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Reginald Low · Khung Keong Yeo *Editors*

Clinical Cases in Coronary Rotational Atherectomy

Complex Cases and Complications

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Clinical cases are a key component in modern medical education, assisting the trainee or recertifying clinician to work through unusual cases using best practice techniques. Interventional cardiology is an important discipline in this regard since it is a highly visual subject requiring the reader to describe often very subtle differences in the presentation of patients and define accurately the diagnostic and management criteria to base their clinical decision-making on.

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Preface

We believe that rotational atherectomy is an essential tool in the treatment of complex coronary artery disease. With the advent of second-generation drug-eluting stents, coronary artery disease is ever more amenable to percutaneous coronary intervention. However, severe calcification, seen commonly in elderly patients, especially those with diabetes mellitus and renal failure remains a major challenge to a successful and safe procedure. Our changing population demographics also mean that, increasingly, cardiologists have to treat these complex patients and their difficult coronary lesions.

Rotational atherectomy has been around for more than 25 years. Despite new technology such as cutting balloons, scoring balloons, and laser atherectomy, it remains a mainstay for the treatment of severe calcific disease. However, not every operator or every laboratory has this tool – for it is technically demanding, has significant risks, and requires substantial experience for both the interventional cardiologist and the supporting team in the cardiac catheterization laboratory. In this book, we have collected a series of basic and complex cases showcasing the range and spectrum of rotational atherectomy. Some of the cases show beautiful results, and a few highlight complications no one wants to have. They all share in having tremendous educational value. We believe that cases in this book will help current and potential users of this device in achieving the best results for their patients. We have enjoyed compiling these cases and believe you, the reader, will enjoy and learn from the experiences shared by these expert operators.

Sacramento, USA Reginald Low
Singapore Khung Keong Yeo

Contents

Abbreviations

ACS	Acute coronary syndrome
BMS	Bare-metal stent
CABG	Coronary artery bypass graft surgery
CHF	Congestive heart failure
CKD	Chronic kidney disease
CTO	Chronic total occlusion
DEB	Drug-eluting balloon
DES	Drug-eluting stent
DM	Diabetes mellitus
IABP	Intra-aortic balloon pump
IVUS	Intravascular ultrasound
LAD	Left anterior descending artery
LCX	Left circumflex artery
LIMA	Left internal mammary artery
LM	Left main artery
LPDA	Left posterior descending artery
LVEF	Left ventricular ejection fraction
MI	Myocardial infarction
NSTEMI	Non-ST-elevation myocardial infarction
OCT	Optical coherence tomography
OM	Obtuse marginal
PCI	Percutaneous coronary intervention
POBA	Plain old balloon angioplasty
RCA	Right coronary artery
RPDA	Right posterior descending artery
RPM	Revolutions per minute
STEMI	ST-elevation myocardial infarction
SVG	Saphenous vein graft

Chapter 1
Overview of Equipment and Procedure

Jonathan Yap, Khung Keong Yeo, Tina Teo, and Reginald Low

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Equipment

RotaWire Guidewire and WireClip Torquer

The RotaWire is very different from a standard coronary guidewire. Its construction prevents unravelling by the rotation of the burr. It is a 325 cm stainless steel, short spring-tipped guidewire. The shaft of the RotaWire is 0.009″. It tapers mainly in the last 13 cm proximal. The spring tip is 0.014″ in diameter and 2.2 cm in length and can be shaped (Fig. 1.1). There is also an extra-support RotaWire with a slightly longer tip (2.8 cm) and stiffer shaft (Fig. 1.2). The thicker wire tip also prevents the burr from going past the shaft of the wire. This is important in helping prevent inadvertent coronary artery perforations. The wire is very easy

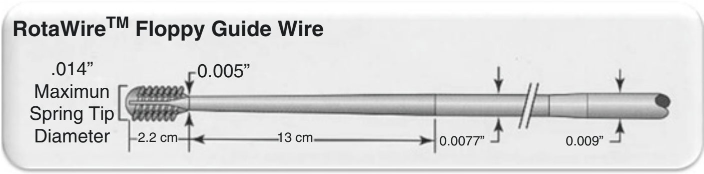

Figure 1.1 RotaWire floppy (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

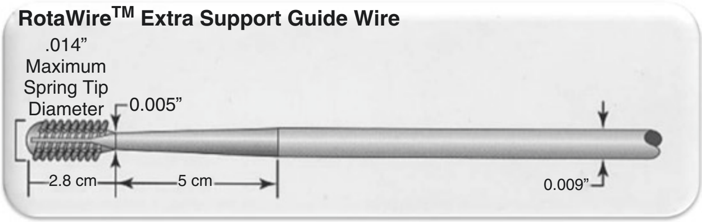

Figure 1.2 RotaWire stiff (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

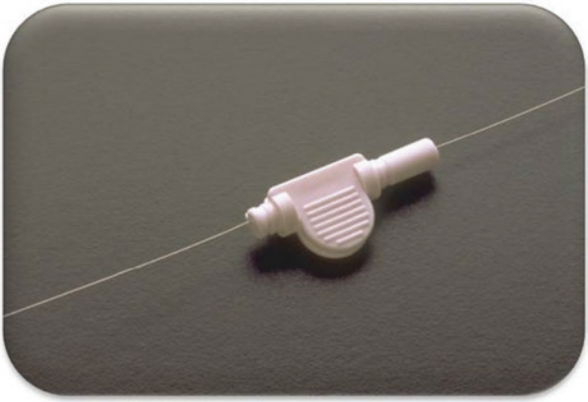

FIGURE 1.3 WireClip torquer (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

to kink. During advancement or removal or exchange of the burr, it is critical not to kink the wire. Kinking of the wire will result in difficulty removing or advancing the burr and can result in loss of wire position.

The WireClip torquer has two clips that allow the torquer to open longitudinally, following which the wire is mounted and gripped from the side (Fig. 1.3). It allows some torquing of the wire and helps prevent spinning of the guidewire when the brake is released. It can also be positioned in the docking port of the advancer in order to release the brake allowing a smooth pullback of the burr (Fig. 1.4).

Rotaburr

The burr is elliptical shaped and nickel coated. The proximal surface is smooth, while the distal edge is coated with 2,000–3,000 microscopic diamond crystals. The diamond crystals are 20 microns, with 5 microns exposed on the surface. The diamond coating is present only in the front half of the elliptical burr and absent at the back (Fig. 1.5). Therefore, the

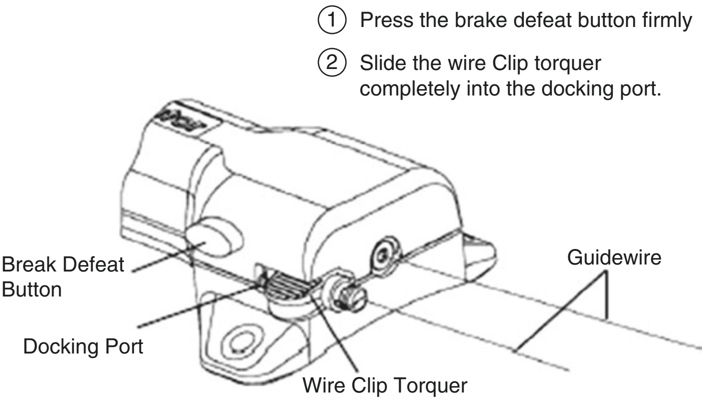

FIGURE 1.4 WireClip torquer docking port (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

FIGURE 1.5 Rotaburr (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

ablation can only occur during antegrade movement. It also means that when a burr is trapped distal to lesion, it will not be able to burr backwards. The sizes of the burr are shown in Table 1.1.

Table 1.1 Burr sizes and guide requirements

Burr diameter (mm)	Recommended guide catheter (French)	Minimum guide internal diameter required (in.)
1.25	6.0	0.060
1.50	6.0	0.063
1.75	7.0	0.073
2.00	8.0	0.083
2.15	8.0	0.089
2.25	9.0	0.093
2.38	9.0	0.098
2.50	9.0	0.102

Foot Pedal

The foot pedal consists of two main components (Fig. 1.6). Stepping on the main pedal allows flow of high-pressure nitrogen through the system activating the burr. Beside the main pedal is the DynaGlide switch, which activates the DynaGlide, allowing retrieval of the burr at lower rotational speeds of 60,000–90,000 rpm.

Rotablator Console

There are several monitors on the main console (Fig. 1.7) – the rotational speed display on the right of the console, the procedure timer in the middle and the pressure gauge on the left. There is a knob to adjust the rotational speed as well as an indicator for DynaGlide activation. It should be noted that the burr speed can decrease when in contact with vessel wall or with the lesion; therefore, the operator must increase the rotational speed knob in order to ensure that the burr is advancing at the desired revolutions per minute.

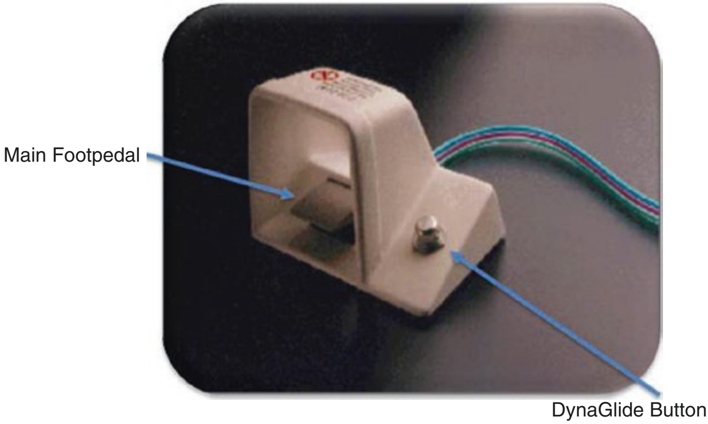

FIGURE 1.6 Foot pedal (Image provided courtesy of Boston Scientific.)

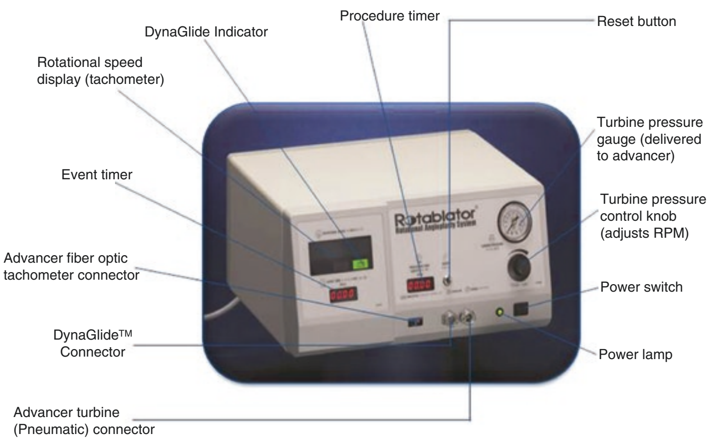

FIGURE 1.7 Main console (Image provided courtesy of Boston Scientific.)

Rotablator Advancer

The body of the advancer has three main connections (Fig. 1.8):

(a) A saline infusion port allowing for continuous infusion of a cocktail infusion (e.g., Rotaglide lubricant) into the drive shaft to help reduce heat and friction. Rotaglide is made of olive oil, egg yolk, phospholipids, sodium deoxycholate, L-histidine, disodium EDTA and sodium hydroxide. An important contraindication for using this solution is an allergy to eggs. In such situations, saline may be used. Some operators have also used a combination of saline with verapamil and nitroglycerin.

(b) An advancer hose which connects to a cylinder of compressed nitrogen gas, delivering high-pressure gas to rotate the drive shaft of the burr. Sufficient nitrogen gas tank must be sufficiently full to drive the rota shaft.

(c) Fibre-optic cable to measure the rotating speed of the burr

The driveshaft is attached to the front of the advancer and the guidewire exits from the back of the advancer. There

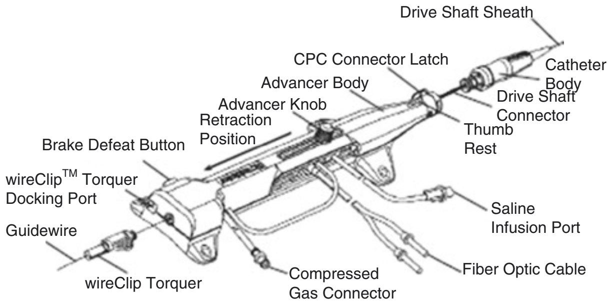

FIGURE 1.8 Rotablator advancer (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

is a brake defeat button at the back end to allow for the wire brake to be released, as well as a docking port for the torquer. There is also a knob on top of the advancer that can be unscrewed and slide to and fro to allow for advancement and retraction of the burr. This is the knob that is advanced to ablate the lesion.

Procedure

The procedure is a high-risk procedure and should ideally be performed in a facility with on-site cardiac surgical support. The operator should be appropriately trained in the procedure. Equally importantly, the rest of the procedure team including the nursing and technical staff should be similarly familiar with the procedure.

Vascular Access, Guide and Burr Selection and Pacing

Burr sizes range from 1.25 to 2.5 mm. In general, the burr-to-artery ratio should not exceed 0.7. In cases of tortuous or very tight lesions, a smaller burr should be chosen first to avoid perforation or burr entrapment and to minimize distal embolization, respectively.

Rotablation can be performed both via the radial and femoral route. The femoral route is usually chosen when a bigger burr necessitates the use of a larger sheath. The choice of guide is usually one that provides adequate support. A guide with a side hole is sometimes required to avoid pressure damping and poor flow distally. The size of the guide required depends on the size of burr (see Table 1.1).

A temporary pacing wire is sometimes inserted for rotablation in dominant right coronary artery/left circumflex artery to mitigate the risk of AV block. However, this is not mandated and is done on a case-by-case basis, as the risk with current technology and good technique is not high. Nonetheless, operators should be cognizant of this complication and be prepared to manage it with a temporary pacemaker.

Pre-ablation Setup

Prior to introduction of the burr into the guide catheter, a quick check using the acronym 'DRAW' should be done.

D – Check that there is sufficient DRIP rate of the infusion.

R – Ensure that the burr is able to rotate at the required rpm.

A – Move the advancer knob to ensure the burr is able to ADVANCE and withdraw smoothly.

W – Tug on the WIRE to ensure the brake is working.

Prior to ablation, the operator should ensure that there is adequate heparinization with ACT >250 s. Patients should also have adequate dual antiplatelet therapy. In patients where this is uncertain, a glycoprotein IIb/IIIa antagonist should be initiated. The operator should also prepare the vessel with arterial vasodilators including nitroglycerin and/or verapamil. The team should also be prepared with the following emergency rescue items:

1. Temporary pacemaker
2. Intra-aortic balloon pump
3. Defibrillation
4. Intracoronary verapamil, nitroglycerin, nitroprusside and adenosine on standby
5. Pericardiocentesis kit

Burr Positioning

The burr is first loaded on the RotaWire as seen in Video 1.1. The device should be tested or 'platformed' before entering the guide catheter. The burr speed should be adjusted to the desired speed during this testing phase. Before the burr enters the guide catheter, lock the advancer knob about

1–2 cm forwards from its distal end. Under fluoroscopic guidance, gently advance the burr to about 1–2 cm proximal to the lesion. To do so, the assistant is required to gently pull back on the wire, with the brake defeat button pressed down, while the main operator advances the burr on fluoroscopy (Video 1.2). Some resistance is expected as the operator navigates the aortic arch and as the burr traverses the primary and secondary curves of the guide catheter. On fluoroscopy, the operator may see the guide being pulled away from the coronary artery ostium. To manage this problem, there are two solutions. The traditional method is to have an experienced assistant pull firmly, while the operator advances the burr. The pulling force is firm and consistent and should not be sudden or excessive. Excessive force can result in loss of wire position or a sudden jump of the guide which can dissect the ostium of the coronary artery. A second method is to use the DynaGlide function to advance the system, by reducing friction. However, there is the risk of ablating the guide, perhaps with microparticles of guide material. In general, we advise the traditional method and to use the DynaGlide function only when there are more challenging cases or when the wire is in a precocious position. Once the burr is in position, the advancer knob is then unscrewed and a forwards and backwards motion is undertaken with the knob to visualize under fluoroscopy, to relieve any tension in the system and to prevent the burr from jumping when the rotablation starts.

Rotablation Procedure

Before ablation begins, the burr should be activated within a non-stenosed part of the vessel proximal to the lesion to confirm the rotational speed. This process is also called ‘platform’. Once ready, the burr should be gradually advanced at rotational speeds of 140,000–160,000 rpm. We generally target a speed of 150,000 rpm. The individual runs should be <30 s (total not to exceed 5 min), and there should be avoidance of decelerations of >5,000 rpm. The duration of the ablation should be individualized. For example, in patients who quickly develop heart block or ST elevation or hypotension, the run duration should be shortened to allow time for coronary perfusion. Do not stop the burr within the lesion and do not burr at the spring tip of the RotaWire. Remember that the theoretical basis of the device is to use the diamond coated tip of the burr to gradually grind down the calcified lesion. Therefore, we advocate a gentle and patient approach which has been likened to ‘sandpapering’ (Video 1.3). This involves gentle advancement to contact the lesion for approximately 3 s followed by 2 s of withdrawal. The contact is needed to allow the burr to ‘sandpaper’ or ablate the lesion; the withdrawal allows for perfusion beyond the lesion. Excessive forwards force can result in decelerations, burr entrapment or large microparticles which can theoretically cause no-reflow. A final polishing run is often performed once the lesion is successfully crossed.

Different techniques have been utilized including the ‘pecking’ or ‘tapping’ technique which involves a quick forwards and backwards movement of the burr.

Regardless of the burring technique, it is crucial to pay attention of the haemodynamics and ECG of the patient. Ischaemia or no-reflow can lead to hypotension and malignant arrhythmias. Complete heart block can also occur. If heart block occurs, the operator should pull the burr back to a normal segment of the vessel and allow coronary perfusion before resuming rotablation. The operator should also pay attention to decelerations and, oftentimes, can rely on the sound of the machine changing in pitch to indicate that excessive deceleration has occurred. When deceleration occurs, the operator should do one of two things: first, it is likely he is advancing the burr too forcefully and should be more gentle. Second, if he is convinced that he is not applying too much force, then he can ask the assistant to increase the speed of the rotations to his desired speed.

While the classical speed has been between 140 and 160,000 rpms, some operators use a much higher speed of 180,000 rpm or even 200,000 rpms. We generally prefer to utilize the more classical speeds of 140–160,000 rpms. At higher speeds, we believe higher temperatures would be created, and there is a theoretically higher risk of platelet activation and resultant no-reflow. Nonetheless, in experienced hands, this discussion is probably less important.

Removal of Burr

Once ablation is completed, the burr has to be removed. Prior to removal of the burr, the brake should be released by pressing the brake defeat. DynaGlide is then activated by stepping on the DynaGlide activation button on the foot pedal, and the burr is then removed while spinning at a lower speed of 60,000–90,000 rpm. This process involves the cooperation of both operators – with the main operator removing the burr while the assistant pushes the wire in, both concentrating on the fluoroscopic position of the wire (Video 1.4). In this step, the main operator should only aim to guide the burr out and need not pull excessively on the burr or the wire position may be pulled out. On the other hand, the assistant's role is more important, and he/she will need to watch the screen carefully to avoid losing wire position. Once the burr tip is removed from the guide, the operator should step off the pedal, the drip should be stopped, and the torque device should be removed.

The operator should then reassess whether a second larger burr is required. We generally prefer a 0.25 mm stepwise increment although up to 0.5 mm increases can be used by experienced operators. The burr may be exchanged as shown in Fig. 1.9 and Video 1.5. It is absolutely critical to ensure that the burr is properly attached to the drive train to ensure proper functioning of the device. It is also critical not to kink the connector which would prevent the rotablator from working properly. Once burring is complete, the burr is removed in a similar fashion as the first burr.

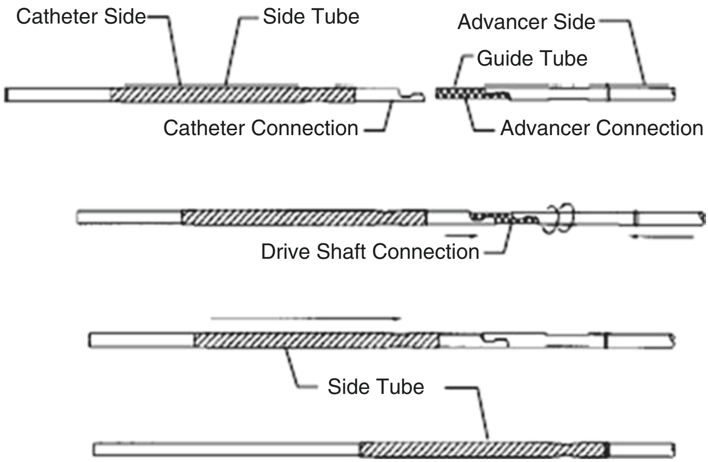

FIGURE 1.9 Attachment of new burr (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

Exchange of RotaWire

To proceed with the intervention, the RotaWire is usually exchanged for a standard PCI wire via a microcatheter or by parallel wiring with the standard PCI wire. The latter is usually not advised as it is possible to wire under a dissection plane caused by the rotational atherectomy.

Acknowledgements We would like to acknowledge and thank Boston Scientific for providing the figures in this chapter.

Chapter 2
Straightforward LAD case

Bradley D. Stauber, Reginald I. Low, and Gagan D. Singh

Case Summary

An 81-year-old man with multivessel disease was referred for high-risk complex PCI. Diagnostic angiography of the left coronary system demonstrated 80% proximal and mid-LAD diffuse calcific stenoses (Fig. 2.1) along with concomitant stenosis of the diagonal artery. The left main coronary artery was engaged with a 7F JL 3.5 guide catheter, and a 0.014 guidewire was advanced past the diagonal lesion. With a 2.0 over the wire balloon, the guidewire was exchanged for a Roto extra-support wire. Next, a 1.25 mm burr was inserted, and rotational atherectomy was performed at 150,000 rpm (Fig. 2.2). Both the burr and the wire were removed, and the wire was directed past the mid-LAD lesion. Rotational ather-

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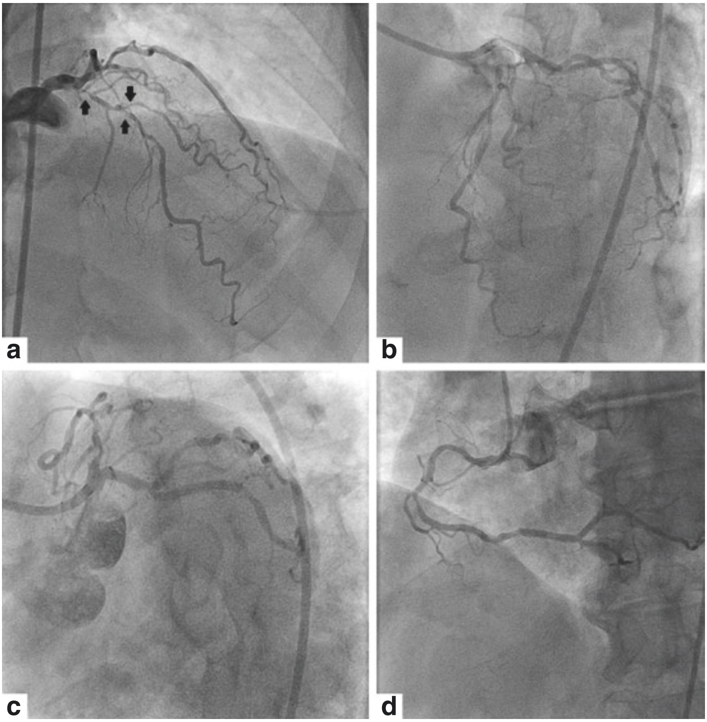

FIGURE 2.1 Baseline angiographic images with severe calcific disease noted in proximal and mid-LAD as well as diagonal artery (best seen in **a**, *black arrows*). The rest of the left coronary system (**b**, **c**) and right coronary artery (**d**) are visualized

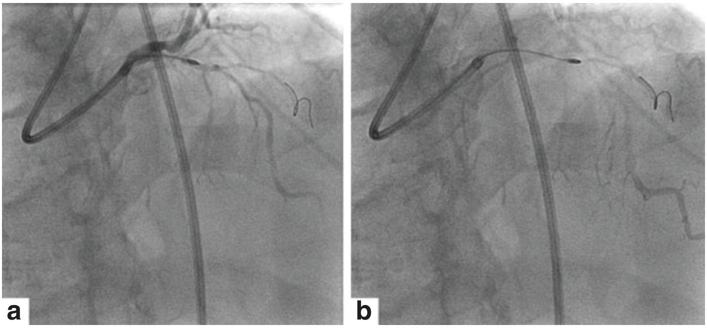

FIGURE 2.2 Rotational atherectomy performed with 1.25 mm burr to proximal LAD (**a**) and diagonal branch (**b**)

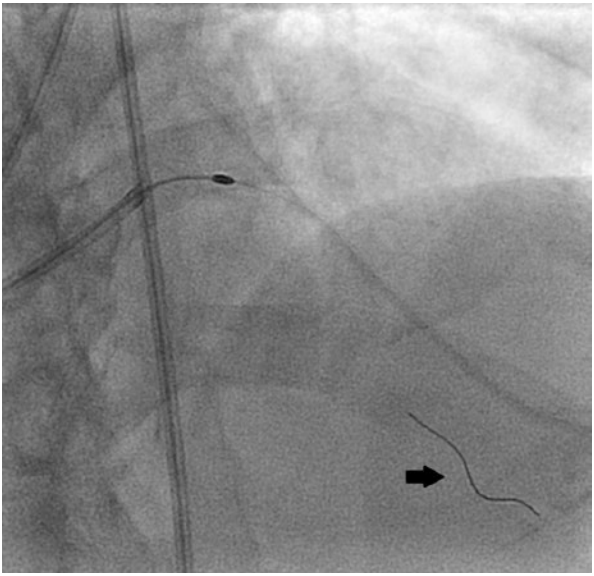

FIGURE 2.3 Rotational atherectomy with 1.5 mm burr to mid-LAD (wire in distal LAD, *black arrow*)

ectomy with the 1.25 mm and a 1.5 mm burr was performed at 150,000 rpm (Fig. 2.3). Angiography post-rotational atherectomy demonstrated improved but still present luminal narrowing (Fig. 2.4).

At this point, separate 0.014 guidewires were inserted into the LAD and diagonal arteries. Balloon angioplasty followed by scoring atherectomy was performed (Fig. 2.5). A 2.25 × 20 mm everolimus DES was inserted into the diagonal artery, and an additional 2.0 mm semi-compliant balloon was advanced into the LAD distal to the diagonal artery. The stent was aligned to the proximal superior edge of the diagonal artery and stent deployed. The stent delivery system was removed, and post-dilatation was performed on the diagonal artery. The post-dilatation balloon was removed. Next the 2.0 LAD balloon was retracted back across the diagonal artery ostium, and the balloon was expanded, and any protruding

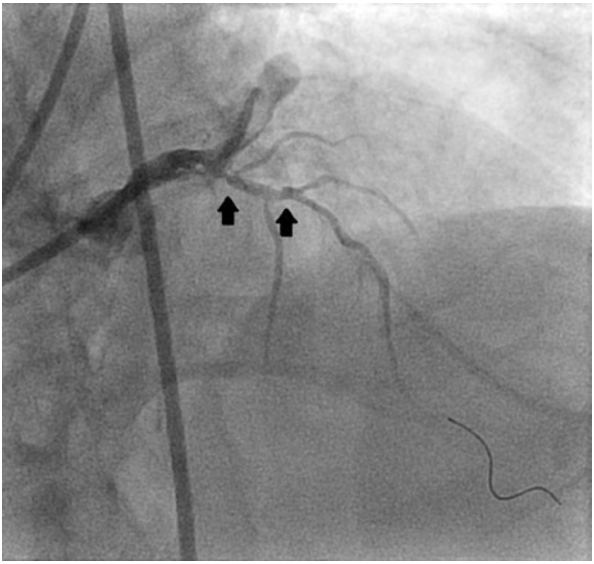

Figure 2.4 Post-rotational atherectomy demonstrating improved but present luminal narrowing (*black arrows*)

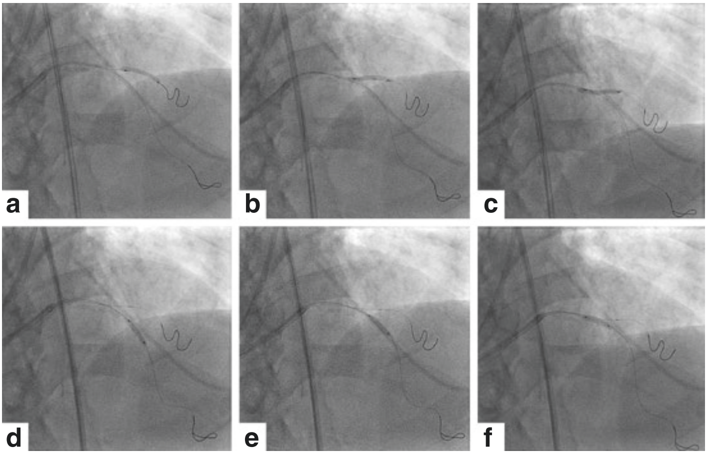

Figure 2.5 Scoring atherectomy to diagonal (**a**–**c**) and LAD (**d**–**f**)

diagonal stent was "mini-crushed." The balloon was then removed. Next, a 2.25 × 24 everolimus DES was inserted into the mid-LAD and deployed and post-dilated (Fig. 2.6). Then, a 2.25 × 23 everolimus DES was deployed to the proximal LAD and post-dilated. Finally, the diagonal artery was rewired from within the LAD stent, and a balloon was inserted into the struts and dilated. This was followed by inserting a balloon into the LAD with simultaneous kissing balloon angioplasty. The balloons were then removed. Final angiography demonstrated well-apposed stents and TIMI-3 blood flow (Fig. 2.7).

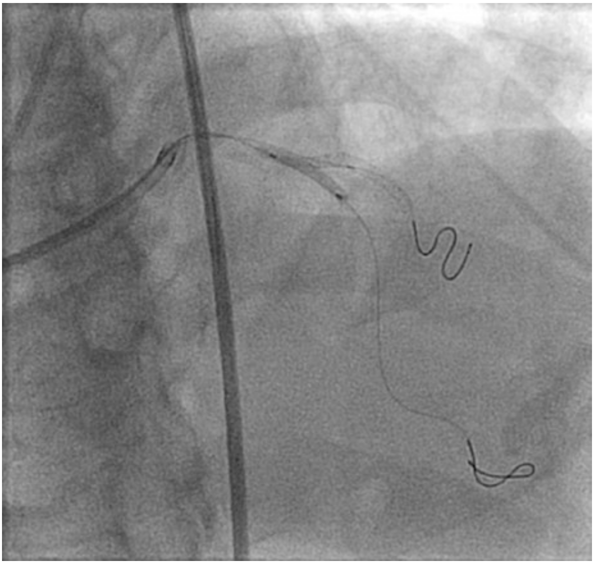

FIGURE 2.6 Mid-LAD stent deployed and post-dilated

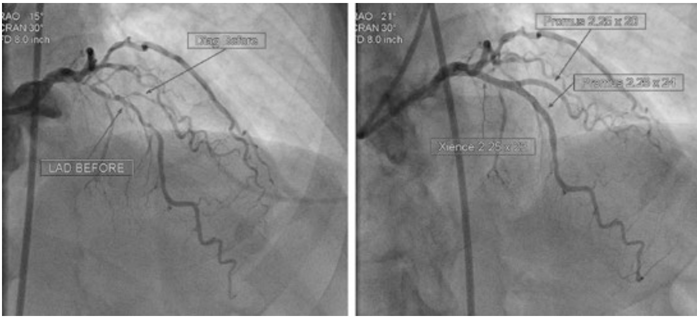

Figure 2.7 Before and after views of LAD and diagonal branch after PCI

Discussion and Learning Points

This case illustrates a basic rotational atherectomy of the LAD and diagonal arteries. Rotational atherectomy allowed for optimal lesion preparation in a calcified vessel, ultimately providing an excellent angiographic result. Both the LAD and diagonal were treated with rotablation. While there is a theoretical risk of loss of the branch vessel when performing rotablation in either artery, this risk is mitigated in appropriately selected patients and careful technique.

Chapter 3
Basic LCX Case

Arie Steinvil and Lowell Satler

Case Summary

The patient is an 82-year-old male with a past medical history of diabetes mellitus, hypertension, dyslipidemia, and known coronary artery disease, with prior PCI to proximal RCA with a 3.0 × 12 mm DES and to the distal RCA with a 2.5 × 12 mm DES 3 years ago. A 60–70% calcified LCX lesion was managed medically at that time. He was admitted to another hospital with unstable angina. He underwent coronary angiography that showed patent stents in RCA; however, his calcified LCX has progressed significantly to 95% and therefore was referred to PCI.

The patient underwent successful PCI of the proximal circumflex with rotational atherectomy using a 1.5 mm burr at a speed of 170–180 k RPMs for two runs. Balloon pre-dilatation with a 2.5 × 12 mm semi-compliant balloon was performed followed by a 3.25 × 15 mm DES implantation (Figs. 3.1, 3.2,

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Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-3-319-60490-9_3) contains supplementary material, which is available to authorized users.

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R. Low, K.K. Yeo (eds.), *Clinical Cases in Coronary Rotational Atherectomy*, Clinical Cases in Interventional Cardiology,
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Figure 3.1 Baseline LCX lesion

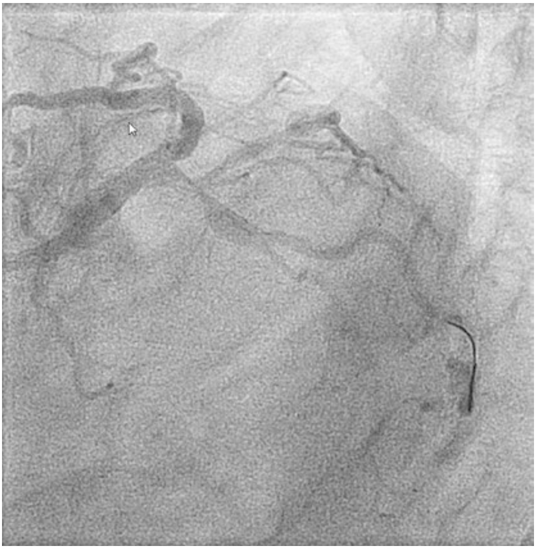

Figure 3.2 Rotational atherectomy with a 1.5 mm burr was performed on the LCX lesion leading to post atherectomy lumen size gain and allowing stent crossing

FIGURE 3.3 Final result: optimal stent deployment was validated with IVUS guidance

and 3.3, Videos 3.1, 3.2, and 3.3). IVUS imaging confirmed optimal apposition and expansion of the treated lesion.

Discussion and Learning Points

For highly calcified lesions, careful lesion preparation with rotational atherectomy and adequate balloon pre-dilatation is required for optimal stent delivery and deployment. This is a simple case involving the LCX. Although LCX lesions can be potentially tricky if there is significant angulation from the LM to the LCX, in this case, it was not excessive, and the case could be safely performed.

Chapter 4
Straightforward LAD Case

Bradley D. Stauber, Reginald I. Low, and Gagan D. Singh

Case Summary

An 84-year-old man presents with atypical chest pain and abnormal perfusion scan indicating a reversible anterior wall defect. Angiography demonstrated diffuse, calcified lesions in his proximal left anterior descending (LAD) artery of approximately 90%. He was also found to have a 90% proximal stenosis in his ramus intermedius branch (Fig. 4.1). Angiography of the circumflex and right coronary artery both showed chronic total occlusions with distal beds supplied by left to right collaterals (Fig. 4.2).

The left main coronary artery was engaged with a vista XB3.5 7 Fr guiding catheter. A 0.014″ guidewire was placed beyond the lesion in the ramus. The lesion was predilated with an AngioSculpt 2.5 × 10 mm balloon with ultimate stenting with a DES 2.75 × 18 mm stent post-dilated to 2.75 mm (Fig. 4.3).

