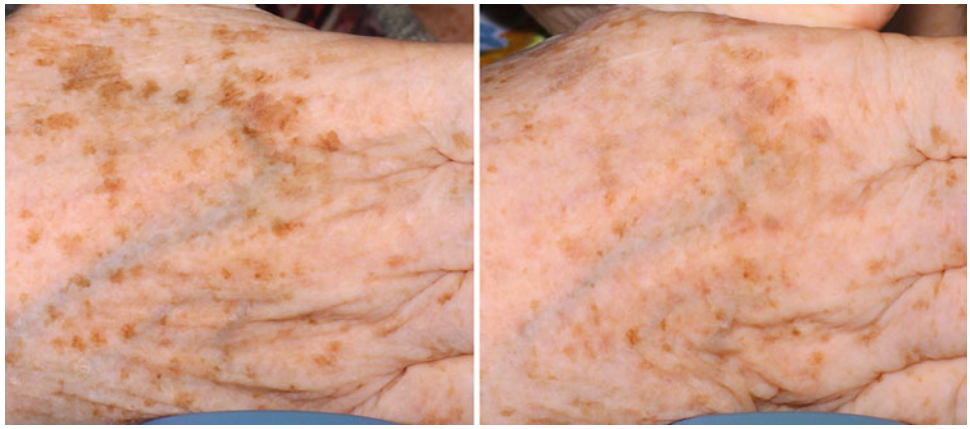


Fig. 15 Results of two sessions of 50% pyruvic acid + spot 40% TCA peels for hand melanoses

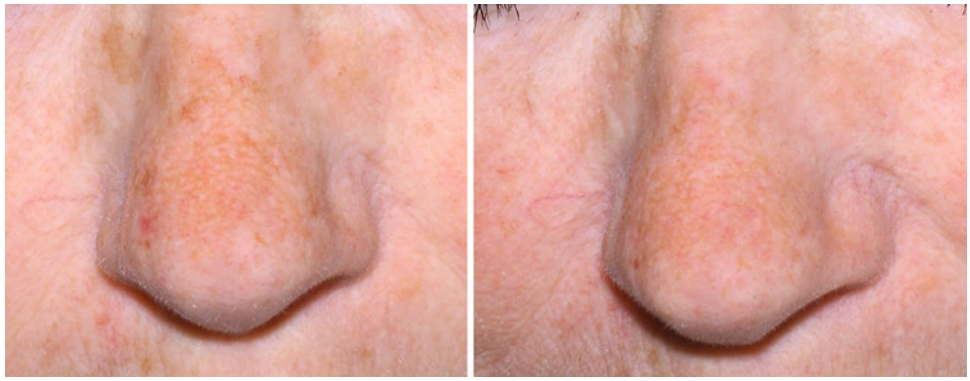


Fig. 16 Results of a single session of 50% pyruvic acid peel full-face followed by 35% TCA on pigmented patches

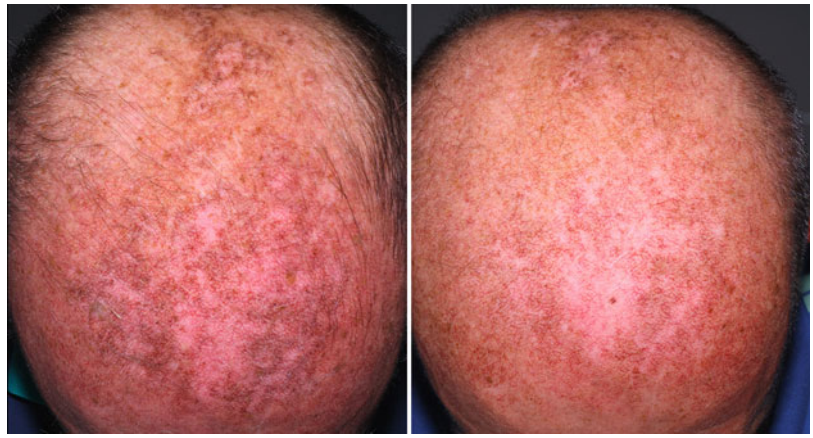


Fig. 17 Treatment of severe actinic keratosis on scalp with a series of three sessions of 50% pyruvic acid peel followed by 35% TCA combo peel

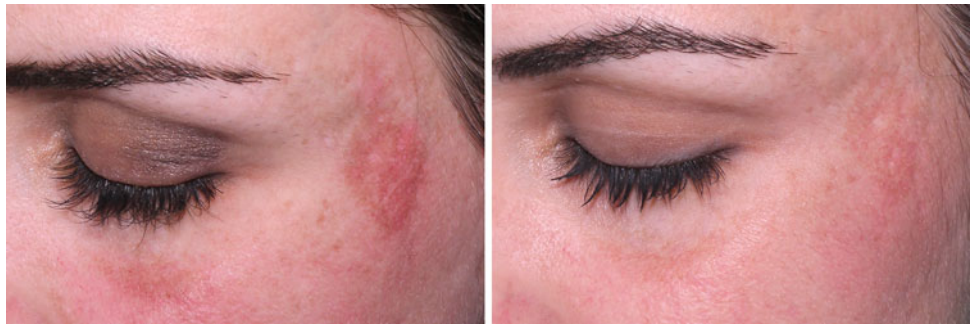


Fig. 18 Hot spots with pyruvic acid peels. Frosting during pyruvic acid peels in a hot spot caused severe persistent erythema followed by development of postinflammatory hyperpigmentation on a area with mild irritation due to bleaching creams (*left*). After 4 monthly treatments with Q-switched 1064 nm laser peels and Kligman formula, the skin was only with mild PIH (*right*)

Fig. 19 Hot spots with pyruvic acid peels. Before the first pyruvic acid peel (*left*). After 4 monthly treatments with Q-switched 1064 nm laser peels and Kligman formula, the skin was with mild PIH (*right*)

application. Neutralization in 5 or 15 min did not present differences with these higher-concentration solutions (Kadunc 1998).

Postpeeling Healing and Aftercare

The skin becomes erythematous for about 4–6 h after peeling. During this period, some patients may experience tingling or burning sensations in periorificial areas. The skin usually does not get dry and scaly as the usual more superficial peels, unless it is combined with a second peel such as retinoic acid.

For after peel care, during the first 3 days, facial shower or bathing should be restricted for up to two times a day, with a mild cleanser lotion, baby shampoo, or mild neutral syndets. During this critical period, patients are recommended to use a non-comedogenic moisturizing cream or gel during the first week, before reintroduction of the maintenance prescription cream.

If a stronger peel is done, such as pyruvic acid combined with TCA, the patient may use ointments such as Vaseline jelly during the healing period.

If any frosting is observed during an uncombined pyruvic acid peel procedure, extreme care should be taken to the hot spot area, with use of superpotent steroid gels such as clobetasol 0.05% gel and tinted, high sun protection factor sunscreens. Even with extreme care, severe PIH may be present after about 14 days (Fig. 18). These PIH are very difficult to manage, in contrast to PIH caused by retinoic acid or Jessner peels. PIH may be treated with Kligman formulas, sunscreen, oral tranexamic acid, and Q-switched 1064 nm laser (Fig. 19).

Take Home Messages

- Pyruvic acid peels are versatile
- Anti-inflammatory and antibiotic effects are its greater difference
- High risk of PIH can be minimized by proper preparation and patient selection
- Combination treatments can achieve better effects

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Jessner's Peel

Jane Marcy Neffá Pinto, Lilian Mathias Delorenze, Wellington Vasques, and Maria Claudia Almeida Issa

Abstract

Jessner's peel is a superficial chemical peel, resulting in destruction of part or all of the epidermis with keratolytic activity. Jessner's solution includes 14% of resorcinol, 14% of salicylic acid, and 14% of lactic acid and add sufficient quantity to 100 mL ethyl alcohol. It is mainly recommended for treatment of photoaging (fine lines, actinic keratosis, solar lentigines), pigmentary disorders (melasma, post-inflammatory), and acne. Jessner's solution can be used on all Fitzpatrick skin types, no sedation is needed, and desquamation is usually well accepted. Overpeel and complication are very rare.

Keywords

Chemical peel • Jessner's solution • Acne • Melasma • Photoaging

Contents

Introduction

Jessner's solution is a superficial chemical peel with keratolytic activity (Jackson 2014; Salam et al. 2013; Sharquie et al. 2006) developed by Max Jessner (Jacobs and Roenigk 2010). This peel has been used for more than 100 years in the treatment of epidermal skin disorders (Jackson 2014; Bae et al. 2013). It is easy to apply and can be used alone or in combination with other peels (Salam et al. 2013; Bae et al. 2013).

Peel Formula and Mechanism of Action

The solution composed by Max Jessner consists of 14% salicylic acid, 14% lactic acid, and 14% resorcinol in 95% ethanol (Jackson 2014; Salam et al. 2013; Jacobs and Roenigk 2010; Bae et al. 2013;

J.M.N. Pinto (✉) • L.M. Delorenze • W. Vasques
Department of Medicine (Dermatology), Hospital Universitário Antonio Pedro, Niterói, RJ, Brazil
e-mail: janeneffa@gmail.com; lili_delo@hotmail.com; wbvasques@ig.com.br

M.C.A. Issa
Department of Clinical Medicine – Dermatology, Fluminense Federal University, Niterói, RJ, Brazil
e-mail: dr.mariaissa@gmail.com; maria@mariaissa.com.br

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Bourelly and Lotsikas-Baggili 2005; Fischer et al. 2010). Salicylic acid is photosensitive, and lactic acid absorbs water present in the air; hence, the solution is sensitive to light and air (Jacobs and Roenigk 2010; Yokomizo et al. 2013).

Its mechanism of action is based on the salicylic acid and resorcinol's keratolytic property and the lactic acid's epidermolysis action (Jacobs and Roenigk 2010; Yokomizo et al. 2013). The keratolytic agents in Jessner's solution cause corneocyte loss of cohesion within the stratum corneum and subsequently producing intercellular and intracellular edema within the upper epidermis following continued application. The clinical end point is erythema and streaky frosting, it is self-neutralizing, and multiple applications can be performed to obtain a deeper injury (Jackson 2014; Bourelly and Lotsikas-Baggili 2005).

The penetration depends on the number of layers, and medium-depth peelings can be used. It can cause a burning sensation which may (or may not) be helped with water. It can be applied in the face and body (neck, dorsum); nevertheless, the procedure must be carried out in only one area per session in order to avoid risk of salicylism (Jacobs and Roenigk 2010; Bae et al. 2013; Yokomizo et al. 2013).

Salicylism or salicylic acid intoxication is a rare complication of salicylic acid peels that occur after peeling of extensive areas. The clinical manifestations include dizziness, tinnitus, and central nervous system toxicity (Landau 2008).

Patient Selection

Jessner's solution is used as superficial chemical peeling agent and can be applied in many cases such as acne, post-inflammatory hyperpigmentation, mild melasma, improvement of skin texture, and photoaging (Salam et al. 2013; Jacobs and Roenigk 2010; Bourelly and Lotsikas-Baggili 2005; Zakopoulou and Kontochristopoulos 2006). However, some authors do not recommend Jessner's solution to be used alone for the treatment of pigmentary changes, acne, or scarring (Salam et al. 2013).

Although superficial peelings can be used in all Fitzpatrick phototypes (I to IV) (Zakopoulou and Kontochristopoulos 2006), caution is recommended when applying Jessner's solution for the treatment of patients with cutaneous phototypes more pigmented (IV to VI), due to higher risk of complications, including post-inflammatory hyperpigmentation (PIH) and hypopigmentation (Jackson 2014; Salam et al. 2013).

A careful patient history should focus on some skin disorders such as various forms of dermatitis, rosacea, psoriasis (risk of a Koebner phenomenon after a peel), or herpes simplex virus (HSV) infection (Jackson 2014; Salam et al. 2013; Yokomizo et al. 2013; Landau 2008; Langsdon and Shires 2012). In patients with a history of HSV infection, prophylactic treatment should be considered starting 2 days before peel treatment until 7–14 days after the procedure. Immunocompromised patients, such as patients infected with HIV, should not routinely receive treatment due to post-treatment infection risks (Salam et al. 2013).

History of radiation exposure, immunosuppression, autoimmune disease, and collagen vascular disease could potentially compromise the healing process (Salam et al. 2013; Langsdon and Shires 2012).

Drug history may be consulted. We recommend that patients wait 6–12 months from the end of isotretinoin therapy before undergoing peeling because isotretinoin can reduce skin-healing capacity (Salam et al. 2013; Langsdon and Shires 2012). Topical retinoids may be discontinued 1 week before application. It's also important to identify any photosensitizers (e.g., minocycline, amiodarone, thiazides, tricyclic antidepressants) and systemic therapies that may cause hyperpigmentation such as oral contraceptives and hormonal treatments and inquire about smoking, previous keloid/hypertrophic scarring, and previous cosmetic procedures (Salam et al. 2013).

Some patients report that they have sensitive skin. These patients must be patch-tested with the peel in a small inconspicuous location before the decision is made to undergo on a full-face chemical peel (Langsdon and Shires 2012; Cortez et al. 2014).

The patient's occupation is important to consider, especially those with outdoor jobs (Salam et al. 2013).

As with all cosmetic procedures, the physician should understand the patient's desire and communicate realistic expectations of the peel. The patient should also understand the importance of the role that he or she will play in the pre- and posttreatment skin care regimen. As always, standardized photographic documentation may help record most conditions (Langsdon and Shires 2012).

Jessner's peel contraindications are: pregnancy, patients within 6-month isotretinoin treatment and active herpes simplex infection (Fischer et al. 2010).

Preprocedural Preparation

During the "initial consultation" and after the patient is determined to be a potential candidate for a Jessner's peel, the procedure, postoperative care, alternatives, risks, complications, limitations, and possible further treatment should be discussed. There are no promises of perfection made (Langsdon and Shires 2012).

Photographs of full face and specific areas of interest are obtained (Salam et al. 2013; Langsdon and Shires 2012).

A peel date needs to be decided to plan the pretreatment preparation. The pretreatment period occurs 2–4 weeks before the peel and is discontinued 3 days before (Salam et al. 2013). The purpose is to enhance the results of the chemical peel. Two primary goals of both phases are to thin the stratum corneum, improve uniform active agent penetration, accelerate healing, and reduce the risk of PIH and/or scarring. Pretreatment with tretinoin 0.05% cream for at least 2 weeks may accelerate healing. Other agents used in the pretreatment phase include hydroquinone, salicylic acid, glycolic acid, kojic acid, retinol, azelaic acid, topical steroids, and sunscreen (Jackson 2014).

Patients should be aware of the risks of skin dryness, irritation, and erythema. Photoprotection may also reduce the risk of post-inflammatory hyperpigmentation. Patient education is essential to reduce the risk of complications (Salam et al. 2013).

Periprocedural

A cleansing step directly prior to the application of the chemical peel substance is a consistent part of every peeling protocol (Fig. 1). It is crucial to obtain homogeneous penetration of the peel and thus a uniform result. The application technique is very simple. The skin is first systematically and thoroughly cleansed to remove fats and oils and to eliminate debris from the stratum corneum with alcohol or acetone. The skin is then rinsed and dried (Monheit and Chastain 2001).

The peeling agent is then applied using, for example, compresses, cotton, an applicator, or a brush (Fig. 2). Reapply a new layer after 3 or 4 min. Rinse with water, removing the crystals of salicylic acid (Jacobs and Roenigk 2010; Yokomizo et al. 2013). Increasing the number of layers leads to a higher amount of product on the skin and, therefore, increasing the depth of its penetration (Bourelly and Lotsikas-Baggili 2005).

Depth Levels

- Level I: one layer. Causes mild erythema and flaking on the surface resembling a powder that can be easily removed.
- Level II: two to three layers. A more intense erythema is observed, as well as frosting in

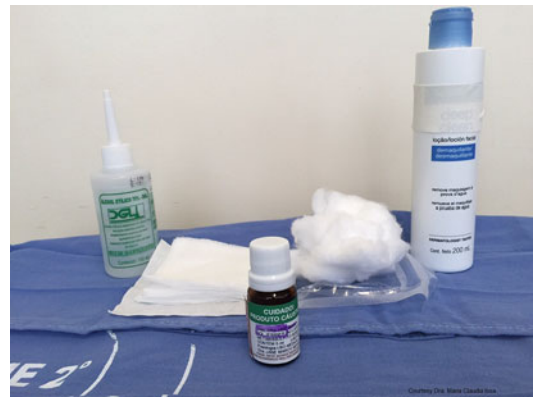

Fig. 1 The material needed for the procedure includes cleansing lotion, alcohol 70% (or acetone), cotton, gauze, and peeling solution

Fig. 2 The peeling application begins in the frontal region, followed by the malar regions, nasal dorsum, chin, and perioral

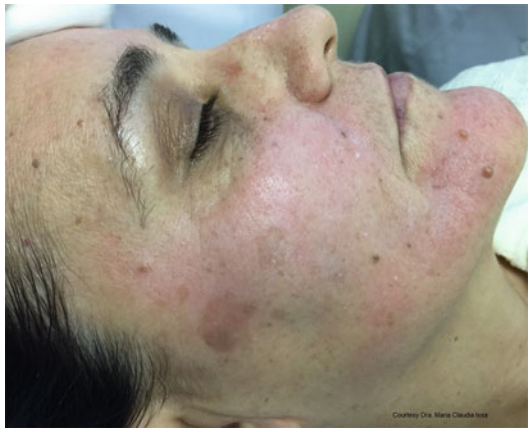

Fig. 3 Depth level II: Erythema with small dots of frosting

dotted thin areas. There is a mild to moderate burning sensation (Fig. 3).

– Level III: three to four layers. Causes significant erythema with areas of frosting and moderate burning sensation (Jacobs and Roenigk 2010; Yokomizo et al. 2013) (Fig. 4).

Postprocedural Skin Care

Post-peel instructions should be given to the patient in writing. Bland emollients should be started immediately after the peel, and wetting

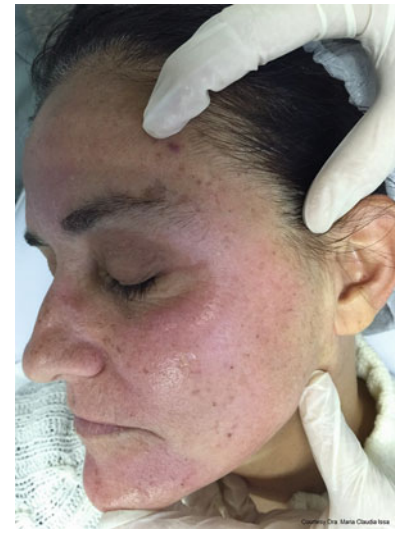

Fig. 4 Depth level III: A more marked erythema is observed

the area should be avoided for 24 h, followed by a return to normal cleansing activities. If the patient exhibits immediate intense erythema, a topical or oral steroid can be prescribed. It's important to apply broad-spectrum sunscreen to the treated area(s) and advise patients to avoid sun exposure (Salam et al. 2013) (Figs. 5 and 6).

Complications and Side Effects

The risk of complications can be significantly reduced with meticulous patient selection, peel selection (volume, combination, and technique of application), patient education, adequate priming, and good intra-peel and post-peel care (Salam et al. 2013).

Postprocedural complications include delayed healing, bacterial and herpes simplex infection, prolonged erythema, contact dermatitis, abnormal scarring, textural abnormalities, PIH, and hypopigmentation (Jackson 2014; Salam et al. 2013). The early recognition and management of these complications is essential for a successful resolution. Post-peel hyperpigmentation may be treated with topical retinoids and skin-lightening agents such as hydroquinone (Jackson 2014).

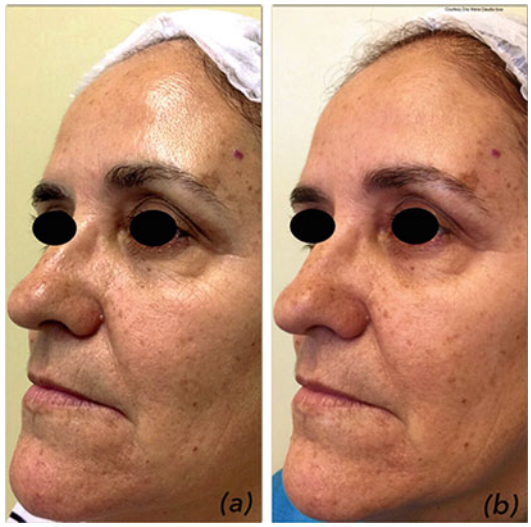

Fig. 5 Pre- (**a**) and post- (**b**) Jessner's peel (two sessions) for improvement of skin texture and photoaging in a woman with Fitzpatrick skin type III

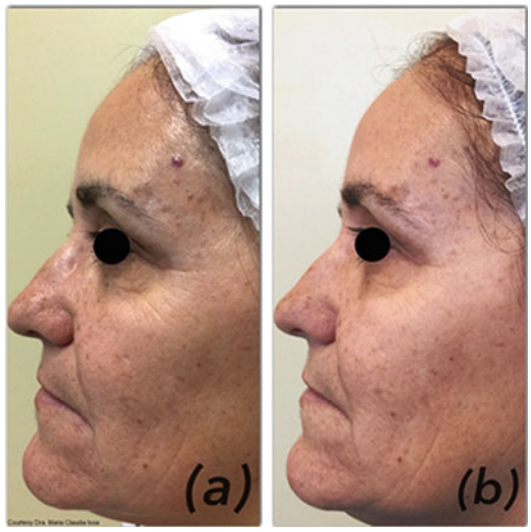

Fig. 6 In detail, there is significant improvement of periorbital wrinkles after two sessions of Jessner's peel

Take Home Messages

- Jessner's solution is a superficial chemical peel with keratolytic activity and consists of 14% salicylic acid, 14% lactic acid, and 14% resorcinol in 95% ethanol.
- It is mainly recommended for treatment of photoaging, mild melasma, post-inflammatory hyperpigmentation, acne, and improvement of skin texture.
- Postprocedural complications include delayed healing, bacterial and herpes simplex infection, prolonged erythema, contact dermatitis, abnormal scarring, textural abnormalities, post-inflammatory hyperpigmentation, and hypopigmentation.
- Jessner's peel contraindications are: pregnancy, patients within 6-month isotretinoin treatment and active herpes simplex infection.

Glossary

Contact dermatitis Any skin inflammation that occurs when the skin's surface comes in contact with a substance originating outside the body. There are two kinds of contact dermatitis, irritant and allergic.

Fitzpatrick phototypes Is a numerical classification schema for human skin color. It was developed in 1975 by Thomas B. Fitzpatrick, as a way to classify the typical response of different types of skin to ultraviolet (UV) light.

Jessner's peel A superficial chemical peel, resulting in destruction of part or all of the epidermis with keratolytic activity. The solution includes 14% of resorcinol, 14% of salicylic acid, and 14% of lactic acid, and add sufficient quantity to 100 mL ethyl alcohol.

Photosensitizers A substance that, in combination with light, will cause a sensitivity reaction in the substance or organism.

Salicylism or salicylic acid intoxication Rare complication of salicylic acid peels that occur after peeling of extensive areas. The clinical manifestations include dizziness, tinnitus, and central nervous system toxicity.

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Combining Superficial Chemical Peels

João Carlos Lopes Simão and Carlos Gustavo Wambier

Abstract

Some dermatological interventions may be combined with superficial peelings to achieve better results by speeding results with increased epidermal turnover. To achieve uniformity of skin tone, combination treatments with Q-switched frequency-doubled Nd-YAG (532 nm) and Q-switched Nd-YAG (1064 nm) lasers are possible effective options. In cases of rosacea, some superficial peels may be associated with intense pulsed light. Superficial peels may also be associated with cryotherapy and 5-fluorouracil cream to improve actinic keratosis. Any superficial- or medium-depth peel may be used before ablative fractionated lasers, to achieve better uniformity of results and to boost the final effects. This chapter describes how to better combine different treatments and focuses on up-to-date alternatives for the classical peeling formulas and combination treatments.

Keywords

Acne • Acne scars • Melasma • Post-inflammatory pigmentation • Photodamage • Photoaging • Chemical peels • Salicylic acid • Glycolic acid • Pyruvic acid • Mandelic acid • Jessner's solution • Modified Jessner's solution • Alpha-hydroxy acids mix • Tretinoin peels

Contents

Introduction

Superficial peels are intended to maximize the epidermal turnover in order to hasten what could be achieved by waiting a long period of time. The best example, and probably the best indication for superficial peels, is post-inflammatory hyperpigmentation (PIH) or superficial erythematous scars caused by acne. If the skin is allowed to heal at its own pace, in

J.C.L. Simão (✉)
Division of Dermatology, Department of Internal Medicine, Ribeirão Preto Medical School, University of São Paulo, São Paulo, SP, Brazil
e-mail: jclsimao@uol.com.br

C.G. Wambier
Department of Medicine, State University of Ponta Grossa, Ponta Grossa, PR, Brazil
e-mail: cwambier@uepg.br

M.C.A. Issa, B. Tamura (eds.), *Chemical and Physical Procedures*, Clinical Approaches and Procedures in Cosmetic Dermatology 2, https://doi.org/10.1007/978-3-319-16805-0_6

about 6–12 months, without new active acne lesions, these would probably spontaneously resolve. With superficial chemical peels, these results can be obtained in about 1–2 months. On the other hand, when a patient is prescribed topical retinoids or azelaic acid, the results are expected to be achieved in a time frame in between the natural gradual resolution and the fastest resolution by a chemical peel.

Other excellent indications for superficial peels are acne, oiliness, melasma, irregular tanning, and melanoses. Combining superficial peels with other treatments intended to improve the same condition could potentially increase the effects in a synergic way. The objective of this chapter is to provide the reader with good applications of combining superficial peels to maximize results in a safe manner.

Indications and Limitations

The main indications for combining a procedure with a superficial chemical peel are increasing strength/penetration and accelerating recovery period through epidermal turnover. The latter is probably the best indication for adding a superficial peel to another treatment. Some superficial treatments might not cause increased epidermal turnover, so normal turnover time is required to peel off treated spots. Intense pulsed light (IPL) and frequency-doubled quality-switched neodymium-doped yttrium aluminum garnet light amplification by stimulated emission of radiation (Q-Switched Nd-YAG laser, 532 nm) treatments commonly cause superficial temporary darkening by formation of brown scales in the sites of ephelides or melanoses.

The main limitations of combining a treatment with superficial peeling are that some patients do not tolerate irritation or temporary burning pain. Very few patients may be allergic to chemicals.

Combining with Other Peels or Chemicals

The use of superficial peels before application of medium-depth 35–40% trichloroacetic acid improves its penetration, causing more uniformity in effects (Cook and Cook 2000; Monheit 2001). The same can be done with another superficial peel, for example, using 30% salicylic acid peel before using 5% retinoic acid peels. In this scenario, multiple treatments are necessary, but the control of acne and the resolution of acne scars happen sooner than with a single superficial chemical peel (Fig. 1). Retinoic acid 5% is easily combined as a "leave-in" mask, because it does not have any specific immediate action, since its pH is almost physiological and its mechanism of action is through nuclear retinoic acid receptors and protein synthesis modulation (Cucé et al. 2001; Ivanov et al. 2006), which starts in the following day, and the phenomena are better clinically appreciated after 48 h and usually last 48–72 h. Thus, this go-home yellow mask may be applied soon after removing residual chemicals or neutralization of a variety of peels, including 10% TCA, 30% salicylic acid in hydroalcoholic (SA-HA) or polyethylene glycol (SA-PEG) vehicles, Jessner's solution, modified Jessner's solution (MJS), and glycolic acid. The 5% tretinoin mask may be improved with the addition of skin color pigments (neutracolor) and sunscreen, which protect extremely photosensitive tretinoin against visible light and ultraviolet rays.

For improvement of comedones, acne, and dilated pores, our preferred combo is SA-PEG (Dainichi et al. 2008a, b), left in the skin for 5–10 min, removed with a soft wet rayon tissue, followed by 5% tretinoin mask (solution or cream). This combination is particularly effective because SA-PEG does not evaporate and penetrates deeply in the follicles. After applying tretinoin, all-trans retinoic acid (ATRA), the residual intrafollicular peel blends with the mask, producing an occlusive intrafollicular effect of both agents.

When facing a patient with extensive facial palpable actinic keratosis (AKs), with the intent of treating the whole field of cancerization, many methods may be used, including photodynamic therapy (PDT), medium- or deep-depth chemical peeling, or dermabrasion. But those methods are usually performed after scheduling, and also, the patient has to plan for downtime. Less painful and no-downtime procedures include daylight PDT and superficial peels, followed by either localized cryotherapy on the thicker AKs or by a mask of

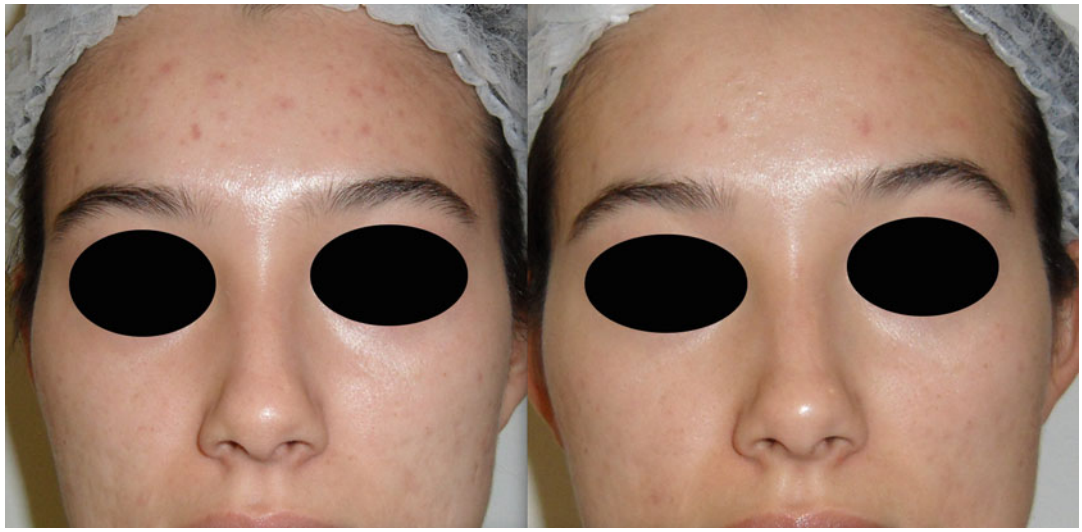

Fig. 1 Combined superficial peels for treatment of superficial acne scars with post-inflammatory hyperpigmentation and erythema. Sessions performed every 2 weeks. *Left*: After first treatment with salicylic acid 30% hydroalcoholic solution, followed by removal of pseudofrosting and application of retinoic acid 5% cream mask for 4 h. *Right*: After second treatment

Efudex®, 5% 5-fluorouracil (5-FU) cream. The superficial peels of choice for these procedures are 30% SA-HA, Jessner's solution, 70% glycolic acid, or 40–50% pyruvic acid. These procedures may be repeated every 7–14 days, until no residual AKs are palpable, usually after five sessions. The whole combo may be performed in the following way: 40% pyruvic acid peel for 5 min, neutralization with 10% sodium bicarbonate solution in a wet rayon soft tissue, removal of residual bicarbonate with a wet rayon soft tissue, and friction with gauze sponge on areas of AKs or soft curettage, application of Metvix®, daylight procedure for 2 h, or exposure to 37 J/cm^2 red LED (about 7 min), cryotherapy on the thicker AKs, and 5% 5-FU mask for 4–6 h. This latter procedure is much more valuable, and may remove most palpable AKs in a single session.

Combining with Q-Switched Nd-YAG Laser

To maximize skin lightening of low-fluency Q-switched 1064 nm laser (laser toning), a superficial chemical peel, such as modified Jessner's solution (Fig. 2), an ethanol solution containing 17% lactic acid, 17% salicylic acid, and 8% citric acid (Rohrich and Herbig 2009), or retinoic acid 5% peel (Figs. 3 and 4) may be used (Cucé et al. 2001; Cucé and Bertino 2002).

Although melanoses and melasma can be treated with prescription bleaching creams and sunscreen only, the association of oral tranexamic acid and/or low-fluency treatment sessions with 1064 nm Q-switched Nd-YAG laser (Shin et al. 2013) may improve results. Some patients, even with adhesion to home treatments, sunscreen, and laser, may exhibit very mild improvement. In such cases, the association of superficial peels may be beneficial (Figs. 2, 3, 4, and 5).

Focal or full-face 532 nm Q-switched Nd-YAG laser treatments cause dark-brown spots in the sites where melanoses are treated. The natural peeling off of thick brown scales usually takes over 10 days. Facial treatments usually take 7–11 days for full epidermal recovery, with faster resolution of inflammation and relatively less possibility of post-inflammatory hyperpigmentation (PIH). Other sites such as the hands and feet might take over 6 weeks until these spots are resolved, sometimes with mild residual PIH.

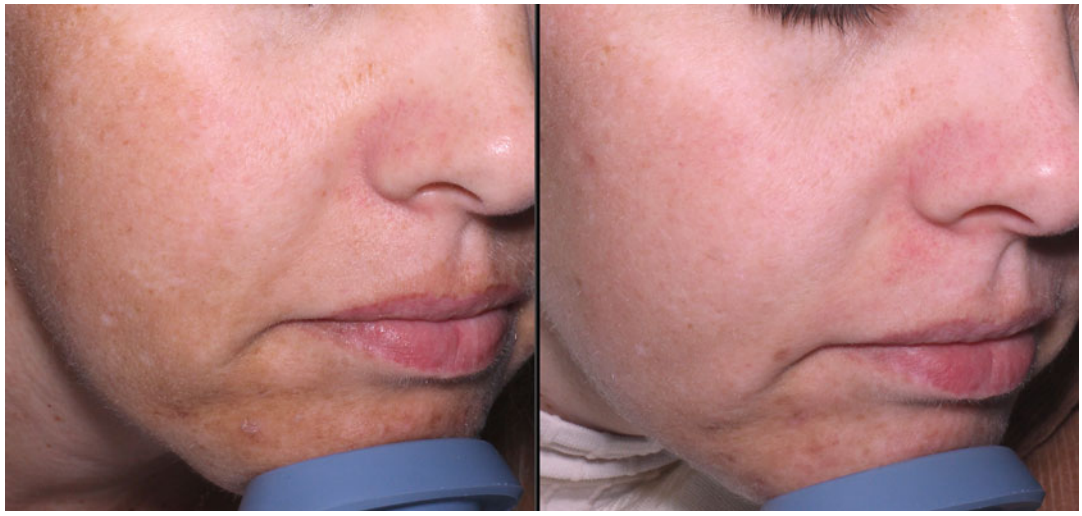

Fig. 2 Combined Q-switched Nd-YAG 1064 nm LASER followed by two layers of modified Jessner's solution for the treatment of recalcitrant melasma with post-inflammatory hyperpigmentation caused by acne. Sessions performed every 2 weeks. *Left*: before. *Right*: after six sessions

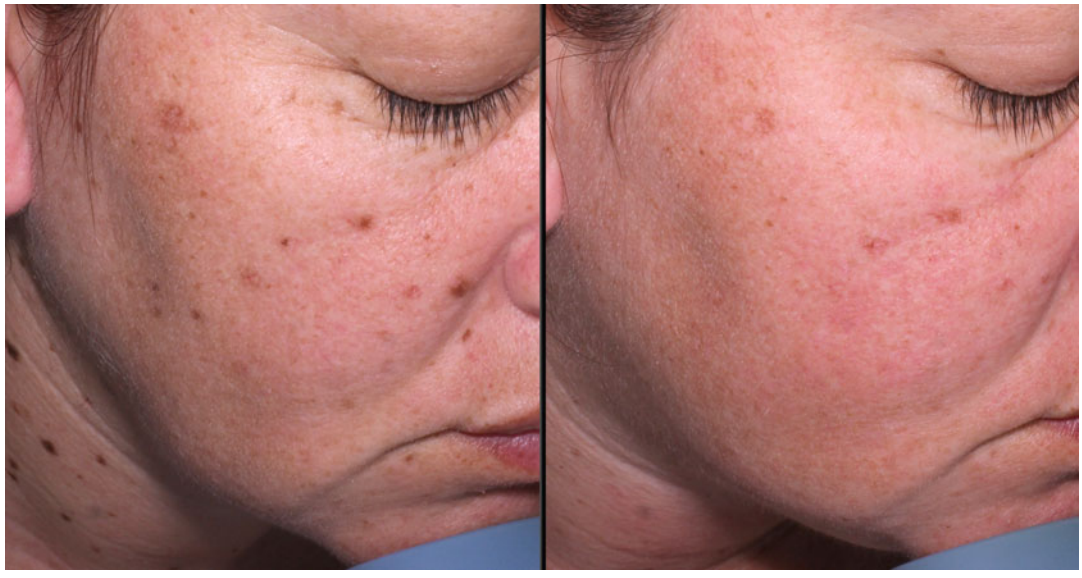

Fig. 3 Treatment of nevi, oiliness, and diffuse melanosis of the face and neck. *Right side* of the face. Monthly treatments of Q-switched Nd-YAG 1064 nm LASER, followed by retinoic acid 5% peel. *Left*: before. *Right*: after four sessions

Thus, superficial peels may be performed right after the laser application to accelerate healing period. They may also be used long after healing to improve PIH. The combination of 532 nm Q-switched Nd-YAG laser facial treatments with 5% retinoic acid peels decreases the downtime due these dark-brown spots, without compromising the final results (Figs. 6 and 7).

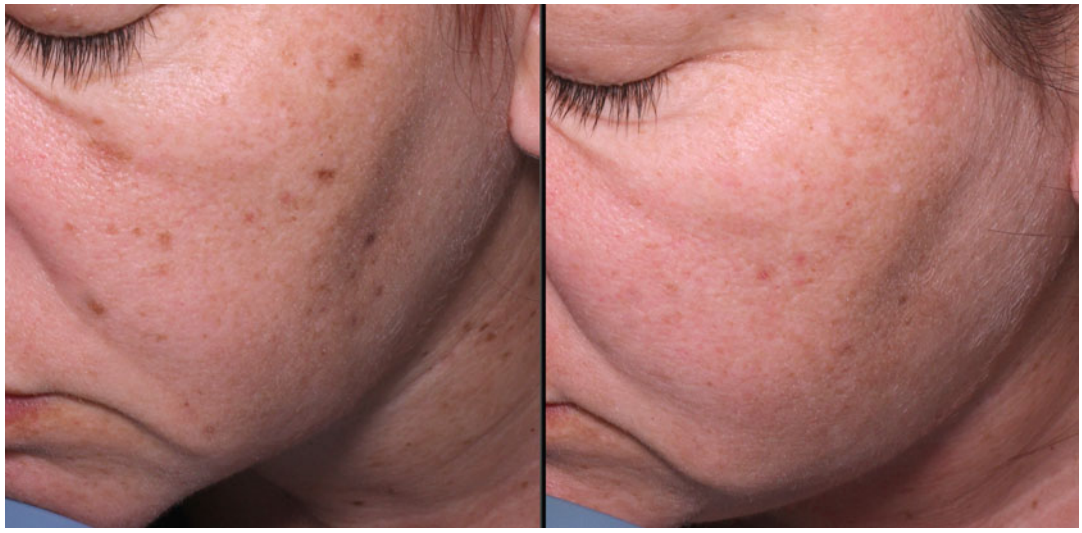

Fig. 4 Treatment of nevi, facial oiliness, and diffuse melanosis of the face and neck. *Left side* of the face. Monthly treatments of Q-switched Nd-YAG 1064 nm LASER, followed by retinoic acid 5% peel. *Left*: before. *Right*: after four sessions

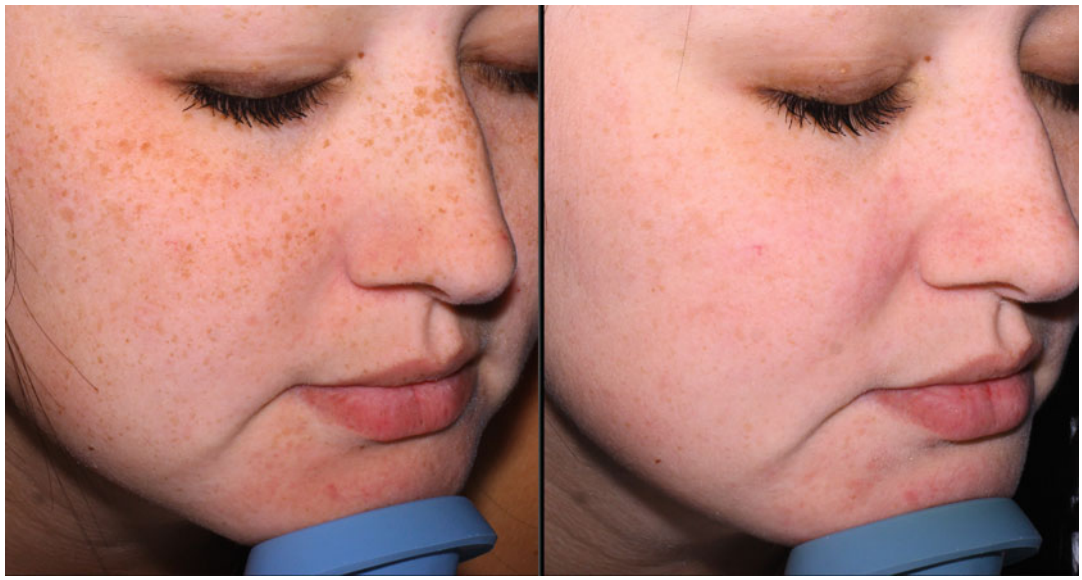

Fig. 5 Monthly treatment of melasma and ephelides with Q-switched Nd-YAG 1064 nm and focal 532 nm, followed by retinoic acid 5% peel mask for 3 h. *Left*: before. *Right*: after two sessions

Combining with IPL

Intense pulsed light (IPL) is an equipment that uses lamps that emit a polychromatic, non-coherent, non-collimated light beam, with wavelengths ranging from 400 to 1,200 nm. The light spectrum is chosen according to the specific skin targets (melanin, hemoglobin, and water) and also porphyrins produced by microbial agents, such as *Propionibacterium acnes* (Babilas et al. 2010;

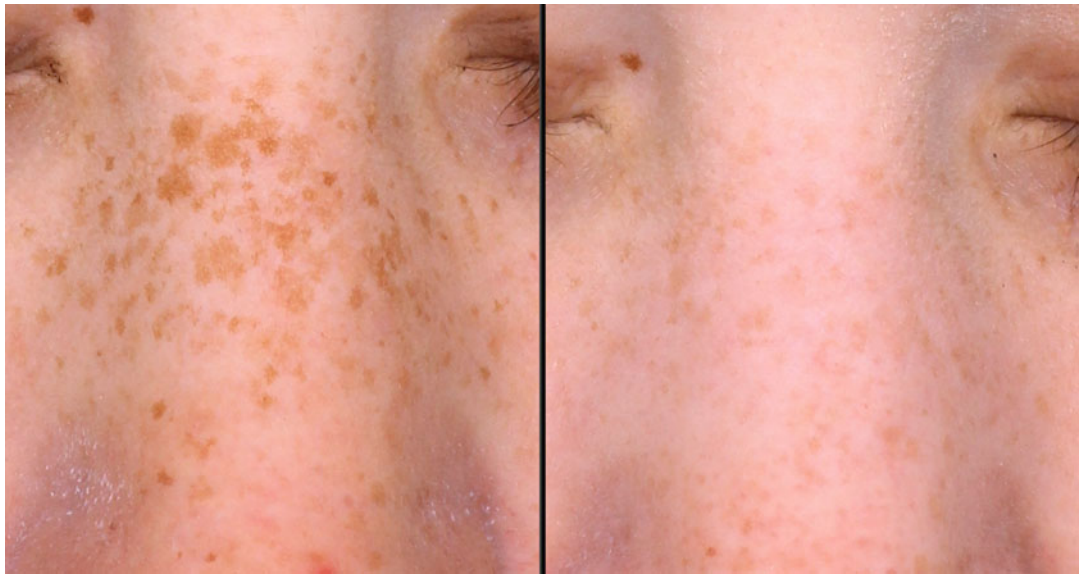

Fig. 6 Monthly treatment of facial melanosis with Q-switched Nd-YAG 1064 nm and focal 532 nm, followed by retinoic acid 5% peel mask for 3 h. *Left*: before. *Right*: after three sessions

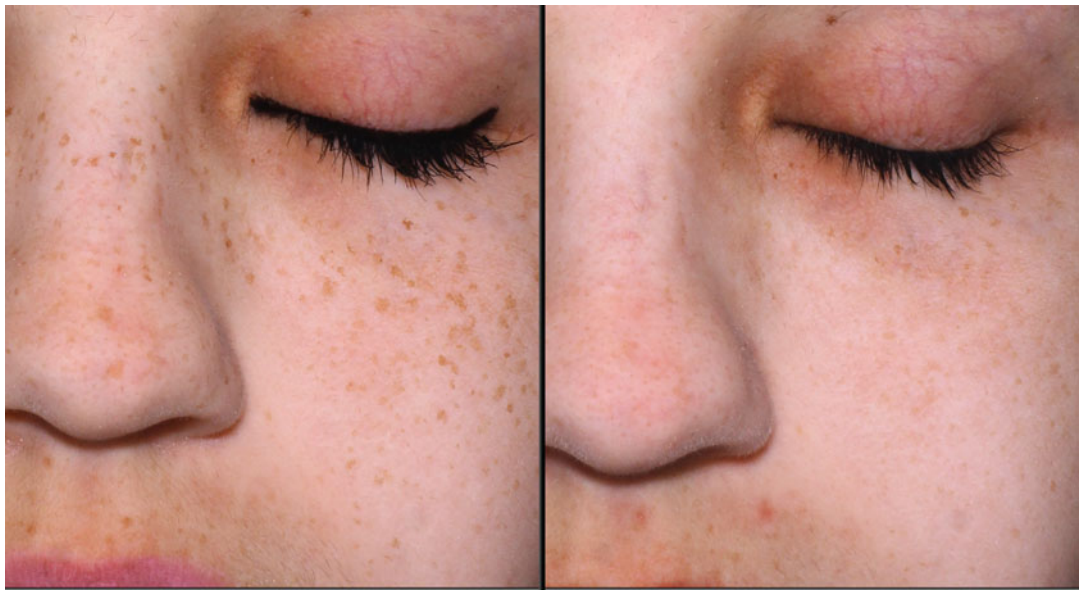

Fig. 7 Monthly treatment of facial melanosis with Q-switched Nd-YAG 1064 nm and focal 532 nm, followed by retinoic acid 5% peel mask for 3 h. *Left*: detail of the nose, before. *Right*: detail of the nose, after three sessions

DiBernardo and Pozner 2016; Degitz 2010; Choi et al. 2010).

IPL is used in combination with superficial peels on the face for treatment of some pigmentary and acne changes.

Solar Melanoses, Ephelides, Post-inflammatory Pigmentation

IPL is applied at wavelengths that are quite absorbed by melanin (between 520 and 540 nm,

with short pulses of 10–15 ms). In the case of post-inflammatory hyperpigmentation, we used longer pulses and lower energies, with a greater number of sessions.

It takes between 5 and 10 min to observe the immediate response in the treated area. We should observe darkening of the lesions with greater concentration of the chromophore melanin with surrounding edema and erythema, with areas interspersed by the skin with virtually no reaction (where there is not enough target).

The cream is then applied with 5% tretinoin (all-trans retinoic acid (ATRA)). Do not use manipulations containing alcohol or other primary irritants that may cause burning. The patient is asked to remove it gently at home after 4–6 h. Micellar waters are excellent removers. In patients with very severe erythema and/or burning sensation soon after IPL, concomitant application of a low- to medium-potency corticosteroid cream is recommended. The application of topical corticosteroids is also recommended shortly after IPL in cases of PIH and home use for 1 week. The treatments for PIH should not be aggressive, thus avoiding worsening of hyperpigmentation.

Melanocytic lesions treated by IPL become darker and have scaling and crusting. Tretinoin increases epidermal turnover and facilitates the dispersion and removal of melanin.

The use of 5% ATRA will promote homogeneous desquamation of the entire face, optimizing the LIP result. Other products with or without tretinoin may be used, provided they are compatible with the combination formulation (vitamin C, ferulic acid, etc.), or even other retinoids available from commercial peelings.

IPL treatment in IV to VI phototypes is not recommended because of the high risk of prolonged or permanent pigmentary changes.

Acne

The lesions of acne, comedones, papules, and pustules are treated with IPL at the wavelength of 400 nm. This wavelength is absorbed by the porphyrins produced by *Propionibacterium acnes* which leads to the generation of reactive oxygen species with subsequent bactericidal effects (Degitz 2010; Choi et al. 2010).

The IPL at wavelength 400 nm is effective for the treatment of acne, especially inflammatory lesions, with a histological decrease in the density of the inflammatory infiltrate and the size of the sebaceous glands (Barakat et al. 2017).

The sessions for treatment of acne with IPL should be weekly. When peels are combined at the same time, the sessions can be weekly or biweekly, depending on the peeling response of the skin. Treatment may be indicated for mild to moderate acne. The association of the superficial peeling of conventional 30% SA-HA immediately after the application of IPL promotes a faster improvement of comedones and inflammatory lesions.

Salicylic acid is a beta hydroxy acid and lipophilic, which removes the intercellular lipids that are in covalent attachment to the cornified envelope around the epithelial cells in the superficial layers of the stratum corneum. There is therefore a decrease in corneocyte cohesion and desquamation. Likewise, there is comedolytic and dry action, with progressive diminution of comedones and inflammatory lesions (Lee and Kim 2003).

After the application of 30% SA peeling, a pseudofrost is obtained and gently removed.

The result can be even better if, after the removal of salicylic acid, we apply 5% retinoic acid and ask the patient to take it out 4–6 h at home. The sessions are fortnightly or more distant. The association of peelings promotes additional improvement of the acne lesions, especially the comedones, promotes homogeneous skin peeling, also acting in post-inflammatory hyperpigmentation (Ahn and Kim 2006).

The use of salicylic acid in a polyethylene glycol vehicle demonstrates no sensation of burning, erythema, desquamation, and crusting (Dainichi et al. 2008b). There is also no histological inflammatory response, which reduces the risk of post-inflammatory hyperpigmentation. There is no pseudofrost, and the product should be removed after 5 min of contact with the skin.

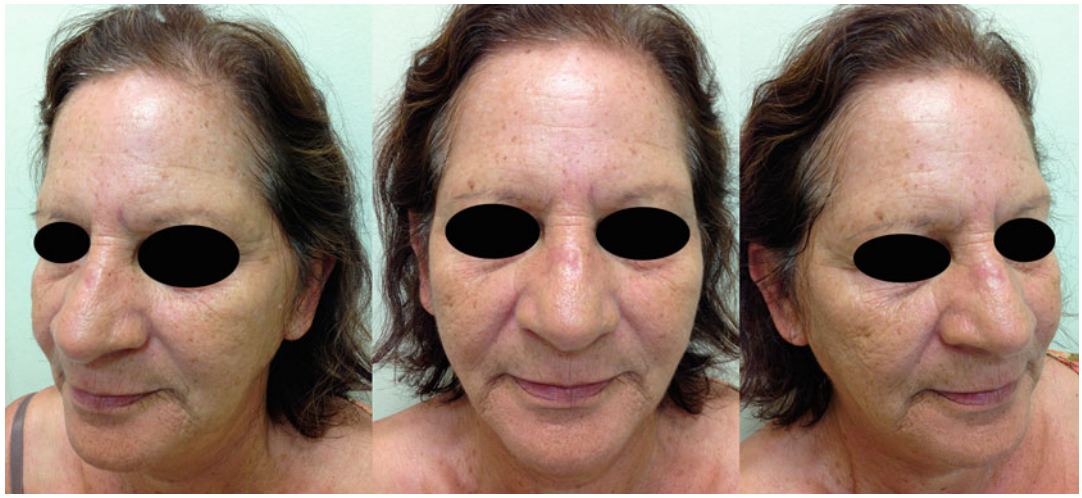

Fig. 8 Jessner's solution + 35% trichloroacetic acid + CO_2 LASER – before

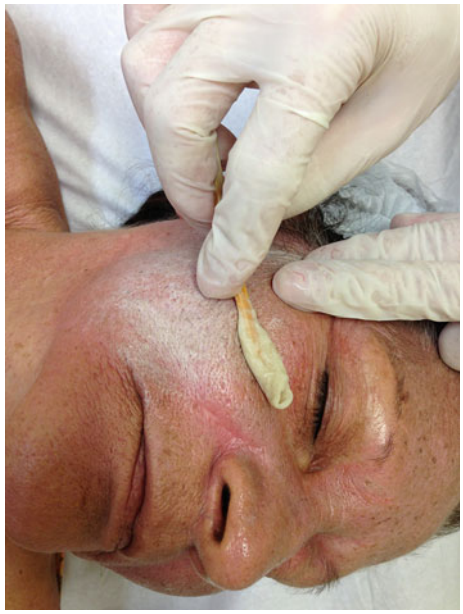

Fig. 9 Jessner's solution + 35% trichloroacetic acid, demonstration of frosting, before CO_2 LASER

Combining with Ablative Fractionated Lasers

Ablative fractionated lasers are currently available with three wavelengths: CO_2 (10,600 nm), Erb:YAG (2,940 nm), and Erb:YSGG (2,790 nm). Erb:YAG (2,940 nm) has higher absorption by tissue water, lower penetration, and less residual thermal damage. CO_2 (10,600 nm) has a lower absorption coefficient by water and causes greater residual thermal damage. Erb:YSGG (2,790 nm) is in an intermediate state. The ablative lasers promote remodeling of collagen by the production of new fibers in the reticular and papillary dermis for at least 3 months after the application of the laser.

Ablative lasers promote microscopic treatment zones (MTZs) by reaching water in the dermis and epidermis with areas of normal skin spared around each MTZ, which allows faster healing (Laubach et al. 2006; Robati and Asadi 2017). The formed channels would facilitate, according to the existing literature, the delivery of agents topically applied through the skin (Lee et al. 2013; Sklar et al. 2014). The two types of lasers most studied are CO_2 and Er:YAG.

Although several articles in the literature demonstrate such efficacy, there are contests based on the histological findings of rapid fibrin formation obstructing the channels formed in the MTZs. Initially, fibrin is formed in the dermal portion of the channel and progresses to the surface portions. In 5 min, more than 25% of the channel length is filled by a fibrin plug. Over time, the channels are progressively filled and, at 90 min, more than 90% of the channel length is occluded (Kositratna et al. 2016).

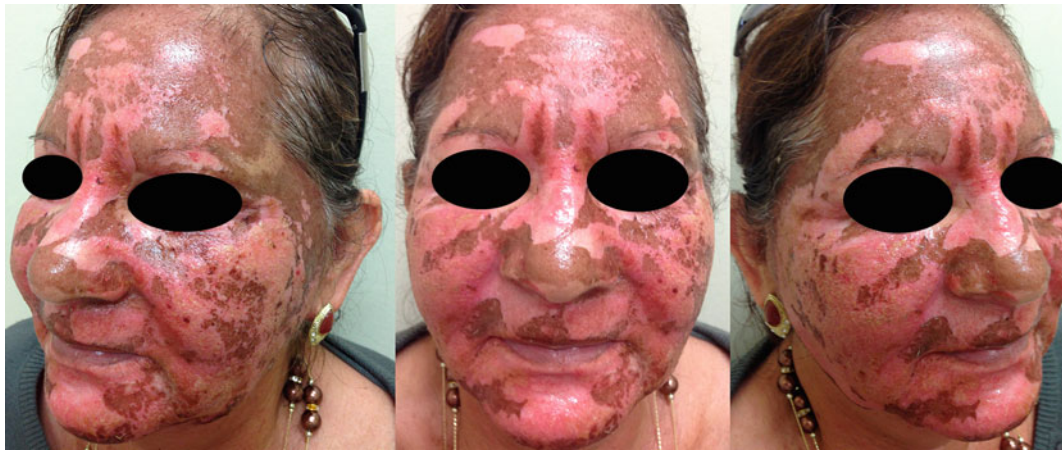

Fig. 10 Jessner's solution + 35% trichloroacetic acid + CO_2 LASER – 4th to 15th postoperative day

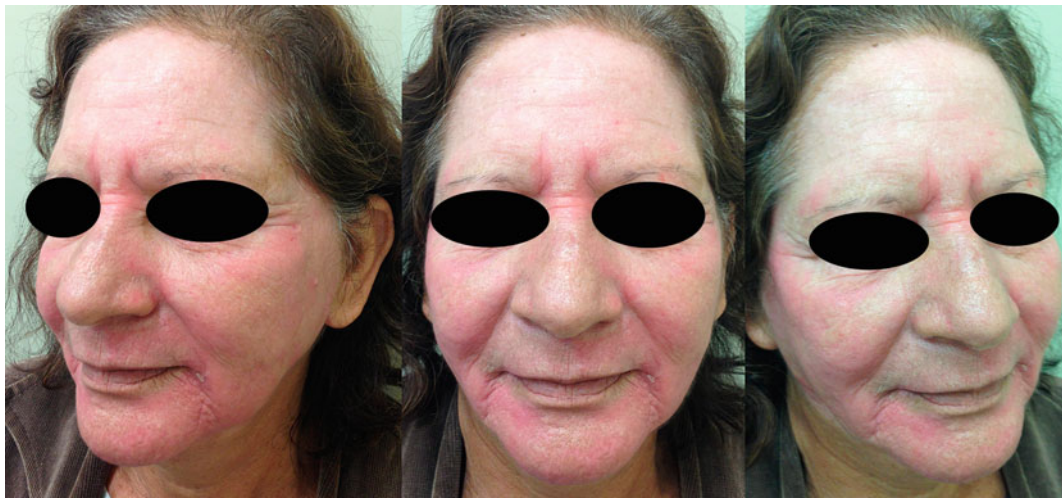

Fig. 11 Jessner's solution + 35% trichloroacetic acid + CO_2 LASER – 15th postoperative day

The most suitable surface peeling agent for application after ablative laser is 5% tretinoin. Retinoic acid stimulates neocolagenesis, in addition to causing homogeneous desquamation in the areas between the MTZ. The vehicle should be in cream, without alcohol. We verified a more homogeneous skin in terms of coloration and texture after performing the combined treatment. We have the habit of performing IPL + CO_2/erbium + ATRA with optimization of the results, in the same session. Retinoic acid, even with intact skin barrier, has a high penetration ability in the skin. With the formation of MTZs, retinoic acid reaches deeper layers faster, increasing the power of its action.

The combination of a Jessner and 35% trichloroacetic acid peel followed by a fractional ablating laser, such as CO_2, allows a homogenous removal of the entire epidermis, combined with the thermal effect of the MTZs. This association allows effective removal of melanoses and actinic and seborrheic keratoses, renewal of the epidermis, and neocolagenesis. Marked rejuvenation occurs (Figs. 8, 9, 10, and 11). Only profissional

with great experience are able to associate ablative lasers and chemical peels.

Take Home Messages

- Superficial peels are extremely versatile for combination treatments, including other peels and technology.
- Combination with superficial peels provides faster detachment of treated melanosis by Q-switched 532 nm laser or IPL.
- After the skin has been wounded by lasers or IPL, the best superficial peel to be applied is tretinoin, because it is a peel that has no immediate action.
- Before ablative lasers, any superficial- or medium-depth peel can be used, with improved uniformity of results. However, this combination should be performed by experienced doctors.

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Trichloroacetic Acid Peel

Patrick Silva Damasceno, Izelda Maria Carvalho Costa, and Keila Gabrielle Pati Gomes

Abstract

A chemical peel is defined as the application of a chemical agent to the skin, which causes a controlled destruction to a specific skin depth leading to exfoliation and removal of superficial lesions, followed by regeneration of new epidermal and dermal tissues with improved surface characteristics.

Chemical peels have been used to improve the skin health and appearance for thousands of years. In 1882, the German dermatologist Unna reported the exfoliating properties of trichloroacetic acid (TCA), phenol, resorcinol, and salicylic acid.

Our society's increasing emphasis on youthful image and aesthetic appearance has resulted in a high demand for skin care products, professional assistance from physicians and nonphysicians and interventional procedures.

It is noteworthy that one medium-depth peel session using the association between Jessner's solution plus TCA 35% can result in a significant improvement in moderate photoaging hardly achieved in a single session of newer technologies.

This chapter will discuss chemical peeling classification, indications, contraindications, skin preparation, medium peel procedure, and some complications with focus in trichloroacetic acid as a medium-depth peel.

Keywords

Chemical peeling • TCA • Peels • Medium-depth peel • Trichloroacetic acid • Jessner • Peeling care • Complications

Contents

P.S. Damasceno (✉) • I.M.C. Costa • K.G. Pati Gomes
Department of Dermatology, University of Brasilia, Brasília, DF, Brazil
e-mail: patrick.damasceno@gmail.com; izelda.costa@gmail.com; izelda@brturbo.com; keila.pati.gomes@gmail.com

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Introduction

Chemical peeling have been used to improve the skin health and appearance for thousands of years. The first records of skin improvement due to chemical peels were reported in ancient Egypt when Cleopatra used sour milk (now known to contain lactic acid) in order to obtain a smoother skin surface. Later, during the French Revolution, ladies of the court used old wine (known to contain tartaric acid) to enhance the appearance of the skin (Brody et al. 2000; Savant 2005). However, only in 1882, the German dermatologist Unna reported the exfoliating properties of trichloroacetic acid (TCA), phenol, resorcinol, and salicylic acid. In the mid-twentieth century, the physicians learned how to use chemical peels as phenol and trichloroacetic acid for facial rejuvenation and improvement of scars resulting from acne. In the late 1980s, they introduced new surface agents with fast recovery time, the alpha-hydroxy acid peels (Lupi and Cunha 2011; Gadelha and Costa 2009).

Our society's increasing emphasis on youthful image and aesthetic appearance has resulted in a high demand for skin care products, professional assistance from physicians and nonphysicians and interventional procedures. Resurfacing methods as a dermatology practice were described over 100 years ago, with their role expanding dramatically over the last several decades. The use of chemical peels have resisted through time and through the advent of newer techniques such as mechanical (motorized dermabrasion or manual dermasanding) and laser resurfacing because of its safety and efficacy record (compared to newer options), its low complexity, low cost, and potential benefits (Brody et al. 2000; Small 2009). It is noteworthy that one medium-depth peel session using the association between Jessner's solution plus TCA 35% can result in a significant improvement in moderate photoaging hardly achieved in a single session of newer technologies (Lupi and Cunha 2011; Gadelha and Costa 2009).

A Chemical peel is defined as the application of a chemical agent to the skin, which causes a controlled destruction to a specific skin depth leading to exfoliation and removal of superficial lesions, followed by regeneration of new epidermal and dermal tissues with improved surface characteristics. Peels are classified according to their depth of penetration. The Trichloroacetic Acid (TCA) may be used in very superficial, superficial and medium depths according to its concentration (Table 1) (Khunger 2008; Bolognia et al. 2012; Tung and Rubin 2011).

Indications

The preprocedure consultation is essential to identify patients who are ideal candidates for intervention as well as to identify at-risk patients who are best avoided or who require an extra-cautious approach. The current indications for medium-depth peels include epidermal lesions, pigmentary disorders, acne issues, and aesthetic (Table 2) (Monheit and Kayal 2003; Khunger 2008; Rendon et al. 2010; Patel et al. 2014; Hession and Graber 2015). The mild depth can also be used in blending of the effects of deeper resurfacing procedures (Bolognia et al. 2012; Tung and Rubin 2011).

