Differential Diagnosis in Small Animal Medicine

By

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Contents

To Naomi and Abigail, for their patience and support,
and Mac, for a lifetime of companionship.

Introduction

This book was written to fill what I felt was a gap in the market. While working up difficult medical cases, I have often wanted a single ready reference to help me formulate a differential list from the clinical information I have available. Unfortunately, I found myself frequently having to consult multiple textbooks to bring all the information I needed together. I decided therefore to write a book that would serve as a ready reference for differential diagnoses of the majority of presentations that are encountered in practice, including both common and uncommon conditions. This text should be of use to veterinary students, general practitioners, university interns, residents and anyone who, like me, cannot fully carry these lists around in their heads. I hope other clinicians find it as useful as I do.

The differential diagnosis list is one of the most important aspects of the problem-oriented approach to clinical diagnosis. For those who are not familiar with the problem-oriented approach, a brief outline follows.

As the name implies, problem-oriented medical management (POMM), concentrates on the individual problems of a patient. A differential diagnosis list should be made for each and every problem that is found in a patient, whether in the history, the physical examination, imaging or clinicopathological tests. Although superficially this may not sound very 'holistic', in fact, if all the patient's problems are considered individually, the whole patient will have been evaluated, without falling into the trap of presuming that all of the findings are caused by a single condition.

The problem-oriented approach starts with a detailed history, and it is important to discover what the owners perceive to be the main problems – after all, they usually know their animal better than the clinician does. However, there may be relevant historical signs that the owners had not considered significant, so failing to systematically ask all the questions which could be of importance in a case can lead to overlooking important information. Using a checklist or form, such as the one in Appendix A can be useful as an aide-memoire.

In every case, a detailed physical examination should be carried out, including body systems that are not apparently of immediate concern. Again, a checklist or form, such as the one in Appendix B, can help ensure a systematic approach.

Once the history has been taken and the physical examination has been completed, the clinician should list every problem that has been discovered. Problems may include such findings as exercise intolerance, pruritus, pyrexia or a heart murmur. A differential diagnosis list should then be created for every problem. The list should be appropriate to that animal. There is no point listing feline leukaemia virus as a likely diagnosis in a dog!

An attempt should also be made to categorise the conditions in order of likelihood, or at least into common and uncommon. Although the more common conditions have been indicated in this book with an asterisk (*), there are few objective data regarding the true incidence of conditions, and the estimate of incidence is largely subjective and influenced by the author's geographical location and caseload. Familiarity with how

common conditions are and their local incidence will help prioritise differential lists. The clinician can then select diagnostic tests in a rough order of probability, although rarer but life-threatening conditions, such as hypoadrenocorticism, should also be ruled out early in the course of investigations. Some authorities rightly point out that emphasis should be placed on historical and physical signs, and that 'over-investigating' can be expensive and potentially detrimental to the patient (Chesney, 2003).

It is this author's opinion, however, that it is possible to place too much importance on probabilities and how commonly a condition occurs. The newly-qualified veterinary surgeon will often look for the rare but exciting and memorable condition they learned about at college, while the experienced practitioner will often remind them that 'common things are common', and suggest they restrict their investigations only to commonly-encountered conditions. The ideal approach is probably somewhere in between.

Although it is self-evidently true that common things are common, it is also true that uncommon things are encountered relatively often. To take a hypothetical example: if a common problem is caused by common conditions A and B with a frequency of 80%, and by rare conditions C to Z the rest of the time, with conditions C to Z occurring with equal frequency, then each individual condition C to Z will be responsible for the problem approximately 0.9% of the time, making each individual condition quite uncommon. However, 1 in 5 presentations of this problem will be caused by an uncommon condition, and so uncommon conditions will be diagnosed commonly, provided they are looked for. The problem-oriented approach ensures that these uncommon conditions are not overlooked.

Some authorities prefer to categorise the initial approach to a case differently, and describe the subjective and objective assessment of a patient as part of the SOAP approach (Subjective, Objective, Assessment, Plan). The principle is the same however, in that a detailed history or physical examination is the basis of the initial differential list.

Once the differential diagnosis list has been formulated, the clinician is in a position to select appropriate tests to aid in making a definitive diagnosis. Prioritising the selection of diagnostic tests helps avoid placing undue financial strain on the client and inappropriate or unnecessary testing on the patient. Tests may be prioritised on such factors as: the number of conditions which will be ruled in and out; the sensitivity and specificity of the tests; the risk/benefit to the patient ratio; the financial cost/benefit to the client ratio; the incidence or prevalence of the condition being tested for; the importance of the condition being tested for (e.g. hypoadrenocorticism is uncommon, but the consequences of failing to diagnose it may be serious).

After the results of initial testing have been obtained the clinician may be in a position to make a definitive diagnosis. Often, however, it is necessary to refine the differential list and select further appropriate testing. The differential list may be reformulated as often as is necessary until a single diagnosis for that problem is made. Often, a single diagnosis will tie in all the problems satisfactorily. However, in many cases, particularly in geriatric patients, concurrent disorders will require multiple diagnoses.

For problem cases in which a clear diagnosis is not made, or the patient fails to respond to treatment as expected, returning to the beginning with the history and physical examination, with the condition often having progressed, can be helpful. However, very few tests are 100% sensitive and specific, and many 'definitive' diagnoses in fact leave room for some doubt. The clinician should never be afraid to revise the initial diagnosis if further evidence comes to light. Those who are concerned that failing to make the correct diagnosis in every case is somehow a sign of inferior clinical abilities

should take heart from a recent study from the School of Veterinary Medicine at the University of California (Kent et al., 2004). In this paper, clinical and post mortem diagnoses of 623 dogs treated between 1989 and 1999 at the Veterinary Teaching Hospital were compared. It was found that the post mortem diagnosis, presumed to be the correct diagnosis, differed from the clinical diagnosis in approximately $^{1}/_{3}$ of cases.

This book is organised into seven parts. Part 1 deals with signs likely to be uncovered during history taking. Part 2 deals with signs encountered at the physical examination. Part 3 deals with imaging findings, Part 4 with clinicopathological findings, and Part 5 electrophysiological findings. Part 6 outlines the techniques involved in some common diagnostic procedures and Part 7 contains some algorithms to aid in the diagnosis of common clinical presentations. Four appendices, containing checklists for diagnostic investigations, and a bibliography follow.

The individual lists are categorised as I felt was logical, for example by the DAMNIT-V organisation. DAMNIT-V is a mnemonic for remembering the various pathological processes that may cause a disease:

D – degenerative
A – anomalous (usually listed as congenital in this book)
M – metabolic
N – nutritional, neoplastic
I – inflammatory, infectious, immune-mediated, iatrogenic, idiopathic
T – traumatic, toxic
V – vascular

This categorisation is not appropriate in all cases, however. The individual lists are largely organised alphabetically. The more common conditions are labelled with an asterisk, but, as stated above, whether or not a condition is considered to be common is largely a matter of subjective opinion. Those conditions that are predominantly or exclusively found only in dogs are marked with a (D) and those in cats are marked with a (C).

Sources for the information in this book are wide ranging. A large number of textbooks, listed in the bibliography, were consulted, but in most cases it was necessary to expand the lists found in these sources, using information from veterinary journals and conference proceedings.

Although there are undoubtedly omissions from some of the lists, encompassing as this book does virtually the whole of small animal veterinary medicine, I have tried to make it as comprehensive as possible. I would be happy to hear of any omissions, corrections or comments on the text, which can be e-mailed with any supporting references to alex.gough@btconnect.com.

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Key

* = more common condition
(D) = condition seen exclusively or predominantly in dogs
(C) = condition seen exclusively or predominantly in cats
q.v. = more information can be found on this condition elsewhere in this book – see Index

References

Chesney, C. (2003) Overdiagnosis in the veterinary field? *JSAP*, **44**:421.
Kent, M. S., et al. (2004) Concurrence between clinical and pathologic diagnoses in a veterinary medical teaching hospital: 623 cases (1989 and 1999). *JAVMA*, **224**:403–406.

PART 1
HISTORICAL SIGNS

1.1 General, systemic and metabolic historical signs

1.1.1 Polyuria/polydipsia

Physiological
Exercise
High environmental temperature

Diet
Increased salt intake
Very low protein diet

Electrolyte disorders
Hypercalcaemia *q.v.*
Hypokalaemia *q.v.*
Hypernatraemia *q.v.*

Endocrine disease
Acromegaly
Diabetes mellitus*
Diabetes insipidus
- Central
- Nephrogenic

Hyperadrenocorticism*
Hyperthyroidism* (C)
Hypoadrenocorticism (D)
Insulinoma
Phaeochromocytoma
Primary hyperaldosteronism
Primary hyperparathyroidism

Hepatobiliary disease, e.g.
Hepatic neoplasia* *q.v.*
Hepatitis/cholangiohepatitis* *q.v.*

Infectious disease, e.g.
Toxaemia, e.g.
- Pyometra

Miscellaneous

Congenital lack of ADH receptors
Hypothalamic disease
Pericardial effusion
Polycythaemia
Psychogenic

Neoplasia*

Renal disorders

Acute renal failure* *q.v.*
Chronic renal failure* *q.v.*
Glomerulonephritis
After urethral obstruction
Primary renal glycosuria
Pyelonephritis
Renal medullary washout

Drugs/toxins

Aminophylline
Corticosteroids
Delmadinone acetate
Diuretics
Ethylene glycol
Indomethacin

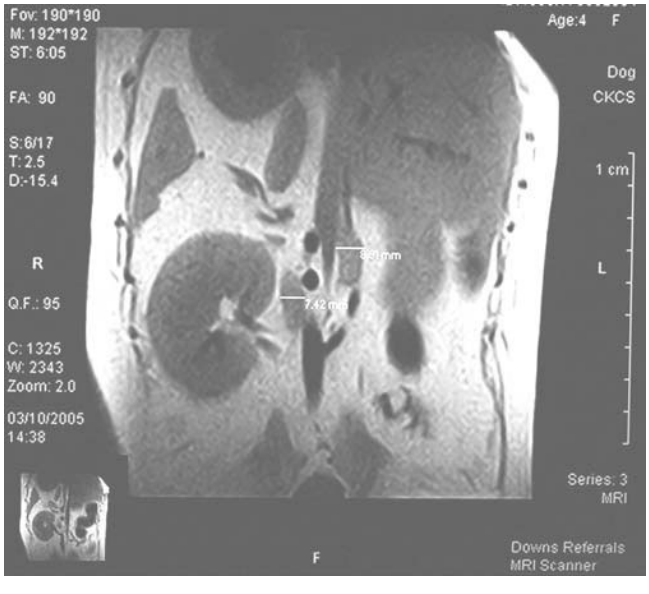

Fig. 1.1 Dorsal T1 weighted MR scan of the adrenal glands of a dog with pituitary-dependent hyperadrenocorticism, showing mild bilateral enlargement. Reproduced with permission of Downs Referrals, Bristol.

Lithium
NPK fertilisers
Paraquat
Phenobarbitone
Potassium bromide
Primidone
Proligestone
Terfenadine
Theophylline
Vitamin D rodenticides

Note: Polyuria and polydipsia are considered together here, since one will lead to the other, with only a few exceptions. These include polydipsia in the face of obstructive lower urinary tract disease or oliguric renal failure, and polyuria which is not matched by fluid intake, in which case dehydration will rapidly follow. None of these scenarios are encountered commonly in practice.

References

Garrett, L. D. (2003) Insulinomas: A review and what's new. *Proceedings, ACVIM, 2003*.

Lunn, K. F. (2005) Avoiding the water deprivation test. *Proceedings, ACVIM, 2005*.

Tobias, et al. (2002) Pericardial disorders: 87 cases of pericardial effusion in dogs (January 1, 1999 to December 31, 2001). *Proceedings, ACVIM*, *2002*.

1.1.2 Weight loss

Decreased nutrient intake

Anorexia *q.v.*
Diet
- Poor-quality diet
- Underfeeding

Dysphagia *q.v.*

Increased nutrient loss

Burns
Chronic blood loss
- Epistaxis *q.v.*
- Haematemesis *q.v.*
- Haematuria *q.v.*
- Melaena *q.v.*

Diabetes mellitus*
Effusions *q.v.*
Fanconi syndrome (D)
Intestinal parasites*
Neoplasia
Protein-losing enteropathy*
Protein-losing nephropathy

Increased nutrient use

Endocrine, e.g.
Hyperthyroidism* (C)

*Neoplasia**

Physiological
Cold environment
Exercise
Fever *q.v.*
Lactation
Pregnancy*

Malassimilation

Cardiac failure*
Exocrine pancreatic insufficiency
Hepatic failure/bile salt deficiency* *q.v.*
Hypoadrenocorticism (D)
Neoplasia*
Renal failure* *q.v.*
Small intestinal disease* *q.v.*

Regurgitation and vomiting *q.v.*

Reference

Rutz, G. M., et al. (2001) Pancreatic acinar atrophy in German Shepherds. *Compend Contin Educ Pract Vet,* **23**:347–56.

1.1.3 Weight gain

Fluid accumulation

Ascites* *q.v.*
Peripheral oedema *q.v.*
Pleural effusion

Increased body fat

Overeating
Boredom
Excessive appetite (normal in some breeds)*
High-calorie diets
Overfeeding*

Endocrinopathies
Acromegaly
Hyperadrenocorticism*
Hypogonadism
Hypothyroidism* (D)
Insulinoma

Increased organ size

Hepatomegaly* *q.v.*
Renomegaly *q.v.*
Splenomegaly* *q.v.*
Uterine enlargement *q.v.*
- Pregnancy*
- Pyometra*

Neoplasia

Large abdominal mass (often associated with poor body condition)*
Drugs, e.g.
- Corticosteroids

References

Garrett, L. D. (2003) Insulinomas: A review and what's new. *Proceedings, ACVIM*, 2003.
Peterson, M. E., et al. (1990) Acromegaly in 14 cats. *JVIM*, **4**:192–201.

1.1.4 Polyphagia

Behavioural/psychological

Normal in some breeds*
Boredom

Physiological

Cold environment
Increased exercise
Lactation*
Pregnancy*

Malassimilation*

Increased nutrient loss

Increased nutrient use

Diet

Highly-palatable food*
Poor-quality food

Endocrine

Diabetes mellitus*
Hyperadrenocorticism*
Hyperthyroidism* (C)
Insulinoma

Miscellaneous

Peritoneopericardial diaphragmatic hernia

Drugs/toxins

Aminophylline

Benzodiazepines
Cannabis
Cyproheptadine
Delmadinone acetate
Glucocorticoids
Phenobarbitone
Potassium bromide
Primidone
Proligestone

References

Garrett, L. D. (2003) Insulinomas: A review and what's new. *Proceedings, ACVIM, 2003*.

Rexing, J. F. & Coolman, B. R. (2004) A peritoneopericardial diaphragmatic hernia in a cat. *Vet Med*, 99:314–18.

1.1.5 Anorexia/inappetence

Difficulty with prehension

Blindness *q.v.*

Myopathy, e.g.
Masticatory myositis
Tetanus

Pain on opening jaw, e.g.
Mandibular or maxillary fracture
Retrobulbar abscess
Skull fractures
Soft tissue trauma
Temporo-mandibular joint disease

Trigeminal nerve disease, e.g.
Neoplasia
Trigeminal neuritis

Difficulty with mastication

Dental disease*
Lingual disease
Oral neoplasia*
Oral ulceration, e.g.
- Ingestion of caustic or acidic substances*
- Renal disease

Difficulty with swallowing

Pharyngeal disease
Foreign body*
Neoplasia
Neurological disease
Ulceration

Oesophageal disease, e.g.
Foreign body*
Neoplasia
Ulceration
Megaoesophagus
Stricture
Vascular ring anomaly

Primary anorexia

Intracranial disease, e.g.
- Hypothalamic neoplasia

Secondary anorexia

Anosmia
- Chronic rhinitis *q.v.*
- Nasal neoplasia
- Other nasal disease
- Neurological disease

Endocrine disease, e.g.
- Diabetic ketoacidosis
- Hypoadrenocorticism (D)

Fever* *q.v.*
Gastrointestinal disease *q.v.*, e.g.
- Gastritis
- Inflammatory bowel disease*

Heart disease, e.g.
- Cardiac failure*

Hepatic disease* *q.v.*
Infection*
Metabolic abnormalities, e.g.
- Hypercalcaemia *q.v.*
- Hypokalaemia *q.v.*

Pain*
Pancreatic disease*, e.g.
- Pancreatitis

Respiratory disease, e.g.
- Airway disease* *q.v.*
- Diaphragmatic hernia
- Pleural effusion* *q.v.*
- Pneumonia *q.v.*

Renal disease* *q.v.*
Drugs
- Acetazolamide
- Amiodarone
- Amphotericin B
- Bethanechol
- Bromocriptine
- Butorphanol
- Cardiac glycosides
- Chlorambucil
- Diazoxide
- Doxorubicin
- Fentanyl

- Hydralazine
- Itraconazole
- Ketoconazole
- Melphalan
- Methimazole
- Mitotane
- Nicotinamide
- Oxytetracycline (C)
- Penicillamine
- Theophylline
- Trimethoprim/sulphonamide (C)

Diet

Recent dietary changes*
Unpalatable diet*

Psychological/behavioural* factors

Altered schedule
New family members
New house
New pets

Reference

Forman, M. A., et al. (2004) Evaluation of serum feline pancreatic lipase immunoreactivity and helical computed tomography versus conventional testing for the diagnosis of feline pancreatitis. *JVIM*, **18**:807–15.

1.1.6 Failure to grow

With good body condition

Chondrodystrophy (normal in many breeds)* (D)
Endocrine disorders
- Congenital hyposomatotropism (pituitary dwarfism)
- Congenital hypothyroidism
- Hyperadrenocorticism

With poor body condition

Dietary intolerance
Exocrine pancreatic insufficiency*

Inadequate nutrient intake

Anorexia *q.v.*
Poor-quality diet
Underfeeding

Cardiac disorders, e.g.

Congenital
Endocarditis

Hepatic disorders, e.g.
Hepatitis *q.v.*
Portosystemic shunt

Oesophageal disorders, e.g.
Megaoesophagus *q.v.*
Vascular ring anomaly (e.g. persistent right aortic arch)

Gastrointestinal disease, e.g.
Histoplasmosis
Obstruction, e.g.
- Foreign body*
- Intussusception*

Parasites*

Renal disease
Congenital kidney disease
Glomerulonephritis
Pyelonephritis

Inflammatory disease

Endocrine disease
Diabetes insipidus
Diabetes mellitus*
Hypoadrenocorticism (D)

Reference

Chastain, C. B., et al. (2001) Combined pituitary hormone deficiency in German shepherd dogs with dwarfism. *Sm Anim Clin Endocrinol*, **11**:1–4.

1.1.7 Syncope/collapse (see Table 1.1)

Cardiovascular dysfunction

Myocardial failure
Myocardial infarction
Shock *q.v.*

Bradyarrhythmias q.v., *e.g.*
High grade second degree heart block
Sick sinus syndrome (D)
Third degree heart block

Tachyarrhythmias q.v.
Supraventricular tachycardia*
Ventricular tachycardia*

Table 1.1 Differentiating seizures from syncope. This table is a guide to the differentiation of generalised seizures from syncopal episodes. However, there is a lot of overlap between the two: syncopal episodes may involve convulsions; seizures may occur on exercise; tonic–clonic motions may not always be observed with seizures.

	Syncope	Seizure (generalised)
Precipitating event/ timing	Exercise, excitement, stress, cough, urination, defecation	Often at rest or on waking
Pre-event	Acute weakness, staggering, vocalisation	Anxiety, attention-seeking
Event	Usually flaccid limbs but may be rigid	Jaw motions, hypersalivation, tonic-clonic limb motion or limb rigidity
	Duration less than 1 minute	Duration often greater than 1 minute
	Rarely urination/defecation	Urination and/or defecation
	Usually retain consciousness, but may lose consciousness	Loss of consciousness
	Abnormal heart rhythm or rate may or may not be palpatated/auscultated	Often sinus tachycardia
Post-event	Rapid recovery	Slow recovery Prolonged post-event disorientation

Obstruction to flow

Congenital, e.g.
- Aortic stenosis (D)
- Pulmonic stenosis (D)

Hypertrophic obstructive cardiomyopathy
Pericardial effusion* (D)
Pulmonary hypertension
Arterial obstruction, e.g.
- Neoplasia
- Thrombosis

Hypoxaemic disease

Carboxyhaemoglobinaemia
Methaemoglobinaemia

Respiratory disease

Upper airway, e.g.
- Brachycephalic obstructive airway syndrome
- Laryngeal paralysis
- Tracheal collapse
- Tracheal obstruction

Lower airway, e.g.
- Pneumonia
- Small airway disease

Ventilation-perfusion mismatch, e.g.
- Lung collapse

Pleural/thoracic disorders, e.g.
- Pleural effusion
- Pneumothorax
- Rib fractures

Right-to-left cardiac shunt, e.g.
Reverse-shunting patent ductus arteriosus
Severe anaemia

Neurological dysfunction

Brainstem disease
Glossopharyngeal neuralgia
Micturition-related collapse
Narcolepsy/cataplexy
Seizures *q.v.*
Swallowing-related collapse

Diffuse cerebral dysfunction, e.g.
Encephalopathy
Haemorrhage
Hydrocephalus
Inflammation
Oedema
Space occupying lesion
Trauma

Lower motor neurone disorders
Endocrine neuropathies, e.g.
- Diabetes mellitus*
- Hyperadrenocorticism
- Hypothyroidism* (D)

Lumbosacral disease
Paraneoplastic neuropathies, e.g.
- Insulinoma

Peripheral nerve neoplasia
Polyneuropathy
Polyradiculoneuropathy

Neuromuscular junction disorders
Botulism
Myasthenia gravis

Upper motor neurone disorders
Central vestibular disease
Cerebellar disease
Cerebral disease
Peripheral vestibular disease
Spinal disease

Miscellaneous

Carotid sinus stimulation, e.g.
- Neoplasia
- Tight collar

Hyperventilation
Postural hypotension
Tussive syncope

Metabolic disorders

Diabetic ketoacidosis
Hypercalcaemia/hypocalcaemia *q.v.*
Hypernatraemia/hyponatraemia *q.v.*
Hyperthermia/hypothermia *q.v.*
Hypoglycaemia *q.v.*
Hypokalaemia *q.v.*
Severe acidosis *q.v.*
Severe alkalosis *q.v.*

Myopathies

Corticosteroid myopathy
Exertional myopathy
Hypocalcaemic myopathy
Hypokalaemic myopathy
Malignant hyperthermia
Mitochondrial myopathy
Muscular dystrophy
Polymyopathy
Polymyositis
Protozoal myopathy

Skeletal/joint disorders

Bilateral cranial cruciate disease
Bilateral hip disease
Discospondylitis
Intervertebral disc disease
Multiple myeloma
Osteoarthritis
Panosteitis
Patellar luxation
Polyarthritis

Drugs

Anti-arrhythmics, e.g.
- Atenolol
- Digoxin
- Propranolol
- Quinidine

Sedatives, e.g.
- Phenothiazines

Vasodilators, e.g.
- ACE inhibitors
- Hydralazine
- Nitroglycerine

References

Berendt, M. (2001) The diagnosis of epilepsy: seizure phenomenology and classification. *Proceedings of the World Small Animal Veterinary Association World Congress, 2001*.

Shelton, G. D. (1998) Myasthenia gravis: lessons from the past 10 years. *JSAP*, **39**:368–72.

Ware, W. A. (2002) Syncope. *Proceedings, Waltham/OSU Symposium, Small Animal Cardiology, 2002*.

Wray, J. (2005) Differential diagnosis of collapse in the dog. 1. Aetiology and investigation. *In Practice* **27**:16–28.

1.1.8 Weakness

Metabolic disease

Renal failure* *q.v.*
Hepatic failure* *q.v.*
Hypoglycaemia *q.v.*
Electrolyte disorders*
- Hypercalcaemia*/hypocalcaemia *q.v.*
- Hyperkalaemia/hypokalaemia* *q.v.*
- Hypernatraemia/hyponatraemia *q.v.*

Acid–base disorders
- Acidosis *q.v.*
- Alkalosis *q.v.*

Infectious diseases*

Bacterial
Viral
Fungal
Rickettsial
Protozoal
Other parasitic diseases

Immune-mediated/inflammatory diseases

Chronic inflammatory conditions*
Immune-mediated haemolytic anaemia* *q.v.*
Immune-mediated polyarthritis

Haematological diseases

Anaemia* *q.v.*
Hyperviscosity syndrome

Endocrine diseases

Diabetes mellitus*
Hyperadrenocorticism
Hyperparathyroidism
Hypoadrenocorticism (D)
Hypoparathyroidism
Hypothyroidism* (D)
Insulinoma

Cardiovascular diseases

Bradyarrhythmias *q.v.*, e.g.
- High grade second degree heart block
- Sick sinus syndrome (D)
- Third degree heart block

Congestive heart failure*
Pericardial effusion* *q.v.*
Hypertension* *q.v.*
Hypotension* *q.v.*
Tachyarrhythmias *q.v.*, e.g.
- Ventricular tachycardia*

Respiratory diseases

Airway obstruction, e.g.
- Feline asthma* (C)
- Foreign body*
- Neoplasia *

Intrathoracic neoplasia*
- Pleural effusion*
- Pulmonary hypertension
- Pulmonary oedema* *q.v.*
- Pulmonary thromboembolism

Severe pulmonary parenchymal disease

Neuromuscular diseases

Epilepsy* *q.v.*
Myasthenia gravis
Myopathies
Vestibular disease* *q.v.*

Intracranial disease, e.g.
Cerebrovascular accident
Infection
Inflammation
Space-occupying lesions

Spinal cord disease q.v.*, e.g.*
Infection
Inflammation
Intervertebral disc disease* (D)
Neoplasia
Trauma*

Peripheral polyneuropathies
Endocrine disorders, e.g.
- Diabetes mellitus*
- Hyperadrenocorticism
- Hypothyroidism* (D)

Polyradiculoneuritis
Paraneoplastic disorders

Drugs/toxins, e.g.
- Cisplatin
- Lead
- Vincristine

Infections
Botulism
Tick paralysis

Systemic disorders
Dehydration*
Fever* *q.v.*
Neoplasia*

Nutritional disorders
Cachexia, e.g.
Heart failure*
Neoplasia*

Inadequate calorie intake, e.g.
Anorexia* *q.v.*
Poor-quality diet

Specific nutrient deficiencies, e.g.
Minerals
Vitamins

Physiological factors
Over-exercise
Pain*
Stress/anxiety*

Drugs/toxins
Alphachloralose
Anticoagulant rodenticides
Anticonvulsants
Antihistamines
Blue-green algae
Cannabis
Diclofenac sodium
Glucocorticoids
Hypotensive agents, e.g.
- Beta-blockers
- Vasodilators

Ibuprofen
Insulin overdosage
Iron salts
Mistletoe
Opioids

Organophosphates
Petroleum distillates
Phenoxy acid herbicides
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Sedatives

References

Sadek, D. & Schaer, M. (1996) Atypical Addison's disease in the dog: a retrospective survey of 14 cases. *JAAHA*, **32**:159–63.
Shelton, G. D. (1998) Myasthenia gravis: lessons from the past 10 years. *JSAP*, **39**:368–72.

1.2 Gastrointestinal/abdominal historical signs

1.2.1 Ptyalism/salivation/hypersalivation

Physiological factors

Appetite stimulation*
Fear*
Stress*

Oral cavity disease

Dental disease*
Foreign body*
Neoplasia*

Inability to close mouth, e.g.

Mandibular trauma*
Trigeminal nerve disease, e.g.
- Idiopathic trigeminal neuritis
- Infiltrating neoplasia, e.g.
  - Lymphoma
  - Nerve sheath tumours

Ulceration, e.g.*

Immune-mediated disease
Ingestion of irritant substance
Renal failure*

*Inflammation**

Faucitis*
Gingivitis*
Glossitis*
Oesophagitis*
Stomatitis*

Organophosphates
Petroleum distillates
Phenoxy acid herbicides
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Sedatives

References

Sadek, D. & Schaer, M. (1996) Atypical Addison's disease in the dog: a retrospective survey of 14 cases. *JAAHA*, **32**:159–63.
Shelton, G. D. (1998) Myasthenia gravis: lessons from the past 10 years. *JSAP*, **39**:368–72.

1.2 Gastrointestinal/abdominal historical signs

1.2.1 Ptyalism/salivation/hypersalivation

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  - Lymphoma
  - Nerve sheath tumours

Ulceration, e.g.*

Immune-mediated disease
Ingestion of irritant substance
Renal failure*

*Inflammation**

Faucitis*
Gingivitis*
Glossitis*
Oesophagitis*
Stomatitis*

Neurological disease
- Cataplexy/narcolepsy
- Hepatic encephalopathy
- Intracranial neoplasia
- Partial seizures

Nausea/regurgitation/vomiting *q.v.*

Salivary gland disease *q.v.*
- Salivary gland necrosis/sialadenitis
- Salivary mucocoele
- Sialadenosis

Normal breed variation, e.g.
- St Bernards

Drugs/toxins
- Adder bites
- Alphachloralose
- Baclofen
- Batteries
- Benzodiazepines
- Bethanechol
- Blue-green algae
- Cannabis
- Carbamate
- Chocolate/theobromine
- Cotoneaster
- Cyanoacrylate adhesives
- Daffodil
- Dieffenbachia
- Dinoprost tromethamine
- Glyphosphate
- Horse chestnut
- Ivermectin
- Ketamine
- Laburnum
- Levamisole (C)
- Loperamide
- Metronidazole
- Mistletoe
- NPK fertilisers
- Organophosphates
- Paracetamol
- Paraquat
- Phenoxy acid herbicides
- Plastic explosives
- Pyrethrin/pyrethroids
- Pyridostigmine
- Rhododendron
- Rowan

Terfenadine
Toads
Trimethoprim/sulphonamide (C)
Xylazine

References

Patterson, E. E., et al. (2003) Clinical characteristics and inheritance of idiopathic epilepsy in Vizslas. *JVIM,* **17**:319–25.
Schroeder, H. & Berry, W. L. (1998) Salivary gland necrosis in dogs: a retrospective study of 19 cases. *JSAP,* **39**:121–25.
Sozmen, M., et al. (2000) Idiopathic salivary gland enlargement (sialadenosis) in dogs: a microscopic study. *JSAP,* **41**:243–47.

1.2.2 Gagging/retching

Congenital disease

Achalasia, e.g.
- Cricopharyngeal achalasia (D)

Cleft palate
Hydrocephalus

Neuromuscular disease

Brainstem disease
Cranial nerve defects (V, VII, IX, XII)
Encephalitis
Laryngeal paralysis*
Muscular dystrophy
Myasthenia gravis

Immune-mediated and infectious disease

Asthma* (C)
Bacterial encephalitis
Fungal disease
- Granuloma complex

Idiopathic glossopharyngitis
Laryngitis*
Pharyngitis*
Rabies
Rhinitis*
Sialadenitis
Viral encephalitis

Systemic disorders

Hypocalcaemia
Renal failure*

Trauma

Foreign body*
Pharyngeal haematoma

Styloid apparatus trauma
Tracheal rupture

Neoplasia
Central nervous system
Epiglottis
Inner ear
Nasal
Pharyngeal
Tonsillar

Nutrition
Food texture and size

Respiratory disease (expectoration), e.g.
Bronchitis*
Haemorrhage
Pulmonary oedema*

Toxic
Botulism
Ingestion of irritant chemical
Smoke

Reference
Schroeder, H. & Berry, W. L. (1998) Salivary gland necrosis in dogs: a retrospective study of 19 cases. *JSAP,* **39**:121–25.

1.2.3 Dysphagia

Infectious/inflammatory disease

Oral disease
Dental disease*
Osteomyelitis of jaw
Periodontitis*
Pharyngitis*
Rabies
Retrobulbar abscess
Severe gingivitis*
Tooth root abscess*
Ulceration, e.g.
- Ingestion of irritant substance
- Renal disease*

Obstruction
Foreign body*
Granuloma

Neoplasia
Sialocoele

Trauma
Fracture*
Haematoma
Laceration*

Temporomandibular joint disease

Neuromuscular disease
Cricopharyngeal achalasia
Myasthenia gravis
Myopathy, e.g.
- Masticatory myopathy

Trigeminal nerve disease, e.g.
- Intracranial disease
- Trigeminal neuritis

References
Meomartino, L., et al. (1999) Temporomandibular ankylosis in the cat: a review of seven cases. *JSAP,* **40**:7–10.
Preifer, R. M. (2003) Cricopharyngeal achalasia in a dog. *Can Vet J,* **44**:993–5.

1.2.4 Regurgitation

Salivary gland disease
Sialadenitis

Oesophageal disease
Foreign body*
Megaoesophagus
- Idiopathic
- Acquired

Neoplasia
Oesophageal diverticulum
Oesophageal fistula
Oesophageal inclusion cysts
Oesophagitis*
Stricture
Vascular ring anomaly, e.g.
- Persistent right aortic arch

Gastric disease
Gastric dilatation-volvulus* (D)
Hiatal hernia
Pyloric outflow obstruction, e.g.
- Foreign body*
- Neoplasia
- Pyloric stenosis

Neuromuscular disease

Peripheral neuropathies, e.g.
Giant cell axonal neuropathy (D)
Lead poisoning
Polyneuritis
Polyradiculoneuritis

Central nervous system disease, e.g.
Brainstem disease
Infection
Inflammation
Intracranial space occupying lesion
Trauma

Neuromuscular junctionopathies, e.g.
Acetylcholinesterase toxicity
Botulism
Myasthenia gravis
Tetanus

Immune-mediated disease

Dermatomyositis (D)
Polymyositis
Systemic lupus erythematosus

Endocrine disease

Hypoadrenocorticism (D)
Hypothyroidism* (D)

References

Han, E., et al. (2003) Feline esophagitis secondary to gastroesophageal reflux disease: clinical: signs and radiographic, endoscopic and histopathological findings. *JAAHA,* **39**:161–7.

Hodges, J., et al. (2004) Recurrent regurgitation in a young cat with an unknown history. *Vet Med,* **99**:244–51.

Schroeder, H. & Berry, W. L. (1998) Salivary gland necrosis in dogs: a retrospective study of 19 cases. *JSAP,* **39**:121–5.

White, R. N., et al. (2003) Vascular ring anomaly with coarctation of the aorta in a cat. *JSAP,* **44**:330–34.

1.2.5 Vomiting

ACUTE VOMITING

Dietary

Dietary indiscretion*
Dietary intolerance*
Sudden change in diet*

Gastrointestinal disease

Colitis*
Constipation/obstipation* *q.v.*
Foreign body*
Gastric dilatation/volvulus*
Gastric or duodenal ulceration*
Gastritis/enteritis*
Haemorrhagic gastroenteritis*
Infection, e.g.
- Bacterial*
- Parasites*
- Viral*

Inflammatory bowel disease*
Intestinal volvulus
Intussusception
Neoplasia*

Endocrine disease, e.g.

Diabetic ketoacidosis*
Hypoadrenocorticism (D)

Metabolic/systemic disease

Hypercalcaemia/hypocalcaemia *q.v.*
Hyperkalaemia/hypokalaemia* *q.v.*
Hyperthermia* *q.v.*
Liver disease* *q.v.*
Pancreatitis*
Peritonitis*
Prostatitis*
Pyometra* (D)
Renal disease* *q.v.*
Septicaemia*
Urinary obstruction*
Vestibular disease*

Miscellaneous conditions

Central nervous system disease
Diaphragmatic hernia
Motion sickness
Psychogenic

Drugs/toxins

Acetazolamide
Adder bite
Allopurinol
Alpha-2 agonists
Aminophylline
Amphotericin B
Apomorphine
Aspirin
Atipamezole
Atropine

Batteries
Benzalkonium chloride
Bethanechol
Blue-green algae
Borax
Bromocriptine
Calcium edetate
Carbimazole
Carboplatin
Cardiac glycosides
Cephalexin
Chlorambucil
Chloramphenicol
Chlorphenamine
Clomipramine
Colchicine
Cotoneaster
Cyclophosphamide
Cyclosporin
Cytarabine
Daffodil
Dichlorophen
Diclofenac sodium
Dinoprost tromethamine
Dopamine
Doxorubicin
Doxycycline
Dieffenbachia
Ethylene glycol
Erythryomycin
Glipizide
Glucocorticoids
Glyphosphate
Honeysuckle
Horse chestnut
Hydralazine
Ibuprofen
Indomethacin
Ipecacuanha
Iron/iron salts
Ivermectin
Ketoconazole
Laburnum
Lead
Levamisole
Lignocaine
Loperamide
Medetomidine
Melphalan
Metaldehyde

Methimazole
Metronidazole
Mexiletine
Misoprostol
Mistletoe
Mitotane
Naproxen
Nicotinamide
Nitroscanate
NPK fertilisers
NSAIDs
Paracetamol
Paraquat
Penicillamine
Pentoxifylline
Petroleum distillates
Phenoxy acid herbicides
Phenytoin
Pimobendan
Piperazine
Plastic explosives
Poinsettia
Potassium bromide
Procainamide
Propantheline bromide
Pyracantha

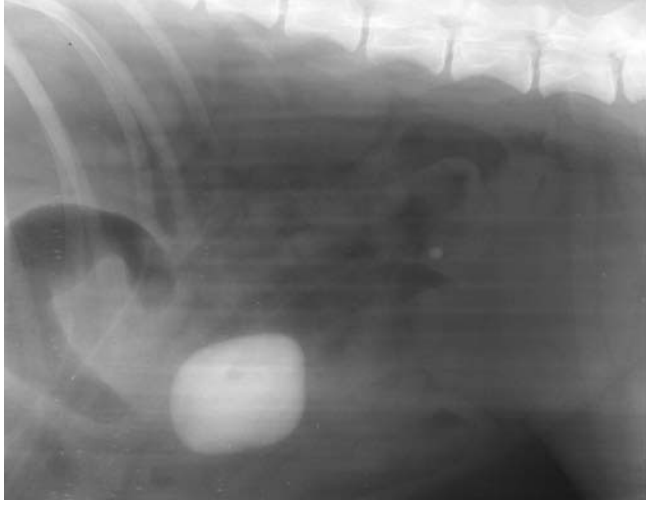

Fig. 1.2 Lateral abdominal radiograph of a dog showing a mineral-density foreign body. Exploratory coeliotomy revealed this to be a large stone within the small intestine. Reproduced with permission of Downs Referrals, Bristol.

Pyrethrin/pyrethroids
Pyridostigmine
Rhododendron
Rowan
Salt
Selective serotonin reuptake inhibitors
Sildenafil
Sotalol
Strychnine
Sulphasalazine
Terfenadine
Tetracycline
Theobromine
Theophylline
Tricyclic antidepressants
Trimethoprim/sulphonamide
Ursodeoxycholic acid
Vitamin D rodenticides
Xylazine
Yew
Zinc

CHRONIC VOMITING

Gastrointestinal disease

Bacterial overgrowth
Colitis*
Constipation/obstipation* *q.v.*
Enterogastric reflux
Gastric motility disorders*
Gastric or duodenal ulceration*
Gastritis/enteritis*
Infection, e.g.
- Bacterial
- Fungal
- Parasites*
- Viral

Inflammatory bowel disease
- Eosinophilic
- Lymphocytic
- Lymphoplasmacytic
- Mixed

Irritable bowel syndrome
Neoplasia*
Obstruction, e.g.
- Foreign body*
- Inflammatory bowel disease (gastritis or enteritis)
- Intussusception*
- Neoplasia*
- Pyloric stenosis

Endocrine disease, e.g.

Diabetes mellitus*
Hyperthyroidism* (C)
Hypoadrenocorticism (D)

Metabolic/systemic disease

Heartworm disease
Hypercalcaemia/hypocalcaemia *q.v.*
Hyperkalaemia/hypokalaemia *q.v.*
Liver disease* *q.v.*
Pancreatitis*
Prostatitis
Pyometra* (D)
Renal disease* *q.v.*

Miscellaneous conditions

Abdominal neoplasia
Diaphragmatic hernia
Sialadenitis

References

Craven, M., et al. (2004) Canine inflammatory bowel disease: retrospective analysis of diagnosis and outcome in 80 cases (1995–2002). *JSAP,* **45**:336–43.
Saxon-Buri, S. (2004) Daffodil toxicosis in an adult cat. *Can Vet J*, **45**:248–50.
Schroeder, H. & Berry, W. L. (1998) Salivary gland necrosis in dogs: a retrospective study of 19 cases. *JSAP,* **39**:121–5.

1.2.6 Diarrhoea

SMALL INTESTINAL DIARRHOEA

Diet

Dietary intolerance, e.g.
Food hypersensitivity*
Food intolerance
Gluten-sensitive enteropathy

Extra-gastrointestinal disease

Exocrine pancreatic insufficiency*
Hepatic disease* *q.v.*
Hyperthyroidism* (C)
Hypoadrenocorticism (D)
IgA deficiency
Nephrotic syndrome
Pancreatic duct obstruction
Pancreatitis*
Renal disease* *q.v.*
Right-sided congestive heart failure*

Systemic lupus erythematosus
Uraemia

Infection

Bacterial, e.g.*
Campylobacter spp
Clostridium spp
E. coli
Salmonella spp
Staphylococcus spp
Small intestinal bacterial overgrowth

Fungal

*Helminths**
Hookworm
Roundworm
Tapeworm
Whipworm

Protozoal, e.g.*
Cryptosporidiosis
Giardia spp

Viral, e.g.*
Coronavirus
Feline leukaemia virus (C)
Parvovirus

Rickettsial

Inflammatory/immune-mediated disease

Basenji enteropathy(D)
Duodenal ulceration
Haemorrhagic gastroenteritis*
Inflammatory bowel disease*
- Eosinophilic
- Granulomatous
- Lymphoplasmacytic

Protein-losing enteropathy and nephropathy of the Soft-Coated Wheaten Terrier (D)

Idiopathic disease

Lymphangiectasia

Neoplasia*, e.g.

Adenocarcinoma
Carcinoid tumours
Leiomyoma
Lymphoma

Mast cell tumours
Sarcoma

Partial obstruction*
Foreign body
Intussusception
Neoplasia
Stricture

Motility disorders, e.g.
Dysautonomia
Enteritis
Functional obstruction (ileus)
Hypoalbuminaemia
Hypokalaemia

Drugs/toxins (see Large intestinal diarrhoea, below)

LARGE INTESTINAL DIARRHOEA

Diet*
Dietary hypersensitivity
Dietary indiscretion

Extra-intestinal conditions
Metastatic neoplasia
Neurological disease leading to ulcerative colitis
Pancreatitis
Toxaemia
Uraemia

Infection

Bacterial, e.g.*
Campylobacter spp
Clostridium difficile
Clostridium perfringens
E. coli
Salmonella spp
Yersinia enterocolitica

*Viral**
Coronavirus
Feline immunodeficiency virus (C)
Feline infectious peritonitis (C)
Feline leukaemia virus (C)
Parvovirus

Fungal, e.g.
Histoplasmosis
Protothecosis

Parasitic, e.g.*
Amoebiasis
Ancylostoma spp
Balantidium coli
Cryptosporidiosis
Giardia spp
Heterobilharzia americana
Roundworm
Tapeworm
Tritrichomonas foetus (C)
Uncinaria spp
Whipworm

Protozoal, e.g.
Toxoplasmosis

Immune-mediated/inflammatory disease
Histiocytic ulcerative colitis of Boxers (D)
Inflammatory bowel disease*

Idiopathic conditions
Fibre-responsive large-bowel diarrhoea
Irritable bowel syndrome

Neoplasia*
Benign, e.g.
Adenomatous polyps
Leiomyoma

Malignant, e.g.
Adenocarcinoma
Lymphoma

Obstruction (see Plate 1.2(a) in colour plate section)
Caecal inversion
Foreign body*
Intussusception*
Neoplasia
Stricture

Miscellaneous
Secondary to chronic small intestinal disease
Stress

Drugs/toxins
Acetazolamide
Adder bite
Allopurinol

Aminophylline
Amoxicillin
Amphotericin B
Ampicillin
Atenolol
Benzalkonium chloride
Bethanechol
Blue-green algae
Borax
Calcium edetate
Carbamate insecticides
Cardiac glycosides
Cephalexin
Chloramphenicol
Chlorphenamine
Colchicine
Cotoneaster
Cyclophosphamide
Cyclosporin
Cytarabine
Daffodil
Diazoxide
Diclofenac sodium
Dieffenbachia
Doxycycline
Glyphosphate
Honeysuckle
Horse chestnut
Ibuprofen
Indomethacin
Iron/iron salts
Laburnum
Lactulose
Levamisole
Lithium
Loperamide
Mebendazole
Metaldehyde
Methiocarb
Misoprostol
Mistletoe
Mitotane
Naproxen
Nicotinamide
NPK fertilisers
NSAIDs
Organophosphates
Oxytetracycline
Pamidronate
Pancreatic enzyme supplementation

Paracetamol
Paraquat
Pentoxifylline
Petroleum distillates
Phenoxy acid herbicides
Piperazine
Poinsettia
Procainamide
Pyracantha
Pyrethrin/pyrethroids
Pyridostigmine
Quinidine
Rhododendron
Rowan
Salt
Selective serotonin reuptake inhibitors
Sotalol
Theobromine
Theophylline
Vitamin D rodenticides
Yew
Zinc sulphate

Note: Perirectal diseases, e.g. anal sac disease, anal furunculosis, perineal hernia, rectal prolapse, perianal adenoma, may cause signs mimicking large-bowel disease (tenesmus, haematochezia, mucoid stool).

References

Chandler, M. (2002) The chronically diarrhoeic dog. 2. Diarrhoea of small intestinal origin. *In Practice,* **24**:18–24.
Craven, M., et al. (2004) Canine inflammatory bowel disease: retrospective analysis of diagnosis and outcome in 80 cases (1995–2002). *JSAP,* **45**:336–43.
Hostutler, R. A., et al. (2004) Antibiotic-responsive histiocytic ulcerative colitis in 9 dogs. *JVIM,* **18**:499–504.
Leib, M. S. (2005) Diagnostic approach to chronic diarrhea I & II. *Proceedings, Western Veterinary Conference, 2005.*
Washabau, R. J. (2005) Infectious GI diseases in dogs and cats. *Proceedings, Western Veterinary Conference, 2005.*

1.2.7 Melaena

Ingestion of blood

Nasal disease (see also epistaxis), e.g.
Coagulopathy* *q.v.*
Neoplasia*
Trauma*

Oropharyngeal haemorrhage
Coagulopathy* *q.v.*
Neoplasia*
Trauma*

Respiratory disease (see also haemoptysis), e.g.
Coagulopathy* *q.v.*
Exercise-induced pulmonary haemorrhage
Parasites
Neoplasia*
Ruptured aneurysm
Trauma*

Gastrointestinal disease

Enteritis*
Gastritis*
Oesophagitis
Parasites*

*Gastrointestinal ulceration**
Gastrinoma
Helicobacter infection
Inflammatory gastroenteric disease*
Neurological disease
Post foreign body*
Stress
Uraemia* *q.v.*
Drugs, e.g.
- Glucocorticoids*
- NSAIDs*

Ischaemia, e.g.
Mesenteric avulsion
Mesenteric thrombosis/infarction
Mesenteric volvulus
Post gastric-dilatation volvulus* (D)

Neoplasia, e.g.*
Adenocarcinoma
Leiomyoma
Leiomyosarcoma
Lymphoma

Extra-gastrointestinal disease

Hypoadrenocorticism (D)
Liver disease* *q.v.*
Mastocytosis
Pancreatitis*
Septicaemia*
Shock* *q.v.*

Systemic hypertension* *q.v.*
Uraemia* *q.v.*
Vasculitis, e.g.
- Rocky Mountain Spotted Fever

Coagulopathy q.v., *e.g.*
Anticoagulant toxicity* *q.v.*
Congenital clotting factor deficiency *q.v.*
Disseminated intravascular coagulation
Thrombocytopenia *q.v.*
von Willebrand's disease (D)

References

Brooks, D. & Watson, G. L. (1997) Omeprazole in a dog with gastrinoma. *JVIM*, **11**:379–81.
McTavish, D. (2002) Eosinophilic gastroenteritis in a dog. *Can Vet J*, **43**:463–5.
Washabau, R. J. (2004) G. I. hemorrhage: pathogenesis, diagnosis and therapy. *Proceedings, Atlantic Coast Veterinary Conference, 2004*.

1.2.8 Haematemesis

Ingestion of blood

Nasal disease (see also epistaxis), e.g.
Coagulopathy* *q.v.*
Neoplasia*
Trauma*

Oropharyngeal haemorrhage
Coagulopathy* *q.v.*
Neoplasia*
Trauma*

Respiratory disease (see also haemoptysis), e.g.
Coagulopathy* *q.v.*
Exercise-induced pulmonary haemorrhage
Parasites
Neoplasia*
Ruptured aneurysm
Trauma*

Gastrointestinal disease

Gastritis*
Haemorrhagic gastroenteritis
Oesophagitis

*Gastrointestinal ulceration**
Gastrinoma
Helicobacter infection*

Inflammatory gastroenteric disease*
Neurological disease
Post foreign body*
Stress
Systemic mastocytosis
Uraemia*
Drugs, e.g.
- NSAIDs
- Glucocorticoids*

Ischaemia, e.g.
Post gastric-dilatation/volvulus* (D)
Neoplasia*, e.g.
- Adenocarcinoma
- Lymphoma

Extra-gastrointestinal disease
Hypoadrenocorticism (D)
Liver disease* *q.v.*
Mastocytosis
Septicaemia*
Shock*
Systemic hypertension* *q.v.*
Uraemia* *q.v.*

Coagulopathies q.v.*, e.g.*
Anticoagulant toxicity*
Congenital clotting factor deficiency
Disseminated intravascular coagulation
Thrombocytopenia
von Willebrand's disease(D)

*Pancreatic disease**, *e.g.*
Pancreatitis

Vasculitis, e.g.
Rocky Mountain Spotted Fever

Toxins, e.g.
Calcipotriol
Paraquat

Reference
Brooks, D. & Watson, G. L. (1997) Omeprazole in a dog with gastrinoma. *JVIM*, **11**:379–81.

1.2.9 Haematochezia

Extra-gastrointestinal disease
Neurological disease leading to ulcerative colitis

Coagulopathies q.v., *e.g.*
Anticoagulant toxicity*
Congenital clotting factor deficiency *q.v.*
Disseminated intravascular coagulation
Thrombocytopenia *q.v.*
von Willebrand's disease (D)

Perirectal disease, e.g.
Anal furunculosis*
Anal sac disease*
Perianal adenoma*
Perineal hernia*
Rectal prolapse*

Gastrointestinal disease

Dietary
Dietary hypersensitivity
Dietary indiscretion

Bacterial, e.g.*
Campylobacter spp
Clostridium spp
E. coli
Salmonella spp

*Viral**
Coronavirus
Feline immunodeficiency virus (C)
Feline infectious peritonitis (C)
Feline leukaemia virus (C)
Parvovirus

Fungal, e.g.
Histoplasmosis
Protothecosis

Parasitic, e.g.*
Amoebiasis
Ancylostoma spp
Balantidium coli
Cryptosporidiosis
Giardia spp
Heterobilharzia americana
Roundworm
Tapeworm
Tritrichomonas foetus (C)
Uncinaria spp
Whipworm

Protozoal, e.g.
Toxoplasmosis

Immune-mediated/inflammatory disease
Histiocytic ulcerative colitis of Boxers (D)
Inflammatory bowel disease*

Idiopathic conditions
Fibre-responsive large-bowel diarrhoea
Haemorrhagic gastroenteritis
Irritable bowel syndrome

Neoplasia
Benign, e.g.
Adenomatous polyps
Leiomyoma

Malignant, e.g.
Adenocarcinoma
Lymphoma

Obstructive disease
Foreign body*
Intussusception*

Drugs
Glucocorticoids

References
Hostutler, R. A., et al. (2004) Antibiotic-responsive histiocytic ulcerative colitis in 9 dogs. *JVIM,* **18**:499–504.
Spielman, B. L. & Garvey, M. S. (1993) Hemorrhagic gastroenteritis in 15 dogs. *JAAHA,* **29**:341–4.