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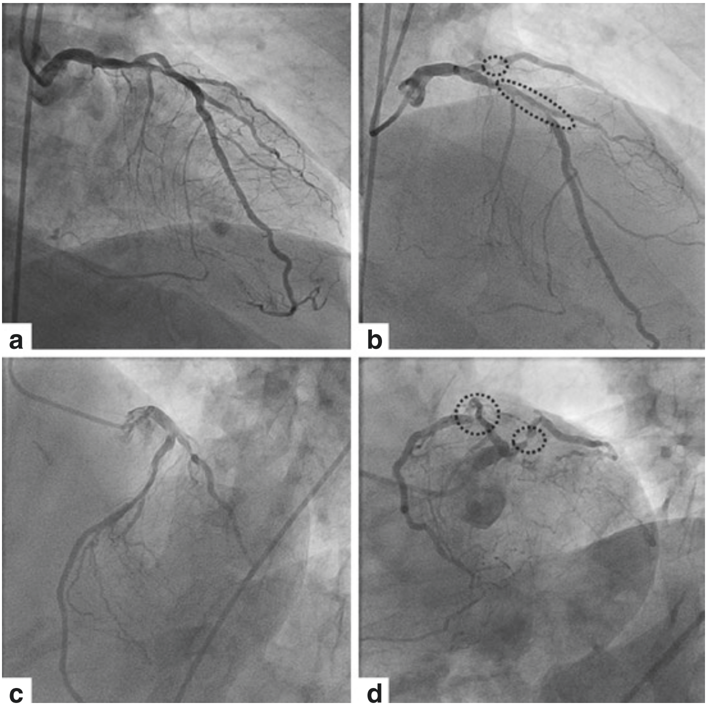

Figure 4.1 Baseline angiographic images, *black ovals*, showing representative LAD and ramus stenosis. (**a**) and (**b**) taken in right anterior oblique views, (**c**) and (**d**) taken in left anterior oblique views

The 0.014″ guidewire was then directed down the LAD and exchanged for a 0.009" Rota extra-support wire. Rotational atherectomy was performed using a 1.25 mm burr at 150,000 rpm for multiple passes (Fig. 4.4) with repeat angiography showing improved but persistent calcific disease (Fig. 4.5). The burr was replaced with a 1.50 mm burr, and rotational atherectomy was again performed with the upsized burr at 150,000 rpm for 60 s for multiple passes (Fig. 4.6). The Rota wire was then exchanged for a standard 0.014″ guidewire. The LAD lesion was further treated with an AngioSculpt 2.5 × 10 mm and 3.0 × 15 mm balloon. Ultimately

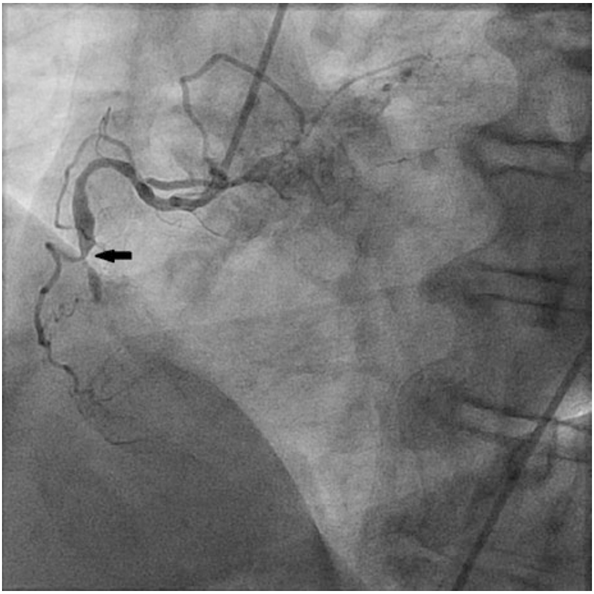

FIGURE 4.2 *Black arrow* showing chronic total occlusion of RCA

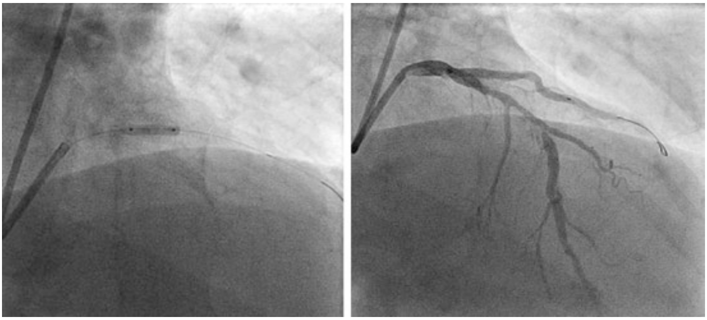

FIGURE 4.3 Scoring balloon atherectomy (*right*) followed by eventual stenting with 2.75 × 18 mm DES

a 4.0 × 38 mm DES was deployed across the LAD lesion. The stent was post-dilated with a noncompliant quantum apex 4.0 × 20 mm balloon (Fig. 4.7). Subsequent angiography

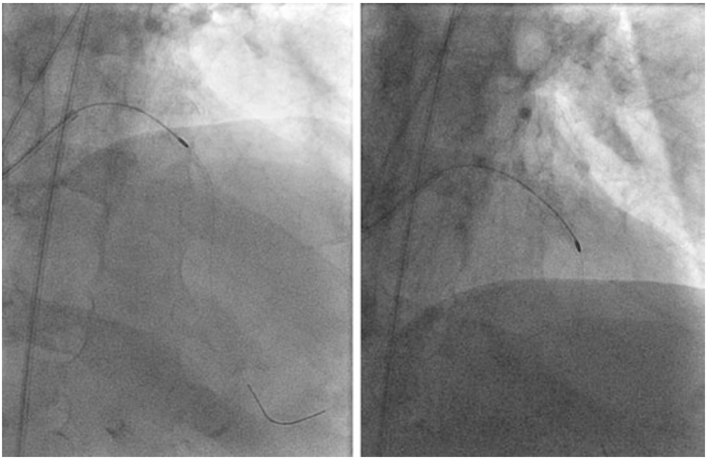

FIGURE 4.4 Rotational atherectomy with 1.25 mm burr to LAD

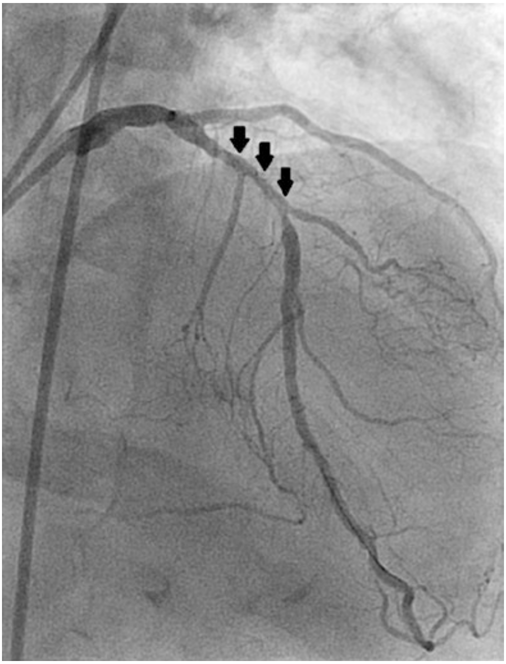

FIGURE 4.5 Repeat angiography after initial round of rotational atherectomy showing persistent calcific disease

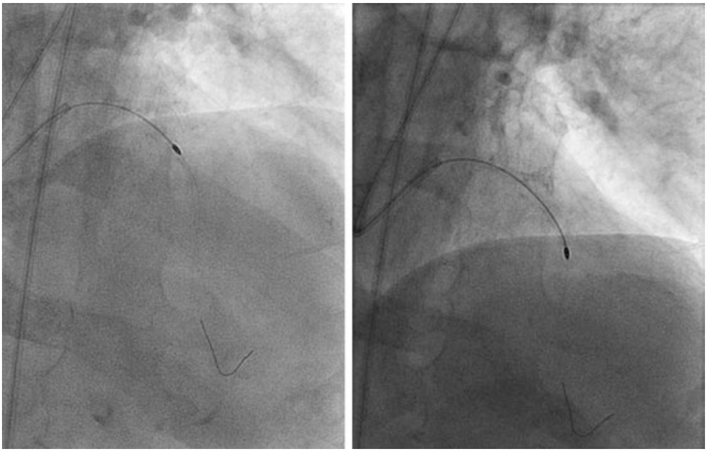

FIGURE 4.6 Rotational atherectomy with upsized 1.5 mm burr to LAD

FIGURE 4.7 Scoring balloon atherectomy (*left*) followed by stenting to proximal LAD (*right*)

revealed that the diagonal vessel had been jailed (Fig. 4.8) with a new ostial stenosis ("pinched") secondary to plaque shifting. We next advanced an additional 0.014″ guidewire through the LAD stent struts and into the diagonal artery (Fig. 4.9). Both the diagonal branch and the LAD stent were post-dilated in a simultaneous kissing balloon (Fig. 4.10) with subsequent angi-

FIGURE 4.8 Repeat angiography after LAD stenting, *black arrow*, showing "jailed diagonal" with new ostial stenosis due to plaque shifting

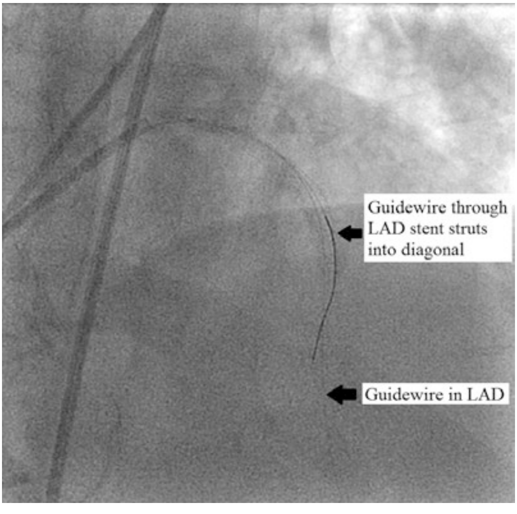

FIGURE 4.9 Guidewires in ongoing LAD and in pinched diagonal branch

ography demonstrating a well-apposed stent and TIMI 3 blood flow and a residual diagonal stenosis of 30%. Final angiography revealed excellent angiographic results (Fig. 4.11).

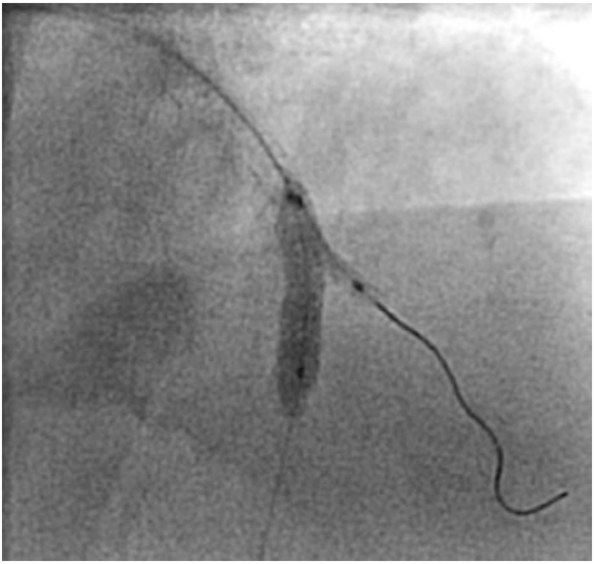

FIGURE 4.10 Kissing balloon angioplasty to pinched diagonal branch

FIGURE 4.11 Before and after angiographic images of ramus intermedius and calcified LAD after stenting

Discussion and Learning Points

This is a rather straightforward case. However, it does illustrate that in heavily calcified vessel, sequential rotational atherectomy runs with greater burr sizes may be needed. Even then the lesion may still require additional plaque modification with balloons such as the AngioSculpt scoring balloon.

Chapter 5
Ostial RCA

Khaled Hammad and Khung Keong Yeo

Case Summary

A 65-year-old female, with a history of hypertension and hyperlipidemia, presented with exertional chest pain. She had CABG in 2013 with the following grafts: LIMA to the LAD and SVG to OM1. Nuclear imaging stress test showed mild ischemia (5%) in the basal inferior wall. The LVEF was 69%. Diagnostic angiography showed severe native triple vessel disease with patent grafts. The RCA had new severe ostial, calcific stenosis (Fig. 5.1a, b, Videos 5.1 and 5.2).

PCI to the ostial RCA was performed. Multiple 6F guides were used including JR4 with side hole, AL0.75 with side hole, AR1 with side hole, XBRCA with side hole, and JR3.5 with side hole. Finally, a JR5 guide successfully engaged the RCA. Wiring the ostial RCA was difficult but was eventually done with a Fielder wire (Fig. 5.2a, Videos 5.3 and 5.4).

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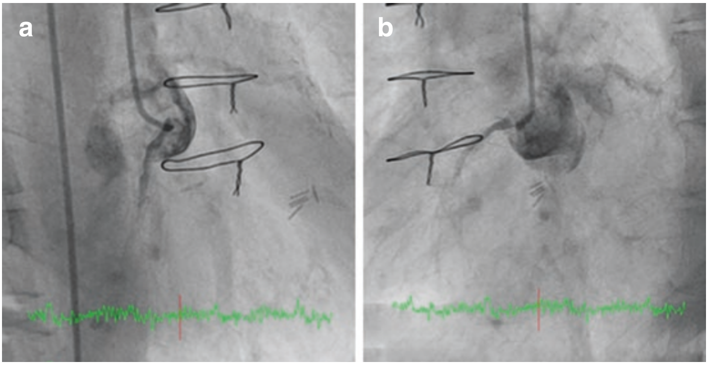

FIGURE 5.1 (**a**, **b**) shows the baseline RCA with severe calcific ostial stenosis

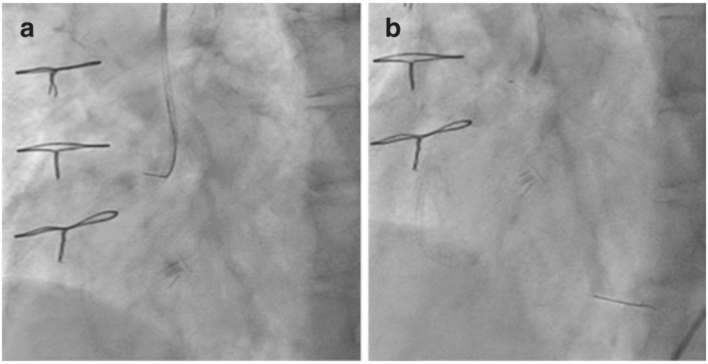

FIGURE 5.2 (**a**) shows awkward angle for engagement of the guide into the ostium of the RCA. Although a Fielder wire was able to cross the lesion, the awkward angle of origin of the RCA and the severe ostial disease accentuated difficulty in wiring the lesion with very poor guide support. (**b**) further illustrates this with difficulty in advancing the Finecross microcatheter across the lesion

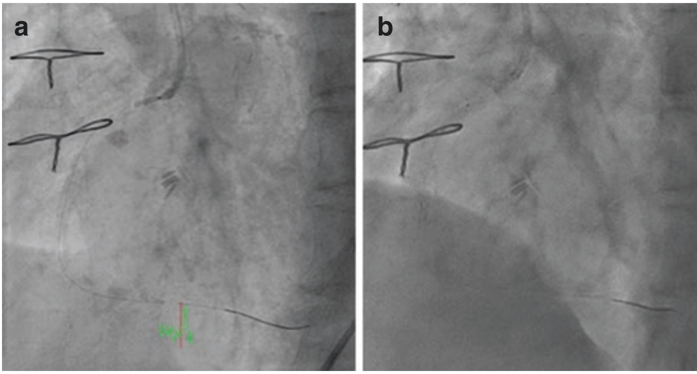

Figure 5.3 (**a**) shows predilation with the 1.5 mm balloon, after predilatation with a 1.0 mm balloon (not shown). (**b**) shows that after predilatation, the microcatheter can cross the lesion and allow exchange for a Rota wire

Although the initial strategy was to perform rotational atherectomy, the lesion could not be crossed with a Finecross microcatheter due to the severe calcific stenosis and lack of guide support (Fig. 5.2b). Predilation with 1.0 and 1.5 mm semi-compliant balloons had to be performed before a Finecross catheter could cross the lesion (Fig. 5.3a, b). The Fielder wire was then exchanged out for a Rota extra-support wire. The rotational atherectomy was then successfully performed with a 1.25 mm burr (Fig. 5.4, Video 5.5). Once rotational atherectomy was performed, the lesion was further modified with a 2.5 × 10 mm AngioSculpt scoring balloon at high pressures (Figs. 5.5 and 5.6). Video 5.6 shows the RCA after predilatation with semi-compliant and scoring balloons (Video 5.6). After that, 2.5 and 3.0 mm DES were then implanted and post-dilated with 2.75 and 3.5 mm non-compliant balloons with excellent final angiographic results (Fig. 5.7, Videos 5.7 and 5.8).

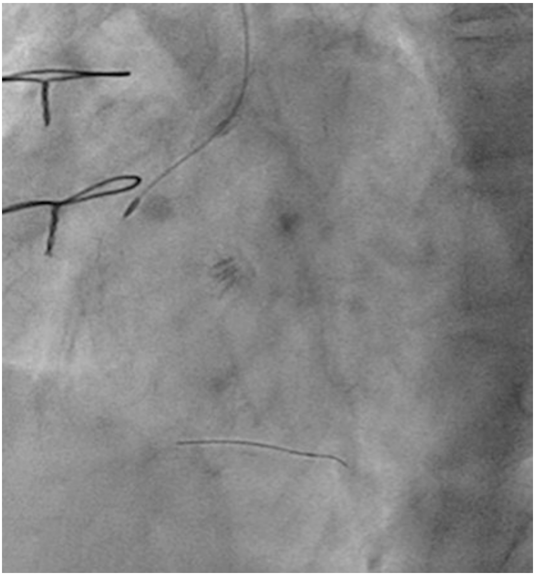

FIGURE 5.4 This shows rotablation with a 1.25 mm burr

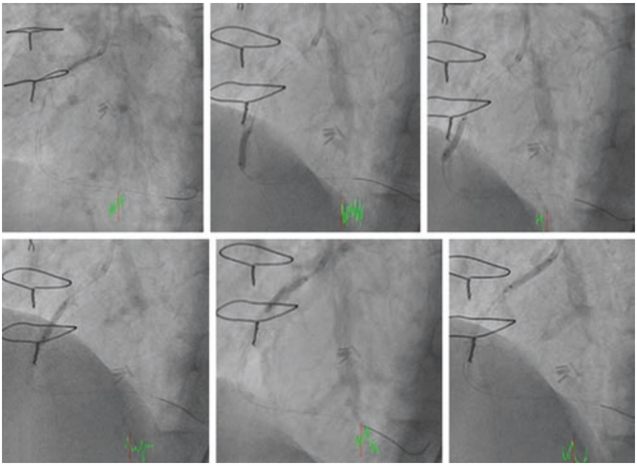

FIGURE 5.5 This shows a panel of images showing predilation with semi-compliant and scoring balloons. Notice that the balloons are all well expanded

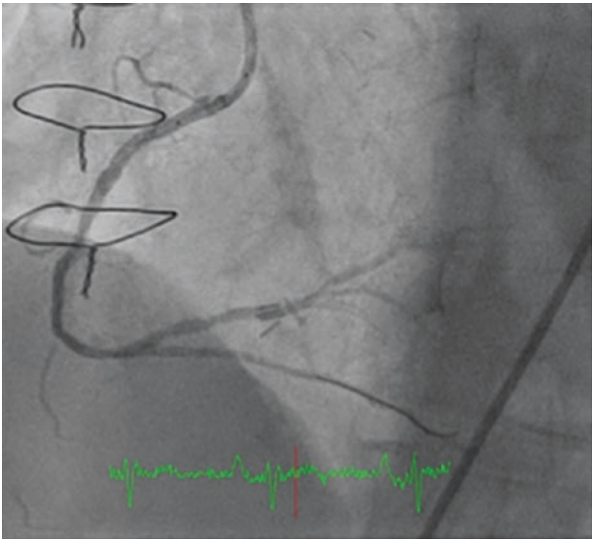

Figure 5.6 This shows angiography of the RCA after predilatation with minimal residual stenosis in the RCA

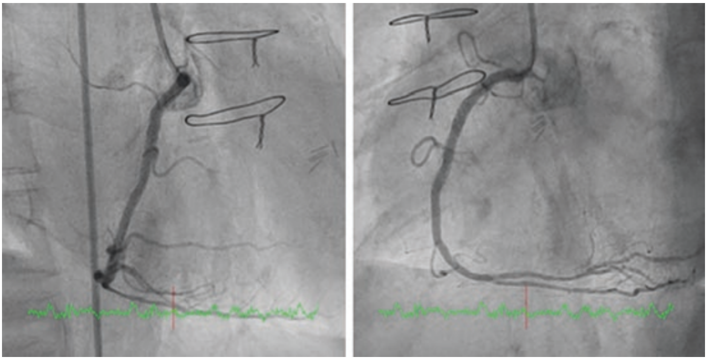

Figure 5.7 This shows the final angiogram showing excellent angiographic results

Discussion and Learning Points

In performing rotablation of an ostial lesion, the key is to ensure coaxial guide positioning, especially since guide engagement into the coronary artery was not possible. If the guide is not coaxial, there is a high risk of wire fracture or breakage by the burr (see Chap. 23). The use of a Rota extra-support wire may also be useful in ensuring a straight rail along which the burr can be advanced.

- Learn how to use small sequential balloons to predilate lesions in order to allow for a microcatheter to cross.
- Learn the importance of coaxial guide placement when performing rotational atherectomy of ostial lesions to avoid wire fracturing or breakage.
- Learn that the use of a Rota extra-support wire can help to provide a straight rail in cases where guide engagement is difficult.
- Learn how to use rotational atherectomy with balloon angioplasty including a scoring balloon to pretreat a calcified ostial lesion. This is an important step. Despite rotablation, there usually remains significant residual stenosis that may be difficult for a standard semi-compliant balloon to predilate. A scoring or similar balloon can help further optimize lesion preparation with adequate predilatation. In situations where the lesion is extremely calcified, a second larger burr may be required. However, this is associated with attendant risks and greater costs.

Chapter 6
Downsizing Burr as a Strategy for Severe Calcific Stenosis

Richard J. Jabbour, Mauro Carlino, and Antonio Colombo

Case Summary

A 77-year-old male with stable angina and past medical history of hypertension and dyslipidemia underwent coronary angiography at our institution via left radial access with a 6F sheath.

Angiography revealed a right dominant coronary artery that was patent without significant stenosis. The left main was unobstructed, but there was a long segment of heavily calcified disease extending from the ostium to mid LAD (Fig. 6.1a, b).

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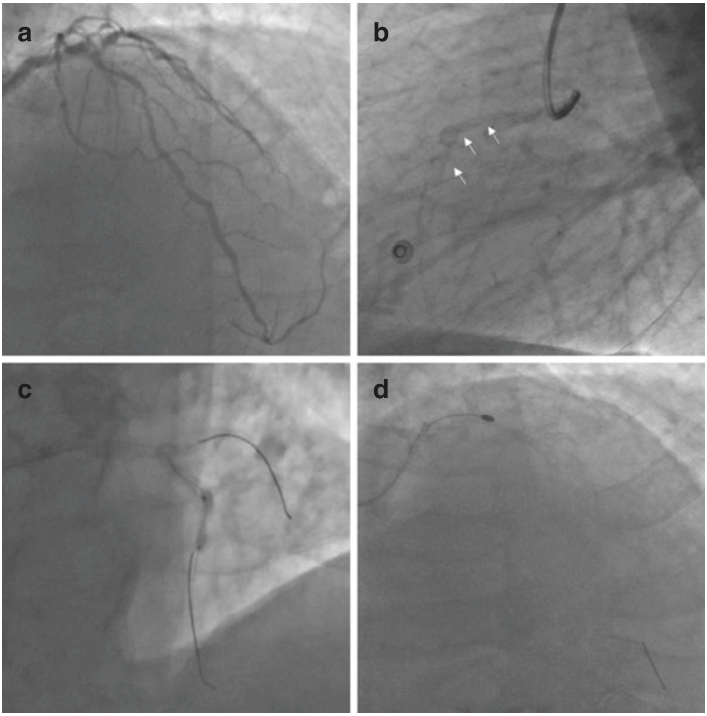

FIGURE 6.1 (**a**) Cranial view of left anterior descending artery showing long segment of diffuse disease from proximal to mid vessel. (**b**) *White arrows* indicate heavily calcified left anterior descending artery. (**c**) Under-expanded 2.5 mm non-compliant balloon with remaining indentation despite inflation at 22 atm. (**d**) Rotational atherectomy was attempted with a 1.75 mm burr, but it did not pass through the heavily calcified proximal segment

The initial strategy was to pre-dilate the lesion with a non-compliant balloon and implant a 3.5 × 38 mm drug-eluting stent starting from the ostium of the LAD. A 2.0 mm balloon was however difficult to advance into the lesion. Therefore, a buddy wire was used for support and the balloon successfully passed. However, when inflating with a 2.5 mm non-compliant balloon to high pressure (22 atm), it was clear that the balloon was not fully expanded (Fig. 6.1c).

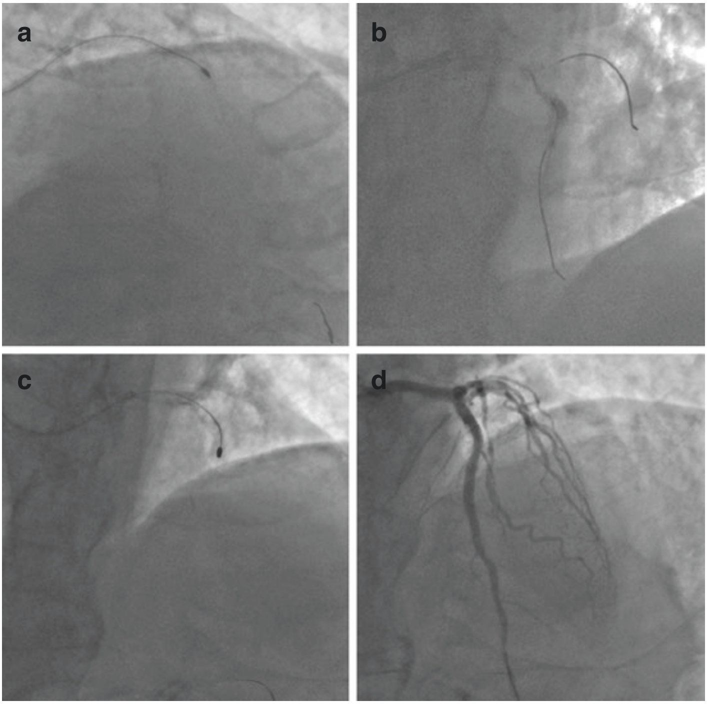

Figure 6.2 (**a**) A smaller 1.25 mm burr was successful in crossing the lesion after several passes. (**b**) Under-expanded 3.0 mm non-compliant balloon with remaining indentation despite inflation at 22 atm. (**c**) A 1.75 mm burr was successful in crossing the lesion after several passes. (**d**) Excellent final angiographic result post implantation of four drug-eluting stents

Therefore, it was decided that rotational atherectomy was needed. A 1.75 mm burr was used, but it was unable to advance across the calcified lesion in the proximal LAD after several attempts (Fig. 6.1d). Therefore, we switched to a smaller 1.25 mm burr (Fig. 6.2a) that successfully passed after several runs.

We then continued pre-dilatation but had difficulties fully expanding a 3.0 mm non-compliant balloon, with remaining balloon indentation, even at 22 atm (Fig. 6.2b). Therefore, it was decided that addition debulking was required, and we decided to use the larger 1.75 mm burr. This time the burr could advance (Fig. 6.2c).

We were then able to prepare the lesion with multiple inflations of a 3.5 mm non-compliant balloon. We then implanted four times drug-eluting stents (3.5 × 20 mm, 3.5 × 32 mm, 3.0 × 20 mm, 30 × 12 mm) with an excellent angiographic final result (Fig. 6.2d).

Discussion and Learning Points

This case highlights the value of adequate lesion preparation prior to stenting. It is important not to advance the burr too aggressively through a calcified lesion in order to minimize the risk of burr entrapment. In situations where a larger burr cannot easily cross a lesion, downsizing to a smaller burr may solve the problem.

Chapter 7
Complex LAD

Arie Steinvil and Lowell Satler

Case Summary

The patient is a 93-year-old male with hypertension, hyperlipidemia, permanent pacemaker, and coronary artery disease with prior PCI with stenting to the proximal LAD, atrial fibrillation, and severe symptomatic aortic stenosis with peak/mean gradient of 52/32 mmHg and aortic valve area of 0.6 cm^2. He was previously functionally active and had developed angina and exertional dyspnea. Pre-transcatheter aortic valve replacement (TAVR) evaluation with cardiac catheterization showed a critical calcified mid-LAD lesion (Fig. 7.1 and Video 7.1). Cardiac surgery determined the patient to be inoperable. Following Heart team evaluation, it was decided to proceed with PCI in order to facilitate TAVR.

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The mid-LAD was lesion was crossed using a Fielder wire loaded on a Finecross microcatheter. A 1.5 × 12 mm semi-compliant balloon was loaded on the wire but could not cross the lesion. Rotablation was done with no vessel pre-dilatation using a 1.5 mm burr at a speed of 170,000 from the proximal LAD to mid-LAD. Following rotablation a dissection was noted in the mid-LAD lesion resulting with hemodynamic compromise and cardiogenic shock (Fig. 7.2, Video 7.2). The patient was stabilized by inotropes and use of intra-aortic balloon counterpulsation on the contralateral femoral artery. Four bare metal stents, two 2.0 × 8 mm and two 2.25 × 8 mm, were deployed sealing the dissection with good angiographic result (Fig. 7.3, Video 7.3).

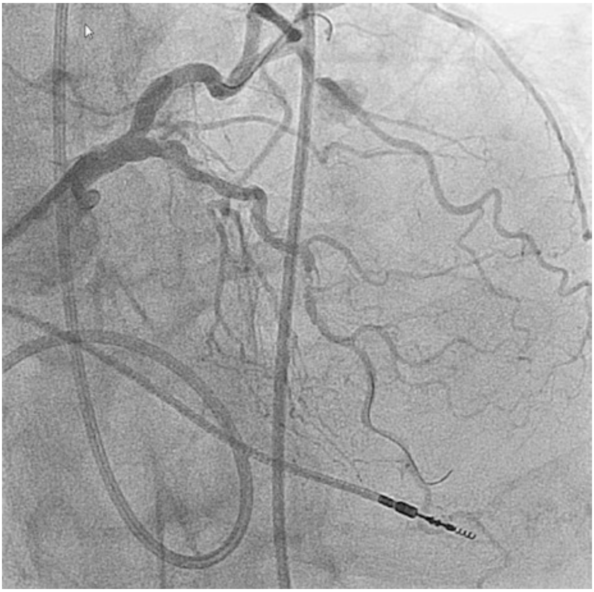

FIGURE 7.1 Baseline LAD lesion. A highly calcified lesion is appreciated in the proximal and mid-LAD

FIGURE 7.2 Rotational atherectomy with a 1.5 mm burr was performed on the LAD lesion resulting in a dissection and hemodynamic compromise

FIGURE 7.3 Final result. Four bare metal stents were deployed sealing the dissection with good angiographic result

Discussion and Learning Points

In severely calcified high-grade lesions, rotational atherectomy should be performed following appropriate lesion preparation. Rotablation can cause no flow or slow flow in the coronary artery with one important cause being dissection of the coronary artery. Special precautionary measures should be prearranged in the cardiac catheterization laboratory (i.e., anesthesia, hemodynamic support devices such as intra-aortic balloon pump, etc.) when there is a high risk for possible complications.

Chapter 8
Complex Case: Rotational Atherectomy in Preparation for TAVR

Bradley D. Stauber, Reginald I. Low, Jason H. Rogers, and Gagan D. Singh

Case Summary

An 84-year-old man with class III angina and heart failure is noted to have critical AV stenosis and severe calcific obstructive disease of the RCA. In preparation for TAVR, PCI of the RCA is undertaken.

After placement of a temporary pacemaker into the right ventricle, baseline angiographic images confirm severe,

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diffuse calcific lesions proximal to distal (Fig. 8.1). A 0.014″ guidewire was advanced past the most distal lesion, and with a 2.0 mm over-the-wire balloon, the wire was exchanged for a Roto extra-support wire. A 1.5 mm burr was inserted, and rotational atherectomy was performed at 150,000 RPM for 60 s with multiple passes (Fig. 8.2). Repeat angiogra-

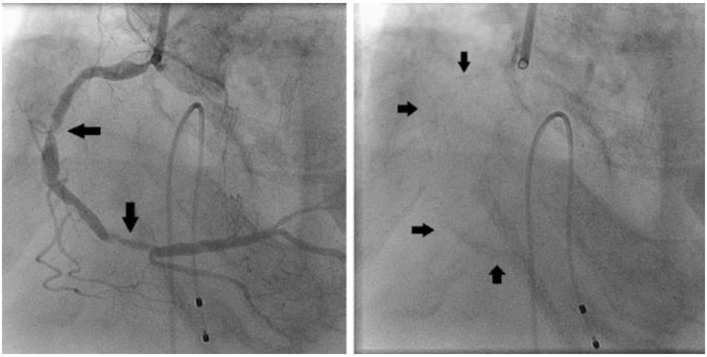

FIGURE 8.1 Baseline angiographic images of RCA (*left*), arrows showing severe obstructive lesions. Image on the *right* shows RCA under fluoroscopy without dye, with *arrows* showing severe calcific disease

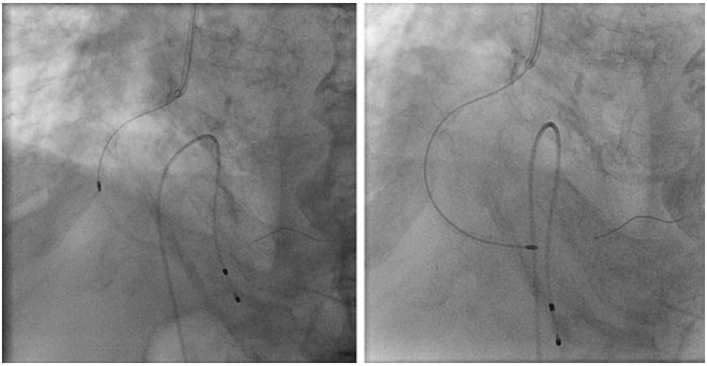

FIGURE 8.2 Rotational atherectomy with 1.5 mm burr to RCA

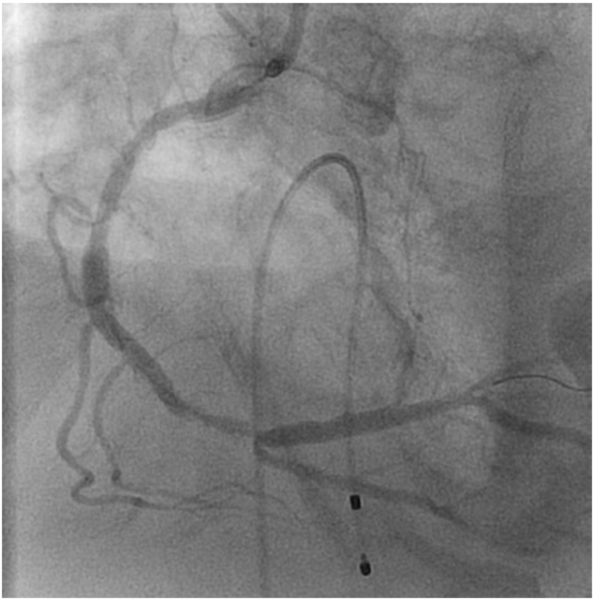

FIGURE 8.3 Repeat angiography after first round of rotational atherectomy with 1.5 mm burr

phy demonstrated persistent calcific disease (Fig. 8.3). The burr was then exchanged for a 1.75 mm burr, and again, rotational atherectomy was performed in the same manner. The Roto wire was then exchanged for a standard 0.014″ guidewire. Scoring atherectomy is performed with a 3.0 × 15 mm AngioSculpt balloon. Next, a 3.0 × 28 mm DES was inserted into the mid-distal RCA followed by a 3.5 × 38 mm DES which was deployed to the mid-segment. Finally, a 3.5 × 28 mm DES was deployed to the proximal segment of the RCA. All stents were then post-dilated to high pressure (Figs. 8.4, 8.5, and 8.6). Final angiographic images showed a well-apposed series of overlapping stents to the right coronary artery.