Photoaging is one of the conditions for which skin mild-depth peels are most often performed and in these patients, the Glogau scale (Table 3) is very helpful in the peel depth choice decision (Glogau 1996). Patients in type I can be managed with superficial chemical peels or microdermabrasion in association with medical cosmeceutical therapy (e.g., glycolic acids, topical retinoids, active cosmeceutical formulas) as they are frequently youthful with minimal to mild photoaging. Individuals in type II are better treated with a medium-depth chemical peel associated with a long-term medical therapy including an α-hydroxy acid (AHA) and/or a retinoid. Patients in category III normally need

Table 1 Classification of peels based on depth of action

Classification	Depth	Examples
Very superficial-light peels	Necrosis up to the level of stratum corneum	TCA 10%, Glycolic Acid (GA) 30–50%, Salicylic acid 20–30%, Jessner's solution (1–3 coats), Tretinoin 1–5%
Superficial-light peels	Necrosis through the entire epidermis up to basal layer	TCA 10–30%, GA 50–70%, Jessner's solution (4–7 coats)
Medium-depth peels	Necrosis up to upper reticular dermis	TCA 35–50%, GA 70% plus TCA 35%, 88% phenol un-occluded, Jessner's solution plus TCA 35%, solid CO_2 plus TCA 35%
Deep peels	Necrosis up to mid-reticular dermis	Baker-Gordon phenol peel

Table 2 Possible indications of medium-depth chemical peels

Epidermal lesions
Seborrheic keratoses
Actinic keratoses
Warts
Milia
Sebaceous hyperplasia
Dermatoses papulosa nigra
Pigmentary disorders
Melasma
Postinflammatory hyperpigmentation
Freckles
Lentigines
Facial melanoses
Acne related
Superficial to mild acne scars
Postacne pigmentation
Comedonal acne
Acne excoriee
Acne vulgaris-mild to moderately severe acne
Aesthetic
Photoaging
Fine superficial wrinkling
Dilated pores
Superficial scars

prolonged medical treatment with a medium-depth chemical peel (with or without dermasanding), a deep chemical peel, dermabrasion, laser resurfacing or associations between them. In type IV patients, the therapies described to type III would certainly be indicated; however, invasive surgical operation such as blepharoplasty, rhytidectomy, scar revision, and others are frequently needed in addition to achieve the expected results (Bolognia et al. 2012; Tung and Rubin 2011; Khunger 2008; Monheit 2004).

During the discussion on correct indication, some data are of extreme relevance. Head and neck are the most important areas due to their aesthetic value, and one must take caution when treating the neck due to its propensity for complications. It is known that areas with more pilosebaceous units have better re-epithelialization (Bolognia et al. 2012). Also beware when indicating procedure to hands and arms because they have less predictable and less impressive results (Gadelha and Costa 2009). Lesions originated in the epidermis (actinic keratosis, lentigines) have betters responses to chemical peels than lesions originated in the dermis (Tosti et al. 2006).

The indication also depends on the patient's tolerances and expectations for correcting his skin condition. Some individuals do not wish to enhance skin surface regardless of serious issues, and others desire marked improvement in relatively minor problem areas. The condition severity and the patient wishes will lead the treatment (Gadelha and Costa 2009). These wishes ought to be tempered with data on what is conceivable and what is alluring for the patient regarding treatment. Approach every patient honestly, discussing about plausible outcomes, risks, advantages, and alternatives (Gadelha and Costa 2009; Bolognia et al. 2012).

Contraindications

History of AIDS, hepatitis, immunosuppressive systemic diseases, or usage of immunosuppressive medication must be identified, as they seem to grant higher frequency of secondary infection after the procedure. In a similar way, a history of abnormal scars or keloids deserves more attention as these patients may end up with an unpleasant

Table 3 Glogau photoaging classification

Type I – No wrinkles
Early photoaging: mild pigmentary disorders, minimal wrinkles, no keratosis Patients typical age (years): 20s or 30s Makeup: Minimal or none
Type II – Wrinkles in motion
Early to moderate photoaging: Early senil lentigines visible, parallel smile lines beginning to appear, keratosis palpable but not visible Patients typical age (years): 30s or 40s Makeup: Usually wear some foundation
Type III – Wrinkles at rest
Advanced photoaging: Obvious dyschromia, telangiectasias, visible keratosis, wrinkles even when not moving facial muscles Patients typical age (years): 50s or older Makeup: Wears heavy foundation
Type IV – Only wrinkles
Severe photoaging: yellow-gray color of skin, prior skin malignancies, wrinkled throughout with no normal skin Patients typical age (years): 60–70s Makeup: Cannot wear ("cakes and cracks")

Table 4 Fitzpatrick's classification of sun-reactive skin types

Skin type	Color	Reaction to first summer exposure
I	White	Always burn, never tan
II	White	Usually burn, tan with difficulty
III	White	Sometimes mild burn, tan average
IV	Moderate brown	Rarely burn, tan with ease
V	Dark brown[a]	Very rarely burn, tan very easily
VI	Black	No burn, tan very easily

[a]Asian Indian, Hispanic, Oriental, or light African descent, for example

outcome. Fitzpatrick sun-reactive skin type classification is another concern, as skin types IV, V, and VI tend to develop postinflammatory hyperpigmentation (Table 4) (Rullan and Karam 2010; Monheit 1995). Patients in use of contraceptives, supplemental hormones, or minocycline should be alerted due to the high risk of postinflammatory hyperpigmentation. Always question about history of facial surgery, prior resurfacing procedure, or oral isotretinoin use in the last 6 months as these can also increase complications (Dingman et al. 1994; Rubenstein et al. 1986). History of radiation therapy is important as it can destroy the pilosebaceous units, which are essential to re-epithelialization (Wolfe 1982).

Special care should be taken in patients with some dermatologic diseases. Vitiligo and psoriasis can be exacerbated due to the isomorphic response. The vasomotor instability in rosacea can lead to an exaggerated inflammatory response postprocedure (Gadelha and Costa 2009). Connective autoimmune diseases, such as cutaneous lupus and scleroderma, can be activated by the chemical peeling trauma. The contraindications in mild-depth peels can be divided into absolute and relative (Table 5).

Besides the contraindications, it is also important to consider the presence of inflammation (seborrhea, retinoid dermatitis, etc.) and skin translucency as the more inflammation present and the more translucent the skin is, the more likely the peeling will increase its depth, leading to possible complications. Have in mind that telangiectasia treatment is not a good chemical peeling indication because it has an unsatisfactory response. Besides, the peeling can also exacerbate them by removing the pigmentary irregularities (Bolognia et al. 2012; Tung and Rubin 2011).

Patients must completely understand the peeling limitations, pre and post care, risks and potential benefits, and must sign an informed consent prior to the procedure. If you feel vulnerability in physician-patient relationship, do not perform the procedure.

Trichloroacetic Acid Peel

Trichloroacetic acid (Fig. 1) is very versatile as it can be used to create very superficial, superficial and medium-depth peels depending on the concentration of TCA used (Table 1), adequacy of skin priming, coats of acid applied, and technique of application. TCA is most commonly used for medium-depth peels, especially to treat pigmentation disorders and early facial rhytides (Lee et al. 2002).

Table 5 Contraindications to mild-depth and deep peels

Absolute
Open wounds
Active infections (bacterial, viral, or fungal)
Use of oral isotretinoin in the last 6 months
Pregnancy
History of drugs with photosensitizing potential
Patient with unrealistic expectations
Uncooperative patient (patient is careless about sun exposure or application of medications)
Poor physician-patient relationship
Relative
Recent facial surgery in the last 6 months
History of abnormal scar formation or delayed wound healing
History of hyperpigmentation
History of therapeutic radiation exposure
Fitzpatrick Phototype IV, V, and VI
History of active dermatologic diseases such as seborrheic dermatitis, rosacea, atopic dermatitis, vitiligo, contact dermatitis, and psoriasis

TCA is a caustic substance obtained through distillation of the product from nitric acid steam on chloral acid. It is found in our environment as an herbicide, as a major metabolite of dry cleaning process and as chemical peels. It has almost nonexistent toxicity, even when applied in concentrated form on the skin. TCA has the lowest pKa and is stronger than any other acids used as chemical peels. As it progresses through the distinctive skin layers, the acid peeling is "neutralized," prompting a coagulation of skin proteins.

Its action is proportional to the concentration and to the amount applied. Higher concentrations of TCA lead to more acidic solutions and deeper penetrations. Higher number of coats or more pressure applied during the procedure also lead to deeper penetration. Note that depending on the skin area, higher number of coats needs to be applied (at same concentration) to achieve the same level of frosting (Fig. 2). As a peculiar characteristic of TCA, its visual changes (from light speckling to white frost) following application in the skin indicate degree of protein coagulation (Tung and Rubin 2011; Landau 2008).

TCA peel should be stored in a cool and dry area in a well-ventilated room. The storage recipient should be unbreakable, and it is preferable to keep TCA peel solutions in opaque glass bottles (Tung and Rubin 2011).

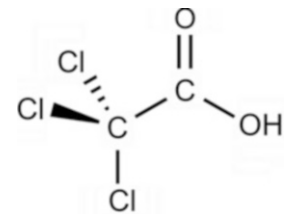

Fig. 1 Molecular structure of TCA

Trichloroacetic Acid as a Medium-Depth Peel

The medium-depth peels produce epidermal and papillary dermal necrosis with papillary dermal edema and homogenization and occasionally, necrosis up to the upper reticular dermis (0.45 mm) with a sparse lymphocytic infiltrate seen within the first several days in the histology. Due to its deeper penetrations, the patient's recovery time is much higher than in superficial depth peelings, happening between 7 and 14 days here. Along a period of 3 months after the procedure, there is an increase of collagen production with an expansion of the papillary dermis and the development of a band of thick fibers in the mid-dermis. The clinical effects of TCA are due to the resultant increase in dermal volume of collagen, glycosaminoglycans and elastin (Handog et al. 2012). These modifications correlate with a continued clinical improvement of the skin during this time.

For many years, TCA in 40–50% concentration was the "gold standard" of the medium-depth chemical peels. However, it was noted that this agent showed a high number of complications, such as dyschromias and cicatricial abnormalities (Fig. 3) (Velasco et al. 2004). These facts resulted in the development of medium-depth peels by a combined therapy: first using a surface agent to cause injury to the epidermis and then applying the TCA 35%. With these two steps, the end result will be a more controlled and smoother procedure with the penetration of the TCA in the papillary dermis (Salam et al. 2013).

Nowadays, the most used combinations are: Jessner's solution and TCA 35% (Monheit combination), glycolic acid 70% and TCA 35%

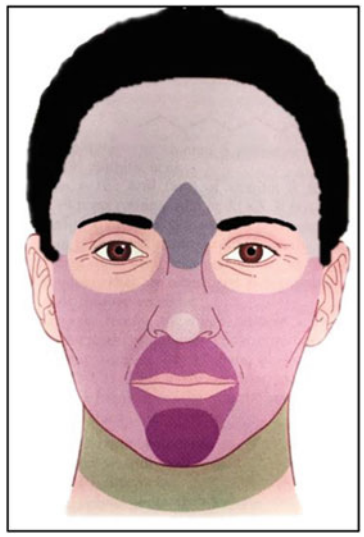

Fig. 2 Skin reactivity to TCA coating. Higher number of coats needs to be applied in darker areas (at same concentration) to achieve the same level of frosting

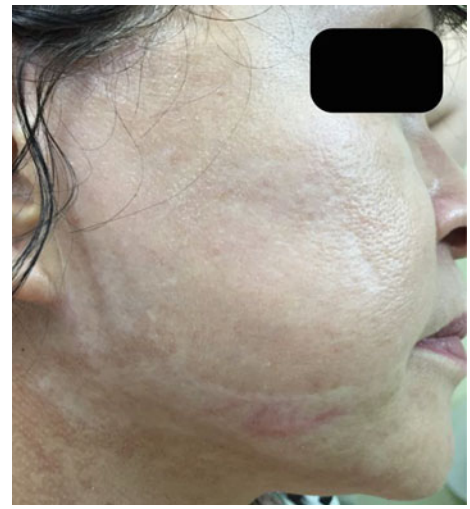

Fig. 3 Scars after 6 months of TCA 50% procedure

(Coleman combination), and Solid CO_2 and TCA 35% (Brody combination). All these associations are as effective as higher TCA concentrations isolated, presenting, however, safer profile. It is important to note that multiple superficial chemical peels generally do not equal the efficacy of a single medium-depth peel. TCA as a medium-depth peeling offers a wide range profile of efficacy (Table 6) (Fischer et al. 2010). In actinic keratosis treatment, Jessner's solution plus 35% TCA peel has been found as effective as topical 5-fluorouracil chemotherapy with lower morbidity and associated improvement in photoaging (Lawrence et al. 1995).

Preparation for Medium-Depth Peeling

Based on the presented information and after the right decision on the procedure indication, some topics must be observed in order to ensure the expected result minimizing possible complications. Take necessary time to answer all the patient's doubts about the procedure. Never forget to photograph patient's skin areas to be submitted to the procedure before the chemical peel for future comparison.

In case of aesthetic complain, some of the patients who are candidates to be submitted to chemical peeling also would benefit from botulinum toxin. If so, it is recommended the injection before the chemical peeling. Botulinum toxin appears to enhance the results of medium-depth peeling by immobilizing the muscles implicated in development of dynamic rhytides during postoperative collagen remodeling. It is important to advise patient not to use Tobacco as it can limit the procedure effectiveness and as it can lead to poor wound healing. A sunscreen with activity in the range of both UVA and UVB (preferable one containing titanium dioxide or zinc oxide) is required in all patients. Patients with Fitzpatrick skin type III–VI (Table 5) may benefit from twice daily application of a 4–8% topical hydroquinone in preoperative and in posthealing, even when they do not have history of pigmentary disorders. Hydroquinone blocks the tyrosinase enzyme, reducing the production of epidermal melanin that may be induced in the procedure.

When the history of herpes simplex recurrent infection is present, caution should be taken as it can be triggered by chemical peels use, especially in periorbital and perioral areas. It is recommended prophylaxis with acyclovir

Table 6 Efficacy TCA treatment

Excellent to good response
Actinic keratoses
Superficial melasma
Superficial hyperpigmentation
Ephelides
Lentigines
Depressed scars (CROSS technique)
Variable response
Seborrheic keratoses
Hypertrophic keratoses
Mixed melasma
Mixed hyperpigmentation
Poor response
Thick seborrheic keratoses
Deep melasma
Deep hyperpigmentation

400 mg three times daily, famciclovir 250 mg twice daily or valacyclovir 500 mg twice daily beginning in the procedure day during at least 10–14 days (Gadelha and Costa 2009; Bolognia et al. 2012).

Using topic tretinoin on a nightly regime prior to the procedure could lead to faster re-epithelialization as retinoids increase epidermal proliferation. Tretinoin increases the depth of a chemical peel by decreasing the thickness of the stratum corneum. A retinoid, typically tretinoin 0.02–0.1% cream, is prescribed as soon as possible. Its effect is observed after just 14 days of daily use. Beware of retinoid dermatitis, which should delay the procedure to prevent prolonged postoperative erythema. After the procedure, you must wait the complete re-epithelialization to restart using retinoids. Exfoliants such as glycolic acid or lactic acid result in decreased corneocyte adhesion and stimulate epidermal growth by disrupting the corneum stratum (Lupi and Cunha 2011; Gadelha and Costa 2009; Khunger 2008).

Jessner's Solution and 35% TCA (Monheit Combination)

The most popular combination for medium-depth peels is the Jessner's solution plus TCA 35% peel. It uses Jessner's solution (14 g resorcinol, 14 g salicylic acid, 14 g 85% lactic acid, with ethanol added to create a total volume of 100 ml) which grants a keratolytic action altering the epidermal barrier prior to TCA application, inducing a better uniform and rapid uptake (Figs. 4, 5, and 6) (Tung and Rubin 2011).

In preparation for this association, the patient should be positioned with the head elevated at 30° and vigorous scrub of the area with acetone or alcohol is applied for 2 min. Pay attention to sebaceous regions such as glabella, hairline, temples, nose, and upper lip. This action leads to greater penetration of agents and better uniformity of procedure. Patient must be instructed to keep their eyes closed during the procedure (if the peeling will be applied on face). In case of hypertrophic actinic keratosis, curettage may be performed before procedure to induce better peel absorption.

The Jessner's solution can be applied with gauze pads folded in four or large cotton swabs. One or two coats of this solution are applied producing erythema and speckled white frost, however, lighter than the TCA (applied later). It is preferable to begin the procedure with the forehead, followed by the malar regions, nose, and chin. After applying Jessner solution, it is recommended to wait 2 min prior to TCA application. Some authors apply a topical anesthetic (i.e., EMLA-lidocaine 2.5% and prilocaine 2.5%) to the area prior to TCA, making the procedure more tolerable. Next step is to apply TCA 35% in the same manner described, taking care not to use gauze soaked with the product. The eyelids are left for last, respecting 3–4 mm away from the eyelid edges. To the eyelids, use cotton swabs. Possible tears must be dried during the procedure to prevent eye damage by capillary attraction. Furthermore, tears run through face diluting agent causing a strip of skin with more superficial exfoliation than planned. Tears with the product can get to the neck, bringing acid for an unprogrammed area. At this stage, patient will feel low- to moderate-intensity pain.

After application, contiguous white frosting begins to appear within 30 s and matures over 2–3 min. At this time, the frosting level (Table 7) should be evaluated having in mind that the desired frosting level for medium-depth peelings is the level II to III. Have in mind that areas with higher tendency to form scars, such as the zygomatic arch and

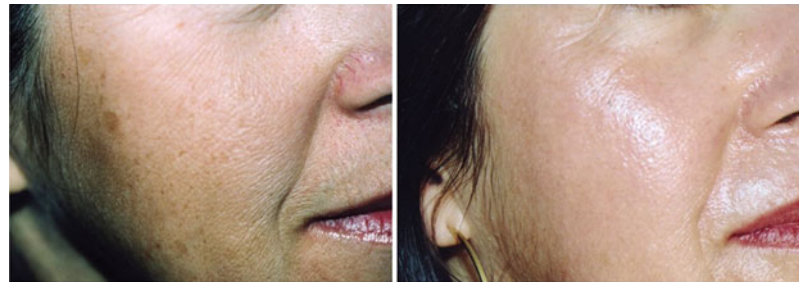

Fig. 4 Patient 1 before and 4 months after Jessner's solution plus TCA 35%.

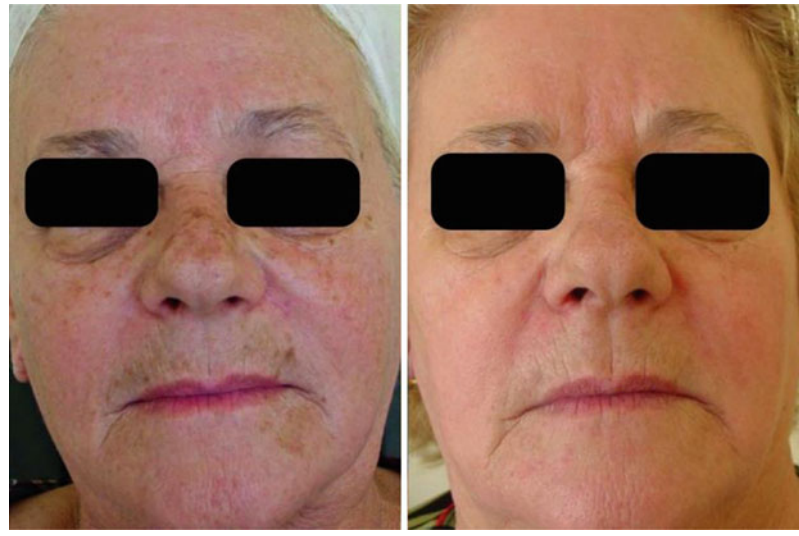

Fig. 5 Patient 2 before and 3 months after Jessner's solution plus TCA 35%.

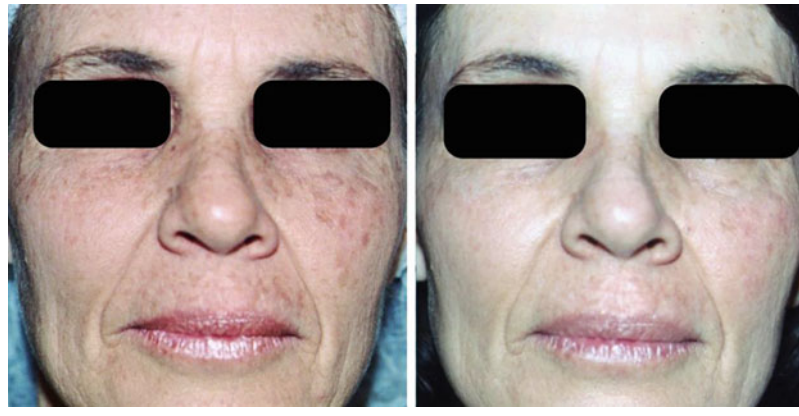

Fig. 6 Patient 3 before and 6 months after Jessner's solution plus TCA 35%.

bony prominences of the jaw line and chin, should not receive frosting level higher than II. Few minutes later, the frost is clear, as well as discomfort due to the important burning sensation, which can be alleviated with the use of fans. You should be careful with the reapplication, reserving them for the incomplete areas. When necessary, you must wait 3–4 min to identify the frosting peak areas avoiding extra-coats in these areas to prevent greater depth and consequently unexpected responses.

Table 7 Frosting grading

Frosting level	Peel type	Clinical response
I	Superficial	Speckled white Mild erythema
II	Medium	Even white coat Background erythema
III	Medium/ deep	Solid white, opaque No background erythema

Applying compresses with cold saline 0.9% makes the procedure more comfortable and provide great relief after the procedure. The white frost at this time will be substituted by erythema. Swelling after the procedure may arise. Collagen remodeling occurs for as long as 3–4 months after the procedure. The results are good, even in the first session, and there is not always a need for new sessions (Lupi and Cunha 2011; Gadelha and Costa 2009).

Glycolic Acid 70% and TCA 35% (Coleman Combination)

This is also a medium-depth peeling that gives similar depth as achieved by degreasing plus Jessner's plus TCA 35%. Histological studies conducted by Coleman show that the chemical injury occurs in the medium dermis with deposition of collagen and fibrous tissue in a "Grenz zone," occurring after 60–90 days of the procedure. The "Grenz zone" is similar to that observed in the combination Jessner + TCA 35% and slightly narrower than the one produced by CO_2 + TCA 35%. The Coleman combination is quite common in the USA as a medium-depth peel.

After positioning the patient with closed eyes and the head elevated at 30°, clean the skin with soap and water with no need of further degreasing. The 70% glycolic acid is applied using folded gauze pads or cotton swabs, and it must remain for strict 2 min. No bicarbonate solution is needed to neutralize the product here. After this period, we should rinse the area with cool tap water. After a few minutes, TCA 35% is applied in the same manner described for Jessner plus TCA 35% procedure above.

Solid CO_2 and TCA 35% (Brody Combination)

Brody published his use of solid CO_2 ice plus TCA 35% for medium-depth peel in 1986. The solid CO_2 creates epidermal injury without risk of deeper dermal freeze and subsequent hypopigmentation or scaring. A skin preparation is performed using alcohol or acetone for about 2 min. After that, you should apply the CO_2 in the desired area with different pressures depending on the depth planned (deeper rhytides around the mouth, thick actinic keratoses, acne scars, etc. must receive heavier freeze). Low pressure can be considered a pressure lasting 3–5 s, a moderate pressure 5–8 s, and a hard pressure 8–15 s. The skin is wiped dry following the TCA 35% peel. Dr. Brody treats the most sensitive areas first (the eyelids, nose, cheeks, and perioral region, followed by forehead). After the TCA 35% peel, cool ice packs wrapped in paper towels are used for 5 min and followed by an emollient. An important disadvantage of this procedure is the variability of technique-dependent results and the difficulty in maintaining and storing solid CO_2.

Post-Peeling Care

Compresses with cold saline for 20 min several times a day are useful, as well as the application of petrolatum. Trichloroacetic acid does not require neutralization. Cold compresses can be applied immediately to relieve the discomfort. The scaling and re-epithelialization will be complete within 7–10 days; however, in some patients, erythema may persist for 2–4 weeks. Edema may last several days with a peak in 48 h. Patient should be warned that preexisting pigmented lesions may become darker in the first few days. After the medium-depth peel procedure, patient must be instructed to stop all products (specially retinoids) used until re-epithelialization. Strict photoprotective measures should be undertaken. It is important to make clear that no further scrubbing is to be performed at home and the patient must resist the urge to pick, peel, or scratch the area. Another medium-depth peel is not recommended

for a period of 6 months, until the phases of healing are completed (Lupi and Cunha 2011; Gadelha and Costa 2009).

Advantages of Medium Peels with TCA

- The results are better than superficial peels
- TCA is an inexpensive solution that can be easily prepared. It is stable and has a long shelf life
- TCA peeling does not have systemic toxicity.
- The combination of a superficial peeling with TCA 35% produces predictable and safe results
- The TCA peelings, besides the cosmetic appearance improvement in photoaging, can also reduce future incidence of non-melanoma skin cancers.

Medium-Depth Peels Complications (See chapter ▶ "Managing Chemical Peels Complications")

Complications from chemical peels include prolonged erythema and pruritus, pigmentation changes such as postinflammatory hyperpigmentation, delayed wound healing, infection, textural changes to the skin, induction of acne or milia, bruises, and scarring (Levy and Emer 2012).

Pigmentary Disorders

Hyperpigmentation is more common in skin types IV–VI (Table 4). May arise during the first 5 days or until 2 months after the procedure. These complications are best handled with sunscreens, hydroquinone, kojic acid, and azelaic acid. In resistant cases, another exfoliation can be performed (TCA 10%, Jessner's solution or glycolic acid 50% are the best choices). Hyperpigmentation is common but, in general, are transitory and respond well to established treatments. Hypopigmentation usually happens when the procedure gets deeper than planned and is difficult to treat.

Persistent Erythema

The post peeling rash usually disappears in a few weeks. It is characterized by the skin remaining erythematous beyond what is normal for an individual peel. Erythema disappears normally in 3–5 days in superficial peel, 15–30 days in medium peel, and 60–90 days in deep peel. Erythema persisting beyond the abovementioned time is abnormal and is an alarming sign. It is a predictor of potential scarring as the persistent redness may indicate or evolve into future hypertrophic scars. The main causes are pre-existing diseases such as rosacea, atopic dermatitis or lupus, contact eczema by the peeling product, or substance used in postexfoliation and also by use or recent use of oral isotretinoin. Treatment should be performed with potent topical corticosteroids.

Infections

Bacterial, viral, or fungal infections may arise and should be readily handled based on etiology. Bacterial infection is rare in TCA and phenol peels since these peels are bactericidal. An important risk factor for bacterial infection is prolonged application of biosynthetic membranes or thick occlusive ointments and poor wound care. It is important to get a swab for culture and sensitivity whenever is possible. Pay attention to immunocompromised patients and diabetics as they are candidates for candidal infection. Superficial pustules can be seen in candidal infections. Also consider recent intake of antibiotics and prolonged topical steroid use as a pre-disposing factor. Herpes simplex infection is characterized by reactivation of herpes simplex on face and perioral area presenting as sudden appearance of grouped erosions associated with pain (Brody 2001).

Scars

Scars may occur in patients with a history of keloid, who underwent peeling when using oral isotretinoin in the first 6 months of use. They can also occur in case of secondary infections, trauma,

or if the scales are taken off by the patient in the postpeeling period. The risk of hypertrophic scarring from medium-depth peels is rare. If it occurs, it is most commonly seen along the mandibular region and in the perioral regions. TCA is more caustic than phenol and may be more likely to produce scarring (Nikalji et al. 2012). The treatment should be initiated as soon as possible with use of a potent topical corticosteroids or intralesional corticosteroid.

Other Complications

Pruritus, delayed wound healing, bruises, acneiform rash, and allergic reactions to products used are some other complications. Agents as trichloroacetic acid (TCA) or glycolic acid have no report of genuine allergic reactions; however, the TCA can lead to cholinergic urticaria (Tung and Rubin 2011).

Take Home Messages

- It is noteworthy that one medium-depth peel session can result in a significant improvement in moderate photoaging hardly achieved in a single session of newer technologies.
- Never forget to photograph patient's skin areas to be submitted to the procedure before the chemical peel for future comparison.
- The most popular combination for medium-depth peels is the Jessner's solution plus TCA 35% peel.
- Applying compresses with cold saline 0.9% makes the procedure more comfortable and provide great relief after the procedure. The scaling and re-epithelialization will be complete within 7–10 days. Edema may last several days with a peak in 48 h.
- Collagen remodeling occurs for as long as 3–4 months after the procedure.

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Combining Trichloroacetic Acid Peel

Bogdana Victoria Kadunc

Abstract

Chemical peelings are among the most widespread aesthetic procedures used in dermatology, since the past centuries. Their best indications include active acne, rosacea, dyschromias, facial and extrafacial photoaging, and some other skin disorders. Successful outcomes can be achieved with careful patient selection as well as appropriate use of specific peeling agents. Trichloroacetic acid is considered the most useful substance in chemical peels for its versatility, accuracy of action on the skin, and absence of systemic toxicity. It can be used, as a caustic agent, for several types of chemical peels and other procedures. In the present review, we summarize the history records about this procedure and the current knowledge on trichloroacetic acid peels, including indications, contraindications, the skin conditioning, details of application, results, and complications. The combination of trichloroacetic acid peelings with other substances and procedures is also covered.

Keywords

Chemical peels • Trichloroacetic acid • Photoaging • Dyschromias • Acne • Rosacea • Actinic keratosis • 5FU • Dermabrasion

B.V. Kadunc (✉)
Pontifícia Universidade Católica de Campinas, São Paulo, SP, Brazil
e-mail: bog@uol.com.br

Contents

Introduction

Chemical peels (CPs) have been prominently used in dermatological procedures since ancient times. Improvements in skin quality and appearance through exfoliation dating back to 1560 are described in the Egyptian *Ebers Papyrus*. In the 1882 book *Therapéutique générale de la peau*, written by Unna, dermatology is mentioned as a lead specialty using chemical peels for therapeutic purposes (Collins 1987).

Emerging from empirical experiences long explored by the laymen, these dermatological

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procedures have since become academic techniques with ethical standards after their properties have been confirmed by experimental, toxicological, and histological studies.

CPs are commonly indicated for the treatment of acne vulgaris, dyschromia, rosacea, and photoaging at different severity levels of presentation. The indication of this kind of treatment must always be based on etiopathogenic criteria and anatomopathological correlations.

According to the depth of penetration into the skin, CPs are classified as very superficial, superficial, medium, and deep. Very superficial peels penetrate the stratum corneum and the granular layer; superficial peels, also known as epidermal peels, can affect the dermoepidermal interface and penetrate the papillary dermis up to 0.45 mm; medium peels reach the superior reticular dermis up to 0.6 mm; and deep peels penetrate the medium reticular dermis and can reach 0.8 mm, which is the upper limit of penetration to prevent scarring (Rubin 1995).

Resorcinol, salicylic acid, trichloroacetic acid (TCA), and phenol are among the most common substances found in CPs along with the more recently introduced alpha hydroxyacids, pyruvic acid (alphaketo acid), and retinoic acid. Each of these substances is associated with a different mechanism of action: keratolysis, keratocoagulation, and epidermolysis.

TCA stands out for its safety and versatility. At different concentrations (between 15% and 45%), volumes, and degrees of friction during application, very superficial, superficial, and medium peels can be obtained (Collins 1989). It has been used alone or in combination with other substances, as well as associated with other procedures.

It has been reported that 50% TCA, if occluded with tape, can yield deep CPs. However, in concentrations higher than 45%, it can cause necrosis through deeper layers of the skin, leading to the development of dyschromic and hypertrophic scars (Resnik 1984; Ayres 1960; Resnik et al. 1976; Stagnone et al. 1987). For this reason, 35% TCA is used for combined medium CPs as it is well established that the combination of different substances or procedures can reduce the risks associated with each substance used alone.

Trichloroacetic Acid (TCA) Peel

TCA: Literature Review

The first major study on the application of TCA (see chapter ▶ "Trichloroacetic Acid Peel," Vol. 2) in human skin was published by Monash in (1945). He locally applied TCA for the treatment of xanthelasma palpebrarum, flat warts, and molluscum contagiosum. He also treated pityriasis versicolor, chronic eczema, and skin lesions caused by lupus erythematous using this substance. TCA CPs were applied all over the face in cases of melasma and acne scars. He used TCA water solutions diluted between 15% and 50% because he previously observed that higher concentrations led to the development of keloid lesions.

Between 1960 and 1962, Ayres (1960, 1962), a dermatologist from Los Angeles, published two articles on TCA. He reported that TCA is extremely potent at its maximal concentrations and has a caustic action much stronger than that of phenol but established that it could be used safely at 25% or 50% dilutions. He also tested the substance in the urine of his patients and concluded that there was no systemic absorption. In his histopathological studies, he was the first to notice the importance of the evaluation of necrosis and tissue repair induced by a chemical substance on the skin. The thickness of necrosis during acute phase and the new collagen layer formed in the dermis were measured 3 weeks after the exfoliation, and he noticed that those values were similar.

In 1976, a study by Resnik et al. (1976) evaluated CPs: superficial, using 20% TCA; medium, using 35% TCA; and deep, using 50% or 70% TCA. The latter was considered a safer alternative to phenol, which could be contraindicated because of its systemic toxicity. However, reports of hypertrophic and atrophic scarring caused by TCA at a concentration higher than 45% became frequent (Lober 1987).

A histological study on pig skin concluded that the depth of aggression to the skin caused by TCA is proportional to the concentration used, as 35–50% TCA penetrate 0.3/0.4 mm and 80% TCA penetrate 0.8/0.9 mm. They concluded that the use of TCA at 50% or higher could cause scarring due to deep necrosis (Roenigk and Broadland 1993).

Thus, since 1980, the aim of specialists has been to deepen exfoliations with TCA in smaller concentrations, to obtain results comparable with phenols with lower risks.

To address this issue, studies emerged in literature on combined CPs that consist of the application of other exfoliation procedures or substances prior to treatment with 35% TCA. In 1986, Brody and Hailey (1986) described this combination for the first time, recommending superficial exfoliations with solid carbon dioxide followed by the immediate application of 35% TCA. According to the authors, with this association, there was sufficient epidermal renewal and a good dermal stimulus with a reduced risk of scarring.

For the same purpose, Monheit (1989) described a variation of this technique in 1989: he combined the Jessner's solution, containing 14% resorcinol, salicylic acid, and lactic acid in ethanol (also known as Combes formula), with 35% TCA, and reported the occurrence of keratolysis and protein coagulation caused by each substance, respectively. In 1994, Coleman also published a similar technique for medium CPs that combined 70% glycolic acid and 35% TCA (Coleman and Futrell 1994).

TCA: Features

Trichloroacetic acid ($C_2HCl_3O_2$) is the prototype of chemical substance for CPs. Its mechanism of action is cutaneous necrosis through the coagulation of intracellular proteins. It consists of deliquescent white crystals highly hygroscopic and is soluble in water, alcohol, and ether. TCA has very intense caustic power and is more potent than phenol at maximum concentrations.

Alcoholic solutions of TCA do not cause good skin penetration, and therefore water is the ideal vehicle for its use. Several different methods can be employed for the preparation of solutions from crystals. To produce 30% TCA, for example, two different methods for dilution are used: the European method, weight/weight (30 g TCA crystals +70 g water), and the standard pharmaceutical (American) method, weight/volume (30 gTCA crystals + water to bring the final volume of the solution to 100 mL).

Studies have shown that a weight/volume method should be adopted, and the physician should inform the intended method to the pharmacist so that the responses can be compared and reproduced (Brindestine and Dolezal 1994).

For stability, the initial concentration is maintained after 23 weeks of storage in amber glass bottles at ambient temperatures.

According to several studies, there is no systemic toxicity associated with the use of this substance on the skin (Ayres 1960; Resnik et al. 1976; Stagnone et al. 1987).

TCA absorption correlates directly with the presence and intensity of erythema and frosting. These signs are very important and have almost precise histological correspondence (Johnson et al. 1996). This advantage makes TCA application easy and safe.

The visual features of TCA action on the skin comprise the following: level 0, absence of erythema and frosting; level 1, irregular light frosting and mild erythema; level 2, mottled frosting with visible erythema; and level 3, continuous and intense solid frosting without erythema. The faster, more solid, and uniform the bleaching, the greater the depth achieved (Rubin 1995).

Chemical Peels: Previous Preparation

One disadvantage in using TCA is its irregular absorption by the skin. It can be observed that frosting is not always uniform and results in variable degrees of exfoliation. Therefore, conditioning the skin with tretinoin to make the cutaneous surface more even is very important because this procedure helps to make the absorption faster and more uniform and as consequence more predictable.

Using tretinoin before the CP procedure also shortens the healing period as this substance can stimulate epidermal proliferation and blood flow to the tissue (Hevia et al. 1991). The standardized photoprotection measures should be adopted when using tretinoin as well as for patients undergoing CP procedures.

In preparing patients for CP, necessary measures are taken to prevent an outbreak of herpes simplex, an acute complication frequently reported. The use of antiviral drugs – acyclovir (800 mg 8/8 h), valacyclovir, or famciclovir – with a prophylactic effect is recommended, starting 2 days before the procedure and prolonging it from 3 days to 2 weeks after, depending on the depth of exfoliation. The deeper the exfoliation, especially in the perioral region, the more intense the care should be, even in patients who did not mention previous outbreaks (Perkins and Sklarew 1996).

Chemical Peels: Application Technique

The basic materials required to perform a CP are simple and inexpensive and comprise deffating material, peeling chemical agents, applicators, gauze, neutralizing substances, and a syringe containing saline to be used in case of unintended eye contact with any of the substances. The modern air-cooled systems, which have become popular with laser procedures, now replace the ventilators used for pain control during the application of CP.

Before starting the procedure, a detailed examination of the target skin is carried out, associating it to the pathology in focus and to the degree of previous preparation.

The depth of absorption of the substance is a consequence of multiple factors, dubbed dynamically interactive variables by Duffy (1998). These include thickness and degree of oiliness of the target skin, integrity of the skin barrier, presence and density of skin appendages, degree of previous degreasing, drug concentration, rubbing, occlusion, and the number of coats (volume) of agents used. The latter is the most important factor. All these details must be simultaneously considered at the time of the application, so that the exfoliation results in the desired therapeutic proposal without risk of scarring or unnecessary aggressions.

The use of topical or infiltrative anesthesia for superficial and middle CP is not common. It may be possible to use the trigeminal nerve blocks in the mid-pupillary line for medium exfoliations, especially in more sensitive patients. Anxiolytics, sedatives, and systemic analgesics may be administered prior to the procedure to make the painful effects bearable.

Cleansing the skin with neutral soap and water and degreasing it with ethyl alcohol, ether, or acetone is necessary for uniformity of the skin surface, control of the intended absorption of the agent, and removal of sebum, cell debris, or a certain portion of the stratum corneum. It should be graded according to the tolerance and sensitivity of the skin, the substance in use, and the planned depth of the CP.

The chosen caustic substances are then applied. The mode of application – gauze or cotton-tipped applicators – can be elected by the specialist. The application is initiated on the frontal region, where the skin is less sensitive, more uniform, and shows a more predictable response compared to the rest of the face, followed by the zygomatic-malar region, upper lip, chin, nose, and, finally, the eyelids. A new applicator must be used in each region, and undesirable absorption by excessive volume of caustic substance must be avoided.

In the medium-depth CPs where Jessner's solution (see chapter ▶ "Jessner's Peel," Vol. 2) is used, the application of 35% TCA starts immediately after only one pass of the first drug. It is necessary to observe the dynamically interactive variables mentioned above, until solid and uniform bleaching is obtained. There is no need to wash or neutralize the skin after the procedure.

The painful sensation after the application of TCA decreases as frosting occurs and may take several minutes. Therefore, the speed of application – with time interval or not between aesthetic units – may vary according to the patient's degree of discomfort.

In the cutaneous region of the upper lip, the application must penetrate 2 or 3 mm in the vermilion to treat the local characteristics rhytids. The mandibular area must be exceeded by 1 cm and always deserves special attention because it is adjacent to the area with lower concentration of skin appendages and great muscle mobility and prone to hypertrophic and keloid scars. Front and back sides of earlobe should also be included. The eyelid area, because of its ultrafine epithelium, is usually the last target, and its skin must be stretched for further application, up to 2 mm away from the ciliary border. At this moment, care should be taken to wipe out tears to avoid the caustic from reaching the orbital cavity by capillary action.

The cervical region should also be treated to avoid demarcation lines but always with superficial CPs.

Photoaging

CPs have a very precise indication in the treatment of this pathology, which is clinically characterized by roughness and irregularity of the skin surface, dyschromia, growth of benign and malignant neoplasias, telangiectasias that arise by the enlargement of small vessels and fine wrinkles due to the weakening of the tissues' support and loss of elasticity. According to Rubin, levels 1, 2 and 3 are based on the location of changes in the different skin layers (Rubin 1995). Thus, irregularities and roughness of the skin surface and epidermal dyschromias can be treated with superficial CPs. Actinic melanoses and keratoses require medium CPs for their resolution, while elastosis from photoaging and deeper pigmentation require procedures that deepen in the dermis for its reversal.

TCA Superficial and Very Superficial Peels

Very superficial CPs with 10% or 15% TCA have a preferential effect on the epidermis, being useful for the control of active acne and rosacea. This indication is of high importance in the treatment of pregnant patients (see chapter "Cosmetic Approach during Pregnancy") due to the absence of percutaneous absorption of the drug avoiding toxicity. Superficial peels can also be used in the adjuvant treatment of melasma and frictional melanosis since it causes a very superficial exfoliation, optimizes the percutaneous absorption of topical bleaching agents, and reduces the risk of postinflammatory hyperpigmentation. (See chapter "Cosmetic Approach for Melasma," Vol. 1; chapter "Q-Switched Lasers for Melasma, Dark Circles Eyes, and Photorejuvenation," Vol. 3; Rivas and Pandya 2013; Sacchidanand et al. 2015.)

Superficial CPs with 15% or 20% TCA also results in excellent therapy for mild facial aging corresponding to Rubin level 1.

During the days following superficial CP, the skin presents a dry appearance, but without signs of inflammation, and should be maintained with gentle cleansing lotions, physical sunscreens, and mild moisturizers.

Very superficial or superficial CPs for the face are indicated in a series of three to five procedures with some weeks of interval, enough to recover the skin barrier on the face.

A 15% or 20% TCA can be a good choice for extrafacial CPs, since there is no absorption and consequent toxicity, even for wide-area applications. It may be applied until erythema or grade 2 mottled frosting occurs, always taking into account that the action of the TCA is slow and the erythema and frosting should always be expected within 5 min before the application of a new layer. For extra-facial areas, the ideal range of sequential peels is monthly.

Contraindications are very rare for superficial CPs with TCA, including active herpes simplex or atopic dermatitis lesions or other skin diseases in the area to be treated.

TCA Medium Peels

Photoaging of levels 2 and 3 with solar lentigines, actinic wrinkles, and a considerable degree of elastosis are the most precise indications for

medium-depth CPs, performed with 35% TCA preceded by the application of solid carbon dioxide, Jessner's solution, or glycolic acid. Jessner's solution, as described by Monheit, is the most commonly used for combined medium CPs (Monheit 1989). They can also be indicated for the treatment of molluscum contagiosum in immunodepressed patients and for prophylaxis of malignant lesions of xeroderma pigmentosum (Nelson et al. 1995; Garrett et al. 1992).

Medium CP contraindications include active or recent herpes simplex, chronic radiodermatitis, and extensive scars due to the decrease or absence of appendages for the perfect re-epithelialization process. Emotional instability also contraindicates this type of procedure that can result in struggle to deal with the discomfort during the postoperative period.

Due to the depth that the medium CPs can reach (papillary to superior reticular dermis), their use should be restricted to the face, where there are enough skin annexes to ensure proper re-epithelialization.

The recovery of medium CP requires 7–10 days. There may be erythema, edema, and thick brownish crusts. The patient does not require rest, but activities requiring a direct contact with the public should be avoided.

Nonhormonal anti-inflammatory drugs may be used systemically for 5 days.

Despite the prophylaxis, monitoring of the possible presence of herpes simplex, which may appear late, sometimes after a week, and eventual bacterial infections, is important.

The face should be washed with nonirritating cleansing lotions and moistened with warm running water for 5 min, four to six times a day. After washing, cutaneous lubrication with liquid petrolatum or other nonirritating agents is recommended. This care should start 4–6 h after the procedure. The crusts, until they come off spontaneously, should be kept clean and lubricated. The patient should be instructed not to remove them before their spontaneous release, thereby preventing delayed recovery and possible scars.

After total detachment of the crusts, the patient is allowed to return to their daily activities, and then the use of physical sunscreens is started. Restoration of routine care occurs 2 weeks after the procedure.

Direct sun exposure should be avoided for up to 60 days. A casual solar exposition does not, however, compromise the good recovery.

Complications including postinflammatory hyperpigmentation may occur in skins with II–IV phototypes and can be treated with standard combinations of tretinoin, hydroquinone, and medium-potency corticosteroids.

Definitive hypochromic scars may arise in areas where there has been excessive deepening, with formation of thick crusts and re-epithelialization exceeding a period of 10 days. Hypochromias are preceded by localized persistent erythema and hypertrophic scars that can be treated with occluded high-potency corticosteroids or intralesional infiltrations.

Medium exfoliations may be repeated, if necessary, after a minimum period of 60 days. The durability of these clinical results extends on average by 18–24 months.

Combining TCA

With regard to CP, the term combination can have several meanings: (Collins 1987) application of two chemical caustics, one on top of the other, in the same area, quoting Jessner's peeling as an example, (Rubin 1995) chemabrasion that defines the use of a caustic followed by dermabrasion in the same area, and (Collins 1989) the use of different techniques in different aesthetic units of the face.

According to Gonzales-Ulhoa, the face can be divided into 11 aesthetic units – forehead, eyelids, ears, zygomatic-malar regions, nose, lip, chin, and neck – each possessing a characteristic type of skin as color, texture, and thickness, which consequently determines different responses against chemical aggressions. In CPs, this concept is important because different levels of absorption, and therefore depth in each aesthetic unit, are expected (Gonzalez-Ulhoa et al. 1954).

By respecting the aesthetic units and taking into account possible color changes, it is possible to perform procedures of different depths, with precise indications according to the needs of each unit individually.

Medium CPs may be associated with deeper ablative procedures in areas where photoaging is more severe, with the perioral region being cited as an example. In such cases, Baker's solution (see chapters ▶ "Phenol Solutions for Deep Peels" and ▶ "Combining Phenol-Croton Oil Peel"), which contains phenol and croton oil, occluded with adhesive tape or not, can be applied, resulting in deep chemical exfoliation reaching the middle reticular dermis (Vasconcelos et al. 2013).

Another possibility to treat the deep rhytids that affect the labial region is chemabrasion. It consists of manual sanding (Maldonado 1997) or conventional dermabrasion with motor and diamond fraises (Meski 2009) of areas previously submitted to the application of TCA, after anesthesia by regional blocks. Chemabrasion facilitates dermabrasion due to the increased tonus that the keratocoagulated skin acquires, providing better results than those obtained with the isolated use of both techniques.

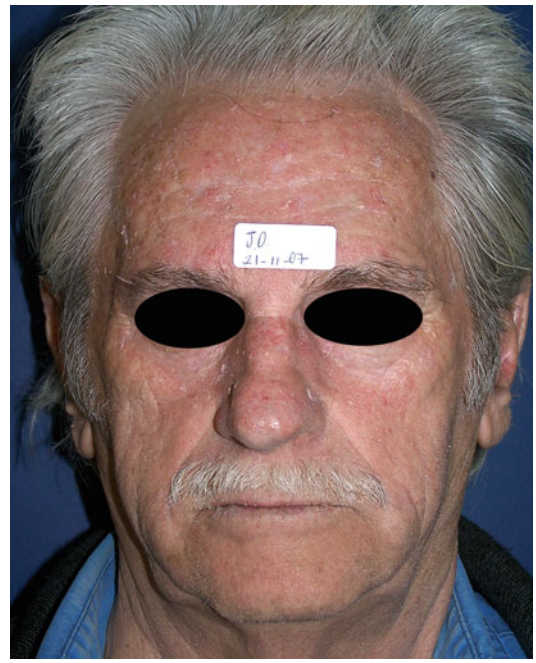

Fig. 1 Initial appearance

CPs and Actinic Keratosis (AK)

The cancerization field concept has changed the treatment for patients who present multiple and disseminated AKs. It is characterized by apparent normal areas adjacent to multiple, ill-defined, contiguous, and diffuse AKs and consists of preneoplastic multilocular points (Ultrich 2007; Goldenberg 2017).

5-Fluorouracil is a fluorinated pyrimidine with antimetabolizing and cytostatic effects. It inhibits the thymidylate-synthetase enzyme, required for DNA synthesis and cell proliferation (Lawrence et al. 1995). The use of 5% 5-FU cream, twice daily during the 7 days preceding medium/fullface 35%–45% TCA CPs, may be a therapeutic alternative for these patients since this substance makes the already visible lesions more clearly delimited as well as reveals the subclinical ones.

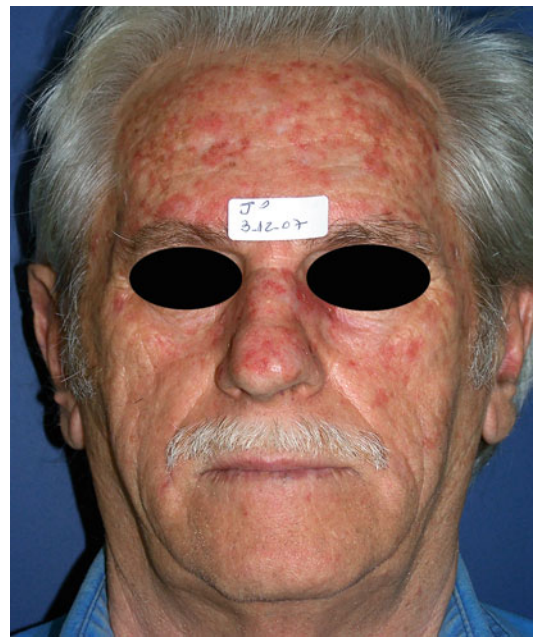

Fig. 2 Multiple actinic keratoses evidenced after 7 days of use of 5% 5-FU cream

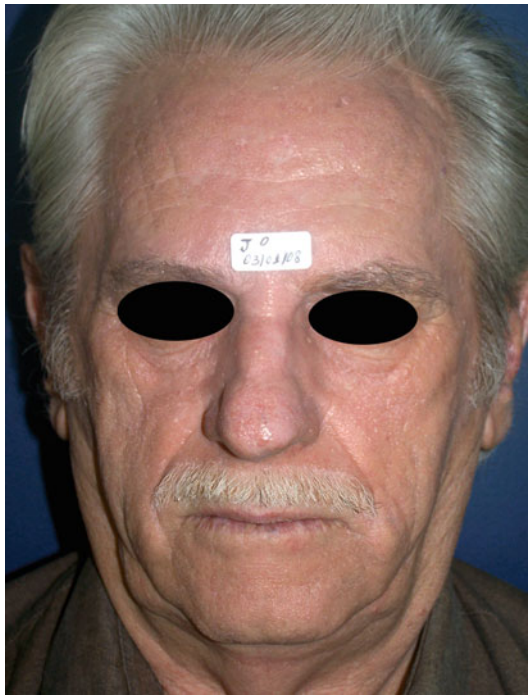

Fig. 3 Appearance 30 days after actinic keratoses curettage and phenol 88% localized application followed by fullface 35% trichloroacetic acid

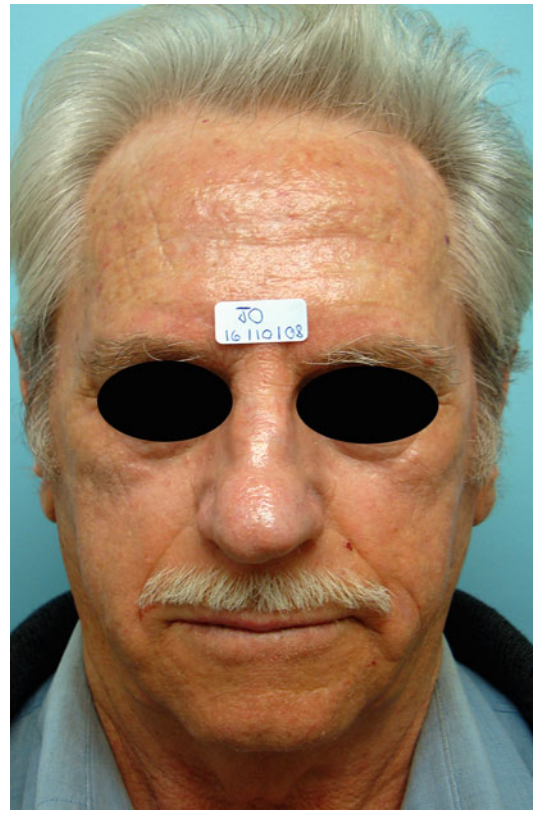

Fig. 4 Appearance 10 months later

On the eighth day, AKs curettage is done, and small volumes of 88% phenol are applied in the curetted areas. Infiltrative anesthesia can be used if necessary. Phenol has an immediate and uniform caustic effect, reinforcing the destruction of the lesions. About 35% or 45% TCA is then applied in the whole face (Figs. 1, 2, 3, and 4).

This type of treatment can also be done on the male scalp presenting multiple AKs (see chapter "Photodynamic Therapy," Vol. 1; chapter "Photodynamic Therapy for Photodamaged Skin" in Vol. 3).

Conclusion

Despite recent advances in laser and other technologies used in dermatological procedures, CPs are still widely used by dermatologists with low costs and great results (Fischer et al. 2010; Jackson 2014). CPs can be combined with other procedures for higher effectiveness and at reduced risks.

Take Home Messages

1. The indication CPs must always be based on etiopathogenic criteria and anatomopathological correlations.
2. The depth of absorption of a substance through the skin is a consequence of the "dynamically interactive variables" which include skin thickness, density of appendages, and degree of oiliness, integrity of the skin barrier, drug concentration, and volume of agents, rubbing and occlusion. All these details must be simultaneously considered at the time of the application.
3. TCA stands out for its safety and versatility. It can be used alone for very superficial and superficial peels, combined with other substances for medium depth peels, and with other procedures at the same moment, without systemic toxicity, even in large extra-facial areas.

4. TCA can be used on the skin only up to 45%. It has a very intense caustic power and is more potent than phenol at maximum concentration. Its action is slow and the erythema and frosting should always be expected within some minutes before the application of a new layer.
5. The use of 5% 5-FU, twice daily during the 7 days preceding medium 35%–45% TCA CPs, may be a therapeutic alternative for the treatment of multiple actinic keratosis, including the cancerization field.

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Phenol Solutions for Deep Peels

Chinobu Chisaki, Gabriela Horn, and Leandro Fonseca Noriega

Abstract

Skin aging is a process that worries many people who seek for medical help to minimize its signs. Facial rejuvenation techniques are abundant and quickly developing, but few may provide such a dramatic improvement as phenol peeling. Severe facial photoaging is its main indication, but pain during and after the procedure, recovery time, and risk of cardiac toxicity may be limiting factors. Therefore, adequate patient selection is fundamental and the procedure should be performed with supportive equipment and staff, cardiac monitoring, and potent analgesia.

Keywords

Phenol • Deep peel • Baker-Gordon peel • Croton oil • Chemical peel • Exfoliation • Photoaged skin • Toxicity

Contents

C. Chisaki (✉) • G. Horn • L.F. Noriega
Department of Dermatology, Hospital do Servidor Público Municipal de São Paulo, São Paulo, SP, Brazil
e-mail: chinobu@uol.com.br; dermatologia.chinobu@bol.com.br; gabi.gh@hotmail.com; leandronorieg@gmail.com

Introduction

Chemical peels consist of the application of exfoliating agents on the skin in order to produce controlled damage of skin's layers with therapeutic and cosmetic purposes. First, a new epidermis

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is formed from the deeper portion of the cutaneous adnexa. Caution should be taken to leave these adnexa unharmed during chemical peels; therefore, the maximum safe limit of exfoliation is up to the middle reticular dermis. Finally, during the wound healing process, regeneration and new collagen production occur.

Phenol-based formulas are traditionally used for deep peels, reaching the middle reticular dermis. In recent literature, phenol-based deep peels are found under the name of "phenol-croton oil peel" or "croton oil peel," because of the croton oil's role in increasing the depth of the peel.

Phenol peel remains the gold standard of chemical peeling, as no other agent rejuvenates as much as phenol. It is also a standard of comparison for other rejuvenation methods such as laser and dermabrasion.

In addition to wrinkle treatment, it also produces a "lifting effect" due to a major skin retraction, leading to a more natural expression. It should be highlighted, however, that it is inappropriate to compare phenol peeling and its indications with the effects of a surgical lifting.

Phenol peeling corrects pigmentary and actinic changes with the additional advantage that it diminishes the appearance of photoaged precancerous and cancerous skin lesions (Figs. 1 and 2).

Due to its toxicity, phenol should be carefully applied, following the recommended technique and the contraindications. Patients should be monitored for emergency assistance in case of any systemic effect.

For this outstanding method of rejuvenation, there are numerous formulas; in this chapter, we will focus on deep chemical peeling with Baker's formula (Table 1).

History

Phenol peeling and its secret formulas were held by aestheticians up to the early 1960s. Lay peelers are reported to be using formulas with phenol and croton oil in Hollywood since the early 1920s. They were famous for helping celebrities to keep their careers, and they proclaimed the technique as "the fountain of youth" (Hetter 2000a). A medical article dated 1917, by Montgomery, described an aesthetician that used occlusive phenol in New York (Hetter 2000a).

Over time, physicians would pay or permute information on these formulas, and in 1927, a surgeon from Los Angeles – H. O. Bames – described in details the occluded phenol peeling technique. He wrote about the importance of applying it by areas and with time interval between areas during procedure, which was not performed by most aestheticians. He also reported that they did not do it on the neck (Bames 1927). In 1959, Adolph Brown, from Los Angeles, patented a formula with phenol and croton oil (Hetter 2000b). In 1960, he published in the *British Journal of Plastic Surgery* the first detailed study of phenol formulas, histology, and toxicity after Bames' study (Brown et al. 1960). In that paper, he outlined some of the incorrect dogmas that persisted for many years, such as (1) phenol is the active ingredient, (2) phenol penetrates more at lower concentrations, and (3) the addition of an agent that reduces the superficial tension increases penetration (Hetter 2000b, c). An example of an agent that reduces the superficial tension is Septisol® (liquid soap). Still in 1959, the plastic surgeon Clyde Litton obtained a formula from an aesthetician and presented, in 1961, in the Plastic Surgery Annual Meeting in New Orleans, the 2-year follow-up of 50 patients (Hetter 2000a, b). But the modern era of phenol peeling began when Thomas Baker obtained data from formulas held by three aestheticians and developed a modified solution of phenol with croton oil, Septisol®, and water (Table 1) and published it in 1962 in Plastic and Reconstructive Surgery (Baker 1962).

Although this formula is extremely strong, it has been the most commonly used and studied during all these years, probably because it is simple and it was the first formula fully published in a journal of great circulation among plastic surgeons.

After that, among numerous papers, those by Stegman in 1980 and 1982 (Stegman 1980, 1982)

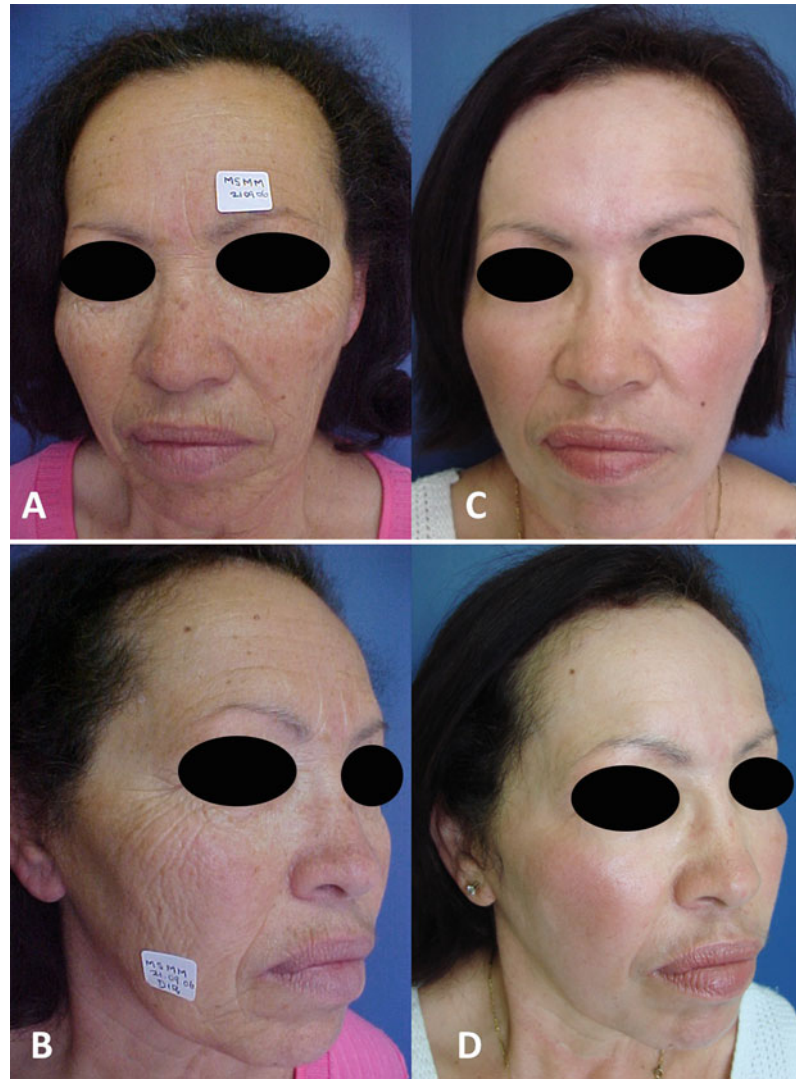

Fig. 1 51-year-old patient with pigmentary changes and severe photoaging. (**a**, **b)** Pre-phenol peeling with occluded Baker's formula. (**c**, **d)** Eight months after the peeling. Lifting effect and improvement of spots and wrinkles

brought a more controlled and scientific understanding of peelings. He concluded that some factors may enhance the skin injury of Baker's formula: 1) increase in phenol concentration; 2) greater number of layers of Baker's emulsion; 3) and occlusion, offering greater penetration. Also, by removing croton oil, less injury was obtained from Baker's formula. In 1996, histological studies by Moy et al. (1996) reinforced Stegman's findings, stating that the more intense and deeper reaction of Baker's peeling is due to the combination of the ingredients.

The series of articles by Hetter in 2000 (2000a, b, c, d) reported a relevant role of croton oil in phenol peeling. Varying its concentration a proportional modulation of the peeling's penetration is obtained. Phenol concentrations were also studied. A more intense tissue reaction was observed with higher concentrations of phenol, therefore challenging Brown's dogmas. The surfactant's (soap or detergent) role is to decrease the superficial tension, emulsifying more easily the oil and phenol/water mixture, allowing a more even application.

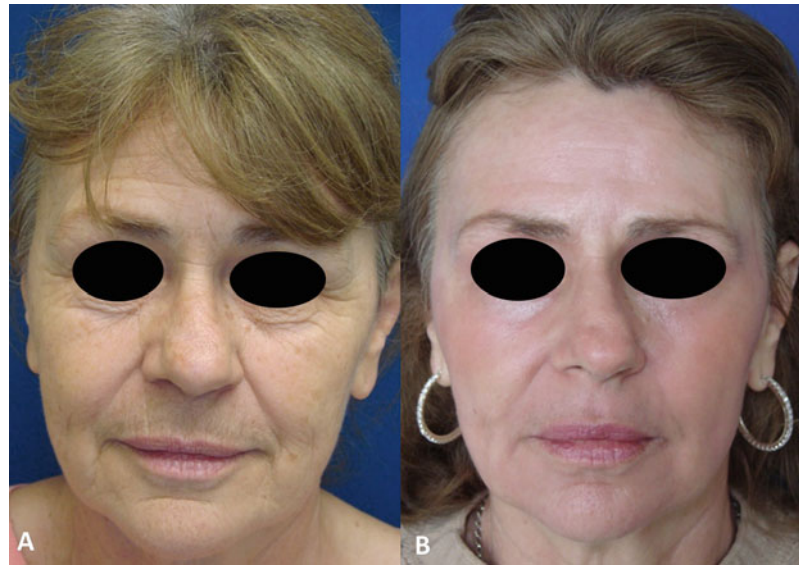

Fig. 2 61-year-old patient. (**a**) Pre-peeling. (**b**) After Baker's peel, with occlusion on perioral area

Table 1 Baker-Gordon formula

Component	Quantity
Phenol USP 88%	3 ml
Distilled water	2 ml
Liquid soap	8 drops
Croton oil	3 drops

Note: 1 drop = 0.04 ml

Phenol-Croton Oil Peeling: Toxicity

Phenol

Phenol – or carbolic acid – consists of a benzene ring with a hydroxyl group, derived from coal tar or synthesized from monochlorobenzene. It is bacteriostatic at 0.2%, is bactericide at concentrations higher than 1%, and has an anesthetic effect at 5%.