1.2.10 Constipation/obstipation

Congenital conditions
Atresia ani
Atresia coli

Diet
Ingestion of hair, bones and foreign material
Low-fibre diets

Systemic disease
Dehydration*
Hypercalcaemia *q.v.*
Hypokalaemia* *q.v.*
Hypothyroidism* (D)

Neuromuscular disease

Feline dysautonomia (C)
Lumbosacral disease*
Pelvic nerve disease, e.g.
- Traumatic*

Obstructive disease (see Plate 1.2(b) in colour plate section)

Intraluminal/intramural
Diverticulum
Foreign body*
Neoplasia*, e.g.
- Adenoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma

Stricture

Extraluminal
Granuloma
Neoplasia*
Pelvic fracture*
Perineal hernia*
Prostatic disease (D)
- Abscess
- Benign prostatic hypertrophy*
- Neoplasia
- Prostatitis*

Sublumbar lymph node disease

Prolonged colonic distension, e.g.

Narrowing of pelvic canal post fracture*

Painful conditions

Anal furunculosis*
Anal or rectal inflammation*
Anal or rectal mass*
Anal or rectal stricture
Anal sac disease*, e.g.
- Abscess
- Anal sacculitis

Pelvic trauma (soft tissue or bony)*
Spinal cord disease*

Behavioural factors*, e.g.

Change of daily routine
Dirty litter box
Hospitalisation
Novel litter substrate

Idiopathic conditions
Idiopathic megacolon*

Drugs/toxins
Aluminium antacids
Butylscopolamine (hyoscine)
Diphenoxylate
Diuretics
Loperamide
Opioids
Propantheline bromide
Sucralfate
Verapamil
Vincristine

References
LeRoy, B. E. & Lech, M. E. (2004) Prostatic carcinoma causing urethral obstruction and obstipation in a cat. *J Feline Med Surg*, **6**:397–400.
Yam, P. (1997) Decision making in the management of constipation in the cat. *In Practice*, **19**:434–40.

1.2.11 Faecal tenesmus/dyschezia

Anal sac disease, e.g.
Abscess
Anal sacculitis*
Neoplasia

Constipation/obstipation *q.v.*

Diet
Excess bone
Excess fibre

Perianal disease, e.g.
Anal furunculosis/perianal fistulas* (D)
Perianal adenoma*
Perineal hernia*
Rectal prolapse*

Caudal abdominal mass*

Pelvic narrowing

Prostatic disease (D)
Abscess
Benign prostatic hypertrophy*
Neoplasia
Prostatitis*

Trauma, e.g.
Pelvic fracture*

Urogenital disease*, e.g.
Lower urinary tract disease
Urethral obstruction

Colorectal disease, e.g.
Colitis *q.v.*
Congenital disease
Large intestinal neoplasia

References
Hardie, R. J., et al. (2005) Cyclosporin treatment of anal furunculosis in 26 dogs. *JSAP*, **46**:3–9.
Simpson, J. (1996) Differential diagnosis of faecal tenesmus in dogs. *In Practice*, **18**:280–87.

1.2.12 Faecal incontinence

Anal sphincter incompetence
Myopathy
Neoplasia*
Trauma*

Neurological, e.g.
Cauda equina syndrome
Degenerative myelopathy/CDRM* (D)
Distemper encephalomyelitis
Dysautonomia
Lumbosacral stenosis
Myelodysplasia/spinal dysraphism
Peripheral neuropathy
Sacrocaudal dysgenesis
Spinal arachnoid cysts
Spinal trauma

Perianal disease, e.g.
Perianal fistula*

Iatrogenic disease, e.g.
Damage to anal sphincter during anal sacculectomy

Reservoir incontinence
Behavioural
CNS disease *q.v.*
Colitis*
Diet*
Neoplasia*

References
Guildford, W. G., et al. (1990) Fecal incontinence, urinary incontinence, and priapism associated with multifocal distemper encephalomyelitis in a dog. *JAVMA,* **197**:90–92.
Skeen, T. M., et al. (2003) Spinal arachnoid cysts in 17 dogs. *JAAHA,* **39**:271–82.

1.2.13 Flatulence/borborygmus

Aerophagia*
Competitive/aggressive eating
Nervous animal

Diet
High fibre diets
Milk products/lactase deficiency
Spoiled food

Maldigestion, e.g.
Exocrine pancreatic insufficiency

Malabsorption, e.g.
Inflammatory bowel disease

Drugs/toxins, e.g.
Lactulose
Metaldehyde

References
Roudebush, P. (2001) Flatulence: causes and management options. *Compend Contin Educ Pract Vet,* **23**:1075–81.
Rutz, G. M., et al. (2001) Pancreatic acinar atrophy in German Shepherds. *Compend Contin Educ Pract Vet,* **23**:347–56.

1.3 Cardiorespiratory historical signs

1.3.1 Coughing

Infection

Bacterial, e.g.
Bordetellosis*

Fungal, e.g.
Coccidioidomycosis

Viral, e.g.
Canine distemper*

References
Guildford, W. G., et al. (1990) Fecal incontinence, urinary incontinence, and priapism associated with multifocal distemper encephalomyelitis in a dog. *JAVMA*, **197**:90–92.
Skeen, T. M., et al. (2003) Spinal arachnoid cysts in 17 dogs. *JAAHA*, **39**:271–82.

1.2.13 Flatulence/borborygmus

Aerophagia*
Competitive/aggressive eating
Nervous animal

Diet
High fibre diets
Milk products/lactase deficiency
Spoiled food

Maldigestion, e.g.
Exocrine pancreatic insufficiency

Malabsorption, e.g.
Inflammatory bowel disease

Drugs/toxins, e.g.
Lactulose
Metaldehyde

References
Roudebush, P. (2001) Flatulence: causes and management options. *Compend Contin Educ Pract Vet*, **23**:1075–81.
Rutz, G. M., et al. (2001) Pancreatic acinar atrophy in German Shepherds. *Compend Contin Educ Pract Vet*, **23**:347–56.

1.3 Cardiorespiratory historical signs

1.3.1 Coughing

Infection

Bacterial, e.g.
Bordetellosis*

Fungal, e.g.
Coccidioidomycosis

Viral, e.g.
Canine distemper*

Parasitic
Aelurostrongylus abstrusus (C)
Angiostrongylus vasorum (D)
Dirofilaria immitis
Oslerus osleri (D)
Paragonimiasis

Immune-mediated/inflammatory disease
Asthma* (C)
Chronic bronchitis* (D)

Miscellaneous conditions
Aspiration pneumonia
Idiopathic pulmonary fibrosis
Inhaled foreign body
Laryngeal paralysis
Left atrial enlargement*
Lung lobe hernia
Primary ciliary dyskinesia

Neoplasia
Adenocarcinoma
Alveolar carcinoma
Bronchial gland carcinoma
Metastatic disease
Squamous cell carcinoma

Pulmonary haemorrhage
Coagulopathy *q.v.*
Exercise-induced
Neoplasia*
Traumatic

Pulmonary oedema
Airway obstruction
Cardiogenic*
Electrocution
Hypoglycaemia
Hypoproteinaemia *q.v.*
Iatrogenic
Ketamine
Neurological
- Cranial trauma
- Seizures

Obstruction of lymphatic drainage
Primary alveolar–capillary membrane injury
Re-expansion

Drugs/toxins/irritants
Benzalkonium chloride ingestion

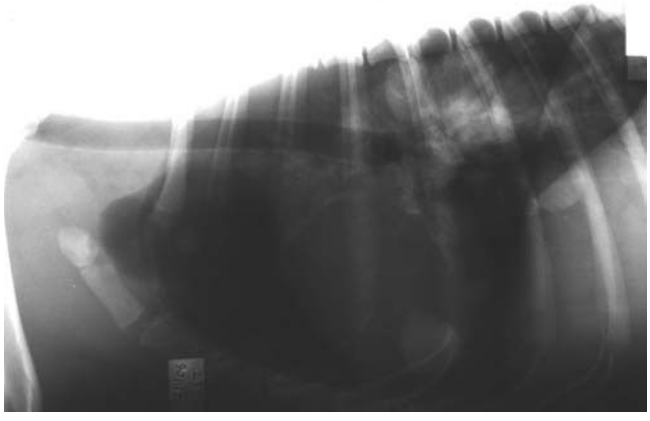

Fig. 1.3 Lateral thoracic radiograph of a dog with pulmonary metastasis secondary to a renal tumour. Reproduced with permission of Downs Referrals, Bristol.

Chemical fume inhalation
Potassium bromide (C)
Smoke inhalation

References

Adamama-Moraitou, K. K., et al. (2004) Feline lower airway disease: a retrospective study of 22 naturally occurring cases from Greece. *J Feline Med Surg,* **6**:227–33.

Brownlie, S. E. (1990) A retrospective study of diagnosis in 109 cases of lower respiratory disease. *JSAP,* **31**:371–6.

Chapman, P. S., et al. (2004) *Angiostrongylus vasorum* infection in 23 dogs (1999–2002). *JSAP,* **45**: 435–40.

Coleman, M. G. (2005) Dynamic cervical lung hernia in a dog with chronic airway disease. *JVIM,* **19**:103–5.

Johnson, L. R., et al. (2003) Clinical, clinicopathologic and radiographic findings in dogs with coccidioidomycosis: 24 cases (1995–2000). *JAVMA,* **222**: 461–6.

Kipperman, B. S., et al. (1992) Primary ciliary dyskinesia in a Gordon Setter. *JAAHA,* **28**:375–9.

Ogilvie, G. K., et al. (1989) Classification of primary lung tumors in dogs: 210 cases (1975–1985). *JAVMA,* **195**:106–8.

Swerczek, T. W. & Lyons, E. T. (2000) Paragonimiasis in a cat in Kentucky. *Vet Med,* **95**:909–11.

Welsh, R. D. (1996) *Bordetella bronchiseptica* infections in cats. *JAAHA,* **32**:153–8.

1.3.2 Dyspnoea/tachypnoea

See Section 2.3.1

1.3.3 Sneezing and nasal discharge

Infection

Viral

Canine distemper virus* (D)
Canine infectious tracheobronchitis* (D)
Feline calicivirus* (C)
Feline herpes virus* (C)
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Feline pox virus
Feline reovirus (C)

Fungal

Aspergillosis
Cryptococcosis
Exophiala jeanselmei
Penicillium spp
Phaeohyphomycosis
Rhinosporidium seeberi

Parasitic

Cuterebra spp
Eucoleus böehmi
Linguatula serrata
Pneumonyssoides caninum

Bacterial/mycoplasmal

*Bordetella bronchiseptica**
Chlamydophila spp*
Coliforms
Mycoplasma spp
Pasteurella spp
Staphylococcus spp
Streptococcus spp

Inflammatory disease

Allergic rhinitis*
Granulomatous rhinitis
Lymphoplasmacytic rhinitis*
Nasopharyngeal polyp* (C)

Physical

Foreign body*
Irritant gases
Trauma

Neoplasia

Adenocarcinoma*

Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Lymphoma*
Mast cell tumour
Melanoma
Neuroblastoma
Osteosarcoma
Squamous cell carcinoma*
Transmissible venereal tumour
Undifferentiated carcinomas*

Dental disease

Tooth root abscess*

Anatomical deformities

Acquired nasopharyngeal stenosis
Cleft palate
Oronasal fistula

Congenital disease

Ciliary dyskinesia

Systemic disease (see also epistaxis)

Coagulopathy *q.v.*
Hypertension *q.v.*
Hyperviscosity syndrome
Vasculitis
- Ehrlichiosis
- Rocky Mountain Spotted Fever

References

Binns, S. & Dawson, S. (1995) Feline infectious upper respiratory disease. *In Practice,* **17**:458–61.

Bredal, W. & Vollset, I. (1998) Use of milbemycin oxine in the treatment of dogs with nasal mite (*Pneumonyssoides caninum*) infection. *JSAP,* **39**:126–30.

McEntee, M. C. (2001) Nasal neoplasia in the dog and cat. *Proceedings, Atlantic Coast Veterinary Conference, 2001.*

1.3.4 Epistaxis

Nasal disease

Physical
Trauma*

Neoplasia
Adenocarcinoma*
Chondrosarcoma

Fibrosarcoma
Haemangiosarcoma
Lymphoma*
Mast cell tumour
Melanoma
Osteosarcoma
Squamous cell carcinoma*
Transmissible venereal tumour
Undifferentiated carcinomas*

Infection
Viral
- Canine distemper virus* (D)
- Canine infectious tracheobronchitis* (D)
- Feline calicivirus* (C)
- Feline herpes virus* (C)
- Feline immunodeficiency virus* (C)
- Feline leukaemia virus* (C)

Fungal
- Aspergillosis
- *Cryptococcus* spp
- *Exophiala jeanselmei*
- *Penicillium* spp
- Phaeohyphomycosis
- *Rhinosporidium seeberi*

Parasitic
- *Cuterebra*
- *Eucoleus böehmi*
- *Linguatula serrata*
- *Pneumonyssoides caninum*

Bacterial/mycoplasmal
- *Mycoplasma* spp*
- *Pasteurella* spp*

Inflammatory disease
Allergic rhinitis*
Lymphoplasmacytic rhinitis*

Dental disease
Oronasal fistula
Tooth root abscess*

Coagulopathies *q.v.*
Coagulation factor deficiency *q.v.*
Platelet disease
- Thrombocytopathia *q.v.*
- Thrombocytopenia *q.v.*

Miscellaneous conditions
Hyperlipidaemia

Hypertension *q.v.*
Hyperviscosity syndrome
Increased capillary fragility
Thromboembolism

References

McEntee, M. C. (2001) Nasal neoplasia in the dog and cat. *Proceedings, Atlantic Coast Veterinary Conference, 2001.*
Strasser, J. L. & Hawkins, E. C. (2005) Clinical features of epistaxis in dogs: a retrospective study of 35 cases (1999–2002). *JAAHA,* **41**:179–84.
Whitney, B. L., et al. (2005) Four cats with fungal rhinitis. *J Feline Med Surg,* **7**:53–58.

1.3.5 Haemoptysis

Pulmonary disease

Pulmonary hypertension
Pulmonary thromboembolism

Infection

Parasitic
- *Aelurostrongylus abstrusus* (C)
- *Angiostrongylus* (D)
- *Capillaria aerophila*
- *Dirofilaria immitis*
- *Paragonimus kellicotti*

Fungal
- Blastomycosis
- Coccidioidomycosis
- Histoplasmosis

Viral
- Infectious tracheobronchitis*

Bacterial
- Nocardiosis
- Pneumonia*
- Pulmonary abscessation

Inflammatory

Bronchiectasis
Chronic bronchitis* (D)
Pulmonary infiltrate with eosinophils

Neoplastic

Adenocarcinoma
Chondrosarcoma
Metastatic tumours*
Squamous cell carcinoma

Physical
Bronchial gland carcinoma
Foreign body
Lung lobe torsion
Trauma

Cardiovascular disease
Arteriovenous fistula
Bacterial endocarditis
Dirofilaria immitis
Pulmonary oedema* *q.v.*

Systemic disease
Coagulation factor deficiency *q.v.*
Thrombocytopathia *q.v.*
Thrombocytopenia *q.v.*

Iatrogenic
Diagnostic procedures, e.g.
- Bronchoalveolar lavage
- Bronchoscopy
- Lung aspirate
- Trans-tracheal wash

Endotracheal intubation*

References
Bailiff, N. L. & Norris, C. R. (2002) Clinical signs, clinicopathological findings, etiology, and outcome associated with hemoptysis in dogs: 36 cases (1990–1999). *JAAHA*, **38**:125–33.
Chapman, P. S., et al. (2004) Angiostrongylus vasorum infection in 23 dogs (1999–2002). *JSAP*, **45**:435–40.

1.3.6 Exercise intolerance

Cardiovascular disease, e.g.
Arrhythmias
Congestive heart failure*
Cyanotic heart disease *q.v.*
Myocardial dysfunction
Obstruction to ventricular outflow

Respiratory disease *q.v.*, e.g.
Idiopathic pulmonary fibrosis
Pleural effusion*
Pulmonary oedema*
Upper airway obstruction *q.v.*

Metabolic/endocrine disease, e.g.
Anaemia*

Hyperthyroidism* (C)
Hypoadrenocorticism (D)
Hypoglycaemia *q.v.*
Hypokalaemic polymyopathy
Hypothyroidism* (D)
Malignant hyperthermia

Neuromuscular/musculoskeletal disease, e.g.

Botulism
Cervical myelopathy (D)
Coonhound paralysis
Ischaemic neuromyopathy* (C)
Intermittent claudication
Lumbosacral pain
Myasthenia gravis
Myopathies
- Congenital
- Hypokalaemic
- Toxic

Peripheral neuropathy *q.v.*
Polyarthritis
Polymyositis
Protozoal myositis
Tick paralysis

Drugs, e.g.

Drugs causing hypotension

References

Axlund, T. W. (2004) Exercise induced collapse in dogs. *Proceedings, Western Veterinary Conference, 2004*.
Jacques, D., et al. (2002) A retrospective study of 40 dogs with polyarthritis. *Vet Surg*, **31**:428–34.

1.4 Dermatological historical signs

1.4.1 Pruritus

Infection

Bacterial
Deep pyoderma*
Surface pyoderma/wet eczema*
Superficial bacterial folliculitis*

Fungal
Candidiasis
Dermatophytosis*

Hyperthyroidism* (C)
Hypoadrenocorticism (D)
Hypoglycaemia *q.v.*
Hypokalaemic polymyopathy
Hypothyroidism* (D)
Malignant hyperthermia

Neuromuscular/musculoskeletal disease, e.g.

Botulism
Cervical myelopathy (D)
Coonhound paralysis
Ischaemic neuromyopathy* (C)
Intermittent claudication
Lumbosacral pain
Myasthenia gravis
Myopathies
- Congenital
- Hypokalaemic
- Toxic

Peripheral neuropathy *q.v.*
Polyarthritis
Polymyositis
Protozoal myositis
Tick paralysis

Drugs, e.g.

Drugs causing hypotension

References

Axlund, T. W. (2004) Exercise induced collapse in dogs. *Proceedings, Western Veterinary Conference, 2004.*
Jacques, D., et al. (2002) A retrospective study of 40 dogs with polyarthritis. *Vet Surg*, **31**:428–34.

1.4 Dermatological historical signs

1.4.1 Pruritus

Infection

Bacterial
Deep pyoderma*
Surface pyoderma/wet eczema*
Superficial bacterial folliculitis*

Fungal
Candidiasis
Dermatophytosis*

Malassezia dermatitis*
Pythiosis

Parasitic
Cheyletiellosis
Demodicosis*
Dermanyssus gallinae
Dirofilariasis
Dracunculiasis
Fleas*
Hookworm dermatitis
Lynxacarus radovsky (C)
Notoedres cati (C)
Otobius megnini (D)
Otodectes cyanotis
Pediculosis
Pelodera dermatitis
Pneumonyssoides caninum (D)
Sarcoptic mange* (D)
Schistosomiasis
Trombiculiasis*

Immune-mediated disease

Drug eruptions
Discoid lupus erythematosus
Systemic lupus erythematosus

Allergy/hypersensitivity
Atopy*
Contact allergy*
Food hypersensitivity*
Hormonal hypersensitivity (D)
Parasite hypersensitivity*, e.g.
- Fleas
- Mosquitoes

Pemphigus complex
Pemphigus erythematosus
Pemphigus foliaceus
Pemphigus vegetans
Pemphigus vulgaris
Bullous pemphigoid

Keratinisation disorders

Acne*
Idiopathic facial dermatitis
Primary seborrhoea
Vitamin A responsive dermatosis

Endocrine disorders

Calcinosis cutis*
Hyperthyroidism* (C)
Predisposing to pyoderma
- Hyperadrenocorticism
- Hypothyroidism* (D)

Environmental

Contact irritant dermatitis*
Sunburn/solar dermatitis*

Neoplasia

Cutaneous T cell lymphoma
Mast cell tumour*
Mycosis fungoides
Other neoplasia with secondary pyoderma
Paraneoplastic pruritus

Neurological, e.g.

Syringohydromyelia

Miscellaneous

Feline hypereosinophilic syndrome (C)
Idiopathic sterile granulomatous dermatitis
Sterile eosinophilic pustulosis
Subcorneal pustular dermatosis
Urticaria pigmentosa
Waterline disease of black Labradors (D)
Zinc responsive dermatosis

Drugs/toxins

Methimazole
Paracetamol

References

Anderson, R. K. & Carpenter, J. L. (1995) Severe pruritus associated with lymphoma in a dog. *JAVMA,* **207**:455–6.

Colombini, S. & Dunstan, R. W. (1997) Zinc-responsive dermatosis in northern-breed dogs: 17 cases (1990–1996). *JAVMA,* **211**:451–3.

Moriello, K. A. (2004) Acutely pruritic eruptions on a dog's extremities and trunk. *Vet Med,* **99**:924–7.

Omodo-Eluk, A. J., et al. (2003) Comparison of two sampling techniques for the detection of *Malassezia pachydermatitis* on the skin of dogs with chronic dermatitis. *Vet J,* **165**: 119–21.

Rosser, E. J. (1997) German Shepherd dog pyoderma: a prospective study of 12 dogs. *JAAHA,* **33**:355–63.

Saevik, B. K., et al. (2004) *Cheyletiella* infestation in the dog: observations on diagnostic methods and clinical signs. *JSAP,* **45**:495–500.

Seavers, A. (1998) Cutaneous syndrome possibly caused by heartworm infestation in a dog. *Aust Vet J,* **76**:18–20.

Differential Diagnosis in Small Animal Medicine
Alex Gough

1.5 Neurological historical signs

1.5.1 Seizures

INTRACRANIAL

Idiopathic*

Congenital

Ceroid lipofuscinosis
Chiari-like malformation
Cortical dysplasia
Hydrocephalus
Intracranial arachnoid cysts
Lissencephaly
Lysosomal storage diseases
Organic acidurias, e.g.
- L-2-hydroxyglutaric aciduria

Infectious

Bacterial, e.g.
Nocardiosis
Pasteurella spp
Staphylococcus spp

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis
Mucormycosis

Parasitic
Aberrant migration of *Cuterebra* spp
Dirofilariasis

Protozoal, e.g.
Neosporosis (D)
Toxoplasmosis

Rickettsial encephalitis
Ehrlichiosis/anaplasmosis
Rocky Mountain Spotted Fever

Viral
Canine distemper* (D)
Canine herpes virus (D)

Eastern equine encephalitis
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Pseudorabies
Rabies

Inflammatory/immune-mediated disease

Breed-specific necrotising meningoencephalitis
Distemper-vaccine-associated (D)
Eosinophilic meningoencephalitis
Granulomatous meningoencephalomyelitis* (D)
Steroid-responsive meningoencephalitis

Physical

Trauma

Neoplasia

Primary intracranial
Astrocytoma
Choroid plexus tumours
Ependymoma
Ganglioblastoma
Glioma
Medulloblastoma
Meningioma
Neuroblastoma
Oligodendroglioma

Local extension
Middle-ear tumour
Nasal/paranasal sinus tumour
Pituitary tumour
Skull tumour

Metastatic, e.g.
Haemangiosarcoma
Lymphoma
Malignant melanoma
Mammary carcinoma
Prostatic carcinoma
Pulmonary carcinoma
Teratoma

Vascular

Haemorrhage, e.g.
Coagulopathy *q.v.*
Feline ischaemic encephalopathy (C)

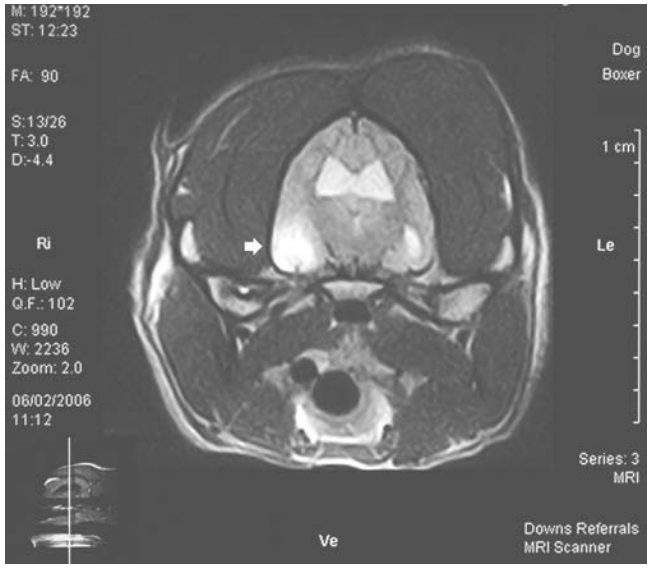

Fig. 1.5(a) Transverse T2 weighted MR scan of the brain of a Boxer with a suspected glioma (arrow). Reproduced with permission of Downs Referrals, Bristol.

Hypertension *q.v.*
Trauma

Infarction, e.g.
Thromboembolism

EXTRACRANIAL

Metabolic

Electrolyte imbalances*, e.g.
- Hypernatraemia *q.v.*
- Hypocalcaemia *q.v.*
- Hyponatraemia *q.v.*

Hepatic encephalopathy* *q.v.*
Hypoglycaemia *q.v.*
Renal failure* *q.v.*

Nutritional

Thiamine deficiency

Drugs/toxins

Alphachloralose
Arsenic
Baclofen
Blue-green algae
Borax

Cannabis
Carbamate
Doxapram
Ethylene glycol
Glyphosphate
Honeysuckle
Hymenoptera stings
Ibuprofen
Iodine-containing myelographic contrast media
Laburnum
Lead
Lignocaine
Metaldehyde
Metronidazole
Mexiletine
Mistletoe
Organophosphates
Paracetamol
Petroleum distillates
Phenoxy acid herbicides
Piperazine
Plastic explosives
Pyrethrin/pyrethroids
Risperidone
Salt
Selective serotonin reuptake inhibitors
Strychnine
Terfenadine
Theobromine
Theophylline
Tricyclic antidepressants
Vitamin D rodenticides
Yew

References

Abramson, C. J., et al. (2003) L-2-Hydroxyglutaric aciduria in Staffordshire Bull Terriers. *JVIM,* **17**:551–6.

Barnes, H. L., et al. (2004) Clinical signs, underlying cause, and outcome in cats with seizures: 17 cases (1997–2002). *JAVMA,* **225**:1723–6.

Duque, C., et al. (2005) Intracranial arachnoid cysts: are they clinically significant? *JVIM,* **19**:772–4.

Farrar, M. D. et al (2005) Eastern equine encephalitis in dogs. *J Vet Diagn Invest*, **17**:614–7.

Foster, S. F., et al. (2000) Cerebral cryptococcal granuloma in a cat. *J Feline Med Surg,* **2**:201–206.

Gough A. (2004) Possible risperidone poisoning in a dog. *Vet Rec,* **155:**156.

Inzana, K. D. (2002) Infectious and inflammatory encephalopathies. *Proceedings, Western Veterinary Conference, 2002.*

Jolly, R. D., et al. (1994) Canine ceroid lipofuscinoses: A review and classification. *JSAP,* **35**:299–306.

Kline, K. L., et al. (1994) Feline infectious peritonitis with neurologic involvement: clinical and pathological findings in 24 cats. *JAAHA,* **30**:111–9.
O' Toole, T. E., et al. (2003) Cryptococcosis of the central nervous system in a dog. *JAVMA,* **222**:1722.
Parent, J. M. & Quesnel, A. D. (1996) Seizures in cats. *Vet Clin North Am Small Anim Pract.* **26**:811–25.
Shell, L. G. (1998) Seizures in cats. *Vet Med,* **93**:541–52.
Singh, M. (2003) Inflammatory cerebrospinal fluid analysis in cats: clinical diagnosis and outcome. *Proceedings, Australian College of Veterinary Scientists Science Week, 2003.*

1.5.2 Trembling/shivering

Physiological

Ballistocardiographic*
Fatigue/weakness*
Fear*
Reduced environmental temperature*

Neurological

Abiotrophies
Cerebellar disease *q.v.*
Central nervous system inflammatory disease
Cerebrospinal hypomyelinogenesis and dysmyelinogenesis
Corticosteroid responsive tremor syndrome ('white dog shaker disease')
Idiopathic head nod of Dobermanns and bulldogs
Lumbosacral disease, e.g.
- Disc herniation
- Discospondylitis
- Neoplasia
- Stenosis

Lysosomal storage disease
Neuroaxonal dystrophy (D)
Nerve root compression
Niemann-Pick disease (C)
Peripheral neuropathies *q.v.*
Primary orthostatic tremor
Senility
Spongiform encephalopathy

Metabolic

Hepatic encephalopathy *q.v.**
Hyperadrenocorticism/hypoadrenocorticism (D)
Hyperkalaemia *q.v.*
Hypocalcaemia *q.v.*
Hypoglycaemia *q.v.*
Primary hyperparathyroidism
Uraemia *q.v.**

Drugs/toxins

5-fluorouracil
Baclofen
Benzodiazepines
Blue-green algae
Bromethalin
Caffeine
Carbamate
Guarana
Hexachlorophene
Horse chestnut
Ivermectin
Macadamia nuts
Metaldehyde
Mexiletine
Mycotoxins
Risperidone
Organochlorines
Organophosphates
Petroleum distillates
Plastic explosives
Piperazine
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Salt
Strychnine
Terbutaline
Theobromine
Theophylline
Tricyclic antidepressants
Yew
Zinc phosphate

References

Garosi, L. S., et al. (2005) Primary orthostatic tremor in Great Danes. *JVIM,* **19**:606–609.

Gough A. (2004) Possible risperidone poisoning in a dog. *Vet Rec,* **155:**156.

Hansen, S. R., et al. (2000) Weakness, tremors, and depression associated with macadamia nuts in dogs. *Vet Hum Toxicol,* **42**:18–21.

Kallet, A. J. (1991) Primary hyperparathyroidism in cats: Seven cases (1984–1989). *JAVMA,* **199**:1767–71.

Munana, K. R., et al. (1994) Neurological manifestations of Niemann-Pick disease type C in cats. *JVIM,* **8**:117–21.

Plumlee, K. H. (2004) Poisons in the medicine cabinet. *Proceedings, Western Veterinary Conference, 2004.*

Wagner, S. O., et al. (1997) Generalized tremors in dogs: 24 cases (1984–1995). *JAVMA,* **211**:731–35.

Young, K. L., et al. (2003) Tremorgenic mycotoxin intoxication with Penitrem A and Roquefortine in two dogs. *JAVMA,* **222**:52–3.

1.5.3 Ataxia/conscious proprioceptive deficits

FOREBRAIN

Degenerative
Leukodystrophy
Lysosomal storage disease
Mitochondrial encephalopathy
Multi-system neuronal degeneration
Spongy degeneration

Congenital
Dandy-Walker syndrome
Hydrocephalus
Intra-arachnoid cyst

Metabolic
Electrolyte/acid–base disorders *q.v.**
Hepatic encephalopathy *q.v.**
Hypoglycaemia *q.v.*
Uraemic encephalopathy *q.v.**

Neoplasia
Choroid plexus tumours
Dermoid cyst
Ependymoma
Epidermoid cyst
Glioma
Lymphoma
Medulloblastoma
Meningioma
Metastatic tumour

Immune-mediated disease/infection
Encephalitis *q.v.*
Feline spongiform encephalopathy

Vascular
Cerebrovascular accident

BRAINSTEM/CENTRAL VESTIBULAR DISORDERS

Degenerative
Lysosomal storage disorders

Congenital
Chiari-like malformation
Hydrocephalus
Intra-arachnoid cysts

Metabolic
Electrolyte abnormalities* *q.v.*
Hepatic encephalopathy* *q.v.*
Uraemic encephalopathy* *q.v.*

Neoplastic
Choroid plexus tumours
Dermoid cyst
Epidermoid cyst
Glioma
Lymphoma
Medulloblastoma
Meningioma
Metastatic tumour

Nutritional
Thiamine deficiency

Immune-mediated/infectious
Feline spongiform encephalopathy (C)
Meningoencephalitis *q.v.*

Trauma

Vascular
Cerebrovascular accident

Drugs
Metronidazole

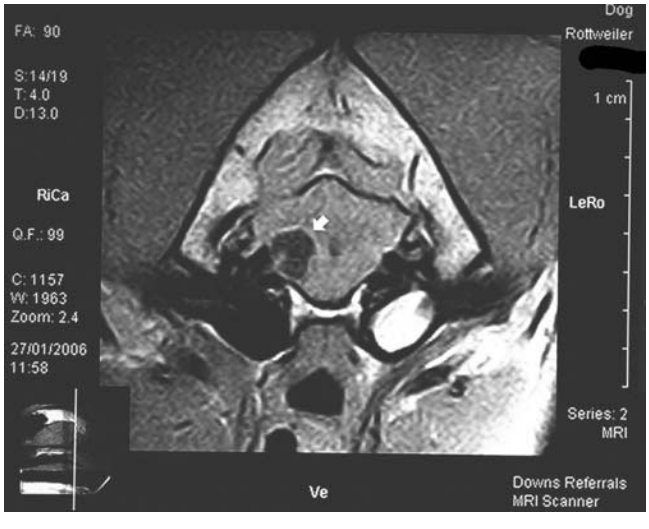

Fig. 1.5(b) Transverse T1 weighted MR scan of a dog showing a cystic tumour in the brain stem (arrow). The contralateral tympanic bulla is filled with a high signal material which in this case was an incidental finding. Reproduced with permission of Downs Referrals, Bristol.

CEREBELLUM (generally ataxia without conscious proprioceptive deficits)

Degenerative
Cerebellar cortical degeneration
Gangliosidosis
Hereditary ataxia of Jack Russell and Smooth-coated Fox Terriers (D)
Leukoencephalomalacia (D)
Neuroaxonal dystrophy (D)
Neuronal vacuolation and spinocerebellar degeneration (D)
Storage diseases

Congenital
Feline cerebellar hypoplasia (C)

Metabolic
Thiamine deficiency

Neoplastic
Choroid plexus tumours
Dermoid cyst
Epidermoid cyst
Glioma
Lymphoma
Medulloblastoma
Meningioma
Metastatic tumour

Immune-mediated/infectious *q.v.*
In utero infection with feline parvovirus (C)

Vascular
Cerebrovascular accident *q.v.*

Drugs/toxins
Heavy metals
Organophosphates

PERIPHERAL VESTIBULAR DISEASE

Congenital
Congenital vestibular disease, e.g.
- Lymphocytic labyrinthitis
- Non-inflammatory cochlear degeneration

Metabolic
Hypothyroidism* (D)

Neoplastic

Middle- or inner-ear tumours, e.g.
Adenocarcinoma
Chondrosarcoma
Fibrosarcoma
Lymphoma
Osteosarcoma
Squamous cell carcinoma

Immune-mediated/infectious

Nasopharyngeal polyps*
Otitis media/interna*
- Primary secretory otitis media in the Cavalier King Charles Spaniel
- Secondary to otitis externa

Idiopathic

Canine geriatric vestibular disease
Feline idiopathic vestibular disease

Traumatic

Drugs/toxins

Aminoglycosides
Chlorhexidine
Topical iodophores

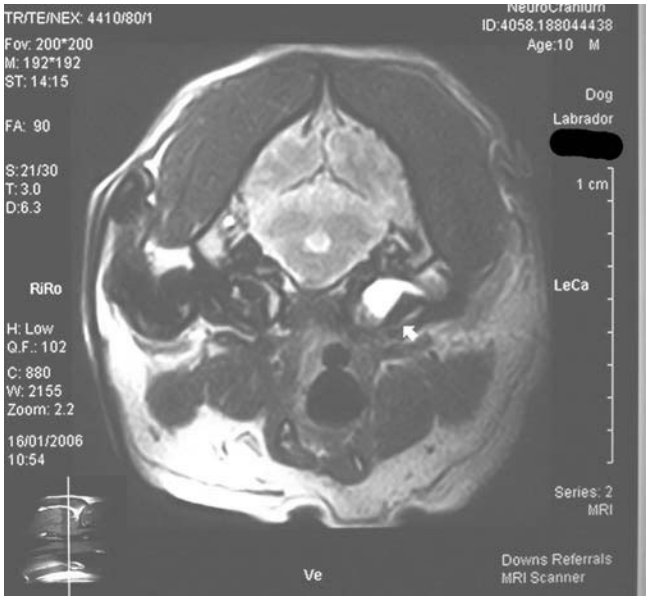

Fig. 1.5(c) Sagittal T2 weighted MR scan of the head of a dog showing high signal material in the tympanic bulla due to otitis media (arrow). Reproduced with permission of Downs Referrals, Bristol.

SPINE

Degenerative

Cervical fibrotic stenosis
Cervical spondylomyelopathy
Degenerative disc disease* (D)
Degenerative myelopathy*
Leukoencephalomalacia
Lumbosacral disease
Lysosomal storage disease
Neuroaxonal dystrophy
Neuronal vacuolation and spinocerebellar degeneration (D)
Other leukodystrophies
Synovial cysts

Congenital

Atlanto-occipital dysplasia
Atlantoaxial subluxation
Cartilaginous exostoses
Dermoid sinus
Epidermoid cyst
Hereditary myelopathy
Meningocoeles
Sacral osteochondritis dissecans
Sacrocaudal dysgenesis
Spina bifida
Spinal arachnoid cyst
Spinal dysraphism
Syringohydromyelia (D)
Tethered cord syndrome
Vertebral malformations *q.v.*

Immune-mediated

Cauda equina neuritis
Granulomatous meningoencephalomyelitis*
Steroid-responsive meningitis-arteritis

Infectious

Discospondylitis
Foreign body
Meningomyelitis
Spinal epidural empyema

Idiopathic

Calcinosis circumscripta
Disseminated idiopathic skeletal hyperostosis

Neoplastic

Extradural
Chondrosarcoma

Fibrosarcoma
Haemangiosarcoma
Lipoma
Lymphoma
Malignant nerve sheath tumour
Meningioma
Metastatic disease
Myeloma
Osteosarcoma

Intradural extramedullary
Malignant nerve-sheath tumour
Meningioma
Metastatic

Intramedullary
Astrocytoma
Ependymoma
Metastatic tumour
Oligodendroglioma

Nutritional

Hypervitaminosis A
Thiamine deficiency

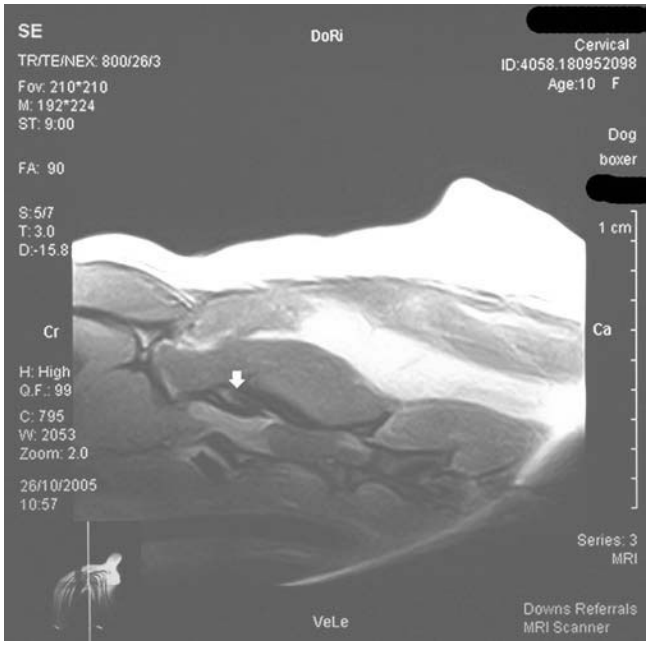

Fig. 1.5(d) Sagittal T1 weighted MR scan of the cervical spine of a dog showing a spinal meningioma (arrow). Reproduced with permission of Downs Referrals, Bristol.

Traumatic

Brachial plexus avulsion
Dural tear
Fracture*
Gunshot wound
Luxation*
Sacrocaudal injury
Traumatic disc injury*

Vascular

Fibrocartilaginous embolism*
Fat graft necrosis
Myelomalacia
Spinal cord haematoma
Spinal cord haemorrhage
Vascular anomaly

PERIPHERAL NERVES (mono- or polyneuropathies)

Degenerative

Birman cat distal polyneuropathy (C)
Boxer dog progressive axonopathy (D)
Giant axonal neuropathy of German Shepherds (D)
Globoid cell leukodystrophy
Golden Retriever hypomyelinating polyneuropathy (D)
Hereditary/idiopathic polyneuropathy of Alaskan Malamutes (D)
Hypertrophic neuropathy
Hypomyelinating polyneuropathy
Laryngeal paralysis–polyneuropathy complex
Lysosomal storage diseases
- Fucosidosis (D)
- Globoid cell leukodystrophy
- Glycogen storage disease type IV
- Niemann-Pick disease (C)

Mucopolysaccharidosis IIIA (D)
Sensory neuropathy (D)

Immune-mediated/infectious

Chronic inflammatory demyelinating polyneuropathy
Feline leukaemia virus associated
Polyradiculoneuritis
Protozoal
Sensory ganglioradiculoneuritis

Neoplastic

Lymphoma
Malignant nerve-sheath tumours
Myelomonocytic neoplasia
Paraneoplastic neuropathy

Traumatic
Bite wounds*
Iatrogenic
Missile injuries
Traction injuries

Vascular
Ischaemic neuromyopathy*
Neurogenic claudication

SYSTEMIC

Metabolic
Electrolyte/acid–base disorders*
Endocrine disease, e.g.
- Diabetes mellitus*
- Hypothyroidism* (D)

Hepatic encephalopathy*
Hyperadrenocorticoid neuropathy
Hyperchylomicronaemia
Insulinoma/hypoglycaemia

Nutritional
Vitamin B_6 (pyridoxine) overdose

Drugs/toxins
Alphachloralose
Baclofen
Benzodiazepines
Blue-green algae
Butorphanol
Cannabis
Carbamate
Codeine
Daffodil
Dichlorophen
Diclofenac
Ethylene glycol toxicity
Fentanyl and other sedatives and tranquillisers
Glyphosphate
Horse chestnut
Ivermectin
Loperamide
Metaldehyde
Methiocarb
Metronidazole
Naproxen
Nitroscanate (C)
Organophosphates
Paracetamol

Paraquat
Phenobarbitone
Phenoxy acid herbicides
Phenytoin
Piperazine
Plastic explosives
Potassium bromide
Primidone
Pyridoxine (Vitamin B_6)
Selective serotonin reuptake inhibitors
Terfenadine
Thallium
Theobromine
Tricyclic antidepressants
Vincristine
Walker Hound mononeuropathy
Yew

References

Chrisman, C. L. (2000) Polyneuropathies of cats. *JSAP,* **41**:384–9.
Cuddon, P. A. (2002) Canine and Feline Neuropathies. *Proceedings, Western Veterinary Conference, 2002.*
Davies, D. R. & Irwin, P. J. (2003) Degenerative neurological and neuromuscular disease in young Rottweilers. *JSAP,* **44**:388–94.
Gandini, G., et al. (2003) Fibrocartilaginous embolism in 75 dogs: clinical findings and factors influencing the recovery rate. *JSAP,* **44**:76–80.
Jans, H. E., et al. (1990) An epizootic of peroneal and tibial neuropathy in Walker Hound pups. *JAVMA,* **197**:498–500.
Jeffery, N. (1999) Peripheral neuropathies in small animals. *In Practice,* **21**:10–18.
Jolly, R. D., et al. (2001) Histological diagnosis of mucopolysaccharidosis IIIA in a wire-haired dachshund. *Vet Rec,* **148**:564–7.
Schmid, V., et al. (1992) Dandy-Walker-like syndrome in four dogs: cisternography as a diagnostic aid. *JAAHA,* **28**:355–60.
Stern-Bertholtz, W., et al. (2003) Primary secretory otitis media in the Cavalier King Charles spaniel: a review of 61 cases. *JSAP,* **44**:253–56.

1.5.4 Paresis/paralysis

SPINAL DISEASE

Degenerative

Afghan Hound hereditary myelopathy (D)
Calcinosis circumscripta
Cervical spondylomyelopathy
Degenerative disc disease* (D)
Degenerative myelopathy* (D)
Labrador Retriever axonopathy (D)
Lumbosacral disease
Lysosomal storage disease

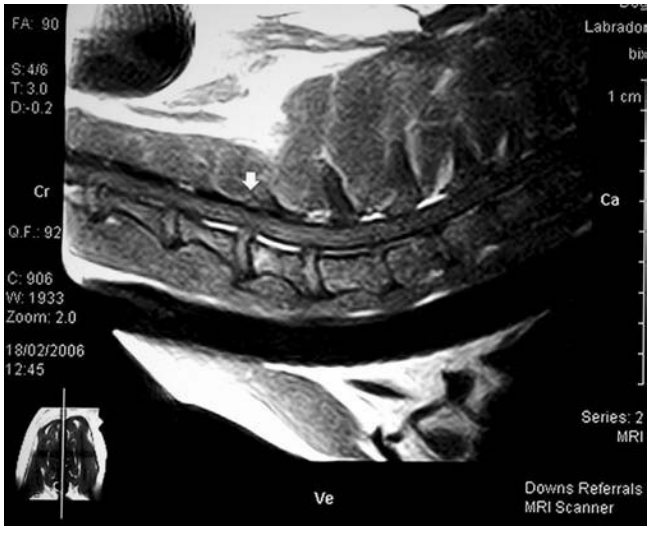

Fig. 1.5(e) Sagittal T1 weighted MR scan of the cervical spine of a dog showing an intervertebral disc protrusion (arrow). Reproduced with permission of Downs Referrals, Bristol.

Neuronal vacuolation and spinocerebellar degeneration (D)
Rottweiler leukoencephalomyelopathy (D)
Other leukodystrophies
Synovial cysts

Congenital

Atlantoaxial subluxation
Atlanto-occipital dysplasia
Cartilaginous exostoses
Dermoid sinus
Epidermoid cyst
Hereditary myelopathy
Meningocoeles
Osteochondromatosis
Sacrocaudal dysgenesis
Sacral osteochondritis dissecans
Spina bifida
Spinal arachnoid cyst
Spinal dysraphism
Syringohydromyelia (D)
Vertebral malformations *q.v.*

Immune-mediated

Cauda equina neuritis
Epidural granuloma
Granulomatous meningoencephalomyelitis*
Steroid-responsive meningitis-arteritis

Infectious

Discospondylitis
Infectious meningoencephalomyelitis
Spinal epidural empyema

Idiopathic

Calcinosis circumscripta
Disseminated idiopathic skeletal hyperostosis

Neoplastic

Extradural

Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Lipoma
Lymphoma
Malignant nerve-sheath tumour
Meningioma
Metastatic
Multiple myeloma
Osteosarcoma
Plasma cell tumour

Intradural extramedullary

Malignant nerve-sheath tumour
Meningioma
Metastatic

Intramedullary

Astrocytoma
Ependymoma
Metastatic tumour
Oligodendroglioma

Nutritional

Hypervitaminosis A
Thiamine deficiency

Traumatic

Brachial plexus avulsion
Dural tear
Foreign body
Fracture*
Gunshot wound
Luxation*
Sacrocaudal injury
Traumatic disc injury*

Vascular

Fibrocartilaginous embolism*
Fat-graft necrosis
Ischaemic neuromyopathy*
Myelomalacia
Neurogenic claudication
Spinal cord haematoma
Spinal cord haemorrhage
Vascular anomaly

PERIPHERAL NERVES (MONO- OR POLYNEUROPATHIES)

Degenerative

Acute idiopathic polyneuropathy
Adult onset motor neuron disease
Birman cat distal polyneuropathy (C)
Boxer dog progressive axonopathy (D)
Chronic idiopathic polyradiculoneuropathy (C)
Distal denervating disease (D)
Giant axonal neuropathy of German Shepherds (D)
Golden Retriever hypomyelinating polyneuropathy (D)
Hereditary/idiopathic polyneuropathy of Alaskan Malamutes (D)
Hypertrophic neuropathy
Laryngeal paralysis–polyneuropathy complex
Lysosomal storage diseases
- Fucosidosis (D)
- Globoid cell leukodystrophy
- Glycogen storage disease type IV
- Niemann-Pick disease (C)

Mucopolysaccharidosis IIIA (D)
Rottweiler distal sensorimotor polyneuropathy (D)
Sensory neuropathy of longhaired Dachshunds (D)
Spinal muscular atrophy

Metabolic

Diabetic neuropathy*
Hyperchylomicronaemia
Hypothyroid neuropathy*
Primary hyperoxaluria

Immune-mediated/infectious

Acute idiopathic polyradiculoneuritis (Coonhound paralysis) (D)
Brachial plexus neuritis
Chronic inflammatory demyelinating polyneuropathy
Protozoal polyradiculoneuritis
Sensory ganglioradiculoneuritis

Neoplastic

Insulinoma
Lymphoma

Malignant nerve-sheath tumours
Myelomonocytic neoplasia
Paraneoplastic neuropathy e.g.

Traumatic

Bite wounds*
Iatrogenic
Missile injuries
Traction injuries

Vascular

Arterial thromboembolism
Ischaemic neuromyopathy*
Traumatic ischaemic neuromyopathy associated with bottom-hung pivot windows and garage doors

Drugs/toxins

Baclofen
Blue-green algae
Cannabis
Daffodil
Horse chestnut
Ivermectin
Methiocarb
Organophosphate
Petroleum products
Phenoxy acid herbicides
Pyrethrin/pyrethroids
Salinomycin toxicity (C)
Thallium
Vincristine
Vitamin K antagonists
Walker Hound mononeuropathy (D)

References

Bergman, P. J., et al. (1994) Canine clinical peripheral neuropathy associated with pancreatic islet cell carcinoma. *Prog Vet Neurol*, **5**:57–62.

Braund, K. G., et al. (1997) Idiopathic polyneuropathy in Alaskan Malamutes. *JVIM*, **11**:243–9.

Cauzinille, L. & Kornegay, J. N. (1996) Fibrocartilaginous embolism of the spinal cord in dogs: review of 36 histologically confirmed cases and retrospective study of 26 suspected cases. *JVIM*, **10**:241–5.

Chrisman, C. L. (2000) Polyneuropathies of cats. *JSAP*, **41**:384–389.

Davies, D. R. & Irwin, P. J. (2003) Degenerative neurological and neuromuscular disease in young Rottweilers. *JSAP*, **44**:388–94.

Fischer, I., et al. (2002) Acute traumatic hind limb paralysis in 30 cats. *Tierarztl Prax Ausg K Klientiere Heimtiere*, **30**:61.

Jans, H. E., et al. (1990) An epizootic of peroneal and tibial neuropathy in Walker Hound pups. *JAVMA*, **197**:498–500.