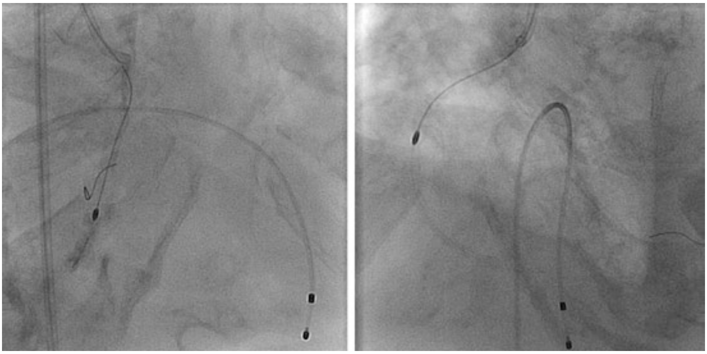

FIGURE 8.4 Rotational atherectomy with 1.75 mm burr to RCA

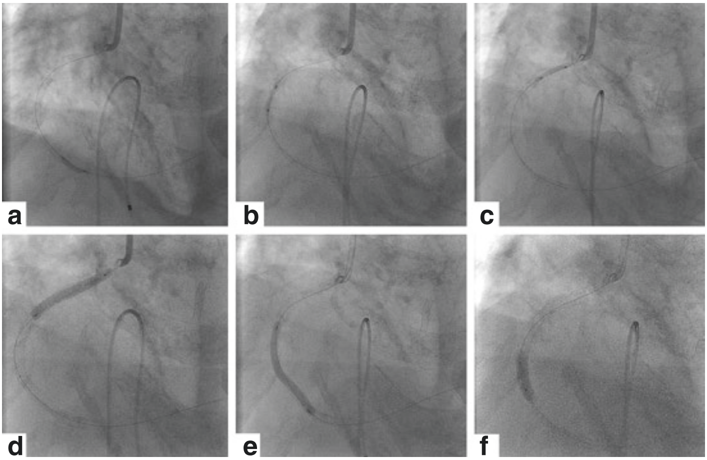

FIGURE 8.5 Scoring balloon atherectomy from proximal to distal RCA (**a**–**c**) followed by stenting (**d**, **e**) and post-dilatation (**f**)

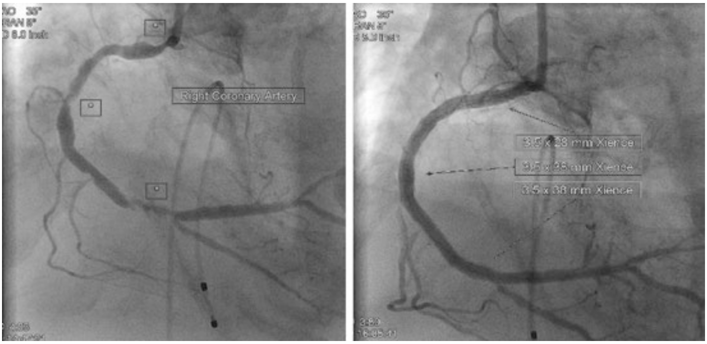

FIGURE 8.6 Before and after images of RCA, s/p rotational atherectomy, scoring atherectomy, and stenting

Discussion and Learning Points

Rotational atherectomy can be safely performed in patients with critical aortic stenosis. In this case, it was crucial to avoid any hemodynamic instability which may lead to a vicious spiral given the critical aortic stenosis. A temporary pacemaker was inserted to mitigate the risk of complete heart block which can occur, especially with rotational atherectomy of the RCA.

Chapter 9
Complex Case: Rotational Atherectomy Involving the Left Main Coronary Artery

Bradley D. Stauber, Reginald I. Low, and Gagan D. Singh

Case Summary

An 88-year-old man with high-risk NSTEMI was referred for angiography. He was found to have critical left main disease with a 99 % stenosis involving the proximal left anterior descending (LAD) artery and the proximal circumflex (LCX) stenosis consistent with Medina 1,1,1 (Fig. 9.1). The lesion was heavily calcified (Fig. 9.2). The right coronary artery system was found to have a chronic total occlusion of the

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proximal RCA with left-to-right and right-to-right collaterals (Fig. 9.3). An intra-aortic balloon pump was placed to augment coronary perfusion. Cardiothoracic surgery consultation was sought; however, given his age and comorbidities, he was of prohibitive risk for surgical revascularization.

Twenty-four hours later, he was brought back to the cardiac catheterization laboratory where he was intubated, and the IABP was removed. Arterial and venous cannulae where then inserted via the femoral approach for cardiopulmonary

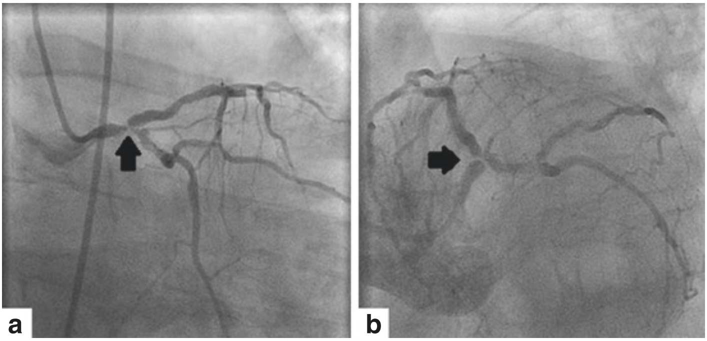

Figure 9.1 Diagnostic angiographic images showing critical left main disease involving the LAD and proximal circumflex artery in Medina 1,1,1 pattern (*black arrow*)

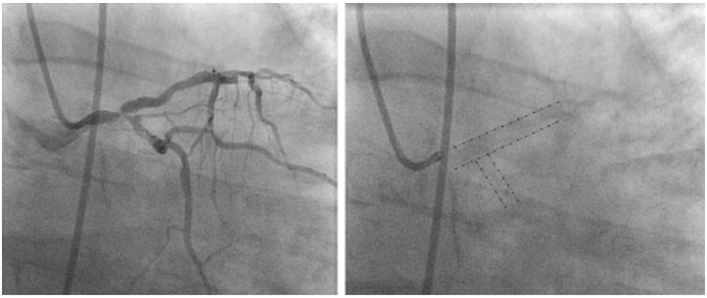

Figure 9.2 Baseline RAO image with dye and without dye illustrating diffuse calcification outlining the LAD and the left circumflex artery (*dashed line*) of left main-LAD-circumflex system

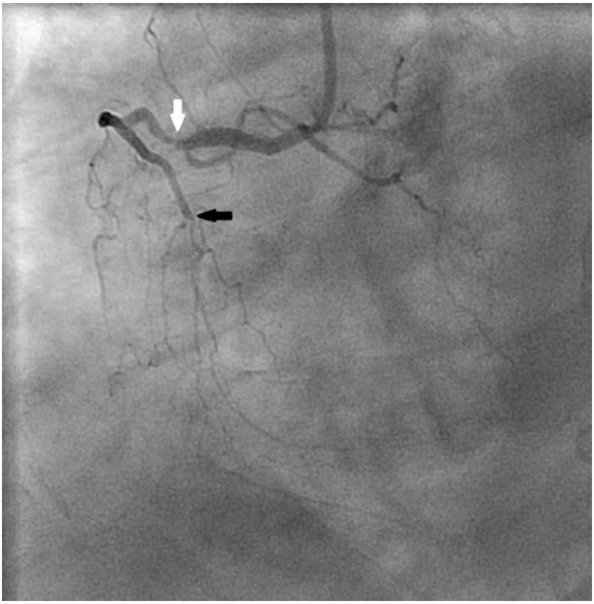

Figure 9.3 Right coronary angiography with chronic total occlusion of the proximal RCA (*white arrow*) with right-to-right collaterals including some supplied from the RV marginal (*black arrow*)

bypass support (i.e., ECMO). Next, an 8-french JL4 guide catheter was then used to engage the left main coronary artery. A 0.014″ guidewire was navigated through the LM lesion and into the first OM of the LCX artery. Using a 2.0″ over the wire balloon, the Fielder wire was exchanged for a 0.09 Roto extra-support wire (Fig. 9.4).

After removal of the over-the-wire balloon, rotational atherectomy was performed with a 1.25 mm burr from the LM and into the proximal LCX and into the first OM. Rotational atherectomy was performed at 150,000 rpm, and multiple passes are made until the burr moved freely without resistance or decelerations. The 1.25 mm burr was removed, and using an over-the-wire balloon, the Roto wire was redirected into the ongoing LCX. A 1.5 mm burr was advanced, and the procedural steps were repeated (Figs. 9.5 and 9.6). Follow-up

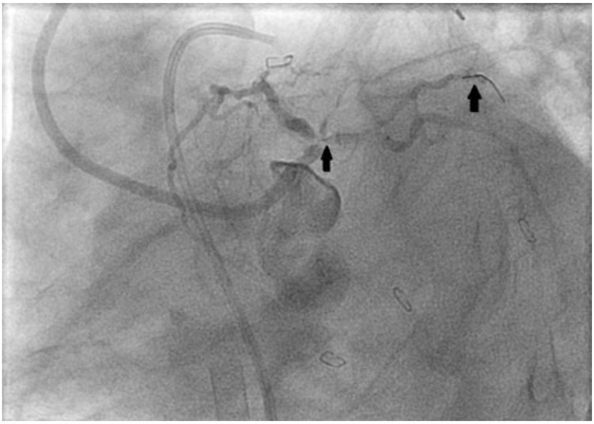

Figure 9.4 Crossing of LM lesion (proximal *black arrow*) into the first OM branch of the left circumflex artery (distal *black arrow*) initially with a 0.014″ Fielder FC wire and then exchanging for a 0.09″ Roto extra-support wire with 2.0″ over the wire balloon

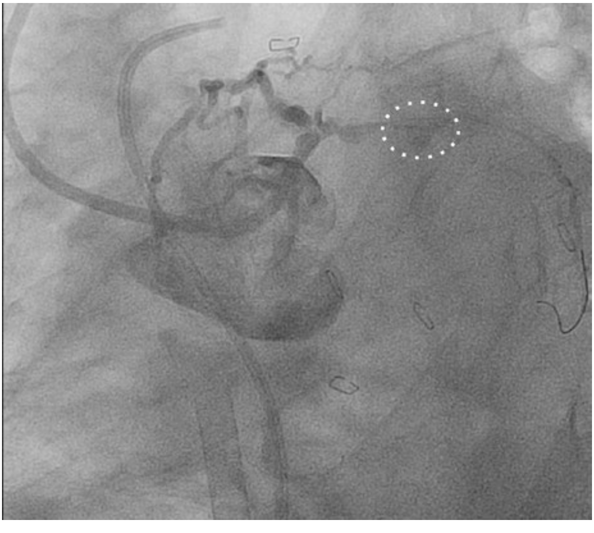

Figure 9.5 Ellis type I vessel perforation of the left circumflex post rotational atherectomy, *(white circle)*, illustrating extravasation of contrast material outside of vessel wall that is not free flowing but rather contained within a cap

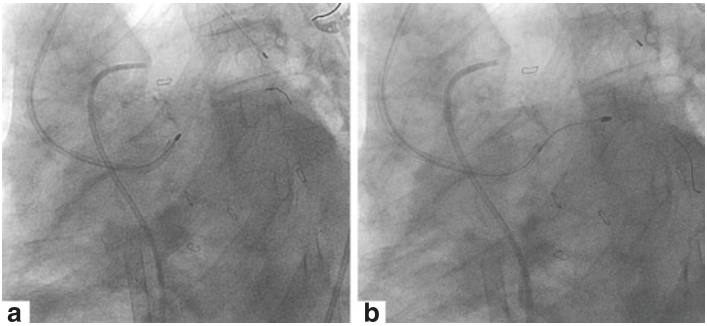

FIGURE 9.6 1.25 mm (**a**) and 1.5 mm (**b**) burr rotational atherectomy to the left circumflex

angiography at this point demonstrated a type C NHLBI (also referred to as Ellis type I vessel perforation – contained) vessel dissection (Fig. 9.5, Video 8.1). As the patient remained hemodynamically stable, we elected not to give up wire position in the LCX because of the dissection. Using an over-the-wire balloon, the LCX Roto wire was exchanged out for a standard 0.014″ wire. We next directed a hydrophilic 0.014″ wire through the LAD lesion and into the distal vessel. Using an over-the-wire balloon, we exchanged out the LAD wire for a roto 0.009″ wire. With the additional wire in the LCX, it becomes critical not to begin rotational atherectomy until the burr is beyond the LCX wire (Fig. 9.7). Rotational atherectomy was performed using a 1.5 mm followed by a 1.75 mm burr. After adequate atherectomy, the burr was removed, and using an over the wire balloon, the Roto wire was exchanged out for a standard 0.014″ guidewire.

We next treated the LM, LCX, and the LAD with scoring atherectomy with 3.0 mm in the LM + LAD and 2.5 mm in the LCX (Fig. 9.8). A “mini-crush” bifurcation stenting strategy was chosen. An unused 3.0 mm NC balloon was advanced into the mid LAD. We next advanced a 2.5 × 38 mm and 2.5 × 20 mm DES into the LCX with the proximal edge of the stent aligned to the ostium of the LCX. Once angiographic

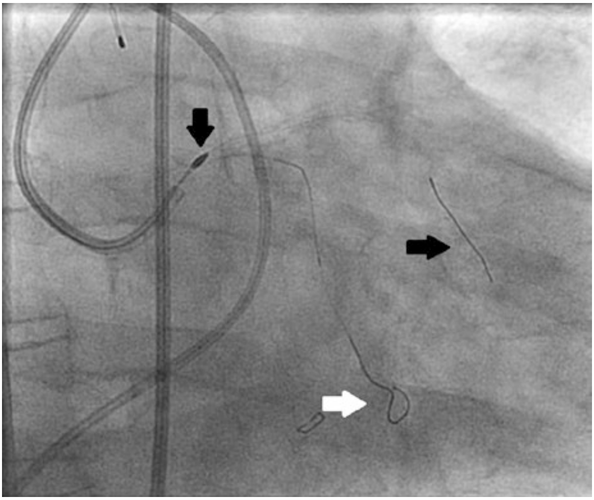

FIGURE 9.7 1.75 mm burr used for rotational atherectomy of proximal LAD, with guidewire remaining in the left circumflex system. *Black arrows* delineate the burr and guidewire in LAD; *white arrow* delineates guidewire in circumflex

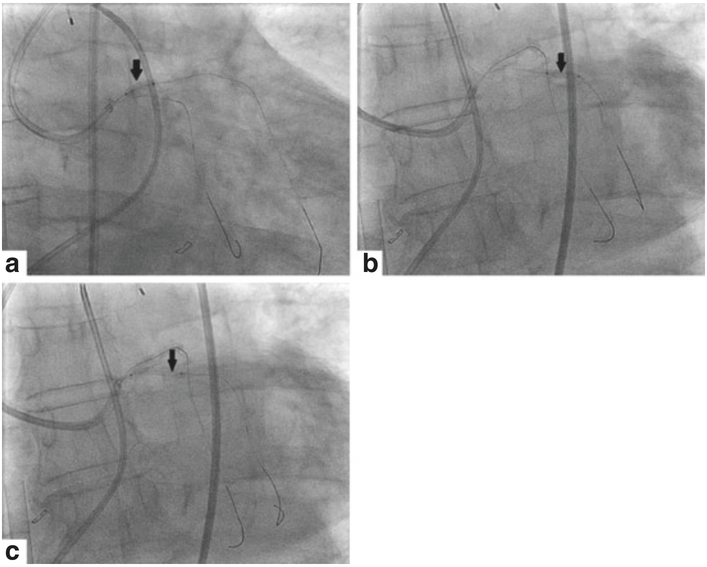

FIGURE 9.8 Scoring atherotomy to the left circumflex and LAD prior to stenting

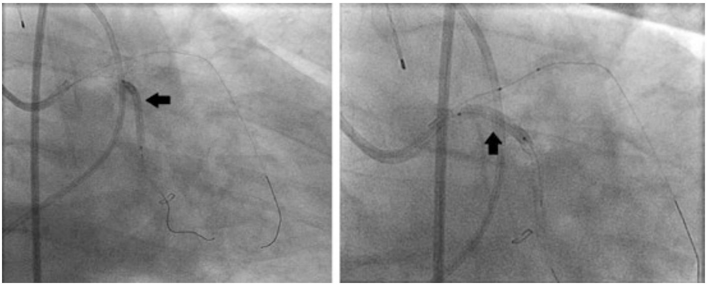

FIGURE 9.9 Deployment of two drug-eluting stents to left circumflex, 2.5 × 38 mm (*left*) and 2.5 × 20 mm (*right*)

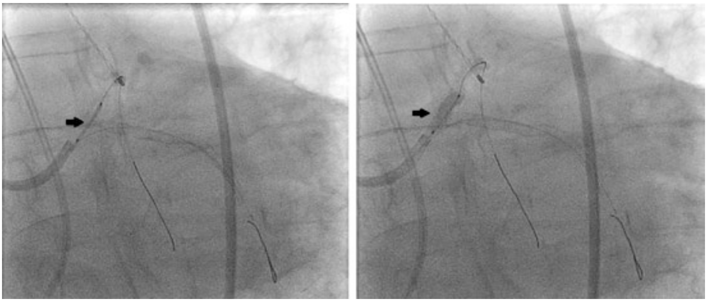

FIGURE 9.10 Positioning of balloon across circumflex stent into LAD (*left*) followed by balloon expansion and crush technique (*right*)

location was confirmed, the stents were deployed (Fig. 9.9). The LCX stent delivery system was removed. We next retracted the mid LAD balloon across the ostium of the LCX, and the protruding struts were then "crushed" over (Fig. 9.10). The 3.0 mm NC balloon was removed. We next inserted a 3.0 × 18 mm DES from the LM into the proximal LAD and stent deployed. The LCX wire was removed, and the LCX was rewired from within the newly deployed LM/LAD stent. At this point, both LAD/LCX and LM stents were then post-dilated individually and finally with kissing inflations. Final angiographic images revealed well-apposed stents with TIMI-3 flow (Fig. 9.11). The patient was weaned from cardiopulmonary support.

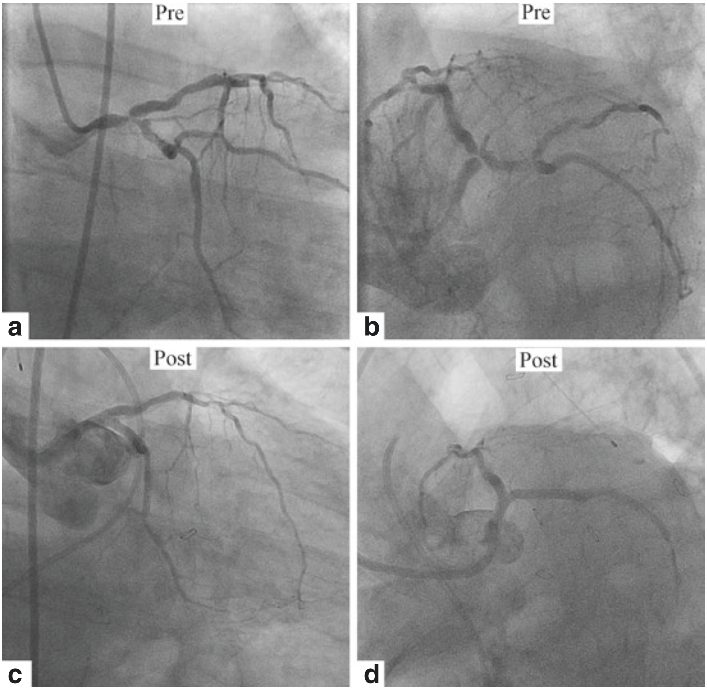

FIGURE 9.11 Pre-intervention angiographic images (**a**, **b**) followed by final angiographic images after LAD and left circumflex stenting (**c**, **d**)

Discussion and Learning Points

This case showcases complex coronary anatomy with LM bifurcation disease. In general, it is important to remove guidewires from the side branch prior to rotational atherectomy. However, in this case, due to the presence of critical LCX disease and a dissected area, there was a real risk of abrupt vessel closure of the LCX. We elected to perform rotablation of the LAD beyond the LCX wire. This is not routinely recommended and should only be performed in extenuating circumstances such as this and by experienced operators only.

The other major learning point is adequate patient preparation. With the RCA CTO, the patient essentially had only the LM supply for the entire heart. Given the critical disease involving the LM, LAD, and LCX, it was felt that he needed ECMO support. With ECMO, the procedure was safely performed. In complex and high-risk situations, the operators should plan for hemodynamic support in order to optimize patient outcomes. This can be an intra-aortic balloon pump, Impella, ECMO, or other similar devices.

Chapter 10
Complex Case: LM and LAD

Jiang Ming Fam and Soo Teik Lim

Case Summary

A 69-year-old female was admitted for unstable angina. She had cardiovascular risk factors of diabetes mellitus, hypertension, and hyperlipidemia. She also had end-stage renal failure secondary to diabetic nephropathy and was on hemodialysis. She presented with severe chest pain 1 month prior to presentation. A diagnostic angiogram done earlier showed severe critical left main disease (Fig. 10.1a, b; Video 10.1, 10.2). Physical examination was unremarkable. After discussion, she declined high-risk surgery and decided for high-risk PCI.

Via right femoral access, a 7F EBU3.5 was used to provide support. The lesion was crossed with a RotaFloppy[R] wire.

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Intravascular ultrasound (IVUS) imaging was attempted; however, the IVUS catheter (Boston Scientific OptiCross 40 MHz 135cm^R) could not cross (Fig. 10.2). Rotational ather-

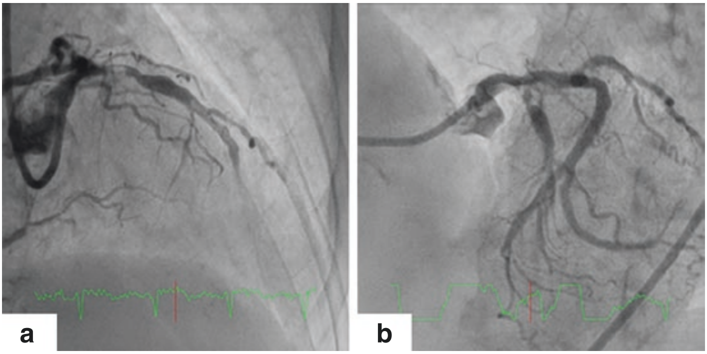

FIGURE 10.1 (**a**, **b**) Shows left coronary system with severe calcific stenosis seen in the left main and LAD

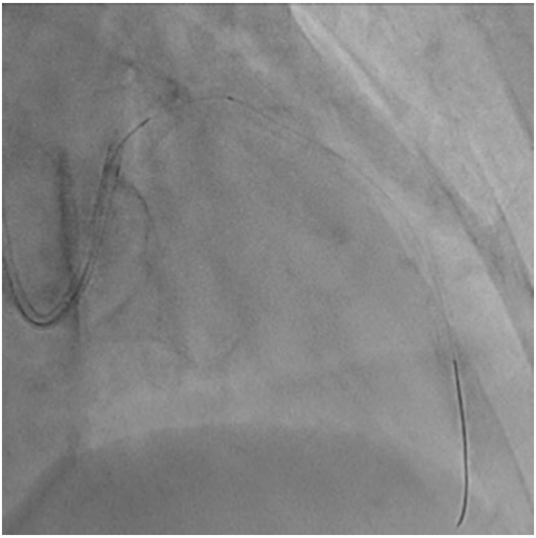

FIGURE 10.2 The IVUS catheter (Boston Scientific OptiCross 40 MHz 135 cm^R) could not cross the lesion

ectomy was then performed using 1.5 mm burr at 150,000 rpm (Fig. 10.3a; Video 10.3, 10.4). Further atherectomy with a bigger 2 mm burr was carried out (Video 10.5, 10.6). Adequate lesion preparation was finally achieved with successful passage of the IVUS catheter (Figs. 10.4a, b and 10.5a–d). Further predilation was performed with a noncompliant balloon 5.0 × 15 mm at 18 atm (Fig. 10.6a–d). A 5 × 26 mm DES

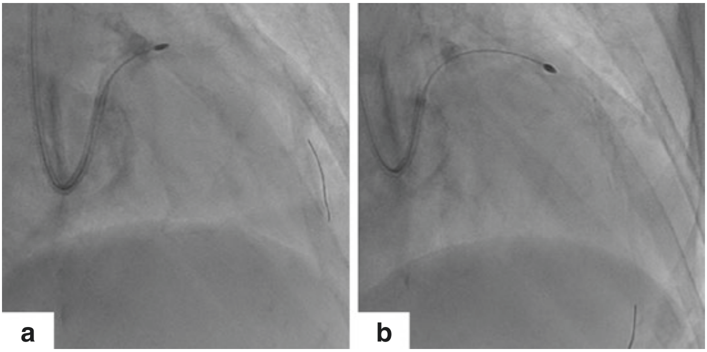

FIGURE 10.3 (**a**, **b**) Shows rotational atherectomy performed with 1.5 and 2.0 mm burrs

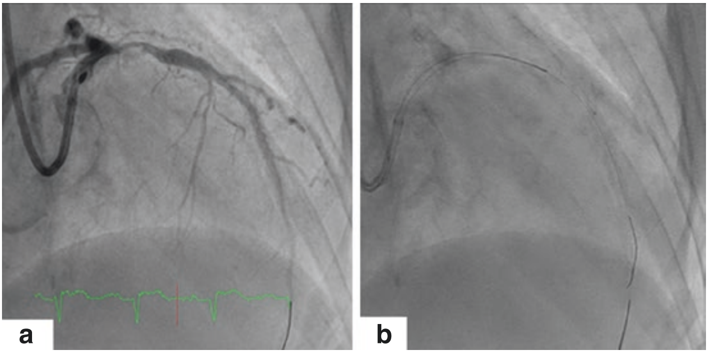

FIGURE 10.4 (**a**) Shows the vessel after rotablation; (**b**) shows the IVUS catheter crossing the lesion

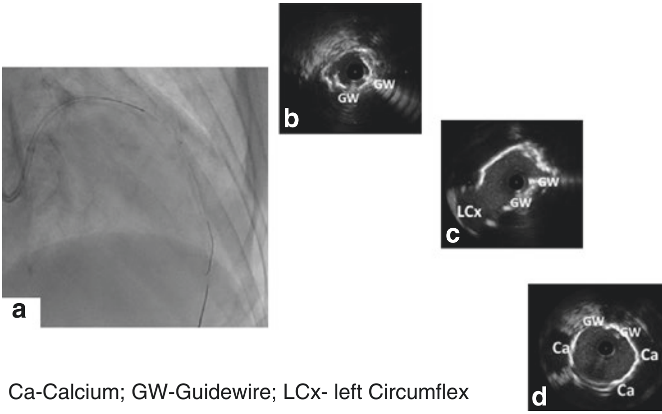

FIGURE 10.5 This shows cross sections of the IVUS. (**a**) Shows two guidewires in the LAD and the presence of the IVUS catheter; (**b**) shows the LAD with two guidewires; (**c**) shows the ostium of the LAD with severe circumferential calcium; **(d)** shows the left main with circumferential calcium

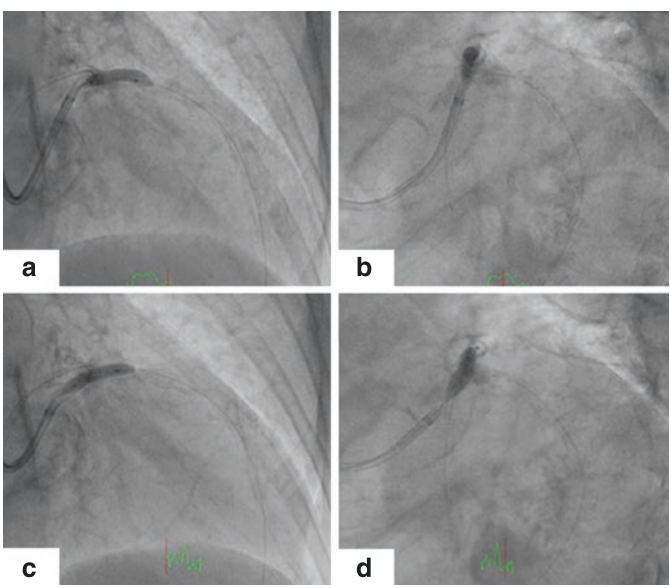

FIGURE 10.6 This shows predilatation with a 5.0 NC balloon

was deployed at the left main to proximal LAD (Fig. 10.7a–c). The stent was postdilated with 5.0 × 15 mm (18 atm) and 5.5 × 12 mm (12 atm) noncompliant balloons. Good angiographic result was achieved as seen in the final angiogram (Fig. 10.8a, b, Video 10.7, 10.8).

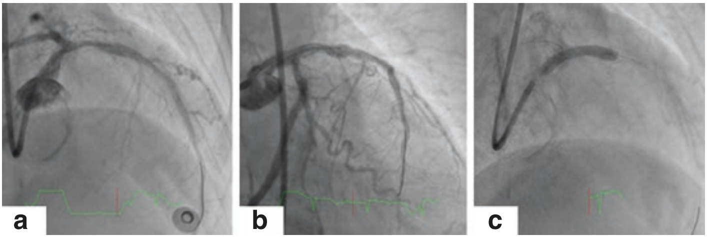

FIGURE 10.7 This shows positioning and deployment of the 5.0 DES

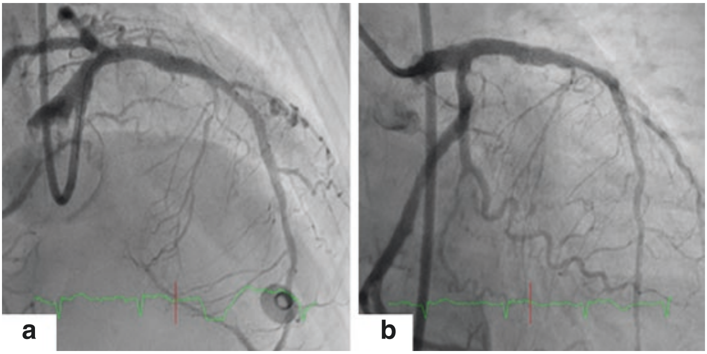

FIGURE 10.8 This shows the final angiogram with an excellent angiographic result

Discussion and Learning Points

The IVUS is a useful invasive diagnostic imaging tool in the evaluation of the left main anatomy, selection of treatment strategy, and optimal stenting outcomes. As the left main is short and lacks a normal segment for comparison, angiography has a limited ability to assess the true luminal size of the left main artery. Post stent implantation, IVUS can assess for adequate expansion of drug-eluting stent, reduce malapposition rates, and achieve full lesion coverage. In this case, the calcific stenosis prevented the IVUS catheter from crossing the lesion. Rotational atherectomy was needed to adequately prepare the lesion before the IVUS catheter could cross and guide subsequent PCI. This case also illustrates the following learning points:

- It is possible to cross a severely stenotic lesion with a Rota Floppy wire.
- IVUS is an essential tool when considering PCI to the left main.

Chapter 11
Complex Case: LM and LCX

Arie Steinvil and Lowell Satler

Case Summary

The patient is a 66-year-old female with a past medical history of hypertension, hyperlipidemia, anemia, obesity, and CAD with CABG in 1999 (LIMA to LAD). She presented with intermittent exertional chest pain. Diagnostic cardiac catheterization demonstrated LM distal 80%, LAD proximal 100% with a patent LIMA/LAD, LCX proximal 80% stenosis, and RCA ostial 50% stenosis. A nuclear stress test demonstrated a small- to medium-sized area of inferior ischemia and LVEF of 67%. She underwent PCI of the LM and LCX lesions using a 3.5 EBU guide catheter. A wire was advanced toward the diagonal branch, and rotational

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atherectomy with a 1.5 mm burr was performed in the left main. This was followed by wiring of the LCX; however, LCX lesion crossing with a balloon was unsuccessful, and the procedure was aborted due to concerns regarding the risk of local complications (Figs. 11.1 and 11.2 and Videos 11.1 and 11.2). The patient was referred for an additional PCI attempt. A BMW wire was used to cross the lesion facilitated with a Finecross micro-catheter. The micro-catheter did not cross the LCX lesion; however, a floppy Rota wire was advanced alongside the BMW wire successfully. The BMW wire was then removed. Rotational atherectomy using a 1.25 mm burr at a speed of 170–180 k was performed followed by a second run with a 1.5 mm burr. Pre-dilatation was performed with a 2.5 × 12 mm noncompliant balloon, followed by successful PCI of the proximal circumflex with a 3.25 × 12 mm drug-eluting stent, and successful PCI of the LM with 3.5 × 23 mm DES overlapping the LCX stent (Figs. 11.3 and 11.4 and

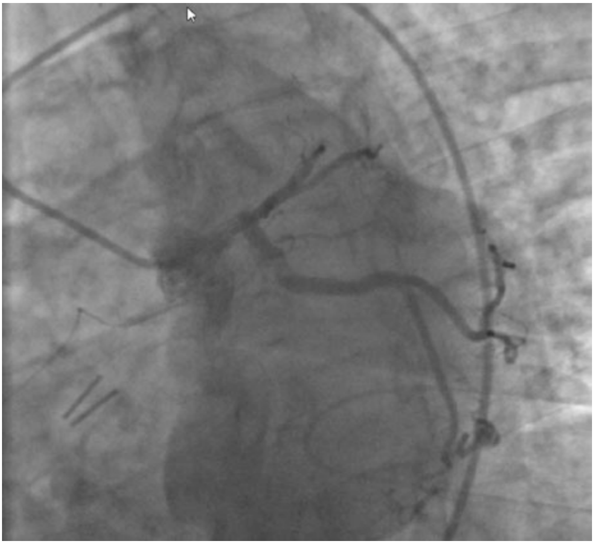

FIGURE 11.1 Baseline LCX lesion. A highly calcified lesion is appreciated in the proximal LCX

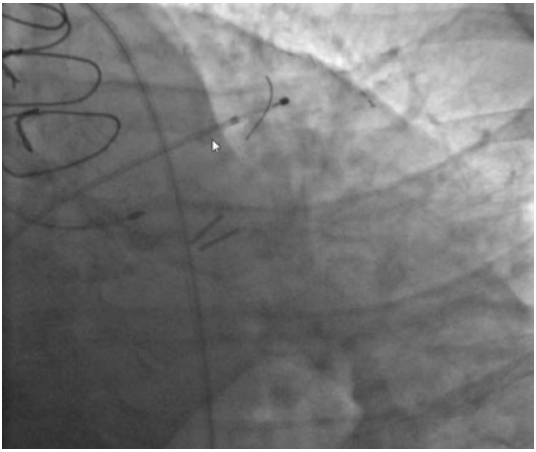

Figure 11.2 A wire was advanced toward the diagonal branch and rotational atherectomy with a 1.5 mm burr was performed

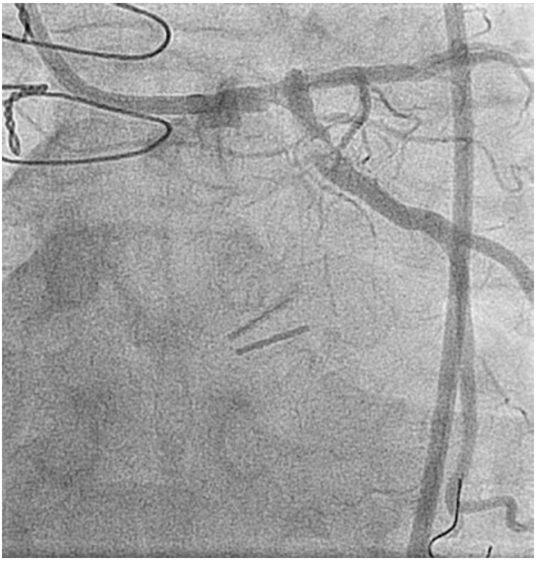

Figure 11.3 Rotational atherectomy with a 1.25 mm burr followed by a 1.5 mm burr was performed on the LCX lesion leading to post-atherectomy lumen size gain and allowing stent crossing

FIGURE 11.4 Final result: Optimal stent deployment was validated with IVUS guidance

Videos 11.3 and 11.4). Excellent angiographic results with TIMI III flow were noted. IVUS imaging confirmed optimal apposition and expansion of the treated lesion.

Discussion and Learning Points

- Rotational atherectomy along the tract of the target lesion is crucial for the advancement of devices through narrow, calcified, or tortuous vessels for appropriate lesion preparation.
- It is sometimes possible to advance the Rota wire alongside a standard wire even if a micro-catheter cannot cross.
- Severely angulated vessels, such as the LCX in this case, may still be rotablated with proper technique.