Phenol is rapidly absorbed percutaneously; 70% of phenol applied to the skin is absorbed within 30 min (Wexler et al. 1984). The absorbed phenol is eliminated through three processes: excretion, oxidation, and conjugation. After absorption, 25% is metabolized into carbon dioxide and water. The remaining 75% may be excreted unchanged through the kidneys or conjugated with glycuronic or sulfuric acids. A small quantity may also be oxidized into hydroquinone and pyrocatechin. Both oxidation and conjugation occur in the liver (Litton 1962).

Signs of systemic toxicity include nausea, vomiting, paresthesia, headache, and obnubilation. Central nervous system stimulation may manifest initially with tremors, hyperreflexia, and hypertension and then followed by central nervous system depression. Poisoning, due to accidental ingestion, causes sudden nervous system depression, cardiorespiratory arrest, and hepatorenal failure.

A phenolemia of 0.68 mg/dl was obtained 1 h after a 3 ml of 50% phenol application all over the face. This represents a safety margin against 23 mg/dl dosed 15 min after phenol ingestion (Litton 1962). Unfortunately there isn't a reliable estimate of the lethal dose due to the great variation of phenol levels in the blood after exposure.

In peelings, phenol absorption and toxicity seem to be more dependent of the total skin area exposed at once than merely the concentration of the agent. Systemic toxicity, if occurs, starts a few minutes after application, but no hepatorenal or central nervous system problems have been reported with phenol peeling when appropriately performed.

However, cardiac arrhythmias have been associated with this peeling rapidly applied all over the

face (Truppman 1979), once phenol is directly toxic to the myocardium (Stagnone et al. 1987). Another rationale for cardiotoxicity is the release of adrenaline due to the pain, transmitted from the trigeminal nerve to the cardiac vagus nerve or from the cerebral cortex directly to the sinoatrial node (Stagnone and Stagnone 1982). The application at each cosmetic unit followed by a pause seems to reduce the risk of cardiac toxicity.

Diuresis promotes the excretion of phenol and reduces arrhythmias. The alkalinization of urine may also contribute by increasing the renal tubular excretion (Matarasso 1994).

If a mild supraventricular arrhythmia occurs, application should be discontinued until the sinus rhythm returns to normal. It is advisable to wait 15 min after the normalization of the rhythm before resuming the procedure. If a severe supraventricular or a ventricular arrhythmia occurs, phenol should be replaced with another exfoliating agent (Brody 1997a).

It is useful to understand that the efficacy of a chemical agent can be modified by associations with other agents that modulate its potency and toxicity.

It is tried to "tame" phenol, as well as trichloroacetic acid, by associating them with additives, emulsifiers, saponins, and surfactants that increase the efficacy and safety of these exfoliating agents. Thus, for example, knowing that the low molecular weight of phenol (94,11) and its polarity allow it to rapidly pass through the cell and endothelial membranes and that it is more rapidly absorbed in an aqueous solution than in an oily solution; it is found in many modified formulations, glycerin, sesame, and/or olive oils, which solubilize phenol and reduce its systemic absorption and aggressiveness (Deprez 1998).

Croton Oil

Croton oil is extracted from the seed of *Croton tiglium*, a native shrub from India and Ceylon. It is composed of 7% glycerin, 37% oleic acid, 19% linoleic acid, 7.5% myristic acid, 1.5% arachidic acid, and less than 1% stearic, palmitic, lauric, valeric, tiglic, butyric, acetic, and formic acids. Croton oil was used as a purgative in India and introduced in Europe in 1630 for that purpose, and it may even lead to death. On the skin, it may cause vesiculation, necrosis, and severe burning (Hetter 2000c).

Deep Peeling Modalities

Occlusion

Deep peeling may be occluded or not (Figs. 3, 4, and 5). Occlusion acts as a mechanic barrier against phenol evaporation and increases skin maceration, promoting higher absorption and deeper penetration. Occlusion may be performed using strips of impermeable adhesive tape, measuring 1–1.5 cm wide, overlapped in two to three layers, and placed directly on the skin for 48 hours (Figs. 6 and 7). However, patients feel a little discomfortable, and many will prefer occlusion with *petrolatum* (Stuzin 1989) or silicone gel, immediately applied on the phenol-treated skin. But be aware that phenol may be carried together with the *petrolatum* or silicone gel into the eyes due to the capillarity through the wrinkles. So in our practice, we do not recommend the application of *petrolatum* or silicone nearby the eyelids during or just after the procedure.

Among the various post-peeling occlusion techniques, thymol iodide powder or bismuth subgallate powder may be used after the removal of the adhesive plaster. They form a second mask that stays in place for 6–9 days (Figs. 8, 9, and 10). This mask is reported to avoid mobilization and to improve wound healing which results in a more even peeling. With this second mask, wound care is not needed, with the benefit that the skin will be fully reepithelized after mask removal. Patient support is advisable, since they may feel a little depressed with the use of this mask for several days.

Baker's Formula

The old Baker's formula, published in 1962, is still up-to-date and is the most commonly used (Table 1).

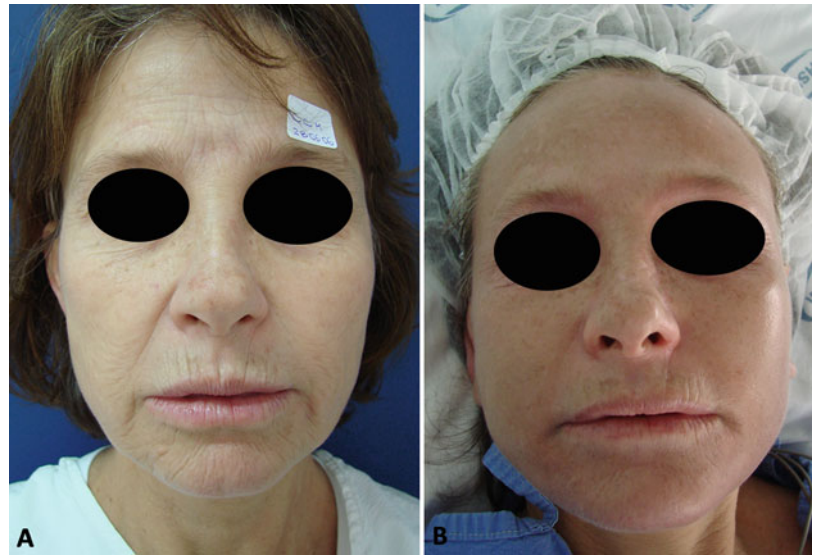

Fig. 3 (**a**) 56-year-old patient, pre-phenol peeling with non-occluded Baker's formula. (**b**) Immediately after, showing edema and erythema on face

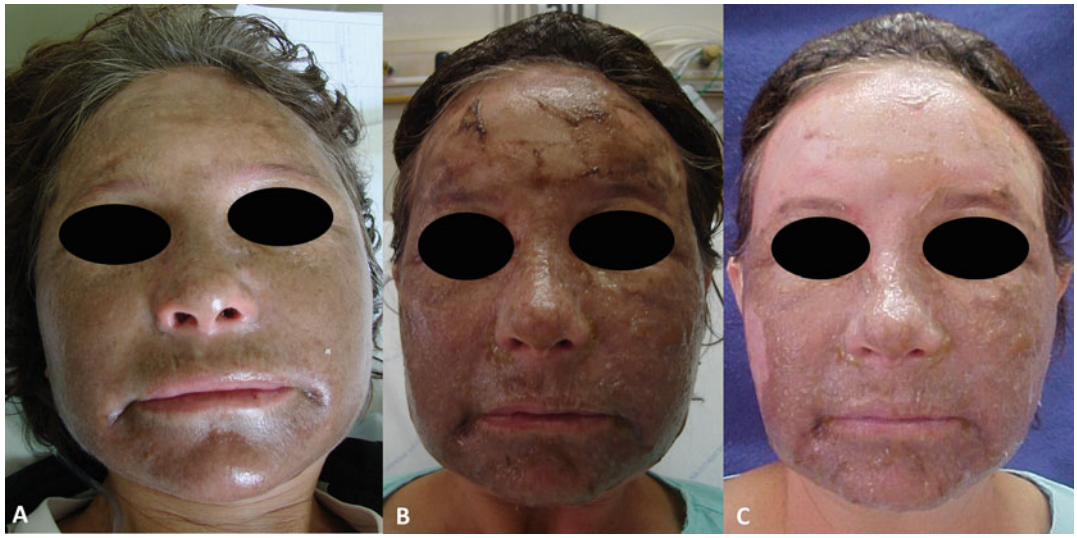

Fig. 4 The same patient of Fig. 3. (**a**) 24 hours post-peeling. Severe edema and darker coloration of the face. (**b**) 48 h post-peeling, before washing the face. Edema, fibrin, skin scaling and detachment. (**c**) 48 h post-peeling. Cleaner face after removal of secretion, fibrins and detached skin

Baker-Gordon's formula is prepared by drawing up 3 ml of phenol into a syringe and depositing it into a recipient. Next, 2 ml of water, eight drops of liquid soap, and finally, three drops of croton oil are added. This dilutes the concentration of phenol to about 50%. It is an immiscible emulsion and should be well stirred at each application (Figs. 11, 12, and 13). Hetter (2000c) shows that peelings with increasing concentrations of phenol at 18%, 35%, and 50% with Septisol® soap and without croton oil, respectively, cause an increased reaction of edema and erythema without significant dermal injury, while 88% phenol without Septisol® causes injury to the dermis. The addition of croton oil to 50% phenol,

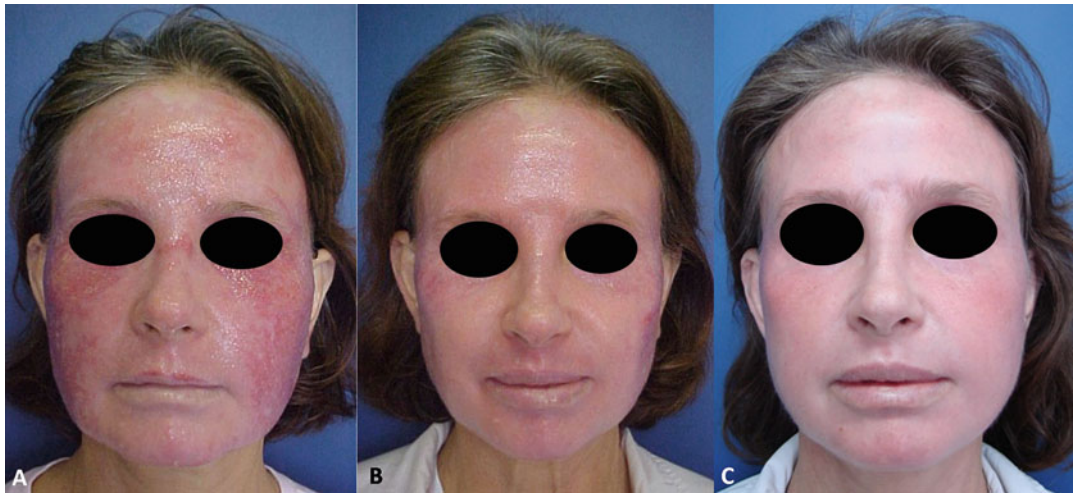

Fig. 5 The same patient of Figs. 3 and 4. (**a**) 4 days post-peeling, using *petrolatum* ointment, already without necrotic epithelium, but with diffuse erythema and some fibrin areas. (**b**) 12 days post-peeling, skin reepithelized, but still with erythema. (**c**) **2** months post-peeling showing improvement of flaccidity and wrinkles

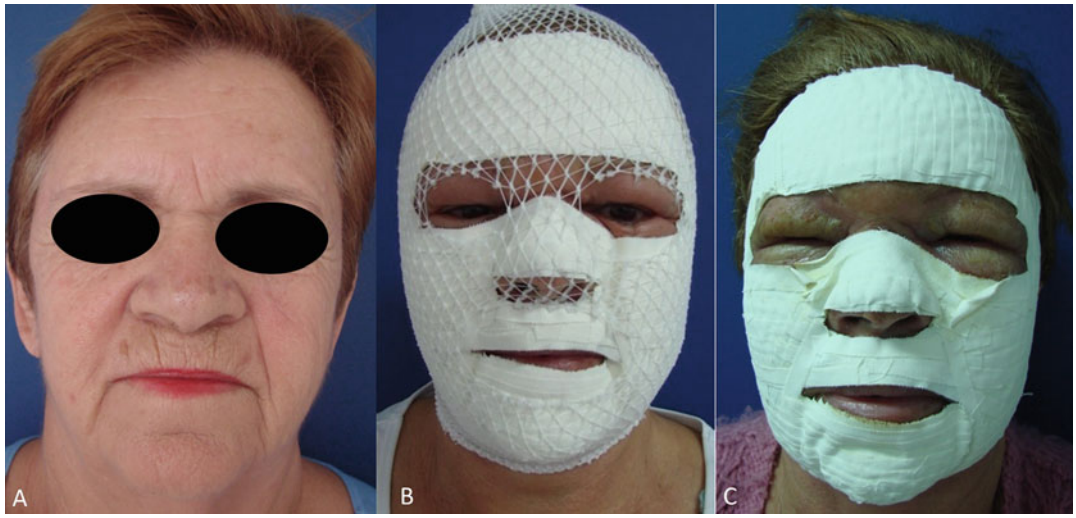

Fig. 6 67-year-old patient. (**a**) Pre-phenol peeling with occluded Baker's formula. (**b**) Immediately after the adhesive tape mask. Note the eyelid edema initiating and the use of a compression dressing (not routinely used). (**c**) 24 h post-peeling with more eyelid edema

however, causes remarkable increase of peeling depth in the dermis.

The same author (Hetter) reports in a personal communication that 33% phenol may produce a mild medium-depth, deep medium-depth, or deep peeling when the croton oil concentration varies of 0.35%, 0.7%, or 1.1%, respectively (Stone 1998). Hetter associated with a 16–50% phenol solution associated with croton oil between 0.25% to 2.78% used healing time to judge peeling depth and concluded that peel depth increases with the concentration of both agents (Hetter 2000d). Croton oil concentration in Baker's formula is 2.08% and seems to play an important role on the peeling depth.

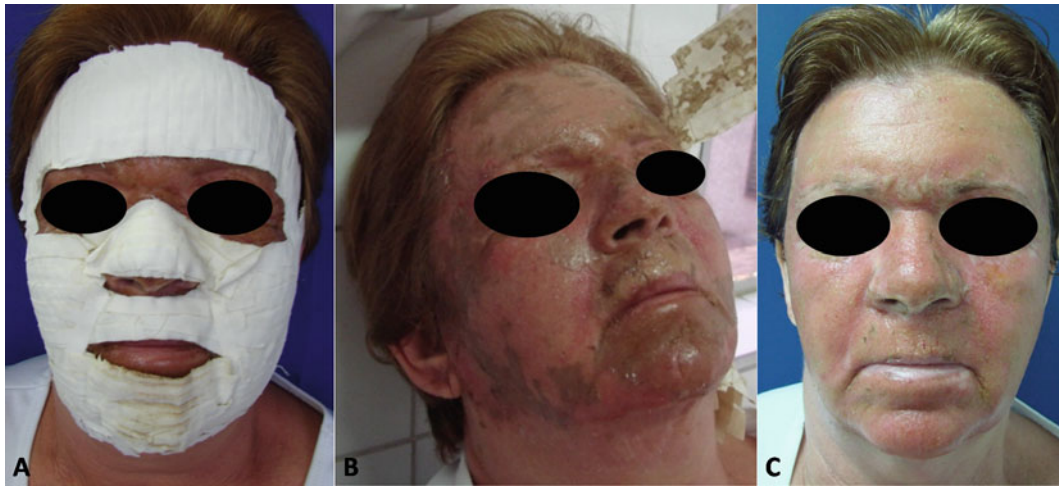

Fig. 7 The same patient of Fig. 6. (**a**) 48 hours post-peeling, before adhesive tape removal. Improvement of eyelid edema. (**b**) 48 hours post-peeling. Adhesive plaster removal. Note the epithelium adhered to the adhesive tape, humid skin with secretion, fibrin, and necrotic epithelium. (**c**) **3 d**ays post-peeling, face with erythema and edema, scale, and fibrin

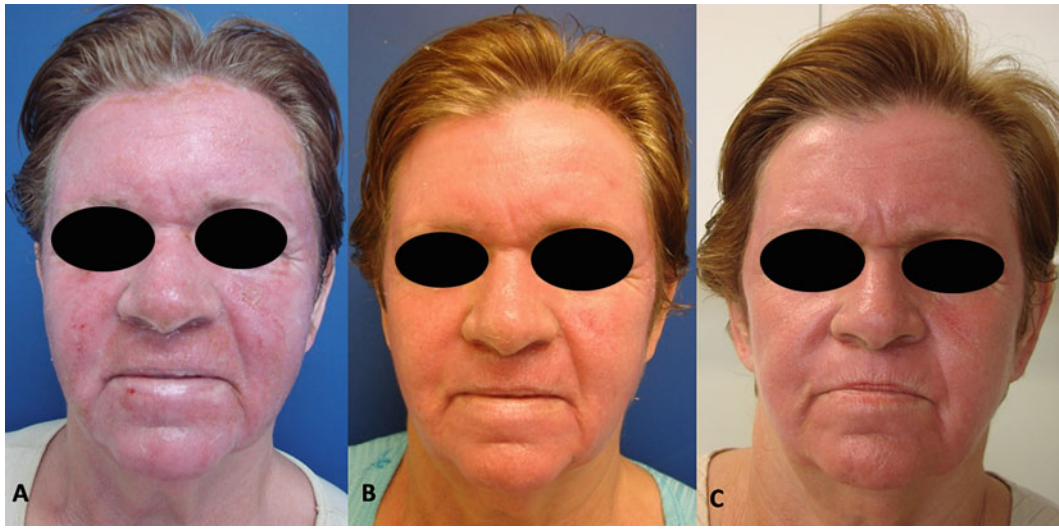

Fig. 8 The same patient of Figs. 6 and 7. (**a**) 6 days post-peeling, face more reepithelized with erythema, dry skin, and scaling. (**b**) 10 days post-peeling, face reepithelized with erythema, edema, and dry skin. (**c**) 15 days post-peeling. Note the irregularity of application on the left side of the eyelid and lip border

Other studies seem to confirm histologically Hetter's statements about the role of phenol and croton oil concentration (Moy et al. 1996; Stone 1998). Nevertheless other factors may influence depth such as occlusion method, pressure exerted in the application, friction, the number of coats on the same area, exposure time to the substance, volume applied, vehicle used, and patient skin type. When using Baker's formula, which is quite concentrated, it is important to take these

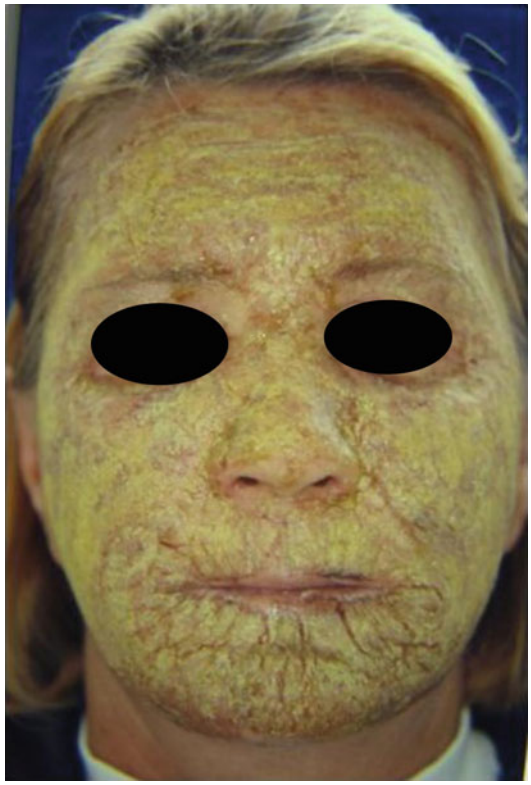

Fig. 9 **4 d**ays with bismuth subgallate powder mask

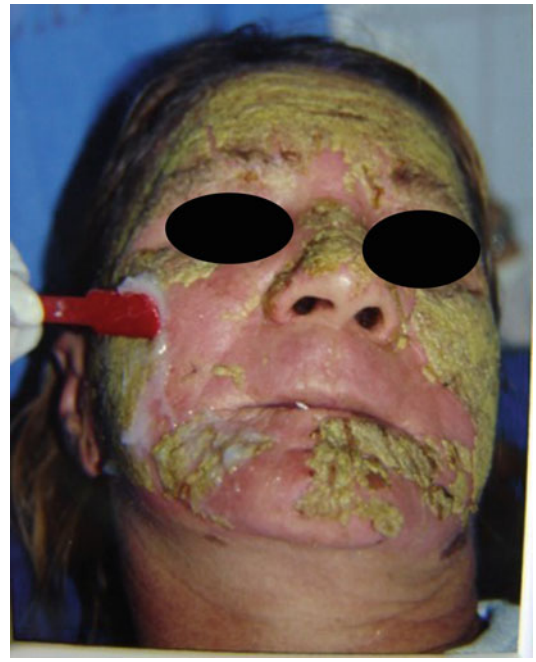

Fig. 10 7 days with bismuth subgallate powder mask, removed with small amount of *petrolatum*

Fig. 11 Baker's formula preparation. Immiscible emulsion

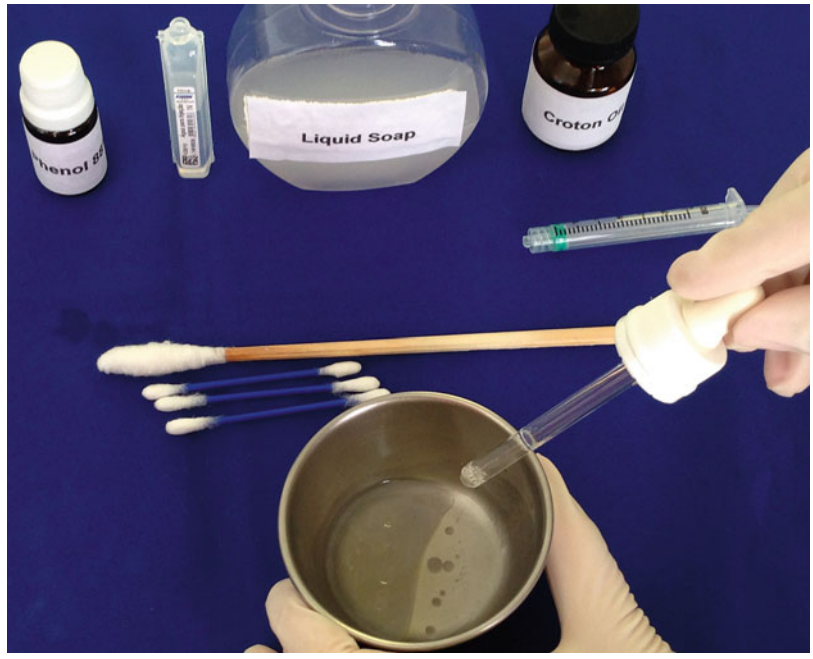

Fig. 12 The addition of croton oil with syringe, considering 1 drop as equivalent to 0.04 ml. Note, the croton oil measured with a dropper may vary due to the dropper size

Fig. 13 Homogenized emulsion after well stirring

into account so that occlusion is not always necessary to achieve the desired results.

There are numerous other formulas before and after Baker's; however, some of them were or still are secret in their entire composition, and currently there are some commercial products for sale.

Phenol "Neutralizers"

Phenol is soluble in oil and can be rapidly removed from the skin with glycerin, propylene glycol, vegetal oils, or 50% alcohol.

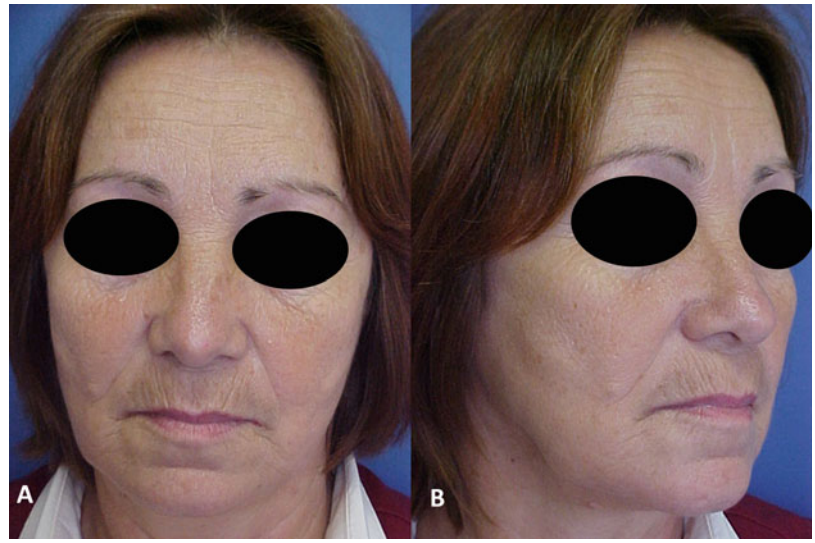

Fig. 14 Pre-phenol peeling, thin wrinkles in a mosaic pattern. (**a**) Frontal view. (**b**) Right frontal-lateral view

However, topically, phenol in high concentrations causes an extremely quick denaturation and coagulation of keratin (frosting), which is irreversible.

Indications

Phenol peeling is indicated for rejuvenation of skins with more severe, thin, and mosaic wrinkles in order to correct pigmentary changes, actinic damage, and irradiated skin damage if the adnexa are present for reepithelization (Figs. 14, 15, and 16).

Traditionally, it is indicated for patients with Fitzpatrick skin types I to III, once phenol – as well as other deep exfoliation procedures – may cause hypopigmentation. Light skins also have lower possibility of visible contrast between the treated and untreated skin. However, localized peelings in types I and II patients may produce contrast between the thicker, elastotic, yellowish photodamaged skin and the treated thinner rejuvenated area without spots. When this occurs, the only option is to treat the entire face (Stuzin 1998). Some authors also state that, in types I and II with naturally less pigment, the hypochromia, even when uniform all over the face, may sometimes draw more attention than in types III and IV. In the latter patients, hyperpigmentation is the rule but often reversible. It is not advisable to perform a deep phenol peel in skin types V and VI, due to the high risk of post-inflammatory hyperpigmentation, irregular hypopigmentation with vitiligo-like appearance, and keloid.

Contraindications

Contraindications to phenol peeling include cardiac, renal, or hepatic diseases and skin phototypes V and VI.

Relative contraindications include herpes simplex infection, hormone therapy with estrogen or progesterone, continuous or prolonged exposure to ultraviolet light that may lead to post-peeling hyperpigmentation, recent use of isotretinoin that may lead to healing changes, psychological problems or unrealistic expectations, previous ionizing radiation therapy, skin phototypes III and IV, predisposition to keloids, anatomic location with few adnexa, and recent facial surgery with undermining or flaps.

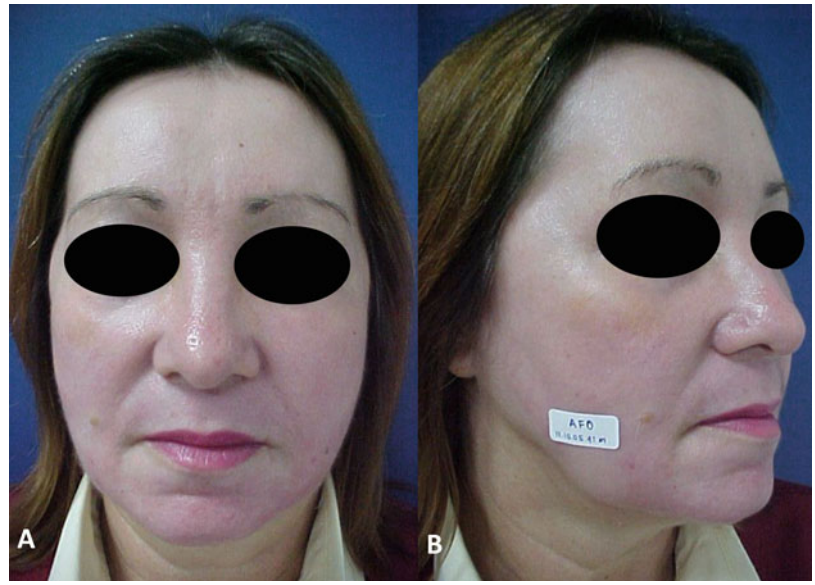

Fig. 15 The same patient of Fig. 14, 4 months post-phenol peeling. (**a**) Frontal view. (**b**) Right frontal-lateral view

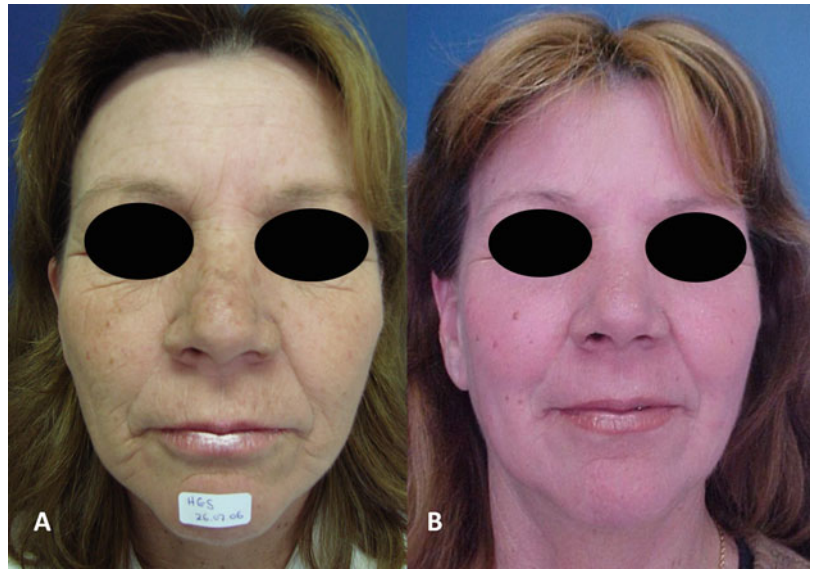

Fig. 16 (**a**) Pre-phenol peeling, Skin presenting photoaging, pigmentary changes, and flaccidity. (**b**) 3 months post-phenol peeling

Pre-peeling Preparation

Prior to procedure, one should:

- Obtain the patient's consent providing treatment options and information about the technique, discomfort, dressings, time to heal, complications, and long-term care with emphasis on photoprotection.
- Obtain the patient's clinical history with special attention to cardiac, renal, and hepatic diseases.
- Request the patient's previous electrocardiogram, complete blood count, and biochemistry, including kidney and hepatic function.
- Take photos of the patient before the peeling.

Unlike other peelings, previous preparation of the skin is not mandatory. In case there was

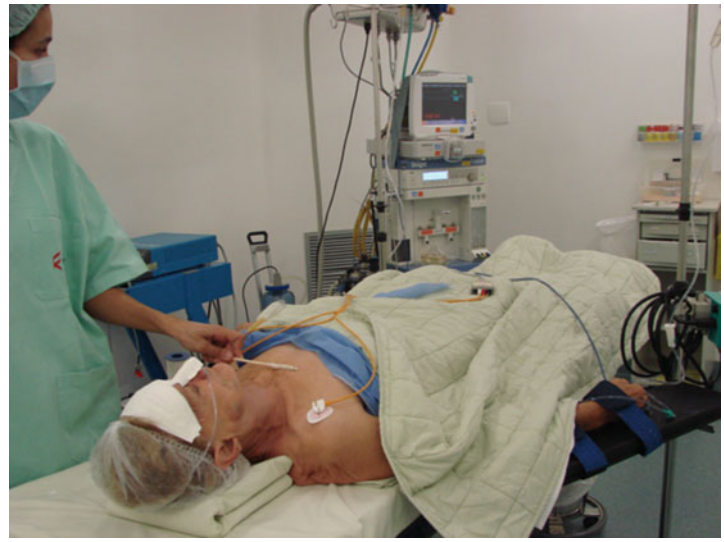

Fig. 17 Patient monitored and with intravenous access

previous use of topical agents, such as retinoid and other acids, check if there is no skin irritation that could lead to an undue peel deepening.

Prophylaxis for herpes simplex infection is mandatory, with or without previous history. Acyclovir 400 mg three times daily, valacyclovir 500 mg twice daily, or famciclovir 250 mg twice daily is recommended, initiated 1 or 2 days prior to the procedure and maintaining it for 10–14 days. Note that cases of herpes infection may occur even after full reepithelization (Perkins and Sklarew 1996).

Bacterial and mycotic infections are rare and, in general, do not require prophylaxis on phenol peeling.

Technique (Full-Face Phenol Peel)

General Care and Safety

Phenol peelings should be performed with supportive equipment and staff, cardiac monitoring, and potent analgesia, preferably in a hospital for greater patient and medical staff safety. Use a ventilated room (to dissipate phenol) and always have cardiopulmonary resuscitation (CPR) equipment and emergency medications available and easily accessible. The patient should be fasting, with an intravenous access, cardiac monitoring, and pulse oximeter installed (Fig. 17).

Local Care and Edge Delimitation of the Peeling

Instruct the patient to perform facial hygiene, usually in the morning of the procedure, and to avoid the use of makeups (Brody 1997a).

Draw a demarcation line just below the mandible (peel border), preferably with the patient in sitting position. Below this line, phenol must not be applied, and this is critical to minimize the risk of permanent color change, visible as a contrast between the face and the cervical region (Brody 1997a).

Just before the beginning of the peeling, the skin should be evenly degreased with acetone or alcohol, following the cosmetic units. This step is crucial for uniformity of application.

Knowing the risk of systemic absorption and phenol's hepatic and renal metabolism, patient hydration is important and may reduce the risk of toxicity (especially cardiac arrhythmias) (Brody 1997b).

Overall, we use lactated Ringer's solution, because it also alkalinizes the urine and contribute

Table 2 Venous hydration volumes in the phenol peeling steps

	Peeling time point	Volume
Lactated Ringer's solution or 0.9% NaCl	Before	500 mL
	During	500–1,000 mL
	Just after	500 mL

Table 3 Summary of the main characteristics and dosages of fentanyl and midazolam (Abeles et al. 2000; Otley and Nguyen 2000; American Society of Anesthesiologists 2002; Di Santis et al. 2014)

Medications	Preparation (ampoules)	Dilution/[final concentration]	Dosage	Effects	Onset of action	Duration of effect
Fentanyl citrate	50 μg/mL	2 mL in 8 mL of distilled water or 0.9% NaCl/ [10 μg/mL]	1–2 μg/Kg[a] (in cases of intense pain, a dose of up to 100 μg/Kg may be reached)	Analgesia and sedation	2–3 min	30 min to 6 h[c]
Midazolam	5 mg/mL	3 mL in 12 mL of distilled water or 0.9% NaCl/ [15 mg/mL]	0.05–0.075 μg/Kg intravenously[b]	Sedation, amnesia, and anxiolysis	Up to 2 min	1–2 h

[a]It can begin with an infusion of 2 mL of the solution, evaluating the need for complementary doses during procedure
[b]In general, it can begin with 2 mL of the solution. Wait for about 2 min to evaluate the effect from the administered dose. During procedure, new doses can be administered according to the need, always avoiding excessive sedation. Patients in use of other anxiolytics require low doses and chronic alcoholics need higher doses
[c]The duration of effect varies according to the dose, with the dose of 100 μg generally lasting 30 min

to reduce the risk of toxicity (Beeson 1987; Matarasso 1994), but 0.9% NaCl solution may be an alternative (Table 2).

A 250–500 mL infusion of 5% dextrose during the procedure may be associated, in order to avoid hypoglycemia and prevent nausea (Asken 1989).

Sedation and Analgesia

Pain with phenol peeling is typically intense, thus drug combinations are needed for significant analgesia and patient's comfort. Adequate analgesia allows higher safety, replicability of the procedure, and avoids prolonged and repeated interruptions (due to patient's discomfort and/or agitation). Consequently, it generates more assurance to the medical staff (Otley and Nguyen 2000; Di Santis et al. 2014).

Conscious sedation is an excellent option; however, it requires expertise and practice in the use of the medications involved, as well as inpatient procedure. It has been more commonly used in dermatological procedures, in virtue of its safety and efficacy.

This anesthetic modality causes a depressed state of consciousness, keeping the protective reflexes, independent and pervious airway, and response to physical and verbal stimuli (Otley and Nguyen 2000; Di Santis et al. 2014). In addition, it shows analgesic and anxiolytic action and retrograde amnesia. The most common association with this goal is fentanyl with midazolam. Table 3 summarizes the main characteristics and dosages of these medications.

Another advantage of these two medications is the possibility of reversion of their effects by using antagonists. Therefore, naloxone may be used in cases of respiratory depression related to excessive doses of fentanyl, while in the case of excessive dose of midazolam, flumazenil may be used (American Society of Anesthesiologists 2002).

Other combinations of sedation with analgesia may be used according to the physician's experience or, preferably, with assistance of an anesthesiologist. Among these, we could mention propofol (sedative and anxiolytic effect, although without analgesia), ketamine (sedative and analgesic), lorazepam (anxiolytic and sedative), and meperidine (analgesic and sedative) (Abeles

et al. 2000; Di Santis et al. 2014; Otley and Nguyen 2000).

We often use an intramuscular dose of corticosteroid, in the end of the procedure (in case there are no contraindications), for example, 1–2 mL of injectable 5 mg betamethasone dipropionate solution + 2 mg betamethasone disodium phosphate. In addition to the analgesic effect, it acts on the reduction of the edema. The use of corticosteroids after deep peelings is controversial, and some authors mention that this medication may delay local healing (Wicke et al. 2000).

In case an anesthesia team is not available, there is the possibility of using analgesic, anti-inflammatory, and anxiolytic medications with lower risk of complications (particularly, respiratory depression). However, these have lower potency for controlling patients' anxiety and discomfort (pain). Diazepam (Dienpax®) 5–10 mg or oral bromazepam (Lexotan®) 3–6 mg may be used as anxiolytics. For initial analgesia, 1 g acetaminophen diluted in 50 mL of isotonic solution for i.v. infusion may be used (this dose may be complemented until it reaches 15 mg/kg) (Kocum et al. 2013). For better pain control, association of a nonsteroidal anti-inflammatory may be useful (e.g., 100–300 mg ketoprofen diluted in 100 mL of isotonic solution, infused during the procedure) (Bassanezi and Oliveira 2006). In case the patient does not tolerate the procedure with this analgesia, tramadol may be associated at a dose of 100 mg, intravenously. It is important to infuse a new dose of acetaminophen after procedure, not exceeding the dosage recommendation.

Remember that drug associations facilitate the emergence of complications such as cardiac arrhythmias, cardiorespiratory and central nervous system depression. Therefore, always evaluate the possibility of interactions with the patient's continuous-use medications.

Agent's Application

Prepare the emulsion just a few minutes before the application (Fig. 18). The emulsion should be well stirred before each application, and to prevent accidents, do not stir it near the patient's eyes.

Divide the face in aesthetical units; the forehead can be subdivided in two areas, if desirable.

The agent should be applied using cotton swabs respecting the aesthetical unit. **It is important to wait about 15–20 min between units**, in order to reduce phenol toxicity.

The application should advance into the scalp border, 1–2 mm inward the vermilion border of the lips, to correct perioral wrinkles, where the complaint that "the lipstick runs out" is frequent. Do not forget the anterior and posterior areas of the earlobes, which improves its flaccid aspect after a skin retration (Fig. 19).

On the eyelids, excessive emulsion in the cotton applicator should be cleaned using gauze before application. It is important to previously verify if there is subclinical ectropion or previous blepharoplasties that could result in ectropion due to retraction of the eyelids.

The application on the upper eyelid should be only performed above the superior border of the tarsal plate away from the ciliary margin; and on the lower eyelid, about 4–5 mm from the ciliary margin. The skin turns whitish (frosting) immediately after the application and in a few minutes it changes to dark red color.

Finally apply adhesive tape by areas, in two or three layers, directly on the treated skin (occluded phenol), during the time interval to apply the agent on the next aesthetical unit (Figs. 20, 21, and 22). The patient should be observed and monitored for at least 1 h after the end of the procedure.

Phenol peeling may be performed in only one aesthetical unit, complementing the rest of the face with a TCA peel, for example. In these cases, cardiac monitoring and intravenous hydration are not needed (Figs. 23, 24, 25, and 26). However, a contrast between the different treated areas may occurs, as mentioned in the topic Indications.

Evolution

Pain is intense and may persist for 8–14 h. At this point, the patient must keep the use of acetaminophen at 500–1,000 mg/dose (respecting the

Fig. 18 Materials for peeling application

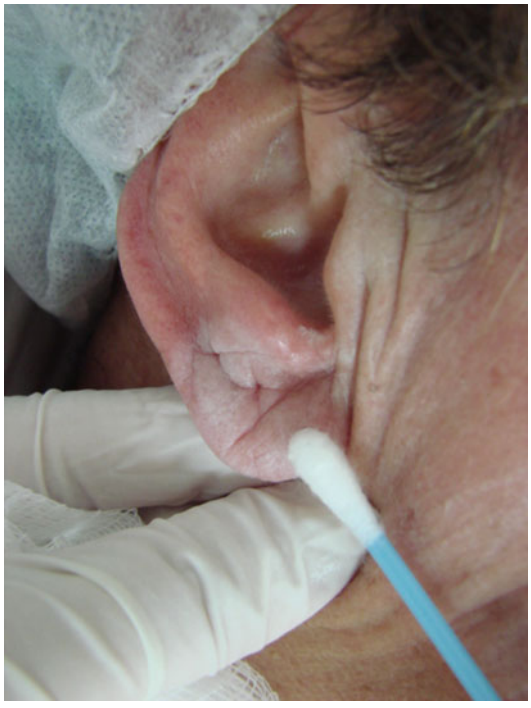

Fig. 19 Frosting on the earlobe with Baker's formula to cause retraction, which improves its flaccid aspect

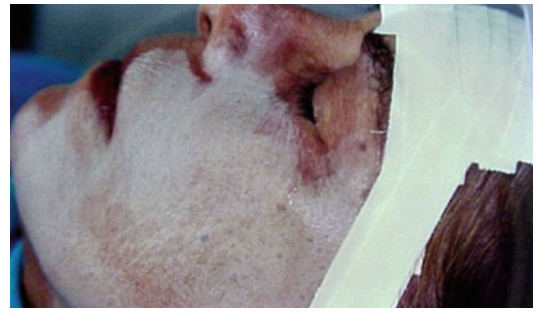

Fig. 20 Immediate frosting after Baker's formula application

interval of 4–6 h between administrations), intercalated with 50 mg ketoprofen every 8 h. Associate tramadol at a dose of 50 mg every 4 or 6 h (attention to the interval between doses, remembering the dose infused during the procedure). As the pain improves, gradually discontinue these medications in the following order: tramadol, ketoprofen, and acetaminophen.

After this initial period, emergence of intense pain requires attention to the diagnosis of complications such as herpes simplex.

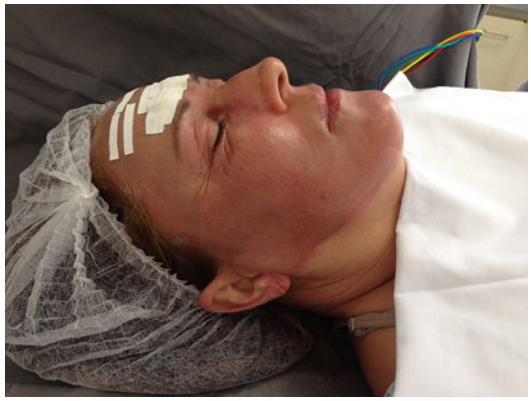

Fig. 21 Dark red coloration after frosting disappearance

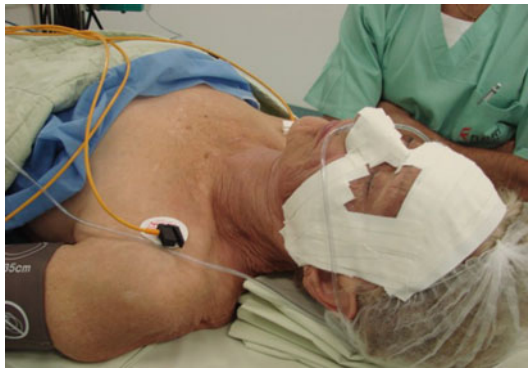

Fig. 22 Wait the time interval between esthetic units for application. Note the occlusion with adhesive tapes

Liquid diet and speaking restraint while occluded is recommended, in order to avoid detachment of the adhesive tape mask and limit facial movements. According to Baker and Gordon, this may preserve integrity of the recovering skin and prevent unfavorable cicatrization.

The adhesive tape mask or occlusive substances are removed after 48 h. At this point the exudate helps detaching the adhesive tape mask, making its removal easier. Parts of the epithelium may be adhered on the surface of the mask. In general, this process does not require anesthesia, but analgesics are required and anxiolytics may be used when necessary.

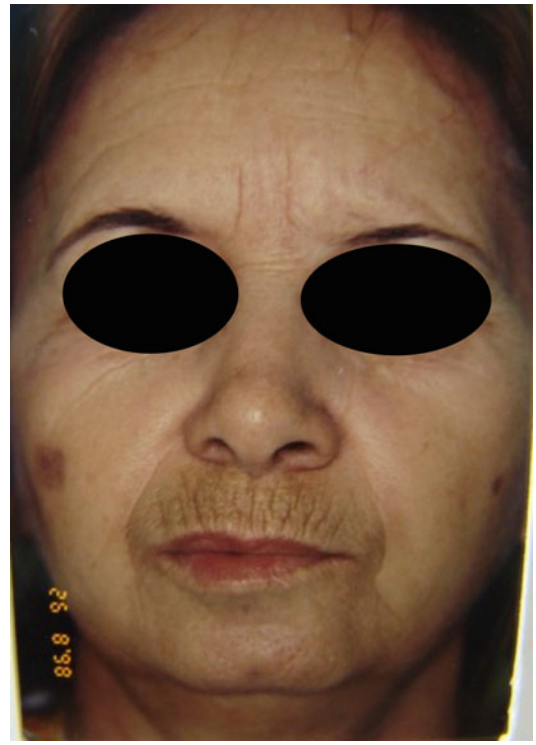

Fig. 23 56-year-old patient with marked perioral wrinkles and melanosis (pre-peeling)

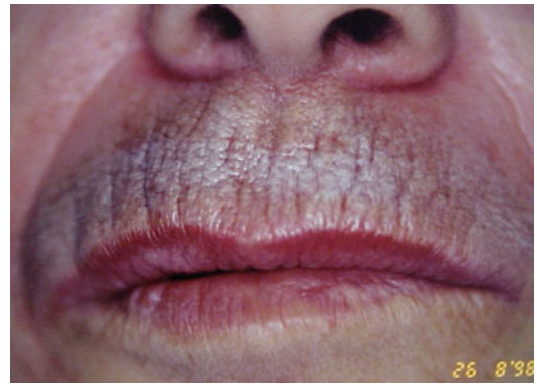

Fig. 24 Immediately after non-occluded phenol peeling performed on upper perioral area

After the removal of the occlusion mask, the skin surface is edematous and humid, and there may be punctiform hemorrhages (Fig. 27); it is also covered with necrotic epithelium, coagulated exudate, and occasional crusts formed from the

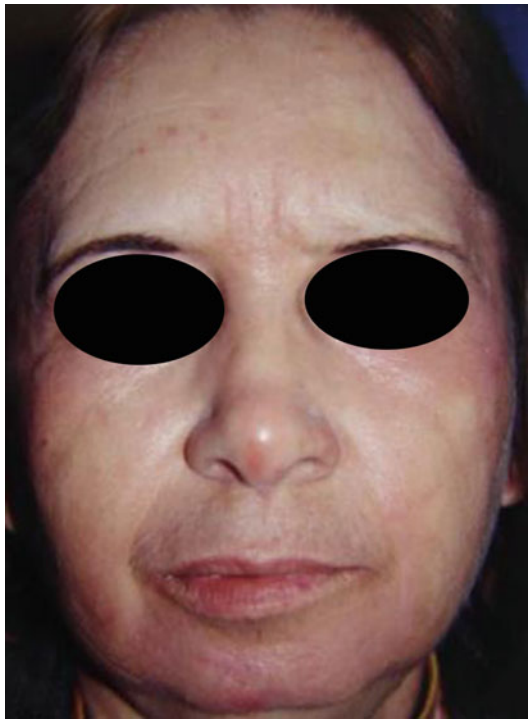

Fig. 25 1 year after upper perioral peeling with non-occluded Baker's formula and 10 days after Jessner and TCA peeling on the rest of the face

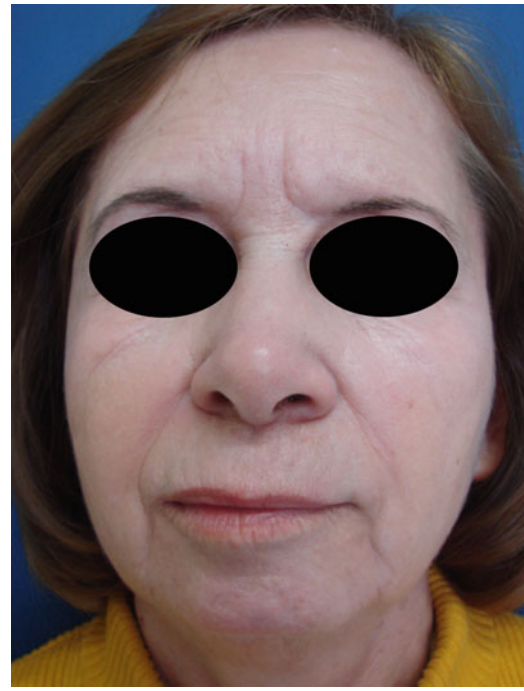

Fig. 26 The same patient of Figs. 23, 24, and 25, 9 years post-peeling

dried exudate in non-occluded areas or where there was early detachment of the adhesive tape mask. It is also common to see edema on the neck and chest.

Gentle wound cleaning should be performed by removing fibrin, crusts, and necrotic epithelium, avoiding aggressive removal of the epithelium that is still adhered.

Once the dermal-epidermal barrier is broken, desiccation and discomfort caused by the direct exposure to environment should be minimized with the application of an ointment, such as 5–10% dimethicone in *petrolatum* (Odo and Chichierchio 1998) or *petrolatum* alone.

Bacterial infection is a rare event with phenol peeling, but careful cleaning should be done by the patient that may clean the wound with saline solution or water several times a day before applying the ointment. This wound cleaning routine continues until full reepithelization, which normally occurs within 7–10 days.

Post-peeling erythema disappears within 45–90 days, generally 90 days when using Baker's formula, and exceptionally may persist for as long as 6 months. The use of makeup for camouflage should be encouraged.

Photoprotection is mandatory, and sunscreens are reintroduced as soon as they are tolerated after reepithelization. It can be initiated with inorganic sunscreens, which are less irritant.

Pruritus and xerosis begin just after reepithelization and may be intense. In these cases, topical hydrocortisone and emollients are useful.

Retinoid or other acids for skin aging prevention may often be reintroduced after about 60 days or more.

Peeling may be repeated in 12 months and localized retouch session may be done after 6 months. In our practice these periods may be shortened in selected cases, such as on sites that clearly there was no penetration of the agent, leaving non-exfoliated irregular areas (Fig. 28).

Association of Deep Peeling and Cosmetic Surgery

Planning in advance is extremely important when associating deep peeling with surgery. If the surgical procedure involves myocutaneous flaps or extensive undermining, full-face phenol peeling should be postponed for 3 months and 6 months after blepharoplasty. This waiting time is necessary because the blood supply to the flap is compromised, and an additional lesion may result in a total skin necrosis or ectropion (Brody 1997b).

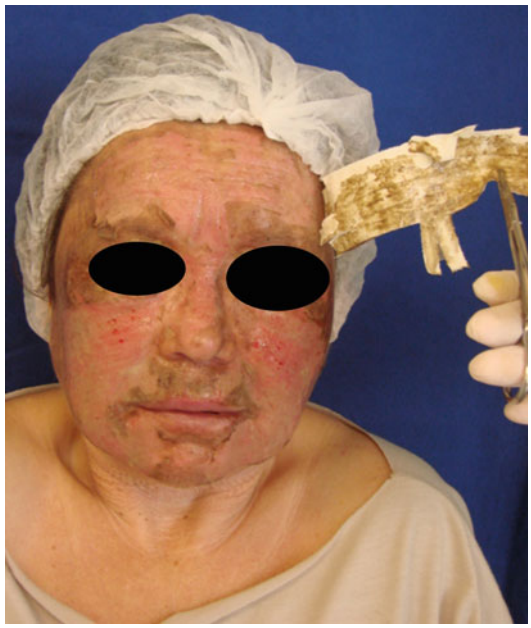

Fig. 27 Removal of occlusion, showing adhered epithelium on adhesive tape and punctiform hemorrhages in malar area

This is also justified by histological studies showing that the collagen remodeling is not complete within up to 60–90 days after the medium or deep peeling.

Complications

The complications associated with phenol peeling are summarized in Table 4.

Pigmentary Disorders

The most common local complications are pigmentary changes. Post-inflammatory hyperpigmentation is easily treated even with common topical depigmenting agents and photoprotection. Irregularity of application may also occur and local reapplication may be required (Figs. 29, 30, and 31).

Phenol peeling inevitably leads to some level of hypochromia, once phenol has direct toxicity to melanocytes (Fulton and Porumb 2004). Although there is good distribution of melanocytes, they contain thin granules of melanin and decreased number of melanosomes. Accentuated hypopigmentation, when occurs, is more difficult to solve and it is often proportional to the peeling depth.

The demarcation line is not a real complication; it shows the difference between the treated and the untreated skin, but it is nonaesthetic if it is too visible (Fig. 32). To minimize the visibility of the demarcation line, attention in applying the peeling a little below the mandible line is needed. If the demarcation line resulting from a localized peeling is an important concern, the

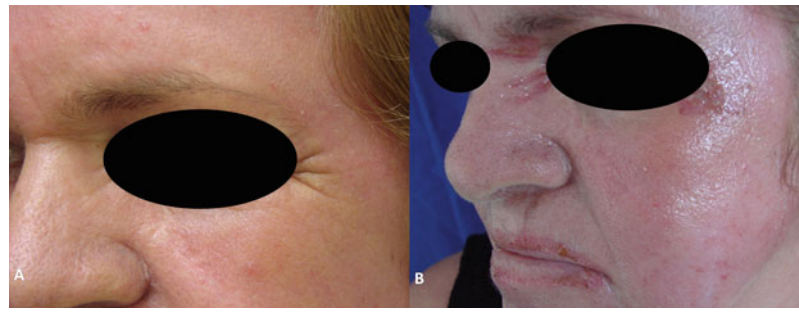

Fig. 28 (**a**) Before a new phenol application on irregularity areas, 3 months after the Baker's formula peel (patient previously shown in Fig. 6). (**b**) 3 days after the new session

Table 4 Phenol peeling-related complications

Complications		
Systemic	Cardiac	
	Renal	
	Hepatic	
	Neurological	
Cutaneous	Pigmentary	Hypopigmentation
		Hyperpigmentation
		Demarcation line
		Nevi: accentuated pigmentation, recurrent nevus, or new lesions
		Persistent erythema
		Persistent flushing
	Healing	Keloids
		Hypertrophic scar
		Atrophic scar
		Necrosis
	Structural defect - scar	Ectropion
		Eclabium
Infectious	Bacterial	Staphylococcus
		Streptococcus
		Pseudomonas
		Toxic shock syndrome
	Viral	Herpes simplex
	Mycotic	Candidiasis
Other complications	Milium, pruritus	
	Texture changes, pore dilation	
	Telangiectasia, laryngeal edema	
	Sensitivity to temperature	
	Neuropsychiatric disorders, depression	

rest of the face may be treated with a medium or deep peeling. A demarcation line on the neck should not be treated with Baker's formula, because the neck has fewer adnexa for reepithelization and higher risk of scars and contractures. For this purpose more superficial chemical peels as trichloroacetic acid or modified phenol formulas may be used.

The darkening of preexisting nevi and the appearance of new nevi sometimes occur after phenol peeling. Large nevi may be removed before the peeling.

Persistent Erythema and Flushing

Persistent erythema may mean potential scar or contact dermatitis. This may be a consequence of the use of systemic retinoid or topical tretinoin, genetic susceptibility, or the presence of active infection (Brody 1989; Maloney et al. 1998). If there is erythema associated with induration, we indicate the use of local massage, application of silicone sheets, potent topical, systemic, or intralesional corticosteroids, and pulsed dye laser to prevent scar formation.

Flushing may last for months; there are reports of persistence for 2 or more years. Hot weather and emotional agitation may worsen it.

Scars

Scars are second ranked among the complications from chemical peelings. It is a feared local complication, because they may be disfiguring.

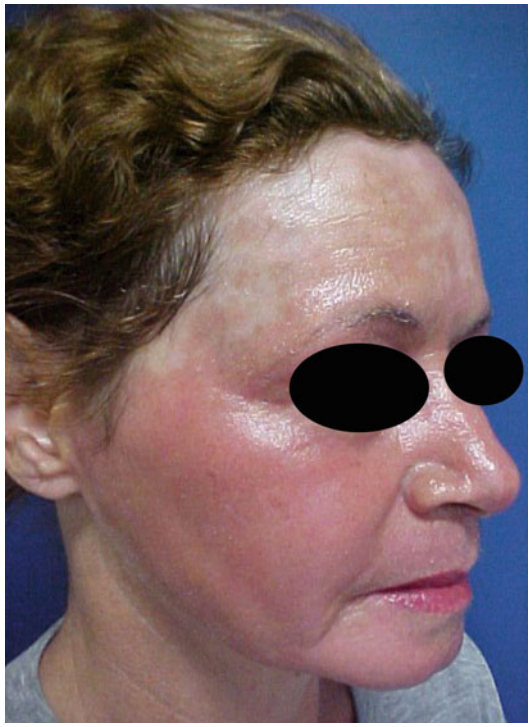

Fig. 29 Post-inflammatory hyperpigmentation, usually initiating 3–4 weeks post-peeling

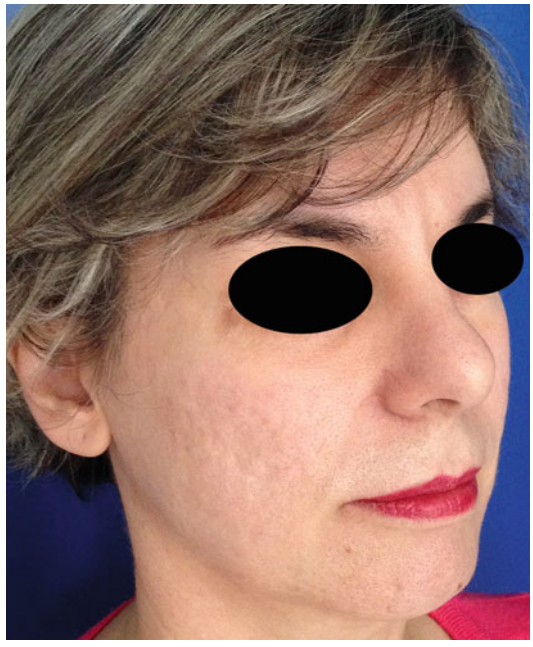

Fig. 30 50-year-old patient 4 years after phenol peeling for acne scar. Irregularity of application on the lower eyelids

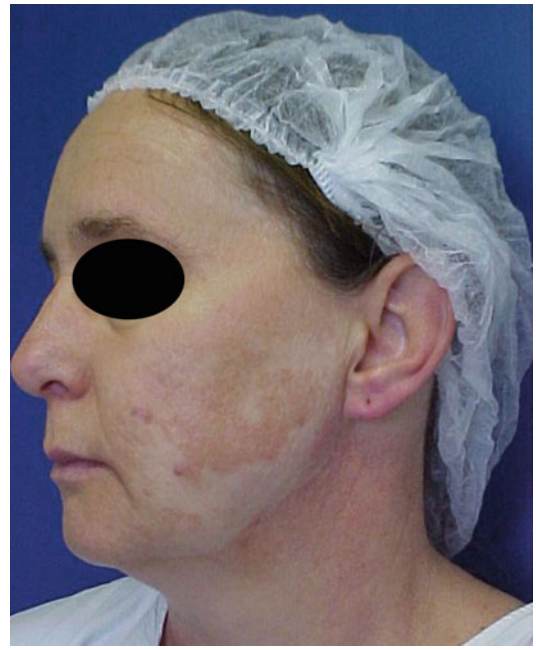

Fig. 31 Extensive irregularity of application

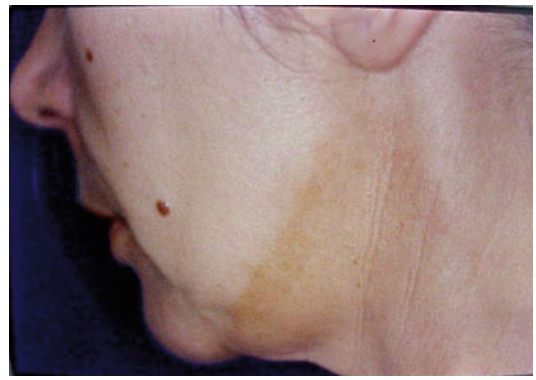

Fig. 32 Demarcation line between the face and neck and accentuation of nevi

Fortunately, we may see more hypertrophic scars that recede without sequels than more inaesthetic keloids, contractures, necrosis, and atrophies (Figs. 33 and 34). They may occur, among other factors, upon the generous application of potent solutions associated with occlusion, constrictive occlusions that worsen with post-peeling edema, infections, or concomitant associations of exfoliation with surgical procedures at the same time or within short intervals.