Kraus, K. H., et al. (1989) Paraparesis caused by epidural granuloma in a cat. *JAVMA*, **194**:789–90.

1.5.5 Coma/stupor (see Table 1.5)

INTRACRANIAL DISEASE

(*Note:* Especially lesions of midbrain through medulla that impair the ascending reticular activating system.)

Degenerative

Inherited neurodegenerative diseases

- Multisystem neuronal degeneration of Cocker Spaniels (D)
- Multisystemic chromatolytic neuronal degeneration
- Spongiform degenerations

Congenital

Hydrocephalus

Table 1.5 Modified Glasgow Coma scale. Table reproduced, with permission, from: Platt, S. (2005) Evaluation and treatment of the head trauma patient. *In Practice,* **27:**31–5.

Sign	Level	Score
Level of consciousness	Occasional period of alertness and responsiveness	6
	Depression or delirium, inappropriate response	5
	Semicomatose, responsive to visual stimuli	4
	Semicomatose, responsive to auditory stimuli	3
	Semicomatose, responsive only to noxious stimuli	2
	Comatose, unresponsive	1
Motor activity	Normal gait and reflexes	6
	Hemiparesis, tetraparesis	5
	Recumbent, intermittent extensor rigidity	4
	Recumbent, constant extensor rigidity	3
	Recumbent, constant extensor rigidity, opisthotonus	2
	Recumbent, hypotonia, depressed/absent spinal reflexes	1
Brainstem reflexes	Normal pupillary light reflexes/physiological nystagmus	6
	Slow PLR/normal or reduced physiological nystagmus	5
	Bilateral unresponsive miosis/normal or reduced physiological nystagmus	4
	Pinpoint pupils/reduced or absent physiological nystagmus	3
	Unilateral unresponsive mydriasis	2
	Bilateral unresponsive mydriasis	1
Prognosis: Score 3–8 = grave Score 9–14 = guarded Score 15–18 = good		

Neoplastic

Primary
Choroid plexus papilloma
Glioma
Meningioma
Pituitary tumour

Metastatic
Carcinoma
Haemangiosarcoma
Lymphoma

Local extension
Nasal tumour
Skull osteochondroma

Inflammatory/infectious *q.v.*

Trauma
Head trauma
Intracranial haemorrhage
Subdural haematoma

Vascular
Cerebrovascular accident
Feline ischaemic encephalopathy (C)
Hypertension *q.v.*
Intracranial haemorrhage

EXTRACRANIAL DISEASE

Metabolic
Electrolyte disturbances* *q.v.*
Hepatic encephalopathy*
Hypoglycaemia *q.v.*
Hypothyroid myxoedema coma
Uraemic encephalopathy* *q.v.*

CNS perfusion disturbances
Anaemia* *q.v.*
Cardiorespiratory disease*
Haemoglobin-related toxicity
Hyperviscosity
Hypovolaemia*

Nutritional
Thiamine deficiency

Drugs/toxins

Alphachloralose
Baclofen
Barbiturates
Benzodiazepines and other sedatives/anaesthetic agents
Blue-green algae
Borax
Cannabis
Carbamate insecticides
Diclofenac sodium
Ethylene glycol
Ibuprofen
Indomethacin
Iron
Ivermectin
Lead
Loperamide
Metaldehyde
Methiocarb
Metronidazole
Naproxen
Organophosphates
Paracetamol
Phenoxy acid herbicides
Salt
Tricyclic antidepressants
Vitamin K antagonists
Water
Xylitol
Yew

References

Atkinson, K. & Aubert, I. (2004) Myxedema coma leading to respiratory depression in a dog. *Can Vet J*, **45**:318–20.

Dunayer, E. K. (2004) Hypoglycaemia following canine ingestion of xylitol-containing gum. *Vet Hum Toxicol*, **46**:87–8.

Reidarson, T. H., et al. (1990) Extreme hypernatremia in a dog with central diabetes insipidus: a case report. *JAAHA*, **26**:89–92.

1.5.6 Altered behaviour – general changes

(e.g. disorientation, increased aggression, forgetfulness)

INTRACRANIAL DISEASE (see Plate 1.5(a) in colour plate section)

Degenerative

Cognitive dysfunction

Congenital

Hydrocephalus
Lissencephaly
Lysosomal storage diseases

Neoplastic e.g.

Glioma
Lymphoma
Meningioma
Metastatic disease
Pituitary

Infectious

Viral

Canine distemper* (D)
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)

Bacterial

Fungal

Protozoal

Neosporosis
Toxoplasmosis

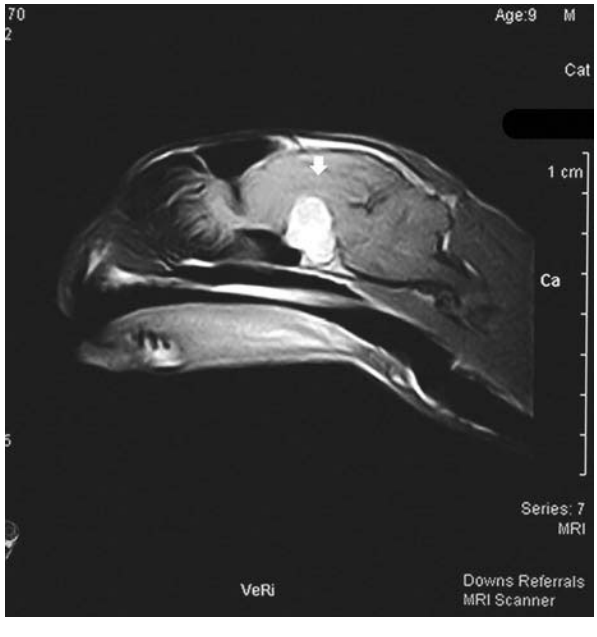

Fig. 1.5(f) Sagittal T1 weighted gadolinium-enhanced MR scan of a cat's brain, showing a large, contrast-enhancing, pituitary tumour. Reproduced with permission of Downs Referrals, Bristol.

Prion
Feline spongiform encephalopathy

Inflammatory/immune-mediated
Granulomatous meningoencephalomyelitis*
Steroid-responsive meningitis-arteritis

Physical
Trauma

EXTRACRANIAL DISEASE

Metabolic
Hepatic encephalopathy *q.v.*
Hypocalcaemia *q.v.*
Hypoglycaemia *q.v.*
Renal failure *q.v.*
Thiamine deficiency

Drugs/toxins
Acepromazine
Benzodiazepines
Other sedatives/tranquillisers
Cannabis
Ibuprofen
Ivermectin
Petroleum distillates
Phenylpropanolamine
Risperidone
Salbutamol
Selective serotonin reuptake inhibitors
Selegiline
Terfenadine

1.5.7 Altered behaviour – specific behavioural problems

Stereotypy/compulsive behaviour
Boredom*
Frustration*
Genetic predisposition*
Physical triggers, e.g.
- Anal sac disease (tail chasing)*
- Dermatitis in (over-grooming)*

Neurological disease
- Brainstem lesions *q.v.*
- Forebrain disease *q.v.*
- Lumbosacral disease (tail chasing)
- Seizures* *q.v.*
- Sensory neuropathies (self-mutilation)

- Vestibular lesions (circling)* *q.v.*

Stress*

Aggression

Dominance*
Fear*
Hypocholesterolaemia
Petting*
Play*
Possessive*
Predatory*
Territorial*

Inappropriate urination and defecation

Cognitive dysfunction
Fear
Gastrointestinal disease *q.v.*
Hyperexcitability
Litter-box related

- Dirty litter
- New location of litter box
- Unfamiliar litter

Separation anxiety
Territorial marking
Urinary tract disease (see Incontinence/inappropriate urination)

References

Gough, A. (2004) Possible risperidone poisoning in a dog. *Vet Rec*, **155**:156.
Kelly, D. F., et al. (2005) Neuropathological findings in cats with clinically suspect but histologically unconfirmed feline spongiform encephalopathy. *Vet Rec*, **156**:472–7.
Jolly, R. D. (1994) Canine ceroid lipofuscinoses: A review and classification. *JSAP*, **35**:299–306.
Penturk, S. & Yalcin, E. (2003) Hypocholesterolaemia in dogs with dominance aggression. *J Vet Med A Physiol Pathol Clin Med*, **50**:339–42.
Shull, E. A. (1997) Neurologic disorders in aged dogs. *Vet Med*, **97**:17–19.
Sorde, A., et al. (1994) Psychomotor epilepsy associated with metastatic thymoma in a dog. *JSAP*, **35**:377–80.

1.5.8 Deafness

Congenital conditions

Aplasia/hypoplasia of auditory receptors
Hydrocephalus

Infection/inflammation

Otitis externa* *q.v.*
Otitis interna*
Otitis media*

Neoplasia

Intracranial
Middle ear
Nasopharyngeal polyp*

Mechanical

Loud noise
Trauma

Degenerative disease

Presbycussis* (D)
- Cochlear conductive defects
- Senile ossicle or receptor degeneration

Idiopathic

Drugs/toxins

Antibiotics

Aminoglycosides
Amphotericin B
Ampicillin
Bacitracin
Chloramphenicol
Colistin
Erythromycin
Griseofulvin
Hygromycin B
Minocycline
Polymixin B
Tetracyclines
Vancomycin

Antiseptics

Benzalkonium chloride
Benzethonium chloride
Cetrimide
Chlorhexidine
Ethanol
Iodine
Iodophores

Cancer chemotherapeutics

Actinomycin
Cisplatin
Cyclophosphamide
Vinblastine
Vincristine

Diuretics
Bumetanide
Ethacrynic acid
Frusemide

Metals/heavy metals
Arsenic
Gold salts
Lead
Mercury
Triethyl/trimethyl tin

Miscellaneous
Ceruminolytic agents
Danazol
Detergents
Digoxin
Dimethylsulphoxide
Diphenylhydrazine
Insulin
Potassium bromide
Prednisolone
Propylene glycol
Quinidine
Salicylates

Reference

Strain, G. W. (1996) Aetiology, prevalence and diagnosis of deafness in dogs and cats. *British Veterinary Journal*, **152**:17.

1.5.9 Multifocal neurological disease

Degenerative
Mitochondrial encephalopathies
Organic acidurias
Storage diseases

Congenital
Hydrocephalus
Syringohydromyelia

Metabolic
Hepatic disease* *q.v.*
Hyperosmolarity
Hypoglycaemia *q.v.*
Hypothyroidism* (D)
Renal disease* *q.v.*

Neoplastic
Leukaemia
Lymphoma
Metastatic neoplasia

Nutritional
Thiamine deficiency

Infectious

Bacterial
Bacterial encephalitis/meningitis
Tetanus

Fungal
Aspergillosis
Blastomycosis
Candidiasis
Coccidioidomycosis
Cryptococcosis

Parasitic
Cuterebra spp
Toxocariasis

Protozoal
Neosporosis
Toxoplasmosis

Rickettsial
Ehrlichiosis/anaplasmosis
Protothecosis
Rocky Mountain Spotted Fever

Viral
Canine distemper virus (D)*
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Herpes virus
Parainfluenza virus
Parvovirus*

Immune-mediated disease
Granulomatous meningoencephalomyelitis
Necrotising encephalitis
Spinal cord vasculitis
Steroid-responsive meningitis-arteritis

Idiopathic conditions
Dysautonomia

Vascular

Intracranial haemorrhage
- *Angiostrongylus vasorum*
- Coagulopathy
- Trauma
- Vascular anomaly

Hypertension *q.v.*
Spinal haemorrhage
Thromboembolism

Drugs/toxins

Alphachloralose
Baclofen
Benzodiazepines
Blue-green algae
Borax
Cannabis
Carbamate
Daffodil
Dichlorophen
Diclofenac sodium
Ethylene glycol
Glyphosphate
Horse chestnut
Ibuprofen
Ivermectin
Laburnum
Loperamide
Metaldehyde
Methiocarb
Naproxen
Organophosphates
Paracetamol
Petroleum products
Piperazine
Plastic explosives
Pyrethrin/pyrethroids
Rhododendron
Salbutamol
Salt
Selective serotonin reuptake inhibitors
Terfenadine
Theobromine
Tricyclic antidepressants
Vitamin D_2/D_3
Vitamin K antagonists
Yew

See Plate 1.5(b) in colour plate section.

References

Koenig, A., et al. (2004) Hyperglycemic, hyperosmolar syndrome in feline diabetics: 17 cases (1995–2001). *J Vet Emerg Crit Care*, **14**:30–40.

Thomas, J. B. & Eger, C. (1989) Granulomatous meningoencephalomyelitis in 21 dogs. *JSAP*, **30**:287–93.

1.6 Ocular historical signs

1.6.1 Blindness/visual impairment

CENTRAL NERVOUS SYSTEM (CNS)

Optic nerve disease, e.g.

Optic nerve hypoplasia/aplasia
Optic neuritis
Space-occupying lesion compressing optic nerve
Trauma

Brain disease

Congenital, e.g.
Hydrocephalus

Degenerative, e.g.
Neuronal ceroid lipofuscinosis
Lysosomal storage diseases

Immune-mediated/infectious, e.g.
Granulomatous meningoencephalomyelitis
Toxoplasmosis

Metabolic, e.g.
Hepatic encephalopathy *q.v.*

Neoplastic, e.g.
Lymphoma
Meningioma
Pituitary tumour

Trauma

Drugs/toxins, e.g.
Ivermectin
Lead
Levamisole
Metaldehyde

Vascular, e.g.
Cerebrovascular accident

References
Koenig, A., et al. (2004) Hyperglycemic, hyperosmolar syndrome in feline diabetics: 17 cases (1995–2001). *J Vet Emerg Crit Care*, **14**:30–40.
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1.6 Ocular historical signs

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Neoplastic, e.g.
Lymphoma
Meningioma
Pituitary tumour

Trauma

Drugs/toxins, e.g.
Ivermectin
Lead
Levamisole
Metaldehyde

Vascular, e.g.
Cerebrovascular accident

INTRAOCULAR/PERIOCULAR

Congenital

Ankyloblepharon
Anophthalmia
Anterior segment dysgenesis
Collie eye anomaly
Congenital vitreous opacification
Corneal dermoid
Entropion (severe)
Microphthalmia
Persistent hyperplastic primary vitreous
Persistent hyperplastic tunica vasculosa lentis
Persistent pupillary membranes
Posterior segment coloboma
Vitreo-retinal dysplasia

Retinal disorders

Congenital retinal dystrophy
Early onset photoreceptor dystrophies
- Early retinal degeneration
- Photoreceptor dysplasia
- Rod–cone dysplasia
- Rod dysplasia

Hemeralopia
Lysosomal storage diseases
Primary retinal dysplasia
Secondary retinal dysplasia
- Idiopathic/inherited
- Intra-uterine trauma
- Maternal infections
- Radiation
- Vitamin A deficiency during pregnancy

Lens disorders

Aphakia
Cataracts
Coloboma
Lenticonus/lentiglobus
Microphakia
Spherophakia

Acquired

Anterior uveitis
Cataract* *q.v.*
Chorioretinitis
Chronic superficial keratitis/pannus*
Chronic uveitis*
Corneal lipid dystrophy/degeneration
Corneal oedema and endothelial dysfunction*
Endophthalmitis
Entropion
Generalised progressive retinal degeneration
Glaucoma*
Hypertensive ocular disease*
Hyphaema
Intraocular haemorrhage*
Keratoconjunctivitis sicca*

Nutritional retinal degeneration
- Taurine deficiency
- Vitamin A deficiency
- Vitamin E deficiency

Phthisis bulbi, e.g.
- Secondary to ocular trauma or chronic uveitis

Pigmentary keratitis
Retinal degeneration
Retinal detachment* *q.v.*
Retinal haemorrhage
Retinal pigment epithelial cell dystrophy
Sudden acquired retinal degeneration
Superficial keratitis
Symblepharon
Trauma*
Ulcerative keratitis and corneal scarring
Vitreal haemorrhage

*Sequelae to chronic uveitis**
Corneal oedema
Cyclitic membranes
Exudative retinal detachment
Hyphaema
Intraocular adhesions
Lens luxation
Phthisis bulbi
Secondary cataracts
Secondary glaucoma
Secondary retinal degeneration*

Reference

Sansom, J., et al. (2004) Blood pressure assessment in healthy cats and cats with hypertensive retinopathy. *AJVR*, **65**:245–52.

1.6.2 Epiphora/tear overflow

Impaired tear drainage

Dacryocystitis
Entropion
Imperforate/obstructed punctum or canaliculus
Lacrimal canicular aplasia
Small lacrimal lakes

Painful/irritating ocular conditions

*Eyelid conditions**
Blepharitis
Distichiasis/Ectopic cilia
Entropion
Facial nerve paralysis
Lid laceration
Neoplasia
Trichiasis

Extraorbital conditions
Diseases of paranasal sinuses
Mechanical or olfactory stimulation of nasal mucosa

Intraocular conditions
Acute uveitis
Anterior lens luxation (D)
Glaucoma
Trauma

*Third eyelid conditions**
Lymphoid hyperplasia
Neoplasia
Prolapsed nictitans gland
Scrolled third eyelid
Trauma

Ocular surface conditions
Conjunctivitis*
Corneal ulceration*
Foreign body
Keratitis*

1.7 Musculoskeletal historical signs

1.7.1 Forelimb lameness

YOUNG ANIMALS

Any site
Infection*
Metaphyseal osteopathy
Panosteitis
Trauma*
- Bruising or strain of soft tissues*
- Laceration*
- Penetrating wound*

Shoulder
Brachial plexus avulsion
Fracture of humerus*
Fracture of scapula
Haemarthrosis
Joint capsule rupture
Luxation (congenital or acquired)
Medially displaced biceps tendon
Osteochondrosis* (D)
Septic arthritis*
Shoulder dysplasia*
Traumatic arthritis*

Elbow
Avulsion of the medial epicondyle
Collateral ligament rupture or avulsion
Degenerative joint disease*
Elbow incongruity
Fracture of humerus*
Fracture of radius*

Intraocular conditions
Acute uveitis
Anterior lens luxation (D)
Glaucoma
Trauma

*Third eyelid conditions**
Lymphoid hyperplasia
Neoplasia
Prolapsed nictitans gland
Scrolled third eyelid
Trauma

Ocular surface conditions
Conjunctivitis*
Corneal ulceration*
Foreign body
Keratitis*

1.7 Musculoskeletal historical signs

1.7.1 Forelimb lameness

YOUNG ANIMALS

Any site
Infection*
Metaphyseal osteopathy
Panosteitis
Trauma*
- Bruising or strain of soft tissues*
- Laceration*
- Penetrating wound*

Shoulder
Brachial plexus avulsion
Fracture of humerus*
Fracture of scapula
Haemarthrosis
Joint capsule rupture
Luxation (congenital or acquired)
Medially displaced biceps tendon
Osteochondrosis* (D)
Septic arthritis*
Shoulder dysplasia*
Traumatic arthritis*

Elbow
Avulsion of the medial epicondyle
Collateral ligament rupture or avulsion
Degenerative joint disease*
Elbow incongruity
Fracture of humerus*
Fracture of radius*

Fracture of ulna*
Growth plate disorders
Haemarthrosis
Luxation (congenital or acquired)
Osteochondrosis (D)*
- Fragmented medial coronoid process
- Osteochondritis dissecans of the medial condyle of the humerus
- Ununited anconeal process

Septic arthritis
Traumatic arthritis*

Carpus

Carpal hyperextension
Collateral ligament rupture or avulsion
Degenerative joint disease*
Dysostosis
Flexor tendon contracture
Fracture of carpal bones*
Fracture of metacarpal bones*
Fracture of radius*
Fracture of ulna*
Growth plate disorders

Fig. 1.7 Lateral condylar fracture of the humerus. Reproduced with permission of Downs Referrals, Bristol.

Luxation
Osteochondrosis
Septic arthritis
Shearing injury
Subluxation

Foot

Avulsion of deep digital flexor tendon
Avulsion of superficial digital flexor tendon
Claw disease *q.v.**
Degenerative joint disease*
Fracture of distal metacarpal bones*
Fracture of phalanges*
Injury to integument, e.g.
- Bite wound
- Foreign body
- Laceration

Other pathology of integument*
Luxation/subluxation
Septic arthritis
Sesamoid disease/fracture

ADULT ANIMALS

Any site

Infection*
Trauma*
- Bruising or strain of soft tissues
- Laceration
- Penetrating wound

Shoulder

Biceps tendon rupture
Bicipital tenosynovitis (D)
Degenerative joint disease*
Fracture of humerus*
Fracture of scapula*
Haemarthrosis
Infraspinatus contracture/other muscle contractures
Joint capsule rupture
Luxation (congenital or acquired)*
Medially displaced biceps tendon
Neoplasia*, e.g.
- Metastatic tumour
- Nerve root tumour
- Primary bone tumour
- Soft tissue tumour
- Synovial sarcoma

Osteochondrosis
Septic arthritis
Shoulder dysplasia
Traumatic arthritis*

Elbow

Collateral ligament rupture or avulsion
Degenerative joint disease*
Elbow incongruity
Fracture of humerus*
Fracture of radius*
Fracture of ulna*
Haemarthrosis
Incomplete ossification of humeral condyle
Luxation (congenital or acquired)
Medial spur
Neoplasia*
- Bone
- Metastatic
- Soft tissue

Osteochondrosis
Septic arthritis
Traumatic arthritis*

Carpus

Carpal hyperextension
Degenerative joint disease*
Fracture of radius*
Fractures of carpal bones*
Fractures of metacarpal bones*
Haemarthrosis
Luxation or subluxation
Neoplasia*
- Bone
- Metastatic
- Soft tissue

Septic arthritis
Shearing injury
Traumatic arthritis*

Foot

Avulsion of superficial or deep digital flexor tendon
Claw disease *q.v.*
Degenerative joint disease*
Fracture of distal metacarpal bones*
Fracture of phalanges*
Fracture of sesamoid bones*
Haemarthrosis
Injury to integument*, e.g.
- Bite wound
- Foreign body
- Laceration

Other pathology of integument*
Luxation
Neoplasia
- Bone

- Metastatic
- Soft tissue

Septic arthritis
Sesamoid disease
Traumatic arthritis*

References

Gilley, R. S., et al. (2002) Clinical and pathologic analyses of bicipital tenosynovitis in dogs. *Am J Vet Res*, **63**:402–407.
Mellanby, R. J., et al. (2003) Magnetic resonance imaging in the diagnosis of lymphoma involving the brachial plexus in a cat. *Vet Radiol Ultrasound*, **44**:522–5.
Remy, D., et al. (2004) Canine elbow dysplasia and primary lesions in German shepherd dogs in France. *JSAP*, **45**:244–48.

1.7.2 Hind limb lameness

YOUNG ANIMALS

Any site

Infection
Metaphyseal osteopathy
Panosteitis
Trauma

- Bruising or strain of soft tissues
- Laceration
- Penetrating wound

Hip

Avascular necrosis of the femoral head (D)
Fracture of acetabulum*
Fracture of femur*
Haemarthrosis
Hip dysplasia*
Luxation*
Septic arthritis
Traumatic arthritis*

Stifle

Caudal cruciate ligament rupture or avulsion
Cranial cruciate ligament rupture or avulsion*
Femorotibial luxation
Fracture of femur*
Fracture of fibula*
Fracture of patella*
Fracture of tibia*
Genu valgum
Haemarthrosis
Long digital extensor tendon avulsion
Meniscal trauma*
Osteochondrosis*
Patellar ligament rupture or avulsion
Patellar luxation*

Septic arthritis
Stifle hyperextension
Traumatic arthritis*

Hock

Calcaneal tendon rupture, laceration or avulsion
Collateral ligament avulsion
Congenital tarsal anomalies
Fracture of tibia*
Fracture of fibula*
Fractures of metatarsal bones*
Fractures of tarsal bones*
Gastrocnemius tendon rupture, laceration or avulsion
Growth plate disorders
Haemarthrosis
Luxation
Osteochondrosis*
Septic arthritis
Shearing injury
Tibial dysplasia
Traumatic arthritis*

Foot

Avulsion of the superficial or deep digital flexor tendon
Claw disease *q.v.**
Degenerative joint disease*
Fractures of distal metatarsal bones*
Fractures of phalanges*
Fractures of sesamoid bones
Haemarthrosis
Injury to integument*, e.g.
- Bite wound
- Foreign body
- Laceration

Other pathology of integument*
Luxation
Septic arthritis
Sesamoid disease
Traumatic arthritis*

ADULT ANIMALS

Any site

Infection
Trauma
- Bruising or strain of soft tissues
- Laceration
- Penetrating wound

Hip

Avascular necrosis of the femoral head*

Degenerative joint disease*
Fracture of acetabulum*
Fracture of femur*
Haemarthrosis
Hip dysplasia*
Luxation*
Myositis ossificans
Neoplasia*
- Bone
- Soft tissue
- Metastatic

Septic arthritis
Traumatic arthritis*

Stifle

Caudal cruciate ligament rupture or avulsion
Cranial cruciate ligament rupture or avulsion*
Degenerative joint disease*
Femorotibial luxation
Fracture of femur*
Fracture of fibula*
Fracture of patella*
Fracture of tibia*
Haemarthrosis
Long digital extensor tendon avulsion
Meniscal trauma*
Neoplasia*
- Bone
- Soft tissue
- Metastatic

Osteochondrosis*
Patellar ligament rupture or avulsion
Patellar luxation*
Septic arthritis
Stifle hyperextension
Traumatic arthritis*

Hock

Calcaneal tendon rupture, laceration or avulsion
Collateral ligament avulsion
Degenerative joint disease*
Fracture of fibula*
Fracture of tibia*
Fractures of metatarsal bones*
Fractures of tarsal bones*
Gastrocnemius tendon rupture, laceration or avulsion
Growth plate disorders
Haemarthrosis
Luxation
Neoplasia*

- Bone
- Soft tissue
- Metastatic

Osteochondrosis*
Septic arthritis
Shearing injury
Superficial digital flexor luxation
Tibial dysplasia
Traumatic arthritis*

Foot

Avulsion of the superficial or deep digital flexor tendon
Claw disease* *q.v.*
Degenerative joint disease*
Fractures of distal metatarsal bones*
Fractures of phalanges*
Fractures of sesamoid bones
Haemarthrosis
Injury to integument*, e.g.

- Bite wound
- Foreign body
- Laceration

Other pathology of integument*
Luxation*
Neoplasia*

- Bone
- Soft tissue
- Metastatic

Septic arthritis
Sesamoid disease
Traumatic arthritis*
Traumatic tenosynovitis

References

Gibbons, S. E., et al. (2006) Patellar luxation in 70 large breed dogs. *JSAP*, **47**:3–9.
Piek, C. J., et al. (1996) Long-term follow-up of avascular necrosis of the femoral head in the dog. *JSAP*, **37**:12–18.

1.7.3 Multiple joint/limb lameness

Young animals

Borreliosis
Chondrodysplasia
Drug reaction

- Sulponamide
- Vaccine

Excessive joint laxity
Collagen defect

- Dietary
- Traumatic

Haemarthroses
Metaphyseal osteopathy (D)
Nutritional secondary hyperthyroidism
Osteochondrosis*
Polyarthritis
Septic arthritis
Viral arthritis

Adult animals

Borreliosis
Chondrodysplasia
Degenerative joint disease*
Drug reaction
- Sulphonamide
- Vaccine

Excessive joint laxity
- Collagen defect
- Dietary
- Traumatic

Haemarthroses
Hyperparathyroidism
Neuromuscular disease
Osteochondrosis*
Nutritional, e.g.
- Hypervitimosis A
- Copper deficiency

Periosteal proliferative arthritis
Polyarthritis
Septic arthritis
Systemic lupus erythematosus
Viral arthritis

Reference

Cohen, N. D., et al. (1990) Clinical and epizootiologic characteristics of dogs seropositive for *Borrelia burgdoferi* in Texas: 110 cases (1988). *JAVMA*. **197**:893–98.

1.8 Reproductive historical signs

1.8.1 Failure to observe oestrus

Abnormal sex chromosomes
Early embryonic death *q.v.*
Idiopathic
Immune-mediated oophoritis
Inadequate display of oestrus*
Inadequate observation of oestrus*
Inappropriate photoperiod (C)
Lactational anoestrus*
Panhypopituitarism
Physical/athletic training
Poor diet
Prepuberty*
Previous ovariectomy*

Adult animals

Borreliosis
Chondrodysplasia
Degenerative joint disease*
Drug reaction
- Sulphonamide
- Vaccine

Excessive joint laxity
- Collagen defect
- Dietary
- Traumatic

Haemarthroses
Hyperparathyroidism
Neuromuscular disease
Osteochondrosis*
Nutritional, e.g.
- Hypervitimosis A
- Copper deficiency

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Polyarthritis
Septic arthritis
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1.8.1 Failure to observe oestrus

Abnormal sex chromosomes
Early embryonic death *q.v.*
Idiopathic
Immune-mediated oophoritis
Inadequate display of oestrus*
Inadequate observation of oestrus*
Inappropriate photoperiod (C)
Lactational anoestrus*
Panhypopituitarism
Physical/athletic training
Poor diet
Prepuberty*
Previous ovariectomy*

Pseudohermaphroditism
Pseudopregnancy*
Seasonal anoestrus (C)*
Social factors
Spontaneous ovulation
Sterile matings
True hermaphroditism

Concurrent disease

Hyperadrenocorticism
Hypoadrenocorticism (D)
Hypothyroidism* (D)
Poor body condition

Iatrogenic

Anabolic steroids
Androgens
Glucocorticoids
Progesterones

Ovarian disease

Ovarian aplasia
Ovarian cysts and tumours
- Granulosa-thecal cell tumours
- Luteal cysts
- Other neoplasms or cysts causing ovarian atrophy

Ovarian hypoplasia
Senile ovarian failure

Stress*

Frequent showing
Frequent travel
Overcrowding
Temperature extremes

References

Chastain, C. B., et al. (2001) Combined pituitary hormone deficiency in German Shepherd dogs with dwarfism. *Sm Anim Clin Endocrinol*, **11**:1–4.
Little, S. (2001) Uncovering the cause of infertility in queens. *Vet Med*, **96**:557–68.
Switonski, M., et al. (2003) Robertsonian translocation (8;14) in an infertile bitch (*Canis familiaris*). *J Appl Genet*, **44**:525–7.

1.8.2 Irregular seasons

Short pro-oestrus followed by anoestrus

Poor diet
Shortened inter-pro-oestrus intervals (see below)
Stress

Reduced intensity of visible signs of oestrus
Concurrent disease*
Drugs*
- Anabolic steroids
- Androgens
- Glucocorticoids
- Progesterones

Prolonged pro-oestrus/oestrus

Excessive adrenal production of oestrogen (C)
Follicular cysts*
Hepatic disease
Merging of waves of follicular growth (C)
Normal in young females*

Iatrogenic
Drugs used to prevent pregnancy after mating
Exogenous gonadotrophins

Ovarian tumours
Adenocarcinoma
Cystadenoma
Granulosa cell tumour

Persistence of oestrus behaviour

Signs of oestrus in absence of true hormonal oestrus
Vaginal foreign body
Vaginal tumour
Vaginitis*
Vulvitis*

Shortened inter-pro-oestrus interval

Follicular cysts
Frequent episodes of pro-oestrus
Ovulatory failure
Short anoestrus
Split heats

Iatrogenic
Bromocriptine
Cabergoline
Prostaglandins

Prolonged inter-pro-oestrus interval

Normal in some breeds
Hypothyroidism* (D)
Idiopathic
Ovarian cysts or neoplasia
Severe systemic disease
Silent heat

Reference

Little, S. (2001) Uncovering the cause of infertility in queens. *Vet Med*, **96**:557–68.

1.8.3 Infertility in the female with normal oestrus

Failure to achieve intromission

Male factors* *q.v.*

Congenital defects of the vestibule and vagina

Intersexes
Vaginal septa
Vestibulovaginal strictures
Vulval constrictions

Acquired vaginal conditions

Foreign body
Post-partum fibrosis
Transmissible venereal tumour
Vaginal hyperplasia*
Vaginal tumours
Vaginal ulceration

Failure of ovulation

Idiopathic (D)
Inadequate number of matings (C)
Incorrect timing of mating* (C)

Miscellaneous

Cervical stenosis
Cystic endometrial hyperplasia*
Early embryonic loss *q.v.*
Endometritis
Herpes virus
Hypoluteodism
Incorrect timing of mating/insemination*
Infertile male
Non-patent oviducts or uterus
Segmental aplasia of the paramesonephric duct
Stress
Uterine polyps
Uterine tumours

References

Freshman, J. L. (2002) The dam's the thing: care of the pregnant bitch. *Proceedings, ACVIM, 2002*.

Kyles, A. E., et al. (1996) Vestibulovaginal stenosis in dogs: 18 cases (1987–1995). *JAVMA*, **209**:1889–93.

Miller, M. A., et al. (2003) Uterine neoplasia in 13 cats. *J Vet Diagn Invest*, **15**:515–22.

Root, M. V., et al. (1995) Vaginal septa in dogs: 15 cases (1983–1992). *JAVMA*, **206**:56–8.

1.8.4 Male infertility

Lack of libido

Age-related
- Prepubertal*
- Senility*

Behavioural
- Inexperience*
- Previous bad experience when mating*
- Training not to display sexual interest*

Management
- Overuse*

Concurrent/systemic disease, e.g.*
- Hypoadrenocorticism
- Hypogonadism
- Hypothyroidism* (D)

Testicular disease
- Idiopathic testicular degeneration
- Orchitis
- Sertoli cell tumour

Drugs
- Anabolic steroids
- Cimetidine
- Glucocorticoids
- Ketoconazole
- Oestrogens
- Overuse of testosterone
- Progestagens

Diet
- Malnutrition
- Obesity*

Inability to mount the female

Prostatic disease *q.v.*

*Orthopaedic disease**
- Hips
- Spine
- Stifle

Failure to achieve intromission

Female factors *q.v.*

Congenital abnormalities, e.g.

Diphallus
Penile hypoplasia
Persistent penile frenulum
Preputial stenosis
Pseudohermaphroditism

Acquired abnormalities

Neoplasia of the penis/prepuce
Phimosis
Trauma of the penis/prepuce
Urethral obstruction and subsequent haematoma

Miscellaneous

Incomplete erection
Ineffective thrusting
- Experience*
- Poor socialisation*
- Short os penis
- Size discrepancy*
- Trauma (desensitised glans)

Premature full attainment of erection in inexperienced dog*
Premature loss of erection*

Lack of fertility where normal mating/s is/are achieved

Failure of/incomplete ejaculation

Discomfort or stress during mating*
Inadequate tie*
Retrograde ejaculation
- Disorder of sympathetic nervous system
- Urethral sphincter incompetence

Low/absent sperm number or quality

Artefact

Poor collection technique/analysis*

Congenital defects

Cryptorchidism
Genetic abnormalities in spermatogenesis
- Chromosomal abnormalities, e.g.
  - XXY syndrome (D)
  - 38,XY/57,XXY (C)
- Immotile cilia (Kartagener's syndrome)

Segmental aplasia of the duct system
Testicular hypoplasia

Acquired defects

Infections causing azoospermia or abnormal sperm/semen
- Balanoposthitis
- Epididymitis
- Orchitis
- Prostatitis
- Urethritis

Increases in testicular temperature
- Chemotherapeutics, e.g.
  - Chlorambucil
  - Cisplatin
  - Cyclophosphamide
- High environmental temperature
- Hyperthermia
- Iatrogenic
- Orchitis in contralateral testis
- Other drugs
  - Anabolic steroids
  - Androgens
  - Glucocorticoids
- Radiation therapy/excessive radiography
- Scrotal dermatitis

Local trauma
- Dog bites
- Kicks/blows
- Lacerations

Neoplasia of the testis
Overuse*
Pain*
Prepuberty*
Retrograde ejaculation
Toxins

References

Axner, E., et al. (1996) Reproductive disorders in 10 domestic male cats. *JSAP*, **37**:394–401.

Kyles, A. E., et al. (1996) Vestibulovaginal stenosis in dogs: 18 cases (1987–1995). *JAVMA*, **209**:1889–93.

Metcalfe, S. S., et al. (1999) Azoospermia in two Labrador retrievers. *Aust Vet J*, **77**:570–73.

Neil, J. A., et al. (2002) Kartagener's syndrome in a Dachshund dog. *JAAHA*, **38**:45–9.

Olson, P. N., et al. (1992) Clinical and laboratory findings associated with actual or suspected azoospermia in dogs: 18 cases (1979–1990). *JAVMA*, **201**:478–82.

1.8.5 Vaginal/vulval discharge

Pseudopregnancy*
Pyometra*

Stump pyometra*
Vaginal or uterine neoplasia
Vaginitis*
Vulvitis*

1.8.6 Abortion

Infection

Brucella canis (D)
Canine adenovirus (D)
Canine distemper virus (D)*
Canine herpes virus (D)
Chlamydophila psittaci (C)
Ehrlichiosis
Feline herpes virus (C)*
Feline infectious peritonitis (C)*
Feline leukaemia virus (C)*
Feline panleukopenia virus (C)*
Leishmaniasis
Toxoplasmosis

Habitual abortion

Abnormal uterine environment, e.g.
- Cystic endometrial hyperplasia

Poor luteal function

Drugs, e.g.

Cabergoline
Corticosteroids
Prostaglandins

References

Dubey, J. P., et al. (2005) Placentitis associated with leishmaniasis in a dog. *JAVMA*, **227**:1266–9.
Sainz, A. (2002) Clinical and therapeutic aspects of canine ehrlichiosis. *Proceedings, WSAVA Congress, 2002*.
Wanke, M. M. (2004) Canine brucellosis. *Anim Reprod Sci*, **82–83**:195–207.

1.8.7 Dystocia

MATERNAL CAUSES

Uterine inertia*

Primary uterine inertia
Fatty infiltration of the myometrium

Hormonal deficiencies
Hypocalcaemia* *q.v.*
Inherited
Maternal systemic disease
Overstretching of myometrium, e.g.
- Excessive intra-uterine fluids
- Large foetuses*
- Large litter*

Poor diet
Senile changes*
Single puppy syndrome*

Secondary uterine inertia
Exhaustion of myometrium*
- Obstruction of birth canal*
- Prolonged labour*

Obstruction of the birth canal

Congenital uterine malformations
- Aplasia of cervix
- Aplasia of corpus uteri
- Aplasia of uterine horns

Fibrosis of the birth canal
Narrow pelvic canal
- Congenital
- Fracture*
- Immaturity*

Neoplasia
Uterine malposition
Uterine rupture
Uterine torsion
Vaginal septa

FOETAL CAUSES

Oversized foetuses

Physically normal but large puppy*
Monstrosities
- Duplications
- Hydrocephalus
- Oedema

Malpresentation*

Backward flexion of front legs
Breech
Lateral or downward deviation of the head
Posterior
Transverse
Two foetuses presenting simultaneously

References

Ekstrand, C. & Linde-Forsberg, C. (1994) Dystocia in the cat: A retrospective study of 155 cases. *JSAP*, **35**:459–64.

Romagnoli, S., et al. (2004) Prolonged interval between parturition of normal live pups in a bitch. *JSAP*, **45**:249–53.

Walett Darvelid, A. & Linde-Forsberg, C. (1994) Dystocia in the bitch: A retrospective study of 182 cases. *JSAP*, **35**:402–407.

1.8.8 Neonatal mortality

Congenital abnormalities*, e.g.

Congenital heart disease
Hydrocephalus
Hypothyroidism

Infections*, e.g.

Feline calicivirus*
Feline herpes virus*
Feline infectious peritonitis*
Feline parvovirus*
Septicaemia

Maternal/management factors*

Asphyxiation
Euthanasia for reasons of congenital deformities or undesirable cosmetic features
Hypoglycaemia *q.v.*, e.g.
- Secondary to sepsis

Hypothermia
Inadequate lactation
Poor environment, e.g.
- Draughts
- Heating

Poor hygiene
Poor mothering
Poor nutrition/health of breeding stock

Miscellaneous

Fading puppy syndrome*
Low birth weight
Neonatal isoerythrolysis
Stillbirth

References

Cave, T. A., et al. (2002) Kitten mortality in the United Kingdom: a retrospective analysis of 274 histopathological examinations (1986–2000). *Vet Rec*, **151**:497–501.

Gelens, H. (2003) Fading neonates and failure to thrive. *Proceedings, Western Veterinary Conference, 2003*.

Nielen, A. L., et al. (1998) Investigation of mortality and pathological changes in a 14-month birth cohort of Boxer puppies. *Vet Rec*, **142**:602–606.

1.9 Urological historical signs

1.9.1 Pollakiuria/dysuria/stranguria

Normal urine

Behavioural*
Idiopathic detrusor-urethral dyssynergia
Neuromuscular

With haematuria, pyuria or bacteriuria

Diabetes mellitus*
Feline lower urinary tract disease* (C)
Hyperadrenocorticism/costeroid treatment
Iatrogenic disorders
Infiltrative urethral diseases
Neoplasia
Neuromuscular disorders
Prostatic disease
Renal disease* *q.v.*
Structural abnormalities
Trauma/bladder rupture
Urolithiasis*

Infection

Bacterial
Fungal
Mycoplasmal
Viral

References

Diaz Espineira, M. M., et al. (1998) Idiopathic detrusor–urethral dyssynergia in dogs: a retrospective analysis of 22 cases. *JSAP*, **39**:264–70.
Macintire, D. K. (2004) Feline dysuria. *Proceedings, Western Veterinary Conference, 2004*.
Moroff, S. D., et al. (1991) Infiltrative urethral disease in female dogs: 41 cases (1980–1987). *JAVMA*, **199**:247–51.

1.9.2 Polyuria/polydipsia (see 1.1.1 for full differentials)

Diet
Congenital lack of ADH receptors
Electrolyte disorders
Endocrine disease
Hepatobiliary disease
Hypothalamic disease

Nielen, A. L., et al. (1998) Investigation of mortality and pathological changes in a 14-month birth cohort of Boxer puppies. *Vet Rec*, **142**:602–606.

1.9 Urological historical signs

1.9.1 Pollakiuria/dysuria/stranguria

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Infiltrative urethral diseases
Neoplasia
Neuromuscular disorders
Prostatic disease
Renal disease* *q.v.*
Structural abnormalities
Trauma/bladder rupture
Urolithiasis*

Infection

Bacterial
Fungal
Mycoplasmal
Viral

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Diaz Espineira, M. M., et al. (1998) Idiopathic detrusor–urethral dyssynergia in dogs: a retrospective analysis of 22 cases. *JSAP*, **39**:264–70.
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Moroff, S. D., et al. (1991) Infiltrative urethral disease in female dogs: 41 cases (1980–1987). *JAVMA*, **199**:247–51.

1.9.2 Polyuria/polydipsia (see 1.1.1 for full differentials)

Diet
Congenital lack of ADH receptors
Electrolyte disorders
Endocrine disease
Hepatobiliary disease
Hypothalamic disease

Infectious disease
Neoplasia*
Pericardial effusion
Physiological
Polycythaemia
Psychogenic
Renal disorders
Drugs/toxins

1.9.3 Anuria/oliguria

Pre-renal

Dehydration*
Hypoadrenocorticism (D)
Shock *q.v.**

Renal

Acute renal failure *q.v.*
Chronic renal failure*
- Acute
- Chronic
- End-stage

Post-renal

Prostatic disease*
Urethral spasm

Neoplasia
Bladder
Extra-urinary tract
Urethra

Trauma
Avulsion of ureters
Ruptured bladder/urethra

*Urolithiasis**
Nephroliths
Ureteroliths
Uroliths in bladder or urethra

1.9.4 Haematuria

Physiological

Pro-oestrus

Renal disease

Cysts

Glomerulonephritis
Iatrogenic
- Biopsy
- Fine needle aspirate

Idiopathic renal haematuria
Infarction, e.g.
- Disseminated intravascular coagulation

Neoplasia*
Parasites
- *Dioctophyma renale*

Pyelonephritis
Renal telangiectasia
Trauma
Uroliths*

Ureteral, urinary bladder and urethral disease

Feline lower urinary tract disease*
Iatrogenic
- Cystocentesis*
- Forceful catheterisation*

Neoplasia
Parasites
- *Capillaria plica*

Polyps
Trauma*
Urethritis
Uroliths*
Drugs
- Cyclophosphamide

Prostatic disease

Abscess
Benign prostatic hyperplasia* (D)
Cysts
Neoplasia
Prostatitis*

Uterine disease

Metritis
Neoplasia
Pyometra*
Sub-involution*

Vaginal disease

Neoplasia
Trauma

Penile disease

Neoplasia
Trauma

Extra-urogenital disease

Coagulopathy *q.v.*
Heatstroke
Drugs/toxins
- Paracetamol

Pseudohaematuria (non-haematuria-related red urine)

Bilirubinuria *q.v.*
Food pigments
- Blackberries
- Beets
- Rhubarb

Haemoglobinuria *q.v.*
Myoglobinuria *q.v.*
Phenazopyridine
Phenolphthalein
Phenothiazines

References

Charney, S. C., et al. (2003) Risk factors for sterile hemorrhagic cystitis in dogs with lymphoma receiving cyclophosphamide with or without concurrent administration of furosemide: 216 cases (1990–1996). *JAVMA*, **222**:1388–93.
Holt. P. E., et al. (1987) Idiopathic renal haemorrhage in the dog. *JSAP,* **28**: 253–63.
Moroff, S. D., et al. (1991) Infiltrative urethral disease in female dogs: 41 cases (1980–1987). *JAVMA*, **199**:247–51.
Moses, P. A., et al. (2002) Polypoid cystitis in a dog. *Aust Vet Pract*, **32**:12–32.
Munday, J. S., et al. (2004) Renal osteosarcoma in a dog. *JSAP*, **45**:618–22.

1.9.5 Urinary incontinence/inappropriate urination

With bladder distension

Detrusor atony
Bladder over-distension
Dysautonomia
Lower motor neurone disease
Neoplastic infiltration of bladder wall
Upper motor neurone disease

Partial physical obstruction
Granulomatous urethritis
Neoplasia
Prostatic disease*
Retroflexion of bladder into a perineal hernia
Urethral fibrosis/stricture
Urolithiasis*
Vestibulovaginal stenosis

Functional obstruction
Reflex dyssynergia*
Upper motor neurone disease
Urethral inflammation*
Urethral pain

Without bladder distension

Bladder hypercontractility
Chronic partial obstruction*
Detrusor instability
Inflammation*
Neoplasia

Reduced bladder storage
Fibrosis
Hypoplasia
Neoplasia

Urethral sphincter incompetence
Congenital
Hormone responsive*
Intersex
Prostatic disease*
Urethral inflammation*
Urethral neoplasia
Urinary tract infection*

Miscellaneous
Ectopic ureters
Ureterocoele
Urolithiasis
Iatrogenic
- Ureterovaginal fistulation

Behavioural
Secondary to polydipsia/polyuria

References

Aaron, A., et al. (1996) Urethral sphincter mechanism incompetence in male dogs: a retrospective analysis of 54 cases. *Vet Rec*, **139**:542–6.

Holt, P. E. & Moore, A. H. (1995) Canine ureteral ectopia: an analysis of 175 cases and comparison of surgical treatments. *Vet Rec*, **136**:345–9.

Hotston-Moore, A. (2001) Urinary incontinence in adult bitches: 2. Differential diagnosis and treatment. *In Practice*, **23**:588–95.

McLoughlin, et al. (1989) Canine ureteroceles: A case report and literature review. *JAAHA*, **25**:699–706.

PART 2
PHYSICAL SIGNS

2.1 General/miscellaneous physical signs

2.1.1 Abnormalities of body temperature – hyperthermia

TRUE FEVER

Infection

Bacterial

Localised, e.g.

- Abscess*, e.g.
  - Dental
  - Lung
  - Retrobulbar
- Cellulitis*
- Cholangiohepatitis
- Cystitis
- Dental disease*
- Discospondylitis
- Endocarditis
- Gastrointestinal infection*
- Metritis*
- Osteomyelitis*
- Peritonitis*
- Pneumonia*
- Prostatitis*
- Pyelonephritis
- Pyometra/stump pyometra*
- Pyothorax*
- Septic arthritis*
- Urinary tract infection*

Generalised/multifocal, e.g.