Chapter 12
Complex Case: Saphenous Vein Graft

Bradley D. Stauber, Reginald I. Low, Jeffrey A. Southard, and Gagan D. Singh

Case Summary

A 61-year-old man with a history of five-vessel coronary artery bypass grafting was found to have symptomatic, severe, and critically obstructive calcific lesions of the vein graft to the RCA.

A 7F MPA guide catheter was directed to the ostium of the vein graft to right coronary artery (Fig. 12.1). A 0.014 guidewire was advanced beyond the distal lesion, and an intravascular imaging catheter was inserted to assess reference vessel diameters and delineation of calcification of the lesions (Fig. 12.2). On IVUS imaging, note that the vessel diameter in the areas of heavy calcification is 3.5 × 3.0 mm.

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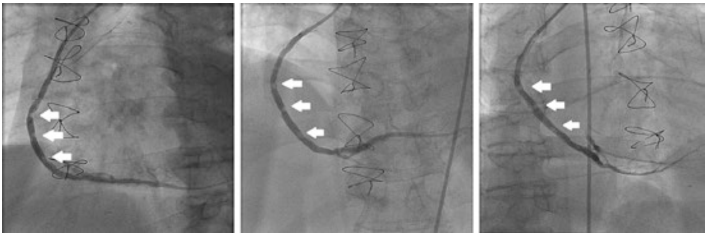

Figure 12.1 Angiography of RCA graft showing multiple critically obstructive lesions

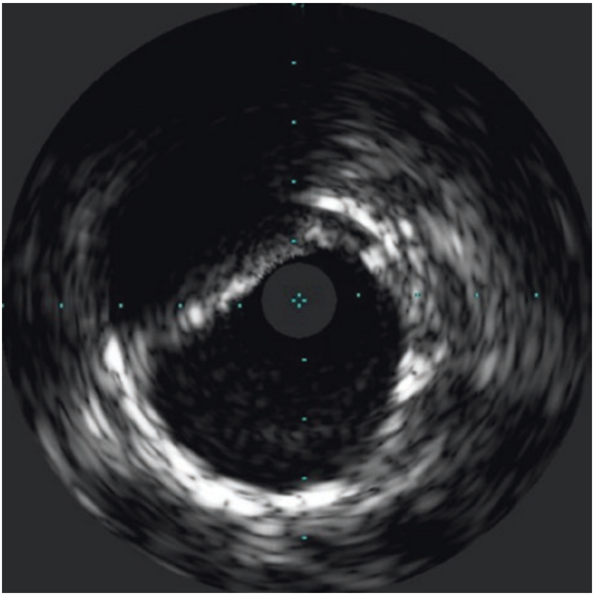

Figure 12.2 Intravascular ultrasound of vein graft showing heavy calcification (*white*), especially from 9 to 12 O’clock

A temporary pacemaker was inserted into the right ventricle. The 0.014″ guidewire was next exchanged for a Roto extra-support wire. The saphenous vein graft was burred at 150,000 RPM with a 1.5 mm (Fig. 12.3) and a 2.0 mm burr (Fig. 12.4). Scoring atherotomy was performed at this stage (Figs. 12.5). Next, three overlapping 4.0 × 28 mm everolimus DES were placed in overlapping fashion (Figs. 12.6, 12.7,

Figure 12.3 Rotational atherectomy of vein graft with 1.5 mm burr followed by repeat angiography

Figure 12.4 Rotational atherectomy of vein graft with 2.0 mm burr followed by repeat angiography

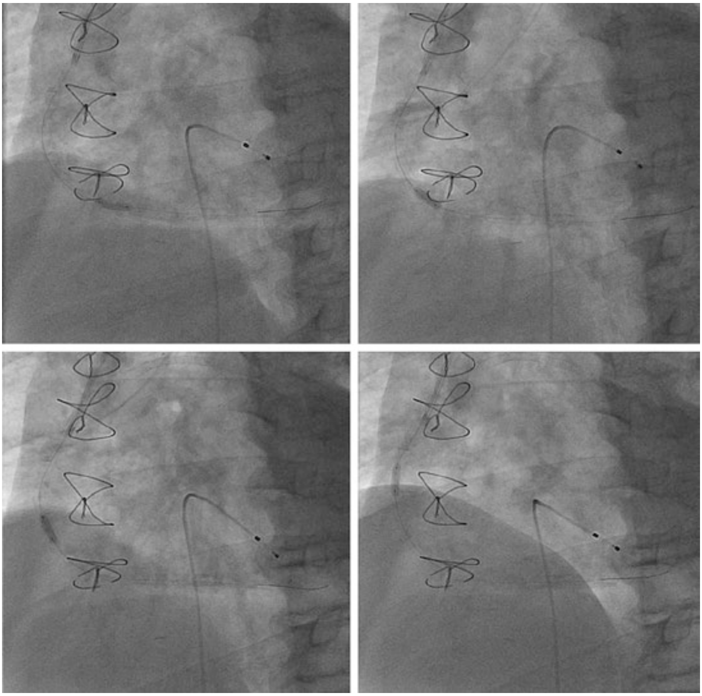

FIGURE 12.5 Scoring atherotomy to vein graft

and 12.8). The intravascular ultrasound catheter was reinserted, showing that the stents were under-deployed in some areas, at which point a 5.0 mm noncompliant balloon was used to post-dilate the stent (Fig. 12.9). Final angiographic images were obtained showing excellent results (Fig. 12.10).

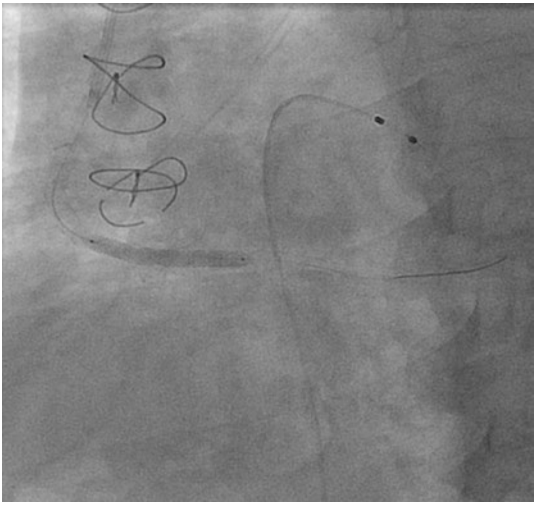

Figure 12.6 Three 4.0 × 28 mm Promus drug-eluting stents placed in overlapping fashion to vein graft

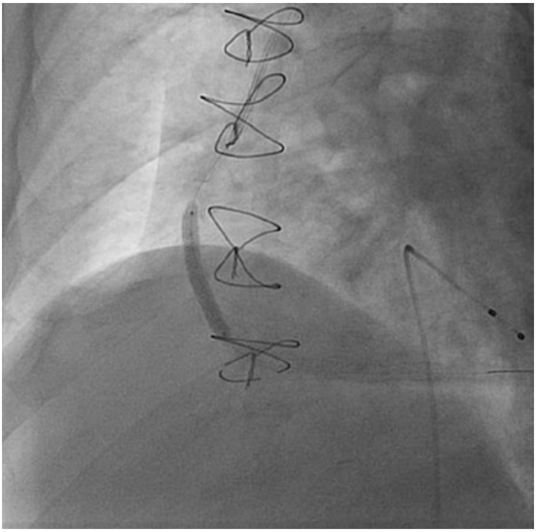

Figure 12.7 Three 4.0 × 28 mm Promus drug-eluting stents placed in overlapping fashion to vein graft

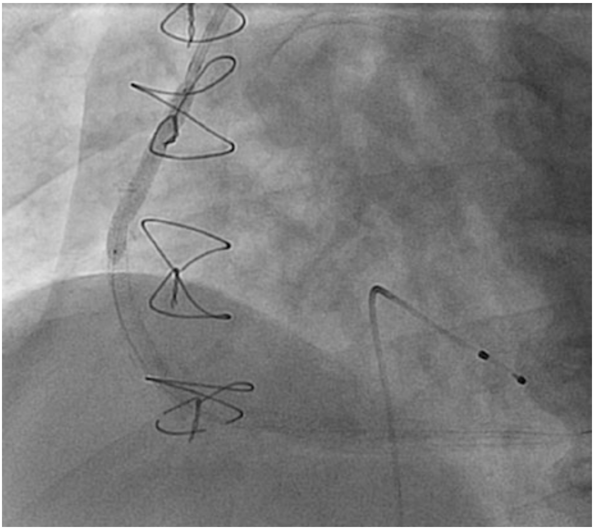

FIGURE 12.8 Three 4.0 × 28 mm Promus drug-eluting stents placed in overlapping fashion to vein graft

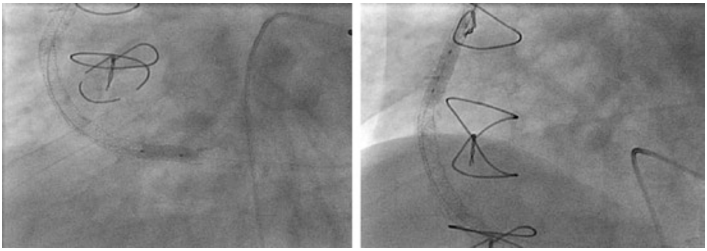

FIGURE 12.9 Noncompliant balloon used to post-dilate the overlapping stents

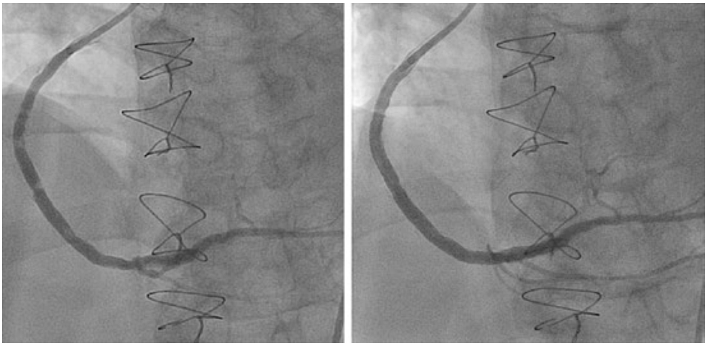

FIGURE 12.10 Final angiographic images (*right*) compared to pre-PCI (*left*)

Discussion and Learning Points

Rotational atherectomy of saphenous vein grafts is possible in appropriately selected patient. The use of rotational atherectomy in this setting is not meant to create a channel as it is normally used in critically stenosed and calcified lesions. Rather, rotational atherectomy in this setting creates fissures/cracks within the calcific lesion allowing for better vessel prep and optimal stent expansion.

Chapter 13
Complex Case: In-Stent Restenosis

Bradley D. Stauber, Reginald I. Low, Jeffrey A. Southard, and Gagan D. Singh

Case Summary

A 51-year-old man with a history of ischemic cardiomyopathy (LVEF 25%) and known coronary artery disease with prior RCA stenting is referred for angiography for high-risk non-ST elevation myocardial infarction.

Diagnostic angiography of the left coronary artery system showed mild to moderate nonobstructive coronary disease (Fig. 13.1). Fluoroscopy, prior to contrast dye injection, shows previously placed stents throughout the right coronary system (Fig. 13.2). Angiography showed severe in-stent restenosis of 90% in the proximal and mid RCA (Fig. 13.3). At this point, the diagnostic catheter was exchanged for an AL 0.75 7F guiding catheter, and a temporary pacemaker was placed in preparation for rotational atherectomy.

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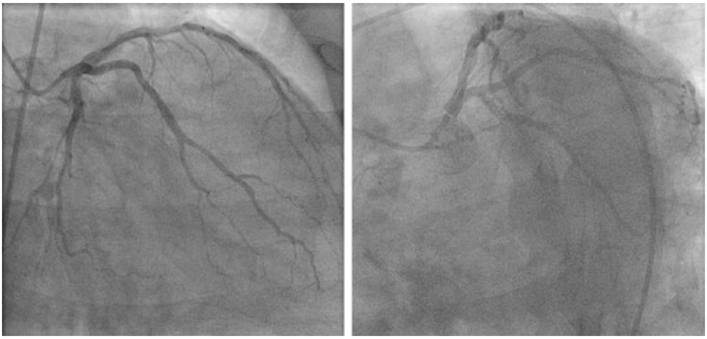

FIGURE 13.1 Baseline angiographic images of the left coronary system showing mild to moderate nonobstructive disease

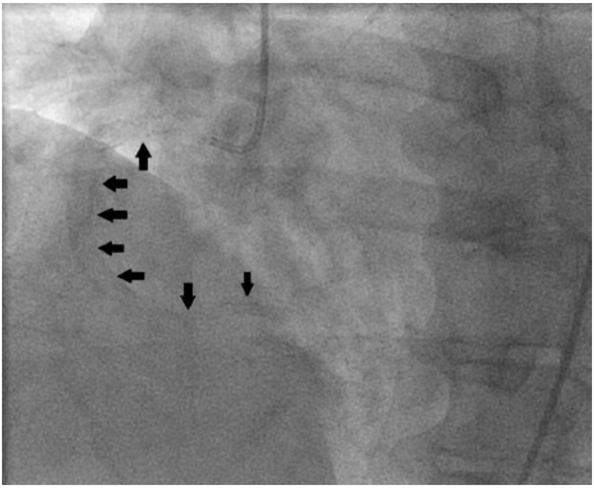

FIGURE 13.2 Fluoroscopy image of RCA without contrast showing previously placed stents (*black arrows* demonstrating outline of stented artery)

A 0.014 guidewire was placed beyond the mid-RCA lesion, and the wire was then exchanged for a 0.014 Extra Support guidewire. Rotational atherectomy was performed using a 1.25 mm burr, with multiple passes made (Fig. 13.4). The rotational atherectomy system was then exchanged for a

FIGURE 13.3 Angiography of RCA showing severe in-stent restenosis of proximal and mid-RCA delineated with *black arrows*

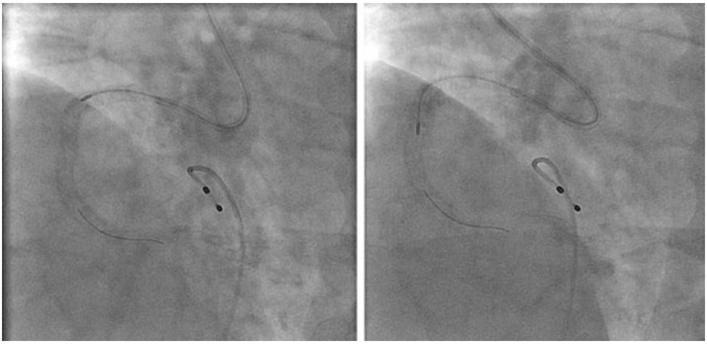

FIGURE 13.4 Rotational atherectomy to RCA with 1.25 mm burr

1.5 mm burr, and more passes were made (Fig. 13.5). Repeat angiography revealed improved but residual luminal narrowing (Fig. 13.6), and the proximal and mid-RCA lesions were dilated with a scoring balloon (Fig. 13.7a, b). Over the wire, a 3.5 × 38 mm DES was deployed (Fig. 13.7c) and post-dilated with a 4.0 × 12 mm noncompliant balloon (Fig. 13.7d). Final angiographic pictures revealed excellent results (Fig. 13.8) with TIMI-3 flow. There were no complications.

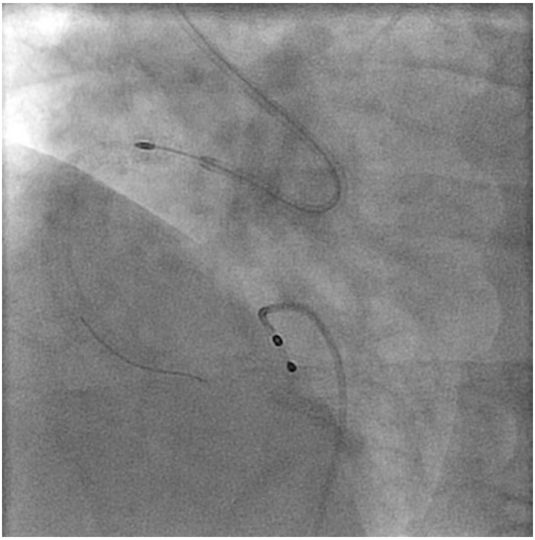

FIGURE 13.5 Rotational atherectomy to RCA with 1.5 mm burr

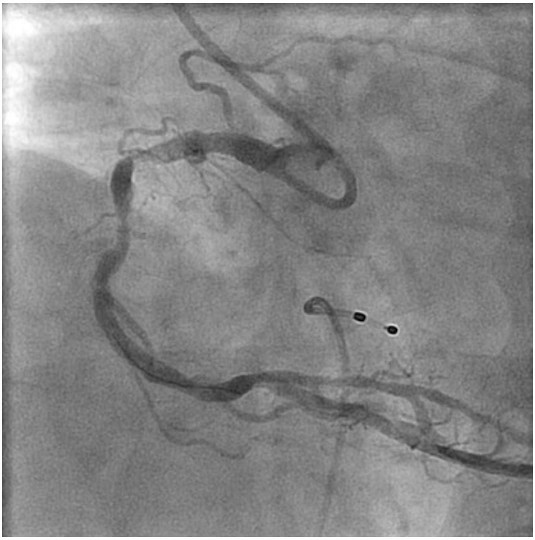

FIGURE 13.6 Repeat angiography post-rotational atherectomy showing improved but residual luminal narrowing

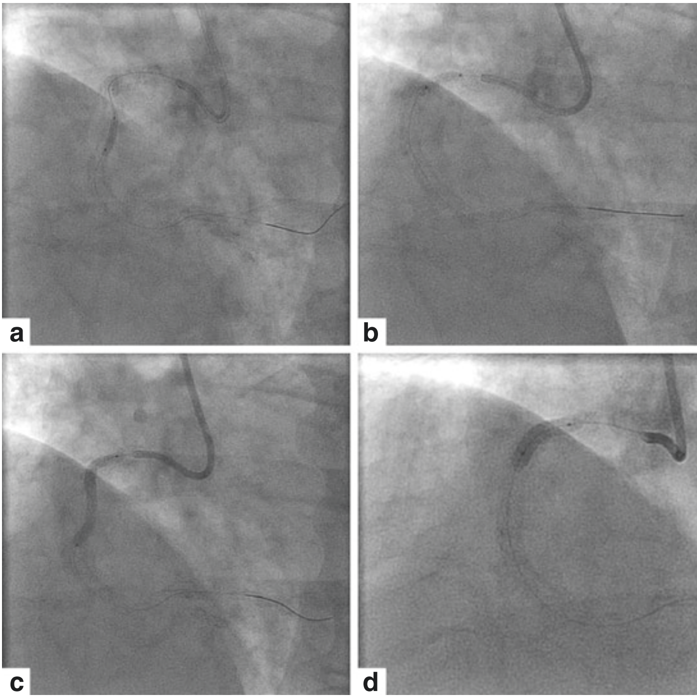

FIGURE 13.7 Scoring atherotomy prior to stenting (**a**, **b**) followed by deployment of 3.5 × 38 mm DES (**c**) and post-dilatation (**d**)

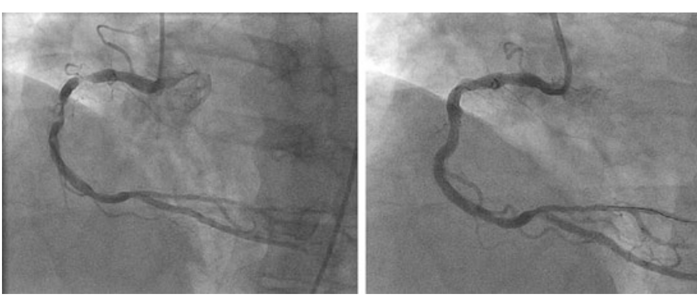

FIGURE 13.8 Before and after images of RCA status post-rotational atherectomy followed by stenting in the setting of in-stent restenosis

Discussion and Learning Points

This case highlights the use of rotational atherectomy to treat severe in-stent restenosis. The presence of prior stents is not a contraindication of rotablation. In this case, tortuosity and extensive prior stenting all make PCI complicated. With rotablation, the procedure becomes much easier.

Chapter 14
Complex Case: High-Risk Acute Coronary Syndrome

Timothy Watson, Hee Hwa Ho, and Paul Jau Lueng Ong

Case Summary

A 68-year-old man with diabetes mellitus, hypertension, chronic kidney disease, hyperlipidemia, and peripheral arterial disease was admitted for non-ST-elevation myocardial infarction. He had known CAD and had previously undergone PCI to the mid- and proximal LAD on separate occasions.

Coronary angiography showed extensive calcification. There was severe stenosis of the distal LM extending into

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the proximal segments of both the LAD and LCX coronary arteries (Figs. 14.1 and 14.2, Videos 14.1 and 14.2). The first diagonal was occluded. The RCA was also heavily calcified with moderate to severe diffuse disease (Fig. 14.3, Video 14.3). The calculated Syntax score was 33. An intra-aortic balloon pump was inserted and he was referred for urgent CABG.

He was stabilized successfully and transferred to the nearest surgical facility. However, due to persistent fevers and high-risk clinical picture, the cardiac surgeons felt that he was at prohibitive surgical risk, and he was returned for further management. Unfortunately, he developed an acute abdomen with CT imaging consistent for intestinal ischemia. The surgical team advised emergency laparotomy. However, the anesthesiologists were reluctant to support this given critical LM disease. It was therefore agreed that he should undergo emergency PCI and be transferred to the operating theater after reversal of systemic heparinization.

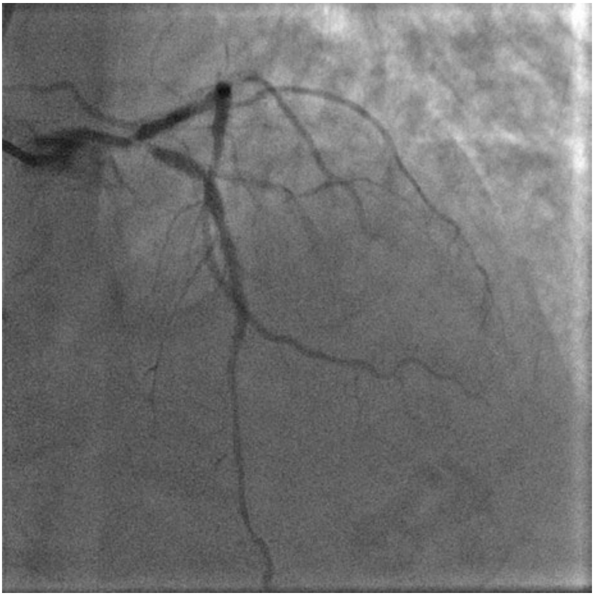

FIGURE 14.1 PA Cranial view of left coronary system. *Note:* the critical proximal LAD disease

Figure 14.2 LAO Caudal view of left coronary system. *Note:* critical LM bifurcation disease (Medina 1,1,1)

Figure 14.3 LAO view of the right coronary system. *Note:* diffuse moderate plaque disease

A 6F XB3.5 guide catheter was inserted from the right radial artery. A 0.009″ floppy Rotawire was advanced down the LAD. We proceeded to debulk using a 1.5 mm burr at 190,000 rpm using gentle but constant pressure on the lesion for a total of 60 s in 20 s bursts taking care to avoid decelerations (Fig. 14.4, Video 14.4). Having proven absence of extensive dissection, the Rotawire was then withdrawn and resited into the LCX. Rotational atherectomy was again performed using the same 1.5 mm burr at 190,000 rpm using the same technique for a total of 40 s. The patient remained hemodynamically stable throughout both these maneuvers.

Both LAD and LCX were then wired with separate High Torque Balance wires (Abbott Vascular, IL, USA) (Video 14.5). Further lesion preparation was undertaken with serial

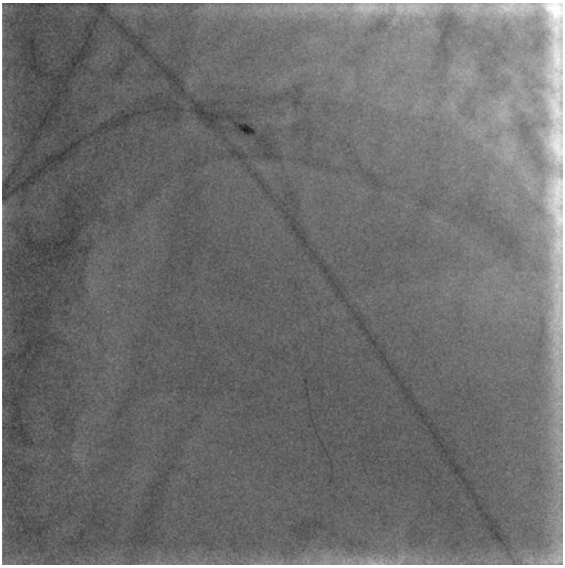

Figure 14.4 PA Cranial view.
Note: the 1.5mm burr is being used to debulk the LM and LAD lesion.

pre-dilatation of LM and proximal segments of both daughter vessels using a 3.0 × 15mm noncompliant balloon. A 3.50 × 12 mm DES was inserted into the LCX, and a second 3.5 × 20mm DES was placed in the LAD into the LM using a T-stenting technique (Fig. 14.5, Videos 14.6 and 14.7). Both stents were post-dilated and kissing balloon post-dilation was performed. Finally, the LM was post-dilated using a 4 × 12 mm NC balloon to 20 atm.

The final angiographic result was excellent and the patient remained hemodynamically stable throughout (Figs. 14.6 and 14.7, Videos 14.8 and 14.9). Immediately following the procedure, our patient was transferred to the operating room and underwent exploratory laparotomy. Extensive ischemic bowel was found and despite surgical resection, he died 4 days later.

FIGURE 14.5 LAO caudal view of left coronary system.
Note: the end markers of the DES are visible and facilitate positioning of the devices in this patient with heavily calcified arteries

FIGURE 14.6 LAO Caudal view of left coronary system. Final angiographic result shows both stents widely patent with significantly improved appearances

Discussion and Learning Points

This was a high-risk, complex case in which a PCI procedure was undertaken using rotational atherectomy of an LMS bifurcation. Although the PCI procedure was successful, the patient ultimately succumbed to profound sepsis and metabolic acidosis due to ischemic bowel.

Sequential rotational atherectomy of both branches of a bifurcation is possible [1]. This strategy does confer some additional risk due to temporary removal of the guidewire from the first branch while undertaking RA to the second branch of the bifurcation. An important step is to avoid entering any dissection plane created by the rotablation.

FIGURE 14.7 PA Cranial view of left coronary system. Final angiographic result of the ostial LAD with widely patent stent visible

Reference

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Chapter 15
Complex Case: Rotational Atherectomy in Myocardial Infarction

Jonathan Yap and Jack Wei Chieh Tan

Case Summary

The patient was a 65-year-old Indian male, with a significant history of diabetes mellitus, chronic kidney disease, and asthma. He was admitted for anterolateral ST-elevation myocardial infarction completed by cardiogenic shock complicated by cardiogenic shock requiring intubation and intra-aortic balloon pump insertion. Coronary angiography revealed heavily calcified triple vessel disease (Figs. 15.1, 15.2, and 15.3 Videos 15.1, 15.2, and 15.3). The family declined coronary artery bypass grafting. In view of ongoing cardiogenic shock, the decision was made to proceed with multivessel percutaneous coronary intervention.

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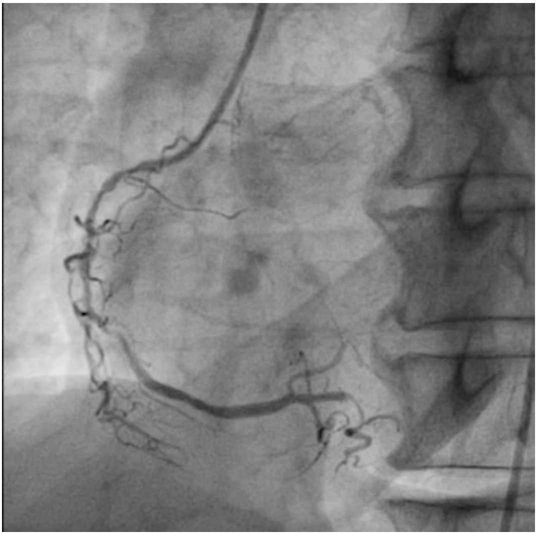

Figure 15.1 Calcified diffuse lesion from proximal to mid RCA

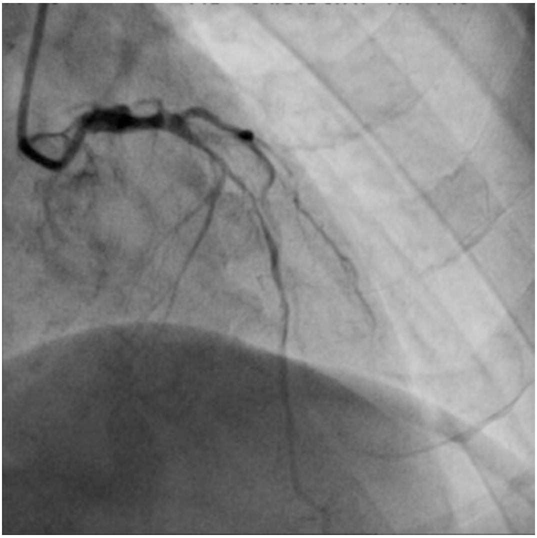

Figure 15.2 Calcified diffuse lesion from proximal to distal LAD

FIGURE 15.3 Calcified disease in distal LCX

The RCA was pre-dilated sequentially with a compliant 2.0 mm and non-compliant (NC) 2.5 mm balloon. However, the lesion was inadequately expanded (Fig. 15.4; Videos 15.3 and 15.4). Two runs of rotablation were then performed using a 1.5 mm burr (Fig. 15.5; Video 15.5), which helped to better prepare the lesion. This was followed by stenting with two overlapping 3.5 mm drug-eluting stent placement and post-dilation with NC 3.5 mm balloon. Video 15.6 show the well-expanded DES in RCA.

Next, the operator proceeded to intervene on the LCX, but there was difficulty passing a balloon to the distal LCX, and decision was made for medical therapy for the LCX lesion. An attempt to pre-dilate the left anterior descending artery with 2.0 mm balloon was made, but the balloon was unable to cross the calcified stenosis (Video 15.7).

Successful rotablation with a 1.5 mm burr was performed (Video 15.8). The "well-prepared" LAD post-rotablation

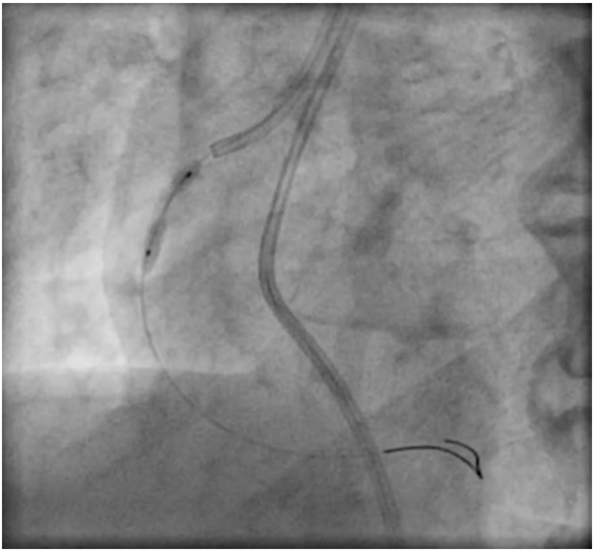

Figure 15.4 “Dogged boned” 2.5mm NC balloon signifying a calcified lesion that cannot be dilated

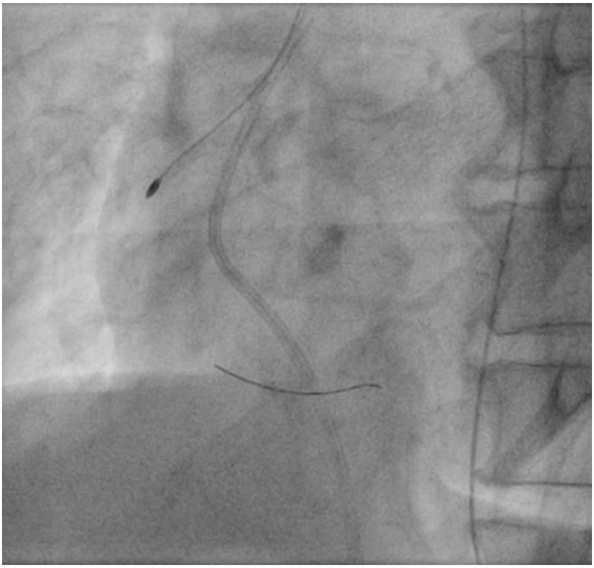

Figure 15.5 Successful Rotablation with 1.5mm Burr

allowed for adequate dilation with a NC 3.0 mm balloon. This was followed by PCI with overlapping DES (4.5 mm, 3.5 mm, and 2.75 mm) from left main to mid-LAD and post-dilated with NC 3.5 mm balloon in the LAD. Final IVUS showed well-expanded and apposed left main to mid-LAD stent with no edge dissection. Final angiogram showed a satisfactory result.

Discussion and Learning Points

This case highlights the successful use of rotablation in a patient presenting with STEMI and cardiogenic shock with concomitant complex calcified lesions that failed traditional methods of lesion preparation.

In STEMI, the use of rotablation has generally not been routinely practiced, and its use in this setting has mainly been used "off-label." The most feared complication is the phenomenon of slow or no reflow, attributed to distal embolization and reperfusion injury [1]. In rotablation in STEMI, an awareness of this complication and strategies to prevent this complication are crucial.

Prevention includes pharmacological means such as the use of atherectomy cocktails (nitroglycerin, verapamil, etc.) and sometimes GpIIb/IIIa inhibitors [2]. Procedural techniques to lower the risk of no reflow involve the use of shorter burr runs, lower rotational speeds, and lower burr size-artery ratio [2].

In the event of such an occurrence, mechanical factors resulting in reduced epicardial flow should be first ruled out. Subsequently, the treatment of established no reflow is mainly pharmacologic as the obstruction occurs at the level of the microvasculature [1]. This involves use of drugs like nitrates, adenosine, nitroprusside, etc. (best delivered to the distal artery via a microcatheter).

Rotablation can be a useful tool in the armamentarium of the interventionist in dealing with complex lesions in the setting of a STEMI. The proceduralist needs to be aware of the possibility of no reflow and be equipped to deal with such a scenario.