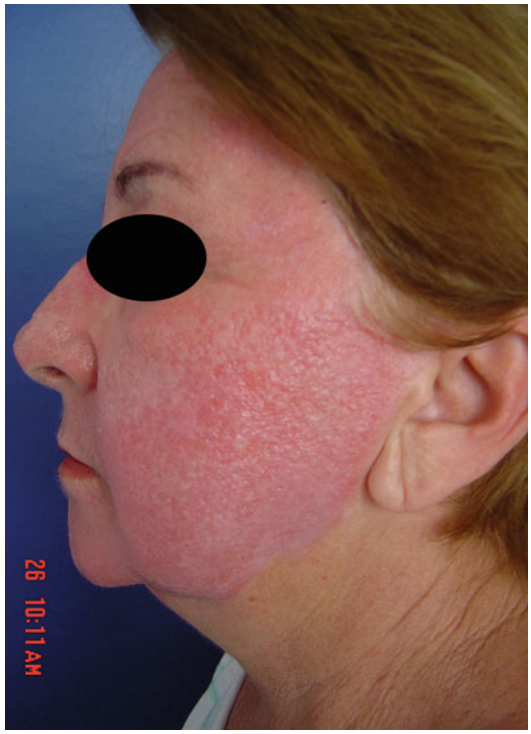

Fig. 33 Hypertrophic scars

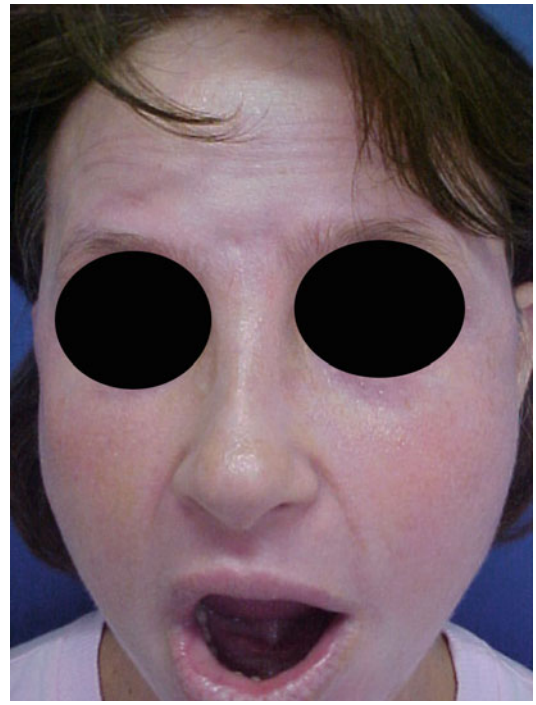

Fig. 35 Patient with temporary ectropion at the recent post-peeling patient previously showed in Figs. 3, 4 and 5

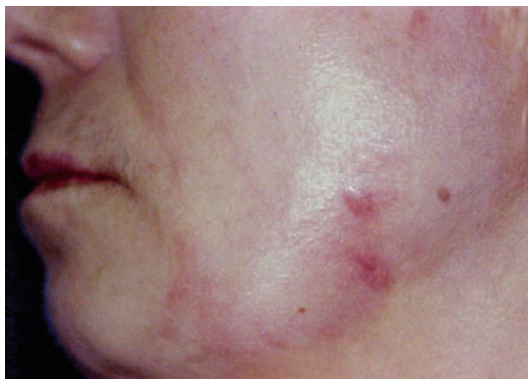

Fig. 34 Post-herpes simplex keloid

Hypertrophic and contracture-related scars may affect facial function and movement, and most cases require surgical interventions associated with a number of measures to minimize the problem. Scars are usually formed within 2–3 months after the peeling (Fig. 35).

Scars are more common on the mandibular, perioral, and zygomatic lines, chin, inner corner of the eyelids, and areas of excessive movement of the face. The higher frequency of scars on the lower third of the face is thought to be related to the movement of speaking and eating as well as the higher frequency of interventions in this area, such as surgery, dermabrasion, and previous peelings.

We highlight that the neck, submental, and sternal regions are prone to form hypertrophic scars. Atrophy is uncommon with phenol peeling.

Infections

Although rare, bacterial infections may result from patient's fear of taking care of their wounds, accumulating necrotic debris and secondary impetiginization. A bacterial infection should be treated with oral antibiotics and local care. All chemical peelings have the potential to induce reactivation of herpes simplex.

Perkins (Perkins and Sklarew 1996) reports that 50% of patients with history of herpes have

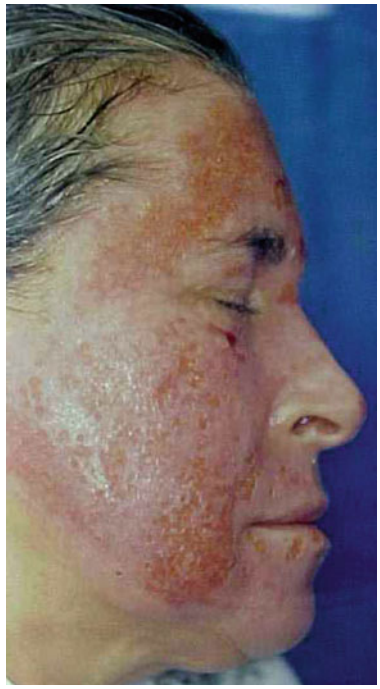

Fig. 36 Herpes simplex initiated 7 days post-peeling. There are no vesicles, only incipient ulcerations

post-phenol peeling perioral eruption, while 6.6% of patients without history have it, in the absence of antiviral prophylaxis. The onset of the eruption may vary from 5 to 12 or more days and it leads to a delay in healing.

Characteristically, herpetic lesions are not vesiculated. They present as round incipient exulcerations or even ulcerations measuring 2–3 mm, alone or in extensive confluent areas, with basal erythema (Fig. 36).

Although herpetic infections may resolve without scarring, they still may lead to inaesthetic scars. Due to significant morbidity associated with herpetic infections during the healing period, patients should be prophylactically treated, regardless of any previous history of herpes simplex as mentioned before.

Therefore, oral antiviral prophylaxis has become a standard for deep exfoliations. Some authors recommend beginning the prophylaxis 2 days before the procedure and continuing it for up to 14 days, as the viral replication mainly occurs when cells are intact, and it is a less

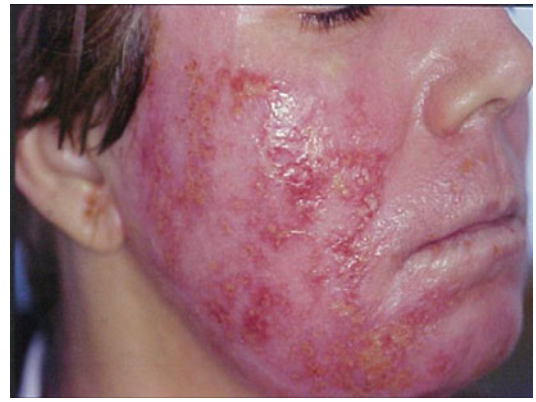

Fig. 37 Herpes simplex infection. The patient was progressing well, when considerable pain started and the facial erythema worsened

probable infection in the first days (Monheit and Chastain 2008). In case of active herpetic infection, it is very important to quickly recognize and treat it properly as early as possible. The antiviral drug dose used for treatment must be the highest recommended (Fig. 37).

As for mycotic infections, they are not usually seen with phenol peeling. *Candida* infections may rarely occur, and it is mostly related to the use of prophylactic antibiotics or local occlusive treatments (Monheit and Chastain 2008).

Systemic Complications

When taking into account all complications, the systemic ones are undoubtedly the most important and most feared. Particularly, cardiac arrhythmias should be prevented by rigorously standardizing the procedure. Phenol is known to have direct toxicity to the myocardium, and animal studies show reduction of the myocardial contraction strength and the electric activity (Stagnone et al. 1987). In humans, there are reports of cardiac arrhythmias, including sinus tachycardia, premature ventricular contractions, bigeminy, and ventricular tachycardia (Truppman 1979). A 10% prevalence of arrhythmias is reported in procedures where a 10–15 min interval between each cosmetic unit was respected (Price 1990).

To minimize the risk of cardiac arrhythmias, minimal quantities of phenol should be used, applying it by cosmetic unit respecting a minimal time interval, intravenous hydration, and promoting diuresis.

Other Complications

Milia resulting from the reepithelization process are formed within 1–3 months after the peeling. The small, superficial cysts of epidermal inclusion are usually self-limited, but they may be removed.

Pruritus is common after reepithelization and usually starts within the first 2 weeks after treatment and continues for about 1 month. Antihistamines, aspirin, nonsteroidal anti-inflammatories, and topical corticosteroids may also be used.

Telangiectasias are not directly affected by the peeling, but it may become more apparent since a lighter skin is expected after treatment. Prevention of purpura is achieved by avoiding physical exercises and exposure to sunlight.

Laryngeal edema may be more commonly seen in smokers.

Other post-peeling complications are psychological destabilization and depression in some patients; therefore, a careful selection of patients is crucial for the procedure.

Histology

Baker's solution completely destructs the epidermis by keratolysis and produces an inflammatory zone of cellular destruction that extends up to the middle reticular dermis. This reaction reaches its peak within 48 h, when epidermal regeneration begins and is completed within 7–14 days later. In the epidermis, there is a normalization of cell polarity and cytological irregularities, followed by a remarking decrease of melanosomes, although melanocytes are regularly distributed.

Dermal thickening begins approximately 2 weeks from the treatment, and collagen remodeling is not complete until 90 days (Figs. 38, 39, and 40). A new band of the dermis measuring 2–3 mm is formed between the epidermis and the underlying elastotic tissue. This new band is formed by thin, compact, organized, parallel collagen bundles, horizontally arranged in relation to the surface. The elastic fibers are regenerated and numerous, forming a network arranged by chance, and sometimes parallel to the new collagen formation.

The follow-up of patients conducted by Kligman, Baker, and Gordon shows that these changes in the epidermis and dermis persist for at least 20 years after the peeling (Kligman et al. 1985).

Although technically simple and low cost, phenol peeling largely depends on the applicator's technique and experience, and may have exceptional results.

It has been known for a long time, but it is still rarely used by dermatologists. The probable reason would be phenol toxicity that may be minimized with planning and proper care.

Phenol peeling has a dramatic clinical and histological effect, and although the aging process continues, histological studies prove that post-phenol dermal reconstruction is long-lasting and probably permanent. Phenol peel is mentioned by some authors as one of the most long-lasting therapeutics in medicine (Fig. 41).

Take Home Messages

- Adequate patient selection: severe photoaging and psychological profile.
- Written pre- and post-op instructions to the patient.
- Effective analgesia, preferably assisted by an anesthesiologist.
- Baker's peeling depth may vary according to the quantity of croton oil, number of coats applied to the skin, volume of solution applied, and occlusion (or not) with adhesive tape.
- Comply with the application technique and respect the time intervals between aesthetical units to avoid cardiac arrhythmias and other systemic effects.
- Careful patient follow-up, mainly during the first week, gradually spacing up until complete 3 months.

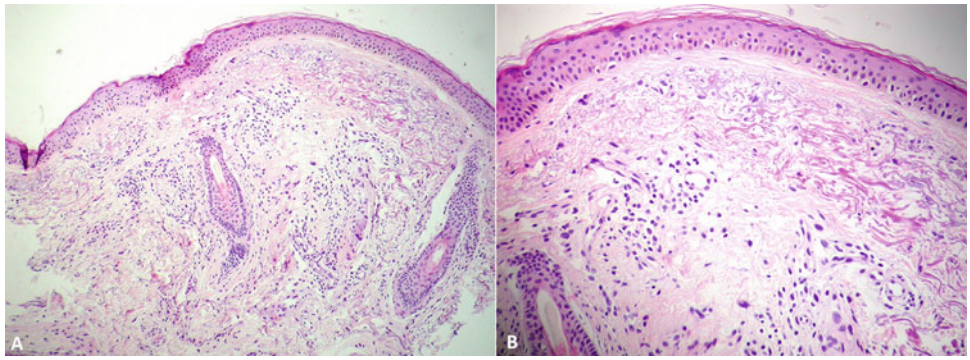

Fig. 38 (**a**, **b**) Pre-auricular Histological evaluations (H&E) before Baker's peel – dermis with intense elastosis and moderate perivascular lymphocytic inflammatory infiltrate

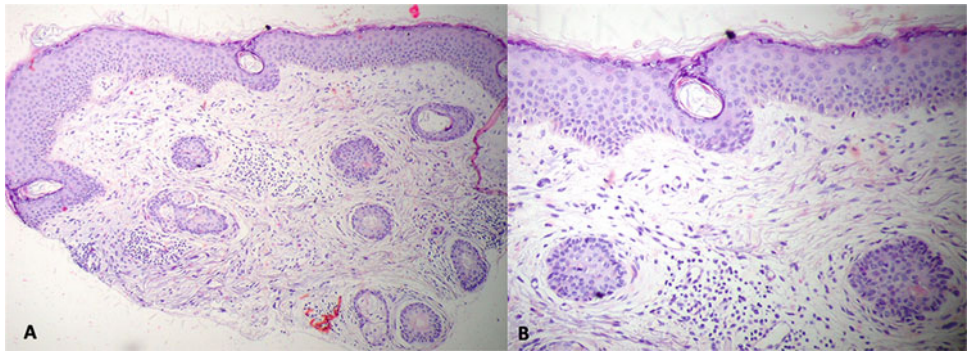

Fig. 39 (**a**, **b**) Histological evacuativos (H&E) 1 month after treatment. Dermis with elastosis, but on the superficial dermis, just above the elastosis, there is a modest deposition of collagen, parallel to the epidermis. Note that there are some well-formed fibroblasts

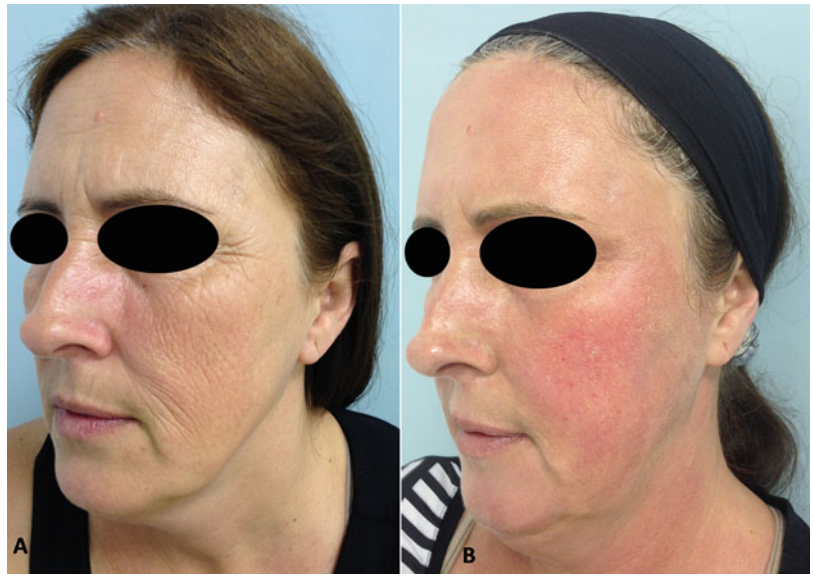

Fig. 40 Clinical photos of the patient submitted to the pre-auricular biopsy (Figs. 38 and 39). (**a**) Pre-peeling. (**b**) 1 month post-peeling. During this phase, the clinical improvement is usually greater than that evidenced upon histology

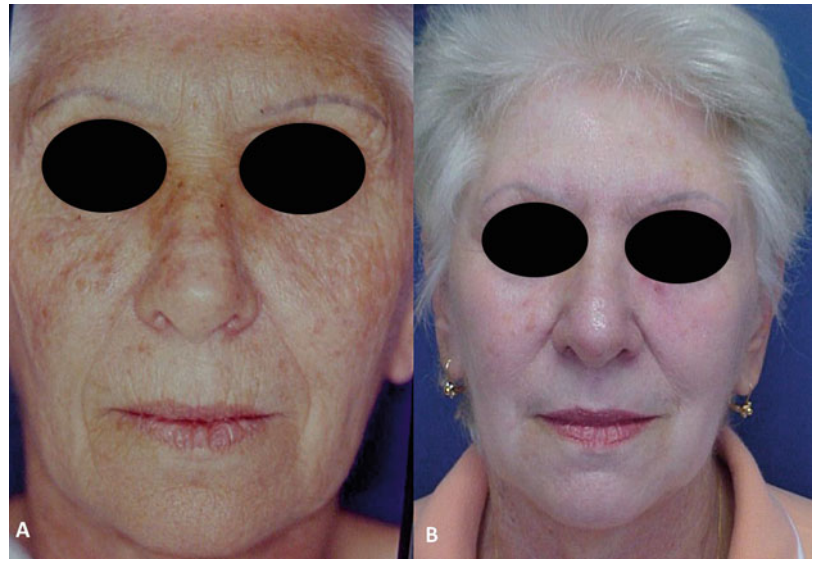

Fig. 41 62-year-old patient with sun-induced melanosis. (**a**) Before phenol peeling with Baker's formula. (**b**) 12 years after phenol peeling. Showing a long-lasting result

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Combining Phenol-Croton Oil Peel

Carlos Gustavo Wambier and Fátima Pires de Freitas

Abstract

Multiple dermatological interventions may be combined with deep phenol-croton oil peeling to improve skin aging and severe acne scars. To achieve uniformity of skin tone, combination treatment with medium-depth chemical peeling with Jessner's solution and 35% trichloroacetic acid, Q-switched frequency-doubled Nd-YAG (532 nm) or Q-switched Nd-YAG (1064 nm) LASERs are possible effective options. To further enhance rejuvenation treatment, individualized correction of facial lipoatrophy, facial sulci, and depressed scars can be performed with multiple injectable dermal and subcutaneous fillers such as polymethyl methacrylate, poly-L-lactic acid, and hyaluronic acid. Deep hyperkinetic facial lines resurfacing is maximized and maintained by adjuvant treatment with botulinum toxin A injections. This chapter describes how to better combine different treatments and focuses on up-to-date alternatives for the classical peeling formulas and combination treatments. Specific limitations, contraindications, preparation, and post-peeling regimens are described.

Keywords

Photodamage • Photoaging • Chemical peels • Phenol • Phenol peels • Carbolic acid • Botulinum toxin A • Dermal fillers • Poly-L-lactic acid • Hyaluronic acid • Trichloracetic acid peels • Acne scars

Contents

C.G. Wambier (✉)
Department of Medicine, State University of Ponta Grossa, Ponta Grossa, PR, Brazil
e-mail: cwambier@uepg.br

F. Pires de Freitas
Instituto de Dermatologia Prof. Rubem David Azulay - Santa Casa de Misericórdia do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
e-mail: fatimap.freitas@hotmail.com

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Introduction

Even the most effective resurfacing treatment available may require adjuvant procedures. In many cases, combining multiple dermatologic treatments produces more impressive effect than the deep phenol-croton oil peel in solo version.

Phenol-croton's oil exceptional results for the treatment for moderate to deep static facial lines occur by synergic action of multiple substances found in croton oil. Croton oil is probably the strongest irritant available for cosmetic treatments, with strong vesicant properties, and possesses unmatched power to rejuvenate the skin. Chemical stimuli and inflammation induced by only some seconds of contact with skin cells are able to evoke more effective rejuvenation than healing from denaturation and coagulation induced by lasers or other chemical peels. Phorbol esters derived from *Croton tiglium* stimulate tissue growth and ameliorate the signs of aging with great efficacy, even in a single exposure. Phorbol 12-myristate-13-acetate and other phorbol are able to induce accelerated deoxyribonucleic acid synthesis (Bertolini 2002) and mitosis (Leite et al. 2011).

Phenol is used as solvent for croton oil and is able to unleash the effect of multiple dissolved substances by deep penetration into the dermis. Although chemical interactions with some active substances of croton oil may occur, this possibility remains to be proven. Until the day this chapter was written, there are no clinical information about the effects in the treatment of severe photoaging with topical application of pure croton oil, without phenol, nor any croton oil derivative. Hopefully, one day, croton oil or active substances could be applied to the skin with drug-delivery procedures with LASER (Sklar et al. 2014) or tattoo machines (Arbache and Godoy 2013), sparing the patient and the physician from toxic effects of phenol. Historically, three to six drops of croton oil have been topically applied to sound skin and rubbed in for a period of 8–12 min, over the laryngeal area for treatment of hoarseness, over the supraorbital area for treatment of local neuralgia, and over the parotid region for treatment of Bell's facial paralysis, causing a deep edematous eruption followed by many vesicles (Hutchinson 1833), apparently, without scar formation.

If one aesthetic unit of the face is treated with a deep chemical peel, in most cases, the other facial aesthetic units will also require treatment to ensure uniformity of results, otherwise, the disparity of skin tone, firmness, vitality, texture, and shine will make it obvious that one unit has acquired a much more youthful appearance. Among the available resources for blending the results, dermatologists can use different phenol-croton oil formulas or laser resurfacing for wrinkles, nanosecond Q-switched LASER for safe and effective treatment of pigmentary disorders, or, alternatively, classical medium-depth trichloroacetic acid (TCA) peels.

For maximization of results in the treatment of deep dynamic lines, adjuvant treatment with botulinum toxin A (BTxA) injections is considered primordial in the maintenance of results and to help healing with smooth and uniform neocollagenesis during the immediate post-peel period. The injection of fillers for mid-face lifting by correction of facial senile lipoatrophy and treatment of facial sulci or depressed scars enhance treatment's final results.

This chapter will focus on specific indications of combined treatments, with the best timing for such procedures.

Indications and Limitations

Dermatologists are frequently faced with more than one cosmetic condition to be treated in the same anatomical site. Occasionally, only one procedure can treat these multiple conditions, however, in most situations, a combination of treatments is required, so that each of the patient's cosmetic complaints is adequately managed. Full awareness of the clinical indications and limitations of each treatment allows the skin specialist to make better decisions when proposing treatment plans to treat multiple conditions.

Phenol-croton oil peels are indicated for the treatment of dermal cosmetic disorders, such as deep wrinkles, atrophic acne scars, elastosis, and lax skin. Other indications may include treatment of actinic keratoses, actinic cheilitis, verruca plana, xanthelasma, and ear lobe cleft repair.

One major limitation of phenol-croton oil peeling is the cardiotoxic effect of phenol when its plasma concentration is increased. Large surface areas are better treated by dividing the treatment into safer fractions of up to 5% of body surface area (BSA). Phenol peeling areas over 5% of BSA in a single session is an absolute contraindication in all patients, and peeling areas over 2% of BSA in a single session is a relative contraindication in those with cardiac conditions such as congestive heart failure, arrhythmias, severe high blood pressure, or severe valvular heart disease. Room air exhaustion during all procedures is recommended.

Even though some treated areas may present transient, minimal, moderate, or intense collateral effects on volumization (increased collagen production), denervation (neural toxicity), and depigmentation (melanocyte toxicity), these effects of phenol-croton oil peels are insufficient or inconstant for general clinical application. Specific treatment for each of these effects is required to achieve desired results.

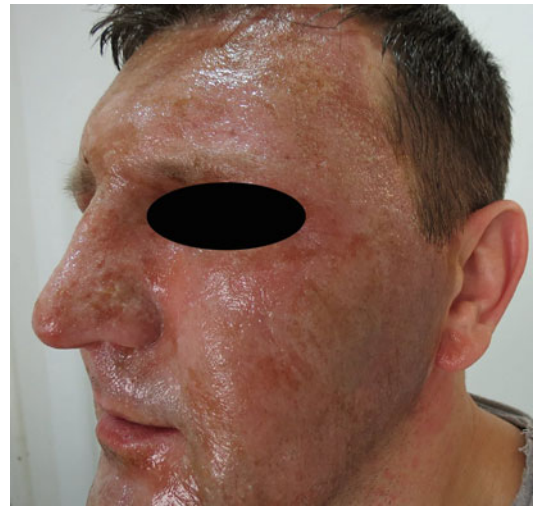

Fig. 1 Phenol-croton oil peeling. Edema is stable after 24 h. Vesication is noted on temples and nasal areas

Patients should be aware of the need to use makeup to cover temporary pigmentary side effects for up to 6 months.

Patient Selection and Skin Preparation

Phenol-croton oil peels are certainly not for everyone. Selection of patients with the proper psychological profile to follow adequate post-peel care is mandatory for satisfactory results. Deep peeling is absolutely contraindicated in patients with compulsive skin picking and excoriations. Patients should quit smoking for at least 1 year and must not be frequently exposed to the sun or other known carcinogens. Phototype I-III, Glogau IV, healthy patients are the ideal candidates for such procedure. To ensure uniform and easy penetration of the peeling compounds, patients may be prescribed to apply, for at least 1 month, a topical retinoid such as 0.1% tretinoin (Retin-A™) or 0.3% adapalene (Differin™), in association with 4% hydroquinone for patients with history or increased risk for intense post-inflammatory hyperpigmentation (PIH). It is advisable to stop the topical prescription medications 48–72 h before the peeling day to avoid excessive irritation in areas prone to hot spots such as perioral or periocular areas. PIH is one expected side effect.

Post-Peeling Healing and Care

Phenol-croton oil peels induce extreme edema, which is completely formed in the first 24 h and usually last 3–4 days (Fig. 1 and 2). During the first day, while the edema builds up, pain is usually severe. Sometimes, periocular edema may be so severe as to completely block vision. Therefore, patients need to have a helping hand during the first 24 h. Pain usually fades away within the first 48 h, when mild to moderate serous to purulent exudate is commonly seen. After 72 h, edema faded almost completely, and patients present with crusts of both the peeled skin and dry exudate, therefore it is useful to remind the patient about proper ointment use (Fig. 3). Facial skin is usually clear of crusting and exudate by the seventh to tenth day after the peel, when epidermis is completely healed. Finally, after the first critical week, mild to severe persistent erythema occurs in the sites where deep peeling was achieved (Fig. 4), which is directly related to both the depth and the strength of the solution. Neocollagenesis is at its full throttle during this period,

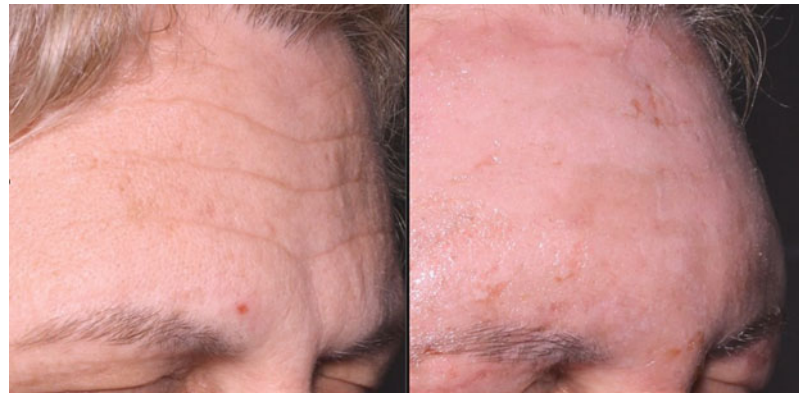

Fig. 2 Phenol-croton oil peeling. Extreme edema is seen after 24 h. Skin is kept moist and occluded with deliberate use of petroleum jelly

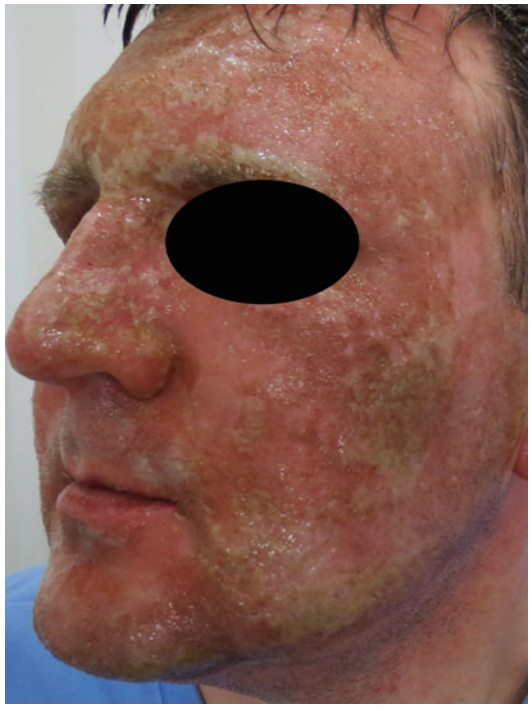

Fig. 3 Phenol-croton oil peeling. *Yellow/brown* crusts associated with fibrin formation after 72 h. Edema has regressed substantially

therefore it is important to avoid systemic or topical potent or superpotent steroids during this period, which inhibit fibroblast activity. After 2–4 weeks, in most patients, it is common to observe hyperpigmentation over the sites of stronger erythema. This PIH usually lasts from 2 to 5 months. Mild pruritus or dysesthesia is commonly felt during these first months, until superficial neural terminals and sensory corpuscles are fully healed.

The higher the concentration of croton oil and/or phenol, the stronger the peeling will be (Hetter 2000a). In treated sites, if erythema is not seen, after 7–10 days, the skin can be retouched, with the same or stronger solution, during the wound care visits in the first 2 weeks, or be planned as a new peeling session, after 2–6 months, when it is possible to switch intervention by combining LASER resurfacing, if residual lines with partial results are mild.

For after-peel care, facial shower or bathing should be avoided for at least 2 days. During this critical period, patients are allowed to wash with cold sterile saline or saline compresses, and should be instructed to apply as much pure petroleum jelly (Vaseline™) as required to maintain crusts always soft. Proper petrolatum occlusion in the first days helps to protect against irritants and allows the dermatologist to examine the healing skin daily. Some dermatologists use adhesive tape for occlusion (Stuzin et al. 1989) which causes greater damage during its removal. After improving from the extreme edema, patient is allowed to shower with hypoallergenic baby shampoo or cleanser lotion. Patients should be warned not to pick, scratch, nor pull crusts. Patients may be instructed to cut any hanging crusts with scissors. Daily office appointments to

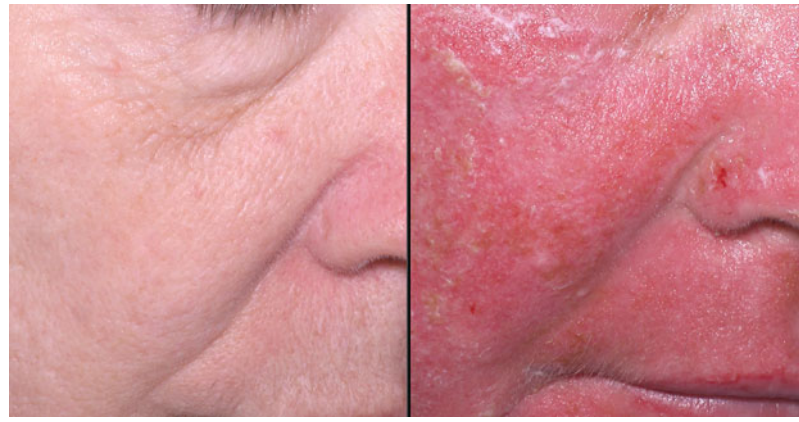

Fig. 4 Phenol-croton oil peeling. Erythema is pronounced on the seventh day

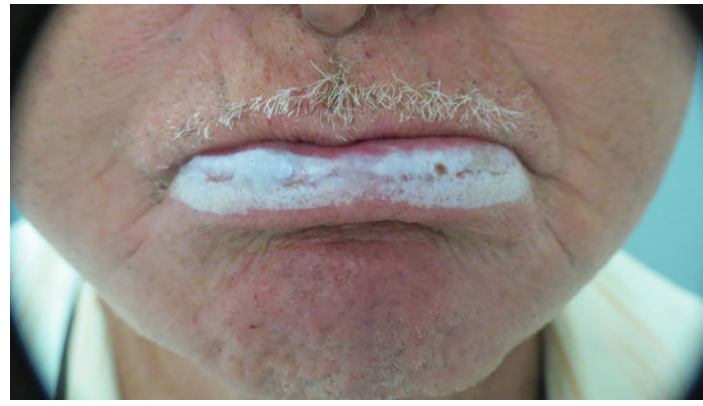

Fig. 5 Treatment of actinic cheilitis with full-strength phenol-croton oil peeling on lower lip. Croton oil concentration of 4% (one drop per ml of 88% liquefied phenol)

check for infections and general wound care are recommended. After 48 h, wound crusts and fibrin must be gently debrided washing with sterile saline jets, after at least 15 min of soaked sterile saline compresses. Wet cotton-tip applicators may be used for gentle lift and debride crusts and fibrin. Delicate sterile surgical instruments such as scissors and atraumatic tissue forceps may be used do debride necrotic skin, crusts, and fibrin.

During such visits, it is not uncommon to start oral and topical antibiotics due to purulent exudates, increased odor, and erythema. Routine use of prophylactic antibiotics should be avoided. Valaciclovir for herpes prophylaxis must be prescribed to all patients, 500 mg 2 times a day during the first 7 days, previous herpes history is irrelevant. For pain management, immediate after-peel application of 4% lidocaine cream before applying petroleum jelly, and previous prescription of codeine 30 mg every 4 h, starting 2 h before peeling. If severe pain is experienced during the first postoperative day, patients are instructed to double the dose of codeine. Stronger opioids, such as oxycodone 10mg can be prescribed for better pain control, taken 3h before the peel and repeated 2 hours after the end of the peel, then, every 8 hours, as needed. Tramadol 100mg every 8h is also an effective alternative. Both oxycodone and tramadol may cause nausea, which is usually controlled with sublingual ondansetron 4mg.

Topical and systemic retinoids and steroids are avoided for at least 6 months. Erythema and

hyperpigmentation are best managed with hypoallergenic cosmeceuticals, such as topical vitamin C, E, nicotinamide, and topical hyaluronic acid.

Strengths and Preparation of Phenol-croton oil Formulas

There is a variety of possible phenol-croton oil formulas. The strongest formula is the stock solution by itself, which contains one drop of croton oil per ml of liquid 88% phenol (Hetter 2000b). This formula contains completely solubilized 4% croton oil in 85% phenol; presents a uniform, monophasic, yellowish hue; provokes very deep peeling; and is currently used by the author to repair incomplete earlobe cleft and treat actinic cheilitis (Fig. 5), xanthelasma, icepick, and boxcar acne scars by chemical reconstruction of scars (CROSS). The author has baptized this full strength solution "capeta" (devil), as a reminder for the novice on chemical peels to be extremely cautious when using this dangerous and extremely strong formula. To prepare this stock solution, add 1 ml of croton oil to 24 ml of pure 88% liquefied phenol (Hetter 2000b). For smaller volume, mix 0.5 ml of croton oil into 12 ml of 88% phenol.

The most traditional formula is the Baker Gordon solution, which contains about 2.1% croton oil in 50% phenol (Baker et al. 1966). This formula causes diffused melanocyte toxicity and requires at least 60 min to peel the whole face with adequate room air exhaustion, due to higher cardiotoxic risk. Extreme acne scars (in association with CROSS technique using "capeta") or extreme facial elastosis on phototype I-II are best managed with this formula. The author does not recommend this peeling for lower eyelids due to increased risk of ectropion. To prepare this super potent formula, mix 3 ml of 88% phenol with three drops of croton oil. Then, add eight drops of Septisol and 2 ml of water and mix well before use, because this and all the next formulas are biphasic.

Hetter's formulas are the most versatile; croton oil concentration varies from 0.4% to 1.6% in 35% phenol, although 50% phenol can also be prepared (Hetter 2000b). To prepare the formulas, the final volume will always be 10 ml. First, add 1, 2, 3, or 4 ml of the stock solution to 3, 2, 1, or "0" ml of 88% phenol, to prepare 0.4% croton oil (mild), 0.8% (medium), 1.2% (potent), and 1.6% (very potent) formulas, respectively. Observe that the sum of ml of the stock solution plus phenol should always be 4 ml in order to obtain 35% phenol solution. Then, add 5.5 ml of water mixed with 0.5 ml of Septisol (remaining 6 ml). To prepare 50% phenol formulas, the volume of phenol may be increased to 5.5 ml, with decrease of water volume to 4 ml. In order to prepare a solution very similar to Baker Gordon formula with this volumetric technique, mix 5.5 ml of the stock solution to 0.5 ml of Septisol dissolved in 4 ml of water (2.2% croton oil in 50% phenol), or mix 5 ml of the stock solution, plus 0.5 ml of 88% phenol into 0.5 ml of Septisol dissolved in 4 ml of water (2% croton oil in 50% phenol).

The mildest formula is 0.105% croton oil in 27.5% phenol (Orra et al. 2015), which is a very safe and tolerable formula with mild edema during healing time, with faint desquamation. To prepare this formula, which was named by Hetter as a "very light peel" of his 1996 Heretic Formulas, mix 4 ml of phenol 88% with 1 drop of croton oil, 16 drops of Septisol, and 6 ml of water. Take 3 ml of this mixture and add 2 ml of phenol 88% and 5 ml of water (Hetter 2000b). Alternatively, a very similar formula may be prepared by mixing 0.3 ml of stock solution with 3 ml of 88% phenol, and add 6.5 ml of water and 0.6 ml of Septisol. That will produce a 0.12% croton oil with 27.5% phenol formula, which can be safely used to attenuate fine wrinkles in lax eyelids.

The decision to which strength to be used is crucial for adequate treatment of each condition. The author considers formulas stronger than 0.4% croton oil in 35% phenol deep chemical peels and more diluted formulas mid to superficial peelings.

Combining with Other Chemical Peel

The traditional combination treatment for phenol-croton oil peels is to apply a milder peel in the remaining facial skin, such as depicted in Fig. 6, in

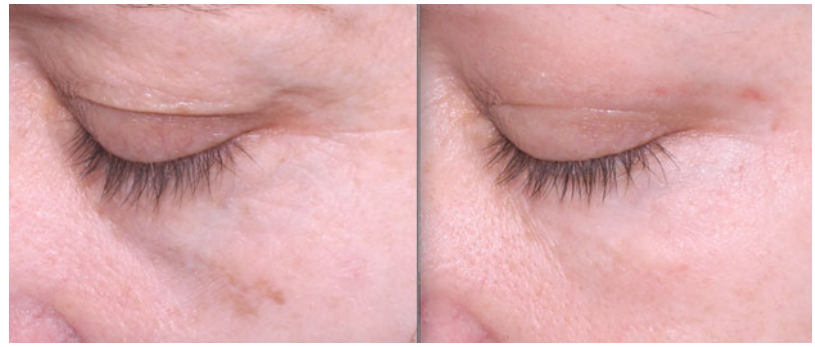

Fig. 6 Combination treatment of periocular phenol 35% and croton oil 0.4% with Monheit's medium-depth peeling in the remaining facial skin. (Jessner's solution followed by 35% trichloroacetic acid). *Left*: pretreatment. *Right*: after 30 days

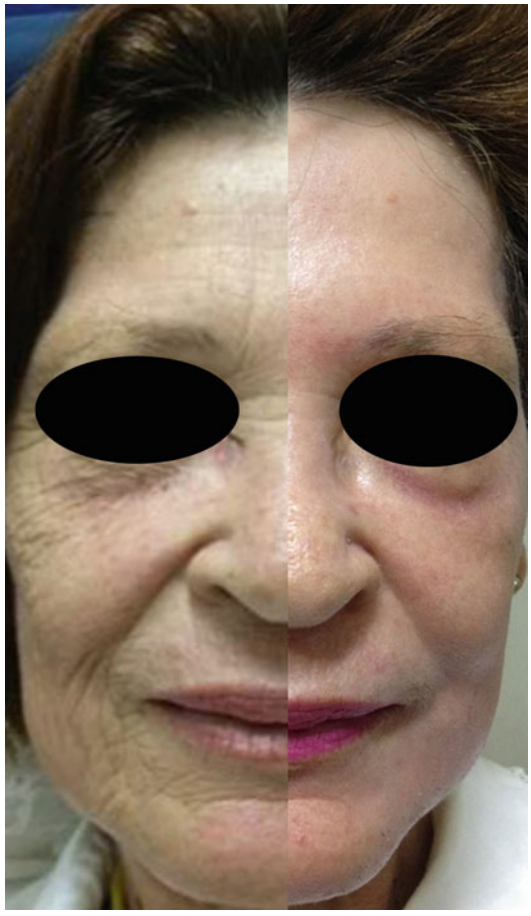

Fig. 7 Full-face phenol-croton oil peeling skipping lower periocular area because of compromised snap-back test due to severe laxity in lower eyelids. After 30 days, lower periocular area was peeled with Monheit's medium depth Jessner's solution followed by 35% trichloroacetic acid peel. *Left* and *Right*: same side, as evidenced by frontal intradermal nevus. *Left*: before. *Right*: after 2 months of phenol-croton oil peel and 1 month of lower eyelid Monheit's peel

a case that was combined with Monheit's Jessner + TCA 35% (Monheit 2001) in the same procedure.

When using a very strong phenol-croton oil formula, such as Baker Gordon formula on mid upper eyelids, in the area that would be excised during a upper blepharoplasty, good results are achieved by the application of plain liquefied phenol 88% in the remaining eyelid skin and periorbital area, plus a milder medium-depth chemical peel in the rest of the face, such as 35% TCA in the remaining aesthetic units of the face (Parada et al. 2008).

Gregory Hetter revolutionized phenol-croton oil peeling by suggesting milder formulas of phenol-croton oil peels to be used in the same procedure, without the need to combine with different chemicals, reducing the risk of demarcation marks between aesthetic units. Hetter suggests that stronger formulas are better used in the perioral area, whereas weaker formulas are used in the eyelids and neck, with excellent results (Hetter 2000b). Nowadays, it is preferable to seize skin tone uniformity with different phenol-croton oil formulas or milder application techniques (less friction, feathering), than to use other chemical agents. When using a different chemical agent, it is recommendable to delay the second peel until full epidermal recovery from phenol-croton oil peel is seen (as seen in Figs. 7 and 8).

Lax periocular area is associated with increased propensity for lower eyelid ectropion. Evaluation of laxity by snap-back test is mandatory. If a lag or ectropion is observed after the

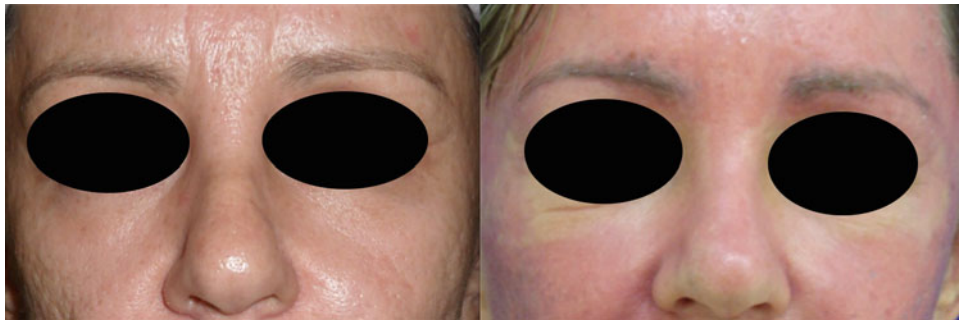

Fig. 8 Full-face phenol-croton oil peeling for treatment of acne scars. Lower periocular area was skipped bilaterally because of asymmetric lower eyelid retraction caused by lower eyelid blepharoplasty performed 5 years earlier. Periocular area was further treated after 2 months with plain 88% phenol with no complications. *Left*: before. *Right*: after 14 days of initial phenol-croton oil peel

Table 1 Various strengths of phenol-croton oil formulas

Strength	[Phenol] (%)	[Croton] (%)	# Drops/ 10 ml	Indication
Very Light	27.5	0.12	0.3	Lax eyelids
Mild	35	0.4	1	Eyelids, neck
Medium	35	0.8	2	Routine
Strong	35	1.2	3	Periocular, deep lines
Very strong	35	1.6	4	Perioral, nose
Super strong (Baker Gordon)	50	2.0	5	Extreme cases
Extremely strong ("capeta")	86	4	10	Xanthelasma, icepick acne scars, actinic cheilitis

snap-back test, there is a very high risk for ectropion with a deep chemical peel. Although phenol-croton oil actually ameliorates superficial skin laxity after full healing, it does not act on deeper structures, such as ligaments. Thus, superficial skin tightening can induce retraction and ectropion.

Furthermore, the periorbital edema in the healing process can produce temporary corneal exposure. Skipping lower eyelid during phenol-croton oil peeling is advisable in patients with compromised snap-back test, ectropion and lower eyelid retraction (Figs. 7 and 8). In these patients it is advisable to combine the procedure with a medium depth peel, which does not cause skin retraction, or a very light phenol-croton oil peel (Table 1).

Best timing recommendations:

- When combining with milder phenol-croton oil peel: same day.
- When combining with other chemicals (Jessner/TCA): 14–30 days (full epidermal recovery). Do not apply in the area peeled with phenol-croton oil.

Combining with Botulinum Toxin A

The most common phenol-croton oil peeling combination treatment is the use of BTxA. Pretreatment with BTxA, 2–3 weeks before the peeling appointment, is indicated to reduce facial movement during the immediate post-peeling period and facilitate healing. Pretreatment could also reduce pain in the intraoperative and postoperative period. However, croton oil may stimulate neural regeneration as observed during historic reports of treatment of

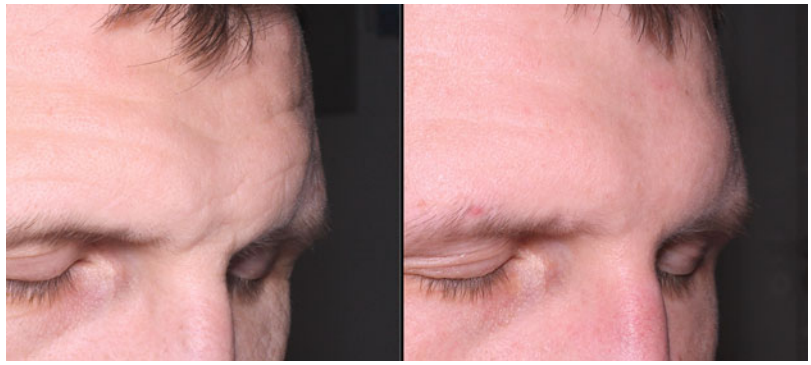

Fig. 9 Combining botulinum toxin A pretreatment with phenol-croton oil peeling. Patient experiences less pain and movement is inhibited in the post-peeling period, producing excellent results; however, there is a risk of reduced duration of neuromuscular blockage by healing properties of croton oil chemicals. In this case, movement was fully reestablished after 3–4 months, when it was decided to anticipate the usual five to six monthly injections. *Left*: before. *Right*: after 4 months, day of reinjection of botulinum toxin A

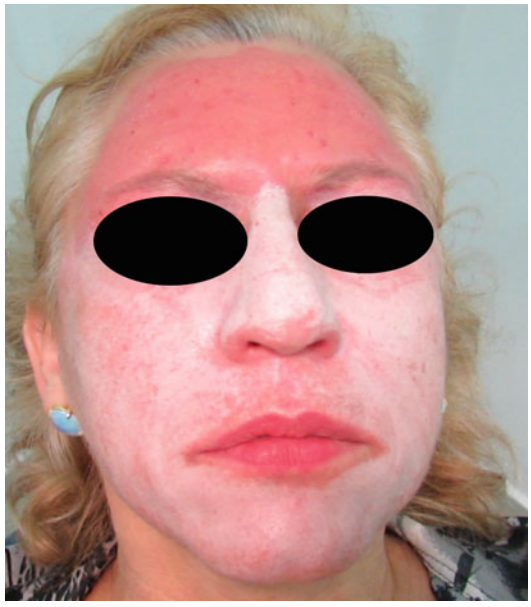

Fig. 10 Multiple combination treatments. After 14 days of initial intervention with phenol 35% and croton oil 1.6% forehead peel (erythema is seen) associated with malar and perioral poly-L-lactic acid injection, botulinum toxin A was injected in the upper third of the face (*red* injection spots) and Monheit's medium-depth chemical peel was applied in the lower two thirds of facial skin (*white* frosting)

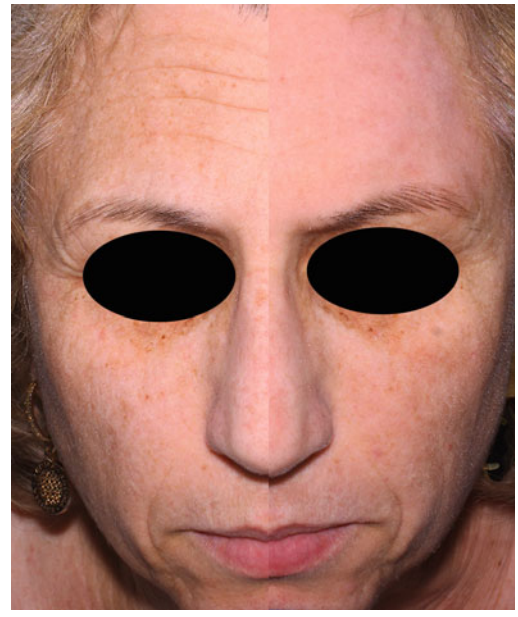

Fig. 11 Excellent results of multiple combination treatments. Four months after initial intervention with phenol 35% and croton oil 1.6% forehead peel (mild hypopigmentation seen) associated with malar and perioral poly-L-lactic acid injection, followed by botulinum toxin A injection to the upper third of the face and Monheit's medium-depth chemical peel

hoarseness and facial paralysis with topical application of croton oil (Hutchinson 1833).

Combining BTxA in the same day of deep peeling is not recommended, because of high risk of diffusion of the toxin by the extreme edema noticed in the first 24 h of peeling (Figs. 1 and 2).

Reduced BTxA duration may be observed after phenol-croton oil peeling (Fig. 9), and

Fig. 12 Combination treatment with botulinum toxin A. After 21 days after initial full-face 35% phenol and 1.2% croton oil peel, facial expression has recovered and patient is ready for post-peeling injections to boost and maintain peeling effects on wrinkles

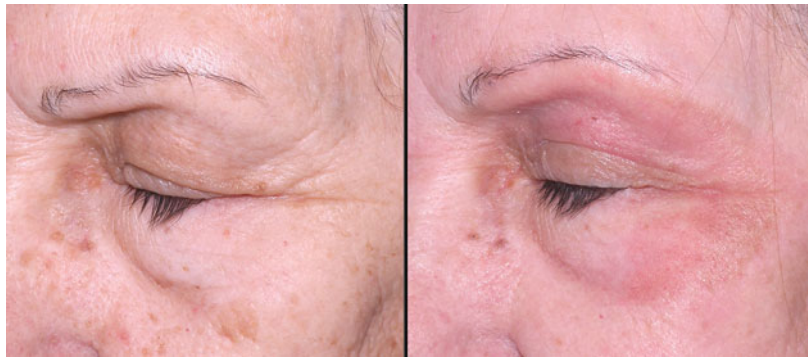

Fig. 13 Combining fillers with phenol-croton oil peel. After 3 months of full-face phenol 35% and 1.2% croton oil with stronger formula, 1.6% croton oil, in the periocular area (erythema and post-inflammatory hyperpigmentation still observed in this picture), patient was submitted to malar filler injection for malar filler injection. In this case, deep 30% polymethyl methacrylate was injected with 21G microcannula with excellent results. *Left*: before chemical peel. *Right*: before filler injection

phenol-croton oil peeling per se causes impairment of facial expressions during the first month, probably because of phenol's neurotoxic action associated with edema. The post peeling treatment with BTxA, for example, 14 days, may provide extended neuromuscular blockage (Figs.10, 11, and 12).

Best timing recommendations:

- When patient is a frequent BTxA user: Inject 21 days before peeling. Warn about new injections 3–4 months after phenol-croton oil peeling.
- When patient never used BTxA: peel first and plan inject 10–14 days after peeling.

Combining with Fillers

Although some patients expect full skin tightening and lifting after full face phenol peels, combined injection of dermal or subcutaneous fillers are required in the late post-peeling follow-up to lift the ptotic or depressed skin caused by senile lipoatrophy. In some instances, such as the patient in Fig. 13, there may be facial areas without dermal changes to indicate phenol-croton oil peels, such as when the lower two thirds of the skin present no deep wrinkles. Malar lipoatrophy is very prevalent in elderly patients. Therefore, this combination may be widely indicated for those patients that tolerate injections (Figs.13, 14 and 15). For depressed scars

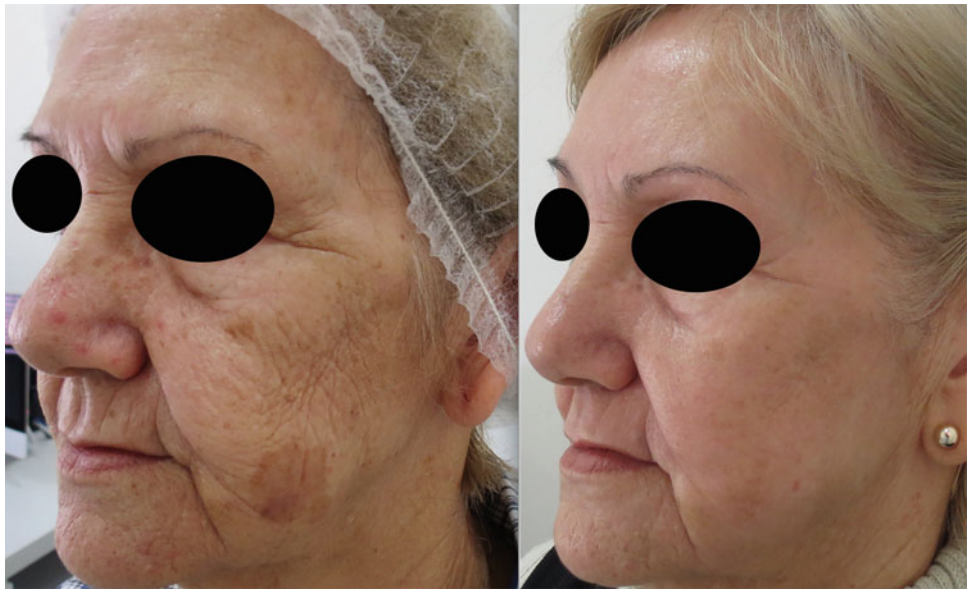

Fig. 14 Combining multiple treatments with phenol-croton oil peel. Before (*left*) and after (*right*) 1 year of full-face phenol 35% and 1.2% croton oil, and periocular 35% phenol and 1.6% croton peel, followed by malar injection of deep 30% polymethyl methacrylate injected with 21G microcannula with excellent persistent results. Two months after the initial chemical peel, the patient also required combined Q-switched 532 nm treatment of residual spots of macular seborrheic keratosis seen jaw line

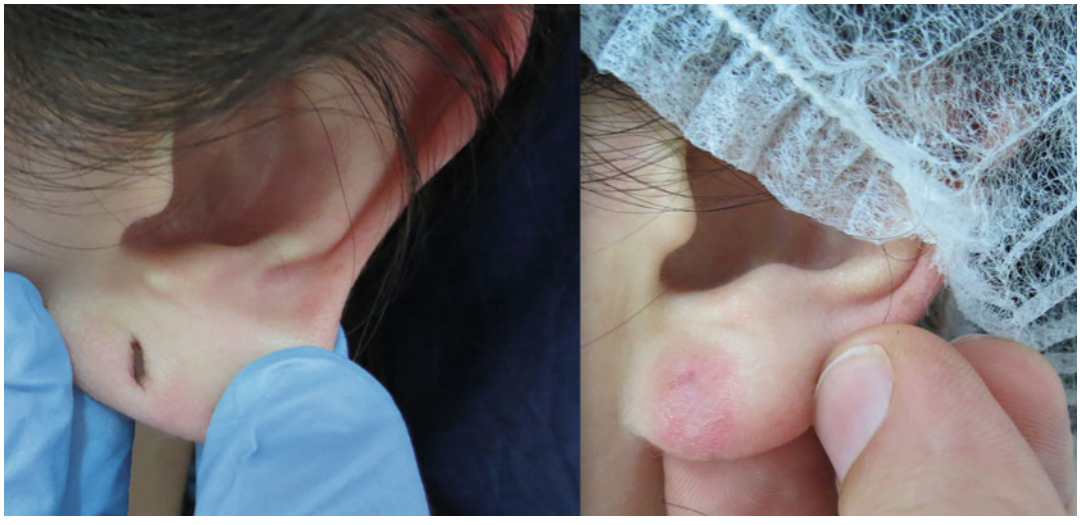

Fig. 15 Chemical repair of incomplete earlobe cleft with five applications of croton oil one drop per ml of liquefied 88% phenol (full strength stock solution, 4% croton oil), every 14 days, combined with hyaluronic acid filling to the remaining depressed scar. Persistent erythema still present after 4 months of the last application of the peeling solution

or intradermal injections, hyaluronic acid or poly-L-lactic acid is preferred (Fig. 15).

Best timing recommendations:

- When combining on different areas: same day
- When combining in the same area: inject 4–6 months after peeling (full healing)

Combining with LASER

Pigmented skin lesions may not be completely cleared with a deep chemical peel, and the patient may also present associated disorders of pigmentation, which may require different treatments. Furthermore, it is not uncommon to observe residual pigment changes after chemical peeling, such as irregular pigmentation or post-inflammatory hyperpigmentation. These problems can be effectively addressed with combination treatment with Q-switched lasers (Figs. 14, 16, and 17). Q-switched frequency-doubled Nd-YAG (532 nm) LASER may be used to treat melanosis, ephelids, macular seborrheic keratoses, and café-au-lait macules, and Q-switched Nd-YAG

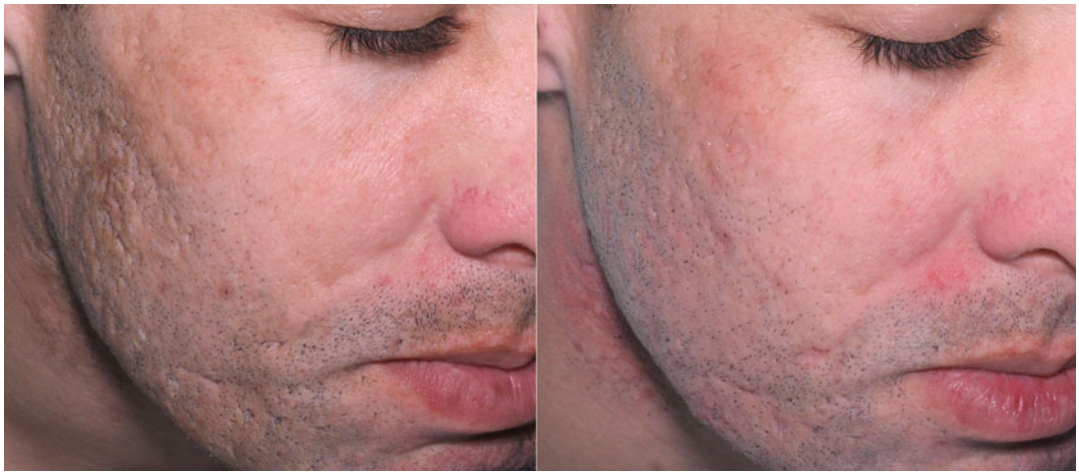

Fig. 16 Chemical reconstruction of acne scars with three monthly CROSS with croton oil one drop per ml of liquefied 88% phenol (full strength stock solution, 4% croton oil), combined with full-face Q-switched Nd-YAG (1064 nm) LASER before each treatment to improve irregular skin pigmentation and melasma

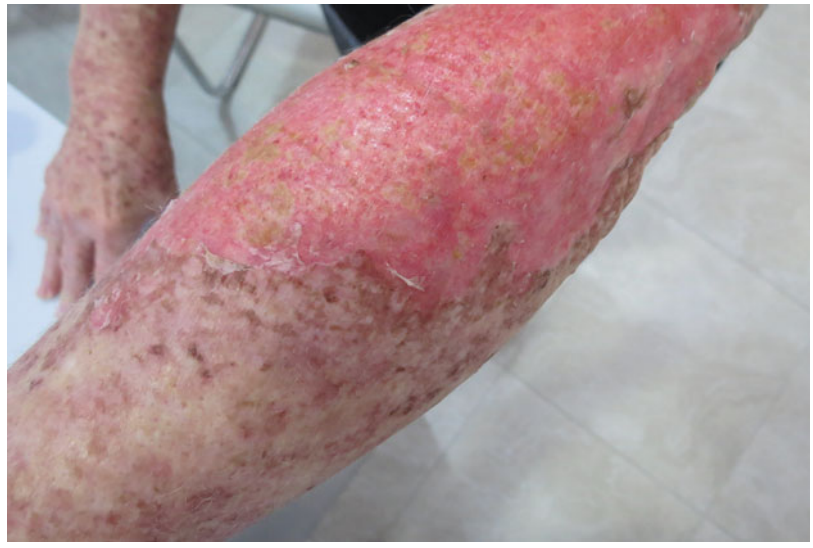

Fig. 17 Two weeks after combined treatment with phenol 35% and 0.8% croton oil in deep wrinkles of arm and forearm (erythema and *yellow/brown* crusts), associated in the same day with Q-switched frequency-doubled Nd-YAG (532 nm) LASER peel in the extremities without wrinkles (pigmented scales)

(1064 nm) LASER is better indicated for treatment of PIH, melasma, and dermal nevi. Some mild wrinkles may persist after deep chemical resurfacing. These can be treated with ablative LASER after 3–6 months, such as 2940 nm Erbium-YAG or 10.600 nm CO2 fractional LASER.

Best timing recommendations:

- Different areas: Use laser after 14–30 days (full epidermal recovery).
- Same area: Use ablative LASER after 4–6 months (full healing).
- Same area: Use Q-switched or nonablative LASER after 30–60 days.

Take Home Messages

- Resurfacing with phenol-croton oil is extremely potent and versatile for skin rejuvenation; however, it does not treat all aspects of aging.
- Combination treatments can be used before, during, or after phenol-croton oil peeling.
- It is advisable to wait until complete healing to combine other treatments.
- When combined with deep phenol-croton oil peeling, mild phenol-croton oil peeling usually offers better skin tone uniformity than classical medium-depth peels.

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Nonfacial Chemical Peels

Marcelo Cabral Molinaro and Paulo S. Torreão

Abstract

Facial peels are widely spread across dermatology practice for either cosmetic or disease purposes. Body peel techniques borrow the knowledge from facial treatments and apply it to body area respecting some differences.

The right agent and the correct technique are the pillars to promote an effective and safe body chemical exfoliation. In order to obtain the best therapeutic results, very superficial stratum corneum and superficial epidermis are the most suitable for body treatments. Body peels should be performed in serial sessions and in a gradual manner according to the indications.

These rules avoid persistent erythema, post-inflammatory hyperpigmentation, acromia, delayed wound healing, and even necrosis which would generate an unaesthetic dermal scarring.

Keywords

Chemical agent • Body peels • Non-facial areas • Supplement to other treatments • Guidelines

Contents

Introduction

Despite of the growing demand for new technologies, the use of exfoliative chemical agent to promote body and facial peels plays an important role in dermatology, regarding its efficiency, safety profile, practicality, or low cost. It is observed, however, that the scientific literature gives greater emphasis to chemical peels for facial areas. Nevertheless,

M.C. Molinaro (✉)
Policlínica Geral do Rio de Janeiro – (PGRJ), Rio de Janeiro, RJ, Brazil
e-mail: molinaro@uninet.com.br

P.S. Torreão
Hospital Federal dos Servidores do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
e-mail: pstorreao@gmail.com

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chemical peels for non-facial areas are used not only for specific disease recommendations but also as a supplement to other treatments. This chapter aims to systematize available information on techniques, care, and guidelines for this type of treatment.

Peculiarities of Non-facial Areas

Non-facial areas carry some particularities, which should be considered:

(a) *Extension of the skin surface*: it constitutes a major factor for skin absorption of chemicals that have systemic toxicity. It is recommended to perform the treatment on a segmented basis for areas of the body previously defined according to its length, respecting the safety profile of each chemical agent. Some chemicals are time dependent and require neutralization. In large areas it is therefore necessary to plan the surface to be treated not to compromise the neutralization.

(b) *Degree of desquamation and of small crust formation*: in the days that follow body peels, we observe the occurrence of desquamation in different degrees according to the depth of treatment. This phenomenon occurs through a longer period compared to facial peels. This particularity is especially valid for superficial body peels when the entire epidermis is treated.

(c) *Healing period*: it is longer on the body treatment due to the following features:
   - Number of pilosebaceous units: the healing processes after a chemical peel occur through the adjacent epidermal proliferation and migration of stem cells present in the pilosebaceous units. As non-facial areas have fewer skin appendages comparing it with the face (even 30 times less in regions of the neck and chest and up to 40 times less on the back of the hands and arms), special attention with peel's depth is necessary to avoid deep necrosis (Kede 2009).
   - Epidermis' thickness: In thinner skin, chemical peels penetrate faster. This is especially true for older people, as the skin gets thinner with age. Caution is always required for choosing the correct peel agent to be used.
   - Blood supply: reduced blood supply in areas as the lower limbs complicates the healing process. When treating these areas, very superficial peels or superficial peels are indicated in order to minimize possible complications.

The right agent and the correct technique are pillars to promote an effective and safe body chemical exfoliation. In order to obtain the best therapeutic results, very superficial stratum corneum and superficial epidermis are the most suitable for body treatments. Body peels should be performed in serial sessions and in a gradual manner according to the indications (Landau 2008).