- Bartonellosis
- Brucellosis (D)
- Leptospirosis*
- Lyme disease
- *Mycobacterium* spp
- Plague
- Septicaemia from septic focus

Fungal, e.g.
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis

Parasitic, e.g.
Aberrant helminth migration
Babesiosis
Chaga's disease
Cytauxzoon felis
Dirofilaria immitis
Haemobartonellosis
Hepatozoonosis
Leishmaniasis

Protozoal, e.g.
Neosporosis (D)
Toxoplasmosis

Rickettsial, e.g.
Ehrlichiosis
Rocky Mountain Spotted Fever (D)
Salmon poisoning

Viral (many), e.g.
Feline calicivirus* (C)
Feline herpes virus* (C)
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Feline panleukopenia virus* (C)
Canine distemper virus* (D)
Canine hepatitis virus* (D)
Canine parainfluenza virus* (D)
Canine parvovirus* (D)

Immune-mediated disease

Autoimmune skin disease
- Bullous pemphigoid
- Discoid lupus erythematosus
- Pemphigus erythematosus
- Pemphigus foliaceus
- Pemphigus vulgaris

Drug reactions
Evan's syndrome
Familial renal amyloidosis
Granulomatous meningoencephalomyelitis
Immune-mediated haemolytic anaemia*

Immune-mediated joint disease*
- Idiopathic
- Periosteal proliferative arthritis
- Polyarthritis/meningitis
- Polyarthritis/polymyositis
- Rheumatoid arthritis
- Systemic lupus erythematosus

Immune-mediated thrombocytopenia
Pemphigus
Plasmacytic-lymphocytic gonitis
Polyarteritis nodosa
Polymyositis
Systemic lupus erythematosus

Immunodeficiency syndromes

Defects in specific immunity, e.g.
Agammaglobulinaemia
C3 deficiency
Canine leucocyte adhesion deficiency
Lethal acrodermatitis
Low immunoglobulins in Weimaraners (D)
Neutrophil defect of Weimaraners (D)
Pneumocystic pneumonia in miniature Dachshunds (D)
Transient hypogammaglobulinaemia
Selective IgA deficiency
Selective IgM deficiency
Severe combined immunodeficiency disease

Defects in non-specific immunity
Bone marrow dyscrasia in Poodles (D)
Canine cyclic haematopoiesis (D)
Canine granulocytopathy syndrome (D)
Chediak-Higashi syndrome (C)
Complement deficiency (D)
Hypotrichosis with thymic aplasia (C)
Immotile cilia syndrome
Pelger-Huet anomaly

Secondary immunodeficiencies
Endocrine
- Hyperadrenocorticism

Infectious, e.g.
- Canine distemper virus* (D)
- Demodecosis*
- Feline immunodeficiency syndrome* (C)
- Feline leukaemia virus* (C)
- Parvovirus

Metabolic
- Uraemia

Neoplastic
- Haematopoietic

Nutritional
- Zinc deficiency

Drugs
- Corticosteroids
- Immunosuppressive therapy

Neoplasia

Lymphoma*
Lymphoproliferative disease
Malignant histiocytosis
Myeloproliferative disease
Solid tumours*

Tissue damage*

Surgery*
Trauma*

Miscellaneous

Metabolic bone disorders
- Hypervitaminosis A (C)
- Metaphyseal osteopathy
- Nutritional secondary hyperthyroidism
- Panosteitis

Pansteatitis (C)
Portosystemic shunt
True pyrexia of unknown origin

Inadequate heat dissipation

Heat stroke*
Hyperpyrexic syndrome

Increased muscular activity

Episodic myokymia
Hypocalcaemic tetany *q.v.*
Normal exercise*
Pain
Seizures* *q.v.*
Stress

Pathological hyperthermia

Hypermetabolic states
- Hyperthyroidism* (C)
- Phaeochromocytoma

Hypothalamic lesions
Malignant hyperthermia

Drugs/toxins

Adder bites

Amphotericin B
Aspirin
Benzalkonium chloride
Benzodiazepines
Borax
Cannabis
Carbamate
Daffodil
Dichlorophen
Diclofenac sodium
Dinoprost tromethamine
Glyphosphate
Horse chestnut
Hymenoptera stings
Indomethacin
Ivermectin
Metaldehyde
Organophosphates
Oxytetracycline
Paracetamol
Paraquat
Penicillamine
Petroleum distillates
Phenytoin
Poinsettia
Procainamide
Pyrethrin/pyrethroids
Salbutamol
Theobromine
Yew

2.1.2 Abnormalities of body temperature – hypothermia

Drugs/toxins

Alphachloralose
Baclofen
Benzodiazepines
Cannabis
Daffodil
Ethylene glycol
General anaesthetics
Ivermectin
Loperamide
Paracetamol
Sedatives
Yew

Miscellaneous

Aortic thromboembolism* (C)
Cardiac disease* *q.v.*
Coma *q.v.*
Environmental cold*
Hypoadrenocorticism (D)
Hypothalamic disorders
Hypothyroidism* (D)
Loss of thermoregulatory abilities following heat stroke
Near drowning
Severe sepsis/endotoxaemia*

References

Bennet, D. (1995) Diagnosis of pyrexia of unknown origin. *In Practice*, **17**:470–81.
Bohnhorst, J. O., et al. (2002) Immune-mediated fever in the dog. Occurrence of antinuclear antibodies, rheumatoid factor, tumor necrosis factor and interleukin-6 in serum. *Acta Vet Scand*, **43**:165–71.
Bosak, J. K. (2004) Heat stroke in a great Pyrenees dog. *Can Vet J*, **45**:513–15.
Donaldson, C. W. (2002) Marijuana exposure in animals. *Vet Med*, **97**:437–9.
Dunn, K. J. & Dunn, J. K. (1998) Diagnostic investigations in 101 dogs with pyrexia of unknown origin. *JSAP*, **39**:574–80.
Foale, R. D. (2003) Retrospective study of 25 young weimaraners with low serum immunoglobulin concentrations and inflammatory disease. *Vet Rec*, **153**:553–8.
German, A. J., et al. (2003) Sterile nodular panniculitis and pansteatitis in three weimeraners. *JSAP*, **44**:449–55.
Lappin, M. R. (2003) Fever of unknown origin. *Proceedings, Western Veterinary Conference*, *2003*.
Smith, S. A., et al. (2003) Arterial thromboembolism in cats: acute crisis in 127 cases (1992–2001) and long-term management with low-dose aspirin in 24 cases. *JVIM*, **17**:73–83.
Van Ham, L. (2004) 'Continuous muscle fibre activity' in six dogs with episodic myokymia, stiffness and collapse. *Vet Rec*, **155**:769–74.
Wess, G., et al. (2003) Recurrent fever as the only or predominant clinical sign in four dogs and one cat with congenital portosystemic vascular anomalies. *Schweiz Arch Tierheilkd*, **145**:363–8.
Wolf, A. M. (2002) Fever of undetermined origin in the cat. *Proceedings, Atlantic Coast Veterinary Conference*, *2002*.

2.1.3 Enlarged lymph nodes

PROLIFERATION/INFLAMMATION

Infectious

Algal
Protothecosis

Bacterial
- Actinomycosis
- *Brucella canis* (D)
- *Corynebacterium* spp
- Localised infection
- *Mycobacterium* spp
- Nocardiosis
- Septicaemia
- *Streptococcus* spp
- *Yersinia pestis*

Fungal
- Aspergillosis
- Blastomycosis
- Coccidioidomycosis
- Cryptococcosis
- Histoplasmosis
- Phycomycosis
- Sporotrichosis

Parasitic
- Babesiosis
- Cytauxzoonosis
- Demodecosis
- Hepatozoonosis
- Leishmaniasis
- Trypanosomiasis

Protozoal
- Neosporosis (D)
- Toxoplasmosis

Rickettsial
- Ehrlichiosis
- Rocky Mountain Spotted Fever
- Salmon poisoning

Viral
- Canine herpes virus* (D)
- Feline immunodeficiency virus* (C)
- Feline infectious peritonitis* (C)
- Feline leukaemia virus* (C)
- Infectious canine hepatitis* (D)

Non-infectious
- Dermatopathic lymphadenopathy
- Drug reactions
- Idiopathic
- Immune-mediated

- Immune-mediated polyarthritides
- Mineral associated lymphadenopathy
- Puppy strangles* (D)
- Rheumatoid arthritis
- Systemic lupus erythematosus

Localised inflammation*
Post-vaccine

INFILTRATION

Neoplastic disease

Haemolymphatic
Leukaemias
Lymphoma*
Lymphomatoid granulomatosis
Malignant histiocytosis
Multiple myeloma
Systemic mastocytosis

Metastatic
Adenocarcinomas
Carcinomas
Malignant melanomas
Mast cell tumours
Sarcomas

Non-neoplastic disease

Eosinophilic granuloma complex
Mast cell infiltration

References

Bauer, N., et al. (2002) Lymphadenopathy and diarrhea in a miniature schnauzer. *Vet Clin Pathol*, **31**:61–4.
Couto, C. G. (1997) Lymphadenopathy in cats. *Proceedings, Waltham Feline Medicine Symposium, 1997*.
Kraje, A. C., et al. (2001) Malignant histiocytosis in 3 cats. *JVIM*, **15**:252–6.

2.1.4 Diffuse pain

Gastrointestinal disease, e.g.

Cholecystolithiasis/cholecystitis*
Gastrointestinal parasitism*
Pancreatitis*

Musculoskeletal disease, e.g.

Polyarthritis
Polymyositis

Neurological disease, e.g.

Meningoencephalitis
Spinal disease* *q.v.*
Thalamic pain syndrome

Urological disease, e.g.

Prostatic disease*
Renal parasitism
Renal urolithiasis
Ureteral urolithiasis
Urethral tumour

Other causes of abdominal pain *q.v.*

Reference

Holland, C. T., et al. (2000) Hemihyperaesthesia and hyperresponsiveness resembling central pain syndrome in a dog with a forebrain oligodendroglioma. *Aust Vet J*, 78:676–80.

2.1.5 Peripheral oedema

Generalised

Hypoalbuminaemia* *q.v.*
Increased central venous pressure
- Central venous occlusion
  - Neoplasia
  - Thrombosis
- Congestive heart failure*

Vasculitis

Regional

Bilateral forelimb oedema/head and neck oedema
Cranial vena cava syndrome
- Compression of cranial vena cava, e.g. by mediastinal mass
- Granuloma of cranial vena cava
- Neoplasia of cranial vena cava
- Thrombosis of cranial vena cava

Bilateral hind limb oedema
Budd-Chiari-like syndrome
Obstruction of sublumbar lymph nodes, e.g. neoplasia

Increased central venous pressure
Central lymph obstruction
Central venous occlusion, e.g.
- Mediastinal mass
- Thrombosis

Localised

Arteriovenous fistula
Cellulitis*
Inflammation*
Lymphangitis
Lymphoedema
Neurogenic or hormonal vasoactive stimuli
Proximal venous obstruction
Vascular trauma
Vasculitis
Drugs/toxins
- Alphaxalone/alphadolone
- Paracetamol
- Salbutamol

References

Jaffe, M. H., et al. (1999) Extensive venous thrombosis and hind-limb edema associated with adrenocortical carcinoma in a dog. *JAAHA*, **35**:306–10.
Kern, M. R. & Black, S. S. (1999) Dyspnea and pitting edema associated with T-cell lymphosarcoma. *Canine Pract*, **24**:6–10.
Miller, M. W. (1989) Budd-Chiari-like syndrome in two dogs. *JAAHA*, **25**:277–83.
Nicastro, A. & Cote, E. (2002) Cranial vena cava syndrome. *Compend Contin Educ Pract Vet*, **24**:701–10.

2.1.6 Hypertension

Adrenal disease

Hyperadrenocorticism
Hyperaldosteronism
Phaeochromocytoma

Anaemia* *q.v.*

CNS disease *q.v.*

Endocrine disease

Acromegaly
Diabetes mellitus* (D)
Hyperoestrogenism
Hyperthyroidism* (C)

Hyperviscosity

Hyperglobulinaemia *q.v.*
Polycythaemia *q.v.*

Iatrogenic

Overzealous fluid administration

Idiopathic

Essential/primary hypertension

Renal disease

Renal arterial disease

Renal parenchymal disease
- Amyloidosis
- Chronic interstitial nephritis*
- Glomerulonephritis
- Glomerulosclerosis
- Pyelonephritis

Thyroid disease
Hyperthyroidism* (C)

Drugs/toxins
Corticosteroids
Cyclosporin A
Dobutamine
Dopamine
Doxapram
Erythropoietin
Fludrocortisone
Phenylpropanolamine
Theobromine

References
Bodey, A. R. & Sansom, J. (1998) Epidemiological study of blood pressure in domestic cats. *JSAP*, **39**:567–73.
Senella, K. A., et al. (2003) Systolic blood pressure in cats with diabetes mellitus. *JAVMA*, **223**:198–201.
Struble, A. L., et al. (1998) Systemic hypertension and proteinuria in dogs with diabetes mellitus. *JAVMA*, **213**:822–5.

2.1.7 Hypotension

Decreased preload
Heatstroke*
Hypoadrenocorticism (D)
Hypovolaemia*
- Blood donation
- Burns
- Effusions *q.v.*
- Diarrhoea *q.v.*
- Haemorrhage *q.v.*
- Polyuria without polydipsia *q.v.*
- Vomiting *q.v.*

Decreased venous return
Cardiac tamponade
Caval syndrome/heartworm disease
Gastric dilatation/volvulus*
Pneumothorax* *q.v.*

Positive pressure ventilation
Restrictive pericarditis

Decreased cardiac function

Arrhythmias* *q.v.*
Cardiomyopathy*
Congenital heart disease
Electrolyte/acid–base disorders* *q.v.*
Hypoxia
Valvular disease*

Decreased vascular tone

Anaphylaxis
Babesiosis
Electrolyte/acid–base disorders* *q.v.*
Hypoxia
Neurological disease *q.v.*
Systemic inflammatory response syndrome

Drugs/toxins

ACE inhibitors
Adder bites
Amiloride
Amiodarone
Daffodil
Diazoxide
Dopamine
General anaesthetics and sedatives
Hydralazine
Hymenoptera stings
Indomethacin
Isosorbide dinitrate
Lignocaine
Medetomidine
Mexiletine
Midazolam
Mistletoe
Nitroprusside
Oxytetracycline (intravenous)
Phenoxybenzamine
Prazosin
Procainamide
Propofol
Pyridostigmine
Quinidine
Ranitidine (intravenous)
Rhododendron
Snake venom
Sotalol
Terbutaline
Terfenadine

Tricyclic antidepressants
Verapamil
Xylazine
Yew

References

Couto, C. G. & Iazbik, M. C. (2005) Effects of blood donation on arterial blood pressure in retired racing Greyhounds. *JVIM*, **19**:845–48.
Jacobson, L. S., et al. (2000) Blood pressure changes in dogs with babesiosis. *J S Afr Vet Assoc*, **71**:14–20.
Tibballs, J. (1998) The cardiovascular, coagulation and haematological effects of tiger snake (*Notechis scutatus*) venom. *Anaesth Intensive Care*, **26**:529–35.

2.2 Gastrointestinal/abdominal physical signs

2.2.1 Oral lesions

Congenital deformities

Neoplasia

Oropharyngeal tumours
Extramedullary plasmacytoma
Fibroma/fibrosarcoma
Fibropapilloma
Granular cell tumour
Haemangiosarcoma
Histiocytoma
Lymphoma
Mast cell tumour
Melanoma*
Mixed mesenchymal sarcoma
Papilloma (D)
Rhabdomyosarcoma
Squamous cell carcinoma
Transmissible venereal tumour (D)

Odontogenic tumours
Acanthomatous epulides
Ameloblastic adenomatoid
Ameloblastoma
Calcifying epithelial odontogenic tumour
Cementoma
Dentinoma
Fibromatous epulides
Fibromyxoma
Hamartoma
Inductive fibroameloblastoma (C)

Tricyclic antidepressants
Verapamil
Xylazine
Yew

References

Couto, C. G. & Iazbik, M. C. (2005) Effects of blood donation on arterial blood pressure in retired racing Greyhounds. *JVIM*, **19**:845–48.
Jacobson, L. S., et al. (2000) Blood pressure changes in dogs with babesiosis. *J S Afr Vet Assoc*, **71**:14–20.
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2.2 Gastrointestinal/abdominal physical signs

2.2.1 Oral lesions

Congenital deformities

Neoplasia

Oropharyngeal tumours
Extramedullary plasmacytoma
Fibroma/fibrosarcoma
Fibropapilloma
Granular cell tumour
Haemangiosarcoma
Histiocytoma
Lymphoma
Mast cell tumour
Melanoma*
Mixed mesenchymal sarcoma
Papilloma (D)
Rhabdomyosarcoma
Squamous cell carcinoma
Transmissible venereal tumour (D)

Odontogenic tumours
Acanthomatous epulides
Ameloblastic adenomatoid
Ameloblastoma
Calcifying epithelial odontogenic tumour
Cementoma
Dentinoma
Fibromatous epulides
Fibromyxoma
Hamartoma
Inductive fibroameloblastoma (C)

Keratinising ameloblastoma (C)
Odontogenic fibroma
Odontoma
Ossifying epulides

Inflammatory masses, e.g.

Feline eosinophilic granuloma complex*

Oral ulceration

Immune-mediated/inflammatory, e.g.
- Eosinophilic granuloma complex*
- Lymphoplasmacytic*

Infectious, e.g.
- Feline calicivirus

Ingestion of irritant substances*
Metabolic, e.g.
- Uraemia* *q.v.*

Traumatic*

Periodontitis/gingivitis

Bacterial infection*
Diabetes mellitus*
Diet (non-abrasive)*
Immune deficiency, e.g.
- Feline immunodeficiency virus* (C)
- Feline leukaemia virus* (C)

Immune-mediated disease, e.g.
- Lymphoplasmacytic*

Periodontal foreign material*, e.g.
- Grass
- Hair

Tooth abnormalities*, e.g.
- Crowding
- Malocclusion
- Rough surfaces

Salivary gland enlargement

Infarction
Infection
Neoplasia
- Acinic cell tumour
- Adenocarcinoma
- Monomorphic adenoma
- Mucoepidermoid tumour
- Pleomorphic adenoma
- Undifferentiated carcinoma

Sialadenitis
Sialadenosis
Sialocoele

Stomatitis

Immune-mediated/inflammatory, e.g.
- Eosinophilic stomatitis
- Lymphoplasmacytic stomatitis*

Infection, e.g.
- *Bartonella henselae*
- Feline calicivirus* (C)
- Feline herpes virus* (C)

Ingestion of irritant substances
Metabolic, e.g. uraemia*
Traumatic*

Tooth disease

Caries
Feline odontoclastic resorptive lesions* (C)
Trauma*

References

Dhaliwal, R. S., et al. (1998) Oral tumours in dogs and cats. Part I. Diagnosis and clinical signs. *Comp Cont Ed*, **20**:1011–20.
Schorr-Evans, E. M., et al. (2003) An epizootic of highly virulent feline calicivirus disease in a hospital setting in New England. *J Feline Med Surg*, **5**:217–26.
Sozmen, M., et al. (2000) Idiopathic salivary gland enlargement (sialadenosis) in dogs: a microscopic study. *JSAP*, **41**:243–47.

2.2.2 Abdominal distension

Abdominal neoplasia*
Ascites* *q.v.*
Bladder distension* *q.v.*
Gastric dilatation*
Gastric distension*
Obstipation* *q.v.*
Organomegaly*
- Enlarged kidney *q.v.*
- Enlarged uterus *q.v.*
- Hepatomegaly *q.v.*
- Splenomegaly *q.v.*

Pneumoperitoneum
Weakness of abdominal musculature
- Hyperadrenocorticism
- Ruptured prepubic tendon

2.2.3 Abdominal pain

Gastrointestinal disease

Colitis*
Constipation* *q.v.*

Enteritis*
Gastric dilatation/volvulus* (D)
Gastric foreign body*
Gastric ulceration*
Gastritis*
Intestinal volvulus
Neoplasia*
Small intestinal foreign body*

Hepatobiliary disease

Cholangitis
Cholecystitis*
Cholelithiasis
Gall bladder obstruction
Hepatitis*
Liver lobe torsion
Portal hypertension

Mechanical factors

Dilatation of a hollow viscus
Bladder distension* *q.v.*
Gastric dilatation/volvulus* (D)
Intestinal dilatation, e.g.
- Foreign body
- Volvulus

Obstruction of outflow
Obstruction of bile outflow
Urinary tract obstruction

Mesenteric tension/traction/torsion

Abscess
Bowel incarceration in hernia or mesenteric tear
Cryptorchid testicular torsion
Foreign body*
Haematoma
Intestinal volvulus
Gastric dilatation/volvulus* (D)
Intussusception*
Neoplasia
Splenic torsion
Stenosis/stricture
Uterine torsion

Musculoskeletal pain

Abdominal muscle rupture
Referred spinal pain*

Organ rupture

Bile duct
Gall bladder

Intestine
Spleen
Stomach
Urinary tract
Uterus, e.g.
- Pyometra

Pancreas
Pancreatic abscess
Pancreatitis*

Peritoneal cavity
Ascites *q.v.*

Haemoabdomen
Coagulopathy *q.v.*
Neoplasia*
Trauma*

Peritonitis
Blunt trauma*
Feline infectious peritonitis* (C)
Iatrogenic, e.g.
- Post-surgical*

Pancreatitis*
Penetrating trauma
Prostatitis*
Rupture or penetration of gastrointestinal tract
Ruptured pyometra

Uroabdomen
Rupture of urinary tract

Reproductive system
Labour/dystocia*
Metritis*
Prostatic disease
Pyometra*

Miscellaneous
Sterile nodular panniculitis and pansteatitis in Weimaraners

Trauma
Fractures*
Ruptured viscus

Urinary system
Cystitis*
Lower urinary tract obstruction*
Nephritis

Pyelonephritis
Ureteral obstruction

Drugs/toxins

Allopurinol
Blue-green algae
Borax
Daffodil
Diclofenac sodium
Dieffenbachia
Horse chestnut
Ibuprofen
Indomethacin
Itraconazole
Loperamide
Metaldehyde
Misoprostol
Naproxen
NPK fertilisers
Paracetamol
Paraquat
Petroleum distillates
Phenoxy acid herbicides
Poinsettia
Rhododendron
Theobromine
Zinc sulphate

References

Burrows, C. F. (2002) The acute abdomen. *Proceedings, WSAVA Congress*, *2002*.
Downs, M. O., et al. (1998) Liver lobe torsion and liver abscess in a dog. *JAVMA*, **212**:678–80.
German, A. J., et al. (2003) Sterile nodular panniculitis and pansteatitis in three weimaraners. *JSAP*, **44**:449–55.
Kirpensteijn, J., et al. (1993) Cholelithiasis in dogs: 29 cases (1980–1990). *JAVMA*, **202**:1137–42.
Richeter, K. (2002) Diagnostic approach to abdominal pain. *Proceedings, Western Veterinary Conference*, *2002*.

2.2.4 Perianal swelling

Anal/rectal prolapse*

Faecal tenesmus*

Anal sac disease

Anal sac abscess*
Anal sac adenocarcinoma
Anal sac impaction*
Anal sacculitis*

Neoplasia
Perianal adenoma*
Other perianal neoplasia

Perineal hernia*
Idiopathic
Secondary to causes of tenesmus *q.v.*

2.2.5 Jaundice

PRE-HEPATIC
Haemolytic anaemia *q.v.*
Increased haem liberation
- Congenital porphyria
- Ineffective erythropoiesis
- Internal haemorrhage
- Severe myolysis

HEPATIC

Intrahepatic cholestasis

Hepatic necrosis, e.g.
Infections
Toxins

Infection
Bacterial*
Fungal
Viral
- Adenovirus* (D)
- Feline immunodeficiency virus* (C)
- Feline infectious peritonitis* (C)
- Feline leukaemia virus* (C)

Inflammation
Cholangitis/cholangiohepatitis*

Miscellaneous
Amyloidosis
Cirrhosis
Hepatic erythrohaemophagic syndrome
Hepatic lipidosis
Polycystic kidney disease (C)

Neoplasia, e.g.
Lymphoma*
Mast cell tumour
Myeloproliferative disease

Drugs/toxins

Barbiturates
Blue-green algae
Carbimazole
Diazepam
Glipizide
Glucocorticoids
Glyphosphate
Griseofulvin
Ketoconazole
Methimazole
Methyltestosterone
Metronidazole
Mexiletine
NSAIDS, e.g.
- Carprofen
- Ibuprofen
- Paracetamol
- Phenylbutazone

Phenobarbitone
Plastic explosives
Primidone
Salicylates
Sulphasalazine
Tetracycline

POST-HEPATIC

Bile duct occlusion

Extraluminal
Choledochal cysts (C)
Duodenal disease
Pancreatic neoplasia
Pancreatitis*
Polycystic disease (C)
Secondary to peribiliary disease
Stricture at *porta hepatis*

Intramural
Cholangitis
Cholecystitis*
Choledochitis
Gall bladder/duct neoplasia

Intraluminal
Choledochal cysts (C)
Cholelithiasis
Gall bladder mucocoele
Haemobilia
Inspissated bile
Polycystic kidney disease (C)

References

Center, S. (2002) Icteric dogs and cats. *Proceedings, Western Veterinary Conference, 2002*.

Macphail, C. M., et al. (1998) Hepatocellular toxicosis associated with administration of carprofen in 21 dogs. *JAVMA*, **212**:1895–1901.

Marchevsky, A. M., et al. (2000) Pancreatic pseudocyst causing extrahepatic biliary obstruction in a dog. *Aust Vet J*, **78**:99–101.

Mayhew, D., et al. (2002) Pathogenesis and outcome of extrahepatic biliary obstruction in cats. *JSAP*, **43**:247–53.

Worley, D. R., et al. (2004) Surgical management of gallbladder mucocoeles in dogs: 22 cases (1999–2003). *JAVMA*, **225**: 1418–23.

2.2.6 Abnormal liver palpation

Generalised enlargement

Endocrine disease

Diabetes mellitus*
Hyperadrenocorticism

Inflammation/infection, e.g.

Abscess*
Cholangiohepatitis*
Feline infectious peritonitis* (C)
Fungal infection
Granuloma
Hepatitis*
Lymphocytic cholangitis

Miscellaneous

Amyloidosis
Cholestasis (see Jaundice *q.v.*)
Cirrhosis (early)
Hepatic lipidosis
Nodular hyperplasia*
Storage diseases

Neoplasia, e.g.*

Lymphoma
Malignant histiocytosis

Venous congestion

Caudal vena cava occlusion (post caval syndrome)

- Adhesions
- Cardiac neoplasia
- Congenital cardiac disease
- Diaphragmatic rupture/hernia*
- Dirofilariasis

- Pericardial disease
- Thoracic mass*
- Thrombosis
- Trauma

Right sided congestive heart failure, e.g.

- Dilated cardiomyopathy*
- Pericardial effusion

Drugs

Glucocorticoids

Focal enlargement

Abscess*
Biliary pseudocyst
Cyst
Granuloma
Haematoma*
Hepatic arteriovenous fistula
Hyperplastic/regenerative nodule*
Liver lobe torsion

Neoplasia

Adenocarcinoma*
Biliary cystadenoma
Haemangiosarcoma*
Hepatocellular carcinoma*
Hepatoma
Lymphoma*
Malignant histiocytosis
Metastatic*

Reduced liver size

Cirrhosis*
Diaphragmatic rupture/hernia*
Hypoadrenocorticism (D)
Idiopathic hepatic fibrosis
Portosystemic shunt

- Acquired
- Congenital

References

Chastain, C. B., et al. (2001) Concurrent disorders in dogs with diabetes mellitus: 221 cases (1993–1998). *Sm Anim Clin Endocrinol*, **11**:14.

Huang, H., et al. (1999) Iatrogenic hyperadrenocorticism in 28 dogs. *JAAHA*, **35**:200–207.

2.3 Cardiorespiratory physical signs

2.3.1 Dyspnoea/tachypnoea

Physiological causes

Exercise
Fear
High ambient temperature
Pain

Upper airway disorders

Cervical tracheal disease
Extraluminal compression
Foreign body
Hypoplasia/stenosis
Neoplasia
- Extraluminal
- Intraluminal
  - Adenocarcinoma
  - Chondroma
  - Chondrosarcoma
  - Leiomyoma
  - Lymphoma
  - Osteochondroma
  - Osteosarcoma
  - Plasmacytoma
  - Polyps
  - Rhabdomyosarcoma
  - Squamous cell carcinoma

Tracheal collapse*
Trauma

Pharyngeal disease
Elongated or oedematous soft palate* (D)
Enlarged tonsils*

Laryngeal disease
Everted saccules* (D)
Laryngeal paralysis* (D)
Neoplasia
Oedema*

Nasal disease, e.g.
Aspergillosis
Foreign body*
Inflammatory disease*
Nasopharyngeal polyp

Neoplasia
Stenotic nares

Lower airway disorders

Thoracic tracheal disease, e.g.
Extraluminal compression
Foreign body
Hypoplasia/stenosis
Neoplasia (extra- or intraluminal)
Tracheal collapse*
Trauma

Bronchial disease
Bronchiectasis
Broncho-oesophageal fistula
Chronic bronchitis* (D)
Cystic-bullous lung disease, e.g. secondary to emphysema
Eosinophilic bronchitis*
Extraluminal compression
- Enlarged left atrium
- Hilar lymphadenopathy, e.g.
  - Fungal disease
  - Granulomatous disease
  - Neoplasia
- Neoplasia

Feline asthma* (C)
Foreign body
Lungworm
Neoplasia
Primary ciliary dyskinesia

Pulmonary parenchymal disease
Foreign body
- Abscess
- Chronic pulmonary fibrosis
- Eosinophilic bronchopneumonopathy
- Eosinophilic pneumonitis
- Eosinophilic pulmonary granulomatosis
- Hilar lymph node enlargement
- Inhalation pneumonia

Idiopathic pulmonary fibrosis
Inflammatory disease
Irritating gases
Near drowning
Neoplasia*
Paraquat toxicity
Pneumonia/infectious disease*
- Bacterial, e.g.
  - *Bordetella bronchiseptica*
  - *Chlamydophila psittaci*

    - *E. coli*
    - *Klebsiella pneumoniae*
    - *Mycobacterium* spp
    - *Mycoplasma pneumoniae*
    - Pasteurellosis
  - Endogenous lipid pneumonia
  - Fungal, e.g.
    - Aspergillosis
    - Blastomycosis
    - Coccidioidomycosis
    - Cryptococcosis
    - Histoplasmosis
    - *Pneumocystis*
  - Parasitic, e.g.
    - *Aelurostrongylus abstrusus*
    - *Angiostrongylus vasorum*
    - *Capillaria aerophila*
    - *Crenosoma vulpis*
    - *Oslerus* spp
    - *Paragonimus kellicotti*
    - Visceral larva migrans
  - Protozoal, e.g.
    - Toxoplasmosis
  - Rickettsial
  - Viral, e.g.
    - Canine distemper virus* (D)
    - Feline calicivirus* (C)
    - Feline immunodeficiency virus* (C)
    - Feline leukaemia virus* (C)

Pulmonary oedema *q.v.*

Pulmonary thromboembolism, e.g.
- Cardiac disease
- Heartworm disease
- Hyperadrenocorticism

Smoke inhalation

Trauma, e.g.
- Pulmonary contusions
- Pulmonary haemorrhage

Restrictive disorders

Diaphragmatic hernia, e.g.
- Peritoneopericardial diaphragmatic hernia
- Traumatic*

Large intra-abdominal mass

Neoplasia
- Mediastinal
- Thoracic wall

Pickwickian syndrome (extreme obesity)

Pleural effusion* *q.v.*

Pneumothorax* *q.v.*

Fig. 2.3(a) Dorsoventral radiograph showing an adenocarcinoma of the lung. Reproduced with permission of Downs Referrals, Bristol.

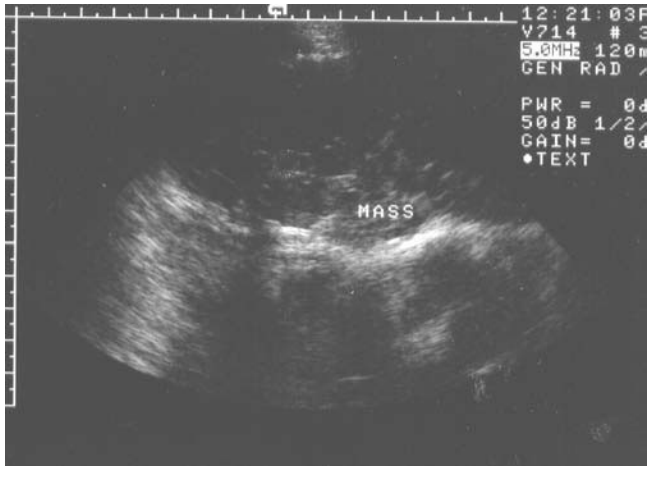

Fig. 2.3(b) Ultrasonogram of a disseminated thoracic thymoma. Reproduced with permission of Downs Referrals, Bristol.

Severe ascites *q.v.*
Severe gastric distension
Severe hepatomegaly *q.v.*
Thoracic wall abnormalities, e.g.

- Neoplasia
- Pectus excavatum
- Trauma*

Systemic and miscellaneous disorders

Anaemia* *q.v.*

Central neurological disease causing damage to respiratory centres, e.g.

- Head trauma
- Hyperthermia* *q.v.*
- Hyperthyroidism* (C)
- Hypoxia*
- Metabolic acidosis *q.v.*
- Neuromuscular weakness, e.g. polyradiculoneuritis
- Shock/hypovolaemia* *q.v.*

Acute respiratory distress syndrome

Aspiration of acidic substances
Drug reaction
Inhalation injury
Lung lobe torsion
Multiple transfusions
Pancreatitis
Sepsis
Shock
Surgery
Trauma

Drugs/toxins

Benzalkonium chloride
Blue-green algae
Dichlorophen
Ibuprofen
Metaldehyde
Naproxen
Paracetamol (methaemoglobinaemia)
Paraquat
Salbutamol
Strychnine
Terfenadine

References

Chapman, P. S., et al. (2004) *Angiostrongylus vasorum* infection in 23 dogs (1999–2002). *JSAP*, **45**:435–40.

Johnson, L. R., et al. (2003) Clinical, clinicopathologic and radiographic findings in dogs with coccidioidomycosis: 24 cases (1995–2000). *JAVMA*, **222**:461–6.

Meiser, H. & Hagedorn, H. W. (2002) Atypical time course of clinical signs in a dog poisoned by strychnine. *Vet Rec*, **151**:21–4.

Parent, C. (1996) Clinical and clinicopathologic findings in dogs with acute respiratory distress syndrome: 19 cases (1985–1993). *JAVMA*, **208**:1419–27.

Schermerhorn, T., et al. (2004) Pulmonary thromboembolism in cats. *JVIM*, **18**:533–5.
Sherding, R. (2001) Diagnosis and management of bacterial pneumonia. *Proceedings, World Small Animal Veterinary Association World Congress, 2001*.

2.3.2 Pallor

Anaemia *q.v.*

Decreased peripheral perfusion
Shock *q.v.*

Drugs/toxins
Adder bites
Baclofen
Diclofenac sodium
Ibuprofen
Ivermectin
Metaldehyde
Naproxen
Paracetamol
Vitamin D rodenticides

2.3.3 Shock

Cardiogenic

Decreased systolic function
Dilated cardiomyopathy*
Myocardial infarction
Myocarditis
Drugs/toxins, e.g.
- Doxorubicin

Decreased ventricular filling
Hypertrophic cardiomyopathy* (C)
Pericardial effusion/tamponade*
Restrictive cardiomyopathy* (C)
Restrictive pericarditis

Obstruction
Heartworm disease
Intracardiac masses
Thrombosis

Severe arrhythmia q.v.

Valve disease
Severe myxomatous degeneration of mitral valve* (D)

Distributive
Anaphylactic
Septic

Hypoxaemic
Anaemia* *q.v.*
Respiratory disease* *q.v.*
Toxins
- Carbon monoxide
- Paracetamol

Metabolic
Heat stroke*
Hypoglycaemia
Sepsis*
Toxins, e.g.
- Cyanide

Hypovolaemic
Haemorrhage* *q.v*
Hypoadrenocorticism (D)

Dehydration, e.g.
Diabetes mellitus*
Diarrhoea* *q.v.*
Prolonged use of diuretics
Renal failure* *q.v.*
Vomiting* *q.v.*

Hypoproteinaemia/plasma loss, e.g.
Abdominal surgery
Ascites *q.v.*
Burns
Peripheral oedema *q.v.*
Pleural effusion

Neurogenic
Acute central nervous system disease
Electric shock
Heat stroke

References
Miller, C. W., et al. (1996) Streptococcal toxic shock syndrome in dogs. *JAVMA*, **209**:1421–6.
Shafran, N. (2004) Shock overview: Cardiogenic and non-cardiogenic shock syndromes. *Proceedings, International Veterinary Emergency and Critical Care Symposium, 2004.*

2.3.4 Cyanosis

PERIPHERAL

Vasoconstriction

Hypothermia* *q.v.*
Reduced cardiac output*
Shock* *q.v.*

Venous obstruction, e.g.

Right-sided heart failure*
Thrombophlebitis
Tourniquet

Arterial obstruction, e.g.

Aortic thromboembolism* (C)

CENTRAL

Hypoxaemia

*Respiratory disease**
Hypoventilation
- Pleural effusion* *q.v.*
- Pneumothorax* *q.v.*
- Respiratory muscle failure
- Toxicity

Obstruction
- Brachycephalic obstructive airway syndrome
- Foreign body
  - Laryngeal
  - Tracheal
- Large airway mass, e.g.
  - Abscess
  - Neoplasia
  - Parasite
- Laryngeal paralysis*

Ventilation–perfusion mismatch
- Acute respiratory distress syndrome
- Chronic obstructive pulmonary disease*
- Pneumonia
- Pulmonary inflammatory conditions
- Pulmonary neoplasia*
- Pulmonary oedema* *q.v.*
- Pulmonary thromboembolism

Reduced inspired oxygen
Altitude
Anaesthetic

Cardiovascular disease (anatomic shunts), e.g.
Pulmonary arteriovenous fistula
Reverse-shunting patent ductus arteriosus
Reverse-shunting ventricular septal defect
Tetralogy of Fallot

Haemoglobin abnormalities

Drugs/toxins
Baclofen
Blue-green algae
Loperamide
Metaldehyde
Paracetamol (methaemoglobinaemia)
Paraquat
Theobromine

References

Fine, D. M., et al. (1999) Cyanosis and congenital methemoglobinemia in a puppy. *JAAHA*, **35**:33–5.
O'Sullivan, S. P. (1989) Paraquat poisoning in the dog. *JSAP*, **30**:361–4.

2.3.5 Ascites (see 3.7.10 for full listing)

Bile
Blood
Chyle
Exudate
Transudate/modified transudate
Urine

2.3.6 Peripheral oedema

Generalised

Hypoalbuminaemia* *q.v.*
Increased central venous pressure
- Central venous occlusion
  - Neoplasia
  - Thrombosis
- Congestive heart failure*

Regional

Bilateral forelimb oedema/head and neck oedema
Compression of cranial vena cava, e.g.
- Mediastinal mass

Thrombosis of cranial vena cava

Bilateral hind limb oedema
Budd-Chiari-like syndrome
Obstruction of sublumbar lymph nodes, e.g.
- Neoplasia

Increased central venous pressure
Central venous occlusion, e.g.
- Mediastinal mass
- Thrombosis

Central lymph obstruction

Localised
Arteriovenous fistula
Cellulitis*
Inflammation*
Lymphoedema
Neurogenic or hormonal vasoactive stimuli
Proximal venous obstruction
Vascular trauma
Vasculitis
Drugs/toxins
- Alphaxalone/alphadolone
- Paracetamol
- Salbutamol

References
Jaffe, M. H., et al. (1999) Extensive venous thrombosis and hind-limb edema associated with adrenocortical carcinoma in a dog. *JAAHA*, **35**:306–10.
Kern, M. R. & Black, S. S. (1999) Dyspnea and pitting edema associated with T-cell lymphosarcoma. *Canine Pract*, **24**:6–10.
Miller, M. W. (1989) Budd-Chiari-like syndrome in two dogs. *JAAHA*, **25**:277–83.
Nicastro, A. & Cote, E. (2002) Cranial vena cava syndrome. *Compend Contin Educ Pract Vet*, **24**:701–10.

2.3.7 Abnormal respiratory sounds

Stridor
Upper airway obstruction
Brachycephalic obstructive airway syndrome
Laryngeal obstruction, e.g.
- Foreign body
- Laryngospasm
- Neoplasia
- Oedema
- Paralysis*

Tracheal obstruction, e.g.
- Collapse*
- Extraluminal compression

- Exudate
- Foreign body
- Haemorrhage
- Neoplasia
- Stenosis

Stertor

Nasopharyngeal obstruction, e.g.
Brachycephalic obstructive airway syndrome
Foreign body*
Neoplasia

Crackles

Exudate in airways*
Haemorrhage in airways
Pulmonary fibrosis
Pulmonary oedema* *q.v.*

Wheezes

Airway narrowing, e.g.
Bronchoconstriction*
Extraluminal compression
Exudate in airways*
Masses in airways

Reference

Allen, H. S., et al. (1999) Nasopharyngeal diseases in cats: a retrospective study of 53 cases (1991–1998). *JAAHA*, 35:457–61.

2.3.8 Abnormal heart sounds

TRANSIENT HEART SOUNDS (HEART SOUNDS OF SHORT DURATION)

Loud S1

Anaemia* *q.v.*
Intensity varies with arrhythmias, e.g.
- Atrial fibrillation
- Heart block
- Sinus arrhythmia*
- Ventricular premature depolarisations*

High sympathetic tone*
Mitral insufficiency*
Systemic hypertension* *q.v.*
Tachycardia* *q.v.*
Thin animals*
Young animals*

Quiet S1

Decreased myocardial contractility, e.g.
- Dilated cardiomyopathy*

Diaphragmatic hernia*
Emphysema
First degree heart block*
Obesity*
Pericardial effusion *q.v.*
Pleural effusion* *q.v.*
Shock* *q.v.*

Split S1

Bundle branch block
Cardiac pacing
Ectopic beats*
Physiological in healthy large-breed dogs*

Note: A split S1 should be differentiated from presystolic gallop, ejection sounds and diastolic clicks.

Loud S2

Anaemia* *q.v.*
Fever* *q.v.*
Hyperthyroidism* (C)
Intensity varies with arrhythmias, e.g.
- Atrial fibrillation
- Heart block
- Sinus arrhythmia*
- Ventricular premature depolarisations*

Tachycardia* *q.v.*
Thin animals*
Young animals*

Quiet S2

Decreased myocardial contractility, e.g.
- Dilated cardiomyopathy*

Diaphragmatic hernia*
Emphysema
Obesity*
Pericardial effusion *q.v.*
Pleural effusion* *q.v.*
Thoracic masses*
Shock* *q.v.*

Split S2

Physiological in healthy large-breed dogs*

Aortic valve closure follows pulmonic valve closure (A2 follows P2)

Aortic stenosis
Left bundle branch block

Systemic hypertension
Ventricular ectopic beats*

Pulmonic valve closure follows aortic valve closure (P2 follows A2)
Left to right intracardiac shunt (atrial septal defect)
Pulmonary hypertension, e.g.
- Heartworm disease

Pulmonic stenosis
Right bundle branch block
Ventricular ectopic beats*

Gallop rhythms

Accentuated S3 (protodiastolic)
Occasionally noted in healthy animals on phonocardiography
Anaemia* *q.v.*
Hyperthyroidism* (C)
Mitral regurgitation*
Myocardial dysfunction*
Patent ductus arteriosus
Septal defects

Accentuated S4 (presystolic)
Inaudible in healthy animals, but may be noted on phonocardiography
Hyperthyroidism* (C)
Hypertrophic cardiomyopathy* (C)
Marked left ventricular hypertrophy
Profound heart failure following rupture of *chordae tendinae*

Early diastolic sounds

Opening snaps (rare)
- Mitral valve stenosis

Pericardial knocks
- Constrictive pericarditis

Plops
- Mobile atrial tumours

Ejection sounds (high frequency sounds in early diastole)

Aortic stenosis
Dilatation of the great vessels
Heartworm disease
Hypertension* *q.v.*
Opening of abnormal semilunar valves
Pulmonic stenosis
Tetralogy of Fallot

Systolic clicks (short, mid- to high-frequency sounds in mid to late systole)

Early degenerative valvular disease

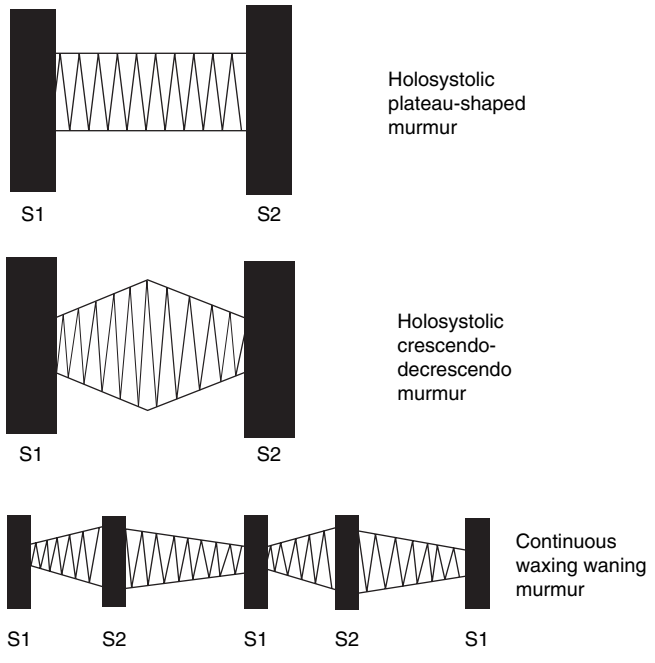

Fig. 2.3(c) Diagrammatic representation of heart murmur shapes.

MURMURS (HEART SOUNDS OF LONGER DURATION ARISING FROM TURBULENT BLOOD FLOW)

Innocent murmurs*

Physiological murmurs

Anaemia* *q.v.*
Fever* *q.v.*
Hypertension* *q.v.*
Hyperthyroidism* (C)
Pregnancy*

Murmurs associated with cardiovascular disease

Systolic

Holosystolic plateau-shaped
- Mitral regurgitation*
- Tricuspid regurgitation*
- Ventricular septal defect

Holosystolic crescendo–decrescendo
- Aortic stenosis
- Pulmonic stenosis
- Ventricular septal defect

Diastolic

Aortic insufficiency (congenital or associated with bacterial endocarditis)
Mitral stenosis

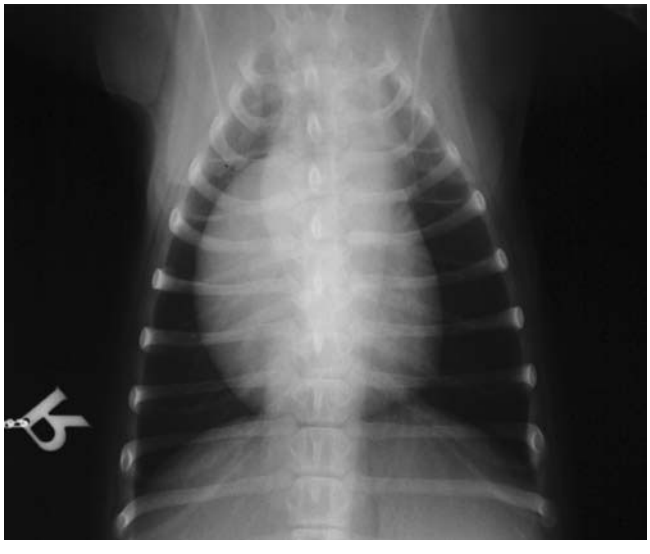

Fig. 2.3(d) Dorsoventral thoracic radiograph of a West Highland White terrier with pulmonic stenosis. Right-sided heart enlargement is evident. Reproduced with permission of Downs Referrals, Bristol.

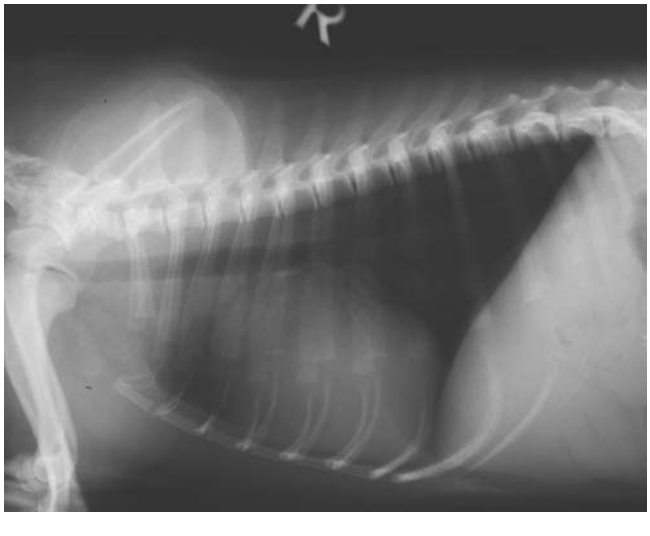

Fig. 2.3(e) Lateral thoracic radiograph of the same dog as in Figure 2.3(d). Note the lung fields appear underperfused. Reproduced with permission of Downs Referrals, Bristol.

Continuous

Coronary arteriovenous fistula
Coronary artery or ruptured sinus aneurysm communicating directly with right atrium
Patent ductus arteriosus
Pulmonary arteriovenous fistula

References

Cote, E. (2004) Assessment of the prevalence of heart murmurs in overtly healthy cats. *JAVMA,* **225**:384–8.

Haggstrom, J., et al. (1995) Heart sounds and murmurs: changes related to severity of chronic valvular disease in the Cavalier King Charles spaniel. *JVIM,* **9**:75–85.

Kvart, C., et al. (1998) Analysis of murmur intensity, duration and frequency components in dogs with aortic stenosis. *JSAP,* **39**:318–24.

2.3.9 Abnormalities in heart rate

BRADYCARDIA

Normal in athletic dogs, during rest/sleep
Cardiac disease/arrhythmias *q.v.*
CNS disease
Hypothermia
Severe systemic disease

Increased vagal tone*, e.g.

Gastrointestinal disease* *q.v.*
Respiratory disease* *q.v.*

Metabolic disease

Hyperkalaemia *q.v.*
Hypoglycaemia *q.v.*
Hypothyroidism*
Uraemia*

Drugs/toxins

Adder bites
Amiodarone
Anti-dysrhythmics, e.g. beta blockers
Atenolol
Baclofen
Bethanechol
Cannabis
Carbamate
Clonidine
Daffodil
Diltiazem
Fentanyl
Glyphosphate
Hypertonic saline
Ivermectin
Lignocaine
Loperamide
Medetomidine
Mexiletine
Organophosphates
Paraquat
Phenoxy acid herbicides
Propranolol
Pyridostigmine

Rhododendron
Sotalol
Theobromine
Timolol maleate
Verapamil
Vitamin D rodenticides
Xylazine
Yew

TACHYCARDIA

Sinus tachycardia

Physiological
Excitement*
Exercise*
Fear*
Pain*

Pathological
Heart failure*
Respiratory disease*
Shock*
Systemic disease
- Anaemia* *q.v.*
- Fever* *q.v.*
- Hyperthyroidism (C)*
- Hypoxia*
- Sepsis*

Other supraventricular tachycardias* *q.v.*

Ventricular tachycardias* *q.v.*

Drugs/toxins

Adder bites
Adrenaline
Atropine
Baclofen
Blue-green algae
Cannabis
Dinoprost tromethamine
Dobutamine
Dopamine
Doxapram
Doxorubicin
Ethylene glycol
Glyceryl trinitrate
Glycopyrronium bromide
Glyphosphate

Hydralazine
Ibuprofen
Isosorbide dinitrate
Ketamine
Levothyroxine
Metaldehyde
Paracetamol
Paraquat
Petroleum distillates
Phenoxy acid herbicides
Phenoxybenzamine
Propantheline bromide
Pyrethrins/pyrethroids
Salbutamol
Selective serotonin reuptake inhibitors
Terbutaline
Terfenadine
Theobromine
Theophylline
Tricyclic antidepressants
Verapamil
Vitamin D rodenticides

References

Little, C. J. (2005) Hypoglycaemic bradycardia and circulatory collapse in a dog and a cat. *JSAP,* **46**: 445–8.
Moise, N. S., et al. (1997) Diagnosis of inherited ventricular tachycardia in German shepherd dogs. *JAVMA,* **210**:403–10.
Peterson, M. E., et al. (1989) Primary hypoadrenocorticism in ten cats. *JVIM,* **3**:55–8.

2.3.10 Jugular distension/positive hepatojugular reflux

Cardiac disease resulting in right-sided heart failure*
Fluid volume overload, e.g.
- Iatrogenic*

Pericardial disease

2.3.11 Jugular pulse components

Cannon a waves

Atrioventricular dissociation, e.g.
Third-degree heart block

Exaggerated a waves

Decreased right ventricular compliance, e.g.
Constrictive pericarditis
Restrictive right ventricular disease
Right ventricular hypertrophy

Prominent v waves
Tricuspid regurgitation

2.3.12 Alterations in arterial pulse

Hypokinetic (weak) pulse
Aortic stenosis
Increased peripheral resistance
Regional loss of pulse (see below)
Small stroke volume, e.g.
- Hypovolaemia* *q.v.*
- Left-sided heart failure*

Tachycardia *q.v.*
Toxins
- Alphachloralose
- Anticoagulant rodenticides

Hyperkinetic (bounding) pulse
Anaemia* *q.v.*
Arteriovenous fistula
Bradycardia* *q.v.*
Decreased diastolic blood pressure
- Aortic insufficiency
- Shunting lesions, e.g.
  - Increased stroke volume
  - Increased systolic blood pressure
  - Patent ductus arteriosus

Fever* *q.v.*
Hyperthyroidism* (C)

Pulsus paradoxus
Exaggerated in pericardial tamponade
Physiological

Pulsus alternans
Myocardial failure
Tachyarrhythmias *q.v.*

Pulsus bigeminus
Ventricular bigeminy

Pulse deficits
Tachyarrhythmias *q.v.*

Regional loss of pulse
Infectious embolus
Neoplastic embolus
Thromboembolism*

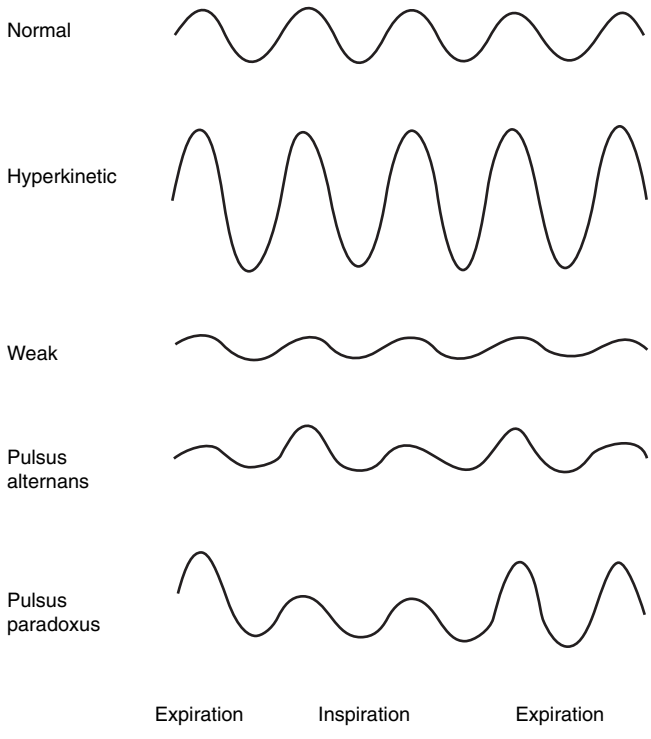

Fig. 2.3(f) Arterial pulse patterns. Modified from Fox, P. R., Sisson, D. & Moise, N. S. (1999) *Textbook of Canine and Feline Cardiology: Principles and Clinical Practice,* 2nd edn. W.B. Saunders, Philadelphia.