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Chapter 16
Complex Case: Rota Gutter in RCA

Bradley D. Stauber, Reginald I. Low, and Gagan D. Singh

Case Summary

A 75-year-old man with a history of CAD with prior CABG, DM, HTN, and CKD presented with NSTEMI. Angiography revealed a well-revascularized left-sided system (Fig. 16.1); however, the vein graft to the RCA was occluded with a heavily calcified and diseased proximal-mid RCA (Fig. 16.2). Also noted is a "shepherd's crook" proximal RCA. Right femoral venous access was obtained, and a temporary pacemaker was inserted into the right ventricular apex. We next advanced a 7 Fr JR4 guide catheter, and the RCA was engaged. We advanced a 0.014″ guidewire past the proximal

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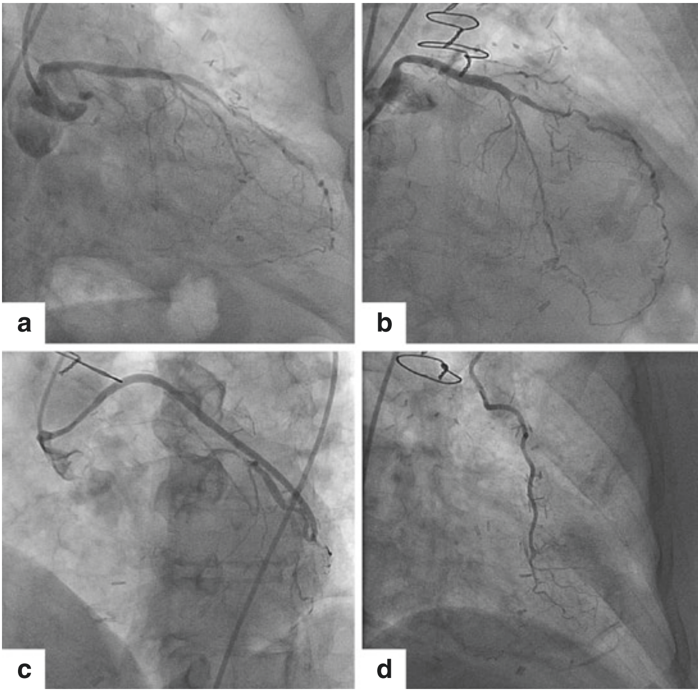

Figure 16.1 Baseline angiography of the left coronary system, showing native LAD/circumflex system (**a**, **b**) with patent vein graft to OM (**c**) and patent LIMA to LAD (**d**)

stenosis and into the distal vessel. Using a Turnpike LP microcatheter (Vascular Solutions, Minneapolis, Minnesota, USA), we exchanged out for a 0.009 rota extra-support wire. The microcatheter was removed and we next inserted a 1.25 mm burr and rotational atherectomy at 150 K RPM was performed. Multiple passes were made (Fig. 16.3). Follow-up angiography demonstrated a "guttered" proximal RCA owing to the heavy calcification, wire bias, and the patient's proximal "shepherd's crook" (Fig. 16.4). At this point, after noting a "guttered" RCA, it is important not to lose wire position. Using a microcatheter, the 0.009″ wire

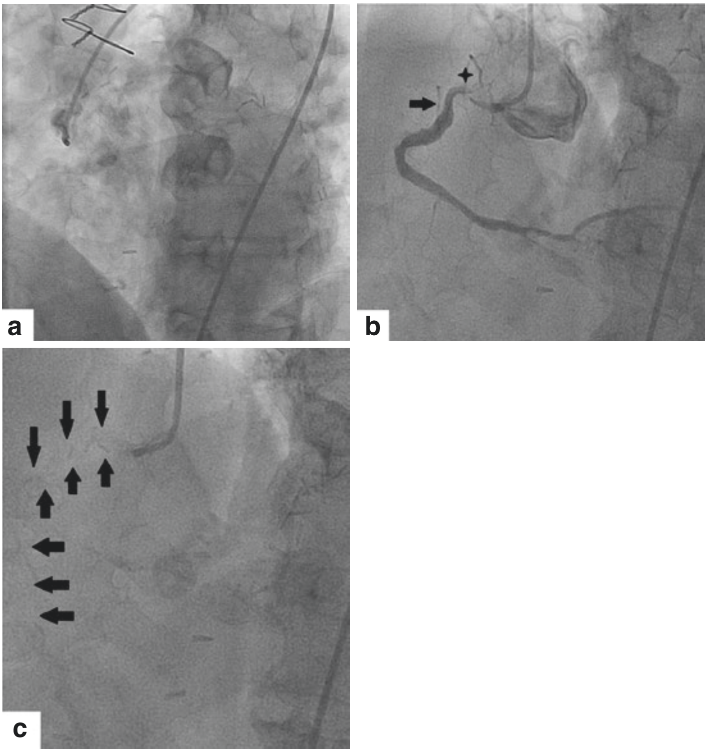

Figure 16.2 Occluded saphenous vein graft to RCA (**a**) and native RCA (**b**), showing shepherd's crook (*star*) and diffuse, obstructive calcific disease (*black arrow*). Native RCA without contrast dye (**c**) shows calcium deposition (outlined by *black arrows*)

was exchanged out for a standard 0.014″ extra-support wire. Predilatation and scoring atherotomy were then performed. We then advanced a DES and deployed it in the proximal-mid RCA. After appropriate postdilatation, there was substantial extra-stent cap noted (Fig. 16.5). We elected to deploy an additional stent within the first stent for enhanced scaffold support (Fig. 16.6). Postdilatation was then performed at high pressure. Follow-up angiography demonstrated a well-apposed proximal RCA stent system (Fig. 16.7).

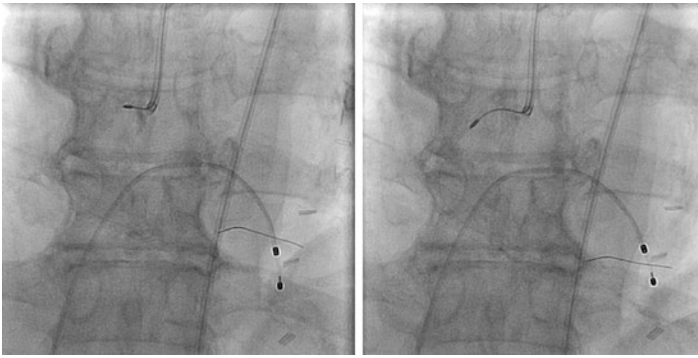

FIGURE 16.3 Rotational atherectomy with 1.25 mm burr to proximal RCA

FIGURE 16.4 Guttered proximal right coronary artery. *White circle* showing "guttered" and dissected cap

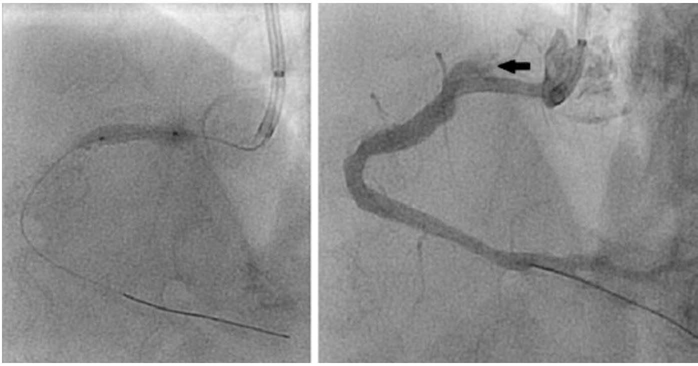

Figure 16.5 Stent deployment to proximal RCA (*left*), with extra-stent cap (*right*, *black arrow*) noted

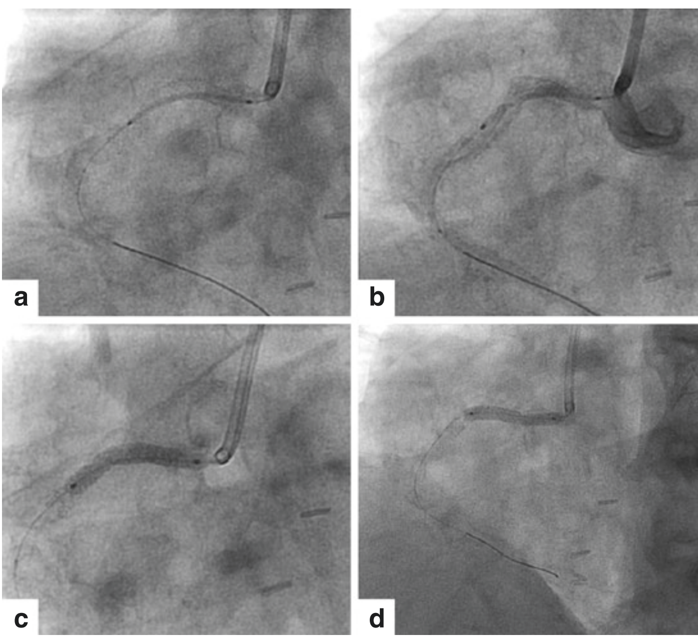

Figure 16.6 Additional stent inserted and dilated into previously placed stent for enhanced scaffold

Figure 16.7 Before and after angiography to native RCA

Discussion and Learning Points

Gutter formation is a known complication of rotational atherectomy [1]. This can lead to enlargement of the vessel lumen larger than the burr size. It may be seen more frequently in highly tortuous vessels or if there is an eccentric plaque in combination with wire bias. In this case, there was a small gutter (or crater) noted in the proximal right coronary artery likely due to the rotational atherectomy, and it was treated by deploying an additional stent and ensuring that wire position is not lost. However, not all gutters or craters need to be treated, and oftentimes, they can be left alone.

Reference

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Chapter 17
Complex Case: Rotablation in Distal RCA

Khung Keong Yeo

Case Summary

A 77-year-old man presented with acute coronary syndrome. He had a history of diabetes mellitus, hypertension, dyslipidemia, and smoking. Diagnostic angiogram showed severe triple vessel disease with left main involvement. The RCA is shown in Figs. 17.1 and 17.2 (Videos 17.1 and 17.2). His left ventricular function was severely impaired, and his blood pressure was 90 mmHg. He declined surgery and was referred for high-risk PCI.

We approached the RCA first. IABP was inserted via left femoral arterial access. A temporary pacing wire was placed in the right ventricular apex. A 6F JR4 guide was used to

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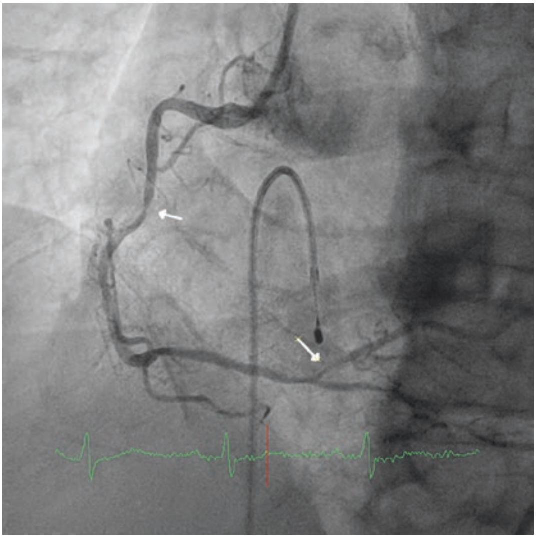

FIGURE 17.1 Baseline angiograms of the RCA with *white arrows* showing the most severe stenoses

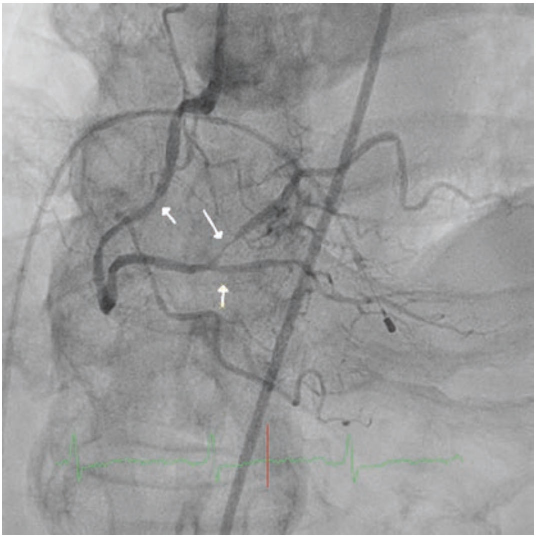

FIGURE 17.2 Baseline angiograms of the RCA with *white arrows* showing the most severe stenoses

engage the RCA. The plan was to perform rotablation given the extensive calcified disease. A standard 0.014″ guidewire was placed in the distal RCA into the right posterolateral branch. Using a Finecross microcatheter, this was exchanged for a rota extra-support wire. Rotational atherectomy with a 1.25 mm burr at 150,000 rpm was performed all the way to the right posterolateral branch (Figs. 17.3 and 17.4 and Videos 17.3 and 17.4). This required gentle technique as well as advancement of the rota sleeve forward to allow sufficient reach of the burr distally. After rotational atherectomy, the rota wire was exchanged for standard guidelines. Balloon angioplasty followed by sequential DES placement was performed. The final angiographic result was satisfactory with TIMI 3 flow (Figs. 17.5 and 17.6 and Videos 17.5 and 17.6).

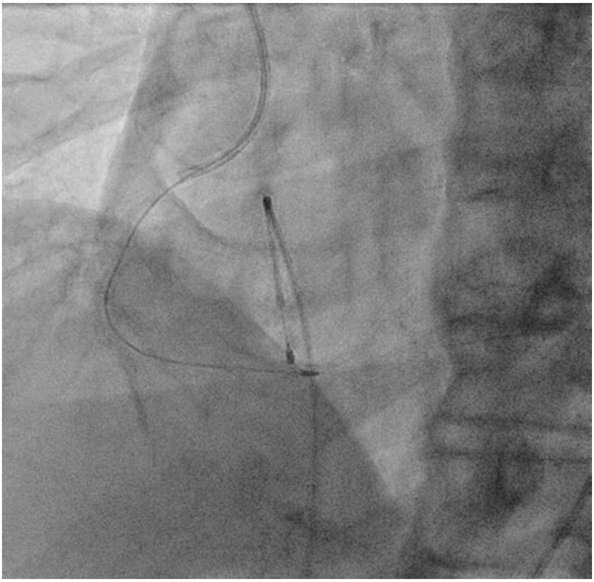

Figure 17.3 Images showing rotablation of distal RCA and the right posterolateral branches

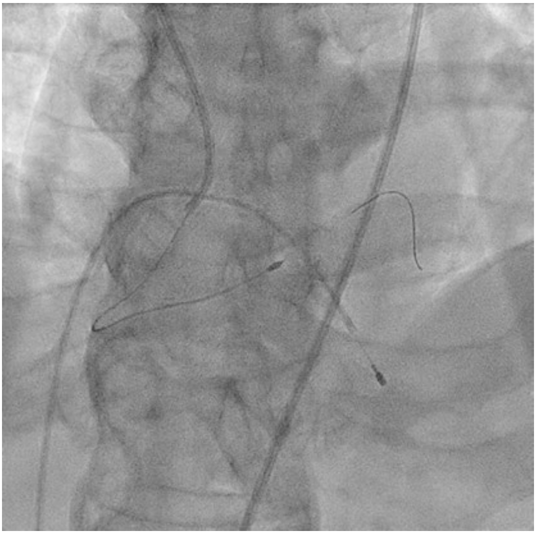

FIGURE 17.4 Images showing rotablation of distal RCA and the right posterolateral branches

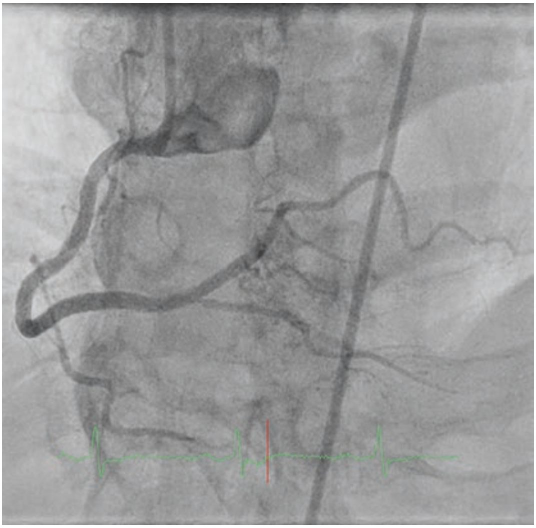

FIGURE 17.5 Final angiographic results

Figure 17.6 Final angiographic results

Discussion and Learning Points

This case highlights the possibility of rotablation in distal vessels. The main technical challenges and risks are:

1. Difficulty in advancing the rota catheter distally during rotablation. This is necessary in order to allow the rota burr to have sufficient reach distally. The technique to do this requires careful coordination between a skilled operator and assistant team. Essentially, as the operator pulls the rota throw backward, he will also advance the catheter sleeve forward.
2. Higher theoretical risk of perforation and dissection as the vessel is smaller distally. In this case, it was important to choose a smaller burr to avoid this risk.
3. Also guide support becomes especially important as poor guide support will result in loss of the wire position as the

burr pushes the guide backward. Key learning points are as follows:

- Distal lesions can be treated with rotablation if necessary.
- Know how to advance the rota catheter during a rota run.
- Choose a small or the smallest burr when rotablating distal arteries.

Chapter 18
Complex Case: Rotablation in Cardiogenic Shock

Bradley D. Stauber, Reginald I. Low, and Gagan D. Singh

Case Summary

A 77-year-old man with a history of end-stage renal disease, ischemic cardiomyopathy (LVEF 30%) presented with a non-ST elevation myocardial infarction, and pulmonary edema. Systolic blood pressure was 90 mmHg. Right heart catheterization showed a pulmonary artery mean pressure of 32 mmHg and a wedge pressure of 25 mmHg, with assumed Fick cardiac output 2.42 L/min and cardiac index 1.56 L/min/m^2, with systemic vascular resistance of 1,800 dyn*s/cm^5 consistent with volume overload and cardiogenic shock. Coronary angiography of the left coronary artery system showed a calcified 60% left main coronary artery and 90% proximal-mid left anterior descending artery (LAD) lesion

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(Fig. 18.1). There was also a 95% mid-circumflex lesion. The right coronary system was engaged showing 100% occlusion in the proximal to mid-RCA with right to right collateralization (Fig. 18.2).

An IABP was inserted via contralateral femoral access for intraprocedural hemodynamic support. Given his comorbid conditions and after discussion with cardiothoracic surgery, he was deemed to be too high risk for bypass surgery, and the decision was made to proceed with percutaneous coronary intervention.

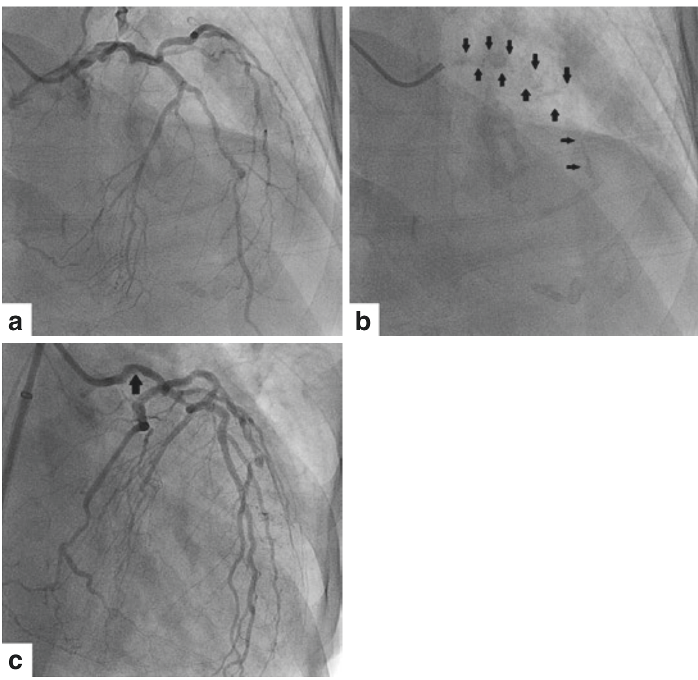

Figure 18.1 Angiography of left coronary artery system, (**a**) with contrast dye and (**b**) without, *black arrows* showing diffuse left main and LAD calcifications. (**c**) *black arrows* shows 60% left main stenosis

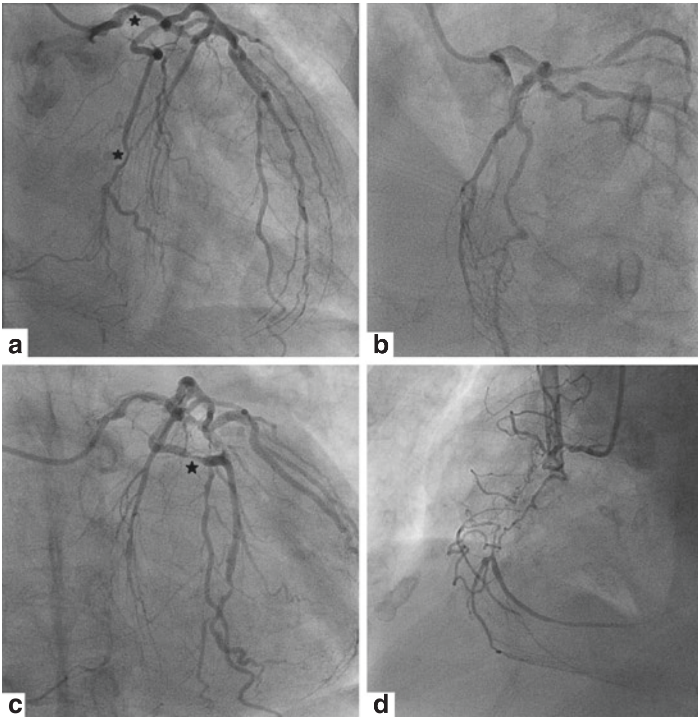

Figure 18.2 Baseline angiographic images showing left main, proximal, and mid-LAD disease and mid-circumflex obstructive lesions (**a**–**c**) with stars identifying representative stenosis. Chronic total occlusion of the mid-RCA with right to right collateralization (**d**)

A 7F XB LAD 4 guiding catheter engaged the left main coronary artery. A standard 0.014 guidewire was advanced to the distal LCx lesion, and balloon angioplasty was performed. The LCx was then treated with two 2.5 × 12 mm tents that were deployed and post-dilated with a 2.75 NC balloon at high pressure (Figs. 18.3 and 18.4). The 0.014 guidewire was then directed into the LAD. The 0.014″

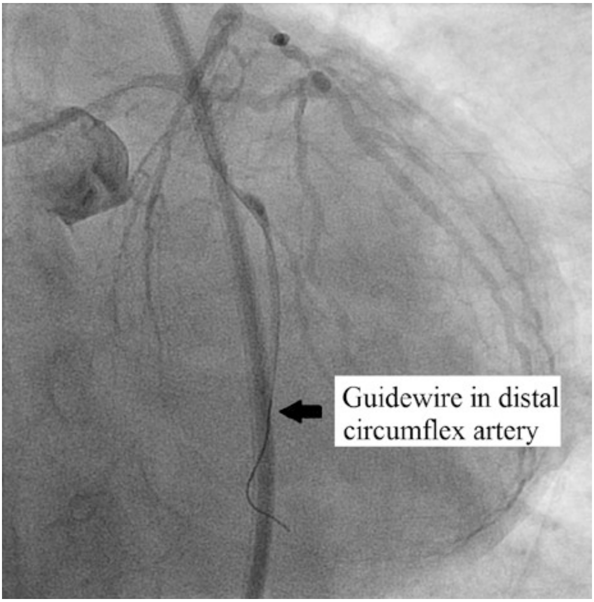

FIGURE 18.3 Guidewire advanced past distal left circumflex lesion prior to stenting

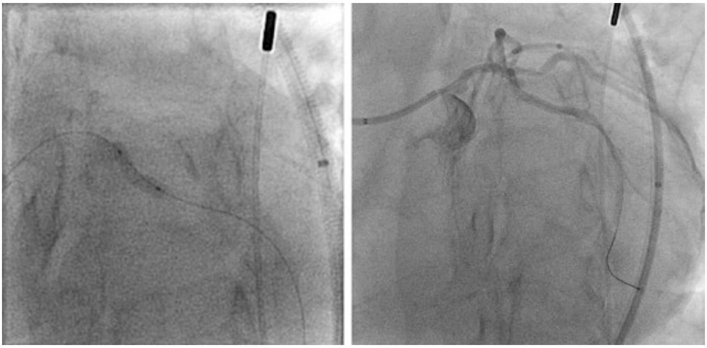

FIGURE 18.4 Post-dilatation of circumflex stent (*left*) and circumflex artery post-stenting

guidewire was then exchanged for a 0.009″ rota extra-support wire using a Corsair support catheter (Fig. 18.5). At this point, rotational atherectomy was performed, initially with a 1.25 mm burr at 150,000 RPM, then a 1.5 mm burr, and finally a 1.75 mm burr (Fig. 18.6). Scoring atherectomy of the LAD was performed using a 2.0 and a 2.5 angiosculpt

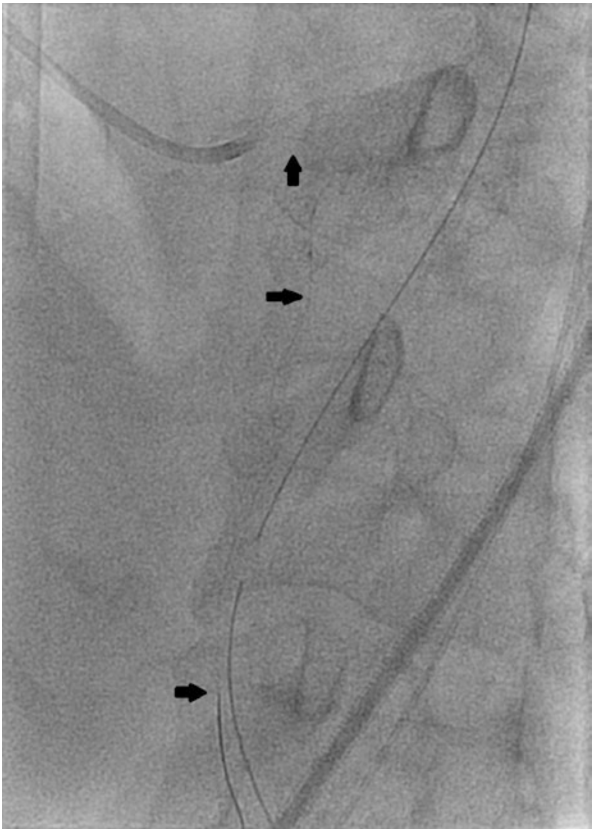

Figure 18.5 Corsair support catheter advanced and crossing LAD lesion prior to rotational atherectomy

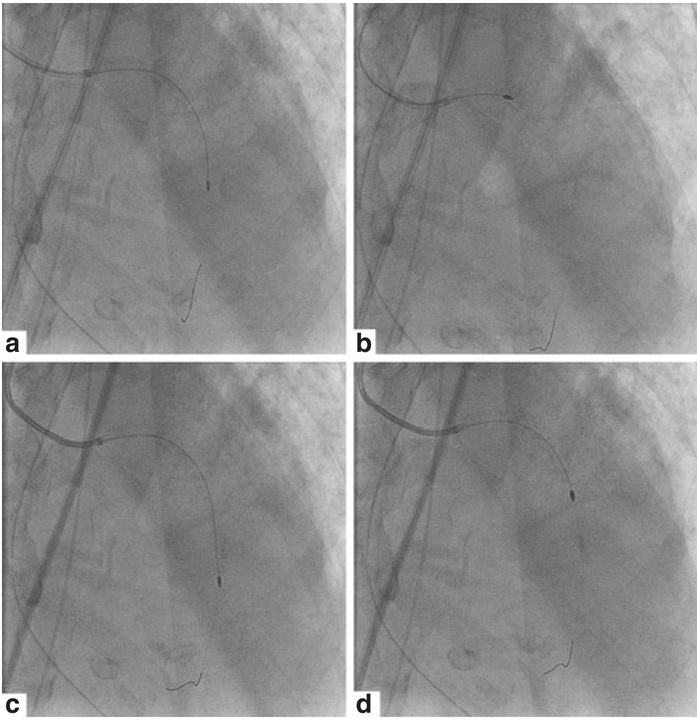

Figure 18.6 Rotational atherectomy to LAD lesion, with 1.25 mm burr (**a**), 1.5 mm burr (**b**, **c**), and 1.75 mm burr (**d**)

balloon. Next, a 2.75 × 28 DES was deployed in the distal left main and into the proximal LAD, following in overlapping fashion with a 2.25 × 28 mm DES, and a 2.25 × 16 mm DES was deployed most distally, with stents post-dilated under high pressure (Fig. 18.7). Next, a 3.5 × 33 mm DES was deployed to the left main coronary artery and post-dilated with a 4.0 × 15 mm and then a 4.5 × 15 mm noncompliant balloon (Fig. 18.8). Final angiographic images showed excellent results (Fig. 18.9).

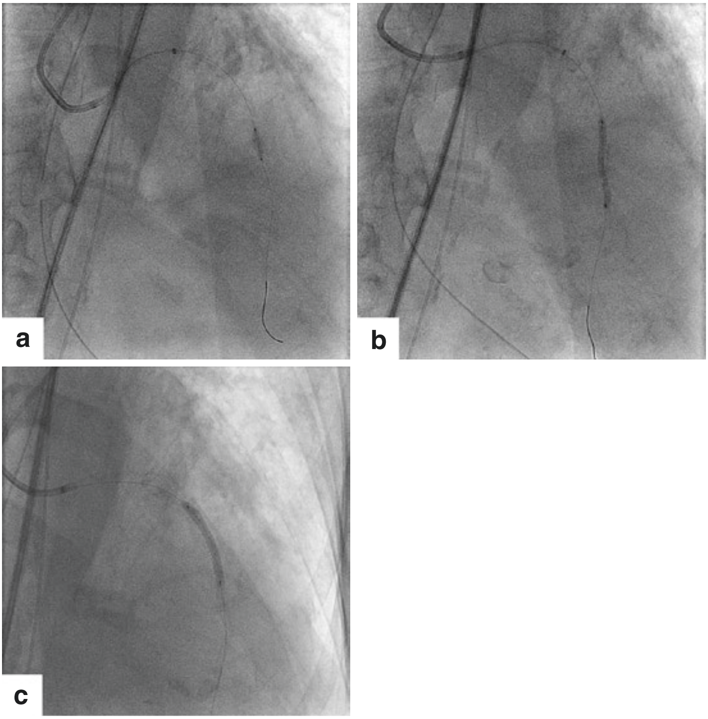

FIGURE 18.7 Scoring atherectomy of LAD (**a**) followed by deployment of mid-LAD and distal LAD stents (**b**, **c**)

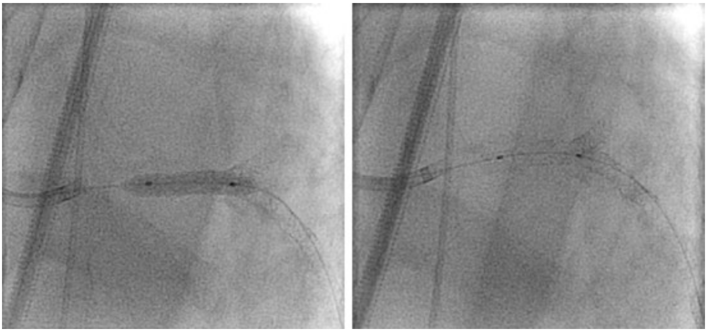

FIGURE 18.8 Deployment of 3.5 × 33 drug-eluting stent to left main coronary artery in overlapping fashion to LAD stent (*left*) followed by post-dilatation with noncompliant balloon (*right*)

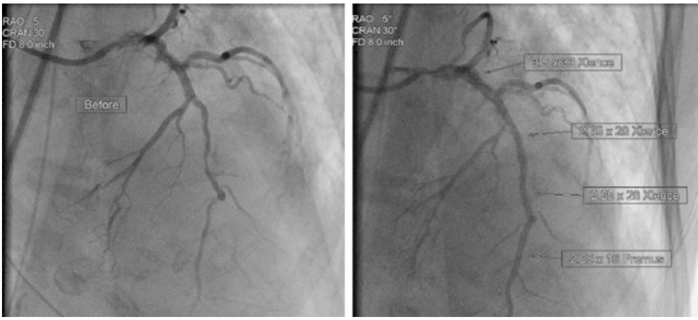

FIGURE 18.9 Before and after angiographic pictures

Discussion and Learning Points

This case shows a rotational atherectomy in a patient in cardiogenic shock, with triple vessel and left main disease. Rotational atherectomy is considered a complex and higher-risk procedure in PCI. However, it is an essential part of an interventionalist's toolkit for complex PCI. This case highlights that rotational atherectomy can be safely performed with experience, good technique, and appropriate planning including hemodynamic support with an intra-aortic balloon pump.

Chapter 19
Complex Case: Rotablation in Cardiogenic Shock #2

Timothy Watson and Paul Jau Lueng Ong

Case Summary

A 70-year-old Chinese lady presented to the emergency department with 2-day history of worsening chest pain and shortness of breath. She has a background history of hypertension, hyperlipidemia, and non-insulin-dependent diabetes mellitus. She was known to have left main stem (LMS) and triple-vessel disease diagnosed in 2008 but had refused surgery back then.

On admission, she became increasingly breathless and hypotensive requiring inotropic support. ECG showed poor R wave progression in anterior leads and 2 mm ST depression laterally. She was loaded with ticagrelor and taken to the cardiac catheterization laboratory for urgent angioplasty. She was adamant that she would not accept open-heart surgery.

Coronary angiography was performed via the right femoral access route after administration of 5,000 iu of unfractionated heparin using a seven French sheath. An IABP was inserted via the left femoral artery in view of her persistent hypoten-

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sion. Angiography of the left coronary system demonstrated extensive calcification. There was severe stenosis of the distal left main stem (LMS) extending into the proximal segments of both the LAD and LCX coronary arteries with TIMI 2 flow in the LAD (Figs. 19.1 and 19.2). The RCA was small and nondominant (Fig. 19.3).

The LMS was engaged with a 7F XB 3.0 guiding catheter. The LAD and LCX arteries were crossed with 0.014″ guidewires, respectively. The ostial LCX was dilated with a 2.5 × 15 mm balloon at 12 atm (Fig. 19.4). With great difficulty, a 2.0 × 15 mm compliant balloon was delivered to the mid-LAD and inflated at 15 atm and again at the ostial LAD at 15 atm. The balloon failed to fully expand (Fig. 19.5). LAD blood flow dropped to TIMI 0 (Fig. 19.6) and patient immediately went pulseless electrical activity (PEA) but only requiring 1 min of cardiac massage. She quickly regained spontaneous circulation, and angiogram showed return of

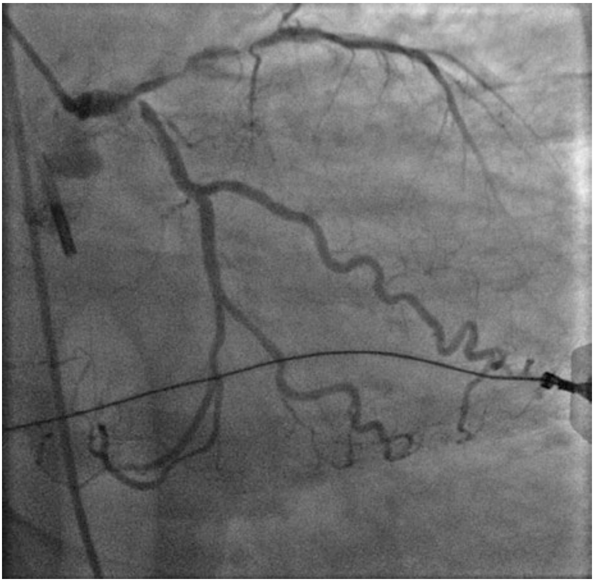

Figure 19.1 Angiogram showing the left main and its bifurcation

FIGURE 19.2 Angiogram showing the LAD

FIGURE 19.3 Angiogram showing the RCA which was small and nondominant

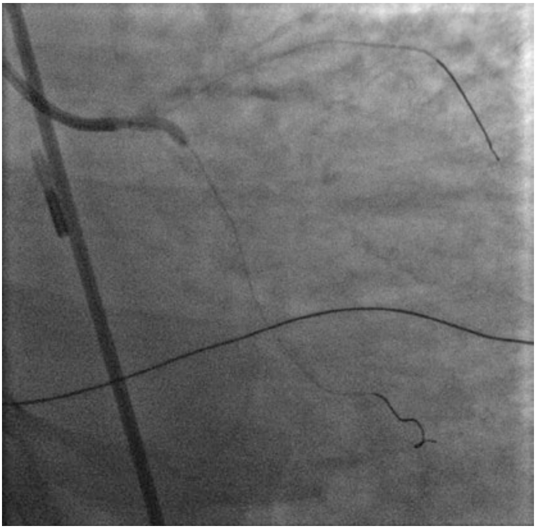

FIGURE 19.4 Balloon angioplasty of the LCX

FIGURE 19.5 Balloon angioplasty of the LAD showing residual narrowing of the balloon

FIGURE 19.6 No reflow in the LAD

TIMI 2 flow in the LAD. However, in light of her hemodynamic instability and likelihood of a prolonged complex PCI, she was intubated on the table.

It became obvious that the heavily calcified LAD would require plaque modification with rotational atherectomy to facilitate subsequent revascularization. The device was set up and made available, while the patient was undergoing emergency intubation.

The guidewire in the LAD was exchanged for a Rotafloppy wire using a microcatheter. The Sion wire in the LCX was removed. Repeated angiogram once again showed loss of blood flow to the LAD. We proceeded to debulk using a 1.5 mm burr set at 180,000 rpm using constant "tapping" pressure on the lesion for 3 runs of 15 s bursts taking care to avoid decelerations. The LMS, proximal LAD, and mid-LAD were crossed after the second run relatively uneventfully (Fig. 19.7). TIMI 3 flow was demonstrated in both the LAD and LCX after rotablation (Figs. 19.8, 19.9, and 19.10).