These rules avoid persistent erythema, post-inflammatory hyperpigmentation, acromia, delayed wound healing, and even necrosis which would generate an unaesthetic dermal scarring. Some important considerations are discussed below.

Preliminary Care Before Chemical Body Peels

- Rigorous medical history, especially regarding past adverse reactions such as allergies, previous keloids, chronic dermatological diseases (seborrheic dermatitis and atopic dermatitis), the use of medications, and mainly oral isotretinoin. It is also important to be cautious with patients with a positive history of post-inflammatory hyperpigmentation, especially those with Fitzpatrick's skin types IV, V, and VI.
- The procedure has a relative contraindication for individuals who have undergone radiation therapy on the body area, due to possible destruction of skin appendages, compromising the reepithelialization. In such cases, the observation of the vellus hair assures the integrity of adnexal structures. Longer healing period or scars also can occur in people who used oral isotretinoin for less than 6 months.
- Excessive sun exposure should be avoided in the days before the procedure to minimize the

risk of melanocyte activation and subsequent hyperchromia after the procedure.

- Previous skin preparation is not completely necessary in very superficial procedures, but it can be done with the aim of preventing dyschromia. The skin preparation should begin with at least 14 days in advance. It is suggested the use of depigmenting agents such as hydroquinone and kojic acid associated with retinoids or alpha hydroxy acids. Those accelerate the healing process, preventing possible hypercromic areas, particularly in Fitzpatrick's phototypes IV, V, and VI. These drugs should be suspended 3–5 days before the procedure not to interfere with the chemical peel agent, avoiding deeper penetration of the peel into the skin.
- In the treatment of epidermal lesions with higher degrees of hyperkeratosis, such as seborrheic and actinic keratoses, the use of electrocoagulation and cryosurgery as previous supporting treatment can optimize clinical results.
- Finally, shaving and removal of body hair should not be performed in the area to be treated during the 5 days before treatment, avoiding epidermal injury, allergic contact dermatitis, or primary irritant dermatitis that may compromise the integrity of the skin.
- At the day of the procedure: important precautions at the day of the procedure include the proper choice of substance to be used for cleansing: mild cleansing lotion, alcohol-ether, or pure acetone. This choice determines greater or lesser penetration of the chemical agent, in particular those with a higher ability to penetrate the epidermis, such as trichloroacetic acid (TCA).

Main Chemical Agents and Their Indications

Salicylic Acid

Salicylic acid consists of a beta hydroxy acid used in concentrations of 20% and 30% in ethanol as a superficial peel. It has comedolytic, keratolytic, and anti-inflammatory properties by acting as an adjuvant in the treatment of acne, pillar keratoses, and post-inflammatory hyperpigmentation. Its therapeutic effect extends to the treatment of mild photoaging, irregularities in skin texture, and fine rhytides (Peterson and Goldman 2011). The treatment protocol ranges from three to six sessions at intervals of 15–30 days, depending on the clinical indication and the morbidity of the lesions. There is often a white precipitation of salicylic acid in 1–3 min, which serves as a parameter for a homogeneous application (Fig. 1a, b).

There is, then, moderate burning which gives in a few minutes, leaving a feeling of light anesthesia in treated area. Small frostings (level 1) can be seen in the areas of inflammatory acne lesions, not requiring neutralization. The excess of white precipitate is removed, after 5–10 min with water or cleansing lotion. In 3–5 days, very fine whitish scaling occurs.

Symptoms of salicylism, while rare, may occur, ranging from light (rapid breathing, tinnitus, hearing loss, dizziness, nausea, vomiting, and abdominal pain) to severe (central nervous system changes simulating alcohol intoxication). For this possibility, the use of this substance is only recommended on smaller surfaces such as neck and presternal region (Brubacher and Hoffmann 1996). Recently, a new preparation containing 30% salicylic acid in a polyethylene glycol (PEG)-based vehicle has been used with good clinical results in volunteers with aged skin, showing improvement in skin texture, and in acne patients with disappearance inflammatory acne and comedones. For being little volatile, PEG has a higher affinity for salicylic acid and thereby releases it only in small amounts in the superficial layers of the epidermis. This affinity justifies lower absorption of the substance, with lower systemic toxicity as well as a reduction of burning sensation during application (Dainichi et al. 2008). On the other hand, salicylic acid formulated in ethanol, being highly lipophilic, has high affinity for the pilosebaceous units, providing certain dryness desirable in patients suffering from body acne (Peterson and Goldman 2011).

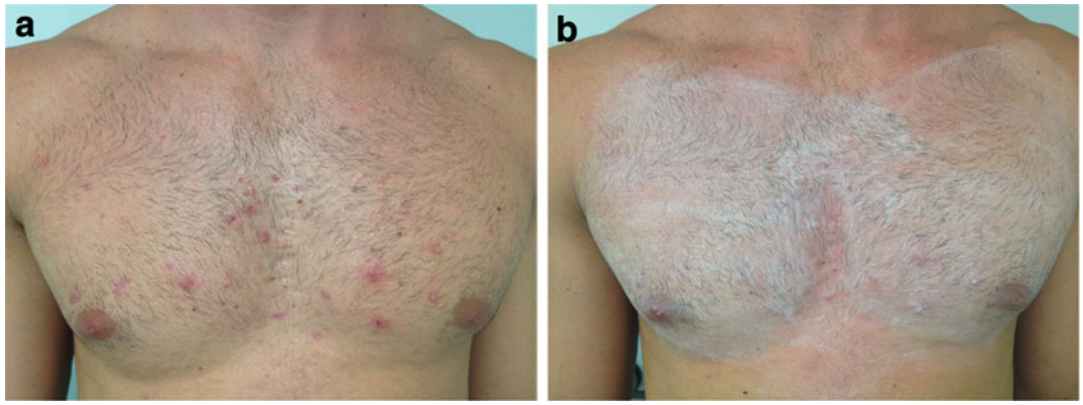

Fig. 1 (**a**, **b**) Salicylic acid peel at 30 % in ethanol for inflammatory acne. The image (**b**) shows the whitish precipitation of the acid

Jessner Solution

Jessner solution consists of 14% salicylic acid, 14% lactic acid, and 14% resorcin in ethanol. The solution has keratolytic, anti-inflammatory, and lightening action. Depending on the number of layers applied on the skin surface and volume used, it acts as a peel that extends from very shallow to medium depth. The penetration is determined partially by the epidermolytic action of lactic acid that, despite being low in concentration, depends on the pH for its release in the formulation.

This peel serves as an adjunct in the treatment of inflammatory acne in areas of hyperchromias on the trunk (anterior and posterior), especially in higher skin types. In such cases, it is preferable to apply it with gauze, exerting some pressure, especially on areas with thicker corneal layers and more numerous sebaceous structures. This peel is also indicated for the treatment of rejuvenation of the neck and colo, but with fewer layers. It avoids therefore an unnecessary depth of the peel (Peterson and Goldman 2011; Brody 1997; Fig. 2a–c).

The Jessner peel is usually very well tolerated by patients, causing mild to moderate stinging, which lasts between 3 and 10 min. After application, there is slight whitening of the skin, due to the precipitation of salicylic acid, followed by variable erythema with light frosting areas (levels 0 to 1). It is recommended to wait 3–4 min between applications of layers, so there is evaluation of the extent of the peel already performed. This is a peel that does not require neutralization. The precipitated salicylic acid can be removed with water or cleansing lotion. Between 3 and 5 days, clear to brown flaking occurs. The Jessner solution should be used in fortnightly or monthly intervals, for three to six sessions.

The Jessner peel is considered to be very safe: the allergic reaction, determined by hypersensitivity to resorcin, has low incidence, and the treatment has little toxicity, due to the low concentration of resorcin and salicylic acid in the formulation. For added security, it is recommended to perform rotation of treated areas, between procedures. This guidance also applies to all other peels that have some degree of systemic absorption of used agents (Table 1).

Resorcin

Resorcin is a caustic agent from the group of phenols, soluble in water and alcohol, used in scrub solution or paste, at concentrations ranging from 10% to 50%. In very superficial body peels, especially for acne on anterior and posterior trunk, the use at lower concentrations is more

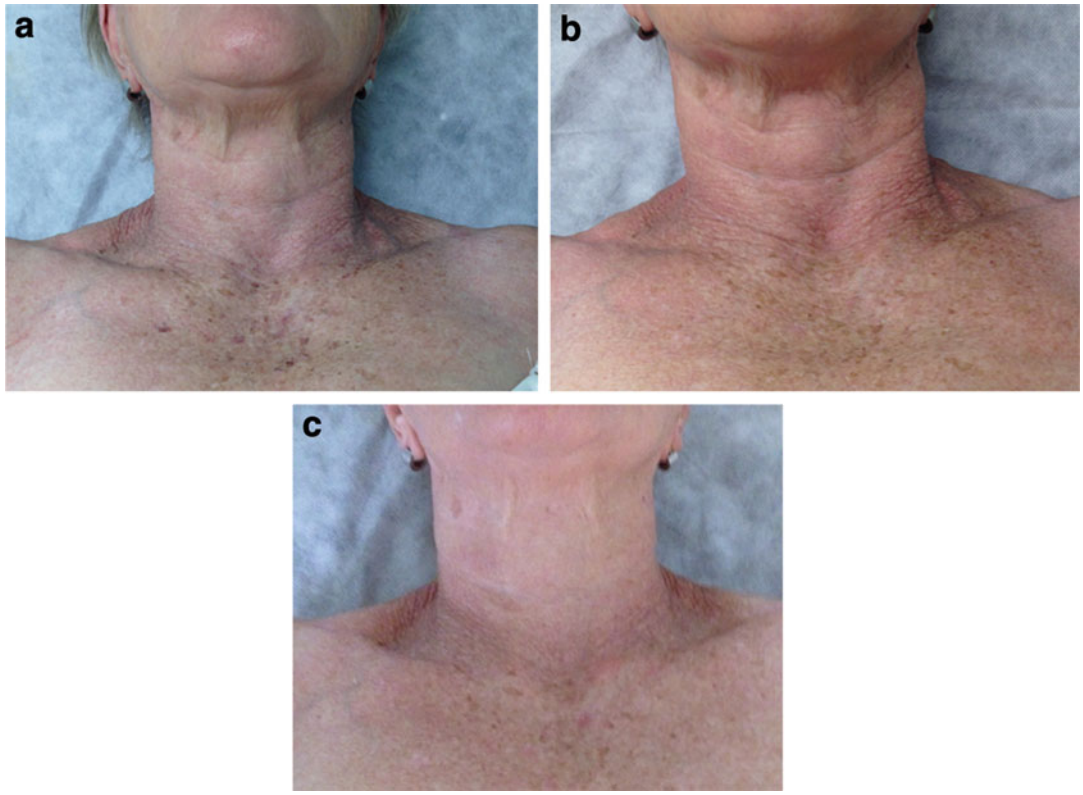

Fig. 2 (**a**–**c**) Jessner peel (three layers) for moderate photoaging. (**a**) Before the procedure, (**b**) after the first session (14th day), and (**c**) after two sessions (40th day)

Table 1 Rotational treatment in body peels

Rotational treatment – body peel			
Period	Area of treatment	Peel type	Interval/number of sessions
First week	Chest and neck	Jessner solution, glycolic acid	Monthly or bimonthly/3–6
Second week	Back of hands and forearms	Trichloroacetic acid, Jessner solution	
Third week	Shoulders and arms	Salicylic acid	
Fourth week	Thighs and legs	Thioglycolic acid	

appropriate, between 20% and 30% (5–10 min) (Clark and Scerri 2008). It can be used in combination with the sulfur, both at 24% solution in distilled water (Kede 2009). This peel is also indicated for the treatment of dyschromia, fine wrinkles, and post-inflammatory hyperpigmentation. Consider taking the pretest as it can cause contact dermatitis (Kede 2009). Special care must be taken in higher concentrations and when applied in more extensive body areas.

Tretinoin

Tretinoin, also known as retinoic acid, is a drug of the class of retinoids used for superficial peels. This peel is formulated in a yellow solution in propylene glycol; the used concentrations range from 5% to 12%. To obtain a cosmetic effect, tint may be incorporated to the formula. This peel is widely used in cosmetic dermatology by a combination of factors: the ability to promote thinning

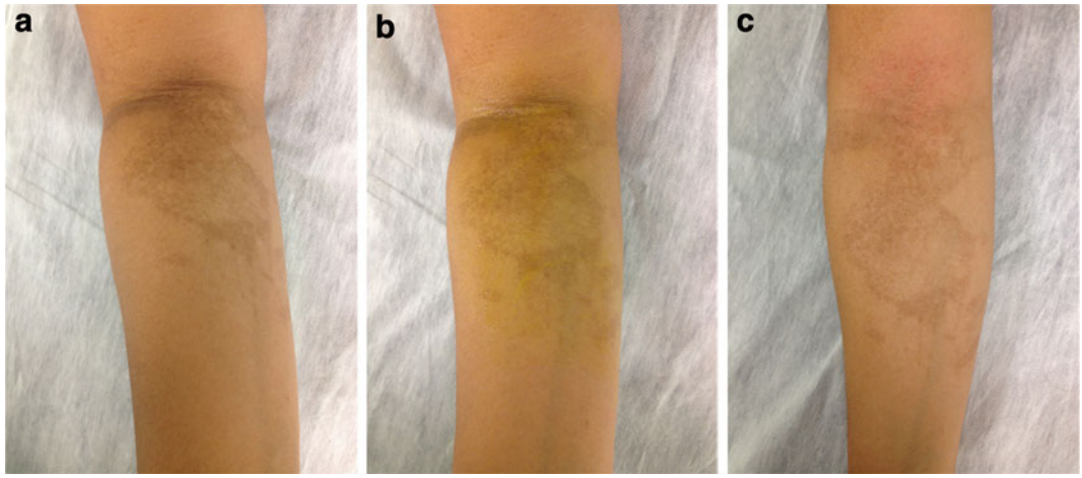

Fig. 3 (**a**–**c**) Tretinoin peel at 5% in propylene glycol for traumatic post-inflammatory hyperpigmentation. (**a**) Before the procedure, (**b**) immediately after the procedure, and (**c**) after the first session (14th day)

and compaction of the stratum corneum, reverse atypia in epidermal cells, stimulate neocollagenesis in the dermis, increase the deposition of glycosaminoglycans, stimulate the reorganization of collagen fibers damaged by sun exposure, and remove and disperse the melanin granules formed in keratinocytes (Kede 2009). Its use is widespread in photoaging treatments and actinic skin changes (e.g., poikiloderma of Civatte) (Landau 2008), in pigmentation disorders such as post-shaving folliculitis, acne, insect bites, and melasma in non-facial areas, and in traumatic injuries, especially in trunk regions and upper and lower members. In the treatment of acne, it corroborates with home-based use of tretinoin promoting the elimination as well as the prevention of follicular hyperkeratosis.

The tretinoin peel is often used after microdermabrasion with aluminum oxide crystals in which the stratum corneum is removed mechanically. This combined procedure optimizes the therapeutic results with an epidermal deepening (Hexsel et al. 2005). The indication extends to the treatment of the old stretch marks, of pearly color, as well as those of recent emergence, in pinkish color. For this purpose the concentration should be of 10%, for a contact period of 4–6 h until the removal with water (Kede 2009). This peel is recommended after procedures like electrocoagulation or cryosurgery of epidermal growths such as seborrheic and actinic keratosis, milia, sebaceous hyperplasia, and papulosis nigricans. Studies show that this association seems to provide a better healing (Hung et al. 1989), promoting uniformity of skin tone and improvement in skin quality.

The tretinoin peel is painless and easy to perform. The chemical agent is applied with the help of a gloved finger. In the mean interval of 3–4 days, there is a white desquamation, dry, fine, and proportional to the concentration and length of exposure to the substance. The application, in a biweekly or monthly interval, is completely painless, because tretinoin has no acidic pH capable of promoting protein coagulation. Being a photosensitive drug, it should be applied late in the day and remain on the surface for at least 6 h (Landau 2008). For best results it is possible to perform a gradual increase of the length exposure in each application from 4 to 12 h limit. This peel is not recommended for pregnant women and should not be carried out throughout the breastfeeding period (Fig. 3a–c).

5-Fluorouracil

5-Fluorouracil (5-FU) is a fluorinated pyrimidine from the group of antimetabolites which acts as a cytostatic agent in the treatment of preneoplastic

and neoplastic cutaneous diseases. It is also called fluorouracil-pulsed peel and consists of a combing two superficial peel agent. Usually it is combined with Jessner or glycolic peel. The first step begins with the Jessner solution or with glycolic acid 70% in fluid gel. When starting with the Jessner solution, it is recommended to apply one or two layers to reach an initial (level 0) erythema or salicylic precipitation, not requiring neutralization. In the case of the glycolic acid, neutralization with water or sodium bicarbonate is required. Then, 5% 5-FU is applied in propylene glycol or cream on a body surface which should not exceed 500 cm^2 (about 23×23 cm) leaving it to act for 6–12 h.

This procedure is performed in weekly or biweekly interval, until eight pulses, for the treatment of multiple actinic keratoses. In a study conducted by Katz (1995), the combined peel with the Jessner solution has enabled a reduction of 86% of studied injuries; in another study, Marrero (1998) obtained the best results, with 92% injury reduction with the combination with glycolic acid at 70%.

Glycolic Acid

Glycolic acid (GA) has its natural source in sugarcane, being produced in the laboratory for use as a chemical peel. It has one of the smallest molecule sizes among the alpha hydroxy acids. Therefore, the penetration of GA in the skin occurs, compared to other alpha hydroxy acids, more easily. GA can be used as very superficial or superficial peeling agent, depending on the concentration used, the pH of the formulation, and the exposure time on the surface (Clark and Scerri 2008; Fischer et al. 2010). The concentration of 70% in pHs lower than 1.0 can become a medium-depth peel, depending on the exposure time on the skin. The higher the concentration of GA, at a lower pH and at longer exposure, the deeper is the peel. This is due to the greater bioavailability of the chemical in these conditions (Kede 2009).

This peel is indicated as an adjunct in the treatment of non-facial areas for photoaging, inflammatory acne, and atrophic acne scars and in pigmentary disorders such as melasma and post-inflammatory hyperpigmentation (Clark and Scerri 2008; Takenaka et al. 2012; Callender et al. 2011). Good clinical results can also be achieved in the treatment of folliculitis and pseudofolliculitis of groin and buttocks. The GA's action results from compaction effect of the stratum corneum, epidermal thickening, and dermal deposition of collagen and mucin.

The GA peels are sold as free acids, partially neutralized. There are different manufacturers with different pHs ranging from 1.0 to 3.0. Some formulations have even lower pH around 0.6. The lower the pH, the greater the amount of acid in the free form, allowing to deeper penetration into the skin with formation of faster and more extensive frostings. These frostings show areas of cell epidermolysis, color ranging from white to grayish white, according to the dermal penetration of GA (Clark and Scerri 2008). In areas with increased thickness of the stratum corneum, formulations with lower pH (0.6–1.0) can be chosen, in order to facilitate penetration of the acid without compromising the security of the application. All peels with alpha hydroxy acids require neutralization when the desired depth is reached. This is done using an alkaline solution or water. It's preferable to use sodium bicarbonate at 10% in fluid gel as neutralizing agent because, by having a clearly alkaline pH, it promotes certain effervescence in the place to be neutralized when in contact with the acid pH of the peel. This effervescence provides better control over the peel, reaching the exact depth we desire.

In GA peel after complete cleanup, a thin layer of the product is applied. The neutralization is done in steps, with sodium bicarbonate, as soon as some frosting area begins. This is done with the aid of a cotton tip, in order to avoid a deeper dermal penetration of the product. Then, with the emergence of a uniform and evident erythema (levels 0–1), total neutralization of the area is performed. The erythema shows that all stratum corneum was achieved and the stratum granulosum penetration is beginning (Clark and Scerri 2008; Fischer et al. 2010). It is advisable to start with 50% GA and increase to 70% GA for subsequent applications. Patients very well

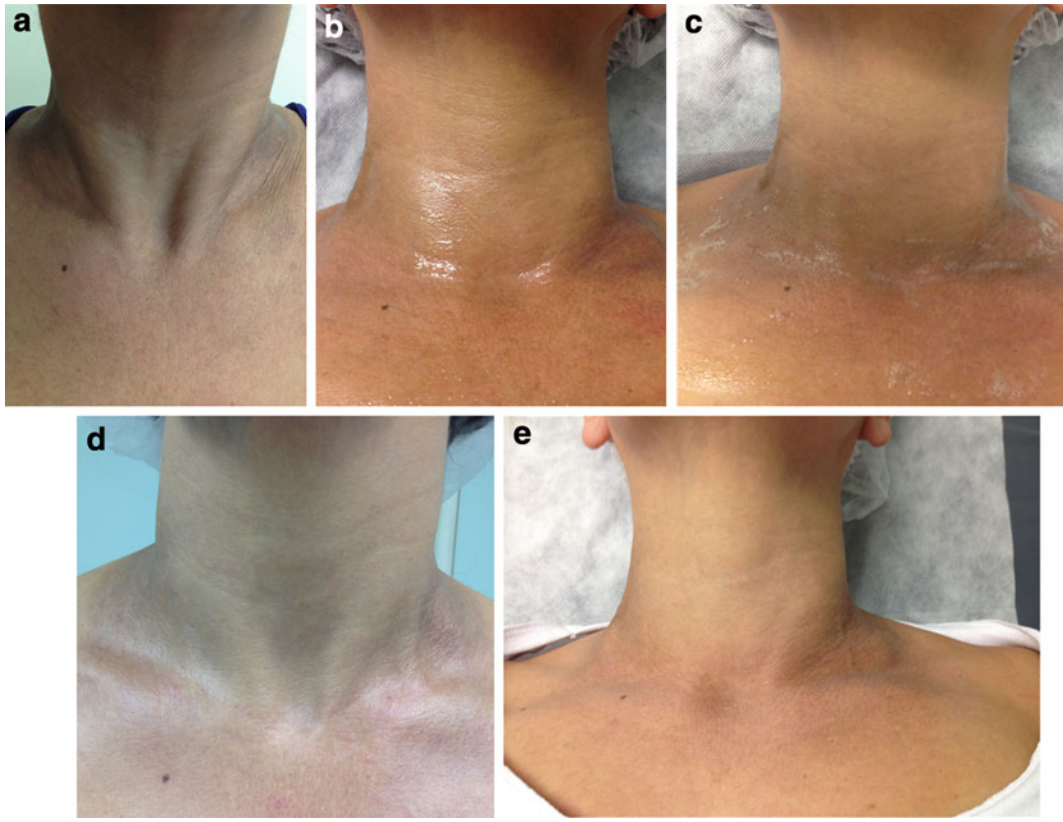

Fig. 4 (**a**–**e**) Glycolic peel acid at 70% (pH=0.6) in gel for post-inflammatory hyperpigmentation. (**a**) Prior to application; (**b**) immediately after application of the translucent gel; (**c**) effervescence of the gel after neutralization with sodium bicarbonate, 10%; (**d**) immediately after application; and (**e**) after the second session (60th day)

tolerate this peel with high concentration of GA, with an initial feeling of warmth and then a certain "sting" and subsequent slight burning (Fig. 4a–d).

Despite being time dependent, it is not prudent to rely on the application time, but in getting the erythema as uniform as possible in this peel. Special attention must be paid in treatments of the neck due to the thinner corneal layer, which facilitates a rapidly penetration of the product. In such areas the emergence of frostings or isolated epidermolysis in greater numbers is common, often necessitating agility when handling the neutralizer. Special care must also be taken in areas of skin folds where larger volume acid should not be retained and occasionally the emergence of small necrosis. The treatment algorithm proposes around six or more applications with a biweekly or monthly interval (Clark and Scerri 2008). This is a widely used nontoxic peel, therefore conferring systemic safety. However, it is recommended to use the same product suppliers to avoid significant variations of vehicles and pHs.

Trichloroacetic Acid

Trichloroacetic acid (TCA) is a stable substance, inexpensive, that does not require neutralization and has no systemic toxicity. It is easily handled because the depth of application is determined by clinical parameters related to the degree of erythema, areas of frostings, and modification of skin turgor, already mentioned in the previous topics. Its frosting or whitening is generated by the attack capacity of TCA, leading to protein denaturation and necrosis of skin cells. It is a versatile peel,

with very good action in body rejuvenation and epidermal pigmentation. TCA can be found in different presentations as described below:

- In vehicle with distilled water

TCA in distilled water is used in the concentration of 10–15% for the achievement of very superficial body peels; 20–25% for superficial peels; and above 30% for medium depth, up to 45% or 50% for reaching superior reticular dermis, with higher degree of unpredictability and high risk of complications both in facial region and mainly in extra-facial areas (Landau 2008).

Born from the concern about unnecessary deepening of the chemical, combined peels were developed, linking two or more chemical substances in the same session. The effect of each substance is thus combined. In this modality, keratolytic agents are used initially with the help of Jessner solution or glycolic acid 70%, succeeded by the immediate use of TCA 35% in distilled water. This type of combined peel, of medium depth, has become very common, especially in face treatments, for its ease of application, greater control on the agent's penetration, and uniformity and certainty in getting the desired frosting level compared to TCA applied alone at higher concentrations (Monheit 1995; Coleman and Futrell 1994). Some professionals reproduce this peel in body treatments with good results, especially for moderate photoaging. However, in order to avoid possible iatrogenic events, this peel is not recommended for inexperienced hands (Costa and Gomes 2012).

In superficial combined peels, the use of lower concentrations of TCA in distilled water is preferred, between 15% and 25%, preceded by one or two layers of Jessner solution. Great results can be achieved in mild photodamage, dyschromia, and the pigment component of poikiloderma of Civatte (Tung and Rubin 2011). The application of the TCA is made with progressive deepening into the epidermis layers to reach the level 1 frosting (erythema with lacy white color). In deeper dyschromias and lingering lentiginoses, after this superficial and combined peel, a higher concentration of TCA can be used, which can vary from 35% to 50% according to anatomical location of the body. It should only be done as a punctual and localized peeling on a specific lesion in order to treat the injury isolated.

Cook and Cook (2000) described a combined chemical medium-depth peel not suitable for facial area, in which peel glycolic acid is used in 70% gel, in an abundant manner, followed by the application of TCA 40% in distilled water. The gel vehicle for glycolic acid is essential, because it acts as a partial barrier for the penetration of TCA. After obtaining the desired frosting, neutralization is done with sodium bicarbonate solution at 10%, terminating the peel.

- In vehicle paste

TCA can also be used in paste at concentrations of 10–20%. Its application is carried out with the aid of a spatula. Once applied, it is necessary to make a "window," removing part of the paste to visualize the deepening parameters, hidden by the opaque color of the vehicle. This "window" control could not represent what is occurring in all anatomical area treated, but is the correct way to evaluate the endpoint to neutralize the peel. The neutralization is done using alcohol solution to remove the TCA paste. This is a safe and good option for treating the hand and forearms.

- In gel vehicle

This presentation, made at the desired concentration by prescription, is the most suitable for body peels when the choice of agent lies on the TCA. This peel appears as a translucent gel, with high plasticity, easy to use, less prone to accidents, and allowing full view of the areas of whitening and skin turgor, elements needed to implement depth control. The TCA is dispersed homogeneously throughout the gel vehicle.

The skin preparation is done by following the same guidelines of TCA peel, with suspension of keratolytic agents prior to the procedure. This peel is used at lower concentrations, ranging from 10% to 20%, depending on the epidermal thickness of

the body segment and the depth to be obtained. This peel is indicated for the treatment of mild to moderate cutaneous photoaging, most commonly in the presternal region, neck, forearms, and back of the hands.

It is done, with gloved fingers, by applying a single thin layer of gel (0.1–0.2 mm thick) in the area being treated (Zanini 2007). The penetration of this peel, for the occlusive effect of the gel, occurs more quickly and uniformly and without the need to apply several layers, compared to vehicle distilled water (Zanini 2007).

The depth to be obtained with TCA gel ranges from level 0 (uniform erythema), for very superficial epidermal peels, in which the removal of the whole corneal layer is desired, to level 1 (stringy or blotchy frosting with background erythema) for peels where we want to destroy the epidermis partially or more extensively. When it comes to body surface areas, the stringy frosting should be the maximum depth parameter that results in predictability. Differently from TCA peels in distilled water, we proceed to immediate removal as soon as we get the whitening pattern desired for the peel. The removal is done with gauze moistened in alcohol or, more easily, with simple local washing with water, preventing thus the deepening of the peel (Fig. 5a–d).

This treatment is done in two to three sessions at intervals of 45–60 days. Serial sessions in lower concentrations enable greater security with good, constant, predictable results and in lower rate of dyschromia and unsightly scars. The recovery time after the procedure is very similar to TCA peels in distilled water or paste, with thin and brown scaling. It is worth remembering that the occurrence of vasodilatation caused by the TCA on large body surfaces can cause, atypically, hypotension, tachycardia, and syncope.

Thioglycolic Acid

Thioglycolic acid is one of the representatives of the thioglycolate class whose substances are used for years in cosmetic industry for the manufacture of body hair removal, hair straighteners, and hair dyes (Costa et al. 2010). It is known as mercaptoacetic acid; it has sulfur in its composition and a high water, alcohol, and ether solubility, with easy oxidation. It has a strong and specific odor. The affinity of this acid with iron is similar to that of apoferritin: the thiol group in its structural composition gives it the ability to chelate iron from hemosiderin (Costa et al. 2010). This peel is used in patient's skin type I to IV in the treatment of hyperchromias with hemosiderotic and melanin origin, as in constitutional infraorbital pigmentation (Costa et al. 2010) and in ochre dermatitis (Yokomizo et al. 2013).

The acid concentration ranges from 5% to 12% in gel vehicle. In body peels to treat ochre dermatitis of the lower limbs, we recommend its use in serial, biweekly, or monthly sessions in concentrations between 10% and 12%. After cleansing the body area, a single thin layer of gel (0.1–0.2 mm thick) is applied with gloved fingers. Its effect on the skin is directly proportional to the application time and should be removed with water, once an initial erythema or level 0 of frosting is present. The peel can cause mild discomfort, associated with discrete erythema at the time of application. Around 3 days later, mild erythema to the appearance of small areas of fine scales in brownish color is expected, depending on the time of exposure to the agent. Special attention must be paid to a possible unnecessary penetration of this peel in the lower limbs presented as difficult healing in the area.

Special Care After the Procedure

We have subdivided special care after the procedure in two modalities: care at the end of the procedure and care in days following the procedure.

Care at the end of the procedure: very superficial body peels are painless, but the patient may experience some itching sensation or slight burning, which disappears within minutes. Superficial peels, with necrosis of the entire epidermis, especially with the use of TCA, initially cause a feeling of heat, followed by moderate burning sensation, which gives in with cold compresses or air coolers.

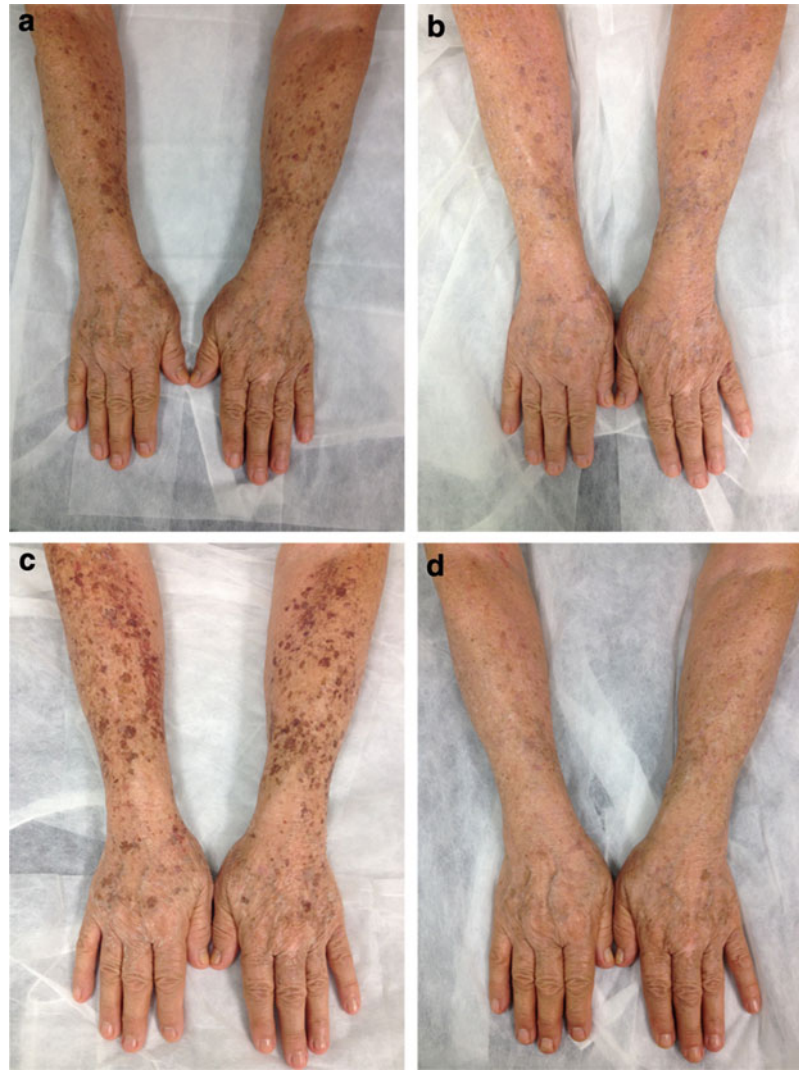

Fig. 5 (**a**–**d**) Trichloroacetic acid peel at 20% in gel for cutaneous photoaging. (**a**) Before the procedure, (**b**) during the procedure (frosting level 1), (**c**) scales and brownish crusts (sixth day), and (**d**) after the first session (40th day)

Care in days following the procedure: such care is very similar to the facial area. The treated area should be kept clean with soaps or cleansing lotions for sensitive skin and should always be well moisturized for 5–7 days with emollients, such as solid or liquid Vaseline, or other recovery moisturizing cream or gel, in order to mimic skin barrier injured by chemical agents. Such wetting procedures reduce any burning or pain after the procedure. In oilier body areas, we recommend using skin products with lower oil content in its composition. Such care prevents the emergence of acneiform eruptions following the procedure.

After 2 days of treatment, the use of sunscreens with broad-spectrum anti-UVA and anti-UVB should be initiated, preferably those with physical filter in its composition. Applying filters immediately after the procedure may cause some burning sensation; therefore chemical-free sunscreen is indicated to avoid irritation. Sun exposure should be avoided in the days following the procedure even if using a suitable sunscreen. In peels in forearms and hands, we recommend the suspension of the chemicals linked to domestic activities, such as abrasive soap and detergents, until complete reepithelialization.

Table 2 Body peel agents and main indication

Body peel agent	Indications
Salicylic acid	Acne, pillar keratosis, melasma
Jessner solution	Post-inflammatory hyperpigmentation, melasma, photodamaged skin
Resorcin	Post-inflammatory hyperpigmentation
Tretinoin	Photodamaged skin
5-Fluoracil	Actinic keratosis
Glycolic acid	Photoaging, inflammatory acne, acne scars, and pigmentary disorders
Trichloroacetic acid	Mild photodamage, dyschromia, poikiloderma of Civatte
Thioglycolic acid	Hyperchromia with hemosiderotic component, ochre dermatitis

The home topical treatment should be restarted as soon as the post-peel inflammation has disappeared. It is important to wear comfortable clothing that reduces potential areas of friction over the treated area.

Complications

Bacterial or fungal infections rarely occur in very superficial or superficial body chemical peels, because their reach is only epidermal. If unwanted deepening occurs, the area should be washed with a solution of acetic acid 0.25%, two to four times a day, followed by water washing. This reduces the crusting and the possibility of infection. However, in the occurrence of infection, immediate antimicrobial therapy should be initiated, preceded by local material collection for culture and antibiogram. These can reduce the possible future complications.

In patients with a history of repeated herpes simplex in the anatomical segment treated or close to it, prophylactic anti-herpes therapy should be done with aciclovir 200 mg, five times a day, or valacyclovir 500 mg, two times a day. This therapy is initiated 2 days before the procedure and continued for more 5 days after the peel for prophylaxis or can be maintained until complete reepithelialization (Tung and Rubin 2011; Anitha 2010).

If there are areas with difficult healing, clinically evidenced by a persistent erythema or small ulcerations, medium- to high-potency corticosteroid is advised, with or without topical antibiotics. This approach minimizes the risk of the emergence of hyperchromias, hypochromias, or even future scars.

Conclusion

While medium-depth peels in the facial region can be considered a simple procedure, this is not a good choice for body peels, due to the high incidence of adverse effects such as difficult healing and even unsightly scars. Superficial peeling is advised for non-facial area, and a good clinical result can be seen after some sessions of treatment.

The body chemical peels should be accompanied by a home care practice that can optimize and perpetuate the benefits produced. In order to minimize complications and reduce the patient recovery time, it is possible to combine body chemical treatment with other technologies such as electrocoagulation or cryosurgery when treating thick lesions.

Once considered the care and techniques here presented, body chemical peels offer an effective treatment, with low cost and excellent clinical results. Therefore, they should also be seen as an excellent alternative for professionals who have more limited access to technologies such as lasers and intense pulsed light (IPL) (Table 2).

Take Home Messages

- Chemical peels for non-facial areas are used not only for specific disease recommendations but also as a supplement to other treatments.

- Some peeling agents are indicated for body peels, such as salicylic acid, Jessner solution, retinoic acid, glycolic acid, TCA, and thioglycolic acid.
- Healing period is longer on the body treatment compared to facial peeling.
- While medium-depth peels in the facial region can be considered a simple procedure, this is not a good choice for body peels, due to the high incidence of adverse effects such as difficult healing and even unsightly scars.
- Superficial peeling is advised for non-facial area, and a good clinical result can be seen after some sessions of treatment.
- The body chemical peels should be accompanied by a home care practice that can optimize and perpetuate the benefits produced.
- It is possible to combine body chemical treatment with other technologies such as electrocoagulation or cryosurgery when treating thick lesions.
- Body chemical peels offer an effective treatment, with low cost and excellent clinical results.
- Excessive sun exposure should be avoided in the days before and after the procedure to minimize the risk of melanocyte activation and subsequent hyperchromia post-procedure.

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Part II

Special Issues in Chemical Peels

Chemical Peels for Dark Skin

Katleen Conceição, André Ricardo Adriano, and Tiago Silveira Lima

Abstract

Patients with darker skin phototypes are more susceptible to complications after dermatological procedures such as lasers and peels due to the higher probability to develop an inflammatory response to a physical or chemical irritation. Among the undesirable reactions, it is possible to highlight the hyperchromia, the hypochromia, hypertrophic scars, and keloids. The dark-skinned patients' demand for cosmetic procedures is increasing; therefore dermatologists should update their knowledge in this field. Regarding chemical peels, it is important to evaluate the best substances and their concentrations, the care before and after the procedure, and the best indications for darker skins. While in Caucasians, the peels are predominantly indicated for photoaging treatment, in African descendent people, peels are commonly indicated for melasma, postinflammatory hyperpigmentation, acne, and pseudofolliculitis barbae. In general, the very superficial and the superficial peels are well tolerated on black skin; medium peels can be performed with caution, and deep peels should be avoided, since the risk of dyschromia and scarring is high. Among the types of chemical peels, which can be used with safe and efficacy for dark black skin, there are glycolic acid peels, salicylic acid, retinoic acid, and Jessner solution. Physical peelings can also be performed isolated or in combination with chemical peels.

Keywords

Black skin • Dark skin • Peels • Glycolic acid peels • Salicylic acid • Retinoic acid • Jessner solution • Trichloroacetic acid • Chemical peel • Spot peel • Melasma • Postinflammatory hyperpigmentation • Acne • Pseudofolliculitis barbae

Contents

K. Conceição (✉) • A.R. Adriano
Instituto de Dermatologia Professor Rubem David Azulay/Santa Casa da Misericordia do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
e-mail: katleendermato@yahoo.com.br; atendimento_3@paulabellotti.com.br; andrehricardo@gmail.com

T.S. Lima
Hospital Universitário Clementino Fraga Filho, Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
e-mail: tsilveiralima@gmail.com

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Introduction

It is essential for the dermatologist to know the differences between white and black skin patients regarding the physiology of the skin, the body anatomy, their concept of beauty, and their cultural peculiarities and expectations. In general, all patients desire a smooth and lush skin, without irregularities or wrinkles and with a homogeneous color.

The black population of the world grows every day. It is estimated that United States will have close to 50% of its population constituted by people with dark skin color by 2050 (US 2000 census), and UK had the proportion of Black Africans duplicated between 2001 and 2011. Despite the fact that great part of the world's population is constituted of patients with darker skin phototypes, the vast majority of scientific literature about peels is related to Caucasians (Salam et al. 2013).

The demand for cosmetic procedures has been increasing, with the emerging of new technologies, more safe and effective methods, and less invasive techniques. Among the low invasiveness procedures, chemical peels are the timeless, with the advantage of having low cost. They are very useful for acne, stretch marks, blemishes, wrinkles, scars, and rejuvenation treatment. The demand of patients with darker skin phototypes for chemical peelings is high, as they have high incidence of diseases that can be treated with good results by chemical peels. However, it is necessary to adapt the substances, their concentrations, and the technique to treat them, due to the fact that black skin has a higher risk to develop transitory or persistent side effects, such as hypochromia, hyperpigmentation, and scarring.

Studies have shown that patients with dark skin (skin phototypes IV to VI Fitzpatrick) have photodamaged (wrinkles and fine lines) about 10–20 years later and to a lesser extent as compared to white-skinned individuals (Roberts 2004). On the other hand, patients with dark skin develop more pigmentary disorders caused by solar radiation. So while in Caucasians the peels are predominantly required to treat wrinkles, they are sought to treat melasma, postinflammatory hyperpigmentation, acne, and pseudofolliculitis barbae in African descent (Roberts 2004).

History and Concept

One of the first historical events about the use of peelings is correlated to Cleopatra, the famous queen of ancient Egypt, in Africa, who used to bath herself in sour milk for skin treatment. Even without knowledge at that moment, this treatment was probably related to the inherent properties of lactic acid (alpha-hydroxiacid) present in milk. It is also reported in literature that other African descent women used to use salt, pumice stone, and urine to exfoliate the skin (Roberts 2004).

The peelings are defined as a controlled physical or chemical damage on the superficial layers of the skin with regeneration by renewed tissue. Chemical peels are cheap, accessible, and highly effective treatment for black skin. In general, very superficial and superficial peels are well tolerated on black skin, medium peels can be performed with caution, and deep peels should be avoided, since the risk of dyschromia and scarring is high (Salam et al. 2013; Davis and Callender 2011).

Many studies about chemical peeling for black skin report the use of glycolic acid with good and safe results. There are also reports of good results with TCA 10–20%, and with Jessner's solution + 15% TCA, with lactic acid solution and salicylic acid solution 20–30% (Al-Waiz and Al-Sharqi 2002; Sarkar et al. 2012; Khunger et al. 2004). Grimes (1999) conducted a study about the use of salicylic acid peels 20–30% for dark-skinned patients. They reported good results for melasma, but 16% of the patients had transitory adverse effects with resolution after 7–14 days. Sarkar et al. (2012) suggested the combination of mandelic acid with salicylic acid in the same

Table 1 Peeling agents used in black skin

Superficial peeling agents (epidermis to upper papillary dermis)
Glycolic acid solution 30–50 % or glycolic gel 70%
Jessner's solution (Combes' formula)
Salicylic acid 20–30 % in ethanol
Tretinoin 1–7 %
Trichloroacetic acid 10–35 %
Medium-depth peeling agents (epidermis to upper reticular dermis)
Glycolic acid solution 70%
Jessner's solution and trichloroacetic acid 35%
Phenol 88% (without occlusion)
Trichloroacetic acid 35–50 %
Trichloroacetic acid 25–35 % + glycolic gel 70%
Deep peels should not be used in Fitzpatrick skin types IV–VI

formulation for dark skin, based on the fact that this association improves the benefits and reduces side effects. These authors also support the use of phytic acid peels. Independently on the type of peel chosen to treat melasma in darker skinned patient, the rate of recurrence is high; therefore many sessions of peeling and use of lighter substances as daily routine are necessary.

Effective peels, traditionally described in the literature and used in black skin (Salam et al. 2013; Roberts 2004; Been and Mangat 2014; Rullan and Karam 2010) are described in Table 1.

Types of Peelings

Salicylic Acid

It is a lipophilic beta-hydroxyacid, which cause desquamation of the superficial layers of the skin, with keratolytic and comedolytic effects. It can be also used in combination with other peels to promote better penetration of the second substance. Usually we use hydroalcoholic solutions of salicylic acid at 20–30%. It is very useful for acne, for both inflammatory and noninflammatory lesions, as well as for postinflammatory pigmented lesions. Salicylic acid peel is also indicated to other types of postinflammatory hyperpigmentation, such as melasma and pigmented keratosis. The peeling causes bearable burning sensation. The "end point" for this peeling is the appearance of a homogeneous erythema with a white powder precipitation. It is not necessary to neutralize this peel. Cold compress can be used only to comfort the patient. Coughing and sneezing can occur during the procedure (Salam et al. 2013; Roberts 2004; Grimes 1999).

Glycolic Acid

It is an alpha-hydroxiacid and similar to other compounds in this pharmacologic group, as lactic, citric, mandelic, malic and tartaric acids, glycolic acid peel causes epidermolysis in minutes after application. It promotes skin peeling and scattering of epidermal melanin. The "end point" is reached when a homogeneous erythema, better seen in caucasian patients, or when the first points of frosting (epidermolysis) are noted. For this reason, it is better to neutralize in 2-3 minutes. At this moment, the dermatologist shall neutralize the process. The acid should be neutralized with sodium bicarbonate solution 1% or with saline solution, or even with water. The effects of glycolic acid peel are time dependent. The concentration ranges from 10% to 70% (Roberts 2004).

It is indicated for acne, based on the anti-inflammatory property and antibacterial effect against *Propionibacterium acnes*. Reduction of acne lesions (comedos, papules, and pustules) is observed as well as improvement on the skin pigmentation after glycolic acid peels. Studies have shown that glycolic acid peel at the concentration of 70% is able of to press out pustules and comedos within few minutes (Salam et al. 2013). It is less effective in the treatment of superficial and mixed melasma and postinflammatory hyperchromia. It offers a slightly higher risk of irritation, hypochromia, and hyperpigmentation in a small percentage of patients. With the aim to reduce the irritation caused by this peel, it is better to manipulate the substance in gel vehicle instead of solution and to request for buffering substance with higher pH. The pH of the unbuffered acid ranges from 0.08 to 2.75. A pH less than 2 increases necrosis index and keratinocytes destruction. It increases the rate of complications without increasing its effectiveness. Therefore,

we recommend the use of buffered product or at least partially buffered (Roberts 2004).

Trichloroacetic Acid

It causes denaturation of proteins with coagulation necrosis and cell death. The degree of necrosis depends on the concentration and on the number of layers performed. It is not possible to neutralize this acid and denaturation of proteins is observed in seconds. Clinically, the protein denaturation is expressed by the presence of a white color spot called "frosting." According to the peeling depth, different grades of grayish-white area above the erythema are noted. The frosting is not desirable for dark skin, therefore low concentrations up to 25% of trichloroacetic acid are recommended. It is a very painful procedure with a severe burning sensation (Salam et al. 2013; Roberts 2004).

Al-Waiz and Al-Sharqi (2002) conducted a study about the application of Jessner peeling immediately followed by TCA 35% peeling acne scars treatment in 15 dark-skinned patients. They observed significant improvement (greater than 75% clearance of lesions) in 1 patient, moderate improvement (51–75% of clearance) in 8 patients, mild improvement (26–50% of clearance) in 4 patients, minimal improvement (1–25% of clearance) in 1 patient, and no response in 1 patient. Nine patients (73.4%) suffered from transient postinflammatory hyperpigmentation. In two of them it was preceded by erythema that lasted for more than 1 month. All patients completely recovered 3 months after procedure. Considering the reasonably low efficacy and potential risks involved, we do not recommend this substance for black skin.

Retinoic Acid

Vitamin A stimulates collagen and reduces blemishes. It can be applied in concentration ranging from 1% to 9%. It is used as a cover mask, which should be maintained on the skin from 4 to 8 h. After this period it should removed with a cleanser (Salam et al. 2013). The scales start to flake after 3–4 days and last more 2–3 days. It is effective for acne, for pigmentary disorders, and for rejuvenation. It is very safe for darker skin phototypes. It usually does not cause any discomfort during the procedure. It has a canary yellow color, but is commonly formulated with a tinted vehicle, simulating a cosmetic foundation, allowing the patient to go out of the office just after the procedure (Fig. 1).

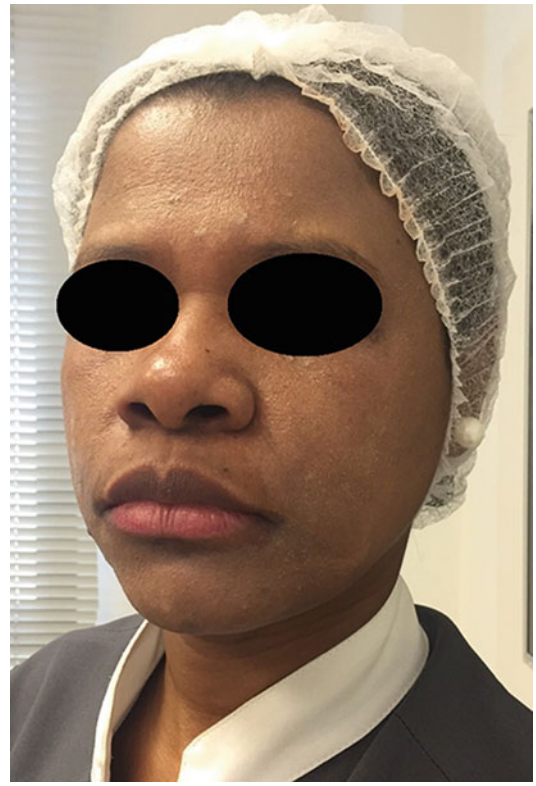

Fig. 1 Acid retinoic peeling with a tinted vehicle

Jessner Solution

Jessner solution contains lactic acid, salicylic acid, and resorcinol. It is excellent to be used as a superficial peel or to be combined with other peel. Its great advantage is the synergistic action of the three keratolytic components. It has a good lightening action due to resorcinol, a phenolic compound (Roberts 2004). However, it is important to

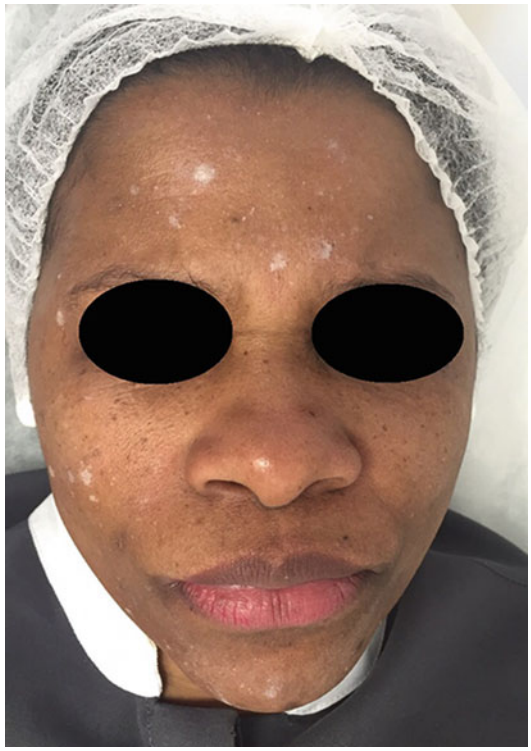

Fig. 2 Spot peel of Jessner solution

emphasize the care and attention when using this peel on skin types V and VI, as resorcinol can cause depigmentation in these patients. The target is to achieve a homogenous erythema with a whitish precipitation (similar to salicylic acid peels) without frosting. It is not necessary to wash or neutralize. This peel also promotes burning sensation and if an exaggerated reaction is realized, the procedure should be interrupted (Fig. 2).

Spot Peel

In some cases we can do a focused peeling. It consists of applying the chemical peel on a localized small area, maintaining the surrounding skin undamaged. It is very useful for localized injuries, such as hyperpigmentation, solar lentigines, seborrheic keratoses, active acne, or acne scars (Burns et al. 1997). The most common peels used with this purpose are salicylic acid (20–30%), Jessner solution, and TCA (20–30%). It is possible to combine two different substances on the area to be treated through spot peel method associating with another substance for the entire face. It also describes the use of different concentrations of the same substance, higher concentration as spot peel and low concentration on the entire face (Salam et al. 2013; Roberts 2004; Al-Waiz and Al-Sharqi 2002).

Chun et al. (2004) reported excellent results with spot peel using TCA (10–65%) for pigmentary lesions (solar lentigines, melasma, and freckles) in oriental individuals with skin phototypes IV–VI. Seborrheic keratoses and lentigines presented the best results, and melasma showed higher relapse rate. The substance was applied with fine-tipped wooden sticks (toothpicks) inside the lesion with pressure. Surprisingly, no severe side effect was reported with higher concentrations.

Indications and Practical Tips

Acne and Pseudofolliculitis Barbae

- Peelings for acne and pseudofolliculitis barbae are indicated due to its keratolytic, anti-inflammatory, and lightener properties. The chemical peels for acne treatment are an excellent choice, as they treat not only the active inflammatory lesions but also post-inflammatory hyperpigmentation.
- If there is no inflammatory lesion, a physical crystal or diamond peeling can be performed before chemical peels. We usually use this combination (physical + chemical peel) with salicylic acid 20% or Jessner solution.
- Another option is to apply higher concentrated salicylic acid (30%) exactly on the top of pustular lesions.
- Retinoic acid peel solution up to 7% maintained on the skin for 4–6 h of contact is other option.
- Alpha-hydroxyacid peels are reported as a good option; however, as it should be neutralized, it is advisable for the doctor to have a good experience to choose this class of peel.

Melasma

- Melasma is one of the most important and common diseases in African descent patients. It is much more prevalent among patients with Fitzpatrick phototype between IV and VI, mainly Hispanics, Africans, African-Americans, and Asians.
- Jessner's solution is indicated to be used isolated or in combination with other peels.
- We have good experience with a peel called Cimel, and we prefer to use Cimel modified formulation which contains 3% hydroquinone, 3% kojic acid, 3% retinoic acid, 3% lactic acid, 9% salicylic acid, 3% ascorbic acid, and 1% in gel cream vehicle.
- Another option is buffered glycolic acid peel (70%) isolated or in combination with retinoic acid 3–7%.

Residual Hyperpigmentation

- We have good experience with superficial peels, combining salicylic acid with retinoic acid.
- The use of substances containing bleaching agents and topical photoprotection (chemical and physical) at home, as a daily routine treatment, is advisable.

Tables 2 and 3 show the level of evidence and strength of recommendations for various peeling agents in ethnic skin, according to literature (Roberts 2004; Sarkar et al. 2012; Rullan and Karam 2010):

Table 2 Levels of evidence and strength of recommendations for various peeling agents in ethnic skin. Peeling agent level of evidence strength of recommendation

Glycolic acid peel II-i A
Jessner's solution II- iii B
Lactic acid peel II-iii B
Phytic acid peel III C
Pyruvic acid peel III C
Salicylic acid peel II-iii B
Trichloroacetic acid peel II-iii B

Patient Selection

Patients should be collaborative and need to understand all the steps of the procedure, including the pre- and postprocedure care. All the benefits and side effects, as well as its limitations should be very well explained to avoid false expectations (Roberts 2004; Rullan and Karam 2010).

Dermatologists should pay close attention or contraindicate chemical peels for dark-skinned patients who have personal or family history of keloids or hypertrophic scars. Chemical peels are not a good indication for patients with subjacent diseases, such as contact eczema, seborrheic eczema, rosacea, sensible skin, vitiligo, and psoriasis. The smokers have low rate of skin recovery. Radiotherapy, recent surgery, and oral retinoids are contraindications as they can interfere in the collagen modulation. An interval of 6–12 months is necessary after stopping the oral retinoid to avoid incorrect healing. The concomitant use of photosensitizing substances (cyclins, amiodarone, thiazides, tricyclic antidepressants, NSAIDs) or hormones should be investigated as they can promote hyperpigmentation (Salam et al. 2013; Roberts 2004; Rullan and Karam 2010).

Before Peeling

The patient is advised to use photoprotection and lightening substances such as hydroquinone, retinoic acid, glycolic acid, or triple combination of hydroquinone + retinoic acid + corticosteroid (Kligman formula) with the aim to prepare the skin, for at least 2 weeks before the procedure. These substances can be suspended 3 days before the procedure. It is important not to perform any depilatory methods or exfoliation 7 days before the procedure. These recommendations decrease the chance of complications, especially post-inflammatory dyschromia. If the patient has past history of recurrent herpes simplex disease, prophylaxis should be done with oral antiviral, such as valacyclovir 500 mg – 12/12 h for

Table 3 US preventive services task force levels of evidence for grading clinical trials

Level of evidence
I Evidence obtained from at least one properly designed, randomized controlled trial
II-i Evidence obtained from well-designed controlled trials without randomization
II-ii Evidence obtained from well-designed cohort or case control analytical studies, preferably from more than one center or research group
II-iii Evidence obtained from multiple-time series with or without the intervention; dramatic results in uncontrolled experiments could also be regarded as this type of evidence
III Opinions of respected authorities based on clinical experience, descriptive studies or reports of expert committees
IV Evidence inadequate because of problems of methodology (e.g., simple size or length of comprehensiveness of follow-up or conflicts in evidence)
Strength of recommendations
A There is good evidence to support the use of the procedure
B There is fair evidence to support the use of the procedure
C There is poor evidence to support the use of the procedure
D There is fair evidence to support the rejection of the use of the procedure
E There is good evidence to support the rejection of the use of the procedure

5 days, starting 2 days prior to the treatment. Patient should sign the consent term in which all the procedures including its benefits and risks are explained. Photographs before and after treatment are useful to evaluate clinical effects and also to prove the patient the results, avoiding possible complains regarding the procedure.

Peeling Procedure

The peel should be chosen according to the indication. However, as many superficial peels can promote similar clinical effect, usually the dermatologists choose the peel in which they have more experience to avoid side effects. We recommend all previously mentioned substances, except trichloracetic acid, remembering that deep peels are not recommended for skin types V and VI.

At first, the skin should be cleaned with the aim to remove makeup, sunscreens, cosmetics, and also to degrease the skin, preparing for peeling application. The patient should wash their face with soap or syndet cleanser and water and then the professional should remove the remaining residue with gauze soaked in alcohol, acetone, or Hoffman liquor with firm and continuous movement until reaching a clean and degreased skin. Depending on the number of passes and on the strength of hand, it is also possible to remove the very superficial cells of stratum corneum. This is important to promote a homogeneous peel penetration.

To prevent inflammation around eyes, nose, or lips, a petrolatum or some other cream can be applied before the procedure, mainly for peels containing salicylic acid. The hair should be covered with a cap.

The peel substance can be prepared in different vehicles and are applied according to the preference of the professional, including gloved fingers, cotton swabs, or wooden objects (such as sticks and tongue depressors). Thicker vehicle can be applied with gloves. Most formulations are prepared in aqueous or hydro-alcoholic vehicle, and for this reason cotton or gauze is preferred for the application. For application, it is suggested to divide the face into anatomical areas, starting the procedure on the frontal region, then malar and nasal area, finalizing on the chin region.

As we know, the depth of the peeling and its inflammatory response depends on different factors: the type and concentration of the chemical substance; the amount of product (number of passes); the pressure against the skin when cleaning or applying the peel; and the period of time that the skin is exposed to the chemical substance, mainly when neutralization is necessary to interrupt the effect. More aggressive procedure promotes more inflammation and subsequently can be responsible for a bad skin recovery which is dangerous for dark skin. According to the patient tolerance, future peelings can be stronger and the level of next peel can be tested before on a small hidden area (retro-

auricular region). Another point that should be taken into account for the black skin is to increase the interval between the peels to reduce complications. Special attention is deserved in nonfacial regions, which have fewer pilosebaceous units, low rate of recovery, and high risk of side effects (Roberts 2004).

After Peeling

Immediately and some hours after the procedure, patient is advised to use moisturizing, healing, and calming creams, as well as thermal water several times a day. For oily and acne prone skin it is recommended to use noncomedogenic and "oil-free" moisturizers. Topical corticosteroid should be prescribed for any area where the peel promotes a greater skin inflammation or persistent erythema to decrease the risk of postinflammatory dyschromia. Topical photoprotection is fundamental. In general, patients can return to their dermatological routine treatment after 7 days. At this moment, the dermatologist should revaluate the patient and usually prescribes bleaching agents.

Side Effects

Even the superficial peels can result in scarring or hypopigmentation in susceptible patients. Erythema and hyperpigmentation are most common, and sometimes, it is difficult to be treated. High potency topical corticosteroid should be prescribed as soon as possible when persistent erythema is detected (Salam et al. 2013).

Allergic reaction, if occurs, is also treated with topical corticosteroids.

Acne and acneiform eruption, which may be reduced with prior physical extraction of comedos, can be treated with usual medicaments for these conditions.

Bacterial and fungal infections are very rare and can be avoided with the correct hygiene and care; herpes simplex can be prevented using antiviral drugs prophylactically in selected patients.

Take Home Messages

- It is essential that the dermatologist knows the peculiarities of black skin, the anatomy of these patients, in addition to their beauty standards, cultural peculiarities, and expectations.
- While in Caucasians the peels are predominantly sought to treat photoaging and fine wrinkles, in black skin patients it is more often sought to treat melasma, post-inflammatory hyperpigmentation, acne, and pseudofolliculitis barbae.
- It is important to adapt techniques such as chemical peels for higher phototypes, as black skin has a higher risk of serious side effects, such as hypochromia, hyperpigmentation, and scarring.
- The most successful peels for dark skin are glycolic acid peels, salicylic acid, retinoic acid and Jessner solution, and techniques such as spot peel and combined peel.
- The chemical peel is an excellent choice for acne treatment in dark-skinned patients.
- Peels, such as salycilic acid and Jessner solution are well indicated to treat not only the active inflammatory lesions of acne but also postinflammatory hyperpigmentation.
- Other options for acne treatment include retinoic acid and glycolic acid.
- Dermatologist should pay close attention to glycolic acid peel in dark-skinned patients, as it should be neutralized to interrupt its effect.
- Spot peels can be used to localized lesions. The most common peels used with this purpose are salicylic acid (20–30%), Jessner solution, and TCA (20–30%).
- Jessner's solution peeling is indicated to be used isolated or in combination with other peels for melasma.
- Another option for melasma is a peel called Cimel (check the components in INDICATONS and TIPS).
- Salicylic acid peel + retinoic acid peel is a good option for residual hyperpigmentation in black skin.
- Medium peel should be performed with very caution and deep peels should be avoided.

- Routine home treatment with bleaching agents and topical photoprotection (chemical and physical), as an adjuvant treatment, is fundamental to reach good results and to avoid complications.

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Innovations in Superficial Chemical Peels

Heloisa Hofmeister

Abstract

Peelings are one of the oldest and most widespread cosmetic procedures worldwide and became very popular among dermatologists. Superficial chemical peels, also called "refreshening peels" or "light peels," are defined by the application of one or more agents to the skin aiming a mild desquamation. Superficial peelings are safe and suitable for the face and, some of them, also for any part of the body. In recent years several new superficial peelings were developed. They usually combine alpha hydroxy acids or retinoic acid and other depigmenting agents. In this chapter we are going to discuss peeling's classification, its indications, the procedure, side effects, and its management.