Reference

Hogan, D. F. (2002) Diagnosis of congenital heart disease. *Proceedings, ACVIM*, 2002.

2.4 Dermatological signs

2.4.1 Scaling

Primary/inherited disorders of keratinisation

Acne*
Canine primary idiopathic seborrhoea (D)
Ear margin dermatosis
Epidermal dysplasia (Armadillo Westie syndrome) (D)
Feline idiopathic facial dermatitis (C)
Feline primary idiopathic seborrhoea (C)
Follicular dysplasia
Follicular hyperkeratosis
Follicular parakeratosis
Footpad hyperkeratosis

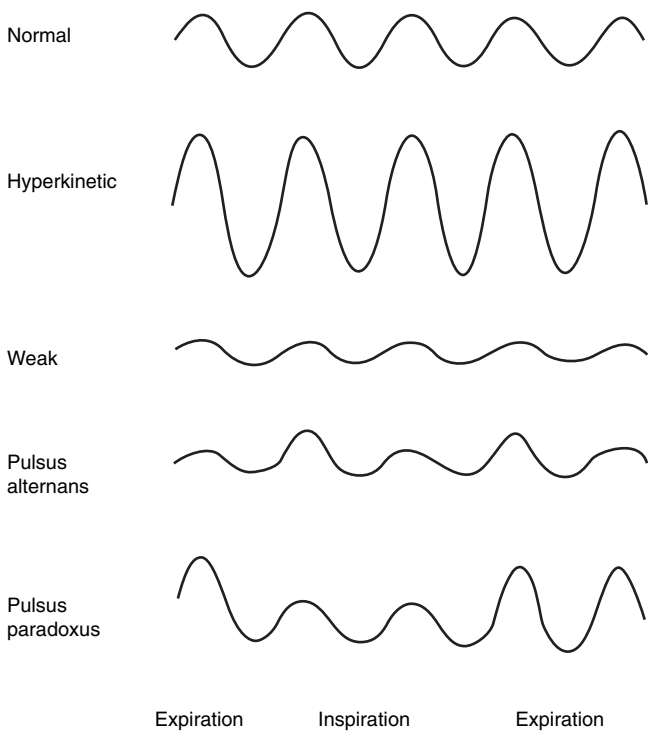

Fig. 2.3(f) Arterial pulse patterns. Modified from Fox, P. R., Sisson, D. & Moise, N. S. (1999) *Textbook of Canine and Feline Cardiology: Principles and Clinical Practice,* 2nd edn. W.B. Saunders, Philadelphia.

Reference

Hogan, D. F. (2002) Diagnosis of congenital heart disease. *Proceedings, ACVIM*, 2002.

2.4 Dermatological signs

2.4.1 Scaling

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Acne*
Canine primary idiopathic seborrhoea (D)
Ear margin dermatosis
Epidermal dysplasia (Armadillo Westie syndrome) (D)
Feline idiopathic facial dermatitis (C)
Feline primary idiopathic seborrhoea (C)
Follicular dysplasia
Follicular hyperkeratosis
Follicular parakeratosis
Footpad hyperkeratosis

Ichthyosis
Lethal acrodermatitis
Lichenoid psoriasiform dermatosis
Nasal hyperkeratosis*
Nasodigital hyperkeratosis
Schnauzer comedo syndrome (D)
Sebaceous adenitis
Tail gland hyperplasia*
Vitamin A responsive dermatosis
Zinc responsive dermatosis

Exfoliative dermatoses

Contact dermatitis*
Drug eruption
Epitheliotrophic lymphoma
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Parapsoriasis
Pemphigus foliaceus
Systemic lupus erythematosus
Thymoma
Toxic epidermal necrolysis

Secondary scaling

Allergic/immune-mediated

Atopy*
Contact hypersensitivity
Drug hypersensitivity
Food hypersensitivity*
Hormonal hypersensitivity
Pemphigus foliaceus

Environmental

Low humidity
Physical/chemical damage

Infectious/parasitic

Bacterial pyoderma
Cheyletiellosis*
Cowpox virus (C)
Demodecosis*
Dermatophytosis*
Endoparasites*
Fleas*
Leishmaniasis
Malassezia spp*
Pediculosis*
Pyoderma*
Scabies* (D)

Metabolic/endocrine
Diabetic dermatopathy
Growth hormone-responsive dermatosis
Hepatic disease
Hyperadrenocorticism
Hyperandrogenism
Hyperthyroidism* (C)
Hypopituitarism
Hypothyroidism* (D)
Idiopathic male feminising syndrome
Intestinal disease
Necrolytic migratory erythema
Oestrogen-responsive dermatosis
Pancreatic disease
Renal disease
Sertoli cell tumour
Sex hormone abnormalities
Superficial necrolytic dermatitis
- Glucagonoma
- Hepatocutaneous syndrome

Testosterone-responsive dermatosis

Neoplastic
Epitheliotrophic lymphoma

Nutritional
Dietary deficiency of essential fatty acids
Malabsorption/malnutrition of essential fatty acids

References

Allenspach, K., et al. (2000) Glucagon-producing neuroendocrine tumour associated with hypoaminoacidaemia and skin lesions. *JSAP,* **41**:402–406.
Binder, H., et al. (2000) Palmoplanter hyperkeratosis in Irish terriers: evidence of autosomal recessive inheritance. *JSAP,* **41**:52–5.
Godfrey, D. R., et al. (2004) Unusual presentations of cowpox infection in cats. *JSAP,* **45**:202–205.
March, P. A., et al. (2004) Superficial necrolytic dermatitis in 11 dogs with a history of phenobarbital administration (1995–2002). *JVIM,* **18**: 65–74.
McEwan, N. A., et al. (2000) Diagnostic features, confirmation and disease progression in 28 cases of lethal acrodermatitis of bull terriers. *JSAP,* **41**:501–507.
Sture, G. (1995) Scaling dermatoses of the dog. *In Practice,* **17**:276–86.

2.4.2 Pustules and papules (including miliary dermatitis)

Primary immune-mediated

Bullous pemphigoid
Pemphigus erythematosus
Pemphigus foliaceus

Pemphigus vegetans
Pemphigus vulgaris
Systemic lupus erythematosus

Immune-mediated diseases causing secondary pyoderma

Atopy*
Contact allergy*
Food hypersensitivity*
Hypereosinophilic syndrome

Infectious/parasitic diseases causing secondary pyoderma

Cheyletiellosis
Demodecosis*
Dermatophilosis
Dermatophytosis*
External parasite bites*, e.g.
- Fleas
- Mosquitoes

Feline immunodeficiency virus*
Feline leukaemia virus*
Lynxacarus radovsky
Malassezia spp*
Notoedres cati
Pediculosis*
Sarcoptic mange*
Superficial pustular dermatitis*
Trombiculiasis*

Miscellaneous

Canine linear IgA pustular dermatosis (D)
Contact irritation*
Drug eruptions
Juvenile cellulitis
Sterile eosinophilic pustular dermatosis
Subcorneal pustular dermatosis

Neoplasia

Epitheliotrophic lymphoma
Mast cell tumour*

Nutritional

Biotin deficiency
Essential fatty acid deficiency

References

Beningo, K. E. & Scott, D. W. (2001) Idiopathic linear pustular acantholytic dermatosis in a young Brittany spaniel dog. *Vet Dermatol,* **12**:209–13.
Preziosi, D. E., et al. (2003)Feline pemphigus foliaceus: a retrospective analysis of 57 cases. *Vet Dermatol,* **14**:313–21.

2.4.3 Nodules

Inflammation

Angiogenic oedema
Calcinosis circumscripta
Calcinosis cutis
Infectious
- Bacterial*
- Fungal
- Parasitic

Granuloma, e.g.
- Eosinophilic*
- Insect bite*

Histiocytosis
Nodular cutaneous amyloidosis
Nodular dermatofibrosis
Sterile nodular granuloma
Urticaria*
Xanthoma

Panniculitis
Idiopathic
- Sterile nodular

Immune-mediated
- Discoid lupus erythematosus
- Systemic lupus erythematosus
- Vasculitis

Infectious
- Bacteria
- Fungi
- Mycobacteria
- Parasites, e.g. insect bites

Pancreatic disease
Physical
- Foreign body
- Post-injection
- Trauma

Vitamin E deficiency

Neoplasia

Epithelial
Apocrine adenoma/carcinoma*
Basal cell tumour*
Ceruminous adenoma/carcinoma*
Keratoacanthoma*
Papilloma*
Perianal gland adenoma/carcinoma*
Pilomatrixoma*

Sebaceous adenoma/carcinoma*
Squamous cell carcinoma*
Sweat gland tumours*
Trichoepithelioma*

Melanocyte
Melanoma

Round cell
Lymphoma
- Epitheliotrophic
- Lymphomatoid granulomatosis
- Non-epitheliotrophic

Histiocytic sarcoma
Histiocytoma*
Mast cell tumour*
Plasmacytoma*
Transmissible venereal tumour

Mesenchymal
Benign fibrous histiocytoma
Dermatofibroma
Fibrolipoma
Fibroma
Fibropapilloma
Fibrosarcoma
Haemangioma/sarcoma
Haemangiopericytoma
Leiomyoma/sarcoma
Lipoma/sarcoma*
Lymphangioma/sarcoma
Myxosarcoma
Schwannoma

Metastatic

Non-neoplastic, non-inflammatory

Benign nodular sebaceous hyperplasia
Cysts*
- Dermoid
- Epidermoid
- Follicular

Fibroadnexal dysplasia
Haematoma*
Naevi/hamartoma
- Collagenous
- Follicular
- Sebaceous
- Vascular

Seroma*
Skin polyp*
Urticaria pigmentosa

References

Malik, R., et al. (2004) Infections of the subcutis and skin of dogs caused by rapidly growing mycobacteria. *JSAP,* **45**:485–94.
Mellanby, R. J., et al. (2003) Panniculitis associated with pancreatitis in a cocker spaniel. *JSAP,* **44**:24–8.

2.4.4 Pigmentation disorders (coat or skin)

HYPOPIGMENTATION

Generalised

Age-related greying*
Albinism
Canine cyclic haematopoiesis (D)
Chediak-Higashi syndrome (C)
Mucocutaneous hypopigmentation
Nutritional deficiencies
- Copper
- Lysine
- Pantothenic acid
- Protein
- Pyridoxine
- Zinc

Oculocutaneous albinism
Piebaldism
Tyrosinase deficiency
Waardenburg syndrome
Drugs

Localised

Trauma
Burns
Chemical
Physical*
Radiation
Surgical*

Immune-mediated
Sutton's halo
Uveodermatological syndrome
Vitiligo

Post-inflammatory
Bullous pemphigoid
Inflammatory dermatitis* *q.v.*
Lupus erythematosus

Infectious
Aspergillosis
Leishmaniasis

Idiopathic
Periocular leukotrichia/Aguirre's syndrome
Seasonal nasal hypopigmentation*

Neoplastic
Basal cell tumour
Epitheliotrophic lymphoma
Gastric carcinoma
Mammary adenocarcinoma*
Melanoma
Squamous cell carcinoma

HYPERPIGMENTATION

Generalised/diffuse

Alopecia X
Demodecosis*
Endocrine disease
- Adrenal sex-hormone dermatosis
- Growth hormone-responsive dermatosis
- Hyperadrenocorticism
- Hyperoestrogenism
- Hypothyroidism* (D)

Iatrogenic
- Prolonged glucocorticoid administration

Malassezia spp*
Recurrent flank alopecia
Ultraviolet irradiation of alopecic regions

Multifocal

Bowen's disease (C)
Demodecosis*
Dermatophytosis*
Lentigines
Melanoderma
Naevus
Post-inflammatory
Pyoderma*
Tumours*
Urticaria pigmentosa

Focal

Acanthosis nigrans
Demodecosis*
Dermatophytosis*
Lentigo
Naevus
Neoplasia*
Post-inflammatory
Pyoderma*
Trauma*
Drugs
- Minocycline
- Mitotane

References

Ackerman, L. (2002) Pattern approach to dermatologic diagnosis. In *Proceedings, Tufts Animal Expo, 2002*.
Nelson, R. W., et al. (1988) Hyperadrenocorticism in cats: Seven cases (1978–1987). *JAVMA*, **193**:245–50.

2.4.5 Alopecia (see Plate 2.4 in colour plate section)

Failure of hair growth

Paraneoplastic alopecia

Endocrine disease
Diabetes mellitus*
Hyperadrenocorticism
Hypothyroidism* (D)

Systemic diseases
Chronic hepatic disease *q.v.*
End-stage renal disease *q.v.*
Feline immunodeficiency virus (C)
Feline leukaemia virus (C)

Follicular diseases
Anagen defluvium
- Cancer chemotherapy
- Endocrine disease*
- Infection
- Metabolic disease*

Colour-dilution alopecia
Congenital follicular dysplasias
Congenital hypotrichosis
Dark hair follicular dystrophy

Hair cycle arrest alopecia
Endocrine disease

- Alopecia X
  - Adrenal sex hormone-responsive dermatosis
  - Castration-responsive dermatosis
  - Growth hormone-responsive dermatosis
  - Oestrogen responsive dermatosis
  - Testosterone responsive dermatosis
- Hyperadrenocorticism
- Hyperoestrogenism
- Hypothyroidism* (D)

Idiopathic cyclic flank alopecia
Pattern baldness
Post-clipping
Telogen defluvium*

- Stress, e.g.
  - Anaesthesia
  - Pregnancy
  - Shock *q.v.*
  - Surgery
  - Systemic illness

Damage to hair follicle

Secondary to pruritus* *q.v.*

Follicular infections

Bacterial folliculitis*
Demodecosis*
Dermatophytosis*

Immune-mediated disease

Alopecia areata
Idiopathic lymphocytic mural folliculitis
Pseudopelade
Sebaceous adenitis

*Neoplasia**

Trauma/physical

Injection site reaction
Over-grooming
Sensory neuropathy
Traction alopecia
Trichoptilosis
Tricorrhexis nodosa

Nutritional

Zinc deficiency
Zinc responsive dermatosis

Miscellaneous

Alopecia mucinosis
Feline acquired symmetric alopecia (C)

Feline pinnal alopecia* (C)
Feline pre-auricular alopecia (normal)
Follicular lipidosis of Rottweilers (D)
Medullary trichomalacia
Psychogenic alopecia*
Short hair syndrome of Silky breeds (D)
Drugs
- Carbimazole

References

Frank, L. A. (2005) Growth hormone-responsive alopecia in dogs. *JAVMA*, **226**:1494–7.
Sawyer, L. S. (1999) Psychogenic alopecia in cats: 11 cases (1993–1996). *JAVMA*, **214**:71–4.

2.4.6 Erosive/ulcerative skin disease

Immune-mediated

Bullous pemphigoid
Discoid lupus erythematosus
Epidermolysis bullosa acquisita
Erythema multiforme
Mucous membrane pemphigoid
Perianal fistulae
Plasma cell pododermatitis
Systemic lupus erythematosus
Toxic epidermal necrolysis
Ulcerative disease of Shetland Sheepdog and Rough Collie (D)

Idiopathic

Feline idiopathic ulcerative dermatosis

Infection

Antibiotic responsive ulcerative dermatoses
Cowpox virus (C)

Neoplasia*

Physical

Burns
Frostbite
Radiation
Trauma

Vasculitis

Idiopathic
Immune-mediated
Infectious

Drugs/toxins

ACE inhibitors
Diuretics
Fenbendazole
Imodium
Itraconazole
Ivermectin
Metoclopramide
Metronidazole
Phenobarbitone
Phenylbutazone
Thallium

References

Bassett, R. J. (2004) Antibiotic responsive ulcerative dermatoses in German Shepherd Dogs with mucocutaneous pyoderma. *Aust Vet J,* **82**:485–9.
Godfrey, D. R., et al. (2004) Unusual presentations of cowpox infection in cats. *JSAP,* **45**: 202–205.

2.4.7 Otitis externa

Primary causes

Hypersensitivity
Atopy*
Contact allergy*
Drug reactions
Food hypersensitivity*

Infection
Fungal
- Dermatophytosis*
- *Sporothrix schenckii*

Parasites
- Demodecosis*
- Fleas*
- *Otodectes cyanotis**
- Pediculosis*
- Sarcoptic mange* (D)
- Trombiculosis*

Pyoderma

Endocrine, e.g.
Hyperadrenocorticism
Hypothyroidism* (D)

Physical
Foreign body*

Immune-mediated
Bullous pemphigoid
Cold agglutinin disease
Drug eruption
Erythema multiforme
Lupus erythematosus
Pemphigus erythematosus
Pemphigus foliaceus
Vasculitis

Disorders of keratinisation
Primary seborrhoea
Sebaceous adenitis
Vitamin A responsive dermatosis

Miscellaneous
Abnormal cerumen production
Juvenile cellulitis

Neoplasia
Adenocarcinoma
Adenoma
Papilloma
Squamous cell carcinoma

Predisposing factors

Systemic immunosuppression

Ear conformation/structure
Ear canal stenosis
- Acquired*
- Inherited

Hypertrichosis*
Neoplasia
Pendulous pinnae* (D)
Polyps*

Excessive moisture
Humidity
Swimming

Iatrogenic
Irritant ear cleaning products
Overuse of cleaning products
Trauma

Perpetuating factors

Acquired changes secondary to chronic ear disease
- Fibrosis*
- Hyperplasia*

- Mineralisation*
- Oedema*
- Ulceration*

Bacterial infection*
- *Enterobacter* spp
- *Proteus* spp
- *Pseudomonas* spp
- *Staphylococcus intermedius*
- *Streptococcus* spp

Candidiasis*
*Malassezia** spp
Otitis media

References

Jacobson, L. S. (2002) Diagnosis and medical treatment of otitis externa in the dog and cat. *J S Afr Vet Assoc,* **73**:162–70.
Little, C. (1996) A clinician's approach to the investigation of otitis externa. *In Practice,* **18**:9–16.

2.4.8 Pododermatitis

Asymmetric pododermatitis

Foreign body*
Irritant*
Neoplasia
Trauma

Infection

Bacterial*
- *Actinomyces* spp
- *Nocardia* spp
- *Proteus* spp
- *Pseudomonas* spp
- *Staphylococcus intermedius*

Fungal
- Blastomycosis
- Candidiasis
- Cryptococcosis
- Dermatophytosis*
- Eumycotic mycetoma
- *Malassezia** spp

Parasitic, e.g.
- Demodecosis*

Miscellaneous

Acral lick dermatitis*
Arteriovenous fistula
Calcinosis circumscripta
Osteomyelitis
Sensory neuropathy

Symmetric pododermatitis

Congenital
- Acrodermatitis of Bull Terriers (D)
- Familial hyperkeratosis in Irish Terriers (D)
- Familial vasculopathy of German Shepherd (D)
- Idiopathic footpad hyperkeratosis
- Tyrosinaemia
- Vasculitis of Jack Russell Terriers (D)

Immune-mediated/allergic
- Atopy*
- Bullous pemphigoid
- Cold agglutinins
- Contact allergy*
- Dermatomyositis (D)
- Drug eruption
- Food allergy*
- Pemphigus foliaceus
- Pemphigus vulgaris
- Plasma cell pododermatitis (C)
- Sterile granuloma/pyogranuloma
- Systemic lupus erythematosus
- Vasculitis

Immunodeficiencies
- Acquired
- Congenital

Infection
- Bacterial, e.g.
  - *Staphylococcus intermedius*
- Fungal, e.g.
  - *Malassezia* spp
- Parasitic, e.g.
  - Demodecosis
  - Hookworm
  - Leishmaniasis
  - Pelodera

Irritant

Metabolic
- Calcinosis circumscripta
- Superficial necrolytic dermatitis

Miscellaneous
- Dermatofibrosis
- Distemper* (D)

Neoplasia

Nutritional
Zinc responsive dermatosis

Psychogenic/neurogenic
Acral mutilation of German Short-Haired Pointers (D)
Sensory neuropathy

References

Boord, M. J. (2002) Canine pododermatitis. In *Proceedings, Western Veterinary Conference, 2002*.
Pereira, P. D. & Faustine, A. M. R. (2003) Feline plasma cell pododermatitis: a study of 8 cases. *Vet Dermatol*, **14**:333–7.
Rosychuk, R. A. (2002) Pododermatitis in dogs and cats. In *Proceedings, ACVIM, 2002*.

2.4.9 Disorders of the claws

Idiopathic conditions
Idiopathic onychodystrophy
Idiopathic onychogryphosis
Idiopathic onychomadesis

Immune-mediated disease
Bullous pemphigoid
Cryoglobulinaemia
Discoid lupus erythematosus/Symmetric lupoid onychodystrophy
Drug eruption
Eosinophilic granuloma complex
Pemphigus complex
Systemic lupus erythematosus
Vasculitis

Infection
Bacterial
- Secondary to trauma or virus*

Fungal
- Blastomycosis
- Candidiasis
- Cryptococcosis
- Dermatophytosis
- Geotrichosis
- *Malassezia* spp
- Sporothricosis

Parasitic
- Ascarids
- Demodecosis
- Hookworm dermatitis

Protozoal
- Leishmaniasis

Viral
- Canine distemper virus* (D)

- Feline immunodeficiency virus* (C)
- Feline leukaemia virus* (C)

Inherited/primary disease

Anonychia
Dermatomyositis
Epidermolysis bullosa
Naevus
Primary seborrhoea
Supernumerary claws

Metabolic/endocrine disease

Acromegaly
Diabetes mellitus*
Hyperadrenocorticism
Hyperthyroidism* (C)
Hypothyroidism* (D)
Necrolytic migratory erythema

Neoplasia, e.g.

Metastatic lung carcinoma
Squamous cell carcinoma

Nutrition

Lethal acrodermatitis
Zinc responsive dermatosis

Drugs/toxins

Thallotoxicosis

Trauma

Irritant chemical*
Physical injury*

Vascular

Disseminated intravascular coagulation
Raynaud-like disease

References

Carlotti, D. N. (1999) Claw diseases in dogs and cats. *Eur J Comp An Prac*, **IX**:21–33.
Mueller, R. S., et al. (2003) A retrospective study regarding the treatment of lupoid onychodystrophy in 30 dogs and literature review. *JAAHA*, **39**:139–50.
Scott, D. W., et al. (1995) Symmetrical lupoid onychodystrophy in dogs: a retrospective analysis of 18 cases (1989–1993). *JAAHA*, **31**:194–201.

2.4.10 Anal sac/perianal disease

Perianal/caudal pruritus

Anal sac impaction*

Anal sacculitis*
Atopy*
Flea bite hypersensitivity*
Food hypersensitivity*
Intertrigo*
- Perineal
- Tail fold
- Vulval fold

Parasitism*, e.g.
- Cheyletiellosis
- Sarcoptic mange

Perianal swelling
Anal sac abscess*
Anal sac neoplasia*
Perianal adenoma*
Other perianal neoplasia
Perineal hernia*
Rectal prolapse*

Perianal fistula
Anal furunculosis*
Ruptured anal sac abscess*

Reference
Esplin, D. G. (2003) Squamous cell carcinoma of the anal sac in five dogs. *Vet Pathol,* **40**:332–4.

2.5 Neurological signs

2.5.1 Abnormal cranial nerve (CN) responses

The anatomical localisation of lesions associated with the abnormal test are listed, together with other disorders that can produce alterations in the cranial nerve tests. Differentiating intracranial disease from peripheral neuropathy can be aided by the fact that intracranial disease is more likely to involve multiple cranial nerves and other neurological signs are usually present. Specific disorders of selected cranial nerves are also listed below.

Anisocoria (see Plate 2.5(a) in colour plate section)

Abnormal pupil–constricted
Corneal ulcers/lacerations
Horner's syndrome
Posterior synechiae
Previous inflammation
Uveitis*

Anal sacculitis*
Atopy*
Flea bite hypersensitivity*
Food hypersensitivity*
Intertrigo*
- Perineal
- Tail fold
- Vulval fold

Parasitism*, e.g.
- Cheyletiellosis
- Sarcoptic mange

Perianal swelling
Anal sac abscess*
Anal sac neoplasia*
Perianal adenoma*
Other perianal neoplasia
Perineal hernia*
Rectal prolapse*

Perianal fistula
Anal furunculosis*
Ruptured anal sac abscess*

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2.5 Neurological signs

2.5.1 Abnormal cranial nerve (CN) responses

The anatomical localisation of lesions associated with the abnormal test are listed, together with other disorders that can produce alterations in the cranial nerve tests. Differentiating intracranial disease from peripheral neuropathy can be aided by the fact that intracranial disease is more likely to involve multiple cranial nerves and other neurological signs are usually present. Specific disorders of selected cranial nerves are also listed below.

Anisocoria (see Plate 2.5(a) in colour plate section)

Abnormal pupil–constricted
Corneal ulcers/lacerations
Horner's syndrome
Posterior synechiae
Previous inflammation
Uveitis*

Drugs, e.g.
- Pilocarpine

Abnormal pupil–dilated

Iris, retina, CN II, CN III
- Chorioretinitis
- Glaucoma
- Iris atrophy/hypoplasia
- Iris trauma
- Posterior synechiae
- Unilateral blindness
- Drugs, e.g.
  - Atropine
  - Phenylephrine

Auditory response reduced

CN VIII
External auditory canal*
Middle* or inner ear

Corneal reflex reduced

Brainstem
CN V
CN VII

Gag reflex reduced

Brainstem
CN IX
CN X

Facial asymmetry (see Plate 2.5(b) in colour plate section)

Facial paralysis
- CN VII
- Idiopathic neuritis
- Neoplasia of the middle ear
- Otitis media*

Masticatory muscle wastage
- CN V
  - Idiopathic trigeminal neuritis
  - Malignant trigeminal nerve sheath tumour
- Masticatory myositis

Jaw tone reduced/inability to close jaw

CN V
- Idiopathic trigeminal neuritis
- Lymphoma*
- Neosporosis

Lack of response to non-irritant smell

CN I
Nasal disease

Menace response reduced

Brainstem
Cerebellum
CN II
CN VII
Forebrain
Immature animal
Retina

Palpebral reflex reduced

Brainstem
CN V
CN VII

Pupillary light reflex reduced

Brainstem
CN II
CN III
Retina

Response to stimulation of nasal mucosa reduced

Brainstem
CN V
Forebrain

Response to vagal manoeuvres reduced

CN X

Spontaneous nystagmus

Brainstem
CN VIII
Toxic, e.g.
- Cannabis
- Metaldehyde

Vestibular disease *q.v.*, e.g.
- Canine idiopathic geriatric vestibular disease*
- Congenital vestibular disease
- Middle ear disease

Strabismus

Ventrolateral
CN III

Dorsolateral
CN IV

Medial
CN VI

Vestibulo-ocular reflex reduced

Brainstem

CN III
CN IV
CN VI
CN VIII

Diseases of CN V

Idiopathic trigeminal neuritis
Infiltrating neoplasia, e.g.
- Lymphoma
- Nerve sheath tumours

Diseases of CN VII

Idiopathic
Insulinoma
Otitis media/interna
Trauma of middle ear
Tumour of middle ear

References:

Bagley, R. S. (2002) Differential diagnosis of animals with intracranial disease, Part 2: diseases of the brainstem, cranial nerves, and cerebellum. In *Proceedings, Atlantic Coast Veterinary Conference, 2002*.

Braund, K. G., et al. (1987) Insulinoma and subclinical peripheral neuropathy in two dogs. *JVIM,* **1**:86–90.

Mayhew, P. D., Bush, W. W. & Glass, E. N. (2002) Trigeminal neuropathy in dogs: a retrospective study of 29 cases (1991–2000). *JAAHA,* **38**:262–70.

2.5.2 Vestibular disease

(Signs include: head tilt, nystagmus, circling, leaning, falling, rolling)

PERIPHERAL VESTIBULAR SYSTEM

Congenital vestibular disease

Metabolic disease

Hypothyroidism* (D)

Neoplasia

Ceruminous gland adenocarcinoma
Chondrosarcoma
Fibrosarcoma
Osteosarcoma
Schwannoma
Squamous cell carcinoma

Idiopathic conditions

Idiopathic geriatric vestibular disease*

Infection

Extension of otitis externa* *q.v.*
Foreign bodies*
Haematogenous spread of infection
Otitis media/interna*
Polyps*

Trauma

Drugs/toxins

Antibiotics
Aminoglycosides
Amphotericin B
Ampicillin
Bacitracin
Chloramphenicol
Colistin
Erythromycin
Griseofulvin
Hygromycin B
Metronidazole
Minocycline
Polymixin B
Tetracyclines
Vancomycin

Antiseptics
Benzalkonium chloride
Benzethonium chloride
Cetrimide
Chlorhexidine
Ethanol
Iodine
Iodophores

Cancer chemotherapeutics
Actinomycin
Cisplatin
Cyclophosphamide
Vinblastine
Vincristine

Diuretics
Bumetanide
Ethacrynic acid
Frusemide

Metals/heavy metals
Arsenic
Gold salts

Lead
Mercury
Triethyl/trimethyl tin

Miscellaneous
Ceruminolytic agents
Danazol
Detergents
Digoxin
Dimethylsulphoxide
Diphenylhydrazine
Insulin
Mexiletine
Potassium bromide
Prednisolone
Propylene glycol
Quinidine
Salicylates

CENTRAL VESTIBULAR SYSTEM
Trauma

Degeneration
Lysosomal storage disorders

Congenital conditions
Chiari-like malformation
Hydrocephalus

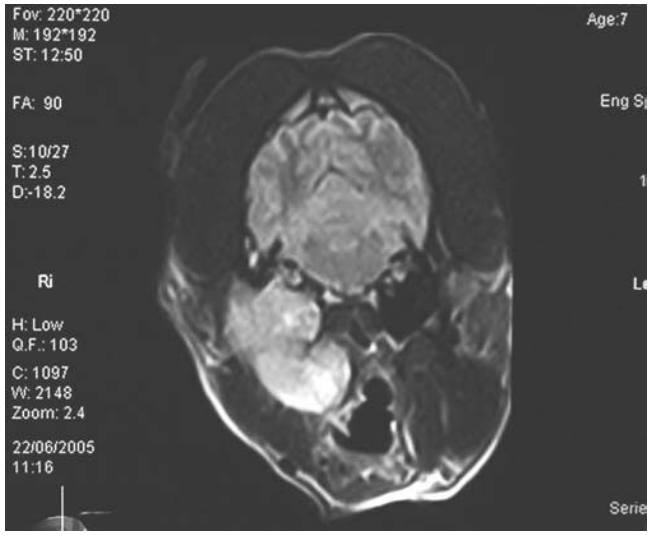

Fig. 2.5(a) Transverse T1 weighted MR scan of the head of a dog, showing a large neoplasm in the middle ear. Reproduced with permission of Downs Referrals, Bristol.

Metabolic disease

Electrolyte abnormalities* *q.v.*
Hepatic encephalopathy* *q.v.*
Uraemic encephalopathy* *q.v.*

Neoplasia

Choroid plexus tumours
Dermoid cyst
Epidermoid cyst
Glioma
Lymphoma
Medulloblastoma
Meningioma
Metastatic tumour

Nutrition

Thiamine deficiency

Immune-mediated/Infection

Feline spongiform encephalopathy (C)
Meningoencephalitis

Idiopathic conditions

Arachnoid cysts

Drugs/toxins

Metronidazole

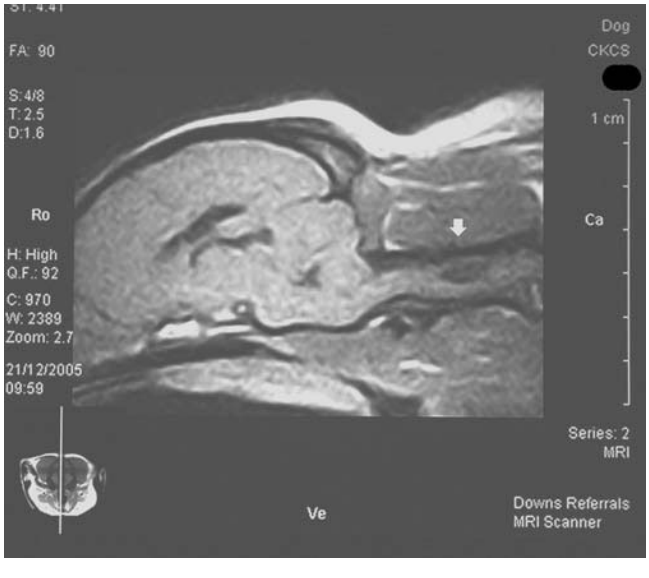

Fig. 2.5(b) Sagittal T1 weighted MR scan of the brain and cervical spine of a Cavalier King Charles Spaniel, showing syringohydromyelia (arrow). Reproduced with permission of Downs Referrals, Bristol.

Vascular disorders

Cerebrovascular accident

References:

Dewey, C. W. (2003) Chiari-like malformation in the dog. *Proceedings, ACVIM*, 2003.
Forbes, S. & Cook, J. R. (1991) Congenital peripheral vestibular disease attributed to lymphocytic labyrinthitis in two related litters of Dobermann Pinscher pups. *JAVMA*, **198**:447–9.
Troxel, M. T., et al. (2005) Signs of neurologic dysfunction in dogs with central versus peripheral vestibular disease. *JAVMA*, **227**:570–4.

2.5.3 Horner's syndrome

1st order (hypothalamus, rostral midbrain, spinal cord to T3)

Intracranial disease, e.g.
- Neoplasia

Spinal disease *q.v.*

Thoracic disease, e.g.
- Cranial mediastinal mass

2nd order (pre-ganglionic) (T1–T3, vagosympathetic trunk, caudal and cranial cervical ganglia)

Brachial plexus avulsion

Cervical soft tissue disease, e.g.
- Mass
- Neoplasia
- Trauma

Cervical surgery, e.g.
- Thyroidectomy

3rd order (post-ganglionic) (middle ear, cranial cavity, eye)

Feline immunodeficiency virus* (C)

Iatrogenic, e.g.
- Bulla osteotomy

Idiopathic*

Middle ear
- Mass
- Neoplasia

Otitis media/interna*
- Under middle ear

Retrobulbar
- Injury
- Mass*
- Neoplasia

Reference

Kern T.J., et al. (1989) Horner's syndrome in dogs and cats: 100 cases (1975–1985). *JAVMA*, **195**:369–73.

2.5.4 Hemineglect syndrome (Forebrain dysfunction *q.v.*)

2.5.5 Spinal disorders (see Fig. 2.5(c) for neurolocalisation)

C1–C5

Acute

Atlantoaxial subluxation
Cervical spondylomyelopathy (D)
Degenerative disc disease* (D)
Discospondylitis
Fibrocartilaginous embolism*
Fracture*
Granulomatous meningoencephalomyelitis
Haematoma
Ischaemic myelopathy
Luxation
Neoplasia

Chronic

Atlanto-occipital dysplasia
Atlantoaxial subluxation
Calcinosis circumscripta
Cervical fibrotic stenosis
Cervical spondylomyelopathy* (D)
Feline infectious peritonitis (C)
Hypervitaminosis A
Neoplasia

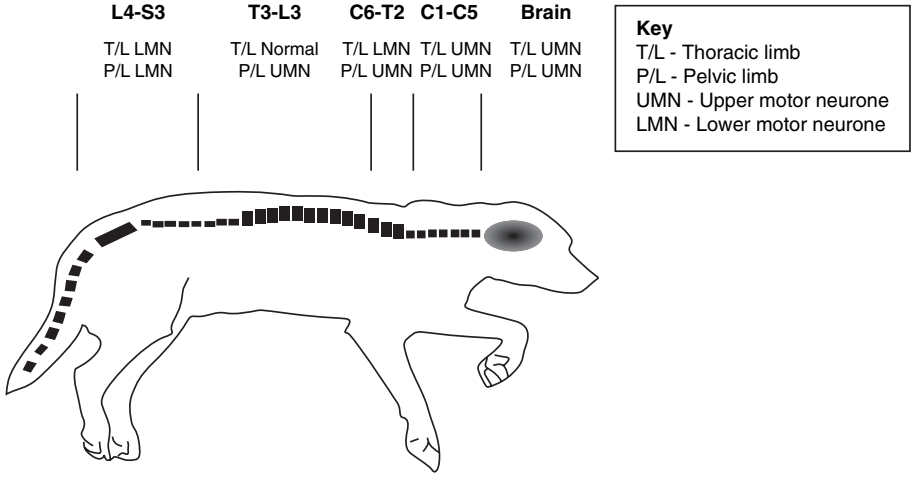

Fig. 2.5(c) Localisation of spinal lesions.

Spinal arachnoid cysts
Synovial cysts
Syringohydromyelia*

C6–T2

Acute

Brachial plexus avulsion
Cervical spondylomyelopathy* (D)
Degenerative disc disease* (D)
Discospondylitis
Fibrocartilaginous embolism*
Fracture*
Granulomatous meningoencephalomyelitis
Haematoma
Luxation
Neoplasia

Chronic (see Plate 2.5(c) in colour plate section)

Cervical spondylomyelopathy* (D)
Dermoid sinus
Neoplasia
Spinal arachnoid cysts
Synovial cysts

T3–L3

Acute

Ascending myelomalacia
Degenerative disc disease* (D)
Discospondylitis
Fibrocartilaginous embolism
Fracture*
Granulomatous meningoencephalomyelitis
Luxation
Neoplasia

Chronic

Calcinosis circumscripta
Degenerative disc disease* (D)
Degenerative myelopathy*
Neoplasia
Spinal arachnoid cyst
Synovial cysts

L4–S3

Acute

Ascending myelomalacia
Cauda equina neuritis* (D)
Degenerative disc disease* (D)

Discospondylitis
Fibrocartilaginous embolism
Fracture*
Granulomatous meningoencephalomyelitis
Ischaemic neuromyopathy
Luxation
Neoplasia
Psoas muscle injury

Chronic
Degenerative myelopathy*
Dermoid sinus
Lumbosacral disc disease* (D)
Neoplasia
Sacral osteochondritis dissecans
Sacrocaudal dysgenesis
Spina bifida
Tethered cord syndrome

References

Jurina, K. & Grevel, V. (2004) Spinal arachnoid pseudocysts in 10 Rottweilers. *JSAP,* **45**:9–15.
Knipe, M. F., et al. (2001) Intervertebral disc extrusion in six cats. *J Feline Med Surg,* **3**:161–8.
Salvadori, C., et al. (2003) Degenerative myelopathy associated with cobalamin deficiency in a cat. *J Vet Med A Physiol Pathol Clin Med,* **50**:292–6.

2.6 Ocular signs

2.6.1 Red eye

CONJUNCTIVITIS

Chemical
Acid
Alkali
Antiseptics
Shampoos

Immune-mediated
Allergic
Arthropod bites*
Atopy*
Drug reaction
Food hypersensitivity*
Idiopathic
Keratoconjunctivitis sicca*

Discospondylitis
Fibrocartilaginous embolism
Fracture*
Granulomatous meningoencephalomyelitis
Ischaemic neuromyopathy
Luxation
Neoplasia
Psoas muscle injury

Chronic
Degenerative myelopathy*
Dermoid sinus
Lumbosacral disc disease* (D)
Neoplasia
Sacral osteochondritis dissecans
Sacrocaudal dysgenesis
Spina bifida
Tethered cord syndrome

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2.6 Ocular signs

2.6.1 Red eye

CONJUNCTIVITIS

Chemical
Acid
Alkali
Antiseptics
Shampoos

Immune-mediated
Allergic
Arthropod bites*
Atopy*
Drug reaction
Food hypersensitivity*
Idiopathic
Keratoconjunctivitis sicca*

Infectious
Bacterial*
Fungal, e.g.
- Blastomycosis

Mycoplasmal
Parasitic, e.g.
- *Thelazia* spp

Rickettsial
Viral, e.g.
- Canine distemper virus* (D)

Neurological
Lack of blink reflex
- Lesions of facial nerve *q.v.*
- Lesions of trigeminal nerve *q.v.*

Lack of tear production
- Neurogenic keratoconjunctivitis sicca

Physical
Cilia*
Dust*
Foreign body*
Masses*
Poor eyelid anatomy*
- Ectropion
- Entropion

Radiation therapy

Neoplastic, e.g.
Mast cell tumour
Melanoma
Squamous cell carcinoma

Systemic diseases
Hepatozoonosis
Leishmaniasis
Listeriosis
Multiple myeloma
Systemic histiocytosis
Tyrosinaemia (D)

ANTERIOR UVEITIS
Idiopathic

Ionising radiation

Infection

Algae
Prototheocosis

Bacteria
Bartonella
Borreliosis
Brucellosis (D)
Leptospirosis
Septicaemia
- Abscesses*
- Bacterial endocarditis
- Dental infections*
- Neonatal umbilical infections
- Prostatitis*
- Pyelonephritis
- Pyometra*
- Pyothorax

Fungal
Blastomycosis
Candidiasis
Coccidioidomyocosis
Cryptococcosis
Histoplasmosis

Parasitic
Angiostrongylosis
Baylisascaris procyonis
Diptera
Dirofilariasis
Toxocariasis

Protozoa
Leishmaniasis
Neosporosis (D)
Toxoplasmosis

Rickettsia
Ehrlichiosis
Rocky Mountain Spotted Fever

Viruses
Canine adenovirus-1 (D)
Canine distemper virus
Canine herpes virus (D)
Feline immunodeficiency virus (C)*
Feline infectious peritonitis (C)*
Feline leukaemia virus (C)*
Rabies

Neoplasia
Adenocarcinomas
Ciliary body
Ciliary body adenoma
Medulloepitheliomas
Melanoma
Metastatic neoplasia, especially

- Haemangiosarcoma
- Lymphoma

Sarcoma
Systemic histiocytosis

Non-infectious inflammatory

Lens-associated anterior uveitis
- Cataract*
- Luxation*
- Penetrating trauma*

Granulomatous meningoencephalomyelitis
Idiopathic
Immune-mediated vasculitis
Pigementary uveitis
Uveodermatological syndrome

Systemic, e.g.

Coagulopathy
Hyperlipidaemia *q.v.*
Systemic hypertension* *q.v.*
Toxaemia

Trauma

Blunt trauma*
Penetrating trauma*/Intraocular foreign bodies
Drugs, e.g.
- Miotics

BULBAR HYPERAEMIA/VASCULAR CONGESTION

Anterior scleritis
Trauma*

Episcleritis

Nodular
Simple

Glaucoma

Primary
Goniodysgenesis
Primary open angle glaucoma

Secondary
Cataract* *q.v.*
Intraocular haemorrhage* *q.v.*
Lens luxation*
Neoplasia
Neovascular tissue overlying pectinate ligament
Pigmentary glaucoma
Trauma

Uveitis* *q.v.*
Vitreous prolapse post-lentectomy
Drugs
- Atropine
- Sildenafil

INSIDE RED EYE
Anterior uveitis
Hyphaema
Iris mass
Retinal detachment
Vitreal haemorrhage

CORNEA RED
Neovascularisation
Granulation tissue
Haemorrhage

References

Pena, M. T., et al. (2000) Ocular and periocular manifestations of leishmaniasis in dogs: 105 cases (1993–1998). *Vet Ophthalmol,* **3**:35–41.
Sansom, J. (2000) Diseases involving the anterior chamber of the dog and cat. *In Practice,* **22**:58–70.
Whitley, R. D. (2000) Canine and feline primary ocular bacterial infections. *Vet Clin North Am Small Anim Pract,* **30**:1151–67.

2.6.2 Corneal opacification

Corneal oedema

Anterior uveitis* *q.v.*
Canine adenovirus-1 (D)
Corneal ulceration* *q.v.*
Endophthalmitis
Endothelial dystrophy
Glaucoma *q.v.*
Historic use of canine adenovirus-1 live vaccine
Intraocular neoplasia
Mechanical trauma*/iatrogenic
Neovascularisation
Persistent pupillary membranes
Drugs/toxins
- Tocainide

Pigmentation

Anterior synechiae
Chronic corneal insult*
Congenital endothelial pigmentation
Corneal sequestrum
Limbal melanoma
Persistent pupillary membranes
Pigmentary glaucoma

Corneal vascularisation

Endophthalmitis
Glaucoma *q.v.*
Intraocular neoplasia
Keratitis*
Pannus*
Uveitis* *q.v.*

Miscellaneous

Calcium deposition
Cellular infiltration
Degenerative changes
Foreign bodies*
Lipid deposition
Neoplastic infiltration
Scarring*
Xerosis

References

Adam, S. & Crispin, S. (1995) Differential diagnosis of keratitis in cats. *In Practice,* **17**:355–63.
Pentlarge, V. W. (1989) Corneal sequestration in cats. *Compend Contin Educ Pract Vet,* **11**:24–32.

2.6.3 Corneal ulceration/erosion

Degeneration

Corneal calcific degeneration
Lipid keratopathy

Dystrophic

Bullous keratopathy
Corneal endothelial dystrophy
Corneal sequestrum (C)
Epithelial basement membrane dystrophy (indolent ulcer)

Infection

Bacterial (secondary invaders)

Bacillus spp
Corynebacterium spp
Escherichia coli
Pseudomonas spp
Staphylococcus spp
Streptococcus spp

Fungal

Acremonium spp
Alternaria spp
Aspergillosis
Candidiasis
Cephalosporium spp
Curvalia spp
Pseudallescheria spp
Scedosporium spp

Protozoal

Viral
Feline herpes virus* (C)

Inflammation/immune-mediated
Feline eosinophilic keratitis
Keratoconjunctivitis sicca*
Punctate keratopathy (D)

Mechanical/irritant trauma
Aberrant hairs*
Distichiasis*
Ectopic cilia*
Eyelid abnormalities*
- Ectropion
- Entropion

Heat
Irritant chemicals
Self-trauma*
Shampoos
Smoke*
Trichiasis*
Ultraviolet light*

Neurological conditions
Ionising radiation
Lack of blink reflex
- Lesions of facial nerve *q.v.*
- Lesions of trigeminal nerve *q.v.*

Lack of tear production
- Neurogenic keratoconjunctivitis sicca

References
Adam, S. & Crispin, S. (1995) Differential diagnosis of keratitis in cats. *In Practice,* **17**:355–63.
Morgan, R. V., et al. (1996) Feline eosinophilic keratitis: a retrospective study of 54 cases: (1989–1994). *Vet Comp Ophthalmol,* **6**:131–4.
Nasisse, M. (2002) Corneal ulcers. In *Proceedings, Tufts Animal Expo, 2002.*

2.6.4 Lens lesions

Cataract
Age-related*
Electrocution
Glaucoma *q.v.*
Lens luxation (see below)
Non-hereditary developmental
Post-inflammation
Radiation
Retinal degeneration

Hereditary, e.g.
Congenital with microphththalmos and rotatory nystagmus
Early onset and progressive
Posterior polar subcapsular cataract

Metabolic
Diabetes mellitus*
Hypocalcaemia
Nutritional secondary hyperparathyroidism

Nutritional
Hand rearing on milk substitutes

*Traumatic**
Blunt
Penetrating

Drugs/toxins
Diazoxide
Dimethyl sulfoxide
Dinitrophenol
Hydroxymethylglutaryl-coenzyme A reductase inhibitors
Ketoconazole
Pefloxacin
Phenylpiperazine
Progesterone-based contraceptives
Sulfonylurea glimepiride
Topical dexamethasone

Luxation/subluxation

Primary

Secondary
Chronic uveitis *q.v.*
Glaucoma *q.v.*
Lens shape/size abnormalities
Trauma

References

Beam, S., et al. (1999) A retrospective-cohort study on the development of cataracts in dogs with diabetes mellitus: 200 cases. *Vet Comp Ophthalmol*, **2**:169–72.
Crispin, S., Bedford, P., Yellowley, J. & Warren, C. (1995) Hereditary eye disease and the BVA/KC/ISDS Eye scheme. *In Practice*, **17**:254–64.
Da Costa, P. D., et al. (1996) Cataracts in dogs after long-term ketoconazole therapy. *Vet Comp Ophthalmol*, **6**:176–80.

2.6.5 Retinal lesions

Retinal detachment

Fibrous vitreoretinal adhesions
Trauma*

Congenital, e.g.
Collie eye anomaly
Persistent hyperplastic primary vitreous and retinal dysplasia

Iatrogenic
Complication of lens surgery

Space-occupying lesions
Extraocular
Intraocular

Systemic disease
Hypertension* *q.v.*
Severe systemic inflammatory disease
Uveodermatological syndrome

Swollen optic disc

Papilloedema, e.g.
Acute glaucoma
Hypertension *q.v.*
Neoplasia of optic nerve
Orbital space-occupying lesion
Raised intracranial pressure
- Brain tumours
- Intracranial haemorrhage

Optic neuritis
Inflammatory
- Granulomatous meningoencephalomyelitis

Infectious
- Blastomycosis
- Canine distemper virus* (D)
- Cryptococcosis
- Histoplasmosis
- Toxoplasmosis

Idiopathic
Local disease
- Orbital abscess*
- Orbital cellulitis*

Neoplasia
Trauma*
Toxins

Pseudopapilloedema
Congenital defects

Disc oedema
Glaucoma *q.v.*
Post-operative hypotony
Uveitis *q.v.*

Neoplasia
Metastatic
Primary

Retinal haemorrhage*, e.g.
Coagulopathy
Hypertensive retinopathy
Hyperviscosity
Inflammatory/infectious chorioretinitis
Neoplastic chorioretinitis

References

Crispin, S., Bedford, P., Yellowley, J. & Warren, C. (1995) Hereditary eye disease and the BVA/KC/ISDS Eye scheme. *In Practice,* **17**:254–64.
Grahn, B. H., et al. (2004) Inherited retinal dysplasia and persistent hyperplastic primary vitreous in Miniature Schnauzer dogs. *Vet Ophthalmol,* **7**:151–8.
Sansom, J. & Bodey, A. (1997) Ocular signs in four dogs with hypertension. *Vet Rec,* **140**:593–8.