FIGURE 19.7 Rotablation of the LAD

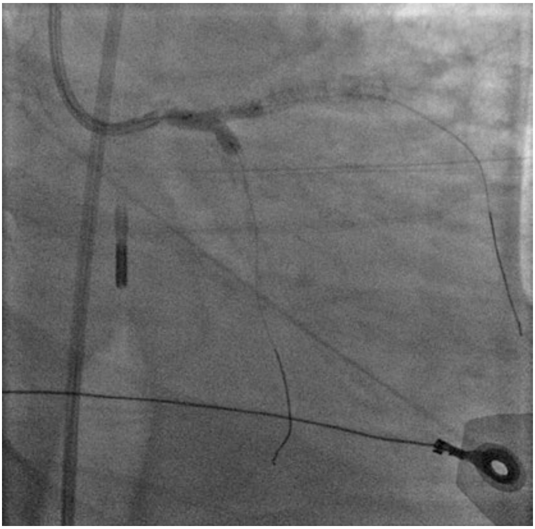

FIGURE 19.8 Kissing balloon after bifurcation stenting

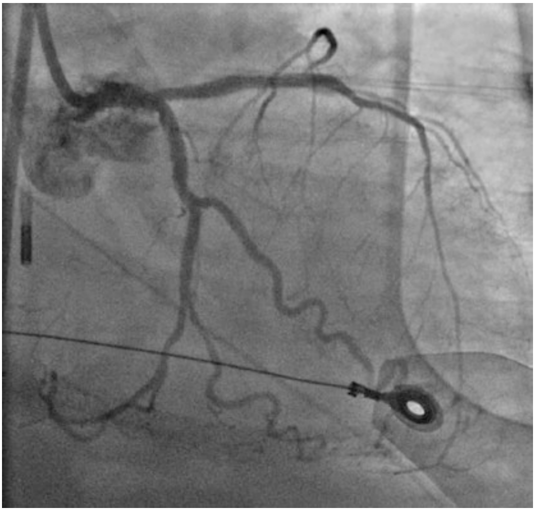

FIGURE 19.9 Final angiographic result

FIGURE 19.10 Final angiographic result

The LAD and LCX were once again wired with earlier 0.014″ wires, and Rota-floppy wire was removed. The LAD was dilated with earlier 2.5 × 15 mm NC balloon at 15 atm showing full expansion. The LM bifurcation was treated with double-kiss double-crush two-stent strategy (DES 3 × 18 mm from distal LMS to LCX and 3.5 × 23 mm LMS to proximal LAD). The mid-LAD was treated with an overlapping DES 2.75 × 28 mm. All stents were aggressively dilated 1 size up with NC balloon up to 20 atm. We finished the case by using a 4.50 mm NC balloon for proximal optimization of the LMS stent.

Immediately following the procedure, our patient was weaned off the noradrenaline infusion and only required a low-dose dobutamine with an IABP-supported BP of 140/80 mmHg. She was successfully extubated in coronary care unit after 36 h and IABP removed shortly afterward.

She had a stormy 26-day hospital course prior to discharging to community care. She was last seen 2 months post-event making excellent recovery and joining the cardiac rehabilitation classes.

Discussion and Learning Points

This was a high-risk, complex PCI case that challenged most of the boundaries of rotablation. Relative contraindications to rotational atherectomy include thrombus, severe TVD or unprotected LMS disease, and severe left ventricular dysfunction. Our patient was in cardiogenic shock in the context of acute coronary syndrome with intermittent no reflow requiring CPR during the procedure. Yet it was with just three very short runs of rotablation which modified the LMS/LAD plaque and made it possible to complete the revascularization thus saving her life.

Our setting up of the rotablation while patient was undergoing intubation saved valuable time. More potent left ventricular assistant device like ECMO or Impella rather than IABP might be more helpful. Unfortunately, neither of these devices were able in our institute. The use of IVUS to optimize stent deployment especially in the LMS should have been used, but again at time of emergency, the operator elected to keep the procedure as short as feasible and not aim for perfection.

Chapter 20
Complex Case: Severe Diffuse LAD Disease

Jiang Ming Fam and Khung Keong Yeo

Case Summary

A 64-year-old gentleman was admitted for gangrene of the left lower extremity and developed recurrent non-ST elevation myocardial infarct with congestive cardiac failure. He had multiple cardiovascular risk factors of diabetes mellitus, hypertension and hyperlipidaemia. He also had a previous cerebrovascular infarct involving the right middle cerebral artery (MCA) and renal impairment. A diagnostic angiogram done earlier showed severe triple vessel disease with a previously known chronic total occlusion involving the right coronary artery (Figs. 20.1, 20.2, 20.3, and 20.4; Videos 20.1, 20.2, 20.3 and 20.4). A two-dimensional transthoracic

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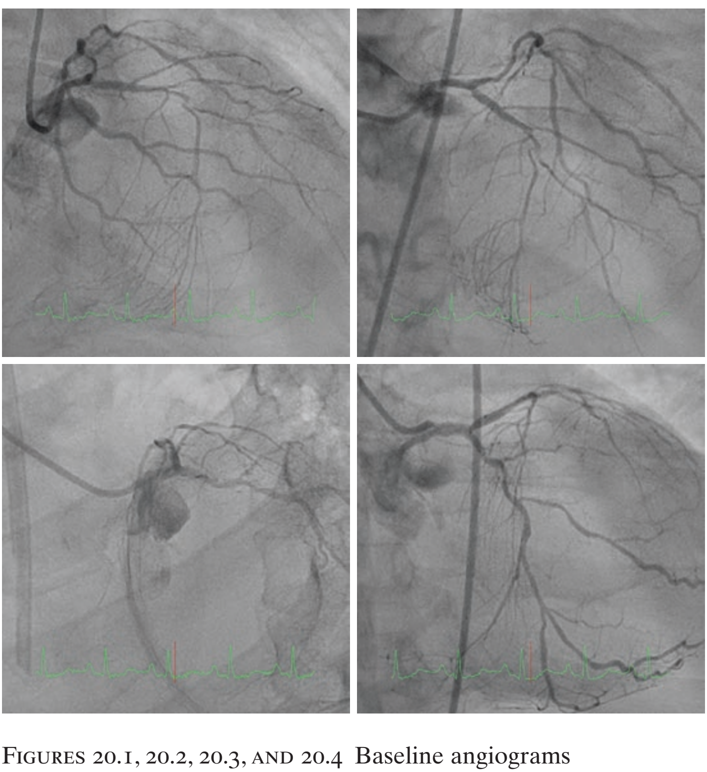
echocardiogram showed that the left ventricular ejection fraction was impaired at 30%.

Left femoral vascular access was obtained using ultrasound imaging guidance. A 6F JL4.0 guide catheter was used. Intervention was performed on the left circumflex artery (LCX) first. The LCX that was crossed was first treated with drug-eluting stents (DES).

The left anterior descending artery (LAD) was severely calcified, and it was difficult to cross the lesion. Support from a microcatheter was required. The 0.014″ guidewire was subsequently exchanged out for Rota extra-support wire. Rotational atherectomy was performed sequentially at the proximal and mid LAD with 1.25 mm burr at 150,000 rpm (Figs. 20.5 and 20.6 and Videos 20.5 and 20.6). Adequate lesion



Figures 20.1, 20.2, 20.3, and 20.4 Baseline angiograms

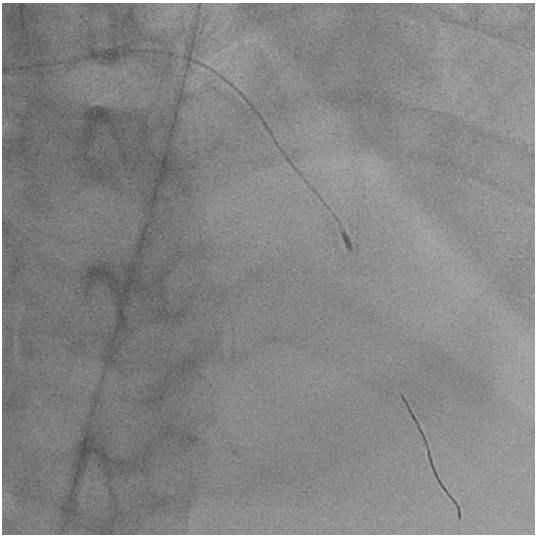


FIGURE 20.5 This shows rotablation of the LAD

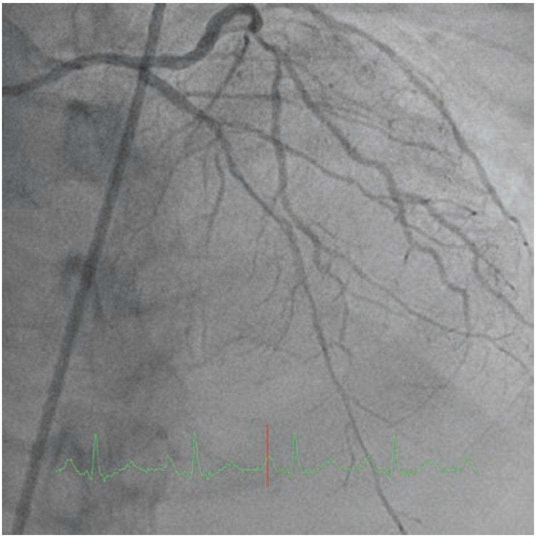
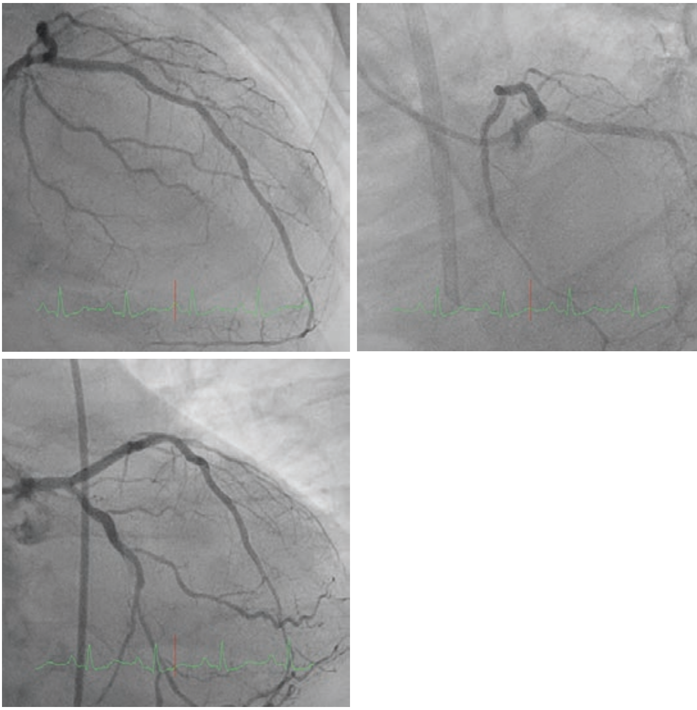


FIGURE 20.6 This shows the LAD after rotablation

preparation was then achieved during predilation with a semi-compliant 2.0 × 15 mm balloon. Two DES (2.25 × 38 mm and 2.5 × 38 mm) were first deployed from the distal to mid LAD, respectively. The left main (LM) to proximal LAD was stented with two DES (3.0 × 38 mm and 3.5 × 8 mm) and post-dilated with 3.5 × 15 mm NC balloon. Good angiographic result was achieved (Fig. 20.7; Figs. 20.8, 20.9 and 20.10; Videos 20.7, 20.8, 20.9 and 20.10).

Figure 20.7 Final angiogram



FIGURES 20.8, 20.9, AND 20.10 Final angiograms showing a satisfactory result

Discussion and Learning Points

Despite the advent of advanced equipment and developments in interventional techniques, calcified lesions, which can be encountered in up to 35% of PCI patients, still pose technical difficulties and may affect outcomes of stent implantation. Lesion calcification has been associated with increased PCI complexity with worse procedural outcomes compared to non-calcified lesions. Operators may encounter difficulty with wire crossing, delivery of equipment during pre- and post-dilation as well as stent delivery. Additional equipment such as the use of microcatheters (e.g. Finecross and Corsair) may be needed to provide the additional support to facilitate wire crossing.

Rotational atherectomy has been used prior to stenting when severe calcification prevents stent passage or if calcified lesion is not dilated adequately. In this case example, rotational atherectomy was used to remove plaque burden in heavily calcified coronary vessels to facilitate passage of balloons for predilation.

This case highlights the use of rotablation to treat severe and diffusely diseased vessels. At first glance, operators may be concerned that the vessel is too small to rotablate or stent. However, the small calibre of the vessel likely represents diffuse disease, which can be debulked with rotational atherectomy. However, with the significant plaque burden, the risk of no reflow is substantial, and operators need to be patient and meticulous in their technique.

Chapter 21
Complication: No Reflow

Jiang Ming Fam and Khung Keong Yeo

Case Summary

A 72-year-old Chinese male with background cardiovascular risk factors of hypertension and diabetes mellitus underwent an elective coronary angiogram. He had a significant medical history of end stage renal failure on hemodialysis, paroxysmal atrial fibrillation on warfarin, anemia of chronic disease, and peptic ulcer disease. He was admitted for a recent creation of arteriovenous fistula which was complicated by a type 2 myocardial infarct with hypotension during dialysis. A transthoracic echocardiogram done showed that the left ventricular ejection fraction was still preserved at 55%. There were infero-septal wall motion abnormalities seen. A stress myocardial perfusion study was positive for ischemia over anteroseptal regions.

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The baseline coronary angiogram showed severe discrete calcified lesions in the proximal-mid left anterior descending artery (LAD; Fig. 21.1a, b; Videos 21.1 and 21.2). Femoral vascular access was used. A 6F JL 4 guide was used. The LAD was crossed with an Abbott Vascular Hi-Torque BMW Universal wire. Lesion preparation with a semi-compliant 2.0 mm balloon was suboptimal as the balloon "melon seeded" during initial lesion preparation. Further lesion preparation using the 2.5 mm AngioSculpt balloon was also not successful with bursting of the balloon at high pressures (Video 21.3). A decision was made to perform rotational atherectomy 1.5 mm burr on a Rotawire extra-support wire at 150,000 rpm (Video 21.4). No flow was noted after the rotational atherectomy (Video 21.5). Further predilation was performed with a noncompliant balloon 2.5 × 15 mm at 18 atm. After predilation, there was partial restoration of TIMI 1 flow (Video 21.6). 2 X BioFreedom DES (3. × 14 mm and 2.75 × 36 mm) were deployed from proximal to mid-LAD (Fig. 21.2a, b). An intracoronary cocktails of adenosine, nitroglycerin, and verapamil was given with improvement TIMI flow grade (Video 21.7). Post-dilation using the noncompliant Neich NC Sapphire II 3.0 × 15 was performed at 20 atm. Post procedure, good angiographic result was achieved with TIMI 3 flow seen in the LAD (Videos 21.8 and 21.9, Fig. 21.3a–c).

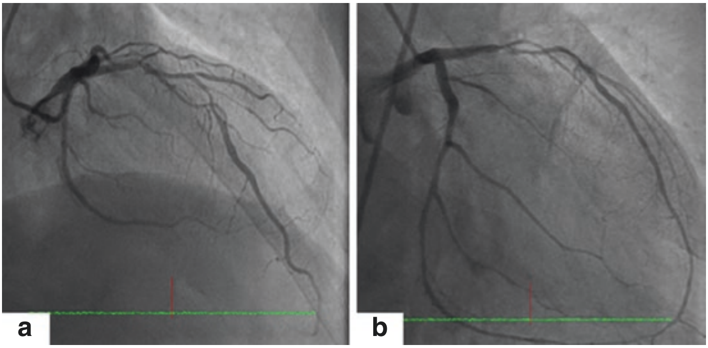

Figure 21.1 (**a**, **b**) show the baseline angiographic appearance of the LAD

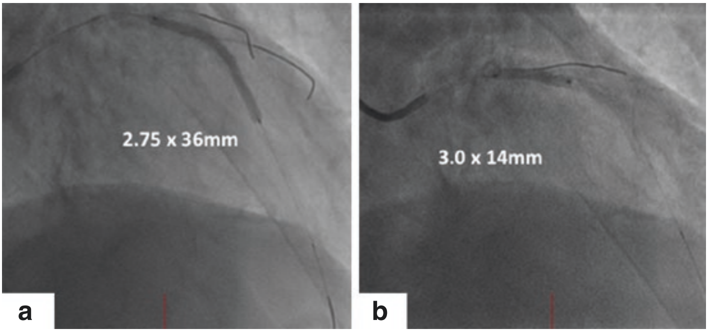

FIGURE 21.2 Deployment of DES in LAD after rotational atherectomy and angioplasty. (**a**) Deployment of 2.75 × 36 mm DES (**b**) Deployment of 3.0 × 14 mm DES

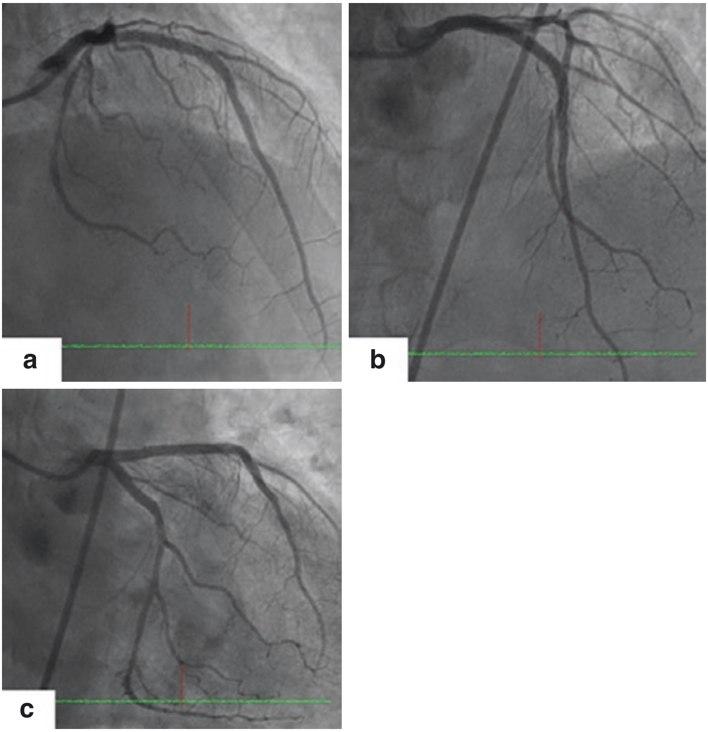

FIGURE 21.3 Final angiogram showing excellent angiographic results (**a**–**c**)

Discussion and Learning Points

No reflow after rotational atherectomy refers to the angiographic appearance of no blood flow in the treated artery even though the treated segment is patent. Sometimes there is blood flow but is reduced by one TIMI study flow grade which is known as slow flow.

No reflow is believed to occur due to a combination of factors including distal embolism of vessel debris after debulking or vasospasm in the microvasculature. It can also be caused by a flow-limiting dissection.

A series of measures may reduce the occurrence of no reflow or slow flow. These include:

- Slow, controlled advancement of the burr, focusing on "sandpapering" the lesion.
- Adoption of a progressive increase in burr size approach in long calcified lesions, preferably in 0.25–0.5 mm increments.
- Ensuring repeated saline flushes to maintain optimal blood flow.
- Using guide catheters with side holes.
- Using an intra-aortic balloon pump to improve diastolic flow in the coronaries.
- Intracoronary infusion of adenosine, nitroprusside, verapamil, and glyceryl trinitrate (GTN) can improve slow flow or no reflow after a short period of time, typically within seconds to minutes. Oftentimes, it is useful to pretreat the vessel with these drugs before rotational atherectomy:
  - GTN 100–200 mcg. Multiple doses may be given as long as blood pressure tolerates.
  - Verapamil: 100–200 mcg.
  - Adenosine: 100–200 mcg. Multiple doses may be given as the drug is very short acting. Do note the risk of heart block and may provoke atrial fibrillation.
  - Nitroprusside: 10–20 mcg.
- Intracoronary delivery of vasodilators may be improved by using a microcatheter (either end-hole or with side-port, such as an aspiration catheter) or by using an over-the-wire balloon inflated to ensure distal drug delivery.

Chapter 22
Complication: Trapped Burr

Lucky R. Cuenza, Aaron Wong, and Kay Woon Ho

Case Summary

A 74-year-old former smoker and hypertensive male with aortic aneurysm was scheduled electively for endovascular aortic aneurysm repair (EVAR). He has been experiencing recurrent angina symptoms despite medical therapy. Echocardiogram showed an ejection fraction of 72% with no regional wall motion abnormalities. Coronary angiogram showed significant two-vessel disease in the left anterior descending artery (LAD) and a calcified lesion in the right coronary artery (RCA) (Fig. 22.1). Patient was then scheduled for multivessel PCI.

Electronic Supplementary Material The online version of this chapter (https://doi.org/10.1007/978-3-319-60490-9_22) contains supplementary material, which is available to authorized users.

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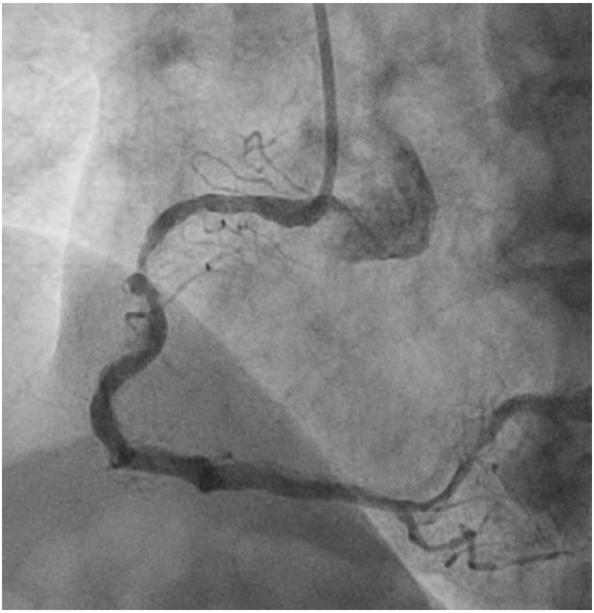

Figure 22.1 The right coronary artery (RCA) on LAO view shows a calcified and tortuous vessel with a tight 90% midsegment stenosis

Using a 6F sheath via right femoral arterial access, percutaneous coronary intervention to the proximal LAD was successful. The RCA was then engaged using AL1 6F catheter and wired using a Sion wire (Asahi Intecc Co. Ltd, Japan). The severely stenosed and calcified mid-RCA lesion was not adequately predilated despite the use of a 2.5-mm semi-compliant and 3.5-mm and 4.0-mm non-compliant balloons, respectively (Figs. 22.2 and 22.3). The decision was then made to perform adjunctive rotational atherectomy.

An intravenous pacing wire was inserted prior to the setup of the Rotablator system (Boston Scientific; USA). Using an 8F guiding catheter, a Finecross microcatheter (Terumo, Japan) was used to exchange the Sion wire for a floppy Rotawire (Boston Scientific; USA) which was easily

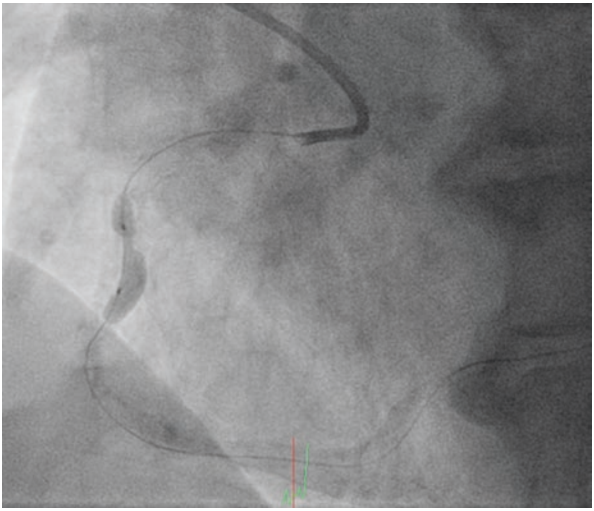

Figure 22.2 Multiple attempts were made to predilate the tight calcified lesion. Note the persistence of the tight "waist" in the middle of the inflated balloon

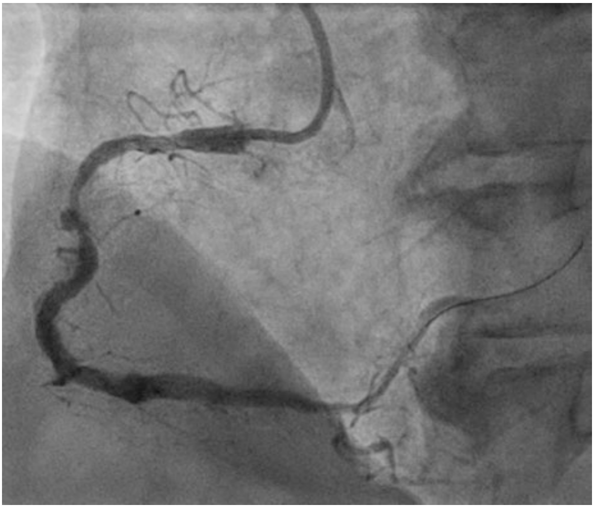

Figure 22.3 The mid-RCA lesion is not adequately dilated even after multiple inflations

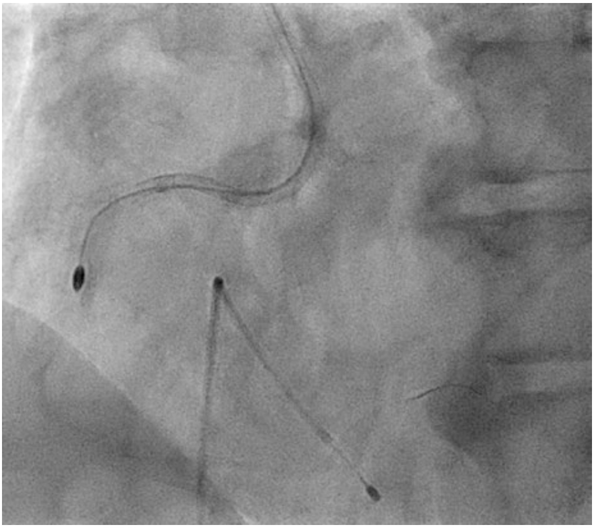

Figure 22.4 The 2.15-mm burr gets trapped during the rotablation procedure

introduced into the distal RCA. Rotablation for the heavily calcified RCA was performed using a 1.5-mm Rotablator burr initially at 170,00 rpm and followed by a 2.15-mm burr. Rotational atherectomy of the 2.15-mm burr also at 170,000 rpm was performed, but after two runs, it was suddenly trapped at the mid-RCA (Figs. 22.4 and 22.5, Videos 22.1 and 22.2).

The team called for urgent surgical backup to be on standby while percutaneous retrieval of the trapped burr was attempted. The burr could not be removed easily by simple pulling nor with manual traction with off-on low-speed rotation in Dynaglide mode. A second guidewire was then inserted in an attempt to place a buddy wire beside the trapped burr but was also unsuccessful.

In our next method, we proceeded with the following sequence of steps: (1) we cut off the drive shaft and sheath of the Rotablator catheter; (2) we then inserted a 5 Fr 120-cm guiding catheter (Heartrail ST01; Terumo, Japan) through the remaining Rotablator system and up to the end of the

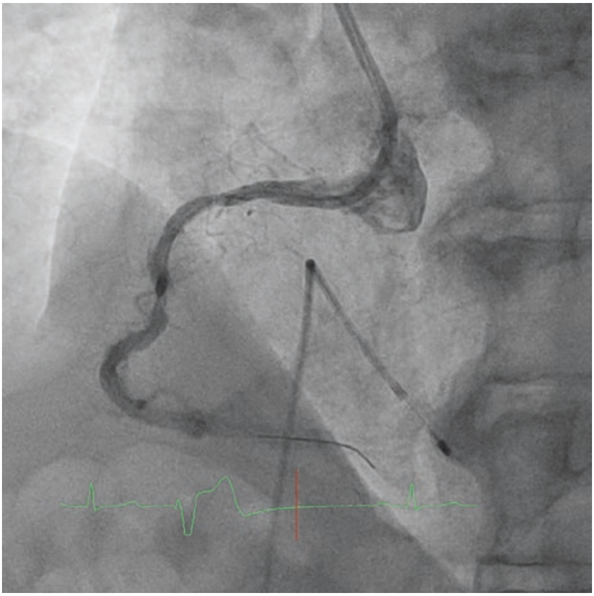

Figure 22.5 The burr is stuck in between the tight calcified plaque of the mid-RCA (Supplementary material available Videos 22.1 and 22.2)

burr; (3) then we pushed the catheter tip to the lesion around the burr accompanied by simultaneous pulling back of the Rotablator; and (4) with this push-and-pull technique, we successfully removed the trapped burr (Figs. 22.6 and 22.7, Videos 22.3 and 22.4).

Coronary angiogram after the retrieval of the burr showed an adequately prepared mid-RCA lesion with no dissection. We then rewired the RCA using a Fielder guidewire and were able to predilate successfully using a 3.5-mm scoring balloon (AngioSculpt; Biotronik, Germany) and a 4.0-mm non-compliant balloon. We then proceeded to successfully deploy two overlapping 4.0-mm drug-eluting stents in the mid- and proximal RCA, respectively, followed by postdilatation using a 4.0-mm non-compliant balloon. The final angiographic result was favorable with good flow and no residual stenosis noted (Figs. 22.8 and 22.9).

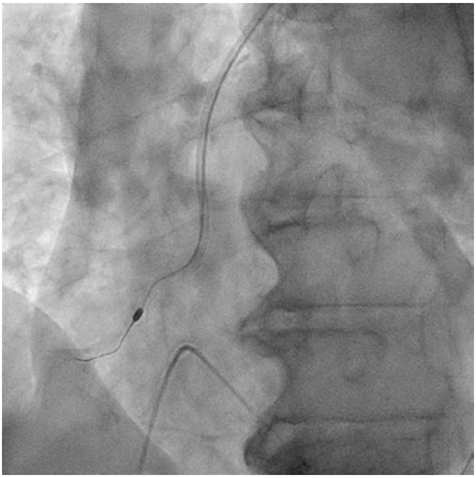

Figure 22.6 Applying the child in mother technique. After cutting off the Rotablator shaft, a 5F Heartrail catheter was inserted up to the end of the burr. Simultaneous pullback was applied on the Rotablator, while countertraction was applied on the catheter

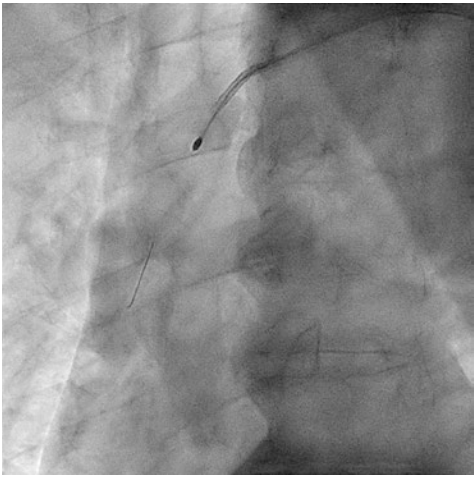

Figure 22.7 The Rotablator burr was successfully retrieved with continuous further manual traction (Supplementary material available Videos 22.3 and 22.4)

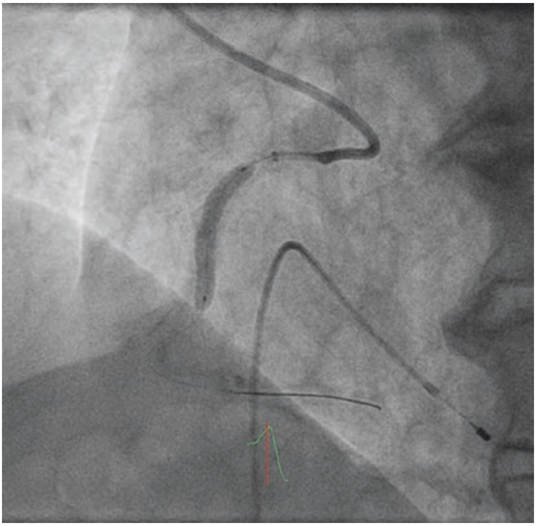

Figure 22.8 A drug-eluting stent is deployed in the mid-RCA area after retrieval of the trapped burr and lesion preparation

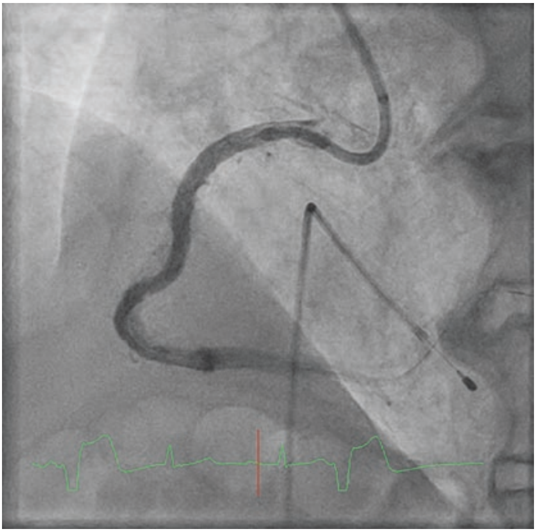

Figure 22.9 Successful stenting to the RCA with TIMI three flow and good angiographic result

Discussion and Learning Points

The increased expertise and experience in the use of rotational atherectomy during the drug-eluting stent era is associated with intraprocedural complications. A trapped burr occurs rarely with a reported incidence of around 0.4% [1] but is a nightmare scenario for interventionists and prompts immediate management. The inherent olive-like shape of the burr consists of a distal part covered with a diamond coating for antegrade ablation, while the proximal part is smooth without the diamond particles. When moving the burr forward, it is in parallel to the outer curve of the vessel wall and it is aligned to the inner curve during backward movement. Advancement of the burr beyond a tight calcified lesion or through a long and angulated calcified lesion can result in burr entrapment.

There are two mechanisms that have been proposed to cause burr entrapment. First is the so called “Kokesi phenomenon,” named after the Japanese dolls handmade from wood, with an enlarged head and no limbs attached to the trunk bearing a resemblance to the olive-like shape of the burr and its shaft (Figs. 22.9 and 22.10). During a high-speed rotation, the coefficient of friction is less than at rest. The frictional heat may also increase the space between plaques. This may cause the burr to slip across the lesion without debulking a significant amount of calcified tissue. The ledge of calcium behind the elliptical burr may prevent withdrawal. The second mechanism involves increased resistance leading to burr stalling, which may occur when large-diameter burrs are crossed in long, heavily calcified, and tortuous lesions, sometimes with concomitant coronary spasm. When a large burr pushes against the complex lesion without sufficient ablation or when it is pushed too aggressively, the rotational speed may decrease and the burr can get entrapped [2]. It is possible that a combination of the two mechanisms contributed to the complication in our case.

The management strategy of last resort remains emergent open surgery. However, this option is obviously more invasive and associated with significant risk of morbidity and

FIGURE 22.10 The Japanese Kokesi dolls (*left*) have a unique design that resembles the appearance of the Rotablator burr and the shaft (*right*)

mortality. Over the years, it has been shown that it is possible to perform percutaneous retrieval of the stuck burr using different techniques. The first step is to deliver intracoronary vasodilators such as nitroglycerin or verapamil as this may cause some coronary vasodilation and aid in the retrieval of the burr.

The easiest method that can be attempted initially is manual traction with off-on low-speed Dynaglide rotation mode. However, this must be done with caution and careful monitoring of the traction on the vessel, as attempting to withdraw the burr may pull the guide catheter deeply down the vessel, leading to vessel injury or perforation. Extreme force on the burr and the burr shaft may also cause shaft fracture. Disengaging the guide catheter and passing down a guidewire deep into the aorta may prevent vessel injury by avoiding deep seating of the guide catheter during traction.

A second option, which we also attempted but was not able to do so successfully, is pass down a second guidewire beside the entrapped burr followed by balloon dilatation to make a crack between the burr and the vessel wall. Due to the heavily calcified lesion surrounding the burr, the use of hydrophilic wire or stiffer wires may be required to pass through the plaque. Hyogo and associates [3] demonstrated the usefulness of using a Conquest wire to accomplish this technique. This may require a larger catheter profile (8 French) to accommodate and possibly introduction of another guide catheter via another vascular access for advancement of the second guidewire and the balloon. Care must be undertaken as the use of hydrophilic and stiffer wires may also increase the risk of downstream vessel dissection. Additionally, balloon inflation may just stretch only the more pliable portion of the vessel wall leaving the calcification still intact.

A third method involves the use of a percutaneous snare which passes over to the burr and tightening the noose proximal to the burr, followed by withdrawal of the burr and simultaneous retraction of the snare and the guide catheter [4].

The fourth method which we applied successfully in our case involves the use of a child catheter first reported by Kimura et al. [5] using a straight 5F Heartrail catheter, again similar to our case. Another variation can involve the use of a 5F Guideliner [6] (Vascular Solutions Inc., Minneapolis, Minnesota).