Keywords

Superficial chemical peels • Alpha hydroxy acids • Glycolic acid • Lipohydroxy acids • Beta-hydroxy acid • Fluor-hydroxy peels • Photoaging • Melasma • Acne

Contents

H. Hofmeister (✉)
Pontificia Universidade Católica do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
e-mail: hah@uol.com.br

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Introduction

Peelings are one of the oldest and most widespread cosmetic procedures worldwide and became very popular among dermatologists. Superficial peels are safe and relatively inexpensive procedures to refresh and rejuvenate skin. Among many other agents, in superficial peels, alpha hydroxy acids and more recently lipohydroxy acids, along with beta-hydroxy acids and their combinations, are used to exfoliate the epidermis and even the upper dermis. It is also known that serial superficial peelings may have deeper impact, being really effective in the clinical rejuvenation of the skin.

Superficial chemical peels, also called "refreshening peels" or "light peels," are defined by the application of one or more agents to the skin aiming a mild desquamation. The penetration is limited to the stratum granulosum and superficial papillary dermis, and so, the peel can be very superficial or a little deeper in the epidermis. Apparently some kinds of superficial chemical peels have a cumulative effect, meaning that probably serial superficial chemical peels may have results comparable to a medium peel. By peeling the epidermis several times, a stimulation of the upper dermis could be obtained with neocollagen production. Besides being very safe, superficial peelings are suitable for the face and some of them also for any part of the body.

History

When still a medical student, I went to the University of São Paulo in Ribeirão Preto for a work experience in Dermatology with Professor Luiz Marino Bechelli and told him I wanted to study "a new specialty in Dermatology, Cosmetology," and he answered: "there is nothing new in it. When Cleopatra bathed in milk, she was using the benefits of lactic acid."

The ancient Egyptians used animal oils, salt, alabaster, and sour milk to esthetically improve the skin. The earliest use of caustic preparations for peeling procedures was described in the Egyptian medicine in the Ebers papyrus as early as 1550 BC (Fischer et al. 2010). When sour milk was used to produce smooth skin, lactic acid, an alpha hydroxy acid, was the active agent. Poultices containing mustard, sulfur, and corrosive sublimate of limestone were used later by the Greeks and the Romans. Pumice, frankincense, myrrh, and tree resins have served to lighten the skin and remove freckles and wrinkles. The Turks used fire to singe the skin in an attempt to induce light exfoliation. Indian women mixed urine with pumice for skin application. In Europe, Hungarian gypsies passed their particular formulas down from generations to generations (Brody et al. 2000). Dermatologists began to show interest in skin peels in the nineteenth century. In 1874 in Vienna, the dermatologist Ferdinand von Hebra used the technique to treat melasma, Addison's disease, and freckles. In 1882 in Hamburg, Paul G. Unna described the actions of salicylic acid, resorcinol, trichloroacetic acid (TCA), and phenol on the skin. Their initial work was followed by that of many other authors (Fischer et al. 2010).

During the twentieth century, the procedure developed enormously, with the valuable contribution of many dermatologists such as F.C. Combes, Thomas Baker, Max Jessner, Sorrel Resnik, Harold Brody, Gary Monheit, and R.F. Bloom, among many others.

In the late 1970's, Eugene Van Scott and R.J. Yu investigated the alpha-hydroxy acids (AHAs). Their experimentation with these chemicals as superficial peeling agents came to fruition in the 1980's, and throughout the 1990's AHAs have been used like no other peelings before in the history of chemical peelings (Brody et al. 2000).

Retinoic acid peels have been introduced in the early 1990's and are widely used specially in Brazil as a "major" peeling agent. Retinoic acid induces neocollagenesis and disperses melanocytes, being very interesting in the treatment of photoaging (Reinoso et al. 1993).

Throughout the 1990's there have been a number of proprietary and patented products to market chemical peeling agents through both independent and major pharmaceutical companies. These variations have consisted of specific esters

and combinations of AHAs with appealing names to market not only the peeling agent but also the regimen of sunscreens and bleaches to be used concurrently (Brody et al. 2000).

We published the first Brazilian scientific article on glycolic acid peels in Brazil in 1996 in the Journal of the Brazilian Society of Dermatology. A research with good clinical results with the use of glycolic acid improved photoaged skin in the clinical point of view either from the patient or from the physician, with an increase in the amount of type I collagen after a 6 month clinical trial using 10% glycolic acid at home with a 70% glycolic acid peels at least monthly at the hospital (Hofmeister et al. 1996).

At the end of the twentieth century, the fluorhydroxy peel was introduced. It combines 5-fluorouracil with either glycolic acid or Jessner solution to treat actinic keratosis.

The combination of substances has been the trend in respect of superficial peels in recent years.

Basic Concepts

A peel is a medical process that uses a chemical substance on the surface of the skin in order to stimulate the turnover in the epidermis and in the dermis.

> "The peel is an act of stimulation!!" (Vigneron JLH, 24th EADV Congress, Copenhagen, 2015)

With chemical peelings you can choose the level from sprucing up to radical renovation. They are irreplaceable aid for aging skins. With the skin peeling one can have:

A rejuvenated appearance
A bright complexion, slightly pink
A reduction in pigmented spots
A decreasing of wrinkles until smoothing
An increased elasticity until a lifting effect

To be able to perform a peeling with safety, the physician must know the mechanism of action of the agent of the peel, understand the clinical-histological correlation which gives the right depth of action, and choose a good and safe peeling with good reproducibility index.

The ideal peeling is the one to produce the minor destruction with the induction of as more new collagen formation as possible.

Some authors discriminate the peelings between very superficial (removing the stratum corneum – depth 0.06 mm) and superficial (causing epidermal exfoliation of the granular layer until the basal layer – depth 0.45 mm). The depth of the peeling depends on several factors: the substance used, its concentration, the pH of the solution, the technique of application, the pre-peeling preparation of the skin, and the time of application (Fischer et al. 2010).

Traditionally the superficial peeling can make alterations in texture and pigment. The superficial peels are used to enlighten the skin, to uniformize the color, and to diminish fine lines and minimize large pores. It can be performed isolated or associated to other procedures, as after microdermabrasion or non-ablative fractionated lasers.

The superficial peeling, as any other peelings, stimulates the mechanisms of regeneration of deep dermal layers. The destruction of the superficial layers leads to a stimulation of the epidermal mitosis but also of the dermal mitosis by ways studied during healing: chemical mediators such as cytokines and stress proteins (HSP). It also facilitates the penetration of molecules during the peeling.

Superficial peels have very little or no downtime.

Indications and Contraindications

Indications

Photoaging: roughness, yellow stains, fine lines, keratosis, and solar lentigines.

Pigmentary disorders: melasma and post-inflammatory hyperpigmentation.

Acne: active inflammatory lesions and superficial/hyperchromic scars

Contraindications

Pregnancy, nursing patients, active herpes simplex, hypersensitivity, and unrealistic patient expectations.

Choosing the Patient

As in any other medical procedure, the choice of the right patient is very important. The dermatologist must take into account skin color, skin type, and the degree of photoaging. But most of all, the dermatologist must understand the expectations of the patient. This is the key for success!

The expectations of the patient must be realistic. The more aggressive the acid, the deeper the peeling with better results but more complication risks. In other words, the more superficial the peeling, the safer with minor results. And the patient must be aware of that.

Superficial peels may be done in the face and many of them in the body, in any phototypes.

Pre-peeling Preparation

Treating the skin before peeling is important for several reasons. It prepares the skin to receive the peeling more evenly, prevents post-inflammatory hyperpigmentation, and enhances the results of the peeling.

From 2 to 4 weeks before the procedure, prescribe a cleanser to be used twice a day chosen according to the degree of oiliness of the skin. At night, if the objective of the peeling is to treat photoaging, the prescription may be tretinoin 0.025–0.1% or AHA 8–10%. In the morning, prescribe AHA 8–10% with or without hydroquinone 3–5%, depending on the pigmentation of the skin. In all patients, prescribe sunscreens and explain its importance to be used daily before and after the peeling process. It must be used early in the morning, after the prescribed routine, and reapplied once or twice during the day depending on the radiation and sun exposure.

Special Care

Take pictures. Always!

The patient must be sitting at an angle of 45°, in a comfortable position.

Avoid irritated or erythematous skin. Pay close attention to the skin during the peel. Erythema and/or frosting are common endpoints. Always have a Q-tip and saline solution ready to protect the eyes if needed.

As a general rule, a very superficial peeling ends with erythema; a superficial one ends in an irregular erythematous frosting.

Many superficial peels require neutralization. Have the neutralizer always on hand.

Agents of Peels

Jessner Solution

Developed by Max Jessner, it is a combination of 14% resorcinol, 14% salicylic acid, 14% lactic acid, and 95% ethanol as the vehicle. Salicylic acid is photosensitive, and lactic acid absorbs water present in the air; hence, the solution is sensitive to air and light. Its mechanism of action is based on the salicylic acid and resorcinol's keratolytic property and the lactic acid's epidermolysis action (Yokomizo et al. 2013).

Known as "Combes peeling," it is used to treat melasma, comedonal acne, acne scars, photoaging, and post-inflammatory hyperpigmentation (PIH) on the face, neck, and trunk. May be combined with TCA or with 5-FU for different purposes and depth. It is very useful and effective for the treatment of the body (extra-facial areas).

The Jessner solution is applied in one to three coats with a gauze until even frosting is achieved

(face) or erythema is seen (body). It may be repeated weekly or every other week.

Modified Jessner solution is a combination of citric acid 8%, SA 17%, and lactic acid 17% in anhydrous ethanol qs 60 ml with a pH of 1.7 (Safoury et al. 2009).

Tretinoin

All-trans retinoic acid is a synthetic vitamin A analogue used as topical therapy for many skin diseases. Khunger et al. compared 1% tretinoin peel applied on one side of the face versus conventional glycolic acid peel applied to the other side at weekly intervals for 12 weeks in the treatment of melasma in phototypes III–V. Both groups were comparable in the reduction of modified MASI score (Khunger et al. 2004).

In Brazil, tretinoin is applied in much higher concentrations. Five to 10% is applied as a mask for a period of 4–8 h. This allows for a gentle peel that lasts for 3–4 days and helps reduce pigmentary disorders and acne (Salam et al. 2013).

It is also effective to reduce photoaging and striae.

As all superficial peelings, it must be done several times for better results.

TCA

Trichloroacetic acid has been used as a peeling agent for a long time and is still the most effective and safest agent for medium peeling, specially when combined with Jessner solution. Its depth of penetration depends on the TCA concentration and on the preparation of the skin, specially the degreasing. Up to 20%, it is considered a superficial peel according to the literature (Fischer et al. 2010). The depth of the peel depends not only on the concentration but also and mainly on the technique of application. If the skin is perfectly degreased, I would say 20% is much deeper than expected.

Cross technique (chemical reconstruction of acne scars) uses 90–100% TCA in a focal application using a needle covered by cotton as a very thin Q-tip pressed down firmly over the entire depressed area of the scar that produces multiple, frosted white spots on each acne scar. It is commonly associated with superficial or medium-depth peels or with lasers. It is intended to thicken the dermis with an enhancing in collagen production. It has been proven effective even in dark complexioned patients, including phototypes IV to VI.

AHAs

The alpha hydroxy acids are a group of organic compounds that has a hydroxyl in the position alpha. AHAs are generally extracted from fruit and sugarcane; they are metabolites of the carbohydrate cycle and other important metabolic processes. AHAs include glycolic, lactic, malic, citric, tartaric, and mandelic acids, which differ in molecular weight and length of carbon chain. Glycolic acid is derived from the sugarcane and has two carbon atoms in its molecular structure. Lactic acid, from the milk, has three carbon atoms in its molecular structure. Malic acid, from apples, presents four carbon atoms. Tartaric acid, from the grapes, has four carbon atoms, and citric acid, from citric fruits, presents six carbon atoms in its molecular structure. Mandelic acid is derived from almonds. The pyruvic acid is a keto acid that physiologically is converted into its hydroxy version, the lactic acid, and vice versa.

All AHAs have one common characteristic when in lower concentrations, as 5–15%. They diminish the cohesion strength of corneocytes, specially in the lower portions of the stratum corneum.

In higher concentrations (50–70%), AHAs diminish the cohesion strength of the keratinocytes and may even cause total epidermolysis and an impact on papillary and reticular dermis being able to induce neocollagenesis.

Glycolic Acid

The first AHA peeling agent was glycolic acid. It is a small molecule that goes down easily to the dermis and stimulates without desquamation. It has been shown that glycolic acid peels act by

thinning the stratum corneum promoting epidermolysis, dispersing basal layer melanin, and increasing collagen gene expression (Bernstein et al. 2001).

In this peeling, the pH of the solution is very important. Often, the use of the pH is very low and the limit between efficiency and burning is thin. Glycolic acid peels are commercially available as free acids, partially neutralized (higher pH), buffered, or esterified solutions.

Glycolic acid is used in solutions at concentrations varying between 25% and 70% and a pH between 1 and 3; tolerance is generally good. The higher the concentration and the lower the pH, the more intense the peeling will be (Fischer et al. 2010).

Its application is performed after degreasing the skin, with the help of Q-tips, disposable brush, or gauze pads (Landau 2008). In my practice, I do prefer disposable brushes.

The skin is covered by a thin film of the solution and must be neutralized when erythema begins, 2–4 min after. The physician must be observing closely, for the penetration may be deeper than expected, with undesired frosting that must be stopped immediately to avoid burning the skin. It can be neutralized by basic solutions such as 1% sodium bicarbonate or water. Several sessions of peelings are required to achieve better results. They can be used every other week or several weeks apart. As sessions progress, the concentration of the solution used may be progressively increased depending on tolerance and the results obtained after preceding sessions.

Glycolic acid is keratolytic and has anti-inflammatory and antioxidant effects.

Lactic Acid

Lactic acid is an AHA and its mechanism of action is similar to glycolic acid. It facilitates dissociation of epidermal cells and promotes desquamation, dispersion of melanin, and increase in the synthesis of collagen and glycosaminoglycans. In addition, it has been also described as having a tyrosinase-inhibiting action and has been used in the treatment of melasma. The usual concentration is 85%, pH of 3.5% in hydroalcoholic solution (Sharquie et al. 2005, 2012).

The first pilot study on lactic acid was done by Sharquie et al., who found it to be a safe and effective peeling agent for melasma in dark skin. In their study of 20 patients, 92% pure lactic acid was applied for a maximum of six sessions, and a significant fall in MASI (56%) was observed in all the 12 patients who completed the study. Further, lactic acid was compared with a well-established peeling agent, Jessner solution in a split-face design, and similar improvement was seen on both the sides with no relapse at a follow-up after 6 months. These studies justify further experimentation with lactic acid as a peeling agent for dark skin (Sharkie et al. 2005).

A recent study showed patients with dark circles around the eyes that were treated with chemical peelings using 15% lactic acid (LA) in association with 3.75% TCA, both agents in low concentrations, and found good results, with brightening and improvement of the dark circles (Vavouli et al. 2013).

Phytic Acid

Phytic acid is an AHA that has efficacy at low pH and does not require neutralization. It has progressive and sequential therapeutic action, in a non-aggressive manner. It does not cause a burning sensation, does not need to be neutralized, and after being applied is left until the following day. Five or six sessions are required. It can be repeated weekly or even twice weekly for a faster effect. It is very safe and effective agent for the treatment of melasma in darker skins (Yokomizo et al. 2013).

Alpha-Keto Acid

Pyruvic Acid

One member of the group of the alpha-keto acids which has gained significant attention in recent years is pyruvic acid. It is so because of its diverse

keratolytic, antimicrobial, and sebostatic properties as well as the ability to stimulate the formation of new collagen and elastic fibers. Apart from being effective for acne, photodamage, and superficial scarring, the agent has also shown benefit in a number of pigmentary disorders in light-skinned patients (Griffin et al. 1989).

However, the intense burning associated with pyruvic acid has limited its frequent use as a peeling agent for various conditions. Recently, a study was conducted by Berardesca, who used a new non-erythematogenic formulation of pyruvic acid and assessed its efficacy and tolerability for the treatment of photodamage, superficial scarring, and melasma. It was seen that the new preparation showed significant benefit in all the three conditions with no burning either during the peel sessions or during the post-peel period (Berardesca et al. 2006).

As all the studies have been conducted in Fitzpatrick types II to IV, it remains to be answered if the peel would do reasonably well when used on ethnic skin as well (Sarkar et al. 2012).

In concentrations from 50% to 80% diluted in ethanol, the pyruvic acid penetrates the skin in 1 or 2 min, and in spite of not having systemic toxicity may easily cause burning and scarring. Its penetration is highly unpredictable, and the erythema resulting from the treatment can last from 15 days to 2 months. Pyruvic acid can treat photoaging, acne, and superficial scars as all AHAs. It can decompose over time forming carbon dioxide gas and acetaldehyde; these vapors if inhaled may be caustic and irritating to the upper respiratory tract. Prevention is achieved using a fan during the application (Yokomizo et al. 2013).

Beta-Hydroxy Acid

Salicylic acid (SA) (ortho-hydroxybenzoic acid) is used in concentrations of 20–30% to obtain a superficial wounding of the skin specially in patients with acne. It is a lipophilic agent and produces desquamation of the upper lipophilic layers of the stratum corneum, with a keratolytic effect. It is the preferred treatment for comedonal acne, as it is lipophilic and concentrates in the pilosebaceous apparatus.

It is applied after degreasing the skin. It immediately feels burning and stinging, and white crystals of SA appear where the solution has been applied. The burning ceases within a couple of minutes, as soon as the vehicle evaporates. After that the face is washed with water. Peeling begins 2 days post-peel and may persist for 5–7 days.

SA peels may be done at weekly sessions for 6–8 weeks. It can also treat post-inflammatory hyperpigmentation, photoaging, and superficial melasma.

It can be formulated in 95% ethyl alcohol and in this case may cause stinging, burning, redness, and frosting, followed by crusting and pigmentation of the treated area. The SA's absorption is high and if done in large areas may cause salicylate intoxication.

It may also be formulated in polyethylene glycol vehicle (SA-PEG) with minimal absorption of SA with the same effectiveness (Dainichi et al. 2008).

Still, it can also be used in higher concentrations in ointment (40–50%) for application in upper limbs (Yokomizo et al. 2013).

Beta-Lipohydroxy Acid

It is a peel that uses a lipophilic derivative of SA, lipohydroxy acid (LHA). It is used in 5% and 10% concentrations. The LHA molecule acts on the corneosome/corneocyte interface to detach individual corneosomes cleanly. The corneosome is detached from adjacent corneocytes without fragmentation, suggesting that the LHA probably acts on transmembrane glycoproteins. This action occurs at the compactum/disjunction interface and does not affect keratin fibers or the corneocyte membrane. LHA also stimulates renewal of epidermal cells and the extracellular matrix, with an effect that is similar to the effect of the reference compound retinoic acid. In contrast to many other chemical peelings, LHA has a pH that is similar to that of normal skin (5.5) and does not require neutralization (Fischer et al. 2010).

Thioglycolic Acid

Also called mercaptoacetic acid, thioglycolic acid is a compound that includes sulfur, with a molecular weight of 92.12 (between trichloroacetic and glycolic acids, which are 163.4 and 76.05, respectively). It is highly water, alcohol, and ether soluble and easily oxidable. In the treatment of hemosiderotic hyperchromias, it is topically used in concentrations from 5% to 12%. Its affinity with iron is similar to that of the apoferritin, entailing the capacity to chelate the iron in the hemosiderin due to the presence of the thiolic group. A trial evaluated the clinical improvement of constitutional infraorbital pigmentation resulting from the application of a series of five 10% thioglycolic acid gel peeling sessions and concluded it is a safe, efficient, and cost-effective treatment (Costa et al. 2010).

For the treatment of ochre dermatitis, the most common concentrations used are from 5% to 20%, progressively increased in every 3 weeks of sessions until desired results. It is neutralized with water or thermal water after 10 min at the first session, and this period of time increases gradually in each peeling until 30–40 min. After the procedure a soothing cream is applied. The thioglycolic acid has an unpleasant and strong sulfur smell. In my clinic is always at the last appointment.

Combination of Peels

In recent years several new superficial peelings were developed. They usually combine alpha hydroxy acids or retinoic acid and other depigmenting agents. We use the following combination, called "Cimel" peeling: retinoic acid (3-5%) + alpha hydroxy acid (latic acid 9%) or beta hydroxy acid (salicylic acid 2-3%) + depigmenting agents (hydroquinone 3-4% + kojic acid 2%). It is applied with gloves on a cleaned skin, on the body or on the face (Fig. 1a, 1b, 1c). We have very good results for acne and hyperpigmentation, even in darker skin. Improvement of the skin texture can also be observed (Figs. 2, 3).

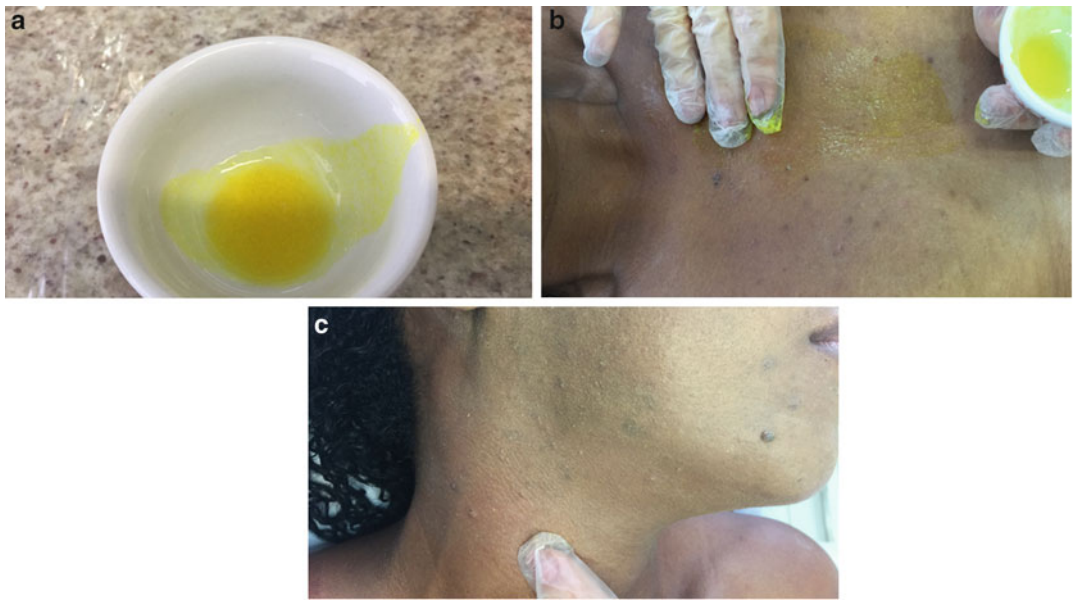

Fig. 1 **(a)** Cimel Peeling. **(b)** Appling Cimel Peeling (Yellow Color) with Gloves. **(c)** Acid precipitation on top of the inflamatory lesions

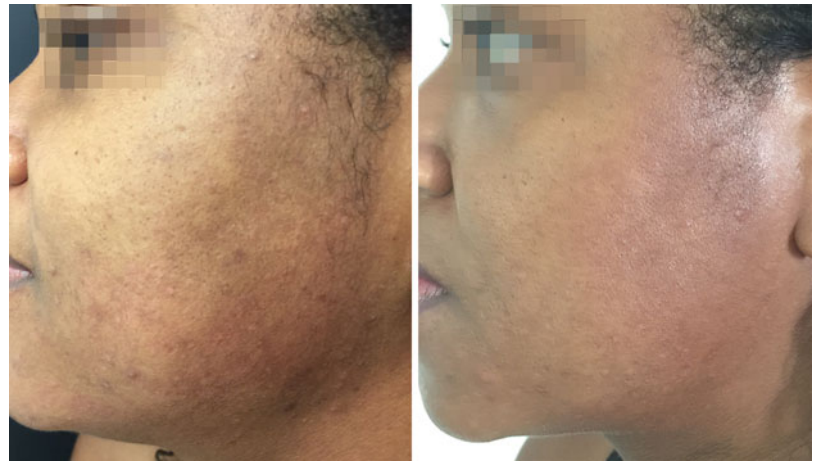

Fig. 2 Before and after one session of cimel peeling: improvement of skin quality and pigmentation

Fluor-Hydroxy Peel

5-Fluorouracil (5-FU) is very effective in the treatment of actinic keratoses (AKs). It inhibits RNA and DNA synthesis and destroys hyperproliferative AKs. However, it leads to severe erythema, local irritation, edema, and discomfort during almost all the treatment and post treatment period, from 4 to 8 weeks.

Glycolic acid with 5-fluorouracil is an especially effective combination to treat actinic keratosis. It has been used in pulses of 70% glycolic acid immediately before the application of 5-FU weekly for 8 weeks. It combines the keratolytic and therapeutic effect of the glycolic acid with the efficacy of the 5-FU, the golden standard treatment of actinic keratosis, without the usual morbidity associated with the use of 5-FU alone in a non-pulse dosage (Marrero and Katz 1998).

Salicylic-Mandelic Acid

This is a combination of a 20% SA that is a beta-hydroxy acid with a 10% mandelic acid, an alpha hydroxy acid. SA, which is lipophilic, penetrates active acne lesions quickly, while the mandelic acid that is one of the largest AHAs penetrates the epidermis more slowly and uniformly, which is ideal for sensitive skins. It is especially useful for ethnic skin because it prevents PIH. The main indications are acne, post-acne scars, and dyschromias, including melasma (Garg et al. 2008).

Mandelic acid is suitable for skins that are sensitive to the other AHAs. Its molecule is big, and so its penetration is very slow, causing no burning or stinging. Skin feels soft. It has a good capacity of neocollagenesis, increasing elastin fibers and GAGs on the papillary dermis. Besides, it has antibacterial and seborregulatory activities. The best vehicles are gel or mask.

It is a safe peel with comparable results with glycolic acid for the treatment of melasma but better tolerated and more suitable for Indian skin (Sarkar et al. 2016).

Other Possible Combinations

Many different combinations are possible. The final formulas will depend on the pharmacological knowledge of the performing physician, the indication of the peeling agent, and the patient. Some of the possible peeling agents are listed below:

***Peeling agents as*:**
Glycolic acid 0.2–30%
Lactic acid 5–25%
Citric acid 5–30%

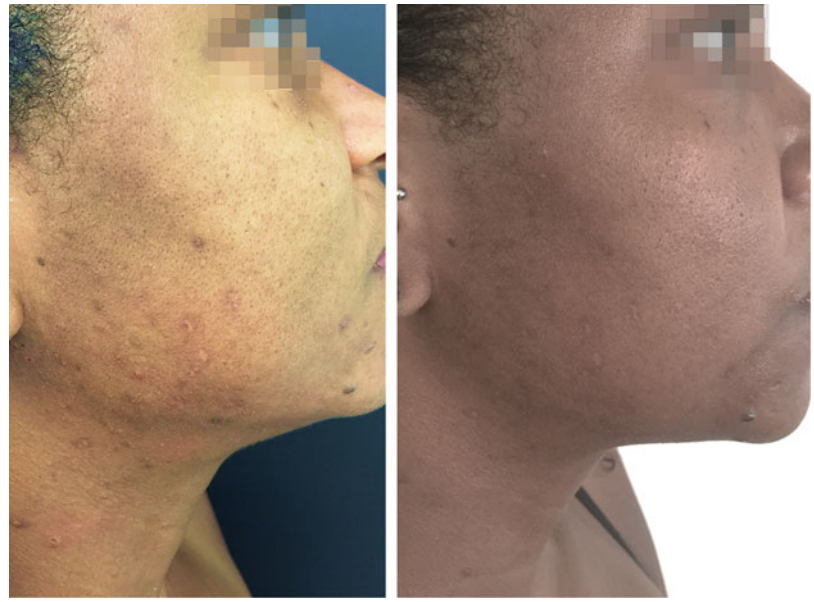

Fig. 3 Before and after one session of cimel peeling: improvement of acne lesions and pigmentation

Phytic acid 2.5%
Mandelic acid 20–40%
Salicylic acid 2–30%
Thioglycolic acid 5–10%
Pyruvic acid 25–40%

***With depigmenting agents as*:**
Kojic acid 5–7%
Alpha-arbutin 2%
Azelaic acid 10–20%
Hydroquinone 2–5%

Side Effects and Their Managements

When done properly, superficial peelings are safe, and side effects and complications are rare.

Redness is common and may last for several days.

Mild peeling is desirable and the patient must be aware of it.

Hyperpigmentation is rare and may be caused by undesired deepening of the peeling agent. It is treated with bleaching products and sun protection.

Take Home Messages

- Superficial peels are very important in any dermatologic practice. They are safe and cost-effective and their results are fast. They enlighten and make the skin more beautiful in just some days.
- It is very important to know how to manage the different superficial chemical peels.
- Combination of chemical agents (alpha hydroxy acids, retinoic acid, and depigmentant) is the growing trend.
- Basic dermatologic knowledge is the clue to all peelings, even the more superficial. The physician must take into account skin classification in terms of color, thickness, laxity, oiliness, and fragility.
- A peel, even a superficial one, should not be performed on a patient unless its skin is conditioned for at least 4–5 weeks with dermatologic treatment.

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Managing Chemical Peels Complications

Izelda Maria Carvalho Costa, Patrick Silva Damasceno, and Keila Gabrielle Pati Gomes

Abstract

Chemical peeling, a procedure wherein a chemical agent is applied to the skin causing a controlled destruction followed by regeneration and remodeling, is a dynamic instrument when used as a feature for treatment of acne, pigmentation issues, and photoaging (Nikalji et al, J Cutan Aesthet Surg 5(4):254–260, 2012). Outcomes and complications are related to the depth of the injury, with deeper peels giving more marked results and higher rates of complications.

Complications are more likely with darker skin types, certain peeling agents, and sun exposure (Nikalji et al, J Cutan Aesthet Surg 5 (4):254–260, 2012). They can vary from minor irritations, uneven pigmentation to long-lasting scars. In extremely unusual cases, complications can be life threatening. This knowledge is really important to prevent, diminish, and eliminate the rate of complications (Gadelha and Costa, Dermatologia cirurgia dermatológica, 2nd edn. Atheneu, São Paulo, 2009).

Swelling, pain, persistent erythema, pruritus, allergic reactions, folliculitis/acne, infection, herpes recurrence, hypopigmentation and hyperpigmentation, demarcation lines, and scarring are some of the complications that will be discussed in this chapter.

The first step in avoiding complications is to recognize the patients at risk, so that complications can be anticipated, prevented, and if they still happen, treated at the soonest.

Keywords

Chemical peeling • Complications • Erythema • Pigmentation • Scarring • Trichloroacetic acid • Phenol

Contents

Introduction

Chemical peeling is a procedure wherein a chemical agent of a defined strength is applied to the skin, which causes a controlled destruction of the skin layers, and is followed by regeneration and remodeling, with improvement of texture and surface abnormalities (Anitha 2010). It has been used

I.M.C. Costa (✉) • P.S. Damasceno • K.G. Pati Gomes
Department of Dermatology, University of Brasilia, Brasília, DF, Brazil
e-mail: izelda.costa@gmail.com; izelda@brturbo.com; patrick.damasceno@gmail.com; keila.pati.gomes@gmail.com

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in the course of recent years as a viable outpatient technique for skin restoration and also as a treatment for an assortment of skin conditions (Schürer and Wiest 2006). A peeling procedure will consider the profundity of the targeted structure and the skin state of the patient to choose among the variables, such as chemical class of the peeling agent, concentration, frequency, and pressure of the application (Fischer et al. 2010).

Chemical peels are classified as superficial, medium, and deep according to the depth of the peeling solution penetration (Landau 2008). Superficial peels, which penetrate just the epidermis, can be utilized to improve treatment for an assortment of conditions, including acne, melasma, dyschromias, and photodamage. Medium-depth peels, entering to the papillary dermis, might be utilized for dyschromia, multiple solar keratoses, superficial scars, and pigmentary disorders. Deep peels, penetrating to the reticular dermis, may be used for extreme photoaging, profound wrinkles, and scars (Rendon et al. 2010).

Results and complications are related to the profundity of the procedure. Despite the fact that more evident results are obtained with deep-depth peels, the utilization of a medium-depth peel permit to acquire fabulous results with less risks than deep peels (Camacho 2005). Prior to begin the peeling use as a routine method in your practice, comprehend that like all medical procedures, chemical peeling has numerous potential side effects.

Complications of chemical peelings might happen even though a controlled chemical wound has been induced. The physician must be absolutely acquainted with the sorts of peels and the administration of postoperative injury care based on the skin type of the patient (Brody 2001). Complications are more frequently seen in darker skin types, certain peeling agents, and sun exposure (Nikalji et al. 2012). They can vary from minor irritations, uneven pigmentation to long-lasting scarring. In extremely unusual cases, complications can be life threatening. This knowledge is crucial to prevent and decrease the occurrence of complications.

The initial step in avoiding complications is to recognize the patients at danger, so that complications can be foreseen, prevented, and if they still happen, treated at the earliest. These patients include those with darker skin type with a propensity to develop postinflammatory hyperpigmentation; with delicate skin or history of atopic dermatitis; with dry skin and reddish rue; with open air occupations; with history of photosensitivity or postinflammatory hyperpigmentation; on photosensitizing drugs; with history of keloids, poor healing (Fig. 1), or herpes infection; who have recently used isotretinoin; with unrealistic desires; uncooperative and fussy patients; and individuals who are mentally disturbed (Anitha 2010).

Selection of the appropriate technique depends on critical examination of the skin defect one wishes to treat balanced against the risks of treatment. The final protocol should be individualized for the needs of each patient (Matarasso and Glogau 1991). Despite the fact that complications can happen, the procedure is still important for specific conditions of the skin that cannot be managed effectively by standard surgical procedures (Litton and Trinidad 1981).

In order to avoid unpleasant situations in the future, a detailed consent form should be taken from every patient and pre-peel photography under proper lighting is advised in all cases (Anitha 2010). Besides, it is always safe to instruct the patient not to schedule an important event for at least 5 days after a superficial peel

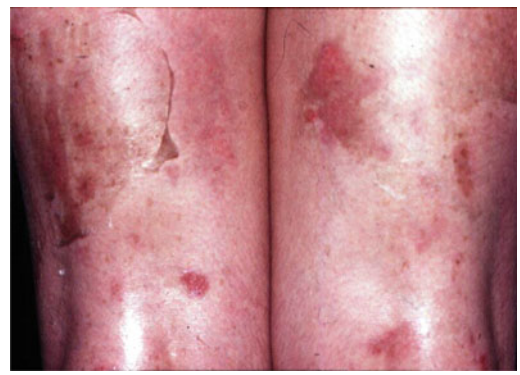

Fig. 1 Poor wound healing. Over 6 weeks to reepithelialization after TCA 25% procedure in the posterior region of the thigh (area with less follicular structures).

Table 1 Common complications of all peel type

Persistent Erythema	Telangiectasia
Ocular injuries	Infection
Swelling	Herpes recurrence
Pain and burning	Milia
Pruritus	Demarcation lines
Folliculitis/acne	Skin textural changes
Allergic reactions	Hypopigmentation
Blistering	Hyperpigmentation
Ecchymosis	Scarring

(Khunger 2009), 20 days after a medium-depth peel, and 30 days after a deep-depth peel.

Most important complications are displayed in Table 1.

Possible Complications in Peels of All Types

- Persistent Erythema

Erythema is normal after all types of peels, but persistent erythema is a consequence of angiogenic variables stimulating vasodilation, which indicates that the fibroplasia is being stimulated for prolonged period of time. Thus, it can prompt skin thickening and scarring (Nikalji et al. 2012).

Some known reasons for persistent erythema are the utilization of topical tretinoin just prior and after the procedure, oral isotretinoin administration preceding the peel, alcoholic beverages ingestion(Spira et al. 1974), contact dermatitis, contact sensitization, and some previous skin conditions (rosacea, atopic dermatitis, lupus erythematosus).

Medium and deeper peels have more prominent and long-lasting erythema. Erythema normally vanishes in 3–5 days in superficial peel, 15–30 days in medium peel, and 60–90 days in deep peel (Monheit 2004). If it continues after the time expected, it should be evaluated since there is a chance of scar development.

Persistent erythema must be dealt with as soon as it is diagnosed with strong topical steroids for 1–2 weeks, hats and sunscreens and continued emollients. Sometimes, cosmetic cover can be utilized to diminish the erythema during treatment. Intralesional, oral, or intramuscular steroids can be used in cases with no response. Persistent erythema has a tendency to respond well with intense pulsed light or pulsed dye laser devices (Tung and Rubin 2011).

Setting expectations before the procedure is mandatory, as patients will appreciate being informed of what to expect in the postpeel period (Levy and Emer 2012).

- Ocular Injuries

Unintentional spillage of any chemical peel agent in the eyes can prompt corneal harm, so it is essential for the doctor to be truly cautious when peeling around the eye. If an inadvertent spillage happens, the eyes should be rinsed with saline to prevent corneal harm. If phenol peels have been used, flushing should be done with mineral oil rather than saline (Nikalji et al. 2012).

An approach to avoid this complication is to have a cotton tipped applicator for quick removal of tears close to the lashes and a syringe filled with saline in case of an accident with the acid solution inside the eyes (Tung and Rubin 2011). An ophthalmologist should be consulted in these cases.

Cases of cicatricial ectropion have been reported in phenol-peeled patients, and lower eyelid ectropion has reportedly occurred in patients undergoing deep-eyelid peel in conjunction with a blepharoplasty (Dailey et al. 1998). The predisposing factors are older patients with senile lid laxity, patients who have experienced previous transcutaneous blepharoplasty, and patients with flimsy skin (Nikalji et al. 2012). Most of the time, this complication is self-limited and does not need specific treatment, just conservative care (massaging of lower lid skin, adequate taping of the eyelid, especially at night and protection of the globe with artificial tears) (Mendelsohn 2002).

- Swelling

All agents used in peels are possible to cause swelling, although it happens more often in deeper peels. The edema is expected and appears

in 24–72 h after the procedure, and it may take several days to recover. Usually, it is a fairly mild edema, yet it can be sufficiently extensive to close the eyes. Knowing this can happen, advising the patient is a way to keep them less worried if this occurs. Ice, antihistamines (loratadine 10 mg, hydroxyzine 25 mg, diphenhydramine 25–75 mg at night), and proper wound care are ways to avoid severe swelling. Systemic steroids, such as prednisone or methylprednisolone, should be utilized in patients who develop severe edema. Some physicians choose to use it preventively, however, it can lead to a bad healing (Tung and Rubin 2011).

- Pain and Burning

Pain is an expected and very ordinary outcome of medium-depth and deep peels. The intensity of pain fluctuates from patient to patient, and it can vary from low intensity to very high. In medium-depth peels, the pain lasts just a few minutes after the application of the peeling, and it is usually not necessary to recommend pain medicine to the patients. During the procedure, 2.5% lidocaine +2.5% prilocaine or 4% lidocaine can be utilized to lessen the pain without influencing the peel penetration. Deep peels usually create more pain and it tends to increase hours after the procedure, enduring a maximum of 8–12 h (Tung and Rubin 2011). Prolonged sun exposure, deficient application of sunscreen, utilizing topical retinoid or glycolic acid instantly after peels can incite this complication (Nikalji et al. 2012). Incomprehensibly, in a few patients, sunscreens can cause themselves contact sensitization or irritant dermatitis (Uday et al. 2007). Pain and burning is normally experienced during a peel procedure in sensitive skin.

Ice application right after the procedure diminishes the pain and burning sensation (Nikalji et al. 2012). When applying deep peels, the utilization of powerful analgesics might be necessary. Likewise, topical calamine cream can be utilized to sooth the skin. Topical steroids such as hydrocortisone or fluticasone are used to diminish the inflammation, emollients moisturize the skin, and sunscreens can be utilized to anticipate postinflammatory hyperpigmentation (Nikalji et al. 2012).

- Pruritus

It happens because of re-epithelialization, normally starts in the initial 2 weeks after treatment and persists for around 1 month, and it is more common after medium- and deep-chemical peels. If it occurs with increased erythema or pustules, beware of a possible contact allergy to the cream being utilized in wound care (Tung and Rubin 2011). Some patients can be truly disturbed because of the pruritus and ought to be given oral antihistamines and topical hydrocortisone creams. In order to avoid atrophy or telangiectasia, fluorinated steroids must be utilized with care.

- Folliculitis and Acne

In susceptible patients, chemical peels can prompt an outbreak of folliculitis or acne. Soon after the peel, numerous erythematous delicate papules can show up, mostly because of the emollient creams utilized in this period. The treatment for this condition is difficult since most topical acne agents are irritative to a recovering skin. Oral antibiotics (tetracycline 500 mg bid/minocycline 100 mg bid) can be utilized in these cases and the eruptions usually vanish in a week (Tung and Rubin 2011).

- Allergic Reactions

Allergic contact dermatitis is more frequent with resorcinol, salicylic acid, kojic acid, and lactic acid (Nikalji et al. 2012). Any peel can cause irritant dermatitis, particularly when utilized with high frequency, improper high concentration, or if vigorous skin preparation using acetone or another degreasing solution is applied.

The hypersensitive response normally caused by resorcinol is an urticarial type eruption. Agents as trichloroacetic acid (TCA) or glycolic acid have no report of genuine allergic reactions; however, the TCA can lead to cholinergic urticaria (Tung and Rubin 2011). If an allergic reaction happens, it can be solved by the use of antihistamines. The challenge is to differentiate an allergic reaction from the

erythema and swelling expected from the peel but, if the patient has a background of allergic reaction by any peeling agent, they should be given antihistamines prophylactically.

- Blistering

It normally occurs in younger patients with loose periorbital skin. Deeper peels, especially alpha-hydroxy acids, can lead to epidermolysis, vesiculation, and blistering particularly in delicate territories, such as nasolabial fold and perioral range. Trichloroacetic acid 50% and glycolic acid 70% can cause blistering. To avoid this complication, the nasolabial folds, internal canthus of the eye, and corners of the mouth should be protected with petroleum jelly (Nikalji et al. 2012).

- Ecchymosis

It normally occurs in the infraorbital region in some patients, being an uncommon complication of chemical peelings. It is strongly associated with severe edema after peels, with patients that have cutaneous atrophy or with patients with actinic damage (Tung and Rubin 2011). It vanishes spontaneously and the best prevention is to treat the swelling before ecchymosis appears, always letting the patient at risk be aware of the possibility.

- Telangiectasia

Superficial telangiectasia can be adequately managed with chemical peels; however, most of them are profound and become more noticeable after a peel, since circumjacent actinic changes and pigmentation are removed with the peel. Advising patients this can occur anticipates surprises.

If they are still disturbed about it, intense pulsed light, electrosurgery, or vascular lasers can be used to clear the telangiectasia (Tung and Rubin 2011). Patients already with telangiectasias might notice worsening after phenol peeling (Gadelha and Costa 2009).

- Infection
  - Bacterial

It is not common the occurrence of infection after chemical peels because the agents utilized in the procedure are bactericidal. However, prolonged application of thick occlusive ointments, poor wound care or even the apprehension of the patient to deal with his injuries, accumulating necrotic debris, and leading to secondary impetiginization are pre-disposing factors and can contribute to the development of microorganisms like *Streptococcus*, *Staphylococcus*, or *Pseudomonas* (Nikalji et al. 2012; Levy and Emer 2012). Clinical features of infections are postponed wound healing, folliculitis, ulceration, and crusting (Fig. 2).

To diminish the risk of infection, patients must be advised to clear the crusted or necrotic skin utilizing compress of 0.5% acetic acid soak three times a day until the crusts vanish or to use intranasal topical antibiotic ointments if the patient is susceptible (Tung and Rubin 2011). If an infection occurs in the postpeel period, it must be watched closely because of the risk of scarring, and appropriate treatment with broad-spectrum antibiotics has to be utilized. Additionally, bacterial cultures and gram stains should be done before starting the treatment since it can help the decision of the adequate antibiotics to be used.

If patients develop fever, syncopal hypotension, vomiting, or diarrhea 2–3 days after a peel followed by scarlatiniform rash and desquamation, physician should be alarmed for toxic shock syndrome. Other symptoms include myalgia, mucosal hyperemia, and hepatorenal, hematological, or central nervous system involvement. Large volumes of parenteral fluid with beta-lactamase-resistant antibiotics should be given to prevent vascular collapse (Dmytryshyn et al. 1983; LoVerme et al. 1987).

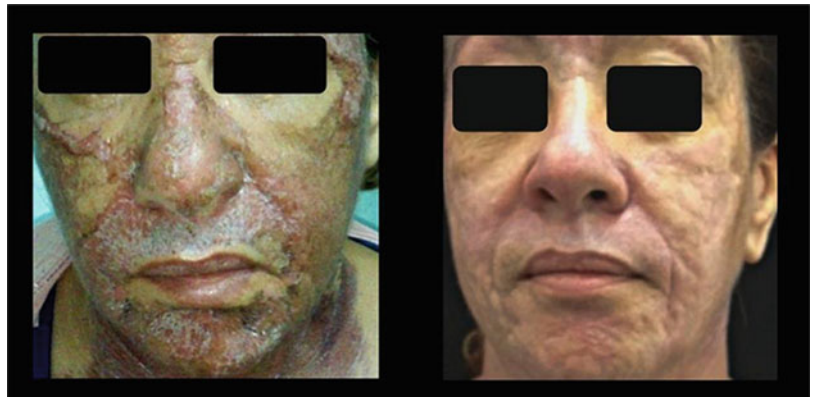

Fig. 2 Bacterial infection afer medium-depth peel (Jessner + TCA 35%). Patient was treated with cephalexin for 1 week and the second image shows the result after 1 week post treatment

- Candidal

  Candida infections can occur and are truly hard to recognize since the skin is eroded. Superficial pustules often happen in candidal diseases (Nikalji et al. 2012).

  Recent intake of oral antibiotics, immunocompromised or diabetic patients, and delayed topical steroid use are pre-disposing factors. It is essential to remember that candidal infections are usually not seen in phenol peeling (Tung and Rubin 2011).

  Treatment can be managed with topical clotrimazole 1% or systemic antifungals (fluconozole 50 mg/day).

- Herpes Recurrence

A herpes recurrence can occur after the injury induced by a chemical peeling, so the patient must be asked about herpes simplex outbreaks. The onset of the herpes eruption might vary from 5 to 12 days or even longer (Gadelha and Costa 2009). Since there is not a fully formed epidermis because of the peel, the herpes lesions are not vesicular, but they appear as exulcerations and often ulceration, with 2 to 3 mm, round shaped, isolated or in areas with extensive confluent erythema on the base. The treatment is acyclovir (400 mg 4–5×/day) or valacyclovir (500 mg 3×/day) (Spira et al. 1974). The prophylactic treatment is oral acyclovir (200–400 mg 3×/day) or valacyclovir (500 mg 2×/day) beginning 2–3 days before the procedure and completing 14 days after it (Nikalji et al. 2012). The treatment aim is to avoid scarring, although herpes infections normally resolve without scarring (Gadelha and Costa 2009; Tung and Rubin 2011). Lasting lesions should be cultured and treated with broad-spectrum antibiotics since it is hard to differentiate impetigo and herpetic infection during the healing period of a peel.

The most common infectious complications are listed in Table 2.

- Milia

Milia have been accounted to happen in up to 20% of patients after chemical peels (Dailey et al. 1998). These are inclusion cysts that appear as a part of the recuperating process. They are formed 1–3 months after the procedure (Gadelha and Costa 2009) and also can be caused by postpeel care of deeper peeling because of the occluding of the upper pilosebaceous units with ointments (Nikalji et al. 2012).

The utilization of retinoic acids prior and after the procedure can diminish appearance of milia (Tung and Rubin 2011). Because it mix up wound healing and can cause irritation, the acid should just be used after erythema has diminished. Milia generally have spontaneous regression and should only be treated if the patient requests it. Inclusion cysts should be removed by needle or lancet or electrodessication.

- Demarcation Lines

Demarcation lines are transition areas with pigmentary changes where peeled skin finds unpeeled

Table 2 Infectious complications

Bacterial	Viral	Mycotic
Staphylococcus	Herpes simplex	Candidiasis
Streptococcus		
Pseudomonas		
Toxic shock syndrome		

skin, being most common to happen below the mandible, close to the eyes, and periorally. It is not a complication itself; it just demonstrates the distinction between the treated and untreated skin. However, it is not aesthetically pleasing when very evident (Gadelha and Costa 2009). To prevent these lines, while doing medium and deep peels, particularly in darker skins, peeling agent with lower concentration should be feathered at the edges to merge with the surrounding normal skin (Nikalji et al. 2012). The physician should also be careful with application irregularities.

For a smooth outcome around the eyes, peels must be done right below the lashes on the lower lids and to the supratarsal crease on the upper lids. In the perioral region, peels must be done into the nasolabial folds, however, should not go onto the cheeks leaving possible demarcation lines on the nasolabial folds rather than on the center of the cheeks. In the hairline and on the mandible, the peel should be feathered into the hairline and reach out underneath the angle of the jaw and onto the neck (Spira et al. 1974). It is vital to notice that patients who undergo procedures such as facelift can have this line set up to the face.

If the demarcation line due to peeling is critical, the rest of the face can be treated with medium or deep peel. The neck has less pilosebaceous units which are important to re-epithelialization. Because of that, the lines between the face and the neck have greater risk of scarring and contractures. It is recommended to avoid Baker formula in the neck. Around there, it is recommended to utilize less deep formulas (Gadelha and Costa 2009).

- Skin Textural Changes

As a result of the removal of stratum corneum, transitory appearance of enlarged pores can happen after the procedure.

Cosmetic products such as oils and other agents should be completely removed before the peel since it can abbreviate the penetration and lead to variations in peel profundity, prompting a poor outcome that can be expressed by noticeable textural changes in the skin. Likewise, skin textural changes can occur because of an improper technique or a patient reaction to the peeling agent. Patients should be advised not to apply oily products the days that succeed the procedure. The physician must apply the agent peel equally in the skin as to avoid more profound penetrations in some regions. If a deeper penetration occurs, microdermabrasion or re-peeling of the affected areas might help solving the problem (Tung and Rubin 2011).

- Hypopigmentation

A slight hypopigmentation is expected after a peel since the agents utilized in the procedure cause an exfoliation. It is normally noticed in the jaw-neck region where untreated skin in the neck seems not quite the same as the recently rejuvenated skin from the face. As the cells are removed, the amount of melanin in the epidermis will diminish. In epidermal peels, the hypopigmentation is expected but temporarily (Spira et al. 1974). If the entire epidermis is removed, melanocytes are additionally removed, and it takes time for new melanocytes to move into the new epidermis. Permanent hypopigmentation, however, is a feared complication of the procedure, happening more frequently in dark-skinned patients. It happens more often when there is an uneven penetration of the peel, appearing in a haphazard distribution and being noticeable. Additionally, infection and scarring can lead to hypopigmentation, which can be truly remarkable in patients with type III or darker skins. Porcelain appearance, also described as the "alabaster statue" look, which can only be seen after erythema fades, is characteristic of phenol peels because of a direct melanotoxic effect of phenol (Tung and Rubin 2011).

- Hyperpigmentation

It can happen any time after a peel, but it normally happens between 4 days and 2 months

after the procedure (Gadelha and Costa 2009). It is the most common complication of trichloroacetic acid peeling, and it can be persistent if treated improperly. It is additionally important to determine through the wood lamp the level of pigmentation. In superficial peels, complications usually are transient hyperpigmentation or dyschromia, particularly in dark-skinned patients (Gadelha and Costa 2009) (Fig. 3). Temporary highlighting of lentigines and nevi may occur since the existing sun harm nearby these lesions has been cleared.

High-risk groups are types III-VI skin, types I and II skin following intense sun exposure and tanning, utilization of photosensitizing agents, early exposure to sunlight without adequate broad-spectrum sunscreens, and utilization of estrogen-containing medicines, such as oral contraceptives and hormone-replacement therapy (Nikalji et al. 2012). In patients with a past of hyperpigmentation from other skin lesions, there is a greater risk of developing postinflammatory hyperpigmentation and a test spot area must be done prior to full-face procedures in these individuals.

Patients that become pregnant in 6 months after the peel also have increased risk of this complication, even when sun avoidance is done. The pregnant ones with darker skin may be treated to avoid postinflammatory hyperpigmentation for up to 1 year postoperatively (Tung and Rubin 2011).

Hydroquinone 4–6% is the most utilized treatment for hyperpigmentation and it can be associated with tretinoin to enhance the bleaching effect when the skin is healed (Tung and Rubin 2011). If the patient is oversensitive to hydroquinone, other alternatives of treatment are vitamin C, kojic acid, and azelaic acid. In some cases, a superficial peel (glycolic acid, 30–40%) is utilized to speed the outcome. If there is a preexisting hyperpigmentation, adequate preparation of the skin for no less than 2–4 weeks preceding peel and discontinuing 3–5 days before the procedure is of vital importance (Tung and Rubin 2011; Levy and Emer 2012). Priming is done by application of a depigmentation agent like hydroquinone or retinoic acid.

For more enduring results, a good skin care regime is important, since studies have demonstrated that peeled skin comes back to its baseline status within 2–6 months without maintenance therapy. The patient should utilize wide-range (ultraviolet A and B) sunscreens previously and after the peels indefinitely and have strict sun avoidance. The suspension of conception prevention pills during pre-peel period is critical because it may invoke pigmentary changes.

- Scarring

Scars are the most feared complications and they normally develop 2–3 months after the peel (Gadelha and Costa 2009). Physicians must alert patients of its possibility before the procedure and should also be aware of patients in higher risk of developing scarring. Persistent erythema can anticipate early scarring. Although it is an unusual complication in chemical peelings, it is the hardest one to manage. Fortunately, scars with some level of hypertrophy are more common than keloids, contractures, atrophy, and necrosis (Gadelha and Costa 2009). Hypertrophic scars and contractures affect the function and movement of the face, therefore surgical interventions associated with multiple treatments to minimize the issue are frequently necessary. The risk of hypertrophic scarring from medium-depth peels is not common, but if it happens, it is normally found in the mandibular line, perioral, cheekbones, jaw, inner corner of the eyelids, and areas of excessive movement of the face (Gadelha and Costa 2009). The highest frequency of scars in the lower third of the face are related to the movement for talking and eating and also related with the highest frequency of intervention in this area. Keep in mind that the neck, suprasternal and submental areas are inclined to develop hypertrophic scars (Gadelha and Costa 2009). Atrophy is uncommon in phenol peeling, and trichloroacetic acid (TCA) is more likely to produce scarring than phenol because it is more caustic (Figs. 4 and 5).

If the patient has a background marked by poor injury healing, keloid or hypertrophic scar formation, excessive actinic damage, or is undergoing a deep peel, he has a greater chance of developing scarring. Skin of the neck, dorsal hands, and chest cannot undergo peeling without the risk of

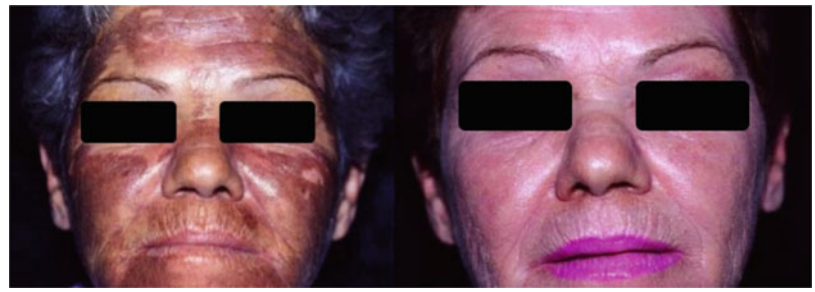

Fig. 3 Hyperchromic stains and spots after 30 days post medium-depth peel application (Jessner + TCA35%). Second image show the final result after retinoic acid plus hydroquinone treatment

scarring because it does not have enough follicular structures. Physicians must be careful to not re-peel an area that has been peeled little time ago and that have not had sufficient time to recuperate.

Other predisposing factors are history of smoking, recent facial surgery, recent ablative resurfacing procedures (including dermabrasion or laser within 6 months of procedure) (Singh-Behl and Tung 2008), numerous applications of TCA, and medium-depth peels on regions like mandible, neck, and chest. Since the TCA is more likely to penetrate deep into the reticular dermis, thin-skinned patients are more inclined for scarring. Some authors have theorized that patients recently treated for hair removal with lasers might experience difficulty healing after medium- or deep-depth peels since re-epithelialization happens from adnexal structures (Nikalji et al. 2012). The utilization of isotretinoin is also connected to delayed wound healing and amplified rate of scarring. A patient using this treatment should wait at least 6 months to undergo a medium- or deep-chemical peel (Tung and Rubin 2011).

The first indications of scarring are persistent erythema, pruritus, and postponed healing (taking over 2 weeks to reepithelialize). If it happens, patient should have immediate treatment with high-potency topical steroid, without forgetting that atrophy and telangiectasias are risks of prolonged utilization of steroids. If the skin takes over 2 weeks to re-epithelialize, there must be a pushy intervention with biologic dressings and antibiotics (Tung and Rubin 2011). If scars appear, the best management is with intralesional injections of steroids (triamcinolone 10–40 mg/cc). Massage, silicone gel sheet, compression over time, and steroid impregnated tape can be useful in softening firm scars. Intense pulse light and pulsed dye lasers devices are helpful to improve red scars. Surgical corrections can be done only after a minimum period of 6 months (Gadelha and Costa 2009).

Complications with Specific Peeling Agents

Although rare, toxicity may occur with resorcinol, salicylic acid, and phenol (Khunger 2008).

- Salicylism

If a great amount of salicylic acid is absorbed, it can have toxic effects as tinnitus, nausea, vomits, deep and rapid breaths, gastrointestinal irritation, and even stroke. Since it is utilized in Jessner's and Combe's formulas, which are of general use, patients should be cautioned of the symptoms and oriented to not take an excessive amount of aspirin, since it can have synergistic effects (Tung and Rubin 2011).

- Resorcinism

Resorcinol has ¼ of the strength of phenol and should not be applied in large areas such as the back (Tung and Rubin 2011). The physician should limit the concentration of this agent in the peel because, if it is over applied, it can prompt systemic toxicity that can be seen as different degrees of nausea, vomits, diarrhea, pallor, cold sweat, tremors, dizziness, drowsiness, headache, bradycardia, paralysis, shortness of breath, diaphoresis,

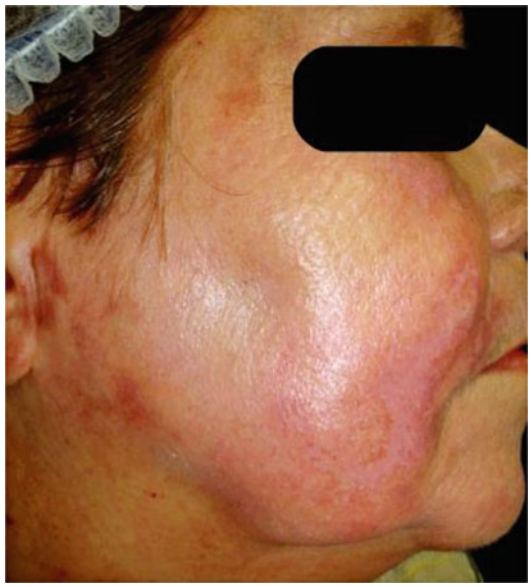

Fig. 4 Scars after 40 days of medium-depth peel (Jessner + TCA 35%)

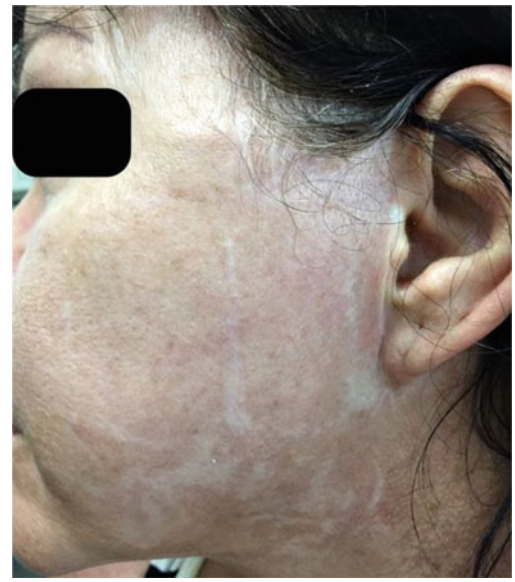

Fig. 5 Scars after 6 months of TCA 50% procedure

and nervousness (Tung and Rubin 2011). Continuous use of resorcinol can lead to myxedema since it has an antithyroid activity. Repeated applications should be applied with caution in low body weight patients (Nikalji et al. 2012).

- Phenol Toxicity

Phenol has hepatic metabolism and renal excretion, being harmful when utilized in high doses. From 20 to 25% of the amount absorbed by the liver is conjugated to glucuronic acid and sulfuric acid and then excreted. Seventy to 80% of phenol absorbed is excreted in urine within 15–20 min after application. Therefore, when using phenol peeling, the face is divided into at least five regions. Thus, applying the product in each region with 15 min time interval, so that the concentration absorbed is eliminated in urine, without causing cardiac problems (Glogau and Matarasso 1995; Stuzin 1998). To raise phenol excretion and minimize systemic complications, patients are hydrated with intravenous fluids and followed with cardiac monitoring (Gross 1984).

Cardiotoxicity is the most seen systemic effect caused by phenol peeling and the higher the dose is, the more systemic effects are likely to appear (Spira et al. 1974). It can lead to arrhythmias despite the fact that there was previous normal heart function. The occurrence of arrhythmias is disconnected to age, sex, or the utilization of saponified or nonsaponified formulations. Thirty minutes time after a phenol peel, the patient can complain of tachycardia followed by premature ventricular contractions, bigeminy, paroxysmal atrial tachycardia, and ventricular tachycardia (Nikalji et al. 2012). Some patients progress to atrial fibrillation (Velasco et al. 2004; Truppman and Ellenby 1979). In order to prevent complications, phenol peels should not be applied in wide areas. Regional phenol peel associated with a medium-depth peel in the other regions of the face is more secure than applying phenol in the entire face.

Landau et col. observed that the occurrence of cardiac complications in properly performed deep chemical peeling was lower than previously appreciated. From a total of 181 patients who have been treated during the study period, in 12 patients (6.6%) cardiac arrhythmia has been recorded during the procedure. Cardiac arrhythmia was more frequent in patients with diabetes, hypertension, and depression according to this study (Landau 2007).

Table 3 Systemic and cutaneous complications

	Cutaneous		
Systemic	Pigmentary	Scarring	Structural
Cardiac	Hypopigmentation Hyperpigmentation	Keloids	Ectropion
Renal	Line of demarcation	Hypertrophic scar	Eclabium
Hepatic	Accentuation of nevi	Atrophic scarring	
	Persistent erythema Persistent flushing	Necrosis	

Symptoms of stridor, hoarseness, and tachypnea developed within 24 h subsequent to peeling and subsided within another 24 h after inhalation therapy with heated aerosol mist was begun (Klein and Little 1983). It might be because of hypersensitivity reaction in the larynx and must be instantly treated. A chronically irritated larynx by tobacco smoke is more likely to develop this complication which may be avoided by antihistamines use before the procedure (Nikalji et al. 2012).

The complications found in phenol peeling are summarized in Table 3.

Conclusion

Acquire knowledge about peelings is essential to comprehend and avoid not only the major complications but also the most common ones. If they still happen, you must have the capacity to deal with it in the best possible manner thereby avoiding an unfavorable result. This chapter was designed to help professionals become more apt in the realization of chemical peelings showing essential data to consider when performing this procedure. Always remember to let the patient be aware of the complications and always establish a good relationship between patient's expectation and reality. For professionals who are new to the utilization of chemical peels, use common sense, do not seek for fast results, and use the correct indications. It is better a disappointed patient with a partial outcome that is easily solved with a new application than a disappointed patient with a complication of difficult treatment such as deep-scars development.

Take Home Messages

- Complications are more frequently seen in darker skin types, certain peeling agents, and sun exposure. They can vary from minor irritations, uneven pigmentation to long-lasting scarring.
- The initial step in avoiding complications is to recognize the patients at danger, so that complications can be foreseen, prevented, and if they still happen, treated at the earliest.
- Always remember to let the patient be aware of the complications and always establish a good relationship between patient's expectation and reality.
- For professionals who are new to the utilization of chemical peels, use common sense, do not seek for fast results, and use the correct indications.
- It is better a disappointed patient with a partial outcome that is easily solved with a new application than a disappointed patient with a complication of difficult treatment such as deep-scars development.