2.6.6 Intraocular haemorrhage/hyphaema

Chronic glaucoma

Coagulopathy

Congenital disease
Collie eye anomaly
Persistent hyaloid artery
Persistent hyperplastic primary vitreous
Vitreoretinal dysplasia

Hyperviscosity syndrome
Hyperglobulinaemia
Polycythaemia *q.v.*

Iatrogenic
Post surgery

Inflammation, e.g.
Uveitis

Neoplasia

Neovascularisation
Retinal
Uveal

Retinal detachment *q.v.*

Systemic hypertension* *q.v.*

Trauma*

References

Friedman, D. S., et al. (1989) Malignant canine anterior uveal melanoma. *Vet Pathol,* **26**:523–5.
Nelms, S. R. (1993) Hyphema associated with retinal disease in dogs: 17 cases (1986–1991). *JAVMA,* **202**:1289–92.
Sansom, J., et al. (1994) Ocular disease associated with hypertension in 16 cats. *JSAP,* **35**:604–11.

2.6.7 Abnormal appearance of anterior chamber

Anterior synechia

Anterior uveitis *q.v.*

Congenital lesions

Coloboma
Iris cysts
Persistent pupillary membranes

Hyphaema *q.v.*

Hypopyon

Deep corneal ulceration
Uveitis *q.v.*

Infiltration by neoplastic cells

Lipaemic aqueous

Masses

Foreign body*
Iris cysts
Luxated lens
Organised fibrin post inflammation*
Uveal tumours

- Adenocarcinoma
- Adenoma
- Medulloepithelioma
- Melanoma
- Metastatic

References

Bedford, P. G. (1998) Collie eye anomaly in the Lancashire heeler. *Vet Rec,* **143**:354–6.

Friedman, D. S. (1989) Malignant canine anterior uveal melanoma. *Vet Pathol*, **26**:523–5.

2.7 Musculoskeletal signs

2.7.1 Muscular atrophy or hypertrophy

ATROPHY

Disuse atrophy*

Orthopaedic disease* *q.v.*
Restricted exercise*

Metabolic/endocrine/systemic disease

Cachexia*
- Cardiac disease*
- Neoplasia*

Glycogen storage diseases
Hyperadrenocorticism
Hyperthyroidism* (C)
Hypothyroid myopathy (D)
Lipid storage myopathy
Mitochondrial myopathy
Poor nutritional states
- Gastrointestinal disease *q.v.*
- Inadequate protein-calorie intake

Myopathies

Degenerative/inherited
Distal myopathy of Rottweilers (D)
Fibrotic myopathy
Labrador Retriever myopathy (D)
Merosin-deficient myopathy
Muscular dystrophy
Nemaline myopathy

Inflammatory/infectious
Bacterial
Dermatomyositis
Extra-ocular myositis
Leptospirosis
Masticatory myositis
Polymyositis
Protozoal
- Neosporosis (D)
- Toxoplasmosis

Tetanus

Friedman, D. S. (1989) Malignant canine anterior uveal melanoma. *Vet Pathol,* **26**:523–5.

2.7 Musculoskeletal signs

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Inflammatory/infectious
Bacterial
Dermatomyositis
Extra-ocular myositis
Leptospirosis
Masticatory myositis
Polymyositis
Protozoal
- Neosporosis (D)
- Toxoplasmosis

Tetanus

Neurogenic

Neoplasia, e.g.
- Malignant nerve sheath tumour

Peripheral neuropathies *q.v.*
Spinal cord disease *q.v.*

HYPERTROPHY/MUSCULAR SWELLING

Athletic training*
Breed related*
Myositis ossificans
Myotonia (D)
Muscular dystrophy
Traumatic ischaemic neuromyopathy associated with bottom-hung pivot windows and garage doors (C)

References

Bley, T., et al. (2002) Genetic aspects of Labrador retriever myopathy. *Res Vet Sci,* **73**:231–6.
Evans, J., et al. (2004) Canine inflammatory myopathies: a clinicopathologic review of 200 cases. *JVIM,* **18**:679–91.
Fischer, I., et al. (2002) Acute traumatic hind limb paralysis in 30 cats. *Tierarztl Prax Ausg K Klientiere Heimtiere,* **30**:61.
Hickford, F. H., et al. (1998) Congenital myotonia in related kittens. *JSAP,* **39**:281–5.

2.7.2 Trismus ('lockjaw')

Temporomandibular joint ankylosis

Infection
Systemic arthropathies
Trauma*
Tumours

Pain on opening jaw

Foreign body*
Retrobulbar cellulitis or abscess*
Temporomandibular joint arthritis*
Tooth root abscess*
Trauma to buccal cavity or temporomandibular joint*

Inflammatory

Dermatomyositis
Granulomatous meningoencephalomyelitis
Infectious
- Neosporosis
- Tetanus
- Toxoplasmosis

Masticatory myositis
Trigeminal neuritis

Mechanical

Foreign body
Malicious, e.g. placement of rubber band
Neoplasia
- Mandibular
- Maxillary
- Oral
- Orbital
- Retrobulbar

Drugs/toxins, e.g.

Cocaine

References

Gilmour, M. A., et al. (1992) Masticatory myopathy in the dog: A retrospective study of 18 cases. *JAAHA*, **28**:300–306.
Meomartino, L., et al. (1999) Temporomandibular ankylosis in the cat: a review of seven cases. *JSAP*, **40**:7–10.
Polizopoulou, Z. S. (2002) Presumed localized tetanus in two cats. *J Feline Med Surg*, **4**:209–12.

2.7.3 Weakness (see 1.1.8 for full listings)

Cardiovascular disease*
Endocrine disease*
Haematological disease*
Immune-mediated disease
Infectious disease*
Metabolic disease
Neuromuscular disease
Nutritional disorders
Physiological
Respiratory disease
Systemic disorders*
Drugs/toxins

2.8 Urogenital physical signs

2.8.1 Kidneys abnormal on palpation

Enlarged kidneys (see Plate 2.8 in colour plate section)

Irregular surface
Feline infectious peritanitis (C)
Infarcts
Neoplasia*
Pericapsular abscess
Pericapsular haematoma

Mechanical
Foreign body
Malicious, e.g. placement of rubber band
Neoplasia
- Mandibular
- Maxillary
- Oral
- Orbital
- Retrobulbar

Drugs/toxins, e.g.
Cocaine

References
Gilmour, M. A., et al. (1992) Masticatory myopathy in the dog: A retrospective study of 18 cases. *JAAHA,* **28**:300–306.
Meomartino, L., et al. (1999) Temporomandibular ankylosis in the cat: a review of seven cases. *JSAP,* **40**:7–10.
Polizopoulou, Z. S. (2002) Presumed localized tetanus in two cats. *J Feline Med Surg,* **4**:209–12.

2.7.3 Weakness (see 1.1.8 for full listings)

Cardiovascular disease*
Endocrine disease*
Haematological disease*
Immune-mediated disease
Infectious disease*
Metabolic disease
Neuromuscular disease
Nutritional disorders
Physiological
Respiratory disease
Systemic disorders*
Drugs/toxins

2.8 Urogenital physical signs

2.8.1 Kidneys abnormal on palpation

Enlarged kidneys (see Plate 2.8 in colour plate section)

Irregular surface
Feline infectious peritanitis (C)
Infarcts
Neoplasia*
Pericapsular abscess
Pericapsular haematoma

Polycystic kidney disease
Renal cyst

Smooth surface
Acute renal failure *q.v.*
Amyloidosis
Compensatory hypertrophy
Hydronephrosis
Neoplasia*
Perinephric pseudocyst
Polycystic kidney disease
Pyelonephritis
Pyogranulomatous nephritis
Renal cyst

Normal-sized kidneys – irregular surface

Infarcts
Neoplasia*
Pericapsular haematoma
Polycystic kidney disease
Renal cyst
Subcapsular haematoma

Fig. 2.8 Dorsoventral abdominal radiograph of a dog with right-sided renomegaly, due to a suspected renal adenocarcinoma. Reproduced with permission of Downs Referrals, Bristol.

Small kidneys

Irregular surface

Chronic generalised glomerulo- or tubulo-interstitial disease* *q.v.*
Hypoplastic kidneys
Multiple infarcts

Smooth surface

Hypoplasia

Absent kidneys

Aplasia
Nephrectomy

References

Cuypers, M. D., et al. (1997) Renomegaly in dogs and cats. Part I. Differential diagnoses. *Compend Contin Educ Pract Vet,* **19**:1019–32.
Ochoa, V. B., et al. (1999) Perinephric pseudocysts in the cat: A retrospective study and review of the literature. *JVIM,* **13**:47–55.
Rentko, V. T., et al. (1992) Canine leptospirosis: A retrospective study of 17 cases *J Vet Intern Med,* **6**:235–44.
Zatelli, A. & D'Ippolito, P. (2004) Bilateral perirenal abscesses in a domestic neutered shorthair cat. *JVIM,* **18**:902–903.

2.8.2 Bladder abnormalities

Palpable mass

Neoplasia*
Urolith*

Large bladder, difficult to express

Mechanical obstruction

Matrix-crystalline plugs*
Neoplasia*
- Bladder
- Urethra

Prostatomegaly*
Urethral stricture
Uroliths*
- Bladder neck
- Urethra

Functional obstruction

Neurological disease
- Upper motor neurone bladder*
  - Spinal disorders cranial to L7 *q.v.*

Psychogenic*
- Pain
- Stress

Reflex dyssynergia
Drugs/toxins, e.g.
- Atropine
- Glycopyrronium bromide
- Propantheline bromide
- Tricyclic antidepressants

Large bladder, easy to express

Normal

Neurological disease, e.g.
Dysautonomia
Lower motor neurone bladder*
- Cauda equina syndrome
- Lesion of sacral spinal cord
- Lesions of pelvic/lumbosacral plexus

Small/difficult to palpate bladder

Congenital hypoplasia
Ectopic ureters
Non-distensible bladder
- Diffuse bladder-wall neoplasia
- Severe cystitis, e.g.
  - Calculi
  - Infection
  - Trauma

Oliguric/anuric renal failure *q.v.*
Recent voiding*
Ruptured bladder
Ruptured ureters

2.8.3 Prostate abnormal on palpation

Enlargement

Diffuse
Bacterial prostatitis
Benign prostatic hyperplasia*
Neoplasia

Focal lesions
Abscess
Cysts
- Paraprostatic
- Prostatic

Neoplasia

2.8.4 Uterus abnormal on palpation

Enlargement on palpation

Haemometra
Hydrometra
Mucometra
Neoplasia*
- Adenocarcinoma
- Adenoma
- Leiomyoma
- Leiomyosarcoma

Post partum*
Pregnancy*
Pyometra*

2.8.5 Testicular abnormalities

Single palpable testis

Castration of single descended testis with subsequent descent of unilateral cryptorchid testis
Unilateral cryptorchid*
Unilateral testicular agenesis

No palpable testis

Bilateral cryptorchid*
Bilateral testicular agenesis
Intersex abnormalities
Previous castration*

Large testis

Acute infection
Inguinoscrotal hernia
Neoplasia
Sperm granuloma
Testicular torsion

Small testis

Chronic inflammation
Cryptorchidism
Degeneration
Hypoplasia
Intersex
Sertoli cell tumour in contralateral testis

Reference

Yates, D. (2003) Incidence of cryptorchidism in dogs and cats. *Vet Rec,* **152**:502–504.

2.8.6 Penis abnormalities

Paraphimosis

Chronic balanoposthitis
Foreign bodies in prepuce
Fracture of the os penis
Idiopathic
Obstruction of the preputial opening by long hair*
Small preputial opening
- Congenital
- Post-surgical
- Traumatic

Soft tissue trauma*
Spinal lesions

Penile bleeding

Haematuria* *q.v.*
Herpes virus
Transmissible venereal tumour
Other tumours
Trauma

Prostatic disease, e.g.
Benign hyperplasia

Urethral disease, e.g.
Urethral prolapse

Reference

Papazoglou, L. G. (2001) Idiopathic chronic penile protrusion in the dog: a report of six cases. *JSAP,* **42**:510–13.

PART 3
RADIOGRAPHIC AND ULTRASONOGRAPHIC SIGNS

3.1 Thoracic radiography

3.1.1 Artefactual causes of increased lung opacity

Chemical stains/dirty cassettes
Dirty or wet fur
Forelimbs not pulled sufficiently forward
Movement blur
Obesity
Poorly inflated lungs
- Abdominal distension
- Expiratory film
- Upper airway obstruction

Underdevelopment
Underexposure

3.1.2 Increased bronchial pattern

Normal variation*
Chondrodystrophic breeds
Older dogs

Bronchial wall oedema, e.g.
Congestive heart failure*

Bronchiectasis

Chronic bronchitis*
Primary ciliary dyskinesia (D)

Infection
Bacterial*
Fungal, e.g.
- *Pneumocystis carinii*

Parasitic, e.g.
- *Crenosoma vulpis* (D)

Protozoal, e.g.
- Toxoplasmosis

Viral

Inflammation, e.g.

Eosinophilic bronchopneumonopathy (Pulmonary infiltrate with eosinophils) (D)
Feline asthma (C)

Endocrine

Hyperadrenocorticism

Figure 3.1(a) Dorsoventral thoracic radiograph of a cat with feline asthma, showing a predominantly bronchial pattern. A microchip is also visible. Reproduced with permission of Downs Referrals, Bristol.

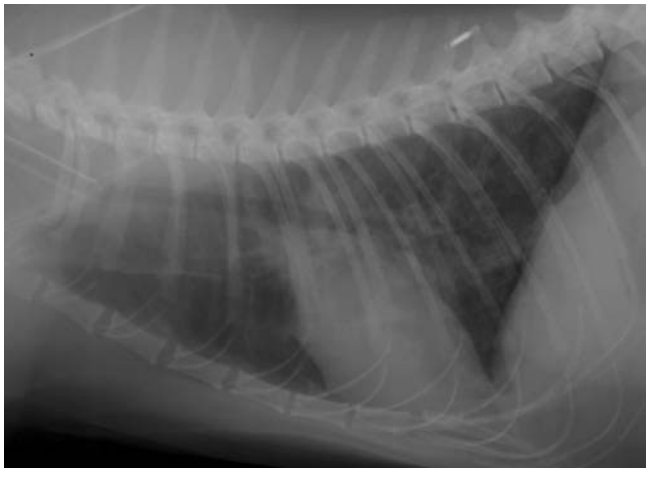

Figure 3.1(b) Lateral thoracic radiograph of the same case as in Figure 3.1(a). Reproduced with permission of Downs Referrals, Bristol.

Neoplasia
Bronchogenic carcinoma
Lymphoma

References

Clercx, C. (2002) Is canine eosinophilic bronchopneumopathy an asthmatic disease? *Proceedings*, *12th ECVIM-CA/ESVIM Congress,* 2002.
Foster, S. F. (2004) Twenty-five cases of feline bronchial disease (1995–2000). *J Feline Med Surg,* **6**:181–8.
Kirberger, R. M. & Lobetti, R. G. (1998) Radiographic aspects of *Pneumocystis carinii* pneumonia in the miniature Dachshund. *Vet Radiol Ultrasound,* **39**:313–17.
Mantis, P., et al. (1998) Assessment of the accuracy of thoracic radiography in the diagnosis of canine chronic bronchitis. *JSAP,* **39**:518–20.
McCarthy, G. (1999) Investigation of lower respiratory tract disease in the dog. *In Practice,* **21**:521–7.
Unterer, S., et al. (2002) Spontaneous *Crenosoma vulpis* infection in 10 dogs: laboratory, radiographic and endoscopic findings. *Schweiz Arch Tierheilkd,* **144**:174–9.

3.1.3 Increased alveolar pattern

Atelectasis

Airway obstruction
Chronic pleural or pulmonary disease*
Collapse of lung lobes under general anaesthesia*
Extra-pulmonary thoracic mass
Feline asthma* (C)
Lack of surfactant (newborn, acute respiratory distress syndrome)
Lung lobe torsion
Pleural effusion* *q.v.*
Pneumothorax* *q.v.*
Recumbency

Neoplasia

Malignant histiocytosis
Primary lung tumour, e.g.
- Bronchoalveolar carcinoma

Pulmonary lymphomatoid granulomatosis

Pulmonary oedema

Acute dyspnoea in Swedish Hunting Dogs
Acute pancreatitis*
Airway obstruction
Brain trauma
Congestive heart failure*
Electrocution
Hypoalbuminaemia
Hypostatic congestion*
Iatrogenic
- Aspirated hypertonic contrast media

- IV contrast media
- Overhydration

Inhalation of irritant gases/smoke
Lung lobe torsion
Near drowning
Obstruction of pulmonary drainage mechanisms, e.g.

- Hilar mass

Post-ictal
Re-expansion, e.g.

- Post pneumothorax

Seizures
Other CNS disease
Uraemia *q.v.*

Acute respiratory distress syndrome
Iatrogenic, e.g.

- Overhydration
- Oxygen therapy

Infection
Inhalation pneumonia
Pancreatitis
Trauma

Toxins
Alphanapthylthiourea
Endotoxin
Ethylene glycol
Paracetamol
Snake venom

Pneumonia

Aspiration pneumonia
Aspirated foreign body*
Cleft palate
Gastrobronchial fistula
Generalised weakness
Iatrogenic, e.g.

- Anaesthetic complication
- Force feeding
- Incorrectly placed stomach tube

Oesophagotracheal/bronchial fistula
Regurgitation, e.g.

- Megaoesophagus

Swallowing disorders
Vomiting

Bronchopneumonia, e.g.
Canine distemper virus with secondary bacterial infection* (D)
Tracheobronchitis*

Bacterial, e.g.
Tuberculosis
Tularaemia

Fungal, e.g.
Pneumocystis carinii

Parasitic, e.g.
Aelurostrongylus abstrusus (C)
Angiostrongylus vasorum (D)
Dirofilaria immitis
Oslerus osleri (D)

Miscellaneous
Kartagener's syndrome
Primary ciliary dyskinesia
Radiation therapy

Pulmonary haemorrhage

Coagulopathy *q.v.*
Exercise-induced
Idiopathic
Neoplasia*
Trauma*

Inflammation/immune-mediated

Eosinophilic bronchopneumonopathy (Pulmonary infiltrate with eosinophilia)

Pulmonary thromboembolism

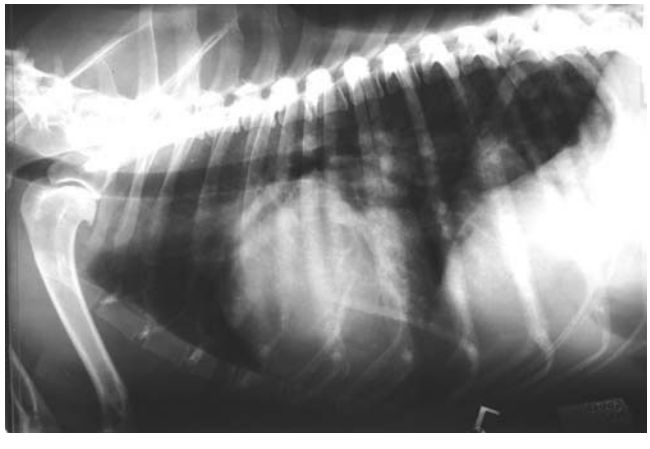

Figure 3.1(c) Lateral thoracic radiograph showing an alveolar pattern due to pulmonary oedema. The enlarged cranial lobar pulmonary veins suggest that this is secondary to left-sided congestive heart failure. Reproduced with permission of Downs Referrals, Bristol.

Figure 3.1(d) Dorsoventral thoracic radiograph of a cat with chylothorax. A microchip is present. Reproduced with permission of Downs Referrals, Bristol.

Figure 3.1(e) Lateral thoracic radiograph of the same cat as in Fig. 3.1(d). Reproduced with permission of Downs Referrals, Bristol.

References

Ballegeer, E. A., et al. (2002) Radiographic appearance of bronchoalveolar carcinoma in nine cats. *Vet Radiol Ultrasound*, **43**:267–71.

Boag, A. K. (2004) Radiographic findings in 16 dogs infected with *Angiostrongylus vasorum*. *Vet Rec*, **154**:426–30.

Drobatz, K. J. (1995) Noncardiogenic pulmonary edema in dogs and cats: 26 cases (1987–1993). *JAVMA*, **206**:1732–6.

Egenvall, A., et al. (2003) Pulmonary oedema in Swedish hunting dogs. *JSAP*, **44**:209–17.

Forrest, L. J. & Graybush, C. A. (1998) Radiographic patterns of pulmonary metastasis in 25 cats. *Vet Radiol Ultrasound*, **39**:4–8.
Kirberger, R. M. & Lobetti, R. G. (1998) Radiographic aspects of *Pneumocystis carinii* pneumonia in the miniature Dachshund. *Vet Radiol Ultrasound*, **39**:313–17.
McCarthy, G. (1999) Investigation of lower respiratory tract disease in the dog. *In Practice*, **21**:521–7.
Sherding, R. (2001) Bronchopulmonary parasite infections. *Proceedings, World Small Animal Veterinary Association World Congress, 2001*.

3.1.4 Increased interstitial pattern

Nodular

Artefact

End-on view of blood vessels
Nipples
Objects adhering to coat
Ossification of costochondral junctions
Thoracic wall nodules

Infection

Abscesses
Feline infectious peritonitis* (C)
Granulomata
- Bacterial
- Foreign body*
- Fungal

Hydatid cysts
Parasitic
- *Aelurostrongylus abstrusus* (C)
- *Crenosoma vulpis* (D)
- *Oslerus osleri* (D)
- *Paragonimus kellicotti* (D)
- Tularaemia
- Visceral larva migrans

Pneumonia
- Fungal pneumonia
- Haematogenous bacterial pneumonia
- Mycobacterial pneumonia

Protozoal, e.g.
- Toxoplasmosis

Neoplasia

Lymphoma*
Metastatic tumours*
Primary lung tumours

Miscellaneous

Calcified pleural plaques*
Disseminated intravascular coagulation

Haematomata
Idiopathic mineralisation
Pulmonary osteomata (heterotopic bone)*

Diffuse/unstructured

Artefact, e.g.
- Expiratory film

Neoplasia
Oedema (early) *q.v.*

Endocrine
Hyperadrenocorticism

Infection
Bacterial
Fungal, e.g.
- Blastomycosis
- Coccidioidomycosis
- Cryptococcosis
- Histoplasmosis
- *Pneumocystis carinii* (D)

Mycoplasmosis
Parasitic
- *Aelurostrongylus abstrusus* (C)
- *Angiostrongylus vasorum* (D)
- Babesiosis
- Dirofilariasis

Protozoal, e.g.
Rickettsial, e.g.
- Rocky Mountain Spotted Fever (D)

Toxoplasmosis
Viral, e.g.
- Canine distemper virus* (D)
- Feline infectious peritonitis* (C)

Inhalation
Dust
Irritant gases

Pulmonary fibrosis
Idiopathic
Secondary to chronic respiratory disease

Pulmonary haemorrhage
Coagulopathy *q.v.*
Exercise-induced
Idiopathic
Neoplasia
Trauma

Miscellaneous
Acute respiratory distress syndrome
Pancreatitis
Pulmonary thromboembolism
Radiation therapy
Uraemia* *q.v.*
Very old animals
Very young animals

Drugs/toxins
Chronic glucocorticoid administration
Paraquat

Reticular pattern
Normal ageing*
Chronic fibrosis
Fungal pneumonia
Lymphoma*
Metastatic neoplasia*

References
Boag, A. K. (2004) Radiographic findings in 16 dogs infected with *Angiostrongylus vasorum*. *Vet Rec,* **154**:426–30.
Forrest, L. J. & Graybush, C. A. (1998) Radiographic patterns of pulmonary metastasis in 25 cats. *Vet Radiol Ultrasound,* **39**:4–8.
Kirberger, R. M. & Lobetti, R. G. (1998) Radiographic aspects of *Pneumocystis carinii* pneumonia in the miniature Dachshund. *Vet Radiol Ultrasound,* **39**:313–17.
Lobetti, R. G. (2001) Chronic idiopathic pulmonary fibrosis in five dogs. *JAAHA,* **37**:119–27.
McCarthy, G. (1999) Investigation of lower respiratory tract disease in the dog. *In Practice,* **21**:521–7.

3.1.5 Increased vascular pattern

Increased size of pulmonary arteries
Aelurostrongylus abstrusus (C)
Angiostrongylus vasorum (D)
Dirofilariasis
Large left-to-right shunts, e.g.
- Atrial septal defect
- Endocardial cushion defects
- Patent ductus arteriosus
- Ventricular septal defect

Pulmonary hypertension
Pulmonary thromboembolism

Increased size of pulmonary veins

Left-sided heart failure*
Left-to-right shunts, in some cases

Increased size of pulmonary arteries and veins

Left-to-right shunts, e.g.
- Atrial septal defect
- Endocardial cushion defects
- Patent ductus arteriosus
- Ventricular septal defect

References

Hayward, N. J., et al. (2004) The radiographic appearance of the pulmonary vasculature in the cat. *Vet Rad & Ultrasound*, **45**:501–504.
McCarthy, G. (1999) Investigation of lower respiratory tract disease in the dog. *In Practice*, **21**:521–7.

3.1.6 Decreased vascular pattern

Generalised

Pericardial disease, e.g.
Pericardial effusion* *q.v.*
Restrictive pericarditis

Pulmonary hypoperfusion
Hypoadrenocorticism (D)
Localised hypoperfusion due to pulmonary thromboembolism
Pulmonic stenosis
Severe dehydration*
Shock*
Tetralogy of Fallot

Pulmonary over-inflation
Air trapping
- Chronic bronchitis* (D)
- Feline asthma* (C)
- Upper respiratory tract obstruction, e.g.
  - Foreign body*
  - Nasopharyngeal polyp* (C)

Compensatory
- Following lobectomy
- Secondary to atelectasis of another lobe
- Secondary to congenital lobar atresia/agenesis

Emphysema
Iatrogenic
- Anaesthesia

Right-to-left cardiac shunts, e.g.
Atrial septal defect
Reverse-shunting patent ductus arteriosus
Tetralogy of Fallot
Ventricular septal defect

Localised
Emphysema
Pulmonary thromboembolism

Reference
McCarthy, G. (1999) Investigation of lower respiratory tract disease in the dog. *In Practice*, **21**:521–7.

3.1.7 Cardiac diseases that may be associated with a normal cardiac silhouette

Bacterial endocarditis
Congestive heart failure overzealously treated with diuretics
Constrictive pericarditis
Functional murmurs*
Hypertrophic cardiomyopathy* (C)
Neoplasia
Small atrial septal defect
Small ventricular septal defect

3.1.8 Increased size of cardiac silhouette

Generalised cardiomegaly
Normal variation, e.g.
- Greyhound*

Artefact
- Bacterial endocarditis
- Bradycardia* *q.v.*
- Chronic anaemia* *q.v.*
- Concurrent mitral and tricuspid valve deficiency
- Dysplasia
- Intrapericardial fat
- Mediastinal fat
- Myxomatous degeneration* (D)

Congenital cardiac disease, e.g.
- Peritoneopericardial diaphragmatic hernia

Enlargement of specific chamber sizes *q.v.*
Pericardial effusion* *q.v.*

Myocardial disease
Inflammatory
- Immune-mediated, e.g. rheumatoid arthritis

- Infectious, e.g.
  - Bacterial
  - Fungal
  - Parvovirus
  - Protozoal

Ischaemic
- Arteriosclerosis

Non-inflammatory
- Dilated cardiomyopathy*
- Hypertrophic cardiomyopathy (C)*
- Restrictive cardiomyopathy (C)

Secondary
- Acromegaly
- Amyloidosis
- End-stage mitral valve insufficiency* (D)
- Glycogen storage disease
- Hypertension* *q.v.*
- Hyperthyroidism* (C)
- Mucopolysaccharidosis
- Neoplasia
- Neuromuscular disease
- Nutrition
  - L-carnitine deficiency
  - Taurine deficiency
- Trauma
- Drugs/toxins
  - Doxorubicin
  - Heavy metals

Volume overload

Iatrogenic

Left-sided heart failure

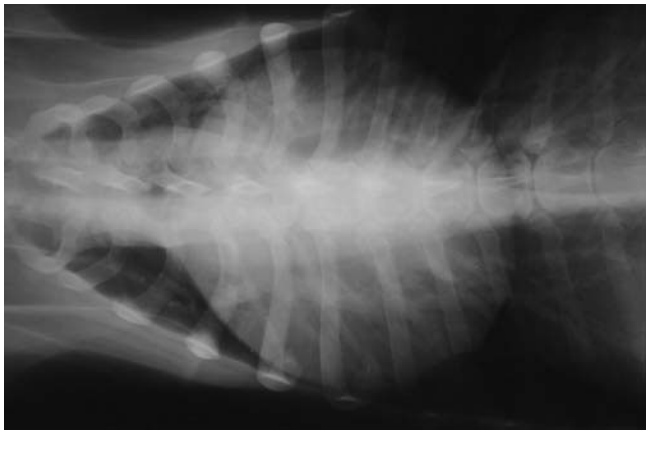

Figure 3.1(f) Dorsoventral thoracic radiograph of a dog, demonstrating a very large cardiac silhouette due to pericardial effusion. Reproduced with permission of Downs Referrals, Bristol.

- Bacterial endocarditis
- Dilated cardiomyopathy*
- Mitral valve dysplasia
- Myxomatous degeneration of the mitral valve* (D)

References

Dark, R. D. (2002) Radiology of cardiac diseases. *Proceedings, Western Veterinary Conference,* 2002.

Ferasin, L., et al. (2002) Feline idiopathic cardiomyopathy. A retrospective study of 106 cats (1994–2001). *Proceedings, ACVIM,* 2002.

Yaphe, W., et al. (1993) Severe cardiomegaly secondary to anemia in a kitten. *JAMVA,* **202**:961–4.

3.1.9 Decreased size of cardiac silhouette

Atrophic myopathies
Constrictive pericarditis
Hypoadrenocorticism (D)
Post thoracotomy

Artefact
Deep-chested dogs
Deep inspiration
Heart displaced from sternum, e.g.
- Mediastinal shift
- Pneumothorax

Pulmonary over-inflation, e.g.
- Emphysema
- Hyperventilation

Decrease in muscle mass
Chronic systemic disease
Malnutrition
Myopathies

*Shock** q.v., *e.g.*
Hypovolaemia, e.g.
- Blood loss
- Severe dehydration

Reference

Melian, C., et al. (1999) Radiographic findings in dogs with naturally-occurring primary hypoadrenocorticism. *JAAHA,* **35**:208–12.

3.1.10 Abnormalities of the ribs

Congenital disorders

Absence of xiphisternum
Agenesis/hypoplasia of 13th rib*
Pectus excavatum
Supernumerary ribs

New bone

Cartilaginous exostoses
Healed fractures
Mineralisation of the costal cartilages*
Neoplasia
Non-union fractures
Periosteal reaction to soft tissue mass

Osteolysis

Metastatic tumours
Osteomyelitis
Primary tumours
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Multiple myeloma
- Osteoma
- Osteosarcoma

Thoracic wall trauma*

References

Fossum, T. W. (1989) Pectus excavatum in eight dogs and six cats. *JAAHA,* **25**:595–605.
Franch, J., et al. (2005) Multiple cartilaginous exostosis in a golden retriever cross-bred puppy. Clinical, radiographic and backscattered scanning microscopy findings. *Vet Comp Ortho Trauma,* **18**:189–93.

3.1.11 Abnormalities of the oesophagus

OESOPHAGEAL DILATATION

Generalised

Transient megaoesophagus
Hiatal hernia
Respiratory infection
Sedation/anaesthesia*

Acquired megaoesophagus
Idiopathic
Immune-mediated myopathies
- Myasthenia gravis
- Polymyositis
- Polyradiculoneuritis
- Systemic lupus erythematosus

Metabolic/endocrine
- Diabetes mellitus*
- Glucocorticoid administration*
- Hyperadrenocorticism*

- Hypoadrenocorticism (D)
- Hypothyroidism* (D)
- Insulinoma
- Renal failure* *q.v.*

Miscellaneous
- Dysautonomia
- Gastric dilatation/volvulus*
- Hypertrophic muscular dystrophy
- Oesophageal foreign body
- Reflux oesophagitis
- Thiamine deficiency

Toxic
- Botulinum toxin
- Chlorinated hydrocarbons
- Heavy metals
- Herbicides
- Organophosphates
- Snake venom
- Tetanus

Congenital megaoesophagus

Canine giant axonal neuropathy (D)
Glycogen storage disease
Hereditary megaoesophagus
Hereditary myopathy
Vascular ring anomaly, e.g.
- Double aortic arch
- Normal aorta with aberrant right subclavian artery
- Persistent right aortic arch
- Persistent right ductus arteriosus
- Right aortic arch with aberrant right subclavian artery

Localised

Redundant oesophagus

Transient

Aerophagia*
Dyspnoea*
Swallowing*

Congenital

Dilatation cranial to a congenital stenosis
Dilatation cranial to oesophageal hiatal hernia
Segmental oesophageal hypomotility
Vascular ring anomaly, e.g.
- Double aortic arch
- Normal aorta with aberrant right subclavian artery
- Persistent right aortic arch
- Persistent right ductus arteriosus
- Right aortic arch with aberrant right subclavian artery
- Oesophageal diverticulum

Acquired

Dilatation cranial to a gastro-oesophageal intussusception
Dilatation cranial to acquired stricture, e.g.
- Extraluminal compression
- Granuloma
- Mucosal adhesion
- Neoplasia
- Post general anaesthesia

Dilatation cranial to an oesophageal foreign body*
Oesophagitis
Scar tissue post trauma

INCREASED OESOPHAGEAL OPACITY

Soft tissue density

Megaoesophagus with collection of food/water
Normal variation, e.g.
- Fluid in oesophagus*
- Superimposition of trachea*

Soft tissue mass

Intraluminal
- Food-containing oesophageal diverticulum
- Foreign body*
- Gastro-oesophageal intussusception
- Oesophageal hiatal hernia

Intramural
- Abscess
- Foreign body
- Granuloma, e.g.
  - *Spirocerca lupi* (D)
- Neoplasia
  - Metastatic
  - Primary oesophageal, e.g.
    Leiomyoma/sarcoma
    Squamous cell carcinoma
  - Secondary to *Spirocerca lupi* (D)

Extraluminal
- Abscess
- Neoplasia
- Paraoesophageal hiatal hernia

Bony density

Foreign body*
Megaoesophagus with collection of food
Osteosarcoma, e.g.
- Secondary to *Spirocerca lupi* (D)

References

Beasley, J. N. (1988) Gastrointestinal parasites in dogs and cats: Some common and unusual complications. *Companion Anim Pract,* **2**:27–30.

Buchanan, J. W. (2004) Tracheal signs and associated vascular anomalies in dogs with persistent right aortic arch. *JVIM,* **18**:510–14.
Kornegay, J. N. (2003) Feline neuromuscular diseases. *Proceedings, ACVIM,* 2003.
Mears, E. A. (1997) Canine and feline megaesophagus. *Compend Contin Educ Pract Vet,* **19**:313–26.
Ranen, E., et al. (2004) Spirocercosis-associated esophageal sarcomas in dogs. A retrospective study of 17 cases (1997–2003). *Vet Parasitol,* **119**:209–21.
Shelton, G. D. (1998) Myasthenia gravis: lessons from the past 10 years. *JSAP,* **39**:368–72.
Spielman, B. L., et al. (1992) Esophageal foreign body in dogs: A retrospective study of 23 cases. *JAAHA,* **28**:570–74.

3.1.12 Abnormalities of the trachea

Dorsal displacement

Artefact
- Expiration
- Rotation
- Ventroflexion

Breed variation*
Cardiomegaly*
Cranioventral mediastinal mass
Heart base tumour
Tracheobronchial lymphadenopathy*

Ventral displacement

Craniodorsal mediastinal mass
Megaoesophagus
Oesophageal foreign body*
Post-stenotic aortic dilatation
Vertebral spondylosis

Lateral displacement

Artefact
- Expiration
- Rotation
- Ventroflexion

Breed variation*
Cranial mediastinal mass
Heart base tumour
Mediastinal shift *q.v.*
Megaoesophagus
Vascular ring anomaly

Narrowing

Congenital hypoplasia

Artefact

Hyperextension of neck
Superimposition of muscle/oesophagus

External compression
Cranial mediastinal mass
Megaoesophagus
Oesophageal foreign body*
Vascular ring anomaly

Mucosal thickening
Feline infectious peritonitis* (C)
Inflammation, e.g.
- Allergy*
- Infection*
- Irritant gases

Submucosal haemorrhage, e.g.
- Coagulopathy

Stricture/stenosis
Congenital
Excessive pressure from the cuff of endotracheal tube
Focal intramural mass
Post-traumatic injury

*Tracheal collapse**
Acquired, e.g.
- Secondary to chronic bronchitis

Congenital

Opacification of lumen

Abscess
Aspiration of positive contrast agents
Foreign body*
Granuloma
Oslerus osleri
Polyp

Neoplasia
Adenocarcinoma
Chondrosarcoma
Leiomyoma
Lymphoma
Mast cell tumour
Osteochondroma
Osteosarcoma

References

Brown, M. Q. & Rogers, K. S. (2003) Primary tracheal tumors in dogs and cats. *Compend Contin Educ Pract Vet,* **25**:854–60.

Buchanan, J. W. (2004) Tracheal signs and associated vascular anomalies in dogs with persistent right aortic arch. *JVIM,* **18**:510–14.

Coyne, B. E. (1992) Hypoplasia of the trachea in dogs: 103 cases (1974–1990). *JAVMA,* **201**:768–72.

3.1.13 Pleural effusion

Bile pleuritis

Ruptured biliary tree with diaphragmatic hernia

Blood

Autoimmune disorders, e.g.
- Immune mediated thrombocytopenia

Coagulopathy
Neoplasia, e.g.
- Haemangiosarcoma

Trauma

Chyle

Congenital duct malformation (D)
Constrictive pleuritis
Cranial mediastinal mass
Diaphragmatic rupture*
Feline dirofilariasis (C)
Idiopathic*
Lung lobe torsion
Neoplasia
Peritoneopericardial diaphragmatic hernia
Post pacemaker implantation (C)
Rupture of thoracic duct

*Heart disease**
Dilated cardiomyopathy (C)
Hypertrophic cardiomyopathy (C)*
Pericardial disease
Right-sided heart failure (C)

Obstruction of thoracic duct
Intraluminal
- Granuloma
- Neoplasia

Extraluminal
- Increased intrathoracic pressure

Exudate

Actinomycosis
Autoimmune disorders, e.g.
- Rheumatoid arthritis
- Systemic lupus erythematosus

Feline infectious peritonitis* (C)
Fungal infection
Neoplasia*
Nocardiosis
Pneumonia*

Pyothorax*
- Foreign body
- Haematogenous spread
- Penetrating thoracic wound
- Penetration of trachea/oesophagus

Tuberculosis

Transudate/modified transudate

Congestive heart failure*
Diaphragmatic rupture*
Foreign body
Hyperthyroidism* (C)
Hypoproteinaemia *q.v.**
- Liver disease*
- Protein-losing enteropathy*
- Protein-losing nephropathy*

Idiopathic
Lung lobe torsion
Neoplasia, e.g.
- Lymphoma*

Pneumonia*
Thromboembolism

References

Demetriou, J. L., et al. (2002) Canine and feline pyothorax: a retrospective study of 50 cases in the UK and Ireland. *JSAP,* **43**:388–94.
Rebar, A. H. (2003) Cytology of pleural and peritoneal effusions. *Proceedings, Western Veterinary Conference,* 2003.
Sturgess, K. (2001) Diagnosis and management of chylothorax in dogs and cats. *In Practice,* **23**:506–13.

3.1.14 Pneumothorax

Artefact

Overdevelopment
Overexposure*
Overinflation of the lungs
Skin folds*
Undercirculation

Iatrogenic

Cardiopulmonary resuscitation
Leaking chest drain
Lung aspiration/biopsy
Thoracocentesis
Thoracotomy

Spontaneous

Bacterial pneumonia
Parasites

- Dirofilariasis
- *Oslerus osleri*
- *Paragonimus*

Pleural adhesions
Rupture of congenital or acquired bullae, cysts or blebs
Tumours*

Trauma

Perforation of lung*
Perforation of oesophagus
Perforation of thoracic wall*
Perforation of trachea/bronchi*

References

Lipscomb, V. J., et al. (2003) Spontaneous pneumothorax caused by pulmonary blebs and bullae in 12 dogs. *JAAHA,* **39**:435–45.
Smith, J. W., et al. (1998) Pneumothorax secondary to *Dirofilaria immitis* infection in two cats. *JAVMA,* **213**:91–3.

3.1.15 Abnormalities of the diaphragm

Cranial displacement

Diaphragmatic rupture/hernia*

Abdominal causes

Abdominal neoplasia*
Ascites*
Gastric dilatation*
Obesity*
Organomegaly*, e.g.

- Liver
- Spleen

Pneumoperitoneum
Pregnancy*
Pyometra*

Thoracic causes

Atelectasis
Diaphragmatic paralysis
Diaphragmatic tumour
Expiratory film*
Lung lobectomy
Pleural adhesions
Pulmonary fibrosis

Caudal displacement

Abdominal causes

Abdominal body wall rupture/hernia leading to abdominal organ displacement
Poor body condition

Thoracic causes
Chronic dyspnoea*
Deep inspiration*
Intrathoracic mass*
Pleural effusion*
Pneumothorax*

Irregular diaphragmatic contour

Diaphragmatic rupture/hernia*
Hypertrophic muscular dystrophy
Pleural masses, e.g.
- Granuloma
- Neoplasia

Severe lung hyperinflation

Lack of visualisation of diaphragmatic border

Artefact, e.g.
- Expiratory film

Diaphragmatic hernia*
Increased lung density, e.g.
- Alveolar pattern*

Neoplasia adjacent to diaphragm*
Peritoneopericardial diaphragmatic hernia
Pleural effusion*

References

Hyun, C. (2004) Radiographic diagnosis of diaphragmatic hernia: review of 60 cases in dogs and cats. *J Vet Sci,* **5**:157–62.
Rexing, J. F. & Coolman, B. R. (2004) A peritoneopericardial diaphragmatic hernia in a cat. *Vet Med*, **99**:314–18.
Smelstoys, J. A., et al. (2004). Outcome of and prognostic indicators for dogs and cats with pneumoperitoneum and no history of penetrating trauma: 54 cases (1988–2002). *JAVMA,* **225**:251–5.

3.1.16 Mediastinal abnormalities

Mediastinal shift

Away from affected hemithorax
Diaphragmatic rupture/hernia*
Lobar emphysema
Lung mass*
Oblique view
Pleural mass*
Unilateral pleural effusion*
Unilateral pneumothorax*

Towards affected hemithorax
Atelectasis
- Feline asthma* (C)

- Foreign body*
- Mass*
- Radiation

Hypostatic congestion*, e.g.

- General anaesthesia
- Illness resulting in prolonged lateral recumbency

Lobar agenesis/hypoplasia
Lobectomy
Lung lobe torsion
Oblique view
Radiation-induced fibrosis
Unilateral phrenic nerve paralysis

Pneumomediastinum

Emphysematous mediastinitis
Iatrogenic
Secondary to severe dyspnoea*

Air from neck
Gas-forming bacteria
Trauma*, e.g.

- Jugular venipuncture
- Oesophagus
- Pharynx
- Soft tissue
- Trachea

Air from bronchi/lungs, e.g.
Lung lobe torsion
Spontaneous
Trauma*

Widened mediastinum

Normal variation*

- Bulldogs

Abscess

- Foreign body

Masses (see below)
Megaoesophagus *q.v.*
Obesity*

Mediastinal effusions, e.g.
Chylomediastinum
Haemorrhage

- Coagulopathy
- Neoplasia
- Trauma*

Mediastinitis/mediastinal abscess
Feline infectious peritonitis (C)
Lymphadenitis

Oesophageal/tracheal perforation
Penetrating neck wound*
Pleuritis*
Pneumonia*

*Oedema**
Congestive heart failure*
Hypoproteinaemia* *q.v.*
Neoplasia*
Trauma*

Mediastinal masses

Aortic aneurysm
Cyst
Granuloma
- Actinomycosis
- Nocardiosis

Haematoma
Hiatal hernia
Oesophageal dilatation
Oesophageal foreign body*
Oesophageal granuloma
- *Spirocerca lupi (D)*

Thymus

Artefact
Left or right atrial enlargement
Lung lobe tip
Pleural fluid
Post-stenotic dilatation of aorta or pulmonary artery

Lymphadenopathy
Neoplasia
- Lymphoma*
- Malignant histiocytosis
- Metastatic neoplasia*

Bacterial
- Actinomycosis
- Nocardiosis
- Tuberculosis

Eosinophilic pulmonary granulomatosis
Fungal
- Blastomycosis
- Coccidioidomycosis
- Cryptococcosis
- Histoplasmosis

Neoplasia
Ectopic parathyroid tumour
Ectopic thyroid tumour

Fibrosarcoma
Heart base tumours
Lipoma*
Lymphoma*
Malignant histiocytosis
Rib tumour
Thymoma

References

Mason, G. D., et al. (1990) Fatal mediastinal hemorrhage in a dog. *Vet Radiol Ultrasound,* **31**:214–16.
Mellanby, R. J., et al. (2002) Canine pleural and mediastinal effusions: a retrospective study of 81 cases. *JSAP,* **43**:447–51.
Zekas, L. J. & Adams, W. M. (2002) Cranial mediastinal cysts in nine cats. *Vet Radiol Ultrasound,* **43**:413–18.

3.2 Abdominal radiography

3.2.1 Liver

Generalised enlargement

Endocrine disease
Diabetes mellitus*
Hyperadrenocorticism

Infection/inflammation
Abscess
Feline infectious peritonitis* (C)
Fungal infection
Granuloma
Hepatitis*
Lymphocytic cholangitis*

Neoplasia, e.g.
Haemangiosarcoma
Lymphoma*
Malignant histiocytosis
Metastatic tumours*

Venous congestion
Caudal vena cava occlusion (post caval syndrome)
- Adhesions
- Cardiac neoplasia
- Congenital cardiac disease
- Diaphragmatic rupture/hernia*
- Dirofilariasis
- Pericardial disease

Fibrosarcoma
Heart base tumours
Lipoma*
Lymphoma*
Malignant histiocytosis
Rib tumour
Thymoma

References

Mason, G. D., et al. (1990) Fatal mediastinal hemorrhage in a dog. *Vet Radiol Ultrasound,* **31**:214–16.
Mellanby, R. J., et al. (2002) Canine pleural and mediastinal effusions: a retrospective study of 81 cases. *JSAP,* **43**:447–51.
Zekas, L. J. & Adams, W. M. (2002) Cranial mediastinal cysts in nine cats. *Vet Radiol Ultrasound,* **43**:413–18.

3.2 Abdominal radiography

3.2.1 Liver

Generalised enlargement

Endocrine disease
Diabetes mellitus*
Hyperadrenocorticism

Infection/inflammation
Abscess
Feline infectious peritonitis* (C)
Fungal infection
Granuloma
Hepatitis*
Lymphocytic cholangitis*

Neoplasia, e.g.
Haemangiosarcoma
Lymphoma*
Malignant histiocytosis
Metastatic tumours*

Venous congestion
Caudal vena cava occlusion (post caval syndrome)
- Adhesions
- Cardiac neoplasia
- Congenital cardiac disease
- Diaphragmatic rupture/hernia*
- Dirofilariasis
- Pericardial disease

- Thoracic mass
- Thrombosis
- Trauma*

Right-sided congestive heart failure, e.g.

- Dilated cardiomyopathy*
- Pericardial effusion *q.v.*
- Tricuspid regurgitation

Miscellaneous

Amyloidosis
Cholestasis *q.v.**
Cirrhosis (early)*
Hepatic lipidosis (C)
Nodular hyperplasia*
Storage diseases

Drugs

Glucocorticoids

Focal enlargement

Infection/inflammation

Abscess
Granuloma

*Neoplasia**

Biliary cystadenoma
Haemangiosarcoma
Hepatocellular carcinoma*
Hepatoma

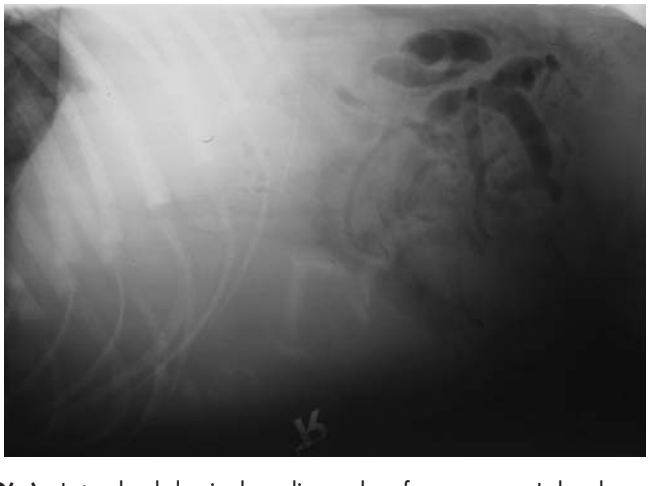

Figure 3.2(a) Lateral abdominal radiograph of a young Labrador demonstrating hepatomegaly. Cytology revealed this to be due to hepatic lymphoma. Reproduced with permission of Downs Referrals, Bristol.

Lymphoma*
Malignant histiocytosis
Metastatic*

Miscellaneous
Biliary pseudocyst
Cyst
Haematoma
Hepatic arteriovenous fistula
Hyperplastic/regenerative nodule*
Liver lobe torsion

Reduced liver size
Cirrhosis
Diaphragmatic rupture/hernia*
Hypoadrenocorticism (D)
Idiopathic hepatic fibrosis
Portosystemic shunt
- Acquired
- Congenital

References
Farrar, E. T., et al. (1996) Hepatic abscesses in dogs: 14 cases (1982–1994). *JAVMA*, **208**:243–7.
Liptak, J. M. (2004) Massive hepatocellular carcinoma in dogs: 48 cases (1992–2002). *JAVMA*, **225**:1225–30.
Melian, C., et al. (1999) Radiographic findings in dogs with naturally-occurring primary hypoadrenocorticism. *JAAHA*, **35**:208–12.

3.2.2 Spleen

Enlargement
Normal, e.g.
Breed related*

Congestion
Gastric dilatation/volvulus*
Portal hypertension
Right-sided congestive heart failure
Sedation and general anaesthesia*
Splenic thrombosis
Splenic torsion

*Haematoma**
Idiopathic
Secondary to neoplasia
Trauma

*Hyperplasia**
Chronic anaemia *q.v.*
Chronic infection
Lymphoid

Inflammation/immune-mediated
Hypereosinophilic syndrome
Immune-mediated haemolytic anaemia
Systemic lupus erythematosus

Infection
Abscess
Babesiosis
Bacteraemia
Ehrlichiosis
Feline infectious peritonitis* (C)
Fungal infections
Haemobartonellosis
Infectious canine hepatitis (D)
Leishmaniasis
Mycobacteria
Toxoplasmosis
Salmonellosis
Septicaemia*

Neoplasia
Fibrosarcoma
Haemangioma
Haemangiosarcoma*
Leiomyosarcoma
Leukaemia
Lymphoma*
Malignant histiocytosis
Multiple myeloma
Systemic mastocytosis

Miscellaneous
Amyloidosis
Extramedullary haematopoiesis*
Infarction
Splenic myeloid metaplasia

Trauma
Foreign body
Penetrating wound

Reduction in size

Dehydration*
Shock* *q.v.*

Absence
Artefact
Displacement though hernia/rupture
Splenectomy

References
O' Brien, R. T. (2004) Sonographic features of drug-induced splenic congestion. *Vet Radiol Ultrasound,* **45**:225–7.
Shaiken, L. C., et al. (1991) Radiographic findings in canine malignant histiocytosis. *Vet Radiol Ultrasound,* **32**:237–42.
Spangler, W. L. & Kass, P. H. (1999) Splenic myeloid metaplasia, histiocytosis, and hypersplenism in the dog (65 cases). *Vet Pathol,* **36**:583–93.