This child in mother technique requires cutting of the atherectomy catheter shaft and the sheath near the advancer and then inserting the second guide catheter or extension catheter to the Rotablator system. Deep intubation with subsequent pullback of all devices focuses the force on the burr. Using simultaneous traction on the shaft and countertraction of the child catheter, the catheter tip acts as a wedge between the burr and the surrounding plaque. The distal end of the child catheter provides countertraction close to the site of the lesion and favorably alters shaft alignment. This also adds additional direct pulling force enough to retrieve the burr. Using the child in mother technique may also protect the coronary artery from injury, which, in our case, allowed us to proceed with stent implantation after burr removal.

An excellent case series and review article by Dmitry and colleagues [7] proposed a very useful algorithm in the management of a stuck rotablator. First an attempt should be made to recross with a second wire, which may require the use of a second guide catheter or cutting off the sheath to remove the outer cover of the Rotablator. If the wire is able to pass the burr, a first attempt at balloon dilatation at the stuck burr site should be made. Another pathway, which can also be done especially if the wire is not able to cross or balloon inflation does not work, involves deep intubation of the vessel. After cutting off the Rotablator shaft, deep intubation is achieved using either another guide catheter or the mother and child technique. This was used successfully in our case and requires a lot of force focused on the burr facilitated by deep intubation. Finally, the algorithm proposes that if these methods fail, surgical removal should be considered.

While there is no way to predict burr entrapment, general tips on how to prevent this include gentle pecking motion with short runs of rotablation to about <15 s. Operators should start the procedure with relatively small burrs and higher speed of rotation especially in eccentric and calcified lesions to prevent the Kokesi phenomenon. Excessive forward force should not be exerted during burr advancement, while at the same time, significant decelerations of rotational speed (<5,000 rpm or >10% decrease) during advancement should be avoided [8]. Continuous high-pressure flushing of nitroglycerin and/or verapamil can help avoid spasm.

Even if it is uncommon, interventional cardiologists should be aware of the various methods and skills required for successful retrieval and management of an entrapped rotational atherectomy burr.

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Chapter 23
Complication: Sheared Wire

Jonathan Yap and Jack Wei Chieh Tan

Case Summary

The patient was an 81-year-old lady, with significant cardiovascular risk factors of diabetes, hypertension and hyperlipidemia, and known triple vessel disease. She was planned for percutaneous coronary intervention on her right coronary artery (RCA) complete total occlusion (CTO).

The RCA was heavily calcified and occluded at the ostium (Fig. 23.1, Video 23.1). A 6F AL2 guide was used. The RCA CTO was successfully crossed with a Fielder wire but

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Figure 23.1 Baseline RCA angiogram

subsequently unable to adequately dilate the stenotic lesions despite use of a 3 mm noncompliant balloon. Video 23.2 shows the RCA post 3 mm NC balloon pre-dilation.

Because of the inadequate lesion preparation, a decision was made to proceed with rotablation. The Fielder wire was exchanged for a rota floppy wire and a temporary pacing wire was inserted. Rotablation with a 1.5 mm burr (Fig. 23.2, Video 23.3) was performed. Resistance was encountered on advancing the burr and the proximal RCA rotawire was inadvertently sheared off (Fig. 23.3, Videos 23.3 and 23.4). The ostium

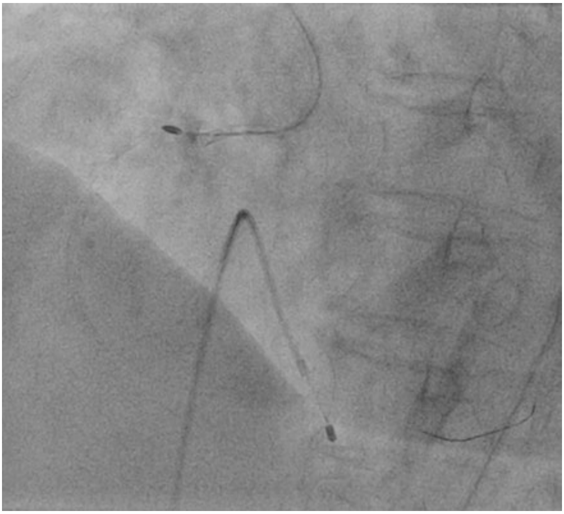

Figure 23.2 Rotational atherectomy of RCA

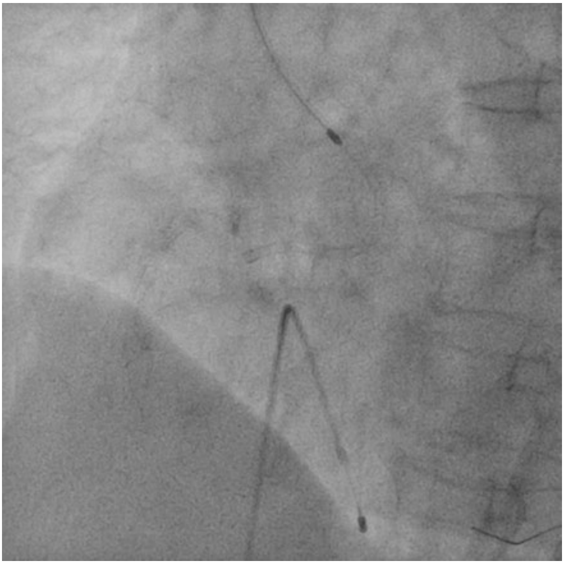

Figure 23.3 Removal of rota burr

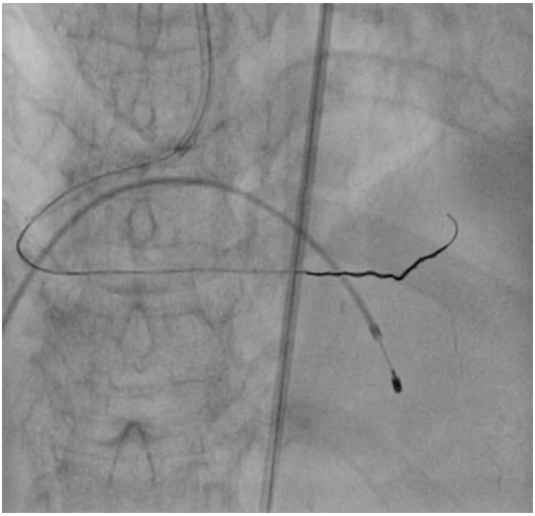

FIGURE 23.4 Sequence of figures showing twisting together of multiple wire in an attempt to trap and withdraw fractured wire

of the RCA was ballooned to facilitate access of a snare, and several unsuccessful attempts to snare the proximal end of the rotawire with a 4 mm Gooseneck snare (Videos 23.5 and 23.6) were made. Two additional guide-wires were introduced in an attempt to retrieve the fractured wire with the twisting wire technique (Figs. 23.4 and 23.5, and Videos 23.7 and 23.8) but this was unsuccessful.

After discussion with the heart team, the decision was made for surgery. The patient subsequently underwent successful coronary artery bypass grafting with RCA arteriotomy performed and removal of the retained guide-wire prior to the grafting.

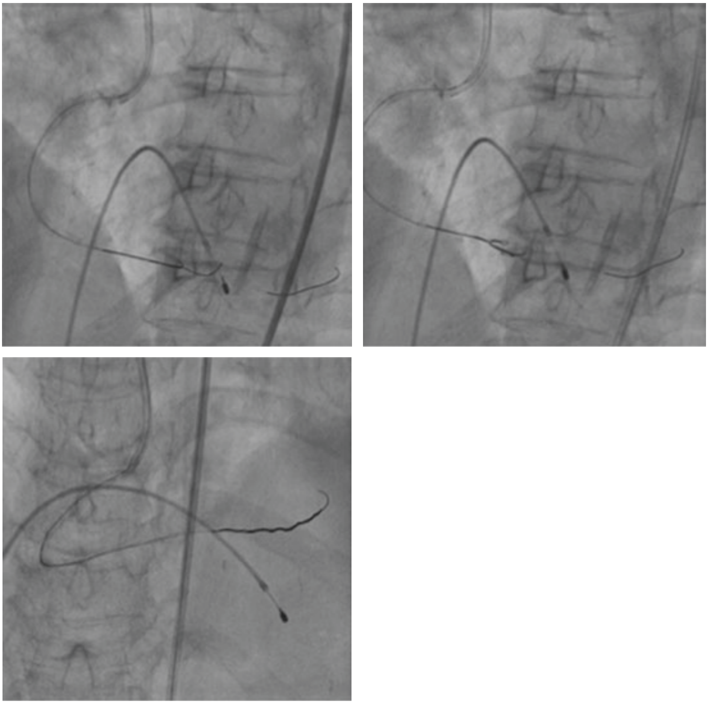

FIGURE 23.5 Sequence of figures showing twisting together of multiple wire in an attempt to trap and withdraw fractured wire

Discussion and Learning Points

This case highlights a feared complication of rotablation – the fracture of the rotawire. In such a scenario, it is important to understand the factors that increase the likelihood of guide-wire fracture as well as methods of retrieval.

Vessel tortuosity such as a tight loop, kink, or sharp bend (>90°) in the wire increases the risk of guide-wire fracture (1). Other considerations include avoiding (a) rotablation at the distal end of the guide-wire, (b) lengthy burr runs (>30s per run), and (c) stationary burr at one location while rotating at high speeds [1].

In the case above, the ostial lesion made coaxial alignment of the guide difficult. As such the burr could not approach the ostial lesion in a coaxial fashion resulting in less support and an angulated entrance (Video 23.3). This likely cause the burr to directly contact the wire resulting in the subsequent fracture.

Rotawire fracture may result in dissection, perforation (may cause tamponade), and embolism. Percutaneous methods of salvage include retrieval using a snare or a twisting wire technique (both described above, Videos 23.5, 23.6, 23.7, and 23.8). Snaring may be difficult especially if the fracture occurs in the radiolucent portion of the wire [2]. In addition, snaring may be difficult if the proximal wire end points against the vessel wall. A snare may not have sufficient space for purchase against the edge of the wire. Tortuous vessels also make advancement of the snare close to the proximal end of the fractured wire difficult. The twisting wire technique involves using two other wires and fixing the proximal end with a torquer. The entire assembly is then rotated via the torque to try and trap the fractured wire. This method is simple and easily available but was unsuccessful in this case. Other alternatives include stenting the lost segment against the vessel wall. However, this depends on the length of the fractured segment and location of the wire. Unstented segments of the wire may predispose to thrombosis. In the event of failure of percutaneous methods, surgical retrieval may be necessary.

The key learning points are:

- The interventionist should be aware of cases highly susceptible to wire fracture (e.g., tortuous segments) and also to ensure coaxial engagement of the guide in cases of ostial disease.
- The interventionalist should also be aware of the methods available to retrieve the fractured segment in the event of such an occurrence.

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Chapter 24
Complication: Dislodged Burr

Jonathan Yap and Khung Keong Yeo

Case Summary

The patient was an 84-year-old Chinese male, with a significant history of diabetes mellitus, hypertension, hyperlipidemia, and previous stroke. He had a recent admission for non-ST-elevation myocardial infarction (NSTEMI) for which an angiogram showed calcified triple vessel disease and significant left main (LM) disease (Figs. 24.1 and 24.2, Videos 24.1 and 24.2). He was offered coronary angiography bypass grafting at that time but declined. Currently, he was readmitted for recurrent NSTEMI and acute pulmonary edema requiring intubation. Due to hemodynamic instability,

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FIGURE 24.1 Baseline calcified left main bifurcation disease

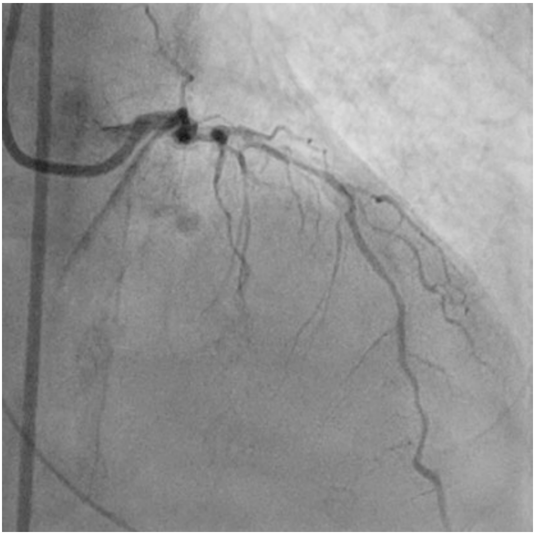

FIGURE 24.2 Baseline calcified left main bifurcation disease

a multidisciplinary team decision was made for urgent revascularization by percutaneous coronary intervention.

An intra-aortic balloon pump was inserted via left femoral access for circulatory support for this high-risk coronary intervention. Noting the degree of calcification, the decision was made for rotablation to prepare the lesion. The Finecross microcatheter initially had difficulty crossing the lesion. The left circumflex was pre-dilated sequentially with a compliant 1.0 mm and 1.5 mm balloon, to facilitate passage of the Finecross to allow for exchange for the extra-support rotawire. Initial rotablation was performed with a 1.25 mm burr (Fig. 24.3, Video 24.3). However, during the process, the burr was dislodged from the shaft and was trapped on the rotawire in the proximal LCX (Fig. 24.4, Video 24.4). During the initial attempt at removal, the drive shaft can be seen to be withdrawn without removal of the burr (Video 24.5). Subsequently, the dislodged rotaburr was suc-

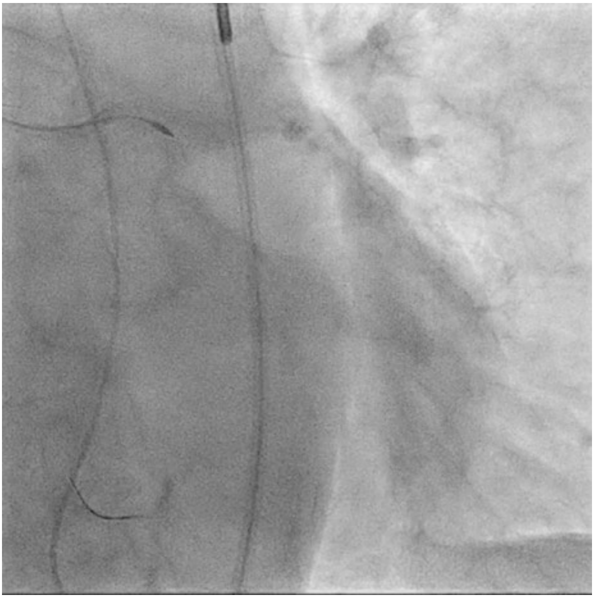

FIGURE 24.3 Initial burring with 1.25 mm burr

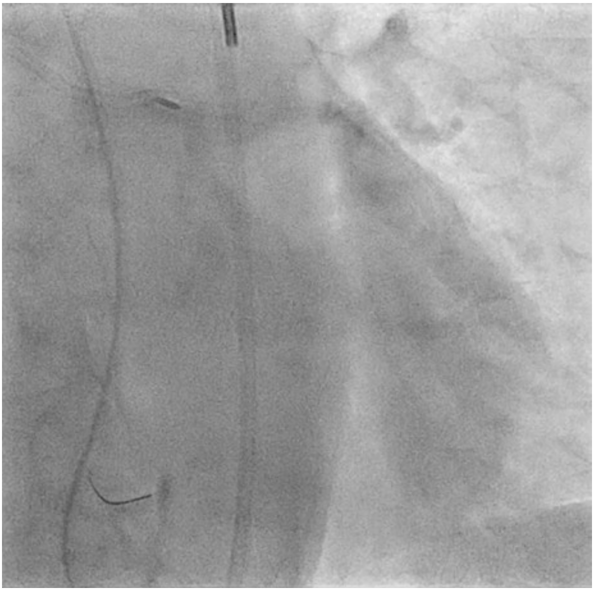

Figure 24.4 The 1.25 mm burr is separated from the catheter and stuck in the left main

cessfully removed by pulling out the rotablation assembly as a whole unit (Video 24.6). The LCX was rewired and repeat rotablation was performed with a new 1.25 mm burr without any complications (Figs. 24.5, 24.6, and 24.7, Videos 24.7, 24.8, and 24.9). A decision was made not to rotablate the LAD. After balloon angioplasty, the mid-LAD was stented with a 2.25 mm drug-eluting stent (DES), and the LM bifurcation was treated with the Coulotte technique with a 2.5 mm DES in the LM-LCX and a 2.75 mm DES in the LM-LAD (Figs. 24.8 and 24.9, Videos 24.10 and 24.11). Figure 24.10 shows the dislodged rotaburr on the rotawire after extraction.

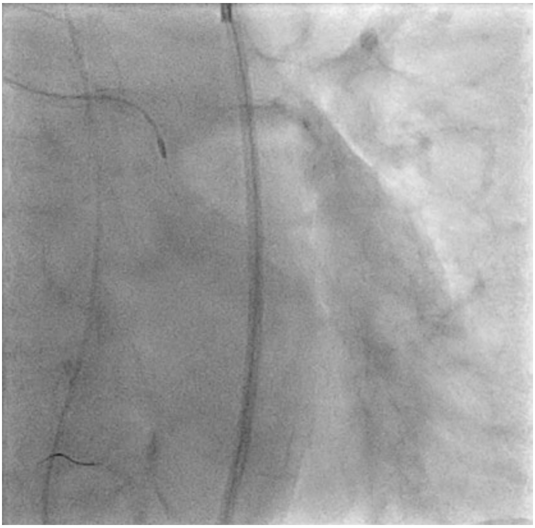

Figure 24.5 Successful repeat rotablation with new 1.25 mm burr

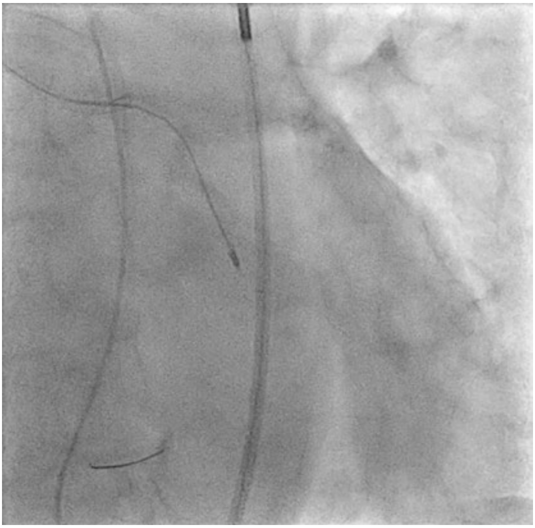

Figure 24.6 Successful repeat rotablation with new 1.25 mm burr

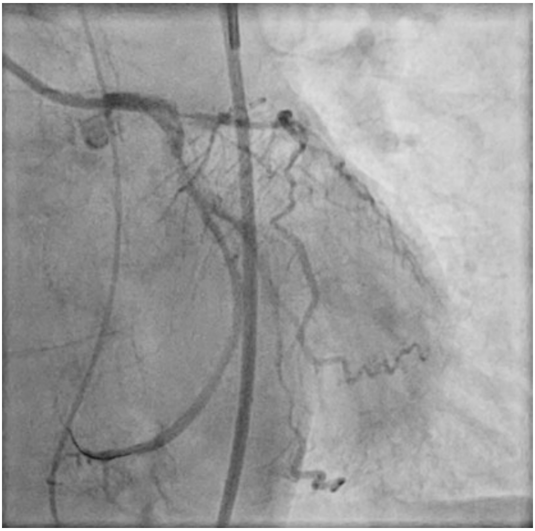

Figure 24.7 LM and LCX after rotablation

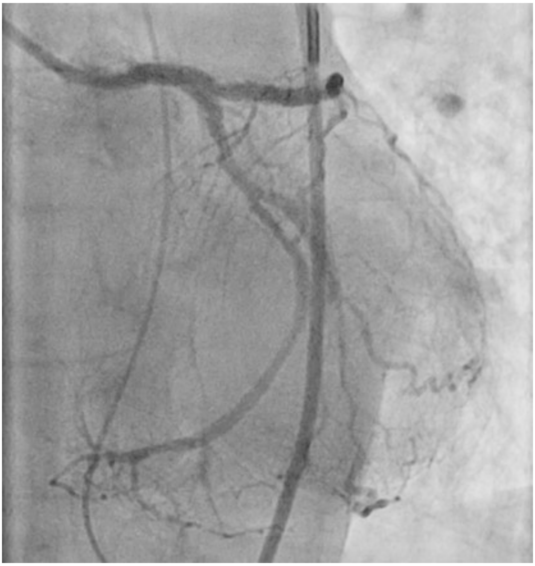

Figure 24.8 Final angiographic images showing satisfactory results after left main bifurcation stenting

FIGURE 24.9 Final angiographic images showing satisfactory results after left main bifurcation stenting

FIGURE 24.10 Dislodged rotaburr on rotawire after extraction

Discussion and Learning Points

To our knowledge, this is the first case describing the complication of a separated and dislodged rotaburr. This case highlights a potential technique to deal with this rare complication. Normally, the burr is attached to the driveshaft (Fig. 24.11). Figure 24.12 explains how to identify the dislodgement of the burr from the driveshaft on fluoroscopy. Oftentimes, the burr remains on the rotawire, as the distal segment of the wire is 0.014″ which is larger than the lumen of the burr at 0.009″. This prevents distal migration of the burr distal to the wire and also prevents the wire from being pulled out from the burr. Thus, one potential option (that was undertaken in this case) to deal with this scenario is to

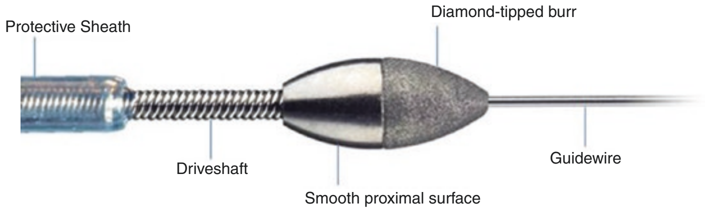

FIGURE 24.11 Normal connection of the driveshaft to rotaburr (Image provided courtesy of Boston Scientific. © 2017 Boston Scientific Corporation or its affiliates. All rights reserved)

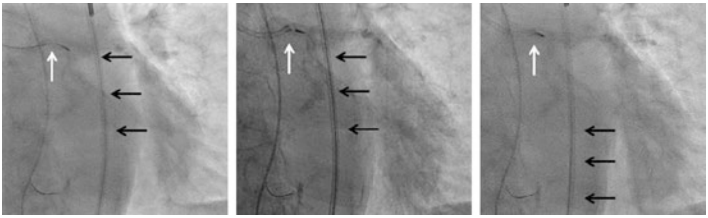

FIGURE 24.12 Dislodged rotaburr from the driveshaft. The *white arrows* show sequentially the separation of the burr from the driveshaft. The *black arrows* show the position of the driveshaft in the guide during removal

remove the entire rotablation assembly, taking care under fluoroscopy to ensure that the burr constantly remains on the wire. Several considerations to note include (a) the need to ensure the burr does not get dislodged off the wire, (b) the guide is well engaged during removal of the rotablation assembly to prevent systemic embolization of the burr should it get dislodged off the wire, (c) loss of access to the lesion and the need to rewire the complex (already pre-dilated) lesion, and (d) when pulling the burr out, the guide will be pulled against the left main. This may result in ostial left dissection which can be catastrophic. The operator should be prepared to immediately deal with such a situation. In the event of dislodgement of the burr off the wire, percutaneous techniques to retrieve the burr or even open surgery may be considered. It should be noted that if the burr is dislodged from the wire, it would usually imply that the wire is also damaged, either partially broken or unraveled. Therefore, in such situations, the burr may be dislodged with a piece of the wire. Fortunately, this did not happen in this case. The key learning point is that in the setting of a separated and dislodged rotaburr, the entire rotablation assembly can be removed carefully under fluoroscopy, taking care not to displace the burr off the rotawire. The rotablation procedure can then be started over using a new burr.

Chapter 25
Specials: Rotablation Through Stent Accordion

Khung Keong Yeo, Garrett Wong, and Reginald Low

Case Summary

A 52-year-old man presented with NSTEMI. He had diabetes mellitus, hypertension, dyslipidemia, prior tobacco, and heavy alcohol use. He had a past history of CAD with CABG 3 years ago with LIMA to LAD, SVG to first diagonal, SVG to OM1, SVG to circumflex, and SVG to RCA. His LVEF was 35%. Coronary angiography showed severe native three-vessel disease, patent LIMA graft to the LAD, occluded SVGs to the OM1, RCA, and circumflex and severe stenosis in the SVG to the diagonal (Fig. 25.1, Videos 25.1 and 25.2) We proceed to intervene on the SVG-diagonal lesion.

A 7F sheath, 7F LCB guide was chosen. The lesion was crossed with a standard 0.014″ guidewire. A 4.0 mm Spider FX filter (Medtronic, Minneapolis, Minnesota, USA) was

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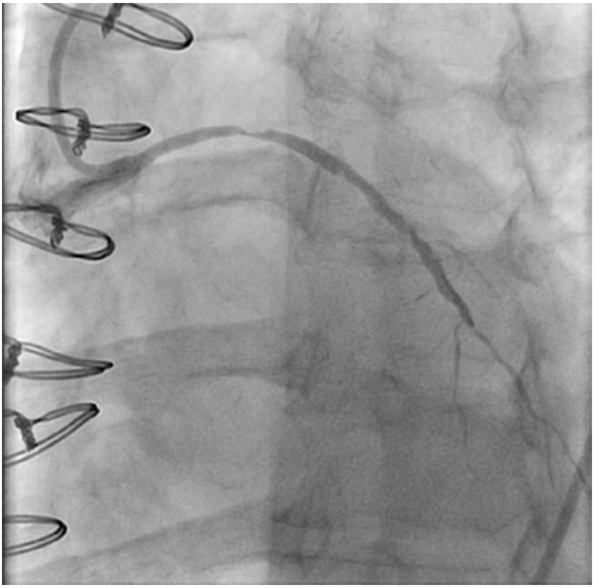

Figure 25.1 Baseline angiogram showing severe SVG stenoses

deployed distally (Video 25.3). Balloon angioplasty with a semi-compliant 2.25 × 12 mm balloon was performed. A 2.5 × 30 mm and a 2.5 × 24 mm Endeavor stent (Medtronic, USA) were deployed at 16 atmospheres (Videos 25.4 and 25.5). We then attempted to post-dilate the stents with a 2.5 × 20 mm noncompliant balloon but this would not cross the proximal part of the stent. A 2.5 × 12 mm balloon also failed to cross the proximal stent. Unfortunately, our attempts to push the noncompliant balloon forward resulted in the guide being pushed backwards, which in turn resulted in the filter wire being pulled more proximally into the previously deployed stent (Fig. 25.2; Video 25.6). This was recognized. We then attempted to push the filter distally but the filter remained trapped with the distal stent. We then attempted to retrieve the filter with its retrieval catheter (Video 25.9). There was difficulty in doing so, and the previously placed stents were crumpled and "accordioned" into the proximal

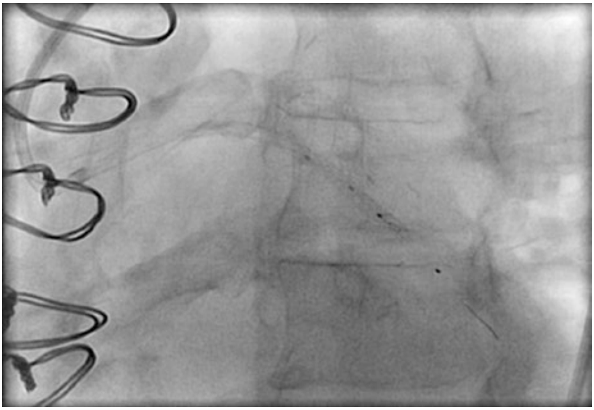

FIGURE 25.2 The filter wire has caught on the distal edge of the stent

vein graft (Video 25.10). The flow into the SVG was now compromised with TIMI 0 flow.

We obtained separately arterial access in the contralateral femoral artery and advanced another 7F LCG guide in anticipation of complex maneuvers. On the original guide, we pulled hard and the filter came out of the guide catheter without the stents. The previously placed two Endeavor stents were now crumpled and “accordioned” in the proximal segment of the vein graft (Fig. 25.3; Videos 25.9 and 25.10).

We could rewire the crumpled stents but could not pass any balloons (smallest balloon available then was a 1.5 mm balloon) through them, despite using aggressive guide support (AL2 guide), mother-and-child catheters, anchor balloon technique, and other techniques.

Eventually, we wedge the tip of the microcatheter in the lesion and directly wired across the lesion with a rota extra-support wire. Careful rotational atherectomy with 1.25 mm and 1.5 mm burrs at 150,000 RPM was performed (Fig. 25.4; Videos 25.11 and 25.12).

We then performed balloon angioplasty to 2.5 × 12 mm semi-compliant balloon to tack the stents against the vessel wall. Three additional Endeavor stents (2.5 × 30 mm, 2.5 × 24 mm, and 2.5 × 24 mm) were deployed at 16 atm.

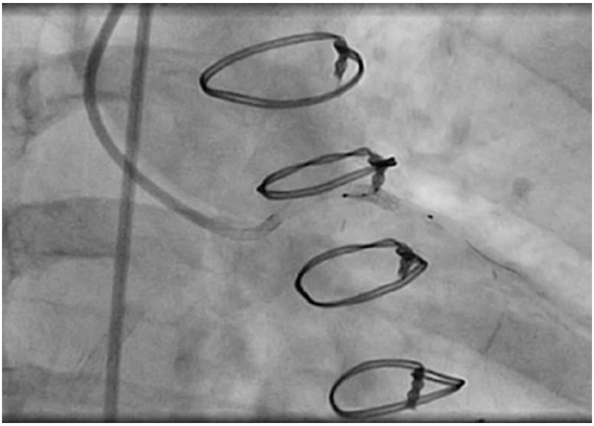

FIGURE 25.3 The stents, together with the filter wire, have “accordioned” into the proximal SVG

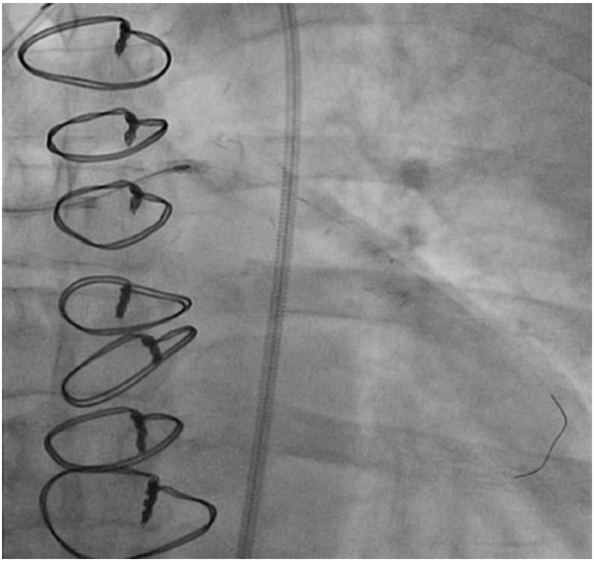

FIGURE 25.4 Rotational atherectomy using a 1.25 mm burr

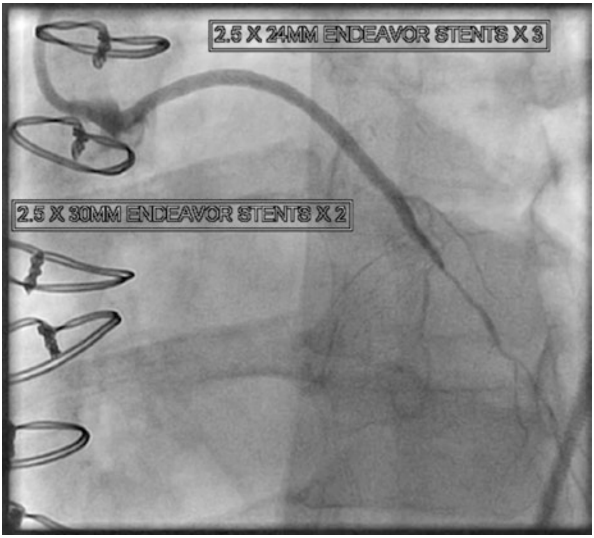

FIGURE 25.5 Final angiogram showing an excellent angiographic result

The stents were post-dilated with a 2.5 mm noncompliant balloon. Final angiography showed TIMI 3 flow (Fig. 25.5; Video 25.13).

Discussion and Learning Points

While there were many learning points from this single case, the key learning points related to rotational atherectomy were:

- It is possible cross complex lesions with a rota wire.
- Rotational atherectomy across stents is technically possible but requires careful technique. We took care not to push too hard, to avoid burr entrapment. We also felt that higher speeds and prolonged runs would result in higher temperatures and the possibility of greater platelet activation.

Chapter 26
Specials: Rotablation Through Jailed LAD

Himanshu Gupta and Khung Keong Yeo

Case Summary

An 86-year-old man with a history of established coronary artery disease and risk factors of diabetes mellitus and hypertension presented with unstable angina for 1 month with two to three episodes of rest angina. Previous cardiac history included three PCI procedures: balloon angioplasty to the LAD in year 1996, PCI with DES to mid-LAD (Taxus 2.5 × 24 mm) in year 2002, and PCI with DES for LAD in-stent restenosis with (Cypher 2.5 × 33 mm) in year 2005.

Coronary angiogram was performed via a 6F right radial artery approach. This showed that the patient had three-vessel CAD with a dual LAD system. The larger LAD was

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jailed by previous two layers of DES. The jailed LAD had 90% ostial stenosis at the bifurcation and had 70% tandem lesions in its mid- and distal part (Figs. 26.1 and 26.2, Video 26.1). The LCX system was small with RCA having 70% discrete lesions in the RPL and RPDA. Considering the complex nature of disease, diabetes mellitus, and presence of in-stent restenosis, the patient was initially offered CABG, but this was declined by the patient and his family, citing age as the main consideration.

Intervention was performed on the LAD as this was most likely the culprit lesion producing symptoms at rest and to stage and do FFR-guided PCI of the RCA later. In planning the procedure, the specific challenges in this case were:

1. 86-year-old patient
2. Large jailed LAD across two layers of first generation DES with combined strut thickness of about 270 μ

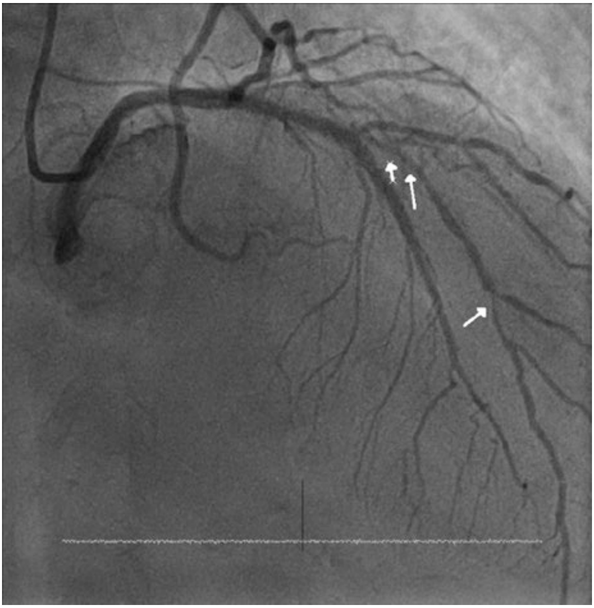

Figure 26.1 Initial coronary angiogram

Arterial access was obtained with 6F right radial approach. A 6F XB3 guide was used. The lesion was crossed initially with BMW wire and Fielder wire into the jailed LAD and its major side branch, respectively. Attempts to cross into the jailed LAD with multiple balloons including Neich Sapphire II 2.0 × 15; 1.0 × 10 mm and TriReme Glider 1.5 × 8mm were unsuccessful (Fig. 26.3). We decided to cross with a Finecross microcatheter and change the strategy to rotablation of the stents. The Finecross could not cross despite adequate guide catheter support (Fig. 26.4). The lesion was then crossed directly with the extra-support Rotawire with the Finecross microcatheter wedged at the lesion (Video 26.2). Rotablation with a 1.25 mm burr was performed at 150,000 RPM along with the use of Rotaglide solution (Fig. 26.5). The stents could be successfully crossed with the 1.25 mm burr after nine rounds of drilling with each round lasting for about 20 s (Fig. 26.6, Video 26.3).