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My Personal Experience with Chemical Peels

Carlos Gustavo Wambier

Abstract

The last decades have been marked by the fast expansion of innovative technology. The associated strong industry marketing recently dominated the realms of procedural dermatology. Chemical peels have no marketing except the few "patented commercial formulas" that try to find their place in the dermatologic practice.

The concepts and techniques written in this chapter are intended to be read by officially certified dermatologists. Many workshops are done regularly during academy and society meetings, and the hands-on experience is the unique way of proper learning. Every medical intervention has its learning curve, and it is ethical to start the learning curve with supervised training such as medical residency.

May this chapter build enthusiasm to those initiating the practice of chemical peels and also bring joy to the experienced peelers.

Keywords

Photodamage • Photoaging • Chemical peels • Pyruvic acid • Croton oil • Trichloroacetic acid • Acne • Acne scars • Salicylic acid • Lactic acid • Retinoic acid • Jessner's solution • Modified Jessner's solution • Glycolic acid

C.G. Wambier (✉)
Department of Medicine, State University of Ponta Grossa, Ponta Grossa, PR, Brazil
e-mail: cwambier@uepg.br

Contents

Introduction

As in any form of art, it is not easy to reproduce exact strokes and movements done by a different artist. The same happens when applying chemicals to the skin. It is much easier to reproduce results defined by numbers such as when using LASER, such as number of passes at a specific pulse duration, spot size, density, and fluency. There is no way to predict the exact volume of liquid in a pass of cotton-tipped applicator or brush and if the exact

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time residual droplets in the surface will take to be absorbed or evaporate.

There are factors that may impact the final results of the procedure, which may be controlled do maximize reproducibility. Keeping these factors in mind may aid to apply specific variations throughout each procedure.

Basics of Chemical Peeling

Chemistry

All solutions are labile and are susceptible to exposure to air, light, temperature, microbiologic agents, wood, cotton, or other chemical or biologic substrate. A little unattended mistake may irreversibly change the composition of the chemical agent. Therefore, all solutions must be labeled with an expiration date, which is a sanitary law.

To preserve the intended expiration date, the bottle should be kept at controlled temperature, it must be closed as soon as the liquid is removed from the bottle to a glass, and, most importantly, *no contaminant shall ever touch the stock solution*, including water; cotton-tipped, plastic or wood applicators; cotton gauze; and gloves with or without talc.

The correct way to handle the stock solution bottle of the agent is to dispose the liquid to a clean glass recipient such as a shot glass and to close the bottle immediately. The liquid in the glass recipient can be used in the following minutes with any kind of applicator.

The best "shot glasses" are the ones with measures of volume (Fig. 1). Use a different shot glass for each agent to avoid cross-contamination.

Fig. 1 Shot glass with measures of volume

Chemical Agent

The main determinant of the final result is the chemical nature of the peeling agent itself. Some peeling agents interact with skin biology and are involved in biochemical and pharmacological actions beyond the physicochemical action (specially those derived from natural sources), that is, retinoic acid acts in nuclear receptors (Cucé et al. 2001; Ivanov et al. 2006; Khunger et al. 2004; Nolting et al. 2009), salicylic acid (Dainichi et al. 2008; Imayama et al. 2000; Marczyk et al. 2014), and pyruvic acid (Caperton et al. 2012; Cotellessa et al. 2004; Marczyk et al. 2014) have anti-inflammatory actions. Croton oil is pro-inflammatory and pro-proliferative agent. Phenol, acetone, and ethanol can be used as solvents. On the other hand, some chemicals produce only chemical coagulation and have no other biochemical effects, such as trichloroacetic acid (TCA) (Dainichi 2003), which confers some amount of safety and predictability of results.

Some agents have isomers with different actions, that is, L-lactic acid and D-lactic acid. The isomeric proportion may influence the final result as well.

Concentration

The strength of the solution is determined by the concentration and so are the expected results. However, in some scenarios "less is more"; this means that there may be one exact concentration to an expected effect. Overconcentration may incur in adverse effects or more pronounced side effects.

All solutions have a saturation point, which is the maximum concentration at a given temperature and vehicle. Some peels are used in an oversaturated solution or "suspension" intended to further interact with the skin, as a "leave in" for some hours.

Stronger effects occur with higher percentage of the agent.

pH and Temperature

Some solutions exhibit different penetration in the skin at different pH and temperature, so it is important to control both the pH and temperature of the final solution. Some solutions crystalize upon refrigeration.

Stronger effects occur with lower pH and higher temperatures of the solution.

Vehicle

Vehicles may evaporate during the procedure, causing a self-limited exposure to the solution, or may provide penetration of the solution in the skin. Some vehicles provide occlusion effect with extra penetration of the agents. Some vehicles dissolve oil in the skin.

Stronger effects occur with oily and solvent vehicles.

Skin

The skin of each patient should be treated as a mildly modifiable ambient. Some pretreatment regimens can affect results and therefore should be prescribed in advance.

The ideal skin for chemical peels in general is healthy, soft, young, non-oily, phototypes I–II, without irritations on the procedure day. Some of these characteristics can be acquired by directed treatments as a pretreatment regimen. Beware that skin irritation may induce hot spots and adverse effects of peelings. Careful examination is mandatory before every peel. Postpone the procedure if needed.

Balance and health should be goals for skin preparation before chemical peels.

Sebum

The skin has its own defense mechanisms against natural chemical agents. One of the most important is the lipid layer. It dissolves and attenuates soluble agents and efficiently repels hydrosoluble agents. Therefore, it is important to remove oil from the skin before applying chemical peels. There are many efficient ways. The most efficient way is to wash the face with a detergent and rinse well. After that, rub mildly but firmly a soaked pad with acetone, ethanol, or ether–ethanol solution in the skin, especially in sebaceous areas such as the nose, eyebrows, cheeks, forehead, and chin. The agents mostly affected by the skin oils are TCA and glycolic acid, which are hydrophilic aqueous solutions.

Areas with increased sebum production heal faster and are thicker. Those are the areas that need extra penetration of the chemical agent for uniform results.

Try not to irritate the skin during degreasing to prevent hot spots, especially on superficial peels. Beware of seborrheic dermatitis or any other dermatitis before peeling with superficial agents. Skin inflammation causes hot spots and may hurt when using the degreasing agent, which may focally increase skin irritation.

Always degrease in the same way for every peeling agent. So you can vary penetration during the application of the agent.

Stronger effects occur in non-oily skin.

Phototype

Some chemical peels such as phenol peels are not recommended for high phototypes (>IV) due to the high possibility of persistent dichromic macules and scar formation. Luckily, in real life, these patients do not present with complaints that would require deep chemical peeling. Post-inflammatory hyperpigmentation (PIH) occurs more frequently on intermediate phototypes (III/IV).

The use of hydroquinone for at least 1 month reduces incidence of PIH and should always be prescribed for phototypes III–V. The use of potent topical steroids on the night before and for the following 2 weeks may prevent PIH.

The patient should stop any irritant prescription at least 48 h before peeling. Benzoyl oxide: at least 1 week before. The use of potent topical steroids after peeling may trigger severe acne, rosacea, hair growth, and telangiectasia (Hengge et al. 2006). Therefore, the risk–benefit should be accessed on individual basis.

Application

The application technique is the variable that can be mostly changed among all the factors to a given expected result. A single, very fast, very light, semidry stroke of TCA 90% may confer results similar a slow, high pressure, wet application of TCA 10%.

The size, thickness, and smoothness of the applicator confer additional characteristics; in the same way, a painter may use a roller, spray, or a paintbrush. Some paintings may require multiple passes, and some may require only one thin pass. It is all part of the art.

Stronger effects occur with more volume, more friction, and more exposure time.

Applicators

All the applicators used in chemical peeling should be disposable (Fig. 2).

Cotton pads or cotton balls generally use soft applicators. These cannot be used with acids that deteriorate the protective gloves (TCA over 50% or phenol). If they are ripped into smaller pieces, they present the advantage of saving important volume of the solution.

Goat hair disposable brushes are excellent for peels with fast and soaked applications such as Jessner's solution and retinoic acid. When using retinoic acid-tinted solutions, the color becomes more uniform as cotton absorbs and filters the solution and the suspension particles.

Fig. 2 Miscellanea of applicators for chemical peels

Cotton-tipped plastic applicators (Q-Tips) present an internal deposit of liquid inside the plastic hollow handle. The liquid accumulates by capillarity and lasts longer without drying the cotton. Q-Tips are great to absorb tears during blepharopeelings.

Cotton-tipped plastic applicators are very easy to be oversaturated and drip during application. These are not recommended for blepharopeeling.

Rayon large applicators are great for both glycolic and TCA peels. The rayon serves as a sponge, and the plastic handle is larger than a usual Q-Tip, which confers less capillary effect. The liquid is delivered in a uniform way.

Cotton-tipped wooden applicators are less susceptible to dripping than the plastic ones. Are great for blepharopeelings.

Cotton-tipped wooden applicators made with tongue depressors are wider than the usual applicators. These applicators are handmade by rolling a small cotton ball in the extremity of a tongue depressor. The wider the tongue depressor, the more pressure it supports while applying friction. Since it is

not symmetrical, it can be used on different angles to confer different surfaces for applications, making it a very versatile, spatula-like applicator.

Wooden toothpicks are excellent for CROSS and for application in deep wrinkles around the eyes or mouth.

Glass capillary tubes (hematocrit tube) are thinner than the inside tube of a Q-Tip. This can be used for TCA CROSS in deep ice picks, since the liquid is expelled only by the very tip of the tube.

4″ × 4″ cotton gauzes have an advantage of causing a mild abrasion while peeling. They should be folded in half twice to reduce surface area and increase precision. There is no need to cut them into small pieces. These work great for TCA application.

Sponges these can be used in many different ways intended to cause mild to moderate abrasion during peels. The green part of the sponge can be used during TCA peeling for severe acne scars, allowing deeper penetration in the scar areas.

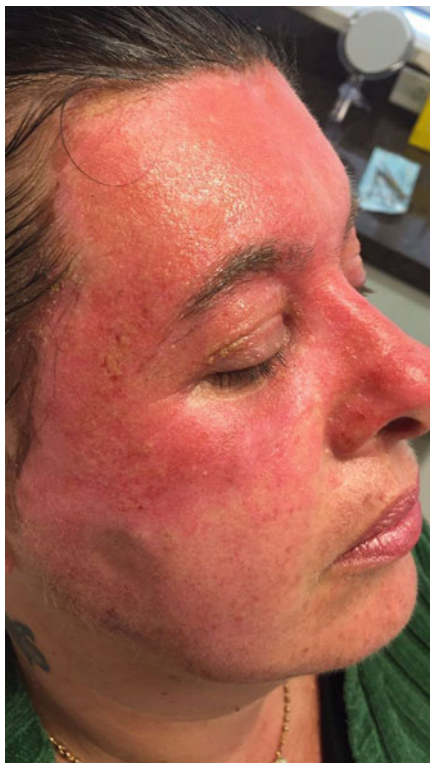

Fig. 3 Phenol-croton oil peeling. "El Zorro" mask with perfect feathering

Fingers with gloves are used for thick peels, such as gels, creams, and pastes, as an alternative to spatulas.

Feathering

To avoid demarcation of the treated areas, it is always good to use the same solution in a light manner around it, to cause a smooth look.

The best way to feather the application is to use the same applicator, after the whole procedure has been done, when it is semidry, in fast motions,

Table 1 List of conditions with medical indications for chemical peels

Condition	First choice	Alternative choices
Acne I–II	SA–RA	SA, RA, JS, MJS, TCA 10–20%, PA
Acne III	PA	SA, RA
Acne scars (mild)	J+TCA	MJS+TCA, SA + TCA 30%, CO2+TCA
Acne scars (severe)	PC +CROSS	J+TCA+CROSS, CO2 +TCA
Actinic keratoses	PA+TCA +5-FU	J+TCA+5-FU, GA+5-FU
Actinic cheilitis	PC	TCA
Blepharopeeling	PC	MJS–TCA, TCA, J+TCA
Keratosis pilaris	PA+RA	SA+RA
Lentigines/ ephelides	J+TCA	MJS+TCA, SA-RA
Melasma	MJS	TCA, SA, RA, PA
Melasma (refractory)	MJS+TCA	Phenol–castor oil
PIH	MJS+TCA	MJS, TCA, SA, RA
Rosacea	TCA	SA
Striae	TCA+RA	PA–RA
Superficial SK	TCA	PA–TCA, PC
Verruca plana	PA+TCA	J+TCA
Wrinkles (superficial)	PC	J+TCA, PA, CO2 +TCA
Wrinkles (deep)	PC	CO2+TCA
Xanthelasma	PC	TCA

5-FU 5-fluoruracil, *CROSS* chemical reconstruction of skin scars, *GA* glycolic acid, *MJS* modified Jessner's solution, *JS* Jessner's solution, *PA* pyruvic acid, *CO2* Solid carbon dioxide, *PC* phenol–croton, *PIH* post-inflammatory hyperpigmentation, *RA* retinoic acid, *SA* salicylic acid, *SK* seborrheic keratosis, *TCA* trichloracetic acid

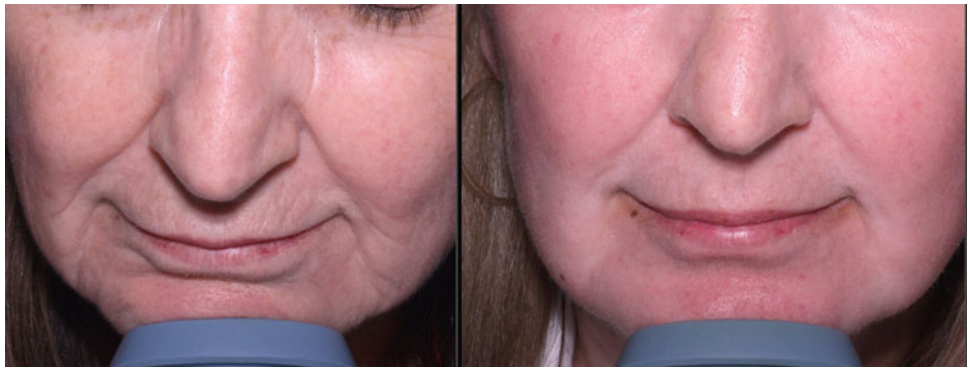

Fig. 4 Phenol-croton oil peeling often exceeds expectations in photoaging treatment

from the peeled area to the unpeeled area while raising the applicator. One technique the author frequently teaches in his practical workshops is the "El Zorro Mask" (Fig. 3), which consists of normal application of the peeling agent in the forehead and around the eyes, with feathering from the eyes to the cheeks and nose, leaving a very uniform final result for patients that do not require peeling in the lower face.

Removal

Some peeling agents such as TCA react and are self-neutralized; other alcohol-solutions dry leaving a crystalized inactive powder (pseudo frost), such as salicylic acid. Two chemical peels that classically need to be removed by neutralization with 10% sodium bicarbonate followed by rinsing and drying are glycolic acid and pyruvic acid to avoid over-peeling. Other peeling agents penetrate the skin leaving no superficial residua for washing.

The face can be washed in a normal sink with care not to spill rinsing water in the eyes or can be done by rinsing the face with a soft wet cloth a couple of times, which allows more control by the physician.

Setting

The peeling room should have air-conditioning for setting a standard on humidity and temperature. On the phenol peels, it is important to also exhaust the air of the room by a fan on the height of the patient's face.

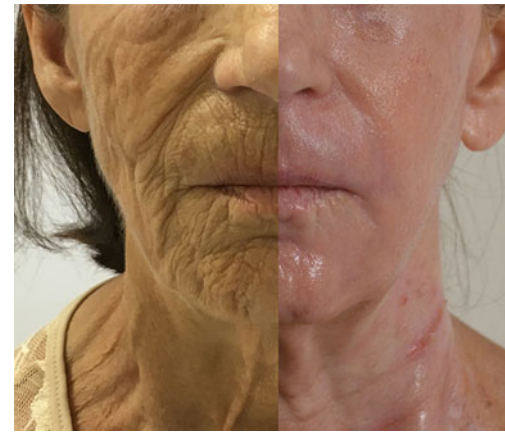

Fig. 5 Two-weeks post-operative magic of phenol-croton oil peeling

During most peels, direct wind or cooled air over the peeled area is needed for the patient's comfort. On situations of high temperature, the peeling solution is also hotter; the skin is also hotter, making the solution react faster and stronger to the skin. When where is high humidity, there is slower evaporation rates of ethanol and phenol.

Safety

The peeling room should be equipped with oxygen, medical equipment, and medications for

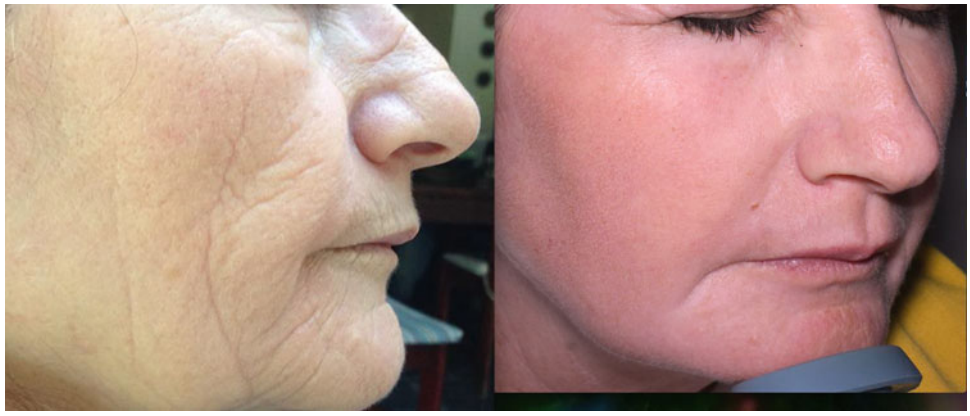

Fig. 6 Phenol-croton oil peeling rejuvenates the skin more naturally than lasers, and fillers combined. Two-months post-operative picture

emergency situations such as anaphylaxis, urticaria, convulsions, arrhythmia, bronchi irritation, and hyperactivity by inhalation of solvents and chemicals. On blepharopeelings and deep peels, it is mandatory for the patient not to drive after the peeling and have someone as company for after the peeling in case of vision impairment by severe edema and for safety during opiate use.

Indications for Chemical Peels

In my private office, most patients seek chemical peels to treat the effects of chronic sun irradiation and acne (Table 1). Other indications include superficial seborrheic keratoses, xanthelasma, and verruca plana. Despite innovative technology, up to 2017 there has been no technology that achieves similar results on severe photoaging as what is experienced with phenol–croton oil peeling (Figs. 4, 5, and 6).

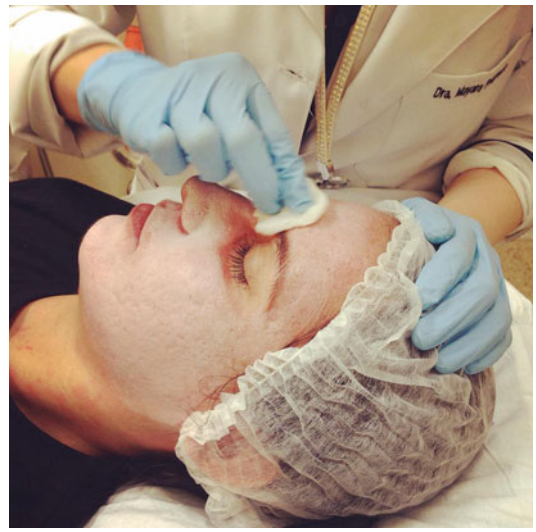

Fig. 7 Third year dermatology resident at Hospital das Clinicas of Ribeirão Preto Medical School, University of São Paulo applying medium-depth peel with perfectly uniform frosting (Photography courtesy of Dr. João Carlos Simão, MD, PhD)

Learning Chemical Peeling

Although chemical peeling was traditionally done by lay peelers, medicine has evolved, and dermatology and plastic surgery have embraced chemical peelings as routine procedures, with emphasis on scientific method for proper knowledge and teaching of chemical peeling techniques.

The best way of learning how to apply chemical peels to the daily practice is by learning with an experienced physician in formal supervised medical training, such as medical residency (Fig. 7). Textbooks may sparkle the interest and give formal guidelines for practical conduct, but in no way, it substitutes eye-to-eye, hands-on teaching, as in any other surgical procedure.

Fig. 8 Fourth postoperative day of medium depth peeling

Proper training not only creates the right set of knowledge to precisely indicate each chemical peel but also builds the visual memory of what is expected for each postoperative day of each chemical peel. So as the physician can act on any collateral or adverse effect caused by the peeling procedure (Fig. 8).

Take Home Messages

- Chemical peels are diverse and require proper training.
- Adequate technique is mandatory for handling and application.
- Despite innovative technology, chemical peels are still regarded as the most effective procedures for severe photodamage and acne.

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Part III

Physical Procedures in Cosmetic Dermatology

Percutaneous Collagen Induction with Microneedles

Emerson Lima, Mariana Lima, and Sarita Martins

Abstract

A trend is currently observed toward the indication of less invasive isolated or combined techniques in the treatment of stretch marks, scars, and aging. Percutaneous collagen induction with microneedles (PCIM) is a treatment option which stimulates collagen production without causing the total de-epithelization observed in ablative techniques. PCIM can be indicated for a broad spectrum of skin alterations, when the goal is to stimulate collagen production. It is necessary to choose the length of the needles according to the degree of injury required for the desired treatments. The number and the directions of passes in the area to be treated also depend on the dermatoses to be treated.

Keywords

Collagen • Wound healing • Ambulatory surgical procedures • Rejuvenation

Contents

Introduction

Ablative treatments aiming to stimulate collagen fibers, inducing dermis remodeling, have been advocated in dermatology. It is widely known that mechanical or chemical removal of the epidermis triggers the release of cytokines and the migration of inflammatory cells, resulting in replacement of damaged tissue by cicatricial tissue (Cohen et al. 1992). Medium and deep chemical peels are examples of popular ablative treatments among dermatologists, due to their indisputable stimulation of collagen production. Medium and deep peels improve scars (Fig. 1) and promote skin rejuvenation (Fig. 2), improving texture, brightness, and color of aged skin. However, the recovery time for these procedures is protracted, and they also result in sensitive skin tissue prone to post-inflammatory hyperpigmentation and photosensitivity. Moreover, it is important to highlight the risk of complications such as hypertrophic scarring, persistent erythema, and dyschromias (Fig. 3). Currently, a trend has been observed toward the indication of less invasive procedures, isolated or in association, aiming to reduce the risk of complications and to allow a patient's earlier return to normal

E. Lima (✉) • M. Lima • S. Martins
Santa Casa de Misericórdia do Recife, Recife, Brazil
e-mail: emersonderma@terra.com.br; marianaderma@terra.com.br; saritamartins@uol.com.br

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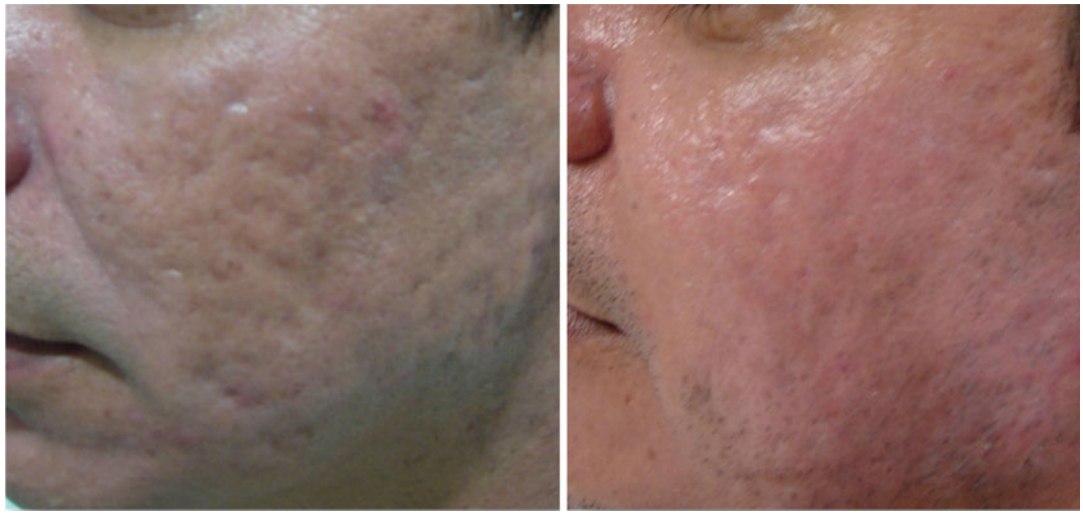

Fig. 1 Patient 60 days after TCA 35% associate to abrasion to treat acne scars

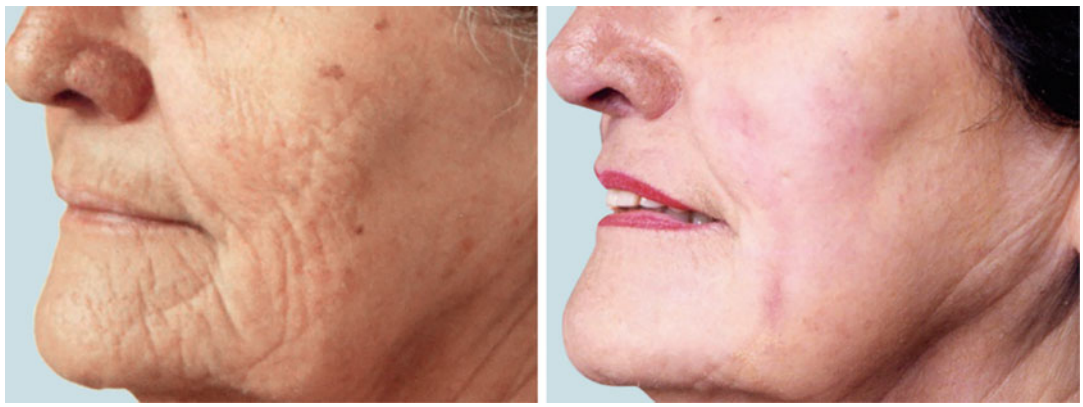

Fig. 2 Patient 60 days after TCA 35% associate to abrasion to treat wrinkles and laxity

life. Microneedling relies on the principle of neocollagenesis, with the benefits of not causing the total de-epithelization observed in ablative techniques.

Fundamentals of PCIM

Orentreich and Orentreith (Orentreich and Orentreich 1995) coined the term subcision to describe the subcutaneous incisionless surgery using hypodermic needles for treating depressed scars and wrinkles, aiming to stimulating collagen production. Based on the same principle of rupturing and removing damaged subepidermic collagen and subsequently replacing it with new collagen and elastin fibers, other authors confirmed this initial study. More recently, a system of microneedles applied to the skin was proposed, with the objective of generating multiple micropunctures, long enough to reach the dermis and cause bleeding, triggering inflammatory response that induces collagen production (Camirand and Doucet 1997; Fernandes 2006).

The percutaneous collagen induction (PCI), as the technique has been called, begins with loss of the

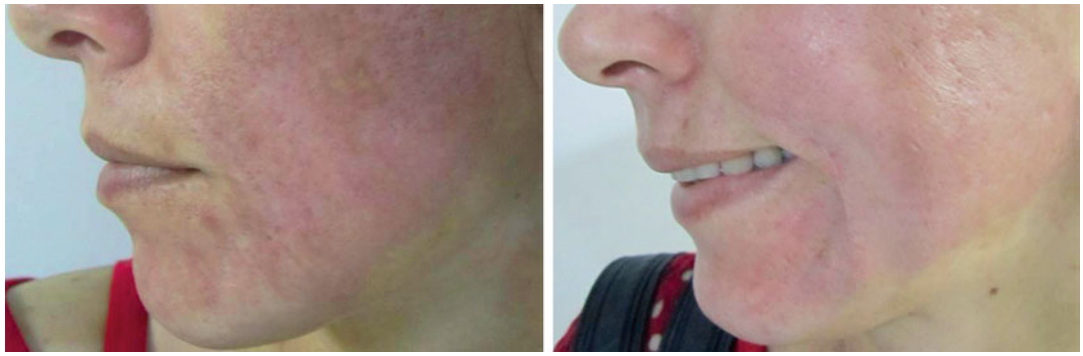

Fig. 3 Patient 30 days and 60 days after procedure presenting dyscromias and persistent erythema

cutaneous barrier integrity (causing keratinocyte dissociation), resulting in release of cytokines such as interleukin-1α (predominantly), interleukin-8, interleukin-6, TNF-α, and GM-CSF and leading to dermal vasodilation and migration of keratinocytes, a process that restores the epidermal damage (Bal et al. 2008). For didactic purposes, three stages of the healing process following trauma with needles can be clearly delineated. The first stage (injury stage) is characterized by the release of platelets and neutrophils (which are responsible for releasing growth factors that act on keratinocytes and fibroblasts, such as transforming growth factors α and β (TGF-α and TGF-β), platelet-derived growth factor (PDGF), protein III (activator of connective tissue), and connective tissue growth factor). In the second stage (healing stage), neutrophils are replaced by monocytes, and angiogenesis, epithelialization, and fibroblast proliferation take place, followed by the production of type III collagen, elastin, glycosaminoglycans, and proteoglycans. Concomitantly, fibroblast growth factor, TGF-α, and TGF-β are secreted by monocytes. Roughly 5 days after the injury inflicted, the fibronectin matrix is completely formed, allowing the deposition of collagen directly beneath the basal layer of the epidermis. In the third stage (maturation stage), type III collagen, which is prevalent in the early phase of the healing process, is slowly replaced by type I collagen (which lasts longer and persists for a period ranging from 5 to 7 years) (Fernandes and Massimo 2008; Aust 2008a, b).

In order for this inflammatory sequence of events to take place, the trauma caused by the needle must reach a depth of 1–3 mm, and the epidermis must be preserved (only perforated and not removed). Hundreds of microlesions are created, resulting in columns of blood collected in the dermis, accompanied by edema of the treated area and virtually immediate hemostasis. The intensity of these reactions is proportional to the length of the needle used in the procedure. For instance, a 1 mm depth entails an almost microscopic hematoma, while that resulting from a 3 mm depth can be seen with the naked eye and can persist for hours. Nonetheless, it is necessary to understand that the needle does not penetrate completely during the rolling process. It is estimated that a 3 mm long needle penetrates only 1.5–2 mm (or roughly 50–70% of its total length). Therefore, with a 1 mm long needle, the injury caused to the skin would be limited to the superficial dermis, resulting in a more limited inflammatory response than that caused by a longer needle (Aust 2008b; Fabroccini and Fardella 2009; Lima et al. 2013; Vasconcelos et al. 2013; Lv et al. 2006; Vandervoort and Ludwig 2008).

Characteristics of PCIM

The device used to perform PCIM comprises a polyethylene roll studded with sterile stainless steel needles symmetrically aligned in rows, totalizing around 190 units (a number that may vary depending on the manufacturer). The length of the needles is fixed throughout the structure of the roll and varies from 0.25 to 2.5 mm, according to the

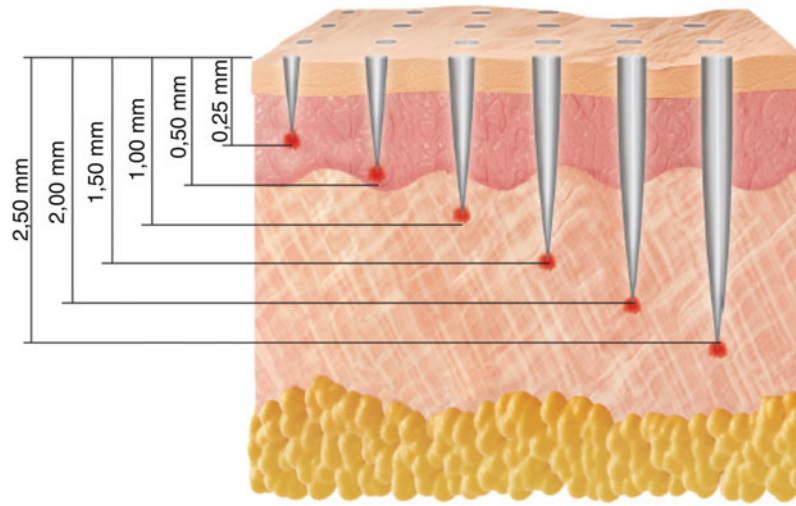

Fig. 4 Correlation between the length of needles and penetration into skin

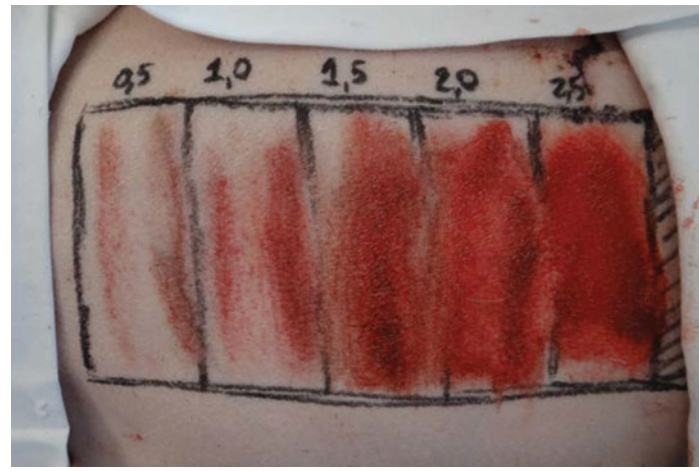

Fig. 5 From left to right, demarcated areas treated with different needle lengths

model. The procedure is usually well tolerated under local anesthesia, with needles not exceeding 1 mm in length (Fig. 4). For greater lengths, anesthetic blockade supplemented by infiltrative anesthesia is recommended (Fernandes 2006).

Aiming to provide more comfort for the patient in situations of prolonged surgical time and deeper injury, local anesthesia with sedation is recommended. PCIM is a technique-dependent procedure, and the final outcome is directly influenced by familiarization with the device used and mastery of the recommended technique. The vertical pressure exerted on the roller must not be strong to avoid damaging deeper anatomical structures and excessive pain. The device is recommended to be positioned between the thumb and index finger—as if holding a *hashi*—controlling the force with the thumb. The back and forth movements must imprint a uniform pattern of perforations (resembling petechiae) throughout the treated area. In order to achieve this, 10–15 passes in the same direction must be made, and at least four crossing passes in the rolling areas seem to be sufficient. In theory, 15 passes allow a controlled damage that corresponds to 250–300 punctures/cm^2.

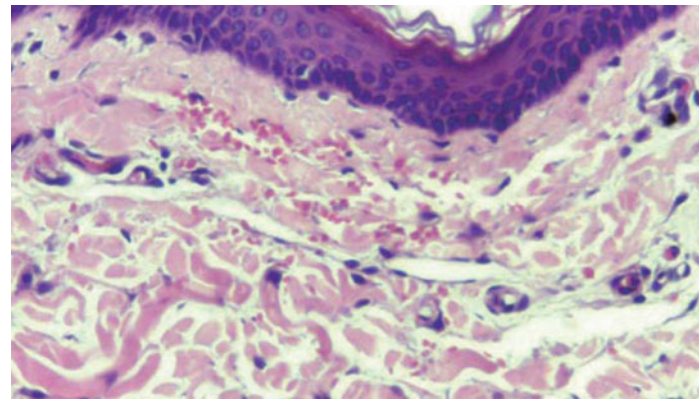

Fig. 6 Superficial hemorrhage restricted to the papillary dermis, with needles 0.5 mm long (HE, 100x)

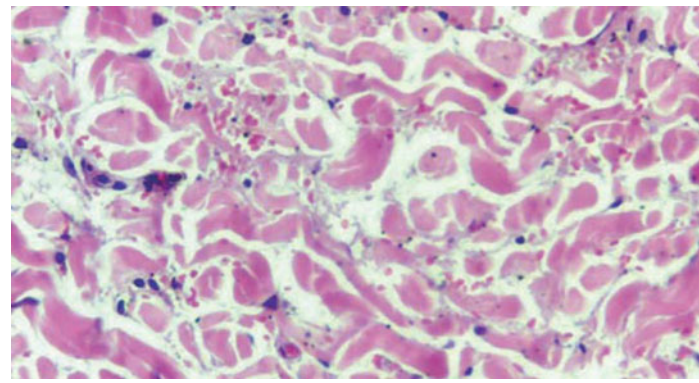

Fig. 7 Deep hemorrhage involving the reticular dermis, with needles 2.5 mm long (HE, 100x)

The time that the petechiae pattern takes to arise varies according to the thickness of the treated skin and the selected needle's length. Therefore, a thinner and looser skin, which is usually photodamaged, will present a uniform petechiae pattern earlier than a thicker and fibrotic skin, which is commonly observed in patients with acne scars, for example. In this manner, the choice of the needle's length depends on the type of the skin to be treated and the ultimate goal of the procedure. There is not yet a classification correlating the length of the device's needles to the depth of the expected damage in the treatment (Fernandes 2006; Fernandes and Massimo 2008).

Emerson Lima et al. (2013) proposed to establish the correlation between the length of the needles used and the depth of resulting damage, using the skin of living pigs, (considering it the most similar to human skin), in this first stage of research. The investigation was performed in vivo, on the skin of living pigs. The right-side region on the dorsum of the pig's skin was divided into tracks on which the roller with needles was passed back and forth, for 2 or 3 minutes. Rollers with needles measuring 0.5, 1, 1.5, 2, and 2.5 mm in length were used. The macroscopic appearance of the pigs' skin after treatment (Fig. 5) evidently suggested that the damage caused by the microneedling holes was proportional to the length of the needle used. The microscopic examination in the first stage (immediately after the injury) revealed predominantly vascular ectasia with the extravasation of erythrocytes. This finding was observed superficially, having affected the papillary dermis with 0.5 mm needles (Fig. 6), reaching the reticular dermis with needles of greater length (Fig. 7). The amount of bleeding also increased

proportionally to the length of the needles. The epidermis remained apparently intact under optical microscopy, except for the presence of the needle path site (Fig. 8). None of the samples presented lesions in the subcutaneous tissue. Based on the results, the authors propose the classification of the injury caused by microneedling as mild, moderate, and deep, correlating to the needles' length and their ability to induce the planned trauma (Charts 1 and 2).

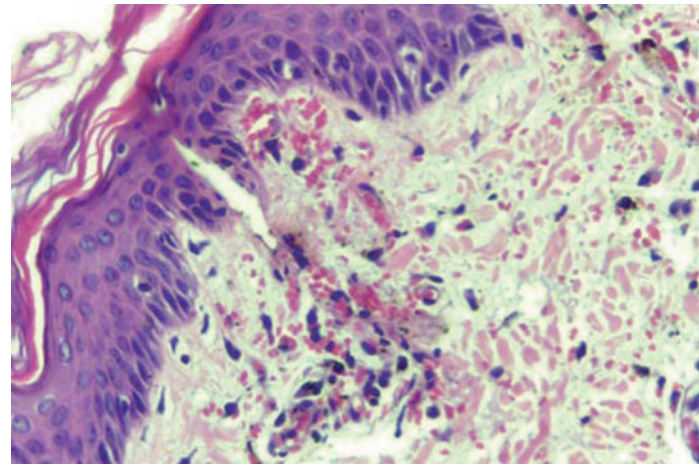

Fig. 8 Needle path associated with hemorrhage. Adjacent epidermis without significant alterations (HE, 100x)

Chart 1 Classification of the severity of the injury caused by microneedling

CHART1: Classification of the severity of the injury caused by microneedling	
Stimulus characteristics	Length of needle
Mild injury	0,25 e 0,5mm
Moderate injury	1,0 e 1,5mm
Deep injury	2,0 e 2,5mm

Chart 2 Classification of the severity of the injury caused by microneedling

CHART2: Classification of the severity of the injury caused by microneedling	
Stimulus characteristics	Length of needle
Mild injury	Drug delivery; Fine wrinkles; improvement in brightness and texture
Moderate injury	Cutaneous sagging; Medium wrinkles; Global rejuvenation
Deep injury	Depressed distensible scars; Estriae; Ondulated and retractile scars

Procedure: Protocol and Management

PCIM is a technician-dependent procedure. Familiarization with the device used and technical mastery are factors that directly influence the final result.

The device used to perform the PCIM comprises a polyethylene cylinder studded with stainless steel sterile needles symmetrically aligned in rows, totaling around 192 units with 2.5 mm length.

We propose the following treatment protocol: to degrease the skin with liquid soap and to do antisepsis with chlorhexidine and block anesthesia of the infraorbital and mentonian nerves, followed by infiltrative anesthesia with 2% lidocaine and saline (1:3) of the genian region, observing the maximum anesthetic dose according to the patient's weight.

The microneedles should be applied with back and forth movements until an uniform bloody dew emerges. At the end of the procedure, a sterile gauze dressing is applied for 24 h, when it is removed, at home, during the bath. A cutaneous barrier regenerator is prescribed three times a day until complete recovery. After procedure, patients should be examined to evaluate possible side effects as erythema, edema, or infections. The return to professional activities occurs within 7 to 10 days. Moderate edema and erythema persisted during a period ranging from 25 to 35 days, but after 15 days, patients are instructed to use topical depigmenting substance (0.05% retinoic acid + 4% hydroquinone + 0.01% fluocinolone acetonide), alternated with a cutaneous regenerator and sunscreens (SPF 50+). After

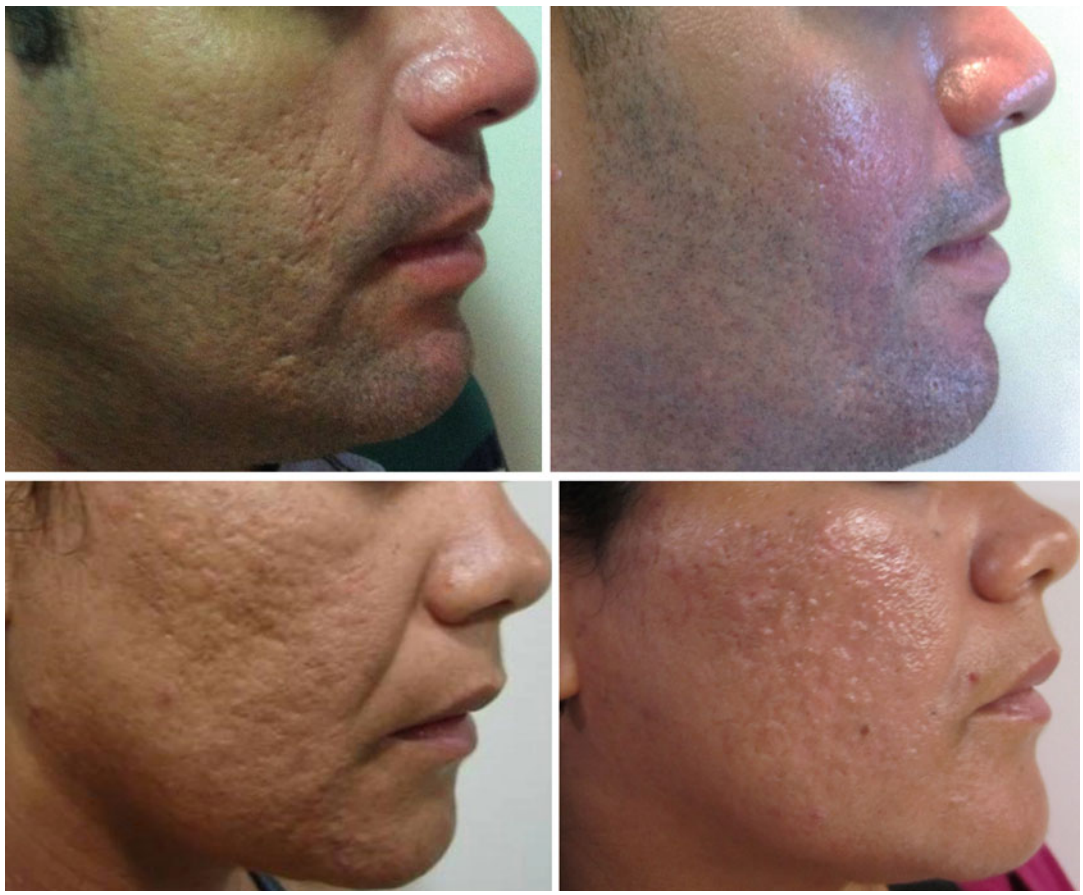

Fig. 9 Patient 30 days after PCIM presenting improvement in acne scars

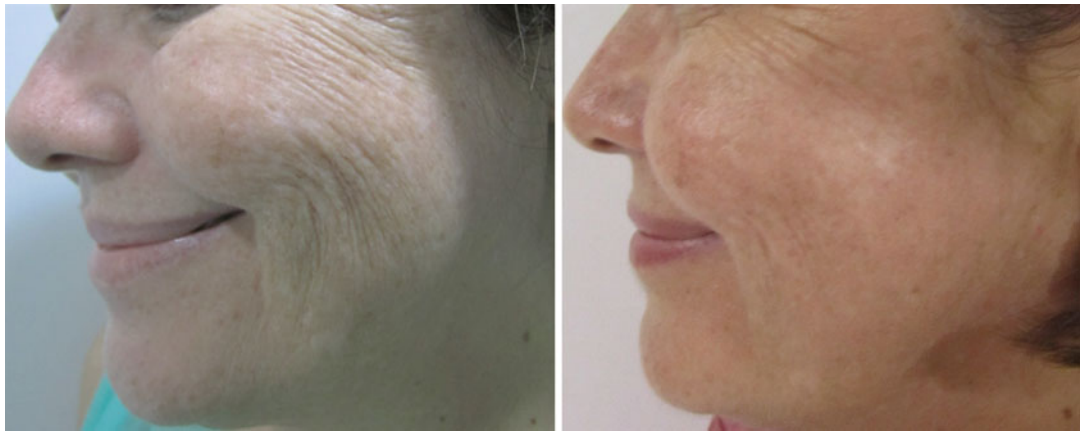

Fig. 10 Patient 30 days after PCIM presenting improvement in wrinkles and laxity

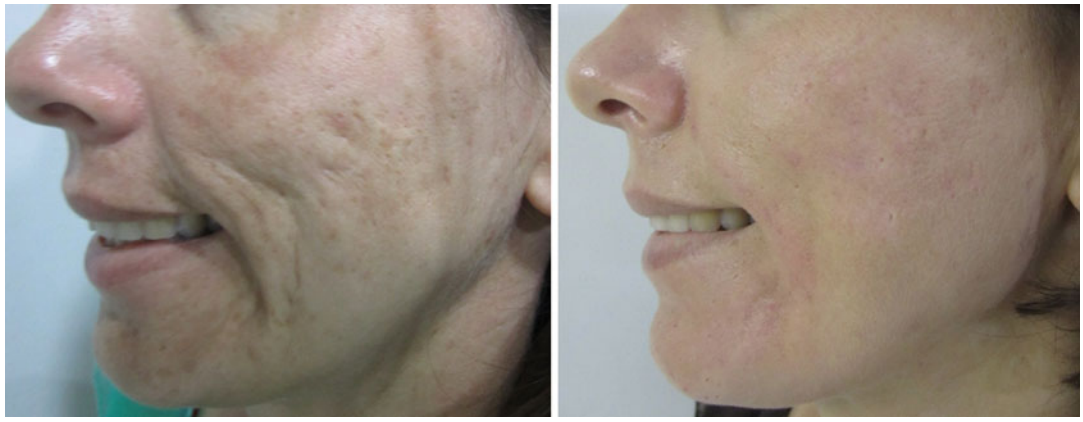

Fig. 11 Patient 30 days after PCIM presenting improvement in acne scars, laxity, and melasma

30 days, the depigmenting cream can be used every night with good tolerability.

The number of passes before the emergence of the petechiae pattern varies according to the skin's thickness and to the selected needle. Thinner and looser skin, as photodamaged skin, presents an uniform petechiae pattern earlier than thicker skins. Acne scar skin is thick, and a larger number of passes and longer needles are necessary to promote the uniform petechiae pattern. Side effects, such as erythema and edema, are similar or more intense when using more aggressive parameters. Moderate post-inflammatory hyperpigmentation can be observed in some patients, but it is reversed with the use of the depigmenting substance during 30–45 days (Figs. 9, 10, 11).

Conclusion

PCIM is an innovative treatment that can be used for a broad spectrum of indications, when the objective is to stimulate collagen production, being an additional weapon in the dermatologist's therapeutic armamentarium. The goal of the present study was to establish the correlation between the length of the needles used in the roller and the extent of damage caused to the skin, thereby facilitating the choice of instrument in different

indications. It is up to the individual dermatologist to perform an accurate assessment of the lesion to be treated and to be technically prepared to perform the procedure within the recommended precepts.

Take Home Messages

- The procedure allows the stimulation of collagen production, without removing the epidermis.
- The healing time is shorter and the risk of side effects is reduced, compared to ablative techniques.
- The skin becomes thicker and more resistant, unlike in ablation techniques, where the cicatricial tissue is more susceptible to photodamage.
- It is indicated for all skin types and colors and can also be used in areas of lower concentration of sebaceous glands.
- Lower cost when compared to procedures that require technologies demanding high investment values.
- It is a technique-dependent procedure and requires training.
- Requires prolonged recovery time if moderate to deep injuries are inflicted.
- Demands careful assessment of the patient and therapeutic proposal compatible with possibly achievable outcomes, avoiding unrealistic expectations.

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Cryotherapy for Cosmetic Procedures

Joaquim Mesquita Filho and Francine Papaiordanou

Abstract

Cryosurgery or cryotherapy is a surgical method that consists of application of very low temperatures to living tissue, resulting in cell destruction. It is considered a versatile treatment option for benign and malignant lesions, with rapid delivery, low cost, and lower morbidity than regular surgery. Cryotherapy may be used to treat a wide range of skin conditions, and in clinical practice, it is most commonly used for treating actinic keratoses, seborrheic keratoses, and verrucae.

Keywords

Cryotherapy • Dermatology • Dermatologic surgery • Benign lesions • Malignant lesions • Actinic keratoses • Seborrheic keratosis

Contents

J. Mesquita Filho (✉) • F. Papaiordanou
Instituto de Dermatologia Professor Rubem David Azulay da Santa Casa, Rio de Janeiro, RJ, Brazil
e-mail: joaquimesquitafilho@hotmail.com; francinepapaiordanou@gmail.com

Introduction

Cryosurgery or cryotherapy is a surgical method that consists of application of very low temperatures to living tissue, resulting in cell destruction (Pasquali et al. 2010). Various methods for freezing skin lesions have been described, such as salt-ice mixture, carbon dioxide snow, nitrous oxide, dimethyl ether, and propane, but liquid nitrogen works faster and achieves much lower temperatures (−196 °C) (Kuflik and Kuflik 2012; Lawrence and Tefler 2010; Vujewich and Goldberg 2008). It is also easy to store and non-flammable (Vujewich and Goldberg 2008).

Cryosurgery is considered a versatile treatment option for benign and malignant lesions, with rapid delivery, low cost, and lower morbidity than regular surgery. It is more acceptable in elderly patients with comorbidities and pregnant women. It also has good aesthetic results, and it can be performed either in surgical areas or doctor's offices (Pasquali et al. 2010). It is useful as a primary

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or an alternate form of treatment (Kuflik and Kuflik 2012).

Cryotherapy may be used to treat a wide range of skin conditions. In the USA, cryosurgery is most commonly used for treating actinic keratoses, seborrheic keratoses, and verrucae (Farhangian et al. 2015; Afsar et al. 2015). In this chapter we will only discuss benign lesions that may cause aesthetic impairment to the patient and premalignant lesions.

Basic Principles

The aim of cryosurgery is to promote freezing of the tissue with subzero temperatures, resulting in tissue damage and subsequent healing by second intention (Pasquali et al. 2010) (Fig. 1). This process leads to cellular structural changes resulting in cell death that occurs due to:

- Cell injury with water crystalizing outside the cell. Initially, water moves out of the cell by osmosis, causing internal dehydration and cell damage. Freezing causes internal crystal formation and further cell disruption. The thawing process leads to larger crystal formation The more freeze-thaw cycles, the longer the thawing time; the coldest the temperature, the greater the cell damage (Pasquali et al. 2010; Kuflik and Kuflik 2012).
- Vasoconstriction, blood stasis, and anoxia. Free radical formation after compensatory vasodilatation contributes to the cell damage (Pasquali et al. 2010; Kuflik and Kuflik 2012; Vujewich and Goldberg 2008).
- Immunologic effect: Release of antigenic components – controversial in the current literature (Pasquali et al. 2010; Lawrence and Tefler 2010).
- pH changes (Kuflik and Kuflik 2012).
- Impairment of homeostatic functions (Kuflik and Kuflik 2012).

The ideal treatment is considered repeated freeze-thaw cycles, rapid freezing, and slow thawing (the thaw time is usually two or three times longer than the freeze time) (Kuflik and Kuflik 2012; Lawrence and Tefler 2010).

Necrosis usually occurs at the center of the area of application, where the temperature should range between −30 °C and −40 °C. There is a rim of partially damaged tissue, and in the peripheral areas, some cells remain alive, but with such injury that triggers later apoptosis. Thermocouples inside the lesion or electrodes around can help to monitor the temperature (Pasquali et al. 2010; Kuflik and Kuflik 2012), but their placement is difficult to standardize (Petres et al. 1996). In practice, the temperature does not need to be measured because clinical studies suggest determined duration of freezing times for the most common skin lesions (Lawrence and Tefler 2010).

The lateral spread of freeze is also important and refers to the freezing of the tissue beyond the margins of the lesion. Benign lesions require usually 2–3 mm, and malignant lesions such as basal or squamous cell carcinomas should reach at least 3–5 mm, or more, if possible (Kuflik and Kuflik 2012).

Melanocytes are the most sensitive to freeze, with cell destruction at −4 °C to −7 °C (depigmentation may occur, especially in more pigmented

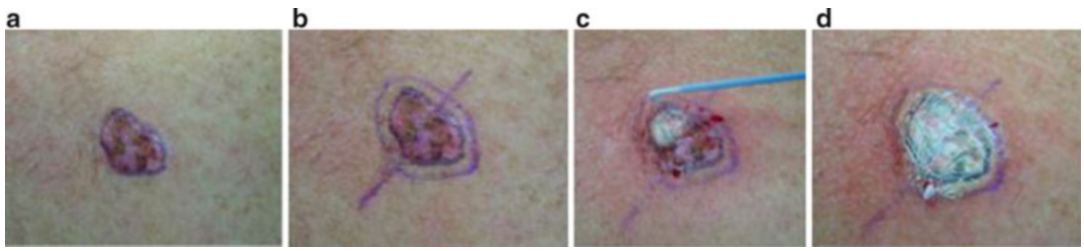

Fig. 1 Basal Cell carcinoma treated by open spray technique. In lager lesions,it is necessary to divide into smaller zones to promote more effective freezing and thawing cycles

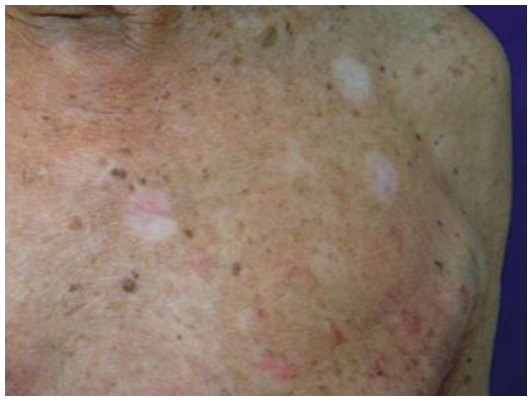

Fig. 2 Hypopigmentation after cryotherapy with liquid nitrogen for actinic keratosis treatment on the trunk

patients). Keratinocyte death requires −20 to −30 °C. Fibroblasts are more resistant to freeze and require temperatures ranging between −30 °C and −35 °C to undergo cell death. Lower temperatures, such as −60 °C, are needed to destroy malignant lesions (Vujewich and Goldberg 2008; Pasqualli 2013). In general, benign conditions require more superficial freezing and, in fact, are better to undertreat a benign lesion than causes an anesthetic hypopigmentation or scar (Fig. 2).

The conductivity of the material interposed between the lesion and the cryogen which determine the final freezing temperatures. Metals are ideal thermal conductors, such as copper (Pasquali et al. 2010).

Thick hyperkeratotic lesions have poor conductivity and should be debridated whenever possible, prior to cryogen application. It is also convenient to debulk nodular lesions or large tumoral masses, to avoid profuse bleeding.

Although there are several hypotheses, the full mechanism of tissue destruction by cryogens remains not completely understood (Petres et al. 1996).

Techniques and Equipment

Over the years, cryosurgical units have evolved from heavy bottles to highly efficient, low-weight, easy-to-use devices. There are storage tanks with 4, 5, 10, 25, 30, 35, and 50 liters of capacity for liquid nitrogen (Pasquali et al. 2010).

There are several techniques to perform cryosurgery. The choice of which should be used depending on the lesion and the operator preference:

- Dipstick technique: The traditional dipping in a cotton-tipped applicator into a cup with liquid nitrogen is generally inadequate, because the freezing is slow and superficial. It is the oldest method (Kuflik and Kuflik 2012). It may be used in small verrucae or similar lesions (Petres et al. 1996).
- Solidified carbon dioxide: A less commonly performed method. A crushed solidified carbon dioxide, contained in a disposable towel, is dipped in acetone and applied lightly onto the lesion, for mild freezing and exfoliation of the skin ("slush therapy") (Kuflik and Kuflik 2012). It can be used for acne vulgaris, acne cysts, rosacea, and flat warts (Kuflik and Kuflik 2012).
- Open spray: The most frequently used. Consists of a handheld cryosurgical unit with a fingertip trigger (Kuflik and Kuflik 2012; Vujewich and Goldberg 2008; Pasqualli 2013). There are different spray tips varying in size. Important factors in determining the amount of cold delivered to the lesion are the tip diameter, intermittent release of the nitrogen, and distance from tip to target (Pasquali et al. 2010). Longer spray times are required for thick and malignant lesions. Shorter times are reserved for benign, thin, and atrophic lesions (Vujewich and Goldberg 2008). Spraying can be delivered in an intermittent or in a continuous manner (Pasqualli 2013). The spray is directed to the lesion from a distance of 1–2 cm (Kuflik and Kuflik 2012). Superficial lesions require a 2–3-mm freeze margin, and malignant and deeper lesions should have a 5-mm margin (Vujewich and Goldberg 2008). The spray devices obtain a temperature of −40 °C to a depth of about 12 mm (Petres et al. 1996).
- Confined spray/closed cone: A variation of the open technique, in which the liquid nitrogen is confined within a cone that is held against the skin. Plastic otoscope cones and specifically designed cones (polycarbonate) can be used.

- Chamber: Another variation of the open technique. The spray is released through an orifice into a metal chamber, firmly held to the lesion. The turbulent movement of the nitrogen inside the chamber lowers the temperature even further. Lower temperatures are achieved faster and require extreme caution. It is usually limited to malignancies (Pasquali et al. 2010).
- Close/cryoprobe/contact: A copper cryoprobe (precooled metal tip) is attached to the cryosurgical unit. The metal probe should be pressed against the lesion on the skin. It is useful for treating small and well-circumscribed lesions or in confined locations (Vujewich and Goldberg 2008).

  The contact freezing achieves −40 °C of temperature but a depth of only about 4 mm (Petres et al. 1996).
- Cryo Tweezers: A variation of the cryoprobe technique, successfully used in pedunculated lesions such as skin tags and warts (Usatine et al. 2015).
- Intralesional: Ideal for voluminous or deep tumors. One or several sterile cannula probes are inserted into one side of the tumor and running it interstitially along the lesion (along the largest axis, at its deepest point) until it appears on the opposite side. Liquid nitrogen is sprayed into the cannula, and an ice cylinder is formed within the center of the lesion. There is minimal surface destruction compared to the previously mentioned techniques (Pasquali et al. 2010).

Preoperative Preparation/Patient Selection

A great advantage for cryosurgery is that it does not require a special surgical area (Pasquali et al. 2010). Therefore it is suitable for patients in wheelchairs or for those who cannot leave their home or nursery. It is a safe technique to patients with underlying medical conditions (heart diseases, bleeding disorders, metabolic diseases).

If there is any suspicion of malignancy, a skin biopsy needs to be performed prior to the cryotherapy procedure. Dermoscopy, ultrasound, radiography, and other imaging tests may be necessary. Once the location, type, and thickness of the lesion are well defined, the surgeon can decide which is the preferable technique to be used. (Pasquali et al. 2010).

Pearls:

- Most lesions do not require previous treatment. In some cases, keratolytic substances, curettage, or debulking may be necessary.
- Irregular surfaces are better treated with the open technique (spray).
- Always work in bloodless areas. Blood increases the local temperature.
- Vascular lesions are better treated with probes, such as hemangiomas and other vascular malformations (see “Laser Treatment of Vascular Lesions”).
- Cartilage and bones are very resistant to freezing.
- Local anesthesia, in most cases, is not required. It may be considered in very anxious patients and children (Pasquali et al. 2010) and in cases of deep freezing (chamber, probe, and intralesional techniques). Topical agents may help and should be applied 30–60 min before the procedure.
- It is very important to inform, verbally and with a consent form, all the expected postoperative course, as possible side effects and probable cosmetic outcome (Pasquali et al. 2010; Pasqualli 2013; Usatine et al. 2015).
- If using probes, be careful not to remove a probe stuck to the surface of the skin. (Pasquali et al. 2010) A small container with warm water may help in case a probe gets stuck to the skin (Pasqualli 2013).
- Fractional cryosurgery may be helpful to avoid deformities and retractile scars in big lesions. It is performed in stages, first in the center of the lesion, reducing its size, and then repeated as necessary until the tumor diameter is smaller than 10 mm, at which the standard procedure is performed (Gonçalves 2009).

Contraindications

- Inexperienced clinicians should avoid this procedure, which can do great harm if used inappropriately (Usatine et al. 2015).
- Despite the lesions, some of them are better dealt with other treatments, such as suspected malignant invasive lesions (melanoma) (Usatine et al. 2015).
- Morpheaform, infiltrative, micronodular, or recurrent basal cell carcinomas are rare, if ever indications for cryosurgery, such as poorly differentiated squamous cell carcinoma. If used, it would only be considered a palliative treatment (Usatine et al. 2015).
- Inappropriate sites: Preauricular and nasolabial folds tend to have high recurrence rates; hair-bearing sites can evolute with permanent hair loss; Fitzpatrick's skin type 4 or 5 patients should be averted about hypopigmentation or hyperpigmentation; lower leg tends to have a bad healing process, especially in patients with poor circulation (Usatine et al. 2015).
- Concurrent diseases that may adversely affect the response to cryotherapy: cold-induced diseases (e.g., cryoglobulinemia, cold urticaria), Raynaud's disease, autoimmune and collagen diseases, platelet deficiency, and pyoderma gangrenosum (Usatine et al. 2015; Zimmerman and Crawford 2012).

Cryotherapy Therapeutic Indications

There are several indications for cryotherapy in the dermatologic field. Above, we list all of them and detail the main and most common in the daily practice.