3.2.3 Stomach

Cranial displacement
Diaphragmatic hernia/rupture*
Hiatal hernia
Late pregnancy*
Microhepatica
Neoplasia/mass, e.g.
- Colonic
- Mesenteric
- Pancreatic

Peritoneopericardial diaphragmatic hernia

Caudal displacement
Enlargement of thoracic cavity, e.g.
- Overinflation of lungs
- Pleural effusion* *q.v.*

Hepatomegaly* *q.v.*

Distended
Acute gastritis*
Gastric dilatation volvulus*
Pancreatitis*

*Aerophagia**
Bolting food
Dyspnoea
Pain

Iatrogenic
Anticholinergic drugs
Endoscopic inflation
Misplaced endotracheal tube
Stomach tube

Outflow obstruction
Fibrosis/scarring
Foreign body*
Granuloma
Muscular or mucosal hypertrophy
Neoplasia
Pylorospasm
Ulceration

Abnormal contents

Gas
Aerophagia*
Gastric dilatation/volvulus*

Mineral opacity
Foreign body*
Gravel sign (outflow obstruction)*
Iatrogenic
- Barium
- Bismuth
- Kaolin

Soft tissue opacity
Blood clot
Food/ingested liquid*
Foreign body*
Intussusception
Neoplasia
Polyp

Increased wall thickness (contrast radiography)

Focal
Artefact
- Empty stomach

Hypertrophy
- Mucosal
- Muscular

Inflammation
- Eosinophilic
- Fungal infection
- Granulomatous

Neoplasia
- Adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma

Diffuse
Inflammation
- Chronic gastritis*
- Eosinophilic gastritis*

Neoplasia
- Lymphoma
- Pancreatic tumour

Chronic hyperplastic gastropathy

Delayed gastric emptying

Gastritis*
General anaesthesia/sedation*

Functional disorders
Adynamic ileus*
Dysautonomia
Pancreatitis*
Primary dysmotilities
Uraemia* *q.v.*

Pylorospasm
Anxiety
Stress

Pyloric outflow obstruction
Chronic hyperplastic gastropathy
Fibrosis/scar tissue
Foreign body*
Granuloma
Neoplasia
- Biliary
- Duodenal
- Gastric
- Pancreatic

Pyloric hypertrophy
- Mucosal
- Muscular

Ulceration

Ulceration
Duodenal
Gastric

References

Guildford, G. W. (2005) Motility disorders: Approach and management. *Proceedings, BSAVA Congress,* 2005.

Swann, H. M., et al. (2002) Canine gastric adenocarcinoma and leiomyosarcoma: A retrospective study of 21 cases (1986–1999) and literature review. *JAAHA,* **38**:157–64.

3.2.4 Intestines

SMALL INTESTINE

Increased number of small intestinal loops visible

Normal distension with fluid, food or gas*

Functional obstruction

Abdominal pain*
Acute gastroenteritis*
Adynamic ileus/pseudo-obstruction*
Amyloidosis
Neurogenic disease
Oedema
Post surgery
Vascular disease
Drugs

Physical obstruction

Adhesions*
Foreign body*
Intussusception
Localised inflammation*
Neoplasia

Decreased number of small intestinal loops visible

Body wall/diaphragmatic hernia/rupture*
Enterectomy
Intussusception
Linear foreign body*
Loss of serosal detail *q.v.*
Normal empty small intestine
Obesity*

Displacement

Diaphragmatic disorders

Peritoneopericardial diaphragmatic hernia
Rupture/hernia*

Cranial displacement

Empty stomach*
Enlarged urinary bladder* *q.v.*
Enlarged uterus*
- Pregnancy*
- Pyometra*

Microhepatica

Caudal displacement

Distended stomach*

Empty urinary bladder*
Hepatomegaly* *q.v.*
Hernias*
- Inguinal*
- Perineal*

Lateral displacement
Hepatomegaly* *q.v.*
Prolonged lateral recumbency*
Renomegaly* *q.v.*
Splenomegaly* *q.v.*

Bunching
Adhesions*
Linear foreign body*
Obesity*

Increased width of small intestinal loops
Artefact
Mistaking colon for small intestine

Mechanical obstruction
Abscess
Adhesions*
Caecal impaction
Constipation*
Foreign body*
Granuloma
Intestinal volvulus
Intussusception
Neoplasia, e.g.
- Adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma

Polyps
Strangulation in hernia/mesenteric tear
Stricture

Functional obstruction
Dysautonomia
Electrolyte imbalances* *q.v.*
Pancreatitis*
Peritonitis*
Recent abdominal surgery*
Secondary to chronic mechanical obstruction*
Severe gastroenteritis*

Variation in small intestinal contents

Gas density

Normal*
Adhesions*
Aerophagia*
Enteritis*
Functional obstruction
- Dysautonomia
- Electrolyte imbalances* *q.v.*
- Pancreatitis*
- Peritonitis*
- Recent abdominal surgery*
- Secondary to chronic mechanical obstruction*
- Severe gastroenteritis*

Mechanical obstruction
- Abscess
- Adhesions
- Caecal impaction
- Constipation*
- Foreign body*
- Granuloma
- Intestinal volvulus
- Intussusception
- Neoplasia, e.g.
  - Adenocarcinoma
  - Leiomyoma
  - Leiomyosarcoma
  - Lymphoma
- Polyps
- Strangulation in hernia/mesenteric tear

Partial obstruction*
Prolonged recumbency*

Fluid/soft tissue density

Normal*
Diffuse infiltrative neoplasia
Functional obstruction
- Dysautonomia
- Electrolyte imbalances* *q.v.*
- Pancreatitis*
- Peritonitis*
- Recent abdominal surgery*
- Secondary to chronic mechanical obstruction*
- Severe gastroenteritis*

Mechanical obstruction
- Abscess
- Adhesions*
- Caecal impaction

- Constipation*
- Foreign body*
- Granuloma
- Intestinal volvulus
- Intussusception
- Neoplasia, e.g.
  - Adenocarcinoma
  - Leiomyoma
  - Leiomyosarcoma
  - Lymphoma
- Polyps
- Strangulation in hernia/mesenteric tear

Mistaking colon or enlarged uterus for small intestine

Bony/mineral density

Food*
Foreign body*
Iatrogenic
- Contrast media
- Medications

Delayed intestinal transit time

Diffuse neoplasia
Enteritis*
Inflammatory bowel disease*
Sedation/general anaesthesia*

Functional obstruction

Dysautonomia
Electrolyte imbalances* *q.v.*
Pancreatitis*
Peritonitis*
Recent abdominal surgery*
Secondary to chronic mechanical obstruction*
Severe gastroenteritis*

Mechanical obstruction (partial)

Abscess
Adhesions*
Caecal impaction
Constipation*
Foreign body*
Granuloma
Intussusception
Neoplasia, e.g.
- Adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma

Polyps
Strangulation in hernia/mesenteric tear

Luminal filling defects on contrast radiography

Foreign body*
Intussusception
Neoplasia
Parasitism*
Polyp

Increased wall thickness (contrast radiography)

Inflammatory bowel disease*
Fungal infections
Lymphangiectasia
Neoplasia, e.g.
- Adenocarcinoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma

LARGE INTESTINE

Displacement

Ascending colon
Adrenal mass
Duodenal dilatation*
Hepatomegaly* *q.v.*
Lymphadenopathy* *q.v.*
Pancreatic mass
Renomegaly *q.v.*

Transverse colon
Diaphragmatic rupture/hernia*
Dilatation of stomach*
Enlarged bladder* *q.v.*
Enlarged uterus*
Hepatomegaly* *q.v.*
Lymphadenopathy* *q.v.*
Microhepatica *q.v.*
Mid-abdominal mass*
Pancreatic mass

Descending colon
Adrenal mass
Enlarged bladder* *q.v.*
Enlarged uterus* *q.v.*
Hepatomegaly* *q.v.*
Lymphadenopathy* *q.v.*
Prostatomegaly*

Renomegaly* *q.v.*
Retroperitoneal fluid
Splenomegaly* *q.v.*

Rectum
Paraprostatic cyst
Perineal hernia*
Prostatomegaly*
Sacral or vertebral mass
Urethral mass
Vaginal mass
Other pelvic/intrapelvic mass

Dilatation

Constipation/obstipation* *q.v.*

Variation in contents

Empty
Normal
Caecal inversion
Enema
Gastric/small intestinal obstruction* *q.v.*
Large intestinal diarrhoea* *q.v.*
Intussusception
Neoplasia
Typhlitis

Soft tissue/mineral density
Caecal impaction
Constipation/obstipation* *q.v.*
Undigested dietary material*

Luminal filling defects on contrast radiography

Caecal inversion
Faeces*
Foreign body*
Intussusception
Masses
- Neoplasia
- Polyps

Increased wall thickness (contrast radiography)

Colitis*
Fibrosis from previous trauma/surgery
Neoplasia

References

Bowersox, T. S. (1991) Idiopathic, duodenogastric intussusception in an adult dog. *JAVMA*, **199**:1608–1609.
Cohn, L. A. (2002) What is your diagnosis? *JAVMA*, **220**:169–70.

Junius, G., et al. (2004) Mesenteric volvulus in the dog: a retrospective study of 12 cases. *JSAP*, **45**:104–107.
Paoloni, M. C., et al. (2002) Ultrasonographic and clinicopathological findings in 21 dogs with intestinal adenocarcinoma. *Vet Rad and Ult*, **43**:562–7.
Patsikas, M. N., et al. (2003) Ultrasonographic signs of intestinal intussusception associated with acute enteritis or gastroenteritis in 19 young dogs. *JAAHA*, **39**:57–66.
Prosek, R., et al. (2000) Using radiographs to diagnose the cause of vomiting in a dog. *Vet Med*, **95**:688–90.

3.2.5 Ureters

Dilated

Ascending infection
Ectopic ureter
- Congenital
- Iatrogenic, e.g.
  - Post ovariohysterectomy

External compression, e.g.
- Abdominal mass*

Hydroureter
- Iatrogenic
- Neoplasia
- Stricture following ureterolith or other trauma
- Ureterolith

Ureteral diverticula
Ureterocoele

Reference

Sutherland, J. (2004) Ectopic ureters and ureteroceles in dogs: Presentation, cause, and diagnosis. *Compend Contin Educ Pract Vet*, **26**:303–10.

3.2.6 Bladder

Non-visualisation

Ascites
Bladder hypoplasia
Bladder rupture
Empty bladder
- Bilateral ectopic ureters
- Cystitis*
- Post voiding*

Lack of abdominal fat
Positioning fault

Displacement

Abdominal hernia/rupture*
Constipation/obstipation* *q.v.*
Enlarged uterus* *q.v.*
Lymphadenopathy* *q.v.*

Obesity*
Perineal hernia*
Prepubic tendon rupture
Prostatomegaly*
Short urethra
Traumatic urethral injury

Enlarged bladder

Normal*

Functional obstruction

Neurological
- Cauda equina syndrome
- Dysautonomia
- Upper motor neurone spinal cord lesion *q.v.*, e.g.
  - Intervertebral disc disease* (D)
  - Trauma
  - Tumour

Psychogenic*
- Lack of outside/litter access
- Pain
- Stress

Mechanical obstruction

Crystalline–matrix plugs*
Neoplasia
- Bladder
- Urethra

Prostatomegaly*
Urethral stricture
Uroliths*
- Bladder neck
- Urethra

Small bladder

Anuria
Congenital hypoplasia
Ectopic ureters
Non-distensible bladder
- Diffuse bladder-wall neoplasia
- Severe cystitis, e.g.
  - Calculi*
  - Infection*
  - Trauma*

Recent voiding*
Ruptured bladder
Ruptured ureters

Abnormal shape

Diverticula

Herniation
Neoplasia
Patent urachus
Positioning errors
Rupture

Increased opacity

Chronic cystitis*
Foreign body
Neoplasia
Radio-opaque calculi*
- Oxalate
- Silica
- Struvite

Superimposition of other organs

Decreased opacity

Emphysematous cystitis
Iatrogenic

Abnormal bladder contents (contrast cystography)

Filling defects

Artefact
- Air bubbles*

Blood clots*
Calculi*
Neoplasia
Polyps
Severe cystitis*

Increased opacity

Blood clots*
Neoplasia
Polyps
Uroliths*

Thickening of bladder wall (contrast cystography)

Chronic cystitis*
Chronic outflow obstruction
Polyps
Small bladder*

Neoplasia

Adenocarcinoma
Leiomyoma
Leiomyosarcoma
Metastatic neoplasia

Rhabdomyosarcoma
Squamous cell carcinoma
Transitional cell carcinoma

Failure of bladder to distend (contrast radiography)

Congenital defects, e.g.
- Ectopic ureters
- Hypoplasia

Cystitis*
Neoplasia
Rupture

References

Labato, M. A. (2002) Management of micturition disorders. *Proceedings, Tufts Animal Expo, 2002*.
Norris, A. M., et al. (1992) Canine bladder and urethral tumors: A retrospective study of 115 cases (1980–1985). *JVIM*, **6**:145–53.

3.2.7 Urethra

Filling defects (contrast urethrography)

Air bubbles*
Blood clots
Neoplasia
Uroliths*

Strictures/irregular surface

Neoplasia
Previous surgery
Previous uroliths
Prostatic disease*
Urethritis*

Displacement

Adjacent neoplasia
Bladder displacement
Prostatic disease*

Contrast medium leakage

Hypospadia
Normal
Previous urethrotomy/urethrostomy
Prostatic disease*
Urethral rupture
- Iatrogenic
- Trauma

Reference

Moroff, S. D. (1991) Infiltrative urethral disease in female dogs: 41 cases (1980–1987). *JAVMA*, **199**:247–51.

3.2.8 Kidneys

Non-visualisation

Artefact/technical factors
Nephrectomy
Obscured by gastrointestinal tract contents*
Reduced intra-abdominal contrast* *q.v.*
Retroperitoneal effusion
- Haemorrhage
- Urine

Unilateral renal agenesis
Very small kidneys

Enlargement

Smooth outline

Acute pyelonephritis
Acute renal failure *q.v.*
Amyloidosis
Compensatory renal hypertrophy
Congenital conditions
- Ectopic ureter
- Ureterocoele

Feline infectious peritonitis* (C)
Hydronephrosis
- Extrinsic mass
- Neoplasia, e.g.
  - Bladder
  - Prostate
  - Trigone
- Paraureteral pseudocyst
- Ureteral blood clot
- Ureteral inflammation
- Ureterolith
- Ureteral stricture

Neoplasia, e.g.
- Lymphoma*

Nephritis*
Perirenal pseudocysts
Portosystemic shunts
Subcapsular abscess
Subcapsular haematoma

Irregular outline

Abscess
Cyst
Granuloma
Haematoma
Infarction
Neoplasia
- Adenoma
- Anaplastic sarcoma

- Cystadenocarcinoma
- Haemangioma
- Metastatic neoplasia
- Nephroblastoma
- Papilloma
- Renal cell carcinoma
- Transitional cell carcinoma

Polycystic kidney disease

Small kidneys

Chronic glomerulonephritis
Chronic interstitial nephritis*
Chronic pyelonephritis

Increased radio-opacity

Nephroliths

Artefact
Superimposition

Dystrophic mineralisation
Abscess
Granuloma
Haematoma
Neoplasia
Osseous metaplasia

Nephrocalcinosis
Chronic renal failure* *q.v.*
Ethylene glycol toxicity
Hyperadrenocorticism
Hypercalcaemia *q.v.*
Nephrotoxic drugs
Renal telangiectasia

Figure 3.2(b) Dorsoventral abdominal radiograph taken during intravenous urography. The right kidney is enlarged, and the ureter fails to opacify, due to a right ureterolith. Reproduced with permission of Downs Referrals, Bristol.

Dilatation of the renal pelvis (contrast radiography)

Chronic pyelonephritis
Diuresis
Ectopic ureter
Nephrolithiasis
Renal neoplasia

Hydronephrosis

Extrinsic mass
Neoplasia
- Bladder
- Prostate
- Trigone

Paraureteral pseudocyst
Ureteral blood clot
Ureteral inflammation
Ureteral stricture
Ureterolith

Renal pelvic blood clot

Coagulopathy
Iatrogenic (post biopsy)
Idiopathic renal haemorrhage
Neoplasia
Trauma

References

Diez-Prieto, I., et al. (2001) Diagnosis of renal agenesis in a beagle. *JSAP*, **42**:599–602.
Grooters, A. M., et al. (1997) Renomegaly in dogs and cats. Part II. Diagnostic approach. *Compend Contin Educ Pract Vet*, **19**:1213–29.
Hansen, N. (2003) Bilateral hydronephrosis secondary to anticoagulant rodenticide intoxication in a dog. *J Vet Emerg Crit Care*, **13**:103–107.

3.2.9 Loss of intra-abdominal contrast

Artefact

Ultrasound gel on coat*
Wet hair coat*

Ascites/peritoneal fluid

Bile

Ruptured biliary tract
- Neoplasia
- Post surgery, e.g.
  - Cholecystectomy
- Severe cholecystitis
- Trauma

Blood
Coagulopathy *q.v.*
Neoplasia*, e.g.
- Haemangiosarcoma

Trauma

Chyle
Lymphangiectasia
Ruptured cisterna chyli
- Neoplasia
- Trauma

Exudate
Feline infectious peritonitis* (C)
Septic peritonitis, e.g.
- Iatrogenic/nosocomial
- Neoplasia*
- Pancreatitis*
- Penetrating wound
- Ruptured viscus
  - Neoplasia*
  - Post surgery, e.g.
    Enterotomy wound dehiscence*
  - Trauma*

Transudate/modified transudate, e.g.
Cardiac tamponade
Caudal vena caval obstruction
Hepatic disease
- Cholangiohepatitis*
- Chronic hepatitis*
- Cirrhosis*
- Fibrosis*

Hypoalbuminaemia* *q.v.*
Neoplasia
Portal hypertension
Right-sided heart failure*

Urine
Lower urinary tract rupture
- Bladder
- Ureter
- Urethra

Diffuse peritoneal neoplasia

Lack of abdominal fat
Emaciation*
Immaturity*

Peritonitis
Neoplasia*

Irritant
Bile
Urine

Septic
Bile leakage
Gastrointestinal tract leakage
- Devitalisation
  - Foreign body*
  - Gastric dilatation/volvulus*
  - Intestinal volvulus
  - Intussusception
- Perforation
  - Enterotomy wound dehiscence*
  - Gastroduodenal ulceration
  - Penetrating wound

Hepatic abscess
Ruptured prostatic abscess
Ruptured uterus
Septicaemia*
Splenic abscesses
Urinary tract disruption

Viral
Feline infectious peritonitis* (C)

Miscellaneous
Pancreatitis*

References

Costello, M. F., et al. (2004) Underlying cause, pathophysiologic abnormalities and response to treatment in cats with septic peritonitis:51 cases (1990–2001). *JAVMA*, **225**:897–902.

King, L. G. & Gelens, H. C. J. (1992) Ascites. *Compend Contin Educ Pract Vet*, **14**:1063–75.

3.2.10 Prostate

Displacement

Abdominal weakness
Full bladder*
Perineal hernia*
Prostatomegaly*

Enlargement

Benign prostatic hyperplasia*
Paraprostatic cysts

Prostatic cysts
Prostatic neoplasia
Prostatitis*
Testicular neoplasia*

Reference

Caney, S. M., et al. (1998) Prostatic carcinoma in two cats. *JSAP*, **39**:140–3.

3.2.11 Uterus

Enlargement

Haemometra
Hydrometra
Mucometra
Neoplasia
Post partum*
Pregnancy*
Pyometra*
Torsion

3.2.12 Abdominal masses

Cranial abdomen

Adrenal mass
Hepatomegaly/hepatic mass* *q.v.*
Pancreatic mass
Stomach distension/mass*

Mid abdomen

Cryptorchidism*
Mesenteric lymphadenopathy*
Ovarian masses*
Renomegaly/renal mass* *q.v.*
Small intestine
- Foreign body*
- Neoplasia*
- Obstruction*

Splenomegaly/splenic mass* *q.v.*

Caudal abdomen

Distended urinary bladder* *q.v.*
Enlarged uterus* *q.v.*
Large intestine
- Foreign body*
- Neoplasia
- Obstruction*

Prostatomegaly*

3.2.13 Abdominal calcification/mineral density

Abdominal fat
Idiopathic
Pansteatitis

Adrenal glands
Idiopathic
Neoplasia

Arteries
Arteriosclerosis

Gastrointestinal tract
Foreign bodies and ingesta*
Iatrogenic
- Contrast media
- Medication

Uraemic gastritis* *q.v.*

Genital tract
Chronic prostatitis*
Cryptorchidism*
Neoplasia
Ovarian neoplasia
Ovarian or prostatic cyst*
Pregnancy*

Liver
Abscess
Cholelithiasis
Chronic cholecystitis*
Chronic hepatopathy*
Cyst
Granuloma
Haematoma
Neoplasia
Nodular hyperplasia*

Lymph nodes
Inflammation*
Neoplasia*

Pancreas
Chronic pancreatitis*
Fat necrosis
Neoplasia
Pancreatic pseudocyst

Plate 1.2(a) An intussusception in a cat. Reproduced with permission of Downs Referrals, Bristol.

Plate 1.2(b) A large perineal hernia in a dog, causing chronic constipation. Reproduced with permission of Downs Referrals, Bristol.

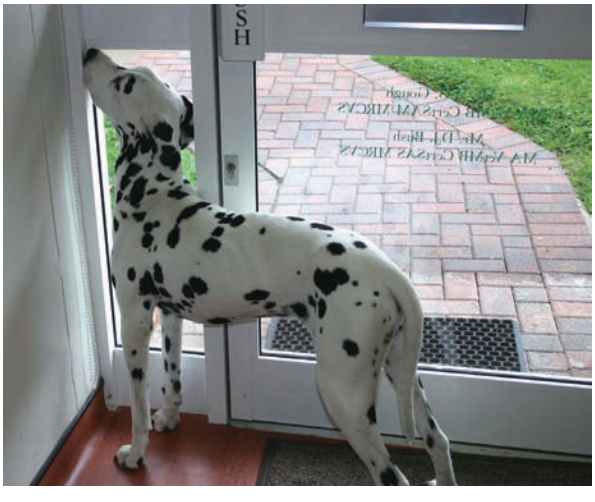

Plate 1.5(a) A Dalmatian dog showing head pressing behaviour due to an intracranial space occupying lesion. Reproduced with permission of Downs Referrals, Bristol.

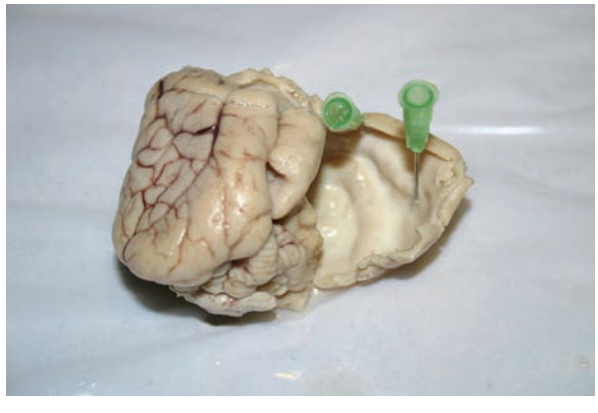

Plate 1.5(b) Post-mortem dissection of the brain of a dog that showed multiple intracranial neurological signs. There is massive dilation of the lateral ventricle and a very thin cerebral cortex. Reproduced with permission of Downs Referrals, Bristol.

Plate 2.4 Alopecia secondary to a severe flea infestation.

Plate 2.5(a) Anisocoria in a cat. Reproduced with permission of Downs Referrals, Bristol.

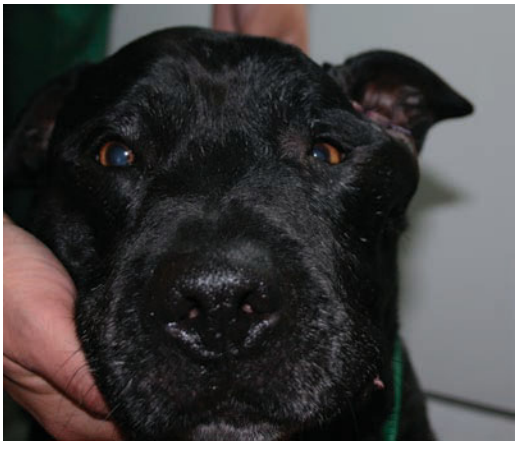

Plate 2.5(b) Unilateral masticatory muscle atrophy due to a malignant nerve sheath tumour of the trigeminal nerve. Reproduced with permission of Downs Referrals, Bristol.

Plate 2.5(c) A Dermoid sinus in a Rhodesian Ridgeback. Reproduced with permission of D. Bush, Downs Referrals, Bristol.

Plate 2.8 Post-mortem dissection of the kidneys of a Persian cat with polycystic kidney disease.

Plate 4.1(a) Peripheral oedema in a dog, secondary to hypoalbuminaemia, demonstrating pitting. Reproduced with permission of Downs Referrals, Bristol.

Plate 4.1(b) Abdominal distension in a dog, due to ascites caused by cirrhosis of the liver. Reproduced with permission of Downs Referrals, Bristol.

Plate 4.1(c) Skin tenting in a severely dehydrated cat. Reproduced with permission of Downs Referrals, Bristol.

Plate 4.3 A parathyroid adenoma in a dog with hypercalcaemia. Reproduced with permission of Downs Referrals, Bristol.

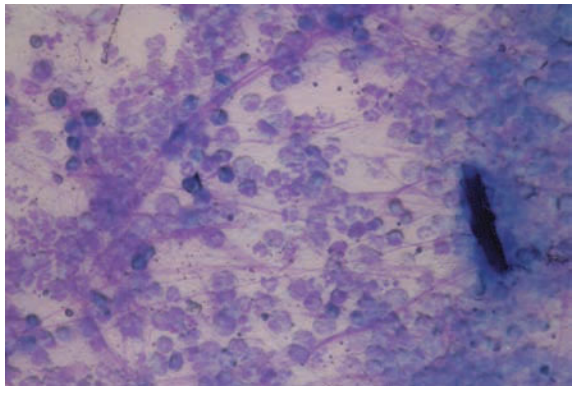

Plate 4.5 A large number of eosinophils detected in a bronchoalveolar lavage from a dog with eosinophilic bronchitis. Reproduced with permission of Abbey Veterinary Services.

Plate 6.12 Measuring buccal mucosal bleeding time.

Spleen
Abscess
Haematoma*
Histoplasmosis

Urinary tract
Chronic inflammation*
Neoplasia
Nephrocalcinosis
- Chronic renal failure* *q.v.*
- Hyperadrenocorticism
- Hypercalcaemia* *q.v.*
- Nephrotoxic drugs *q.v.*

Urolithiasis*

Miscellaneous
Calcinosis cutis
Chronic hygroma
Foreign body*
Mammary gland neoplasia*
Myositis ossificans

References
Lamb, C. R., et al. (1991) Diagnosis of calcification on abdominal radiographs. *Vet Rad and Ultrasound*, **32**:211–20.
Lefbom, B. K., et al. (1996) Mineralized arteriosclerosis in a cat. *Vet Radiol*, **37**:420–23.

3.3 Skeletal radiography

3.3.1 Fractures

Congenital/inherited weakness, e.g.
Incomplete ossification of the humeral condyle

Pathological
Bone cyst
Osteopenia *q.v.*

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia
Multilobular osteochondrosarcoma
Multiple myeloma
Osteosarcoma*

Spleen
Abscess
Haematoma*
Histoplasmosis

Urinary tract
Chronic inflammation*
Neoplasia
Nephrocalcinosis
- Chronic renal failure* *q.v.*
- Hyperadrenocorticism
- Hypercalcaemia* *q.v.*
- Nephrotoxic drugs *q.v.*

Urolithiasis*

Miscellaneous
Calcinosis cutis
Chronic hygroma
Foreign body*
Mammary gland neoplasia*
Myositis ossificans

References
Lamb, C. R., et al. (1991) Diagnosis of calcification on abdominal radiographs. *Vet Rad and Ultrasound*, **32**:211–20.
Lefbom, B. K., et al. (1996) Mineralized arteriosclerosis in a cat. *Vet Radiol*, **37**:420–23.

3.3 Skeletal radiography

3.3.1 Fractures

Congenital/inherited weakness, e.g.
Incomplete ossification of the humeral condyle

Pathological
Bone cyst
Osteopenia *q.v.*

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia
Multilobular osteochondrosarcoma
Multiple myeloma
Osteosarcoma*

Osteomyelitis
Bacterial*
Fungal
Protozoal, e.g.
- Leishmaniasis

Iatrogenic
Bone biopsy
Complication of orthopaedic surgery

Traumatic*

References
Banks, T., et al. (2003) Repair of three pathologic fractures in a dog with multiple myeloma. *Aust Vet Pract*, **33**:98–102.
Higginbotham, M. L. (2003) Primary bone tumors in dogs. *Proceedings, Western Veterinary Conference, 2003*.
Marcellin-Little, D. J., et al. (1994) Incomplete ossification of the humeral condyle in Spaniels. *Vet Surg*, **23**:475–87.

3.3.2 Altered shape of long bones

Abnormally straight
Premature closure of growth plate

Angulation
Fractures*

Bowing
Asymmetric growth plate bridging
- Iatrogenic, e.g.
  - Plating
- Metaphyseal osteopathy

Chondrodysplasia
Chondrodystrophy
- May be normal breed variation*

Congenital hypothyroidism
Rickets
Tension
- Quadriceps contracture
- Shortening of ulna

Irregular margination
Calcifying tendinopathy
Bone cyst
- Enchondromatosis

Metaphyseal osteopathy
Neoplasia
- Chondrosarcoma

- Multiple cartilaginous exostoses
- Osteosarcoma*

Periosteal remodelling *q.v.*

Reference

Watson, C. L. & Lucroy, M. D. (2002) Primary appendicular bone tumors in dogs. *Compend Contin Educ Pract Vet*, **24**:128–38.

3.3.3 Dwarfism

Proportionate

Hypothyroidism (D)
Pituitary dwarfism

Disproportionate

Chondrodysplasia
Hypervitaminosis A
Hypothyroidism (D)
Mucolipidosis type II
Mucopolysaccharidosis
Rickets

Reference

Tanner, E. & Langley-Hobbs, S. J. (2005) Vitamin D-dependent rickets type 2 with characteristic radiographic changes in a 4-month-old kitten. *J Feline Med Surg*, 7:307–11.

3.3.4 Delayed ossification/growth plate closure

Chondrodysplasia
Copper deficiency
Early neutering
Hypervitaminosis D
Hypothyroidism (D)
Mucopolysaccharidosis
Pituitary dwarfism

3.3.5 Increased radiopacity

Artefact
Bone infarcts
Folding fractures*
Growth arrest lines
Lead poisoning
Metaphyseal osteopathy
Neoplasia
Panosteitis
Skeletal immaturity* (metaphyseal condensation)

Osteomyelitis

Bacterial*
Fungal
Protozoal, e.g.
- Leishmaniasis

Osteopetrosis

Acquired
- Chronic excess dietary intake of calcium
- Chronic hypervitaminosis D
- Feline leukaemia virus* (C)
- Idiopathic
- Myelofibrosis

Congenital

Reference

Buracco, P., et al. (1997) Osteomyelitis and arthrosynovitis associated with *Leishmania donovani* infection in a dog. *JSAP*, **38**:29–30.

3.3.6 Periosteal reactions

Craniomandibular osteopathy
Hip dysplasia*
Hypertrophic osteopathy
Hypervitaminosis A
Metaphyseal osteopathy
Mucopolysaccharidosis
Neoplasia
Panosteitis
Trauma*

Infection

Bacterial*
Fungal
Protozoal
- Hepatozoonosis
- Leishmaniasis

Tuberculosis

References

Gawor, J. P. (2004) Case reports of four cases of craniomandibular osteopathy. *Eur J Comp An Pract*, **14**:209–13.
Tyrrel, D. (2004) Hypertrophic osteodystrophy. *Aust Vet Pract*, **34**:124–6.

3.3.7 Bony masses

Neoplasia

Benign

Chondroma
Endochondroma
Monostotic osteochondroma
Multiple osteochondroma (C)
Osteoma
Polyostotic osteochondroma/multiple cartilaginous exostoses

Malignant

Locally invasive soft tissue
- Malignant melanoma of digit
- Soft tissue sarcomas
- Squamous cell carcinoma of digit

Primary bone
- Chondrosarcoma
- Fibrosarcoma
- Giant cell tumour
- Haemangiosarcoma
- Liposarcoma
- Lymphoma
- Multiple myeloma
- Multilobular osteochondrosarcoma
- Osteosarcoma
- Parosteal osteosarcoma
- Plasma cell tumour
- Undifferentiated sarcoma

Tumours which metastasise to bone
- Mammary carcinoma
- Prostatic carcinoma
- Pulmonary carcinoma
- Sarcomas of rib/chest wall

Proliferative joint disease

Disseminated skeletal hyperostosis
Feline periosteal proliferative polyarthropathy (C)
Hypervitaminosis A
Osteoarthritis*

Trauma

Callus*
Hypertrophic non-union
Periosteal reaction

Miscellaneous

Craniomandibular osteopathy
Enthesiopathies

References

Blackwood, L. (1999) Bone tumours in small animals. *In Practice*, **21**:31–7.

Franch, J., et al. (2005) Multiple cartilaginous exostosis in a Golden Retriever cross-bred puppy. Clinical, radiographic and backscattered scanning microscopy findings. *Vet Comp Ortho Trauma*, **18**:189–93.

Gawor, J. P. (2004) Case reports of four cases of craniomandibular osteopathy. *Eur J Comp An Pract*, **14**:209–13.

3.3.8 Osteopenia

Artefact

Disuse

Fracture*
Lameness*
Paralysis

Iatrogenic

Chronic anticonvulsant therapy, e.g.
- Phenobarbitone
- Phenytoin
- Primidone

Chronic glucocorticoid administration
Stress protection from plating/casting

Metabolic/endocrine/systemic

Diabetes mellitus*
Hyperadrenocorticism
Hyperthyroidism* (C)
Lactation*
Mucopolysaccharidosis
Pregnancy*
Primary hyperparathyroidism
Renal secondary hyperparathyroidism*

Neoplasia

Multiple myeloma
Pseudohyperparathyroidism (see below)

Nutrition

Chronic protein malnutrition
Hypervitaminosis A
Hyper-/hypovitaminosis D
Nutritional secondary hyperparathyroidism
Pseudohyperparathyroidism
- Adenocarcinoma of apocrine glands of anal sacs
- Gastric squamous cell carcinoma
- Lymphoma*
- Mammary adenocarcinoma
- Multiple myeloma

- Testicular interstitial cell tumour
- Thyroid adenocarcinoma

Rickets

Miscellaneous

Ageing changes
Osteogenesis imperfecta
Panosteitis

Toxins

Lead poisoning

References

Schwarz, T., et al. (2000) Osteopenia and other radiographic signs in canine hyperadrenocorticism. *JSAP*, **41**:491–5.
Seeliger, F., et al. (2003) Osteogenesis imperfecta in two litters of dachshunds. *Vet Pathol*, **40**:530–39.
Tomsa, K., et al. (1999) Nutritional secondary hyperparathyroidism in six cats. *JSAP*, **40**:533–9.

3.3.9 Osteolysis

Avascular necrosis of the femoral head* (D)
Bone cysts
Feline femeral metaphyseal osteopathy (C)
Fibro-osseous dysplasia
Fibrous dysplasia
Infarct
Intraosseous epidermoid cysts
Metaphyseal osteopathy
Pressure atrophy
Retained cartilaginous core
Trauma*

Infection

Bacterial
- Bone abscess
- Iatrogenic, e.g. around surgical implants*
- Osteomyelitis*
- Sequestra

Fungal
Protozoal
- Leishmaniasis

Neoplasia

Enchondroma
Malignant soft tissue tumour
Metastatic tumour
Multiple myeloma
Osteochondroma/multiple cartilaginous exostoses
Osteoclastoma

Reference
Piek, C. J., et al. (1996) Long-term follow-up of avascular necrosis of the femoral head in the dog. *JSAP*, **37**:12–18.

3.3.10 Mixed osteolytic/osteogenic lesions

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Liposarcoma
Malignant soft tissue tumour*
Metastatic*
Osteosarcoma*

Infection
Bacterial
Osteomyelitis*
Sequestrum

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis

Protozoal
Leishmaniasis

Reference
Johnson, K. A. (1994) Osteomyelitis in dogs and cats. *JAVMA*, **204**:1882–7.

3.3.11 Joint changes

Soft tissue swelling – joint effusion
Haemarthrosis
Ligament injury
Osteoarthrosis
Osteochondrosis
Shar Pei fever (D)
Soft tissue callus
Synovial cyst
Trauma*
Villonodular synovitis

Arthritis
- Iatrogenic
  - Drugs, e.g.
    - Sulphonamides
  - Vaccine reactions
- Idiopathic polyarthritis
- Immune-mediated disease
  - Arthritis of the Akita (D)
  - Gastrointestinal disease associated
  - Idiopathic
  - Neoplasia associated
  - Polyarteritis nodosa
  - Polyarthritis/meningitis
  - Polyarthritis/polymyositis
  - Systemic lupus erythematosus
  - Vaccine reaction
- Infection
  - Borreliosis
  - Ehrlichiosis
  - Sepsis (bacterial)*

Periarticular swelling
- Abscess*
- Cellulitis*
- Haematoma
- Neoplasia
- Oedema*

Reduced size of joint space
- Degenerative joint disease*
- Erosive rheumatoid arthritis
- Erosive septic arthritis
- Periarticular fibrosis
- Positioning artefact*

Increased size of joint space
- Degenerative joint disease
- Intra-articular soft tissue mass
- Joint effusion*
- Juvenile animal
- Positioning artefact/traction
- Subluxation

Epiphyseal dysplasia
- Chondrodysplasia
- Congenital hypothyroidism
- Mucopolysaccharidosis
- Pituitary dwarfism

Subchondral osteolysis
- Neoplasia

Osteochondrosis
Rheumatoid arthritis
Septic arthritis*

Osteolytic joint disease

Avascular necrosis of the femoral head* (D)
Chronic haemarthrosis
Epiphyseal dysplasia causing apparent osteolysis
Incomplete ossification in juveniles
Osteochondrosis
Osteopenia *q.v.*
Rheumatoid arthritis
Subchondral cysts
Villous nodular synovitis

Infection

Feline tuberculosis (C)
Leishmaniasis
Mycoplasmosis
Septic arthritis*

Neoplasia

Metastatic digital carcinoma
Synovial sarcoma
Other soft tissue neoplasia

Proliferative joint disease

Disseminated idiopathic skeletal hyperostosis
Enthesiopathies
Hypervitaminosis A
Mucopolysaccharidosis
Systemic lupus erythematosus

Neoplasia

Osteoma
Osteosarcoma*
Synovial osteochondroma

Osteoarthritis

Ageing*
Angular limb deformities
Chondrodysplasia
Elbow dysplasia*
Hip dysplasia*
Post articular fractures*
Post surgery*
Other chronic joint stresses
Repeated haemarthroses
Soft tissue damage, e.g.
- Ruptured cranial cruciate ligament*

Mixed osteolytic/proliferative joint disease

Avascular necrosis of the femoral head* (D)
Feline periosteal proliferative polyarthropathy (C)
Feline tuberculosis (C)
Leishmaniasis
Neoplasia
Non-infectious erosive polyarthritis
Osteochondromatosis
Periosteal proliferative polyarthritis
Repeated haemarthroses
Rheumatoid arthritis
Septic arthritis*
Villonodular synovitis

References

Nieves, M. A. (2002) Differential diagnosis for 'swollen joints'. *Proceedings, Western Veterinary Conference, 2002*.

Roush, J. K. (1989) Rheumatoid arthritis subsequent to *Borrelia burgdorferi* infection in two dogs. *JAVMA*, **195**:951–3.

3.4 Radiography of the head and neck

3.4.1 Increased radiopacity/bony proliferation of the maxilla

Healing/healed fracture*
Neoplasia
Osteomyelitis*

3.4.2 Decreased radiopacity of the maxilla

Granuloma
Nasolacrimal duct cysts

Hyperparathyroidism

Nutritional secondary
Primary
Renal secondary*

Neoplasia

Fibrosarcoma
Local extension of tumour, e.g.
- From nasal cavity*

Malignant melanoma
Osteosarcoma*
Squamous cell carcinoma

Odontogenic cysts

Adamantinoma

Mixed osteolytic/proliferative joint disease

Avascular necrosis of the femoral head* (D)
Feline periosteal proliferative polyarthropathy (C)
Feline tuberculosis (C)
Leishmaniasis
Neoplasia
Non-infectious erosive polyarthritis
Osteochondromatosis
Periosteal proliferative polyarthritis
Repeated haemarthroses
Rheumatoid arthritis
Septic arthritis*
Villonodular synovitis

References

Nieves, M. A. (2002) Differential diagnosis for 'swollen joints'. *Proceedings, Western Veterinary Conference, 2002*.
Roush, J. K. (1989) Rheumatoid arthritis subsequent to *Borrelia burgdorferi* infection in two dogs. *JAVMA*, **195**:951–3.

3.4 Radiography of the head and neck

3.4.1 Increased radiopacity/bony proliferation of the maxilla

Healing/healed fracture*
Neoplasia
Osteomyelitis*

3.4.2 Decreased radiopacity of the maxilla

Granuloma
Nasolacrimal duct cysts

Hyperparathyroidism

Nutritional secondary
Primary
Renal secondary*

Neoplasia

Fibrosarcoma
Local extension of tumour, e.g.
- From nasal cavity*

Malignant melanoma
Osteosarcoma*
Squamous cell carcinoma

Odontogenic cysts

Adamantinoma

Ameloblastoma
Complex odontoma
Dentigerous cyst

Periodontal disease*

Reference

Watanabe, K. (2004) Odontogenic cysts in three dogs: one odontogenic keratocyst and two dentigerous cysts. *J Vet Med Sci*, **66**:1167–70.

3.4.3 Increased radiopacity/bony proliferation of the mandible

Acromegaly
Canine leukocyte adhesion deficiency (D)
Craniomandibular osteopathy
Healing/healed fracture*
Neoplasia
Osteomyelitis*

Reference

Trowald-Wigh, G., et al. (2000) Clinical, radiological and pathological features of 12 Irish Setters with canine leukocyte adhesion deficiency. *JSAP*, **41**:211–17.

3.4.4 Decreased radiopacity of the mandible

Granuloma
Periodontal disease

Hyperparathyroidism

Nutritional secondary
Primary
Renal secondary*

Neoplasia

Fibrosarcoma
Malignant melanoma
Osteosarcoma*
Squamous cell carcinoma

Odontogenic cysts

Adamantinoma
Ameloblastoma
Complex odontoma
Dentigerous cyst

Reference

Watanabe, K. (2004) Odontogenic cysts in three dogs: one odontogenic keratocyst and two dentigerous cysts. *J Vet Med Sci*, **66**:1167–70.

3.4.5 Increased radiopacity of the tympanic bulla

Positioning artefact

Abnormal contents

Cholesteatoma
Granuloma
Neoplasia
Otitis media*
Polyp*

Thickening of bulla wall

Canine leukocyte adhesion deficiency (D)
Craniomandibular osteopathy
Neoplasia
Otitis media*
Polyp*

References

Griffiths, L. G., et al. (2003) Ultrasonography versus radiography for detection of fluid in the canine tympanic bulla. *Vet Radiol Ultrasound*, **44**:210–13.
Trowald-Wigh, G., et al. (2000) Clinical, radiological and pathological features of 12 Irish Setters with canine leukocyte adhesion deficiency. *JSAP*, **41**:211–17.

3.4.6 Decreased radiopacity of the nasal cavity

Artefact

Turbinate destruction

Aspergillosis
Congenital defect of hard palate
Destruction of palatine or maxillary bone, e.g.
- Neoplasia*

Foreign body*
Previous rhinotomy
Viral rhinitis*

References

Henderson, S. M., et al. (2004) Investigation of nasal disease in the cat – a retrospective study of 77 cases. *J Feline Med Surg*, **6**:245–57.
Tomsa, K., et al. (2003) Fungal rhinitis and sinusitis in three cats. *JAVMA*, **222**:1380–84.

3.4.7 Increased radiopacity of the nasal cavity

Artefact

Epistaxis *q.v.*

Neoplasia

*Nasal cavity**
- Adenocarcinoma*
- Chondrosarcoma
- Esthesioneuroblastoma
- Fibrosarcoma
- Haemangiosarcoma
- Histiocytoma
- Leiomyosarcoma
- Liposarcoma
- Lymphoma*
- Malignant fibrous histiocytoma
- Malignant melanoma
- Malignant nerve sheath tumour
- Mast cell tumour
- Myxosarcoma
- Neuroendocrine tumours
- Osteosarcoma
- Paranasal meningioma
- Rhabdomyosarcoma
- Squamous cell carcinoma*
- Transitional cell carcinoma
- Transmissible venereal tumour
- Undifferentiated carcinomas*
- Undifferentiated sarcoma

Nasal planum
- Cutaneous lymphoma
- Fibroma
- Fibrosarcoma
- Haemangioma
- Mast cell tumour*
- Melanoma
- Squamous cell carcinoma

Miscellaneous
- Foreign body
- Hyperparathyroidism
- Kartagener's syndrome
- Polyp
- Primary ciliary dyskinesia

Rhinitis* ***q.v.***

Reference

Henderson, S. M., et al. (2004) Investigation of nasal disease in the cat – a retrospective study of 77 cases. *J Feline Med Surg*, **6**:245–7.

3.4.8 Increased radiopacity of the frontal sinuses

Neoplasia

Carcinoma*
Local extension, e.g.
- Nasal tumour*

Osteoma
Osteosarcoma

Obstruction of drainage

Neoplasia*
Trauma*

Sinusitis

Allergic*
Bacterial*
Fungal
Kartagener's syndrome
Viral*

Miscellaneous

Canine leukocyte adhesion deficiency (D)
Craniomandibular osteopathy

3.4.9 Increased radiopacity of the pharynx

Foreign body*
Mineralisation of laryngeal cartilages
Nasopharyngeal stenosis
Obesity*
Pharyngeal paralysis
Salivary calculi

Pharyngeal soft tissue mass

Abscess*
Granuloma
Nasopharyngeal polyp*
Neoplasia
- Carcinoma
- Lymphoma

Retropharyngeal mass

Abscess*
Enlarged lymph nodes*
Neoplasia, e.g.
- Lymphoma*

Soft palate thickening

Brachycephalic obstructive airway syndrome* (D)
Mass
- Cyst
- Granuloma
- Neoplasia

3.4.10 Thickening of the soft tissues of the head and neck

Focal

Abscess*
Cyst*
Foreign body*
Granuloma
Haematoma*
Iatrogenic, e.g.
- Subcutaneous fluid administration*

Neoplasia*

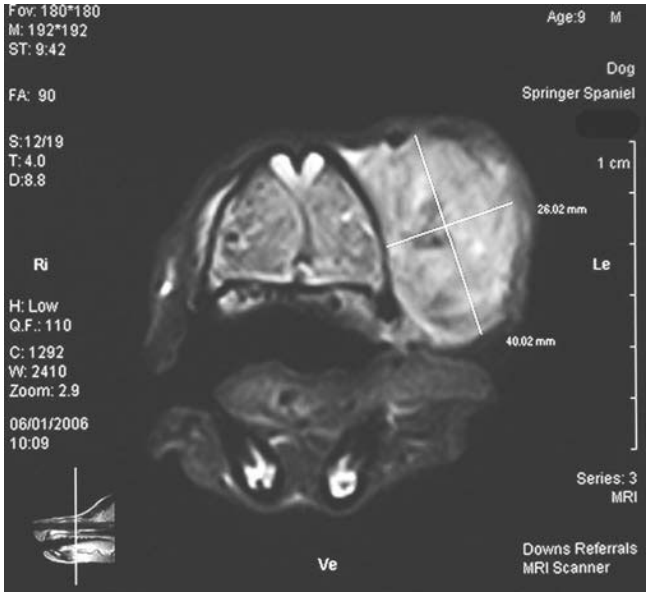

Figure 3.4 Transverse T2 weighted MR scan of a dog with a large facial sarcoma. Reproduced with permission of Downs Referrals, Bristol.

Diffuse

Acromegaly
Cellulitis*
Cranial vena cava syndrome
Neoplasia*
Obesity*
Oedema*

Reference

Peterson, M. E., et al. (1990) Acromegaly in 14 cats. *JVIM*, **4**:192–201.

3.4.11 Decreased radiopacity of the soft tissues of the head and neck

Gas

Abscess*
Perforation
- Oesophagus
- Pharynx
- Skin
- Trachea

Pneumomediastinum

Fat

Lipoma*
Obesity*

3.4.12 Increased radiopacity of the soft tissues of the head and neck

Artefact

Calcification

Calcinosis circumscripta
Calcinosis cutis

Calcification of:
Abscess
Granuloma
Haematoma
Tumour

Foreign body*

Neoplasia

Iatrogenic

Barium
Microchip

References

Kooistra, H. S. (2005) Growth hormone disorders: diagnosis & treatment: the veterinary perspective. *Proceedings, ACVIM, 2005*.

McEntee, M. C. (2001) Nasal neoplasia in the dog and cat. *Proceedings, Atlantic Coast Veterinary Conference, 2001*.

Nicastro, A. & Cote, E. (2002) Cranial vena cava syndrome. *Compend Contin Educ Pract Vet,* **24**:701–10.

3.5 Radiography of the spine

3.5.1 Normal and congenital variation in vertebral shape and size

Normal variation

C7 may be shorter than adjacent vertebrae
L7 may be shorter than adjacent vertebrae
Ventral L3 and L4 may be poorly defined

Congenital variation

Abnormal dorsal angulation of the dens of C2
Agenesis/incomplete development of dens of C2
Anomalous development of a transverse process of a lumbar vertebra
Block vertebrae
Butterfly vertebrae
Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Chondrodystrophic dwarfism
Congenital metabolic disease
- Congenital hypothyroidism
- Pituitary dwarfism

Fused dorsal spinal processes
Hemivertebrae
Mucopolysaccharidosis
Narrowed vertebral canal
- Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome) (D)
- Congenital lumbosacral stenosis
- Secondary to hemivertebrae or block vertebrae
- Thoracic stenosis

Occipital dysplasia
Perocormus
Sacrococcygeal dysgenesis
Scoliosis
Shortened dens of C2
Spina bifida
Spinal stenosis
Transitional vertebrae

References

Kooistra, H. S. (2005) Growth hormone disorders: diagnosis & treatment: the veterinary perspective. *Proceedings, ACVIM, 2005*.

McEntee, M. C. (2001) Nasal neoplasia in the dog and cat. *Proceedings, Atlantic Coast Veterinary Conference, 2001*.