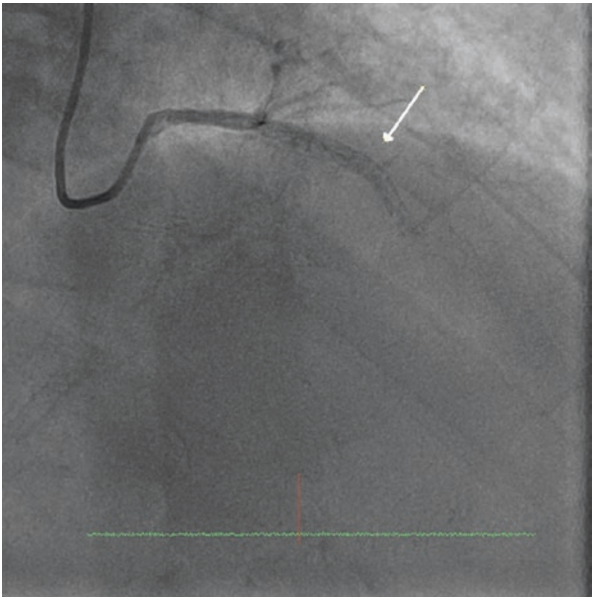

Figure 26.2 This shows the two layers of first-generation DES

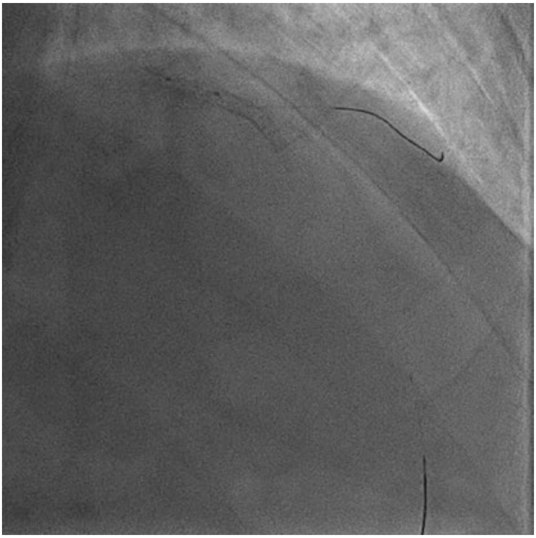

Figure 26.3 This shows that the 2.0 mm balloon could not cross the lesion. The 1.0 mm semi-compliant balloon could not cross as well (not shown)

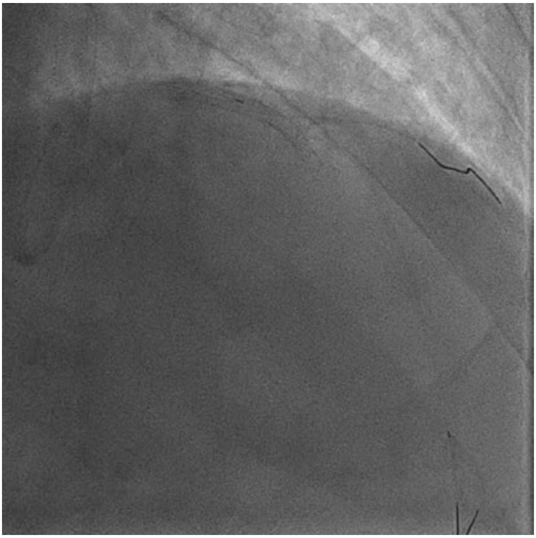

Figure 26.4 The Finecross microcatheter could not cross as well

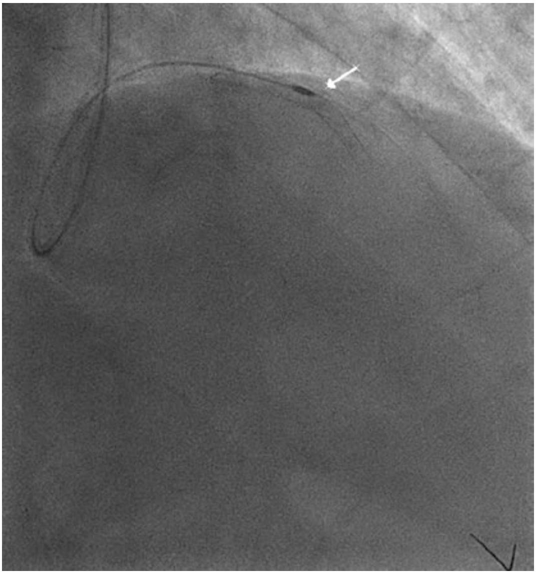

FIGURE 26.5 Rotational atherectomy with a 1.25 mm burr

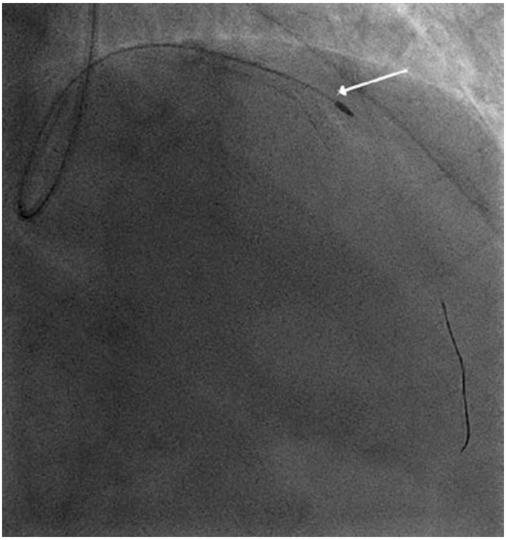

FIGURE 26.6 Successful crossing of the stents with 1.25 mm burr

Despite the requirement of multiple rounds of rotablation, the burr speed was kept at 150,000 RPM to decrease the chances of thermal injury, slow flow/no reflow, and other complications.

After successful rotablation, there was transient slow flow which was managed with intracoronary adenosine and nitroglycerin. Stent struts were further dilated with a Ikazuchi®1.5 × 15 mm and 2.0 × 15 mm balloons (Fig. 26.7). At this point, it was decided to treat the side branch with a two-stent strategy and the Coulotte technique was chosen.

The distal LAD was stented with three overlapping DES, Xience Alpine 2 × 23 mm, 2.5 × 23 mm and the ostial part of the main LAD branch with a Xience Alpine 3 × 33 mm (Fig. 26.8). The stents were post-dilated with 2.5 mm and 3.0 mm NC balloons (Neich NC sapphire). Final kissing balloon inflation (Fig. 26.9) was performed with 3.0 mm NC balloons in both the main and the side branch vessels with excellent angiographic result and TIMI3 flow (Figs. 26.10 and 26.11, Video 26.4).

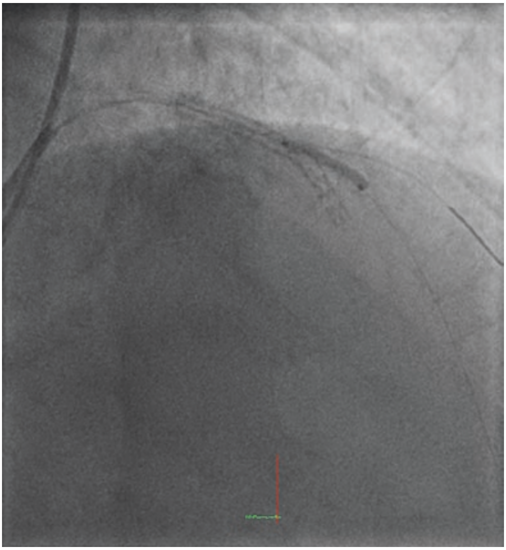

Figure 26.7 Initial balloon dilatation through stent struts with 2.0 mm semi-compliant balloon

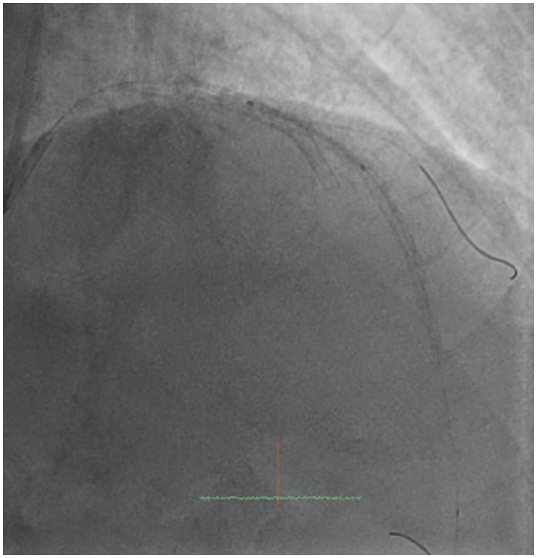

Figure. 26.8 Stent across the main branch as part of Coulotte technique

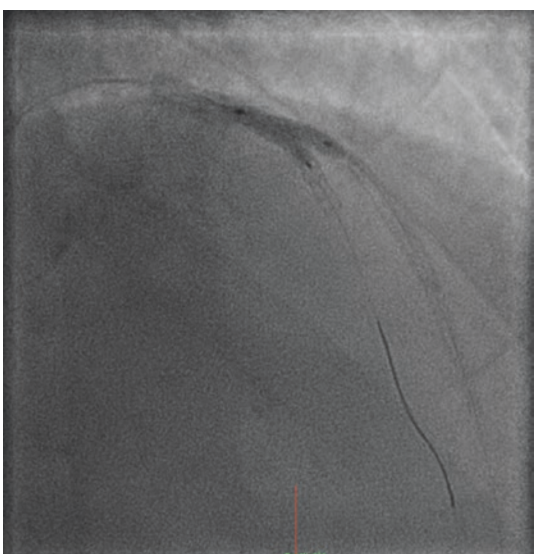

Figure 26.9 Kissing inflation between MB and SB

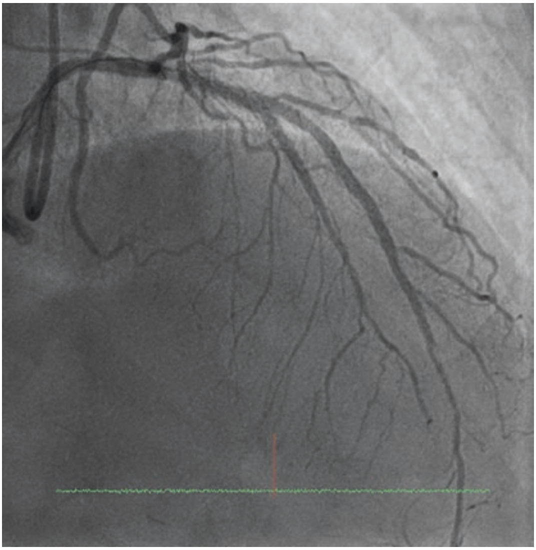

Figure 26.10 Final angiogram in RAO cranial view

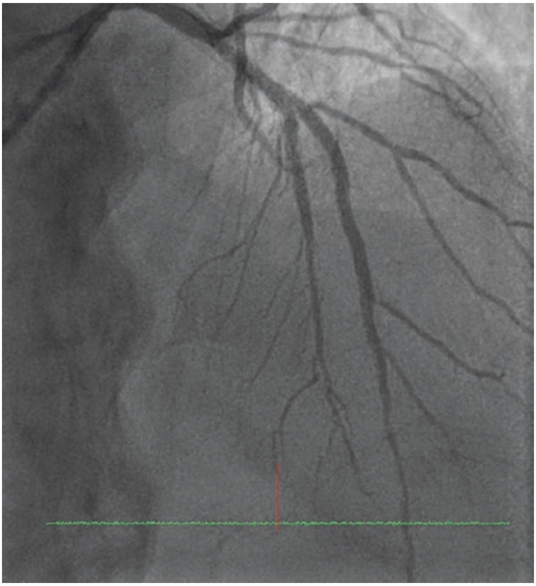

Figure 26.11 Final angiogram in AP cranial view

Discussion and Learning Points

The primary indication for rotational atherectomy is the calcific lesion, which increases the risk of procedural failure, stent under-deployment, restenosis, and major complications.

The Rotablator burr is capable of ablating metallic stent struts and does so preferentially because of the same principle of differential cutting. This has permitted the selective use of rotational atherectomy to treat underexpanded ("stent regret") or crushed stents embedded in obstructive, calcific lesions [1] (14).

However, the use of rotational atherectomy to access a side branch which has been jailed across two layers of stent has not been reported to the best of our knowledge till yet. What is of particular importance is that rotablation of two stent layers is more challenging, needs longer ablation time, and is likely to have more complications including slow flow/no reflow and entrapment of burr.

Analysis of metallic particulate generated by stent ablation reveals particles similar in average size to those generated by atheroablation, 5.6 ± 3.6 μ with 95% of particles <15 μ in size [1, 2]. But longer ablation times and resulting thermal injury may contribute to the increased incidence of slow flow/no reflow in such cases.

In our case, we had to do nine runs of rotablation before we could cross but still the speed was not increased beyond 150,000 RPM. The key learning points are:

- Rotablation can be used to ablate stent struts not only in the case of an underexpanded stents but also to access a side branch when needed.
- One has to be a patient while doing ablation in these cases as the ablation times are longer and the risk of complications is higher.
- Slow flow and no flow are important complications but these may be managed with the arterial vasodilators in most cases.

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Chapter 27
Specials: Rotablation Through LM In-Stent Restenosis

Khaled Hammad and Khung Keong Yeo

Case Summary

An 89-year-old man with a past history of hypertension, hyperlipidemia, and chronic kidney disease presented with recurrent episodes of unstable angina and heart failure. He had prior CAD with triple vessel disease. He had declined CABF and subsequently had PCI to the RCA, left main, LAD, and LCX. One year ago, he had Coulotte stenting of the left main, LAD, and LCX, with everolimus-eluting stents. Four months after that, he had presented with an acute coronary syndrome and angiography showed severe restenosis of

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the ostial LAD and LCX. The operator at that time opted to treat with balloon angioplasty and drug (paclitaxel)-coated balloon therapy. He represented with multiple admissions for acute syndromes and heart failure (six times over a 4-month period). He had previously preferred medical therapy but due to frequency of events, finally decided for high-risk repeat coronary angiography and possible PCI.

Figure 27.1 and Video 27.1 show severe in-stent restenosis of the distal left main and ostial LAD and ostial CIRC. The vessels were calcified and the prior stents were noted. The RCA shows minor in-stent restenosis. A 7F JL4 guide was used. Both LAD and LCX were wired and balloon angioplasty with 2.5 mm then 3.0 NC balloons were used to predilate the lesion (Fig. 27.2) but significant residual stenosis was seen in the distal LM and ostial LCX (Video

FIGURE 27.1 Baseline angiogram

27.2). Rotational atherectomy of the ostial LCX was performed with a 1.25 mm, then 1.5 mm burr at 150,000 RPM, over a rota extra-support wire (Videos 27.3 and 27.4). The burr had ablated through the previously placed stents and created a trough in the vessel (Videos 27.3 and 27.4). There was a concern that if the wire in LCX was removed, the LCX would occlude. The angiogram was carefully examined and it was felt that the there was sufficient gap between the LAD and LCX wires, and the wire could be left in the LCX (Fig. 27.3). Rotational atherectomy of the LAD was next performed with a 1.5 mm burr, at 150,000 RPM (Video 27.5). Further predilation with AngioSculpt balloon (3.0 × 10 mm) was performed (Fig. 27.4). New drug-eluting stents were deployed in the LCX and LAD again in a Coulotte technique (Fig. 27.5). Post dilation, final kissing balloon post-dilatation

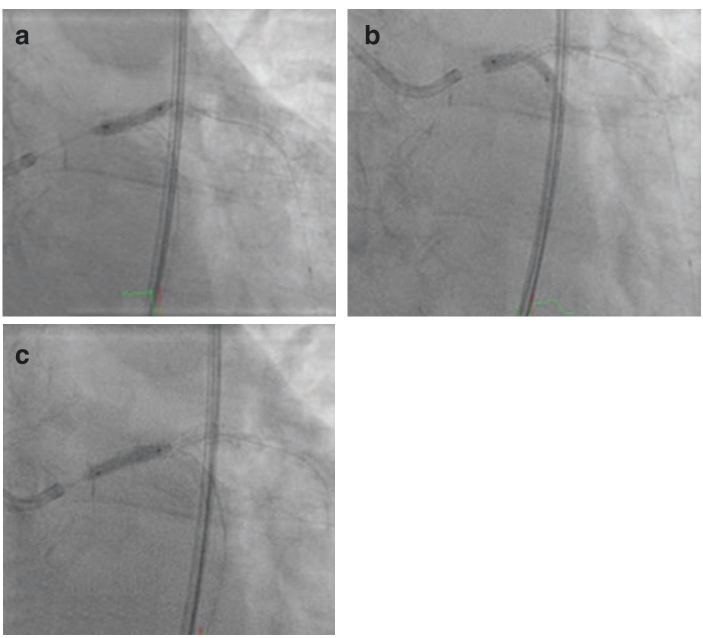

Figure 27.2 Balloon angioplasty of the left main bifurcation showing residual 'waist'

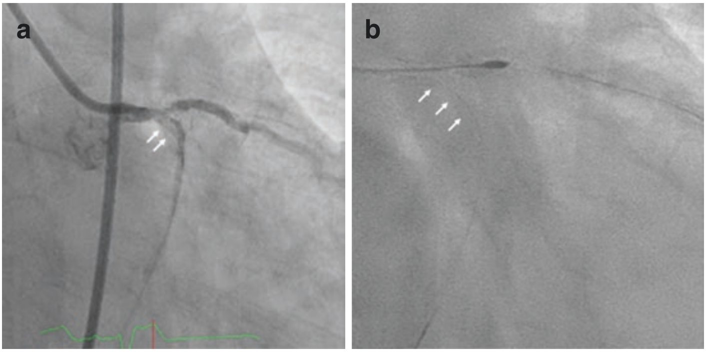

FIGURE 27.3 **(a)** Shows the left circumflex after rotablation. There is a trough in the vessel. (**b**) Shows positioning of the burr in the LAD ostium, away from the circumflex wire

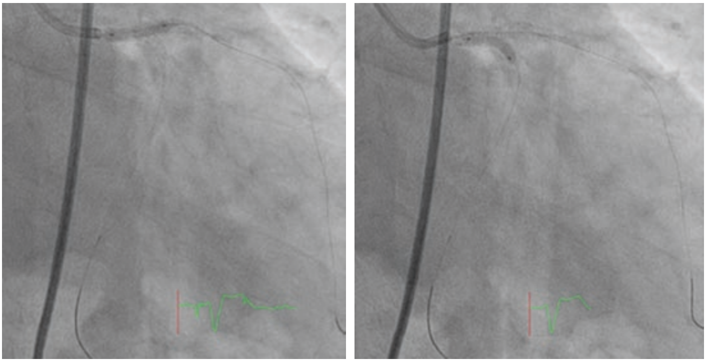

FIGURE 27.4 Further balloon angioplasty

and proximal optimization were performed using standard technique (Fig. 27.6). Final angiogram and IVUS showed a good result (Fig. 27.7, Videos 27.6 and 27.7).

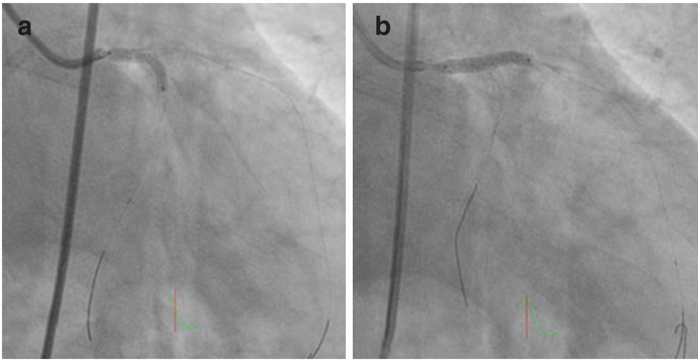

FIGURE 27.5 Deploying new stents using Coulotte technique

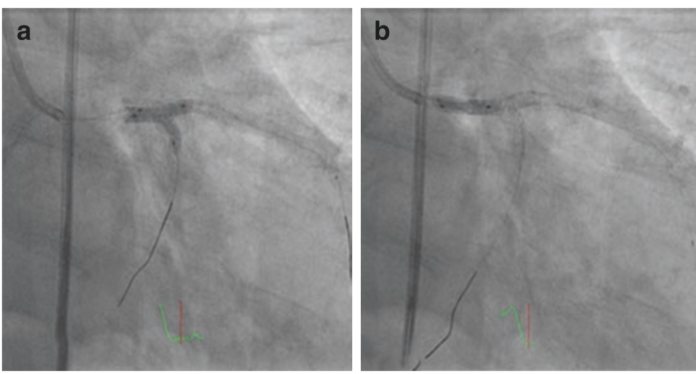

FIGURE 27.6 Final kissing post dilatation (**a**) and post dilatation of the ostium (**b**)

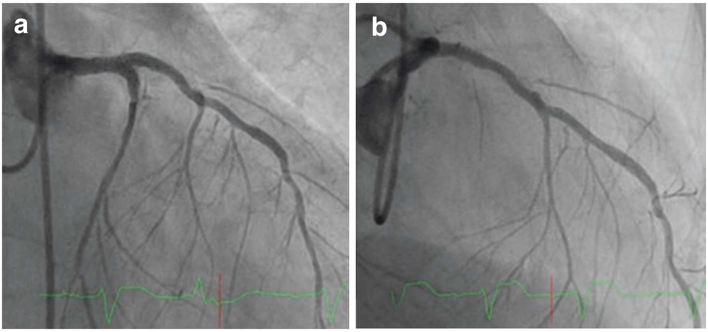

FIGURE 27.7 Final result

Discussion and Learning Points

- Rotational atherectomy to ablate previously stented segments is technically feasible with good technique and patience.
- It is important to remove the wire in a side branch before rotational atherectomy; otherwise, the side branch wire may be sheared off. However, in specific instances such as the one described here, rotational atherectomy can be performed leaving the wire in the side branch. To do so safely, the operator must ensure sufficient space between the wire and the burr. Second, it is advisable to use a larger guide so that the burr does not damage the other wire (e.g., when on dynaglide mode).

Chapter 28
Specials: Rotablation of LIMA into LAD

Aaron Wong and Khung Keong Yeo

Case Summary

A 55-year-old woman with a history of CAD with prior CABG presented with unstable angina. Her other comorbidities include hypertension and hyperlipidaemia. The CABG was performed 10 years ago with LIMA to LAD and SVG to obtuse marginal. At this most recent presentation, her ECG showed T wave inversions anteriorly, and echocardiography showed mildly impaired left ventricular function with LVEF 40–45%.

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Coronary angiography showed mid LAD and LCX CTOs, moderate disease of the RCA and ostial disease in the diagonal. There was also severe disease in the mid LAD after the insertion of the LIMA graft. The SVG was patent. A decision was made to intervene on the mid LAD beyond the LIMA graft. Via 6F femoral access, a 6F IMA guide catheter was used to engage the LIMA. A 0.014″ guidewire was able to cross the lesion with the aid of a microcatheter. Balloon angioplasty with semi-compliant balloons 2.0 and 2.5 × 15 mm was unsuccessful with significant residual stenosis or 'waist' as shown in Figs. 28.1, 28.2, 28.3, 28.4, 28.5, 28.6, 28.7, 28.8, 28.9, 28.10, 28.11 and 28.12. The operator decided to perform rotational atherectomy with a 1.25 mm burr. After rotablation, balloon angioplasty could be performed with a 2.0 × 15 mm semi-compliant balloon.

However, the immediate angiogram after angioplasty showed extensive spiral dissections. The operator proceeded to implant three 2.5 × 28 mm DES to cover the flow limiting dissection. The patient was stable and discharged after 2 days on dual anti-platelet therapy.

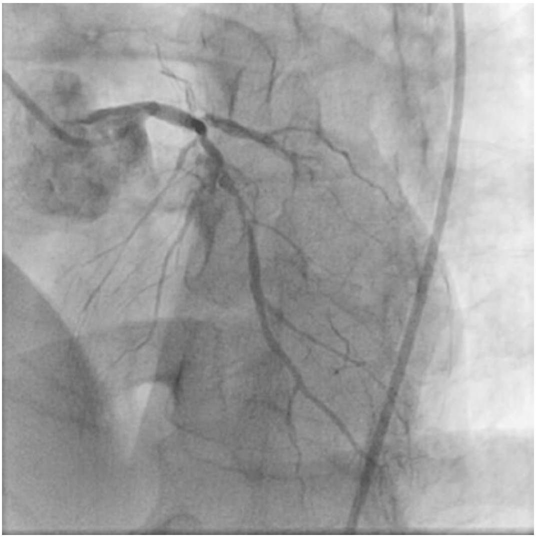

Figure 28.1 Native left coronary system

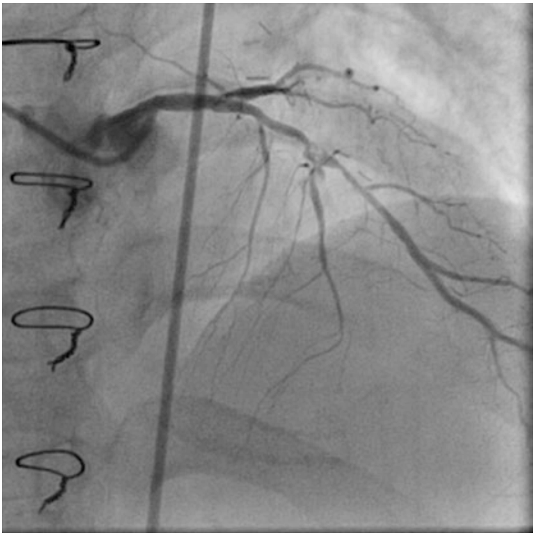

FIGURE 28.2 Native left coronary system

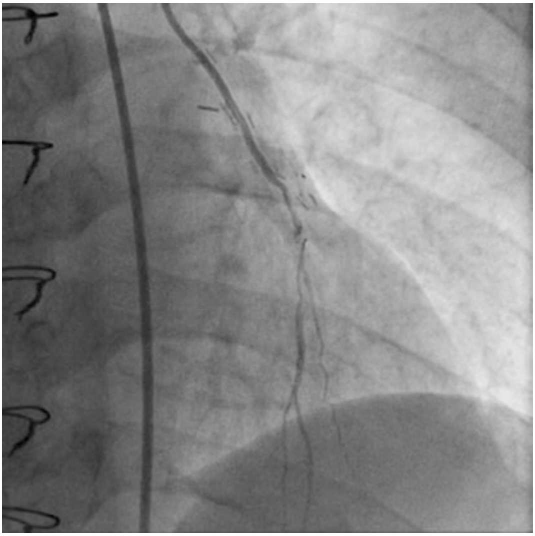

FIGURE 28.3 Angiogram of LIMA graft to LAD showing the severe mid-LAD stenosis distal to graft insertion

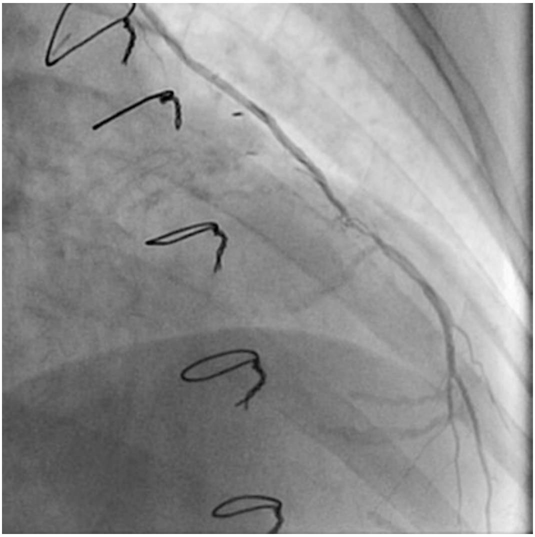

FIGURE 28.4 Angiogram of LIMA graft to LAD showing the severe mid-LAD stenosis distal to graft insertion

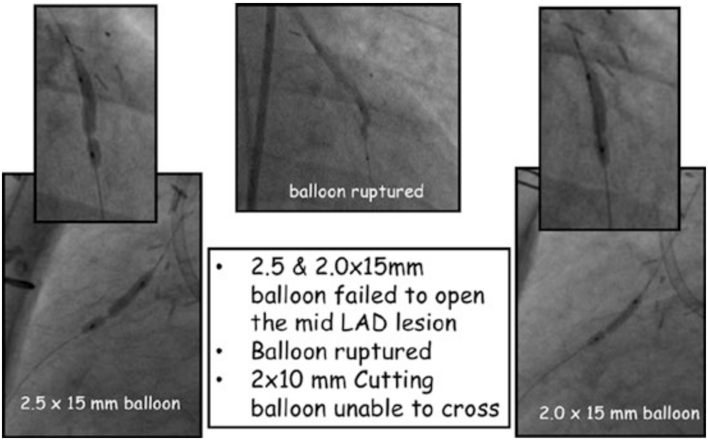

FIGURE 28.5 Composite figure showing residual narrowing of the stenosis with balloon angioplasty

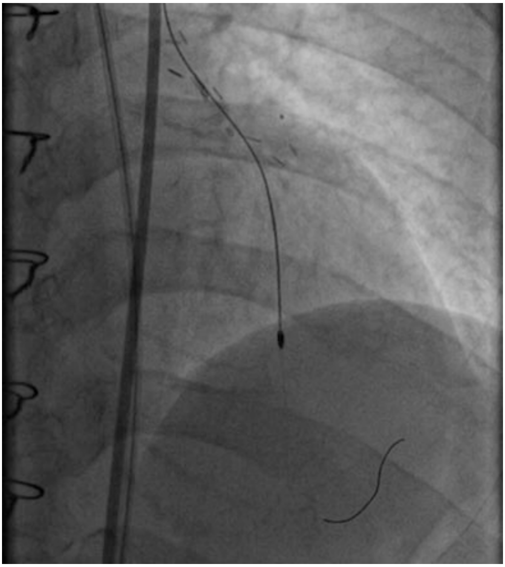

FIGURE 28.6 Rotational atherectomy of the LIMA graft to LAD

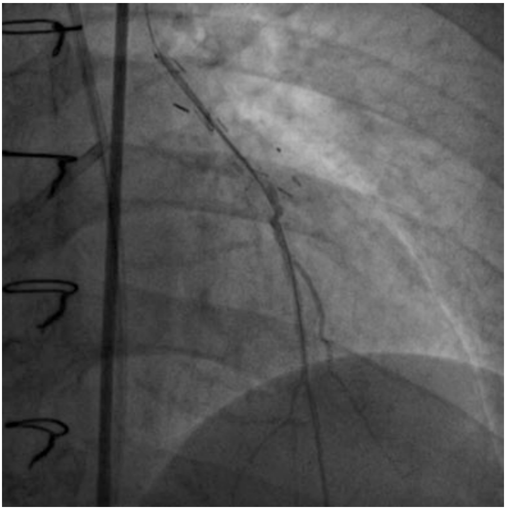

FIGURE 28.7 Dissection in the LIMA graft with flow limitation

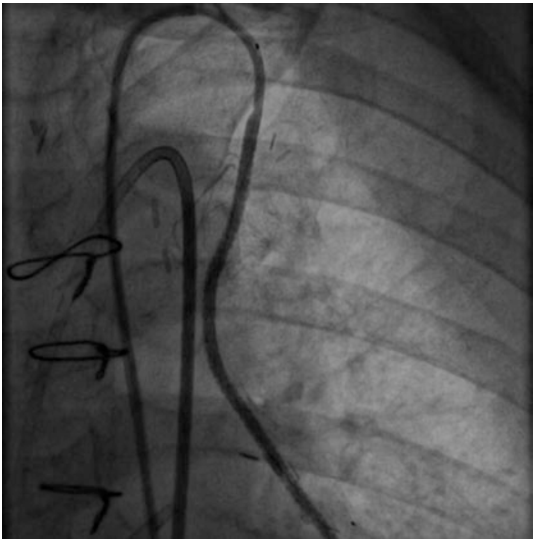

Figure 28.8 Final angiogram of LIMA graft after stenting

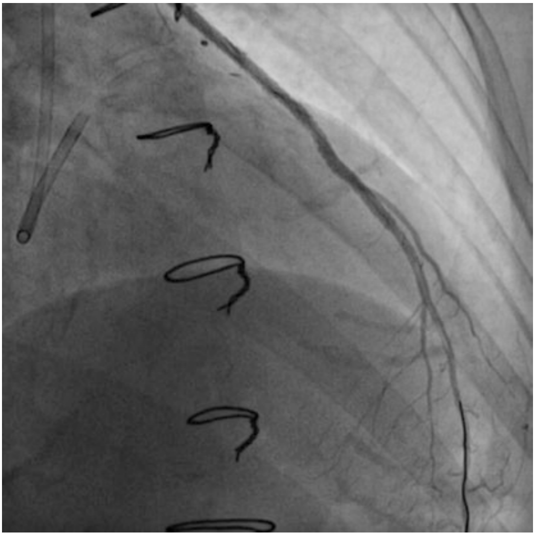

Figure 28.9 Final angiogram of LIMA graft after stenting

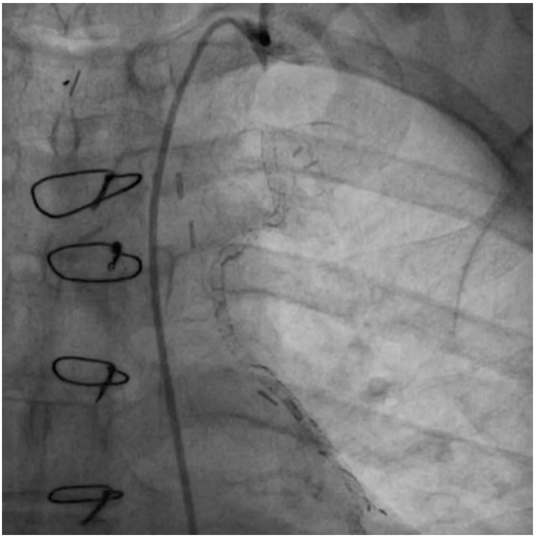

FIGURE 28.10 Occluded LIMA graft

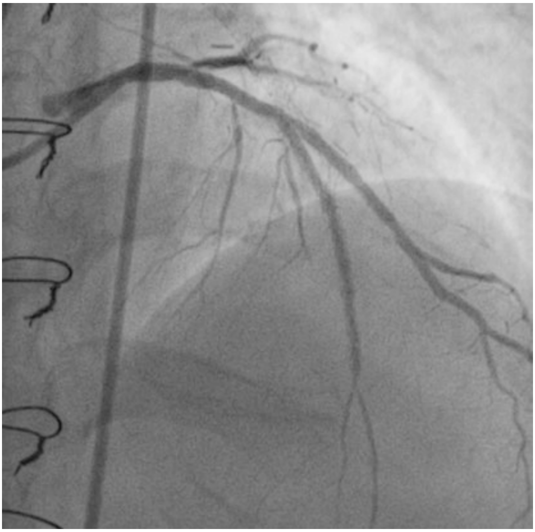

FIGURE 28.11 Final angiogram after PCI of the LAD CTO

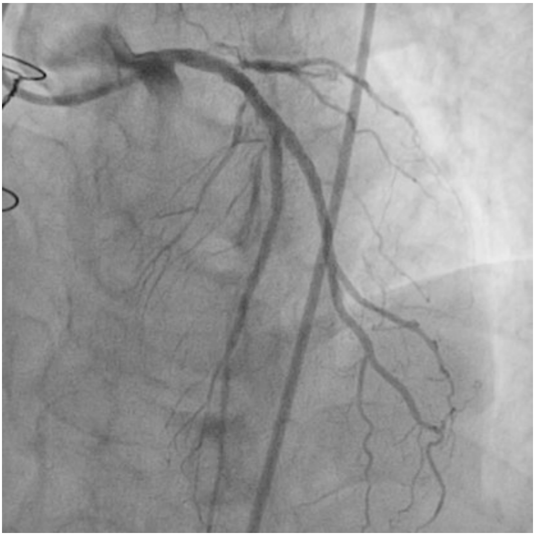

FIGURE 28.12 Final angiogram after PCI of the LAD CTO

She was readmitted 4 weeks later for a staged procedure to the unprotected large diagonal. Unfortunately, angiography at this time showed that the LIMA graft had been totally occluded. The operator decided to attempt the LAD CTO. This was successfully performed.

Discussion and Learning Points

The LIMA is a very fragile arterial conduit prone to dissections. We would urge extreme caution in attempting any rotablation of the LIMA or via the LIMA into the LAD as the risk of significant spiral dissection is very high even in experienced hands. In this case, an attempt on the LAD CTO is probably safer than PCI via the LIMA graft.