Benign Lesions (Electrosurgery)

- Acne cysts

  The advent of effective modern medication has decreased the use of cryosurgery to treat inflammatory acne. Some deep nodules may respond to freeze-thaw cycles of 10–20s. Superficial cysts require a single freeze of 5–10s, and the results can be dramatic. There may be temporary crusting. The results can be improved with intralesional triamcinolone (Usatine et al. 2015).
- Acrochordons

  Cryospray with a bent spray tip or a small aperture is a fast and easy method to treat this lesion. Cryo Tweezers is the least painful and efficient technique and especially useful in the eyelids (Usatine et al. 2015).
- Angiofibromas

  Angiofibromas or adenoma sebaceum are cutaneous lesions seen in tuberous sclerosis. Some case reports describe good results with repeated cycles of cryosurgery, but with long freeze times, that may evolute with hypopigmentation. Angiofibromas may be seen as smaller lesions in patients who do not have the syndrome and may respond well to cryospray or contact probe (Usatine et al. 2015).
- Angiomas

  Small vascular lesions such as senile angiomas ("cherry") and spider angiomas may respond to cryosurgery using a cryoprobe, which compresses the lesion during freezing. Ten seconds should be needed. In cases of large angiomas, they may be anesthetized and shaved off, with electrosurgery of the base (Usatine et al. 2015).
- Benign lichenoid keratosis

  Also called lichen planus-like keratosis. Often needs a biopsy to be diagnosed. Once the diagnosis is defined, cryosurgery is an effective treatment option if there is any remaining lesion.
- Chondrodermatitis nodularis helicis

  It is a painful nodule on the pinna, related to mechanic pressure on the ear. It is crucial to be sure that the nodule is not a skin cancer before using a destructive method such as cryotherapy. When clearly benign, it can be frozen with a cryoprobe or spray for 10–20s. Additional treatment includes surgical excision and intralesional steroid injection (Usatine et al. 2015).

- Viral warts/condyloma acuminate

  Cryosurgery remains a standard treatment option to the treatment of viral warts in adults. Young children may not endure the pain (Usatine et al. 2015). The use of local anesthetic cream 1–2 h before therapy may be useful. Human papillomavirus lesions are usually sensitive to cryosurgical procedures and sometimes can be treated in one single session with excellent results (Pasquali et al. 2010).

  As previously mentioned, reduce keratin of verrucae by shaving or using keratolytic substances may improve the results. Wet the area before the freeze cycle to increase cold conductivity.

  In common warts, initially 1–2-mm halo ice should surround the wart and the ice field maintained for 5 s. Filiform warts can be treated with Cryo Tweezers. The maximum results can be achieved with 3 weeks of intervals sessions.

  For the treatment of flat warts, cryosurgery must be carefully considered because there is a high risk of pigmentary changes.
- Dermatofibroma

  Using a freezing method, certainly the nodular component can be flattened, but a pale area may be left behind. Specific studies show that cryospray for at least 30s and a 2 mm border of freeze obtain a good or excellent result (Usatine et al. 2015). Some authors suggest 60s of cycles due to the fibrotic nature of the lesion (Vujewich and Goldberg 2008).
- Digital myxoid cyst

  Cryosurgery is not the gold standard treatment, but if it is chosen, it needs to be aggressive enough to produce fibrosis in the wall of the cyst. Generally it requires two or more freeze-thaw cycles of 30s. Considerable pain and swelling may be present. Draining the viscous fluid before freezing allows a less aggressive 10–20s of cycle (Usatine et al. 2015).
- Granuloma annulare

  The freezing injury may bring a shrinkage or clearing of a plaque, the same as reported with a diagnostic biopsy. When cryosurgery is performed, 5–10-s freeze cycles are recommended to avoid blistering and post-inflammatory hyperpigmentation (Usatine et al. 2015).
- Granuloma faciale

  Cryosurgery has been used as a sole therapy with 10-s freeze cycles, but best results are achieved with following corticosteroid injection.
- Guttate leucoderma

  There is not a gold standard treatment for this lesion. Most of the options have limited improvement rates. Ploysangam et al. reported more than 90.8% success with cryoprobe technique for 10s (Playsangam et al. 1990). Kumarashinghe reported that a 3–5-s cycle is sufficient to achieve repigmentation in idiopathic guttate leucoderma. The exact mechanism of repigmentation is not well defined (Kumarashinghe 2004). It is possible that liquid nitrogen destroys abnormal melanocytes and keratinocytes and permits that surrounding normal melanocytes migrate into the hypopigmented area (Kumarashinghe 2004).
- Hemangiomas

  In newborn babies, a cryoprobe should be firmly applied with a contact interface gel, for 10–20s. Hyperpigmentation and scarring may occur. After the advent of oral and topical beta-blocker for infantile treatment, the use of cryosurgery has fallen out. However, in adults, it remains as a treatment option (Usatine et al. 2015).
- Keloids and hypertrophic scars (see "CO2 laser for scars")

  Cryosurgery is often a good approach but it may fail or need to be repeated several times. There are four approaches for hypertrophic scars and keloids with a cryogen (spray or probe):

  1. Monotherapy: 15-s cycle with 1 mm halo and should be repeated every 4–6 weeks as necessary
  2. Cryosurgery + intralesional corticosteroids: Many studies report a better response rate with this association. Response rate of 86.7%, compared to 70% after cryotherapy alone.
  3. Surgical debulking + contact cryosurgery: Surgical excision, not extending to the

normal skin, followed by a contact cryosurgery of the base of the keloid.

4. Surgical debulking + transfixing cryosurgery: Surgical excision, not extending to the normal skin, followed by transfixing cryosurgery, using a hollow needle, which perforates the base of the keloid, transfixing the lesion. The liquid nitrogen passes through the needle. With this technique the exudate and swelling set up quickly, with less tenderness and less hypopigmentation. It allows shorter intervals between treatments (Usatine et al. 2015).

Recent lesions have an earlier and better response. An Egyptian clinical study showed that a better therapeutic response was achieved after intralesional cryosurgery comparing to contact cryosurgery, with higher flattening rates and fewer side effects (Abdel-Meguid et al. 2015; Weshahy and Abdel 2012). Intralesional therapy also causes minimal damage to the skin surface and less complaints of pain and pruritus (Choudhary et al. 2010; van Leeuwen et al. 2015).

- Lymphangiomas

  Although lymphangiomas may shrink with cryosurgery, the chance of complete resolution is small.

- Molluscum contagiosum

  This is a common viral infection. The number of lesions may vary from one to several hundred and can persist for years (Usatine et al. 2015). Both open and closed techniques can be used (Pasquali et al. 2010). Liquid nitrogen is applied until the lesion becomes white, and the central dimple is highlighted. Point the spray in the center of the lesion, avoiding pendular movements. It is not necessary to freeze beyond the margin of the lesion. If using a probe, it allows the treatment of multiple lesions in a shorter time. There may be temporary swelling, and then shrinkage until the papule falls off.

- Mucocele

  Also called labial mucoid cyst or retention cyst, usually on the lower lip, up to 1 cm. They respond well to cryosurgery but larger lesions should be drained first. Lubricant gel may be applied before the placement of the probe, which is pressed on the lesion for about 10–20s. No lateral spread of ice is necessary (Usatine et al. 2015).

- Pearly penile papules

  Acral angiofibromas often misdiagnosed as warts or sebaceous hyperplasia. Occur after puberty on the corona and sulcus of the glans penis. Cryosurgery is a quick and effective method. Two cycles of 10s with a fine spray are very effective with low morbidity (Usatine et al. 2015).

- Porokeratosis

  No treatment is entirely effective but cryosurgery is often acceptable despite the hypopigmentation. Short freeze of 5–10s with a spray is recommended.

- Pyogenic granulomas

  If there is any doubt, biopsy should be performed. Depending on the size of the lesion, the cycles may range from 15 s to 45 s. Recurrent lesions sometimes require more than one cycle of 20–30s. Higher cure rates are obtained with prior shaving of the lesion, followed by curettage and electrodesiccation.

- Sebaceous hyperplasia

  These lesions not necessarily need treatment, but several therapies are available for aesthetic purpose. If there is any suspicion of BCC, biopsy is mandatory. Cryospray or a tiny probe is placed in the central depression for 5–10s.

- Seborrheic keratosis

  Treatment by cryosurgery is effective, although large and hyperkeratotic lesions are best treated by curettage or shave alone. For lesions with up to few millimeters thick or pedunculated ones, liquid nitrogen can be used. The goal is to produce an ice halo of 2 mm. Treatment times vary widely according to size and thickness but usually range from 10–20s. Curettage after cryospray is also a good option (Pasquali et al. 2010) (Fig. 3).

  Er:YAG laser is also an alternative for the treatment of SKs (Seborrheic Keratosis) in one-step procedure, with better cosmetic results compared to cryotherapy (Gurel and Aral 2015).

  *Dermatosis papulosa nigra is a variant of SK, mainly seen in high Fitzpatrick's phototypes. When treated with cryosurgery, this

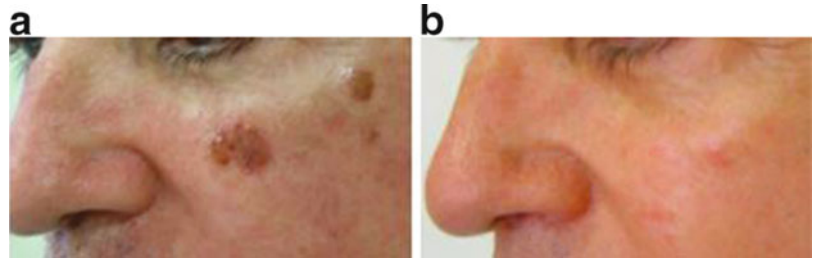

Fig. 3 Seborrheic Keratosis: before (**a**) and after (**b**) 1 session

lesion has a high risk of pigmentary side effects. Light cryosurgery is a better alternative (see "CO2 laser for other indications"; "Fractional Ablative and Non-ablative Lasers for Ethnic Skin").

- Solar lentigo (see "Intense Pulsed Light for Photorejuvenation")

  Most importantly prior to treat any of these lesions, it is to be sure that there are any sign of malignancy (lentigo maligna or lentigo maligna melanoma). If there is any suspicion, a biopsy is the first step.

  For benign lesion, cryosurgery is a quick and effective option. Both spray and cotton-tipped technique is acceptable. The risk of postinflammatory pigment changes exists. Sun protection after the procedure is mandatory. Therefore, a test site in a cosmetically less noticeable region may be performed first before treating multiple lesions. Most of them are superficial, and a single freezing cycle carried out with the spray technique is sufficient to cause a small bulla and sloughing (Vujewich and Goldberg 2008).

  Cryospray can be directed in a zigzag pattern for 1–5 s and should extend 1 mm of the normal skin at the periphery.

  Cryotherapy is considered more effective in achieving substantial skin lightening than TCA but more painful and with longer healing time. Hyperpigmentation is almost equal (Raziee et al. 2008).
- Steatocystoma multiplex

  Although this is not the gold standard treatment, the open spray technique is acceptable as an alternative to surgery. A case report describes a 10-s nitrogen spray cycle with considerable flattening of the cysts after 6 months. (Usatine et al. 2015)
- Syringomas

  Syringomas are purely a cosmetic issue. There are several destructive treatments such as electrodessication, laser, topical TCA, and cryosurgery, all of them with limited success. Cryosurgery may cause swelling around the eyes and hypopigmentation; however, a test may be performed prior to the procedure. Freeze times of 5 s are suggested. Care must be taken to avoid liquid nitrogen in the eye.
- Venous lakes

  Cryoprobe or cryospray may be useful. The advantage of the probe is that it compresses the lake in order to treat the deeper portion of the lesion. Freeze times of 5–15 s with 1–1.5 mm are suggested, according to the size of the lesion.
- Verrucous epidermal naevi

  Hamartomas characterized by epidermal and adnexal structures hyperplasia. Cryosurgery is considered an effective therapeutic modality to treat this condition, with low cost and good cosmetic results.

  Panagiotopoulos et al. described two open spray technique cycles of 10-15 s each, in 12 patients. Ten patients had their naevi successfully treated with no scarring with two to five sessions. One patient showed relapse within 8 months; one patient developed hypochromic scarring (phototype 5), but with repigmentation after 6 months. (Panagiotopoulos et al. 2009).
- Xanthelasma

  Cholesterol-filled yellow plaques usually on the eyelids. They are always benign, and treatment is undertaken for cosmetic reasons.

Cosmetic treatment options include TCA 50–10%, cryosurgery, and surgical excision. Although excision is preferred, cryosurgery may be used but inevitably leads to marked swelling (Simon et al. 2015). When cryotherapy is chosen, the closed probe technique is recommended with 15-s repeated freeze-thaw cycles, depending on the size of the lesion.

Premalignant Lesions

- Actinic keratosis (AK) (see chapter "Photodynamic Therapy" Vol. 1)

  The more affected sites are the back of the hands, forearms, and upper face. There are different morphological varieties: common, pigmented, and cutaneous horn.

  A biopsy should be undertaken in thick lesions with rapid growth, lesions that show any other features of a squamous cell carcinoma (horn, bleeding, pain), pigmented AKs if in melanoma suspicion, and AKs that have failed prior to cryotherapy or other local treatments.

  AKs are most often treated by cryosurgery, with 97% cure rates and 2.1% recurrence in 1 year (Usatine et al. 2015). Freeze times vary from 5s to 10s, with a 1-mm halo, depending on the size and thickness of the lesion. Longer freeze times may evolute with hypopigmentation. (Vujewich and Goldberg 2008; Usatine et al. 2015).

  A European prospective and randomized study compared the efficacy, tolerability, and safety of low-dose 5-FU topical solution (to) cryosurgery in patients with moderate/severe AKs (6 weeks of once daily 5-FU or up to two cryosurgery treatments with 3-week interval). They concluded that 5-FU achieved greater hystological clearance and lower recurrence rates than cryosurgery (Simon et al. 2015).

  Cryopeeling is a modality of treatment that uses diffuse cryotherapy not only in AKs but all over the photodamaged skin. It is an easy-to-perform option, with low cost and reduced healing times, in cases of widespread actinic keratoses. It is highly effective, and the incidence of squamous cell carcinoma is also greatly reduced (Chiarello 2000).
- Actinic cheilitis

  Actinic cheilitis may be treated by cryosurgery using a single 5–10-s freeze-thaw cycle, no margin/halo needed. A second procedure is recommended if the first one was not aggressive enough (3–4-week intervals). If the lesion does not respond to the treatment, a biopsy is needed to avoid SCC.
- Bowen's disease

  Also known as a SCC in situ. There are the common type, the hyperkeratotic type, and the genital type. A biopsy is always recommended to exclude the progression to an invasive malignancy.

  For small and thin lesions, curettage and electrosurgery are appropriate. For small and thicker lesions, excision is the best option. Topical 5-FU 5% and imiquimod 5% cream and PDT can be also considered.

  Cryospray technique can be applied (except in the genital area) with a single 20–30-s freeze cycle with a 2-mm halo including healthy tissue around. Larger lesions can be divided into overlapping circles. Larger lesions may be treated using the spiral or paint-spray technique (20–30s).

  Hyperkeratotic lesions do not respond well to cryosurgery alone and should be debulked priorly.

  For Bowen's disease of the genitalia, a 15–20-s freeze-thaw cycle is recommended and usually has a rapid healing time with good functional and cosmetic results.

  Lesions on the leg, especially in older patients, may have a delayed healing process due to underlying venous stasis, and aggressive cryosurgery may lead to ulceration.

  Recurrence is common if the freeze is not aggressive enough, because the cells migrate back to the surface (recurrence rates range from 5% to 10% if adequate cryosurgery is used).

Postoperative Care and Follow-Up

Postoperative care varies according to the type of the lesion and location and depth of freeze (Kuflik and Kuflik 2012). Patients should be informed about the expected healing time, secondary effects, and complications that may occur, more commonly, erythema, discomfort, or even pain/burning usually (Pasquali et al. 2010).

In superficial freezing, there is no need to cover the lesion; for deep freezing, the wound should be covered with gauze for 48 h, and an antibiotic ointment is optional.[a] In most cases, regular wash with water and soap is sufficient. (Kuflik and Kuflik 2012; Pasqualli 2013) In case of malignancies, there is an extensive exudation process that diminishes as the wound heals. The same procedure of regular washing should be done, but more often (3–4 times/day) in the exudative stage and less often in the granulation phase. A bulla formation is not considered a complication (Kuflik and Kuflik 2012), and it can be drained or not (Pasqualli 2013). Exudation can last a few days to 10–15 days after the procedure. If a crust formation occurs (Fig. 4), the removal can be helpful to speed healing (do not remove crusts of vascular lesions).

In cases of lesions on the legs and ears, and in cases of clinically confirmed secondary bacterial infection (which is rare), some authors recommend oral antibiotic (Kuflik and Kuflik 2012).

An appropriate follow-up after cryosurgery is needed either soon or in long term, to wound check, management of possible side effects, and repeated cycles for same or other lesions if necessary and in cases of recurrent lesions (Usatine et al. 2015).

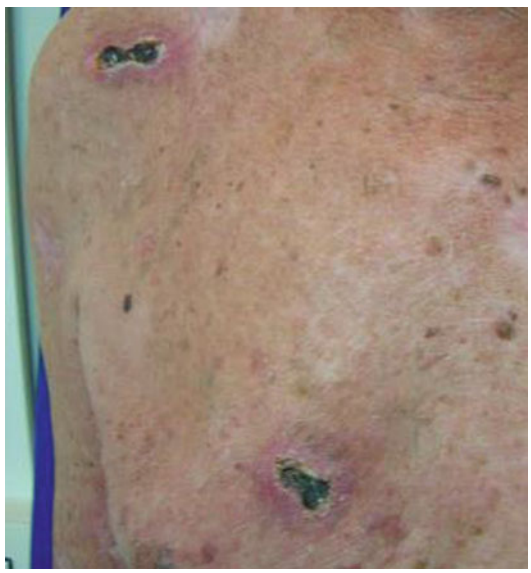

Fig. 4 Crusts formation after cryotherapy with liquid nitrogen for actinic keratosis treatment on the trunk

Side Effects and Complications

The incidence of complications after cryosurgery is low. It is important to distinguish between what is expected and what is occasional/unusual, temporary, and permanent (Table 1). (Pasquali et al. 2010; Kuflik and Kuflik 2012; Lawrence and Tefler 2010; Vujewich and Goldberg 2008; Petres et al. 1996; Pasqualli 2013; Usatine et al. 2015).

Conclusion

Cryosurgery is considered a versatile treatment option for benign and malignant lesions, with rapid delivery, low cost, and lower morbidity than regular surgery. It is more acceptable in elderly patients with comorbidities and pregnant women. It also has good aesthetic results, and it can be performed either in surgical areas or doctor's offices. Cryotherapy may be used to treat a wide range of skin conditions. The aim of cryosurgery is to promote freezing of the tissue with subzero temperatures, resulting in tissue damage and subsequent healing by second intention. There are several techniques to perform cryosurgery. The choice of which should be used depends on the lesion and the operator preference. Inexperienced clinicians should avoid this procedure, which can do great harm if used inappropriately (Usatine et al. 2015).

Table 1 Expected effects and complications table

Expected
Edema/swelling
Pain
Intradermal hemorrhage
Hypopigmentation
Eschar formation
Vesicle/bulla formation
Exudation
Occasional/unusual/temporary
Secondary infection
Burn
Milia
Headache
Syncope
Hemorrhage of the wound site
Delayed healing
Pyogenic granuloma
Permanent
Hypopigmentation
Achromia
Retraction
Notching of the ala of the nose or ear
Alopecia
Nail dystrophy
Atrophic scar
Hypertrophic scar
Neuropathic pain
Tendon damage
Ectropion
Mucocele on the lip
Erosive pustular eruption on the scalp
Trigger for vitiligo

Take Home Messages

1. Cryotherapy is a useful method in the treatment of multiple lesions.
2. It can be combined with other therapies such as peelings and lasers.
3. It can be used as superficial anesthesia in selected procedures.
4. Cryopeeling can be used to treat a wide cancerization field.
5. Good cosmetic and therapeutic outcome for actinic keratoses.

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Electrosurgery for Cosmetic Procedures

Sarita Martins, Emerson Lima, Mariana Lima, and Marcio Martins Lobo Jardim

Abstract

Electrosurgery is a general term used to encompass all methods in which electricity is used during the performance of surgery. Clinical applications of the appropriate output can result in selective incision, excision, ablation, or coagulation of tissue. This chapter provides a detailed explanation of the basic principles of electrosurgery, such as procedure techniques, adverse effects, and its complications, which include burns, risk of explosion, interference with pacemakers, and production of surgical smoke.

Keywords

Electrosurgery • High frequency • Electrosection • Electrical energy current • Coagulation • Cut • Electrodesiccation • Electrofulguration • Granulomas • Syringoma • Xantelasma • Angiomas • Sebaceous hyperplasia • Seborrheic keratoses • Trichoepitheliomas • Basal cell carcinoma • Hidradenitis suppurativa • Benign tumors • Nevus • Milium • Burn

Contents

S. Martins (✉)
Federal University of Pernambuco, Recife, Brazil

Ceder, Pernambuco, Brazil

São Paulo University, São Paulo, SP, Brazil
e-mail: sarita@clinicasaritamartins.com

E. Lima
São Paulo University, São Paulo, Brazil
e-mail: emersonderma@terra.com.br

M. Lima
Miami University, Oxford, OH, USA
e-mail: marianaderma@terra.com.br

M.M.L. Jardim
Department of Dermatology, Iamps/SP, São Paulo, Brazil
e-mail: martinslobojardim@gmail.com

M.C.A. Issa, B. Tamura (eds.), *Chemical and Physical Procedures*, Clinical Approaches and Procedures in Cosmetic Dermatology 2, https://doi.org/10.1007/978-3-319-16805-0_14

Introduction

Electrosurgery is a general term used to encompass all methods in which electricity is used during the performance of surgery (Bezerra and Jardim 2013; Bezerra et al. 2013; Fewkes et al. 1992). It is a procedure by which tissue is removed or destroyed using an electrical energy current. These currents may be generated by a spark gap, radio tube, or transistorized or battery-operated electrosurgical equipment (Popkin 1987).

Dermatologists have used electrosurgery for well over 80 years. However, although well-known to dermatologists, the advantages of this technique are less appreciated by other physicians. These advantages include that it is not time-consuming, is ideally suited to office and clinical dermatology practices, requires few instruments, and patient acceptance is high. When used in properly selected cases, electrosurgery yields acceptable to excellent cosmetic results in both benign and malignant lesions. Over the years, devices for electrosurgical treatment have become increasingly sophisticated (Popkin 1987; Chiarello 2003).

Mechanism of Action

To optimize the use of an electrosurgical device, the clinician should have an understanding of how the equipment functions. The circuitry of all electrosurgical instruments shares certain design features necessary for production of suitable electrical outputs for electrosurgery. First, a standard household current passes through a transformer, which alters the voltage, thus providing the levels and characteristics required for the various circuit functions of the instrument. The current next travels through an oscillating circuit, which increases its frequency. Finally, it is delivered to the treatment electrode (Chiarello 2003). The current may be applied to the patient either mono- or bi-terminally. Bi-terminal electrosurgery employs a large dispersive electrode that both grounds the electrosurgical apparatus and connects the patient to the it using an active treatment needle electrode. Thus, the patient is incorporated into and is an integral part of circuit. In mono-terminal electrosurgery, the patient is not a part of the circuit and there is no ground required for the apparatus. The electrons are shed from the patient to the air, table, and floor (Blankenship 1979).

All electrosurgical units consists of a hand piece connected with an active electrode, a dispersive electrode (ground plate), and a transformer. The radio waves are generated, travel from the electrode tip to the lesion, and return to the unit through the ground plate (Fewkes et al. 1992).

History

Medical practitioners have used heat for tissue destruction for centuries. Hot cautery was used by the Egyptians and Greeks in ancient times to treat tumors and abscesses as well as to stop bleeding (Fewkes et al. 1992). However, the use of electrically generated heat destruction did not occur until the mid-ninth century when electrical physics advanced to a level of practical

application. Claude Paquelin developed the use of electrocautery in 1875; this new modality was similar to the old form of hot cautery (in which a hot tip is brought directly into contact with tissue to transfer heat and burn the tissue without passing any current through it) except that it generated heat electrically (Fewkes et al. 1992; Sebben 1988). However, the real beginnings of modern electrosurgery were the recognition and development of a high-frequency alternating current. In 1891, Jacques Arsene d'Arsonval developed the circuitry required for generation of high-frequency electricity. He found that high-frequency currents above 10,000 cycles per second (10,000 hertz) could pass through the body without pain, muscle contraction, or other obvious harm to the body (Bezerra and Jardim 2013; Bezerra et al. 2013;Fewkes et al. 1992; Chiarello 2003; Matzle et al. 2006; Pollack 2000; Sebben 2000).

In 1893, Oudin designed a resonated circuit with a balance between capacitive resistance and inductive resistance; this allowed a maximum amount of current flow by minimizing the amount of circuit resistance. Oudin used the resonated gap generator to destroy various skin lesions. In 1908, Walter de Keating-Hart noted that high-frequency currents could spark from the electrode to the tissue in long sparks resembling lightning (fulgur). He used these long sparks to destroy skin cancers and therefore developed the modality of electrofulguration. In 1911, William Clark used very high voltage and low amperage for monopolar tissue destruction. A current applied directly to tissue produced marked desiccation in the area of electrical contact. Clark identified the modality as electrodesiccation (Fewkes et al. 1992; Sebben 1988; Matzle et al. 2006; Pollack 2000). In 1908, Doyen is believed to have been the first to develop a method for delivering lower-voltage, higher-current electrical energy to patients by placing a large indifferent or dispersive electrode under them. In 1926, William Bovie, a physicist, collaborated with Harvey Cushing, a neurosurgeon, to develop a high-frequency electrosurgical instrument that allowed a variable amount of "damping" as well as variable voltage and current output. This instrument could coagulate vessels of many sizes with or without cutting tissue and was the direct forerunner of modern electrosurgical devices. The next major event in the development of electrosurgery came in 1923 when Dr. George A. Wyeth a noted that a tumor surgeon used electrosurgery to cut tissues (Matzle et al. 2006; Pollack 2000). In 1932, the Birtcher Corporation introduced its spark gap-based Hyfrecator™, which has become popular for office-based mono-terminal and bi-terminal electrofulguration, electrodesiccation, and electrocoagulation. Currently, there are numerous commercially available electrosurgical devices (Fewkes et al. 1992).

Electrosurgical Modalities

Variation in the voltage, amperage, frequency, and method of application gives each of the electrosurgical modalities its unique qualities. Equally important, however, is the waveform of each current (Bougthon et al. 1987).

There are four different types of waveform in electrosurgery:

- Fully filtered (undamped wave), e.g., cut (electrosection): suitable for cutting a waveform with minimal coagulation.
- Fully rectified (slightly damped wave), e.g., cut and coagulation (electrosection with coagulation): suitable for cutting and coagulating simultaneously.
- Partially rectified (moderately damped wave), e.g., coagulation: suitable for coagulation of bleeding vessels.
- Spark gap wave (markedly damped wave), e.g., fulguration: suitable for fulguration (Chiarello 2003).

Clinical Applications of Electrosurgery (Table 1)

Specific applications for the various electrosurgical modalities are dependent on the surgeon's preference and experience; electrosurgery can be used for incisional techniques that produce full-thickness excision of nevi, shave techniques that

Table 1 Indications

Benign lesions: nevi, sebaceous hyperplasia, rhinophyma, acrochordon (skin tags), angiomas, angiofibroma, dermatofibroma, fibrous papula, keratoacanthoma, seborreheic keratosis, syringoma, venous lake, wart
Premalignant lesions: actinic keratosis
Malignant lesions: basal cell carcinoma (well-defined, small, superficial, primary, low-risk area)
Cosmetic lesions: wrinkles and laxity

produce partial-thickness removal of superficial lesions, and removing vascular lesions such as hemangiomas or pyogenic granulomas (Pollack 1991).

Electrodesiccation

Electrodesiccation is a very common method used mostly by dermatologists, and is the process by which a mono-terminal (one treatment) high-frequency electrosurgical electrode is held in contact with the tissue, resulting in fine sparks that are absorbed by the tissue that cause thermal injury with less carbonization than that produced by electrofulguration (Fewkes et al. 1992; Chiarello 2003; Sebben 1988).

Electrodesiccation is used for very superficial lesions, such as those involving only the epidermis. The treatment electrode contacts the tissue, resulting in dehydration and coagulation. In electrosurgical destruction by electrodesiccation, when using minimal power settings, most of the damage is epidermal and there is minimal risk of scarring. However, at high power settings, there is coagulation of the deeper tissues and potential scarring. Generally, there is a combination of electrodesiccation and electrofulguration because the treatment electrode is not always in complete tissue contact and some degree of arcing occurs.

If the electrode is held at a slight distance from the tissue, a spark is formed between the electrode and the tissue—this technique, termed electrofulguration, achieves only very superficial destruction because the surface carbonization it produces insulates the underlying tissue from electrosurgical damage (Chiarello 2003; Bougthon et al. 1987). It is the method of choice when the most superficial type of tissue destruction is desired, for example, for seborrheic and actinic keratosis, spider angioma, cherry angiomas, angiokeratomas, acrochordons (skin tags), syringomata, plantar warts, condylomata, or small epidermal nevi. Hemostasis of mild capillary bleeding can also be achieved using this type of current. A standard technique for treating keratoses via this method is to move the electrode slowly across the surface of the lesion (for small lesions) or to insert it directly into the lesion (for larger lesions) while applying a current at a low power setting. After a few seconds, the lesion bubbles as the epidermis separates from the underlying dermis. It can then be removed easily with a curette or simply by rubbing a piece of gauze across the treatment site. The clinical endpoint in treating epidermal lesions is punctate bleeding, which is controlled with pressure, spot electrocoagulation, or topical hemostatic agents such as aluminum chloride. More profuse bleeding indicates probable damage to the dermis, with a greater likelihood of subsequent scarring. Extremely small superficial lesions can be treated by electrofulguration, which causes the least amount of damage to adjacent tissues (Chiarello 2003).

Electrocoagulation

Electrocoagulation is the process by which a bi-terminal high-frequency, high-current electrosurgical electrode is placed on or near tissue, resulting in significant electrical current passing through the tissue, thermally coagulating it (Fewkes et al. 1992). It is particularly useful for deep and wider tissue destruction and surgical hemostasis (clamping of a bleeding point or blood vessel). A moderately damped current is applied in a bi-terminal manner (i.e., both concentrative and dispersive electrodes are used). This current is of higher amperage and lower voltage than that utilized for electrodesiccation (Chiarello 2003; Sebben 1988). The electrode is brought into direct contact with the tissue to be treated and is

moved slowly across the lesion, which eventually becomes charred. A curette is then used to remove the charred tissue.

The principal use of electrocoagulation is to obtain hemostasis of larger blood vessels. This method is indicated to treat warts, superficial telangiectases, unwanted hair, pyogenic granulomas, ingrown toenails, syringomas, xantelasma, small hemangiomas, mucous cysts, ruby angiomas, sebaceous hyperplasia, seborrheic keratoses, trichoepitheliomas, and small and uncomplicated primary basal cell carcinomas on specific areas. To treat this last condition, the procedure should be repeated two additional times in an attempt to remove any small tumor extensions. During the last curettage, a small curette is often used to remove the final tiny "roots" of the tumor. Scarring must be expected with this procedure and should be discussed with the patient (Popkin 1987; Chiarello 2003).

The user should be aware that electrocoagulation for surgical hemostasis should be applied in a dry surgical field because if there is a barrier of blood, the electrical current will be conducted through the blood and distributed over a wider area of tissue. The coagulation effect is diminished or prevented through dispersion. High power outputs should be avoided whenever possible because there will be a large mass of coagulated and carbonized tissue, which may slough and cause delayed bleeding. An alternative device for electrocoagulation is the bi-terminal forceps; both "poles" of the bi-terminal forceps are alternating active electrodes. The tissue between the two active electrodes receives very concentrated, high-current flow, and coagulation is through. Another alternative is the use of a clamp or forceps to hold the blood vessel while contact is made with the active electrode. This technique is not very useful for mono-terminal devices because the current is usually too low and too dispersed to generate sufficient heat to coagulate the vessel. However, because of its deep penetrating, destructive ability, electrocoagulation often causes inadvertent damage and necrosis of deeper adjacent tissue, which may affect wound healing and nerve function (Pollack 1991).

Electrofulguration

Electrofulguration is a process by which a mono-terminal high-frequency electrosurgical electrode is held at a distance of 3–4 mm from the tissue surface, resulting in a coarse spark that crosses the gap and causes tissue damage and carbonization.

The difference between electrofulguration and electrodesiccation is largely a matter of electrode position. The advantage of electrofulguration is that there is sufficient power to stop bleeding but less damage to the tissue than with direct contact electrodesiccation. It may also produce less scarring than electrodesiccation. High-amperage electrosurgical generators used primarily for coagulation do not produce sufficient voltage to deliver an electrofulguration current. Some units have a secondary coil added to the circuit to boost the current to a voltage level sufficient to bridge the air gap. Cutaneous lesions treated using this technique usually heal rapidly because there is very little thermal damage. The arc only needs to span a very small distance. A common error in the application of fulguration is to turn the electrosurgical machine to a very high setting so that a large visible spark arcs across a great distance. The large amount of current applied can produce excessive tissue damage, charring, and carbonization. Electrofulguration offers no advantage at high-power settings. The principal indications for using this current are solar melanose, actinic keratoses, seborrheic keratoses, and peelings (Pollack 1991).

Electrosection (Cutting)

Electrosection is a process by which a bi-terminal high-frequency, high-current electrosurgical electrode is physically passed through tissue, cutting as it goes; it is used to incise, divide, or separate tissue (Fewkes et al. 1992). Electrosection involves the bi-terminal application of a slightly damped current. The low voltage and high amperage current causes minimal lateral heat spread and tissue damage and has the additional advantage of simultaneously achieving hemostasis and cutting. "Pure" cutting can be obtained using a true

undamped tube current, which provides the least amount of lateral heat spread and causes vaporization of tissue without hemostasis (Chiarello 2003). Electrosection can be used to perform rapid and effortless electrosurgical excisions or incisions without bleeding (Chiarello 2003; Sebben 1988, 1998)—virtually no manual pressure is required by the operator. Maximum power density can be achieved with a minimal amount of current; the power density value increases as the radius of the curvature on the electrode decreases. Electrosection can be performed with a variety of electrodes, the most common of which are thin wire loops. Blade-shaped electrodes are also available but tend to produce excessive thermal injury because of the greater power required and the larger surface area of the flat electrode that is in contact with the tissue as it cuts. A wire loop electrode also produces greater thermal injury than a straight-line wire electrode because of the increased electrical power required to produce the cutting power density (Fewkes et al. 1992; Sebben1998; Sebben and Davis 1988). The difference between electrosection and scalp excision is immediately apparent to the first-time user of electrosection. At the appropriate power setting, the electrode passes smoothly through the tissue like a "hot knife through butter." However, the tissue should be hydrated continuously with wet gauze. If perceptible sparking occurs during incision, the power setting is too high; if the electrode "drags," the power setting is too low (Chiarello 2003).

The major advantage of electrosection over scalpel surgery is that hemostasis is achieved immediately as the incision is made. However, large blood vessels (>1 mm in diameter) require additional spot electrocoagulation (Chiarello 2003) and there can be greater tissue damage and slower healing with cutting current procedures. Wounds that have been created with a cutting current can often be closed primarily, but the wound takes longer to achieve satisfactory tensile strength. Excessive energy levels or a very slow cutting speed can produce overcoagulation, a wider band of tissue damage, and poorer wound healing. Cutting should be at a steady, brisk speed. The optimum speed will cause clean separation with little or no charring—charring produces better hemostasis but causes a larger zone of thermal damage. The motion should be kept at a rate that incises the tissue adequately without a cooked or charred appearance; an optimal cutting rate of electrode movement is 5–10 mm per second (Fewkes et al. 1992; Sebben 1988, 1998). Because a small amount of charred tissue may adhere to the cutting electrode, thereby interfering with the cutting or coagulating action, the electrode should be cleaned regularly during the procedure. If char buildup seems excessive, the power may be too high or the cutting speed too slow (Fewkes et al. 1992).

Electrosurgery is extremely useful for achieving relatively bloodless excision on the head and of large bulky lesions, for incisional and shave techniques, to treat rhinophyma, hidradenitis suppurativa, and some nevus, for the excision of benign and malignant cutaneous tumors, and for skin biopsy, blepharoplasty, scalp reduction, scalp flaps, scalp lifting, and all surgical defects when allowed to heal by secondary intention (Fewkes et al. 1992; Popkin 1987; Chiarello 2003; Sebben 1988, 1998; Weber et al. 2000).

Direct-Current Surgical Galvanism

Few dermatologists have the equipment available to produce a direct galvanic current as galvanic surgery has very few useful applications in everyday practice. Its most common use is in electrolysis, a process by which low-flow direct-current electricity is passed through tissue between two electrodes, resulting in tissue damage via a chemical reaction that occurs at the tip of one of the electrodes (Fewkes et al. 1992; Sebben 1988; Sampaio and Piazza 2009). Electrolysis is commonly used to destroy hair follicles (epilation or permanent hair removal). This method is quite effective and associated with little pain and low risk of scarring, but it is a time-consuming procedure and with the laser devices available now the indication for its use is restricted to only when we want to ablate an occasional hair follicle (Shaw et al. 1988).

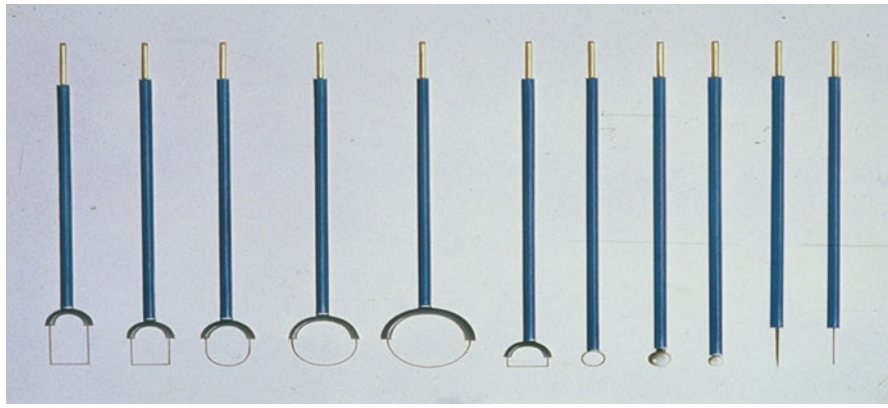

Fig. 1 Types of electrodes

Electrocautery

Electrocautery uses a heat-producing electrode without the transfer of an electrical current. However, this is an old technique that is no longer in use (Sampaio and Piazza 2009). Electrodesiccation can produce essentially the same results but electrocautery can cause greater tissue damage and slower healing. High-frequency equipment has largely replaced cautery (Blankenship 1979;Sebben 1988).

Electrodes (Fig. 1)

There are different types, shapes, and sizes of electrode on the market, and they are available in a sterile or non-sterile form. The choice of electrode depends on the wave form and diagnosis of the lesion. The response by the tissue varies greatly depending on the type of electrode used. The larger the electrode, the more lateral heat produced and the higher the power setting necessary to operate it. The smaller the electrode, the less lateral heat produced and the lower the power setting necessary to operate it (Sebben 1988; Taheri et al. 2013).

Types of Electrode
Fine needle electrode
Wire loop electrode of different sizes
Ball electrode
Desiccation-fulguration needle electrode
Wire electrode
Scalpel blade electrode
Diamond loop electrode
Ellipse electrode
Triangle electrode
Epilating needle
Bipolar forceps
Matricectomy electrode.

Electrodes may be rigid or bendable. An electrode becomes less efficient as charred tissue deposits on its surface. As this occurs, the delivery of the electrosurgical current becomes less precise and higher power settings are required. Therefore, it is important to keep electrode tips clean during the course of electrosurgical procedures.

Factors Causing Less Collateral Heat Damage
Smaller electrode diameter
Shorter contact time between the electrode and lesion
Lower intensity of power
Higher frequency of current
Cutting waveform.

Electrosurgical Procedures

There are many electrosurgical devices available, and each provides a variety of waveforms—any of these machines can be used. We use the

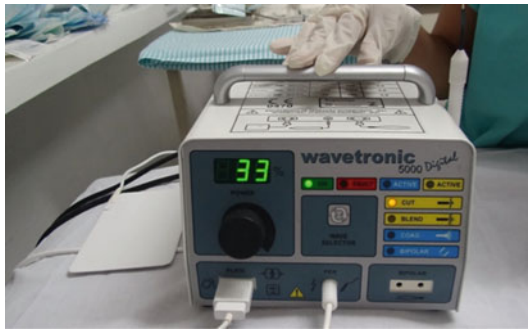

Fig. 2 Radio-frequency device made in Brazil (Wavetronic 5000 Digital; Loktal Medical Electronics)

Wavetronic 5000 Digital (Fig. 2) radio-frequency device (Loktal Medical Electronics, Brazil).

Because electrosurgical procedures are mostly painful, they require the use of anesthesia to make it a painless procedure. This anesthesia could be topical (2.5% lidocaine +2.5% prilocaine cream), anesthetic, local infiltrative, or troncular anesthesia (2% lidocaine with or without epinephrine). However, we do not recommend topical anesthesia because the patient should be very comfortable and quiet during the procedure. Before the anesthesia, the lesion and the surrounding skin should be cleansed with povidone-iodine or chlorhexidine solution (never alcohol due to the potential ignition effect). Electrosurgery should be performed with the patient in a comfortable seated or lying position on an operating table, with the lesion exposed and illuminated (Weber et al. 2000). The electrode should be kept clean and free of eschar.

Standard post-operative wound management, incorporating semi-occlusive dressings, needs to be followed. Patients should be warned of the possibility of delayed bleeding and should be reassured that it can be controlled by 10–30 min of constant direct pressure over the wound. They should also be told that scarring may occur, but that it is usually minimal. Cosmetic results are usually excellent (Fewkes et al. 1992).

Recently, Loktal Medical Electronics developed the HF Megapulse Fraxx® (Fig. 3), a new technology that controls the thermal effects of radiofrequency through a sophisticated electronic fractionate energy system, used with the

Fig. 3 The HF Megapulse Fraxx® (Wavetronic 5000 Digital) is a new technology that controls the thermal effects of radiofrequency through a sophisticated electronic fractionate energy system

Wavetronic 5000 Digital, which allows the same refinement and precision obtained by traditional fractional CO_2 lasers. Distributed control ensures that all micro points are not energized simultaneously, work in a predefined random sequence, and shoot sequentially through 8 mm needle columns. The two adjacent columns do not shoot in sequence, avoiding an additive thermal side effect: the device allows the selection of active power time (active) and rest time (delay) between columns. With 60% power, an active time (active) of 60 ms, a rest time (delay) of 60 ms, and a cut wave, we achieved very similar ablations to that of fractional CO_2 lasers with minimal thermal side effects and no concentrated ablative effect in the upper reticular dermis corresponding to "background" ablation (Casabona et al. 2014).

Application Technique: To prepare high phototype skin, we should use pigmentation inhibitors

and sun filters. In case of a history facial herpes simplex we use preventive of famciclovir 125 mg, every 12 hour during 5 days prior to procedure. The most important consideration is related to analgesia because thermal ablation methods cause pain in some patients and this should be mitigated to the patient's comfort level. The use of oral analgesics may be useful, e.g. ketorolac trometamol 10 mg sublingual 10 min before application or local measures such as cold compresses, cold plates, etc., infiltration of lidocaine 2% with epinephrine, or an infiltrated expander solution of 30 ml saline solution (SF) + 10 ml 2% lidocaine + 0.4 ml epinephrine + 1 ml 8.4% sodium bicarbonate (optional).

Another key aspect is the maintenance of the humidity of the area via application of SF, while avoiding excessive humidity, the purpose of which is to increase conductivity and obtain uni form and deep penetrations.

To avoid intact skin spaces between pulses, i.e., to "join" the pulses, the subsequent shot should "enter" a few millimeters to the side of the pen edge in the previous pulse." The depth of thermal effect depends mainly on the active time of the current. The density of the shots (number of passes) substantially determines the influence on the thermal effect.

Attention: micro-ulcerations may appear in some areas of thinner skin (eyelids) if the device head passes more than three times.

Post-operatively, if a rash and not very pronounced swelling that lasts on average 3 days is noticed, saline solution cold compresses, thermal water, or skin barrier-repairing unguents can be used, among other things.

The relatively common habit of self-excoriation or post-operative manipulation can prolong recovery and surface sequelae (guidance should be given to the patient). In terms of complications, post-inflammatory hyperchromia are relatively frequent in high prototypes and are mainly temporary. HF Megapulse Fraxx® has been used to treat stretch marks and for acne scar revision, skin resurfacing, and non-ablative tightening of the skin to improve laxity and reduce wrinkles (Casabona et al. 2014).

Casabona et al. 2014 demonstrated the thermal effect of fractional ablative radiofrequency in 20 women with lower eyelid sagging. The procedure was performed under infiltrative local anesthesia, one session three times. Before the skin was humidified with sterile saline solution, the device used was the Wavetronic 5000 coupled to the HF Megapulse Fraxx®. This is an electronic circuit provided with fractional power connected to a pen with 64 microneedles of 0.2 mm thickness and 0.8 mm divided into eight columns of eight needles each. The device parameters used were 60% power and cut option. The pen contacted the skin perpendicularly with a 2 mm overlap. The megapulse system allows measurement of the time that the skin is exposed to the heat of eight needles each in milliseconds, which in this case is named sequence 2; this is carried out by selecting the P key followed by the E key on the device. The energy delivered is randomized in columns in a predetermined sequence to allow cooling between shots and as a result cause less thermal damage (Casabona et al. 2014).

Lima recently developed 2 and 8 tungstem needle electrodes with a diameter of 200 thousandths of a millimeter, weight and identical length arranged parallel in order to reach the same depth plane with a length of 1.5 mm. These needles act beyond the epidermis and dermis, stimulating contraction and collagen renewal. This technique has been used for the treatment of various dermatological conditions, including wrinkles, enlarged pores, and also atrophic and hypertrophic scars, skin tightening, skin rejuvenation, stretch marks, chloasma, or other pigmentation (Lima and Martins 2010).

Clinical Applications

These settings may vary depending on tissue resistance, electrode size, tissue moisture, and the electronic unit used. It should be remembered that an insufficient current will produce tissue adherence and will decrease the efficiency of the procedure.

Xantelasma (Fig. 4)

Current selector: blend
Power setting: 35
Electrode: cut tip needle
Technique: multiple punctures until the yellow tissue is destroyed + curettage

Milium (Fig. 5)

Current selector: blend
Power setting: 30
Electrode: cut tip needle
Technique: one puncture

Hidrocystoma (Fig. 6)

Current selector: blend
Power setting: 30
Electrode: cut tip needle
Technique: multiple punctures

Seborrheic keratosis (Fig. 7)

Current selector: coagulation
Power setting: 50
Electrode: ball tip
Technique: lightly touch the lesion and gaze curettage

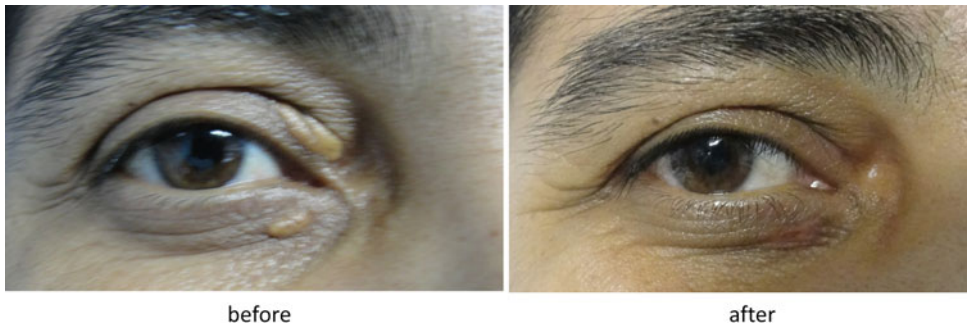

Fig. 4 Xantelasma (parameters: current selector—blend; power setting—35; electrode—cut tip needle; technique—multiple punctures until the yellow tissue is destroyed + curettage)

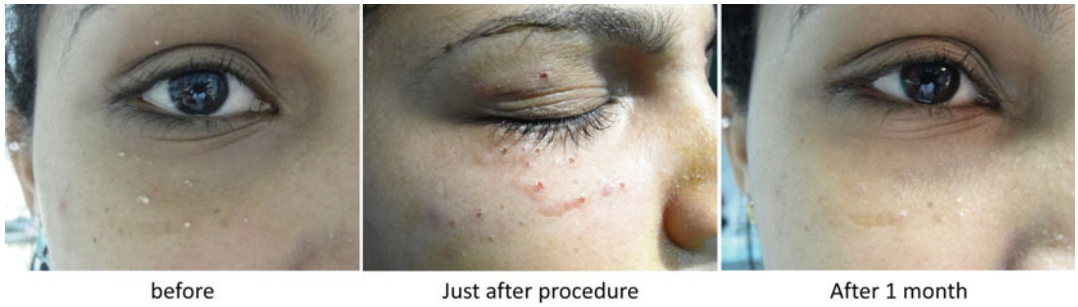

Fig. 5 Milium (parameters: current selector—blend; power setting—30; electrode—cut tip needle; technique—one puncture)

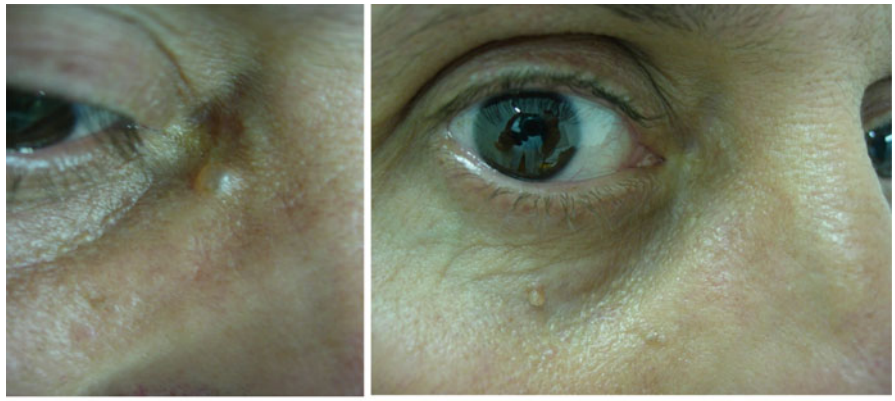

Fig. 6 Hidrocystoma (parameters: current selector—blend; power setting—30; electrode—cut tip needle; technique—multiple punctures)

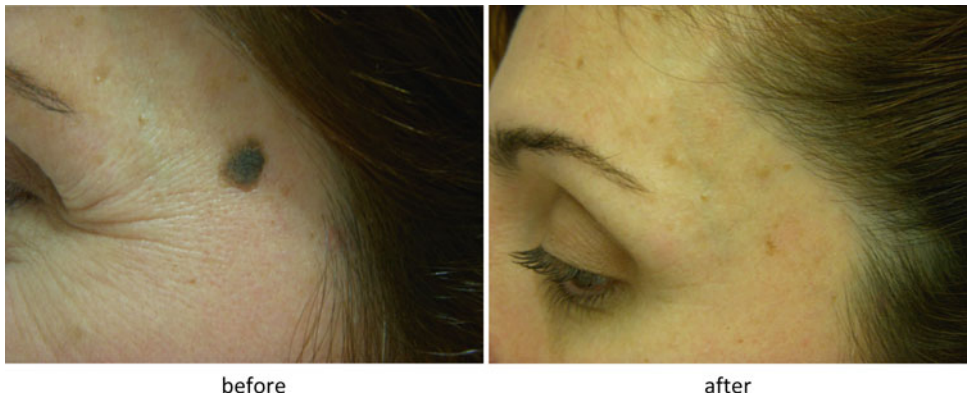

Fig. 7 Seborrheic keratosis (parameters: current selector—coagulation; power setting—50; electrode—ball tip needle; technique—light touch and gaze curettage)

Pyogenic granuloma (Fig. 8)

Current selector: coagulation
Power setting: 60
Electrode: ball tip
Technique: forcefully contact the lesion

Skin tag (Fig. 9)

Current selector: blend
Power setting: 35
Electrode: needle tip
Technique: cut the pedicle

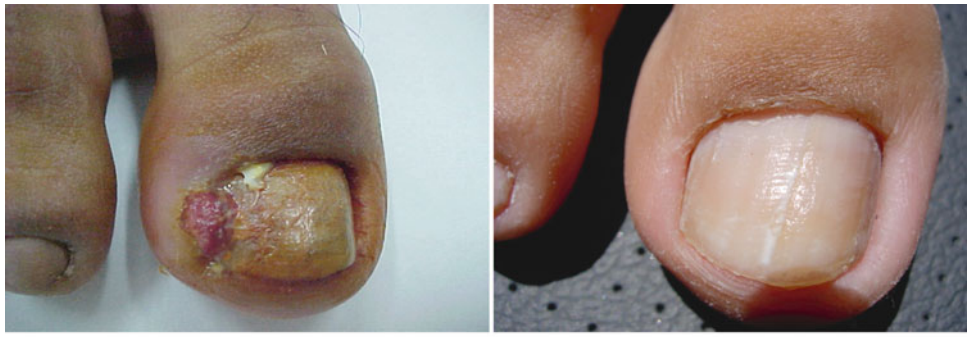

Fig. 8 Piogneic granuloma (parameters: current selector—coagulation; power setting—60; electrode—ball tip needle; technique—vigorous touch)

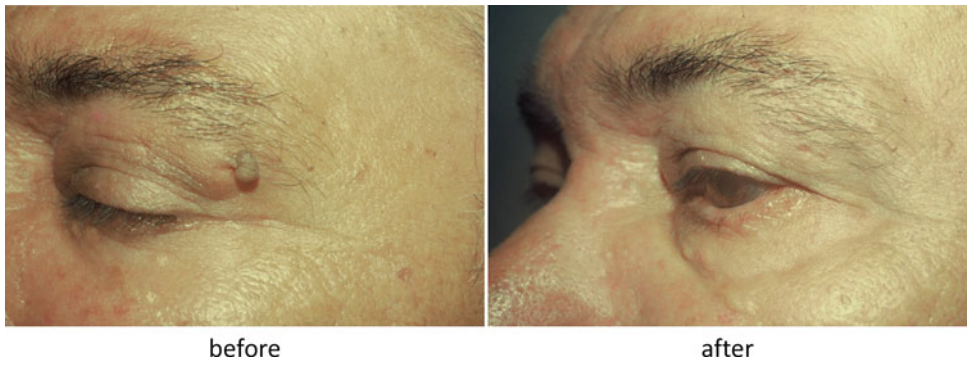

Fig. 9 Skin tags or acrochordons (parameters: current selector—blend; power setting—35; electrode—cut tip needle; technique—cut the pedicle)

Rhinophyma (Fig. 10)

Current selector: blend
Capacity: 35
Electrode: wire loop tip
Technique: shaving

Verrucous nevus

Current selector: blend
Power setting: 30
Electrode: wire loop
Technique: shaving

Syringoma

Current selector: blend
Power setting: 30
Electrode: cut tip needle
Technique: multiple punctures

Acne Scars, Wrinkles, and Laxity (Fig. 11)

Current selector: cut
HF Megapulse Fraxx sequence: 2
Active, 60 ms; delay, 60 ms
Power setting: 60

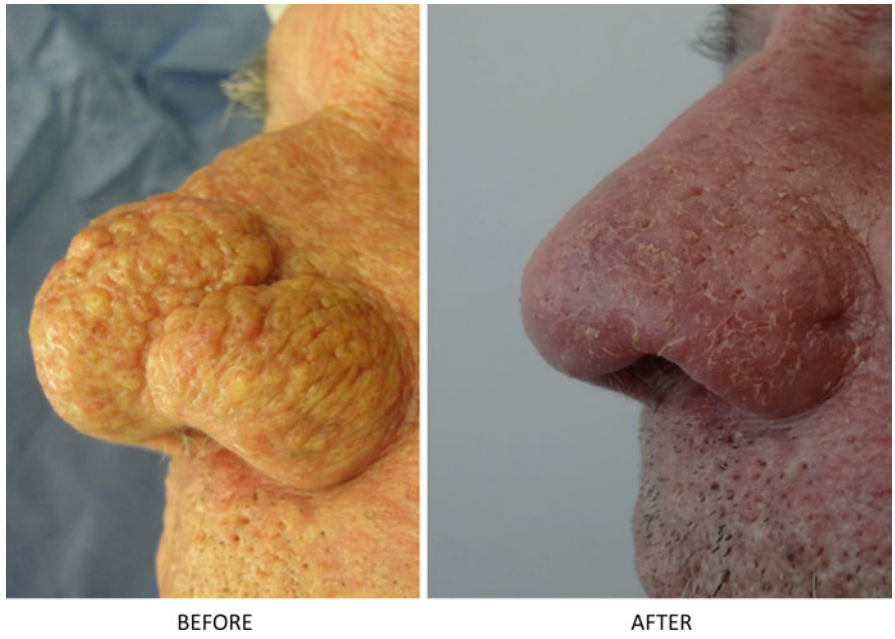

Fig. 10 Rhinophima (parameters: current selector—blend; power setting—35; electrode—wire loop tip; technique—shaving)

Fig. 11 Wrinkles (parameters: current selector—cut; HF Megapulse Fraxx sequence—2; active 60 ms, delay 60 ms; power setting—60; electrode—HF Megapulse Fraxx tip; technique—two re-passes)

Electrode: HF Megapulse Fraxx tip
Technique: two re-passes

Risks

There are few risks to the patient from properly applied electrosurgery. However, potential hazards should be understood so they can be minimized as more emphasis is currently being placed on the potential risks to the surgeon and operating room personnel.

Burns

Burns may result from inadvertent contact between the electrode and the skin of the patient or surgeon, but the most common burn injury in electrosurgery occurs when there is inadequate contact between the patient and the dispersive

electrode plate. Occasionally, the patient or surgeon may inadvertently touch a grounding element such as the metal on the treatment table, resulting in a burn or shock (Fewkes et al. 1992; Sebben 1988; Hainer 2002; Pollack 2011).

Channeling

So-called channeling is rarely a problem at the lower power setting used in most office-based cutaneous surgical practices. Channeling is always avoided by using bipolar forceps or electrosurgery devices (Fewkes et al. 1992; Pollack 2011).

Fire Hazard

It is important to be aware of the presence of flammable or explosive liquids or gases. There is a risk of fire or explosion if electrosurgical procedures are conducted in the presence of alcohol, oxygen, or bowel gases (methane). Special attention is necessary in the scalp, where residual alcohol may remain unnoticed, and care should be taken in the perianal region. For this reason, non-flammable antiseptic solutions such as povidone-iodine or chlorhexidine should be used.

Plume

The smoke from electrosurgery has been shown to have mutagenic potential, much like the smoke from cigarettes. However, of potentially greater concern is the possible presence of infectious particles on the electrode or in the plume or splatter caused during electrosurgery. Infective hepatitis B virus has been demonstrated to be present on electrode tips after electrodesiccation. This strongly argues against the use of the same unsterilized electrode on consecutive patients. Electrodesiccation has been shown to produce a fine aerosol and splatter of blood droplets for at least several centimeters around the electrodesiccated site. If inhaled, this aerosol may be infectious. Herpes virus particles have shown to be dispersed by these devices. Transfer of bacteria during electrodesiccation has also been demonstrated in a laboratory setting. The presence of human papillomavirus (HPV) particles from carbon dioxide lasers and electrosurgery has also been investigated and found in the plumes of both procedures. A graver implication of these HPV studies is that other viruses such as human immunodeficiency virus (HIV) and the hepatitis viruses may also remain intact in the plume and be inhaled by the surgeon or operating room personnel. No laboratory or clinical evidence for this exists as yet, and additional studies are needed; however, the use of a smoke evacuator from the operative site and a special face mask being worn by the surgeon are indicated (Fewkes et al. 1992; Chiarello 2003; Sebben 1988; Sampaio and Piazza 2009; Pollack 2011).

Cardiac Pacemaker

Most modern pacemakers operate in a demand mode, requiring sensing and output circuits. Any of these circuits may be interfered with by a high-frequency electrical current, which may have adverse effects on pacemaker function. Despite the fact that most modern pacemakers are normally well-shielded and filtered to avoid interference from outside electrical currents, high-frequency electrosurgery should be avoided in patients with pacemakers (Fewkes et al. 1992; Sebben 1988, 1998; Pollack 2011). However, although sporadic reports have identified device malfunction following electrosurgery, the incidence appears to be extremely low, especially with newer-generation pacemakers and implantable cardiac defibrillators.

Thus, electrosurgery should not be used by anyone who uses a pacemaker without consulting the physician to ensure that the pacemaker is protected and not affected by high-frequency interference. The surgeon should use appropriate precautions, which include proper grounding and avoidance of high-amperage outputs, particularly with current-cutting procedures. Bipolar forceps with short bursts and low voltage should be used,

and electrosurgery should be avoided within the vicinity of the pacemaker or implantable cardiac defibrillators (Hainer 2002). However, limited electrodesiccation of small lesions probably poses no risk to the relatively healthy pacemaker patient. Electrocautery is an acceptable substitute, since no electrical current passes into the patient.

Sterilization

Electrodes should be sterilized by autoclave to prevent cross-contamination as it has been shown that viral and bacterial infection can be transferred on such electrodes (Matzle et al. 2006; Pollack 2000; Sampaio and Piazza 2009; Hainer2002; Bennett and Kraffert 1990). If a non-sterile electrode tip is used, the potential for cross-contamination and subsequent infection would exist either from patient to patient or from patient to physician (Bennett and Kraffert 1990). Disposable electrodes can be used or adapters are available that allowed disposable metal hypodermic needles to be used as electrodes. Another significant contamination potential in the office setting results from the handling of electrosurgical pencils and cords. Although the electrode may be changed, the handle may be subject to contamination. A disposable plastic sheath cover that envelops the electrosurgical handpiece should be used (Bennett and Kraffert 1990).

Advantages:

Simple procedure
Rapid healing
Minimal or no bleeding
Aesthetically pleasing scars
Shorter operating time
Histopathology examination of surgical specimens
Fewer surgical risks and complications
Inexpensive
Can be completed as an outpatient.

Disadvantages:

Leads to greater tissue damage
Creates necrotic tissue within a wound
Delays wound healing
Cannot be used near anyone with an unshielded pacemaker
Smoke and an unpleasant odor may be produced.

Post-Procedure Course

After the procedure, the patient is advised to keep the wound clean and dry. The healing process takes at least several weeks or longer, depending on the size of the wound and other factors. It should be noted that necrotic tissue under the post-operative crust can appear to be pus and infection to the inexperienced electrosurgeon. Large, loose soggy crusts are best removed, but dry adherent crusts should be left undisturbed. Dryness of the post-operative site is desirable for healing and the site is covered only for protection or cosmetic reasons. The wounds may be cleansed daily and then covered with an antibiotic ointment that provides a moist environment for new tissue growth. The wound may then be covered with common adhesive bandages (Pollack 1991).

Adverse Effects

The greatest hazard of electrosurgery is associated with treatment technique and involves excessive destruction of tissue. As a result, slow healing and tissue necrosis can lead to an unsightly or hypertrophic scar. The surgeon must take special care to avoid electrosurgical damage to adjacent areas. Coagulation can cause extreme damage to larger nerves and blood vessels, and at times can lead to delayed hemorrhage from unsuspected injury to blood vessel walls. Delayed post-operative bleeding with the sloughing of the crust can occur, and the patient should be instructed beforehand in applying direct pressure to control any bleeding (Blankenship 1979).

Complications

Complications include occasional hypopigmentation, atrophy of the treated site, hypertrophic scarring (especially on the back and chest), and ectropion (e.g., following eyelid electrosurgery). Excessive application of electrodesiccation or electrocoagulation currents can produce tissue destruction extending far beyond the actual treatment site (Sebben 1988;Sebben and Davis 1988).

Destruction of deep lesions may lead to contracture of the upper lip and nasal ala, depression of the nose tip, and notching of the rim of the ear (Blankenship 1979). When working near the eyes, special shields should be used to protect the corneas (Sebben and Davis 1988).

Take Home Messages

- Always plan the procedure before starting it.
- Infiltrative anesthesia should be preferred over topical anesthesia.
- Always humidify the lesion before the procedure.
- Activate the electrodes before contacting the skin.
- An insufficient current will produce tissue adherence.
- Remove debris from the electrode.
- Wait for tissue cooling.
- A mask should always be used by the doctor and surgical personnel.

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