Nicastro, A. & Cote, E. (2002) Cranial vena cava syndrome. *Compend Contin Educ Pract Vet*, **24**:701–10.

3.5 Radiography of the spine

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Normal variation

C7 may be shorter than adjacent vertebrae
L7 may be shorter than adjacent vertebrae
Ventral L3 and L4 may be poorly defined

Congenital variation

Abnormal dorsal angulation of the dens of C2
Agenesis/incomplete development of dens of C2
Anomalous development of a transverse process of a lumbar vertebra
Block vertebrae
Butterfly vertebrae
Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Chondrodystrophic dwarfism
Congenital metabolic disease
- Congenital hypothyroidism
- Pituitary dwarfism

Fused dorsal spinal processes
Hemivertebrae
Mucopolysaccharidosis
Narrowed vertebral canal
- Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome) (D)
- Congenital lumbosacral stenosis
- Secondary to hemivertebrae or block vertebrae
- Thoracic stenosis

Occipital dysplasia
Perocormus
Sacrococcygeal dysgenesis
Scoliosis
Shortened dens of C2
Spina bifida
Spinal stenosis
Transitional vertebrae

3.5.2 Acquired variation in vertebral shape and size

Altered vertebral shape

Hyperparathyroidism
- Nutritional secondary
- Primary
- Renal secondary*

Hypervitaminosis A
Mucopolysaccharidosis
Spondylosis deformans
Trauma
- Fracture*

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia*
- Haemangiosarcoma
- Lymphosarcoma
- Prostatic carcinoma

Multiple cartilaginous exostoses
Multiple myeloma
Osteochondroma
Osteosarcoma*

Increased vertebral size

Baastrup's disease
Bone cyst
Callus formation secondary to trauma/pathological fracture
Disseminated idiopathic skeletal hyperostosis
Hypervitaminosis A
Mucopolysaccharidosis

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia*, e.g.
- Haemangiosarcoma
- Lymphosarcoma
- Prostatic carcinoma

Multiple cartilaginous exostoses
Osteochondroma
Osteosarcoma*

Spondylitis
Bacterial, e.g.
- Foreign body*

- Haematogenous
- Puncture wound

Fungal, e.g.
- Actinomycosis
- Aspergillosis
- Coccidioidomyocosis

Parasitic, e.g.
- *Spirocerca lupi*

Protozoal, e.g.
- Hepatozoonosis

Spondylosis deformans
Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Chronic disc disease* (D)
Degeneration of annulus fibrosis
Discospondylitis
Hemivertebrae
Post surgery
Trauma*

Decreased vertebral size

Discospondylitis
Fracture*
Intervertebral disc herniation* (D)
Mucopolysaccharidosis
Nutritional secondary hyperparathyroidism

Vertebral canal changes

Widened
Arachnoid cyst
Syringohydromyelia
Tumour

Narrowed
Adjacent bone pathology, e.g.
- Callus

Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Lumbosacral stenosis

References

Bailey, C. S. & Morgan, J. P. (1992) Congenital spinal malformations. *Vet Clin North Am Small Anim Pract,* **22**:985–1015.

Morgan, J. P. (1999) Transitional lumbosacral vertebral anomaly in the dog: a radiographic study. *JSAP,* **40**:167–72.

Sturges, B. K. (2003) Congenital spinal malformations. *Proceedings, Western Veterinary Conference, 2003*.

Tomsa, K., et al. (1999) Nutritional secondary hyperparathyroidism in six cats. *JSAP,* **40**:533–9.

3.5.3 Changes in vertebral radiopacity

Generalised decrease in radiopacity

Disuse atrophy
Hyperadrenocorticism
Hyperparathyroidism
- Nutritional secondary
- Primary
- Pseudohyperparathyroidism*
- Renal secondary*

Hyperthyroidism* (C)
Hypothyroidism* (D)
Osteogenesis imperfecta
Senile osteoporosis

Generalised increase in radiopacity

Osteopetrosis

Focal or multifocal decrease in radiopacity

Discospondylitis
Osteomyelitis*
Vertebral physitis

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia
Multiple myeloma
Osteochondroma
Osteosarcoma*

Focal or multifocal increase in radiopacity

Neoplasia
Chondrosarcoma
Fibrosarcoma
Haemangiosarcoma
Metastatic neoplasia*, e.g.
- Haemangiosarcoma
- Lymphosarcoma
- Prostatic carcinoma

Osteochondroma
Osteosarcoma*

References

Bertoy, R. W. & Umphlet, R. C. (1989) Vertebral osteosarcoma in a dog : Pathologic fracture resulting in acute hind limb paralysis. *Companion Anim Pract,* **19**:7–10.

Jimenez, M. M. & O'Callaghan, M. W. (1995) Vertebral physitis: a radiographic diagnosis to be separated from discospondylitis: a preliminary report. *Vet Radiol,* **36**:188–95.

3.5.4 Abnormalities in the intervertebral space

Widened disc space

Normal variation
Adjacent to hemivertebra
Artefact (traction)
End-plate erosion
- Discospondylitis
- Neoplasia

Mucopolysaccharidosis
Trauma
- Luxation
- Subluxation

Decreased size of disc space

Adjacent hemivertebra
Adjacent neoplasia
Artefact
- Divergence of X-ray beam at periphery of radiograph
- Positioning artefact

Cervical vertebral malformation malarticulation syndrome (Wobbler syndrome)* (D)
Degenerative canine lumbosacral stenosis
Discospondylitis
Hansen type I disc extrusion* (D)
Hansen type II disc protrusion* (D)
Post surgery
Spondylosis deformans*
Subluxation
Within block vertebra

Irregular margination of disc space

Ageing in cats
Degenerative intervertebral disc disease
Discospondylitis
Mucopolysaccharidosis
Nutritional secondary hyperparathyroidism
Spondylosis deformans*

Increased radiopacity of disc space

Artefact
- Superimposition of normal bone/soft tissue

Incidental mineralisation
Intervertebral disc disease* (D)

Reference

Dickinson, P. J. (2003) Non-Contrast Spinal Radiography. *Proceedings, Western Veterinary Conference, 2003*.

3.5.5 Contrast radiography of the spine (myelography)

Artefact

Contrast medium in soft tissues outside vertebral canal
Contrast medium in spinal parenchyma
Epidural leakage
Injection of contrast into central canal
Injection of gas into subarachnoid space
Subdural injection

Extradural lesions

Congenital abnormalities
Foreign body
Neoplasia

Degenerative

Hansen type I disc extrusion* (D)
Hansen type II disc protrusion* (D)
Hansen type III disc high velocity low volume extrusion
Hypertrophied ligamentum flavum
Arachnoid cysts

Inflammatory

Abscess
Granuloma

Trauma

Fracture*
Luxation*

Vascular

Haematoma
Haemorrhage

Intradural/extramedullary

Degenerative

Disc disease

Neoplasia

Lymphoma
Meningioma
Nerve root tumour
Nerve sheath tumour

Idiopathic
Intra-arachnoid cyst

Inflammatory
Subdural granuloma

Vascular
Subarachnoid haematoma
Subarachnoid haemorrhage

Intramedullary

Degenerative
Disc disease* (D)

Congenital
Syringohydromyelia* (D)

Neoplastic
Ependymoma
Glioma
Lymphoma
Metastatic tumours

Figure 3.5(a) Dorsoventral myelogram of the thoracolumbar spine of a dog, demonstrating loss of contrast at T13–L1, suggesting a prolapsed intervertebral disc. Reproduced with permission of Downs Referrals, Bristol.

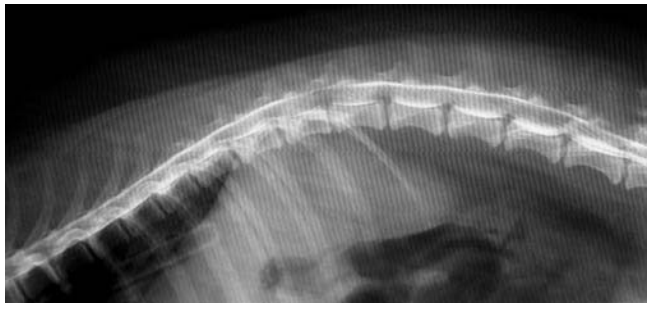


Figure 3.5(b) Lateral myelogram of the same dog as in Figure 3.5(a). Reproduced with permission of Downs Referrals, Bristol.

Inflammatory
Granulomatous meningoencephalomyelitis

Traumatic
Cord swelling
- Concussion
- Disc extrusion

Vascular
Ischaemic myelopathy*
Myelomalacia secondary to infarction

Contrast column splitting
Lateralised extradural compression(s)
Midline extradural compression

References

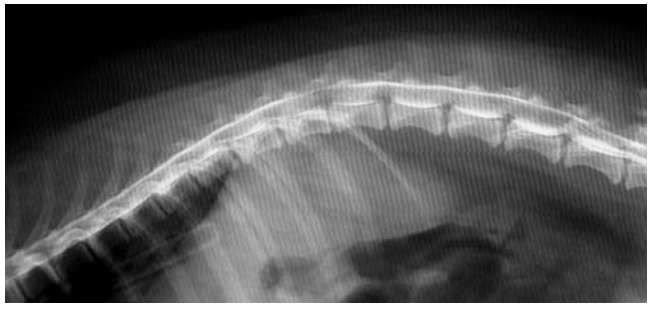
Diaz, F. L. (2005) Practical contrast radiography. 4. Myelography. *In Practice*, **27**:502–10.

Tanaka, H., et al. (2004) Usefulness of myelography with multiple views in diagnosis of circumferential location of disc material in dogs with thoracolumbar intervertebral disc herniation. *J Vet Med Sci*, **66**:827–33.

3.6 Thoracic ultrasonography

3.6.1 Pleural effusion

(See 3.1.13 for full listings)
Bile pleuritis
Blood
Chyle
Exudate
Transudate/modified transudate



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Inflammatory
Granulomatous meningoencephalomyelitis

Traumatic
Cord swelling
- Concussion
- Disc extrusion

Vascular
Ischaemic myelopathy*
Myelomalacia secondary to infarction

Contrast column splitting
Lateralised extradural compression(s)
Midline extradural compression

References

Diaz, F. L. (2005) Practical contrast radiography. 4. Myelography. *In Practice,* **27**:502–10.

Tanaka, H., et al. (2004) Usefulness of myelography with multiple views in diagnosis of circumferential location of disc material in dogs with thoracolumbar intervertebral disc herniation. *J Vet Med Sci,* **66**:827–33.

3.6 Thoracic ultrasonography

3.6.1 Pleural effusion

(See 3.1.13 for full listings)
Bile pleuritis
Blood
Chyle
Exudate
Transudate/modified transudate

3.6.2 Mediastinal masses

Granuloma
Idiopathic mediastinal cysts
Neoplasia
- Lymphoma*
- Mast cell tumour
- Melanoma
- Thymoma*
- Thyroid carcinoma

Reactive lymphadenopathy*
Thymic branchial cysts

Reference

Malik, R., et al. (1997) Benign cranial mediastinal lesions in three cats. *Aust Vet J*, 75:183–7.

3.6.3 Pericardial effusion

Secondary to cardiomyopathy (C)*

Haemorrhagic

Coagulopathy *q.v.*
Left atrial rupture

Idiopathic*(D)

Neoplastic*

Haemangiosarcoma
Heart base tumours
- Chemodectoma
- Metastatic parathyroid tumour
- Metastatic thyroid tumour
- Other metastatic tumours*
- Nonchromaffin paraganglioma

Lymphoma
Mesothelioma

Pericarditis

Bacterial
- Bite wounds
- Extension of pulmonary infection
- Foreign bodies
- Oesophageal perforation

Fungal
Uraemic
Viral
- Feline infectious peritonitis* (C)

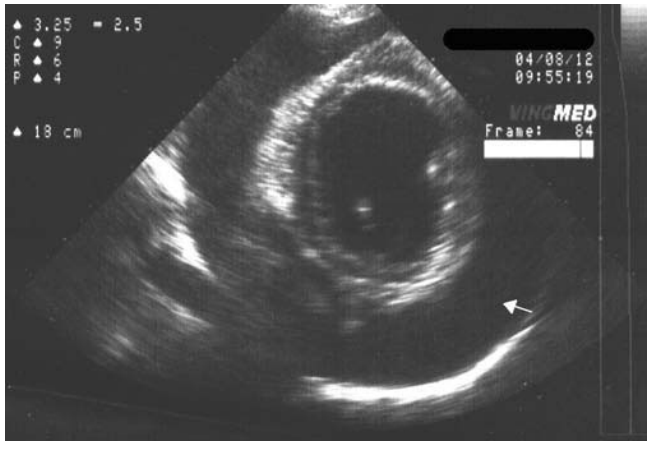

Figure 3.6(a) Right parasternal short axis echocardiogram at the level of the chordae tendinae showing a pericardial effusion (arrowed). Reproduced with permission of Downs Referrals, Bristol.

References

Miller, M. W. (2002) Pericardial diseases. *Proceedings, Waltham/OSU Symposium, Small Animal Cardiology, 2002*.

Stafford Johnson, M., et al. (2004) A retrospective study of clinical findings, treatment and outcome in 143 dogs with pericardial effusion. *JSAP*, **45**:546–52.

3.6.4 Altered chamber dimensions

LEFT HEART

Enlarged left atrium

Chronic bradycardia
Dilated cardiomyopathy*
Hyperthyroidism* (C)
Hypertrophic cardiomyopathy* (C)
Left-to-right shunt
Mitral dysplasia
Myxomatous degeneration of the mitral valve* (D)
Primary atrial disease
Restrictive cardiomyopathy (C)

Left ventricle

Dilatation

Anaemia
Arteriovenous fistula
Chronic bradycardia *q.v.*
Chronic tachyarrhythmia *q.v.*
Dilated cardiomyopathy

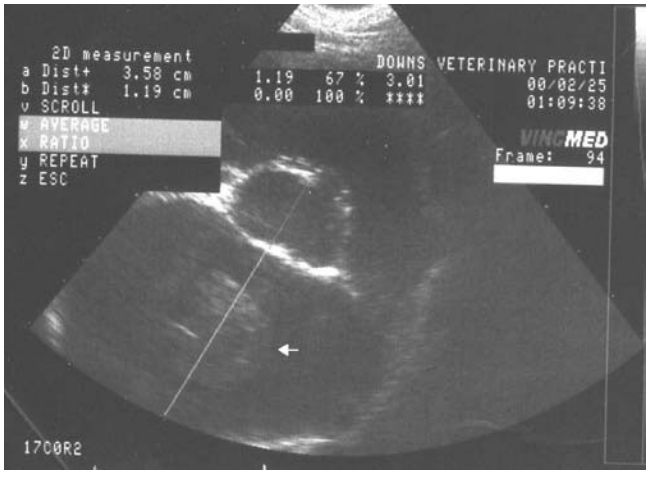

Figure 3.6(b) Right parasternal short axis view of the left atrium at the level of the aortic valve, showing left atrial dilation and an atrial thrombus. Reproduced with permission of Downs Referrals, Bristol.

- Idiopathic*
- Parvovirus
- Taurine deficiency
- Drugs/toxins, e.g.
  - Doxorubicin

High output states
- Anaemia* *q.v.*
- Hyperthyroidism* (C)

Myocarditis

Volume overload
- Aortic insufficiency
- Left-to-right shunts
  - Arteriovenous fistulas
  - Atrial septal defects
  - Patent ductus arteriosus
  - Ventricular septal defects
- Mitral regurgitation, e.g.
  - Mitral dysplasia
  - Myxomatous degeneration of the mitral valve* (D)

Hypertrophy

Cardiomyopathy
- Hypertrophic* (C)

Coarctation of the aorta

Endomyocardial fibrosis

Hyperthyroidism* (C)

Infiltrative cardiac disease, e.g.
- Lymphoma

Pressure overload
- Aortic/subaortic stenosis
- Systemic arterial hypertension*

Pseudohypertrophy from volume depletion*

Reduction
Hypovolaemia *q.v.**

Wall thinning
Aneurysm
Dilated cardiomyopathy*
Infarction
Prior myocarditis

RIGHT HEART

Right atrium

Anaemia *q.v.*
Arteriovenous fistula
Atrial septal defect
Chronic bradycardia
Cor pulmonale
Dilated cardiomyopathy*
Heartworm disease
Hyperthyroidism* (C)
Hypertrophic cardiomyopathy* (C)
Myxomatous degeneration of the tricuspid valve* (D)
Primary atrial myocardial diseases
Pulmonary hypertension
Restrictive cardiomyopathy (C)
Right-to-left shunts
Tricuspid dysplasia
Tricuspid stenosis/atresia

Right ventricle

Dilatation
Right ventricular volume overload
- Atrial septal defects
- Cardiomyopathy
  - Dilated cardiomyopathy* (D)
  - Hypertrophic cardiomyopathy* (C)
  - Restrictive cardiomyopathy (C)
- Pulmonic insufficiency
- Tricuspid insufficiency
  - Myxomatous degeneration of the tricuspid valve* (D)
  - Tricuspid dysplasia

Hypertrophy
Hypertrophic cardiomyopathy* (C)

Figure 3.6(c) Right parasternal short axis echocardiogram at the level of the pulmonic valve in a dog with pulmonic stenosis (stenotic pulmonic valve arrowed). Reproduced with permission of Downs Referrals, Bristol.

Pressure overload
- Cor pulmonale
- Heartworm disease
- Large ventricular septal defect
- Pulmonary hypertension
- Pulmonary thromboembolism
- Pulmonic stenosis
- Tetralogy of Fallot

Restrictive cardiomyopathy (C)

Reduction

Cardiac tamponade
Hypovolaemia* *q.v.*

References

Guglielmini, C., et al. (2002) Atrial septal defect in five dogs. *JSAP*, **43**:317–22.
Luis-Fuentes, V. (2003) Echocardiography: Canine & feline case vignettes. *Proceedings, ACVIM, 2003*.
Washizu, M., et al. (2003) Hypertrophic cardiomyopathy in an aged dog. *J Vet Med Sci*, **65**:753–6.

3.6.5 Changes in ejection phase indices of left ventricular performance (fractional shortening – FS%, ejection fraction – EF)

Apparently reduced performance (decreased FS%, decreased EF)

Decreased preload, e.g.

Hypovolaemia* *q.v.*

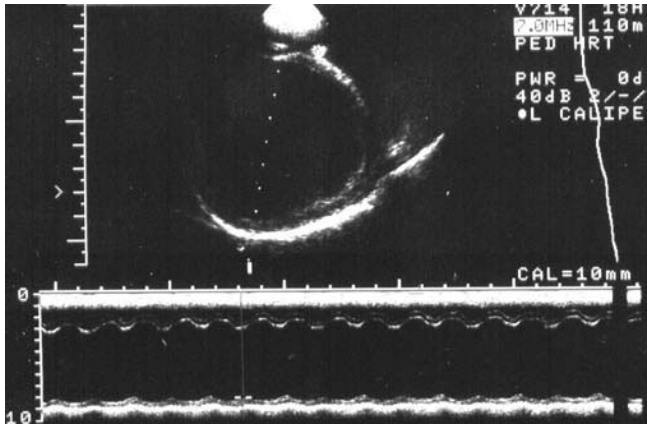

Figure 3.6(d) M-mode view of the left ventricle, showing ventricular dilatation and a poor fractional shortening, due to dilated cardiomyopathy. Reproduced with permission of Downs Referrals, Bristol.

Increased afterload, e.g.
Aortic stenosis
Systemic arterial hypertension* *q.v.*

Reduced systolic function
Canine X-linked muscular dystrophy
Chronic valvular heart disease* (D)
Dilated cardiomyopathy*

Apparently increased performance (increased FS%, increased EF)

Decreased afterload, e.g.
Hypotension
Mitral valve regurgitation*

Increased preload, e.g.
Iatrogenic fluid overload*

Myocardial disease, e.g.
Hypertrophic cardiomyopathy* (C)

Reference

Vollmar, A. C. (1999) Use of echocardiography in the diagnosis of dilated cardiomyopathy in Irish Wolfhounds. *JAAHA*, 35:279–83.

3.7 Abdominal ultrasonography

3.7.1 Renal disease

Diffuse abnormalities

Renomegaly *q.v.*
Small kidneys *q.v.*

Increased cortical echogenicity with normal or enhanced corticomedullary definition
End-stage renal disease* *q.v.*
Ethylene glycol toxicity
Fat in cortex*
Feline infectious peritonitis* (C)
Glomerulonephritis
Interstitial nephritis*
Nephrocalcinosis
Renal lymphoma
Squamous cell carcinoma

Medullary rim sign
May be normal*
Chronic interstitial nephritis*
Ethylene glycol toxicity
Feline infectious peritonitis* (C)
Hypercalcaemic nephropathy
Idiopathic acute tubular necrosis
Leptospirosis*

Increased cortical echogenicity with reduced corticomedullary definition
Chronic inflammatory disease*
Congenital renal dysplasia
End-stage kidneys*

Reduced cortical echogenicity
Lymphoma

Focal abnormalities

Anechoic/hypoechoic lesions
Abscess
Acquired cysts secondary to nephropathies
Congenital cysts
Cystadenocarcinoma
Haematoma
Lymphoma
Perirenal pseudocyst
Polycystic kidney disease*
Tumour necrosis

Hyperechoic lesions
- Calcified abscess
- Calcified cyst wall
- Calcified haematoma
- Calculi
- Chronic renal infarcts
- Fibrosis
- Gas
- Granuloma
- Neoplasia
  - Chondrosarcoma
  - Haemangioma
  - Haemangiosarcoma
  - Metastatic thyroid adenocarcinoma
  - Osteosarcoma

Mixed echogenicity lesions
- Abscess
- Acute infarct
- Granuloma
- Haematoma
- Neoplasia
  - Adenocarcinoma
  - Haemangioma
  - Lymphoma

Pelvic dilatation
- Contralateral renal disease/absence (mild dilatation)
- Polyuria/diuresis
- Pyelonephritis
- Renal neoplasia

Congenital conditions
- Ectopic ureter
- Ureterocoele

Hydronephrosis
- Extrinsic mass
- Neoplasia
  - Bladder
  - Prostate
  - Trigone
- Paraureteral pseudocyst
- Ureteral blood clot
- Ureteral inflammation
- Ureteral stricture
- Ureterolith

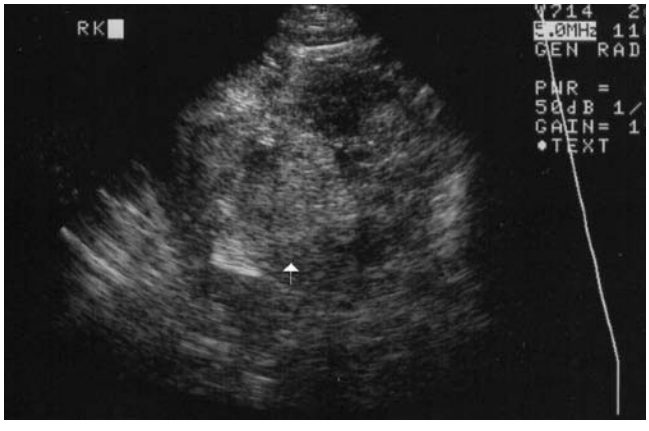

Figure 3.7(a) Renal ultrasonogram. The kidney is enlarged, and the renal architecture is disrupted by a presumed neoplastic lesion. Reproduced with permission of Downs Referrals, Bristol.

References

Cannon, M. J., et al. (2001) Prevalence of polycystic kidney disease in Persian cats in the United Kingdom. *Vet Rec*, **149**:409–11.

Hansen, N. (2003) Bilateral hydronephrosis secondary to anticoagulant rodenticide intoxication in a dog. *J Vet Emerg Crit Care*, **13:**103–107.

Mantis, P. & Lamb, C. R. (2000) Most dogs with medullary rim sign on ultrasonography have no demonstrable renal dysfunction. *Vet Radiol Ultrasound*, **41**:164–6.

Matton, J. S. (2003) Upper urinary ultrasonography. *Proceedings, Western Veterinary Conference, 2003*.

3.7.2 Hepatobiliary disease

Focal or multifocal hepatic parenchymal abnormalities

Nodular hyperplasia (D)*

Abscess

Biliary disease*
Chronic glucocorticoid administration
Diabetes mellitus*
Liver lobe torsion
Neoplasia*
Pancreatitis*
Penetrating foreign body

Cysts

Acquired cysts
- Biloma
- Polycystic renal disease*

Congenital cysts

Cyst-like masses
- Biliary pseudocyst
- Inflammation
- Necrosis
- Neoplasia*
- Trauma

Haematoma
- Coagulopathy *q.v.*
- Trauma*

Hepatic necrosis
- Chemical insult
- Immune-mediated*
- Infection*
- Toxin

Neoplasia
- Biliary cystadenoma
- Cholangiocellular adenocarcinoma
- Cholangiocellular adenoma
- Hepatocellular adenocarcinoma*
- Hepatocellular adenoma*
- Lymphoma*
- Metastatic tumours*

Diffuse hepatic disease
- Hepatomegaly *q.v.**
- Microhepatica *q.v.*

Decreased echogenicity
- Amyloidosis
- Congestion*
- Hepatitis*
- Leukaemia
- Lymphoma*

Increased echogenicity
- Chronic hepatitis*
- Cirrhosis*
- Fatty infiltration
  - Diabetes mellitus*
  - Obesity*
- Lymphoma*
- Steroid hepatopathy*

Mixed echogenicity
- Cirrhosis*
- Diffuse neoplasia*
- Hepatocutaneous syndrome

Biliary obstruction (see also Jaundice)

Abscess
Biliary calculi
Gastrointestinal disease* *q.v.*
Granuloma
Hepatobiliary disease* *q.v.*
Lymphadenopathy* *q.v.*
Neoplasia*
Pancreatitis*

Focal/multifocal increased echogenicity of gall bladder

Biliary calculi
Gall bladder mucocoele
Gall bladder sludge*
Neoplasia
Polyps

Gall bladder wall thickening

Acute hepatitis* *q.v.*
Cholangiohepatitis*
Cholecystitis* *q.v.*
Chronic hepatitis* *q.v.*
Gall bladder mucocoeles
Hypoalbuminaemia* *q.v.*
Neoplasia*
Right-sided congestive heart failure*
Sepsis*

Dilatation of caudal vena cava and hepatic veins

Haematological disorders
Systemic infection*

Obstruction of caudal vena cava/hepatic veins

Budd-Chiari syndrome
Liver disease* *q.v.*
Neoplasia*
Strictures
Thrombosis
Trauma*

*Right-sided heart failure**

Cardiac tamponade
Dirofilariasis
Myocardial disease
Pulmonary hypertension
Pulmonic stenosis
Tricuspid insufficiency

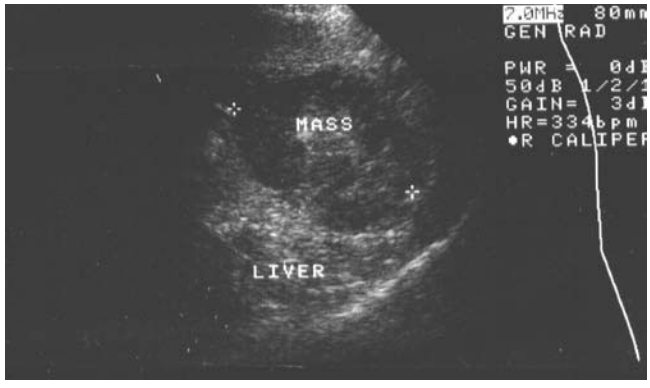

Figure 3.7(b) Hepatic ultrasonogram showing a hypoechoic mass. Cytology revealed this to be a lymphoma. Reproduced with permission of Downs Referrals, Bristol.

References

Henry, G. (2003) Hepatic ultrasonography. *Proceedings, Western Veterinary Conference, 2003*.

Lamb, C. R. & Cuccovillo, A. (2002) Cellular features of sonographic target lesions of the liver and spleen in 21 dogs and a cat. *Vet Radiol Ultrasound*, **43**:275–8.

Liptak, J. M. (2004) Massive hepatocellular carcinoma in dogs: 48 cases (1992–2002) *JAVMA*, **225**:1225–30.

Sergeeff, J. S., et al.(2004) Hepatic abscesses in cats: 14 cases (1985–2002). *JVIM*, **18**:205–300.

3.7.3 Splenic disease

Diffuse splenic disease – splenomegaly

Abscess
Amyloidosis
Extramedullary haematopoiesis
Immune-mediated disease*
Infarction
Parenchymal necrosis
Portal hypertension
Splenic vein thrombosis

Congestion

Anaesthetic agents*
Haemolytic anaemia*
Portal vein obstruction
Right-sided heart failure*
Torsion of splenic pedicle
- Gastric dilatation/volvulus
- Isolated

Toxaemia*
Tranquillizers*

Infection
Bacterial*
Fungal

Neoplasia
Lymphoma*
Lymphoproliferative disease
Malignant histiocytosis
Mastocytosis
Myeloproliferative disease

Parasites
Babesiosis
Ehrlichiosis
Haemobartonellosis

Focal or multifocal splenic disease

Abscess
Fat deposits
Nodular hyperplasia

Haematoma
Abdominal trauma
Coagulopathy

Infarcts
Cardiovascular disease*
Hyperadrenocorticism
Hypercoagulability
Inflammatory diseases
- Endocarditis
- Pancreatitis*
- Septicaemia*

Liver disease* *q.v.*
Neoplasia*
- Fibrosarcoma
- Haemangioma
- Haemangiosarcoma
- Leiomyosarcoma
- Lymphoma

Renal disease* *q.v.*

Neoplasia
Chondrosarcoma
Fibrosarcoma
Fibrous histiocytoma
Haemangioma*
Haemangiosarcoma*
Leiomyosarcoma
Liposarcoma

Lymphoma*
Metastatic tumours*
Myxosarcoma
Osteosarcoma
Rhabdomyosarcoma
Undifferentiated sarcoma

References

Henry, G. (2003) Splenic ultrasonography. *Proceedings, Western Veterinary Conference 2003*.
O' Brien, R. T., et al. (2004) Sonographic features of drug-induced splenic congestion. *Vet Radiol Ultrasound,* **45**:225–7.

3.7.4 Pancreatic disease

Focal pancreatic lesions

Abscess (D)
Cyst-like structures
- Congenital cysts
- Pseudocysts
- Retention cysts

Neoplasia
Nodular changes

Diffuse enlargement

Pancreatic neoplasia
Pancreatic oedema
Pancreatitis*

References

Coleman, M. G. (2005) Pancreatic masses following pancreatitis: pancreatic pseudocysts, necrosis, and abscesses. *Compend Contin Educ Pract Vet,* **27**:147–54.
Coleman, M. G., et al. (2005) Pancreatic cyst in a cat. *N Z Vet J,* **53**:157–9.
Saunders, H. M., et al. (2002) Ultrasonographic findings in cats with clinical, gross pathologic, and histologic evidence of acute pancreatitis necrosis: 20 cases (1994–2001). *JAVMA,* **221**:1724–30.

3.7.5 Adrenal disease

Adrenomegaly

Unilateral

Adrenal tumour
- Adrenocortical adenocarcinoma*
- Adrenocortical adenoma*
- Blastoma
- Metastatic tumours
- Phaeochromocytoma

Bilateral

Adrenal tumours
- Adrenocortical adenocarcinoma*
- Adrenocortical adenoma*
- Metastatic tumours

Hyperplasia
Pituitary dependent hyperadrenocorticism*
Stressful non-adrenal illness*
Drugs
- Trilostane

References

Besso, J. G., et al. (1997) Retrospective ultrasonographic evaluation of adrenal lesions in 26 dogs. *Vet Radiol*, **38**:448–55.

Mantis, P., et al. (2003) Changes in ultrasonographic appearance of adrenal glands in dogs with pituitary dependent hyperadrenocorticism treated with trilostane. *Vet Rad & Ult*, **44**:682–5.

3.7.6 Urinary bladder disease

Increased wall thickness

Diffuse

Chronic cystitis*
Emphysematous cystitis
- Clostridial infection
- Diabetes mellitus

Empty bladder*
Fibrosis/calcification of bladder wall

Focal or multifocal

Mural haematomas
- Coagulopathies *q.v.*
- Iatrogenic
- Infection
- Neoplasia
- Trauma

Neoplasia
- Adenocarcinoma
- Chemodectoma
- Fibroma
- Fibrosarcoma
- Haemangioma
- Haemangiosarcoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma
- Myxoma
- Rhabdomyosarcoma
- Squamous cell carcinoma

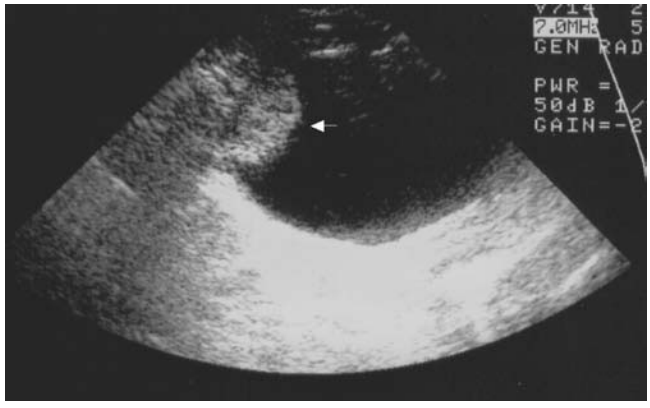

Figure 3.7(c) Ultrasonogram of the bladder of a cat, demonstrating a mass at the cranial pole (arrowed). Reproduced with permission of Downs Referrals, Bristol.

- Transitional cell carcinoma
- Undifferentiated carcinoma

Focal wall defects

Acquired diverticulum
Patent urachus
Urachal diverticulum
Ureterocoele

Intraluminal lesions, e.g.

Blood clots*
Foreign bodies
Gas bubbles
Sediment*
Uroliths*

References

Biller, D. S. (1990) Diagnostic ultrasound of the urinary bladder. *JAAHA*, **26**:397–402.

Norris, A. M., et al. (1992) Canine bladder and urethral tumors: A retrospective study of 115 cases (1980–1985). *JVIM*, **6**:145–53.

Nyland, T. G. (2002) Sonograms of the urinary tract. *Proceedings, Western Veterinary Conference, 2002.*

3.7.7 Gastrointestinal disease

Increased wall thickness

Diffuse

Acute haemorrhagic gastroenteritis*
Colitis* *q.v.*

Gastritis*
- Dietary*
- Infectious*
  - Parvovirus*
- Inflammatory*
- Uraemic* *q.v.*

Inflammatory bowel disease*
Neoplasia
- Lymphoma*

Focal/multifocal
Benign adenomatous polyps
Chronic hypertrophic gastropathy
Congenital hypertrophic pyloric stenosis
Inflammatory bowel disease*
Intussusception (apparent)
Neoplasia
- Adenocarcinoma
- Adenoma
- Carcinoid tumours
- Carcinoma
- Leiomyoma
- Leiomyosarcoma
- Lymphoma
- Neurilemmoma

Decreased intestinal motility (ileus)

Functional
Abdominal pain*
Acute gastroenteritis*
Amyloidosis

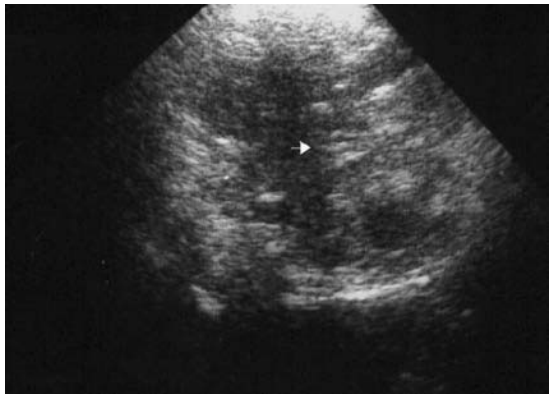

Figure 3.7(d) Abdominal ultrasonogram of a palpable abdominal mass (arrowed). Exploratory coeliotomy revealed the mass to be a retained swab from previous abdominal surgery. Reproduced with permission of Downs Referrals, Bristol.

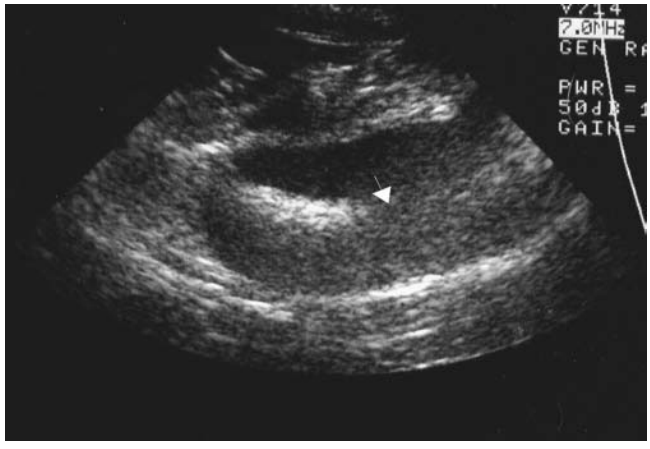

Figure 3.7(e) Abdominal radiograph of a cat with a palpable abdominal mass. There is a thickening of the small intestine wall (arrowed), with loss of normal layering, due to severe inflammatory bowel disease. Reproduced with permission of Downs Referrals, Bristol.

Neurogenic disease
Oedema
Postoperative abdomen*
Vascular disease
Drugs

Mechanical
Adhesions*
Foreign body*
Intussusception
Localised inflammation*
Neoplasia

References

Beck, C., et al. (2001) The use of ultrasound in the investigation of gastric carcinoma in a dog. *Aust Vet J*, **79**:332–4.

Guilford, W. G. (2005) Motility disorders: approach and management. *Proceedings, BSAVA Congress, 2005*.

Paoloni, M. C., et al. (2002) Ultrasonographic and clinicopathologic findings in 21 dogs with intestinal adenocarcinoma. *Vet Radiol Ultrasound*, **43**:562–7.

Penninck, D. (2003) Diagnostic value of ultrasonography in differentiating enteritis from intestinal neoplasia in dogs. *Vet Radiol Ultrasound*, **44**:570–5.

3.7.8 Ovarian and uterine disease

Ovarian masses

Ovarian stump granuloma

*Cysts**
Follicular
Luteinising

Neoplasia
Adenoma
Adenocarcinoma
Dysgerminoma
Granulosa cell tumour
Luteoma
Teratoma
Thecoma

Uterine enlargement

Haemometra
Hydrometra
Mucometra
Post partum*
Pregnancy*
Pyometra*

Uterine wall thickening

Neoplasia
Adenocarcinoma
Adenoma
Fibroma
Fibrosarcoma
Leiomyoma
Leiomyosarcoma
Lymphoma

References

Bigliardi, E., et al. (2004) Ultrasonography and cystic hyperplasia-pyometra complex in the bitch. *Reprod Domest Anim,* **39**:136–40.

Yeager, A. E., et al. (1992) Ultrasonographic appearance of the uterus, placenta, fetus, and fetal membranes throughout accurately timed pregnancy in beagles. *Am J Vet Res,* 53:342–51.

3.7.9 Prostatic disease

Prostatic enlargement

Diffuse
Bacterial prostatitis*
Benign prostatic hyperplasia*
Neoplasia
Squamous metaplasia

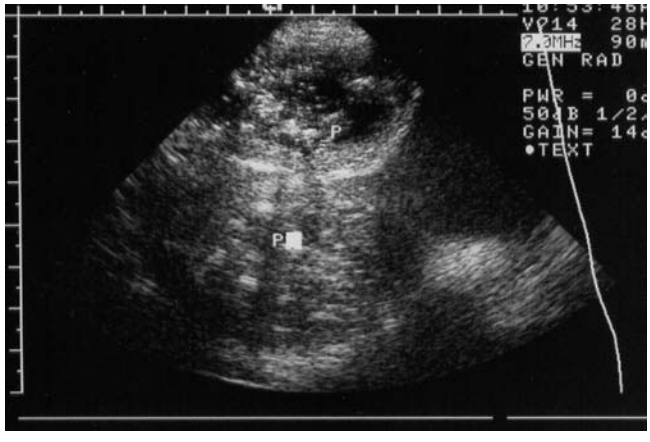

Figure 3.7(f) Ultrasonogram of the prostate, showing prostatic adenocarcinoma. Reproduced with permission of Downs Referrals, Bristol.

Focal lesions

Abscessation
Cysts
- Paraprostatic
- Prostatic

Neoplasia
- Adenocarcinoma
- Fibroma
- Leiomyoma
- Leiomyosarcoma
- Squamous cell carcinoma
- Transitional cell carcinoma
- Undifferentiated carcinoma

References

Stowater, J. L. (1989) Ultrasonographic features of paraprostatic cysts in nine dogs. *Vet Radiol Ultrasound*, **30**:232–9.
Williams, J. & Niles, J. (1999) Prostatic disease in the dog. *In Practice*, **21**:558–75.

3.7.10 Ascites

Bile – ruptured biliary tract

Neoplasia
Post surgery, e.g.
- Cholecystectomy

Severe cholecystitis*
Trauma

Blood

Coagulopathy

Neoplasia, e.g.
- Haemangiosarcoma*

Organ or major blood vessel rupture
Thrombosis
Trauma
Vasculitis

Chyle

Congestive heart failure
Feline infectious peritonitis (C)
Lymphangiectasia
Lymphangiosarcoma
Lymphoma
Mesenteric root strangulation
Ruptured cisterna chyli
- Neoplasia
- Trauma

Steatitis

Exudate

Diaphragmatic hernia
Feline infectious peritonitis* (C)
Hepatitis
Neoplasia
Organ torsion
Pancreatitis
Pericardiodiaphragmatic hernia

Septic peritonitis

Abscess
Haematogenous spread
Iatrogenic/nosocomial
Local extension of infection from elsewhere
Migrating foreign body
Neoplasia*
Pancreatitis*
Penetrating wound
Ruptured viscus, e.g.
- Neoplasia
- Post surgery, e.g.
  - Enterotomy wound dehiscence*
- Pyometra
- Trauma

Steatitis

Transudate/modified transudate

Cardiac tamponade *q.v.*
Caudal vena caval obstruction
Hepatic disease
- Cholangiohepatitis* *q.v.*

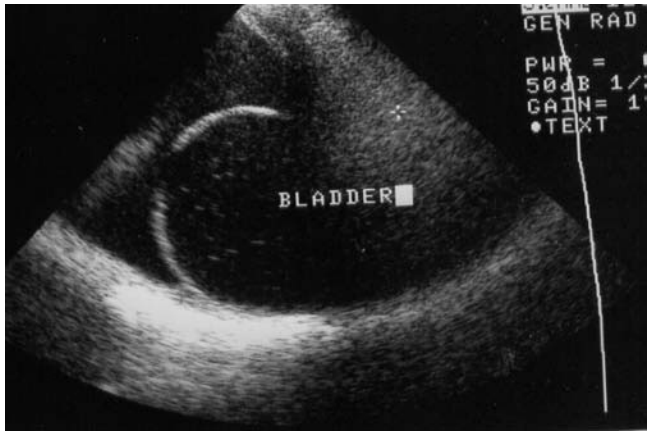

Figure 3.7(g) Abdominal ultrasonogram demonstrating ascites. The bladder wall is clearly visible. The apparent hole in its cranial pole is artefactual. Reproduced with permission of Downs Referrals, Bristol.

- Chronic hepatitis* *q.v.*
- Cirrhosis*
- Fibrosis*
- Portal hypertension

Hypoalbuminaemia* *q.v.*
Inflammation
- Feline infectious peritonitis

Neoplasia*
Portal hypertension
Right-sided heart failure*
Ruptured cyst
Splenic disease

Urine – lower urinary tract rupture

Bladder
Ureter
Urethra

References

Monteiro, C. B. & O' Brien, R. T. (2004) A retrospective study on the sonographic findings of abdominal carcinomatosis in 14 cats. *Vet Rad & Ult,* **45**:559–64.
Savary, C. M., et al. (2001) Chylous abdominal effusion in a cat with feline infectious peritonitis. *JAAHA,* **37**:35–40.
Tasker, S. & Gunn-Moore, D. (2000) Differential diagnosis of ascites in cats. *In Practice,* **22**:472–9.

3.8 Ultrasonography of other regions

3.8.1 Testes

Enlargement

Neoplasia*
Orchitis
Torsion

Focal lesions – neoplasia

Interstitial cell tumour*
Seminoma*
Sertoli cell tumour*

Reference

England, G. C. (1995) Ultrasonographic diagnosis of non-palpable Sertoli cell tumours in infertile dogs. *JSAP,* **36**:476–80.

3.8.2 Eyes

Intraocular masses

Foreign body*
Inflammation*

*Infection**
Bacteria
Fungi
- Blastomycosis
- Coccidioidomyocosis
- Cryptococcosis
- Histoplasmosis

Viral
- Feline infectious peritonitis* (C)

Neoplasia
Ciliary body adenocarcinoma
Ciliary body adenoma
Lymphoma
Medulloepithelioma
Melanoma
Metastatic cancer
Squamous cell carcinoma

*Organised haemorrhage**
Chronic glaucoma
Coagulopathy *q.v.*
Diabetes mellitus*

Hypertension* *q.v.*
Neoplasia
Neovascularisation
Persistent hyaloid artery
Trauma*
Vitreoretinal disease

Point-like and membranous lesions of vitreous chamber

Asteroid hyalosis
Endophthalmitis
Foreign body
Haemorrhage (see above)
Persistent hyperplastic primary vitreous
Posterior vitreal detachment
Vitreous floaters
Vitreous membrane formation

Retinal detachment *q.v.*

Retrobulbar masses

*Abscess/cellulitis**
Extension from nasal cavity
Extension from paranasal sinuses
Extension from tooth-root infection*
Extension from zygomatic salivary gland
Foreign body
Haematogenous spread
Oral inflammatory disease
Penetrating wound

Neoplasia
Metastatic tumours
- Chondrosarcoma
- Haemangiosarcoma
- Lacrimal gland tumour
- Lymphoma
- Meningioma
- Nasal adenocarcinoma
- Neurofibrosarcoma
- Osteosarcoma
- Rhabdomyosarcoma
- Squamous cell carcinoma
- Zygomatic gland tumour

Primary epithelial and mesenchymal tumours

References

Bayon, A., et al. (2001) Ocular complications of persistent hyperplastic primary vitreous in three dogs. *Vet Ophthalmol,* **4**:35–40.
Homco, L. D. & Ramirez, O. (1995) Retrobulbar abscesses. *Vet Radiol,* **36**:240–42.

3.8.3 Neck

Enlarged parathyroid gland(s)

Neoplasia
Adenocarcinoma
Adenoma

Hyperplasia
Nutritional secondary hyperparathyroidism
Renal secondary hyperparathyroidism

Enlarged thyroid gland(s)

Neoplasia
Adenocarcinoma*
Adenoma*

Miscellaneous
Thyroid cyst
Thyroiditis

Lymph node enlargement

Inflammation/infection
Abscess*
Inflammation*

Neoplasia
Lymphoma*
Metastatic neoplasia*

Salivary gland enlargement

Salivary cysts
- Retention cyst
- True cyst

Salivary gland abscess*
Salivary gland neoplasia
Sialitis
Sialocoele*
Sialolithiasis

Neck masses at other sites

Inflammation/infection
Abscess*
Cellulitis
Granuloma

Neoplasia
Lipoma*

Metastatic neoplasia
Primary neoplasia

Miscellaneous
Arteriovenous malformation
Cyst*
Haematoma*

References

Sueda, M. T. & Stefanacci, J. D. (2000) Ultrasound evaluation of the parathyroid glands in two hypercalcemic cats. *Vet Radiol Ultrasound,* **41**:448–51.
Wisner, E. R., et al. (1994) Ultrasonographic examination of cervical masses in the dog and cat. *Vet Radiol Ultrasound,* **35**:310–15.

PART 4
LABORATORY FINDINGS

In order to avoid repetition, 'laboratory error' has been omitted from the differential diagnoses in this chapter. However, it should always be borne in mind that factors such as mislabelling or misidentification of samples, errors introduced by the laboratory machinery (especially certain in-house laboratories where quality control is inadequate), errors due to ageing samples or incorrect collection techniques can all cause apparent abnormalities. Where a test result is unexpectedly abnormal it should be repeated, preferably by a different method. It is also important to remember that normal ranges are usually based on the values into which 95% of the healthy population would fall, so small changes outside these values may not be significant. Finally, different laboratories use different reference ranges, due to differences in testing methodology.

4.1 Biochemical findings

4.1.1 Albumin

Increased

Artefact
- Lipaemia

Haemoconcentration*
- Dehydration

Decreased

Relative (dilutional)

Decreased protein intake

Malabsorption*
Maldigestion
Malnutrition

Decreased production

Chronic inflammatory disease*
Hepatic failure* *q.v.*

Increased loss

Cutaneous lesions, e.g.
- Burns

External haemorrhage*, e.g.
- Coagulopathy *q.v.*
- Gastrointestinal neoplasia

- Gastrointestinal ulceration
- Trauma

Protein-losing enteropathy*
- Acute viral infection
- Cardiac disease
- Inflammatory bowel disease
- Gastrointestinal neoplasia
- Gastrointestinal parasitism
- Gastrointestinal ulceration
- Lymphangiectasia
  - Intestinal inflammation
  - Intestinal neoplasia
  - Lymphangitis
  - Primary/congenital
  - Venous hypertension

Protein-losing nephropathy *q.v.*

Sequestration

Body cavity effusion* *q.v.*

See Plate 4.1(a) in colour plate section.

References

King, L. G. (1994) Postoperative complications and prognostic indicators in dogs and cats with septic peritonitis: 23 cases (1989–1992). *JAVMA*, **204**:407–14.

McGrotty, Y. & Knottenbelt, C. (2002) Significance of plasma protein abnormalities in dogs and cats. *In Practice*, **24**:512–17.

Simpson, J. W. (2005) Protein-losing enteropathies. *Proceedings, BSAVA Congress, 2005*.

4.1.2 Alanine transferase

Decreased (see Plate 4.1(b) in colour plate section)

Chronic liver disease

Normal variation*

Nutritional deficiency
- Vitamin B_6
- Zinc

Increased

Artefact

Haemolysis

Lipaemia

Liver disease

Cholangiohepatitis* *q.v.*

Cholangitis* q.*v.*

Chronic hepatitis* *q.v.*

Cirrhosis*

Copper storage disease (D)
Feline infectious peritonitis* (C)
Hepatotoxin
Neoplasia, e.g.
- Hepatocellular adenocarcinoma*
- Lymphoma*

Trauma*

Extrahepatic disease
Anoxia
Endocrine disease, e.g.
- Hyperadrenocorticism
- Hyperthyroidism (C)

Inflammatory disease, e.g.
- Pancreatitis

Drugs/toxins
Barbiturates
Cimetidine
Colchicine
Cyclophosphamide
Danazol
Diazepam (C)
Glucocorticoids
Griseofulvin
Itraconazole
Ketoconazole
Methamizole
Methotrexate
Metronidazole
Mexiletine
Nandrolone
NSAIDs, e.g.
- Ibuprofen
- Paracetamol
- Phenylbutazone

Oxytetracycline
Phenobarbitone
Phenylbutazone
Phenytoin
Primidone
Procainamide
Salicylates
Tetracycline
Trimethoprim/sulphonamide

References

Foster, S. F., et al. (2000) Effects of phenobarbitone on serum biochemical tests in dogs. *Aust Vet J*, **78**:23–6.

Kaufman, A. C. & Greene, C. E. (1993) Increased alanine transaminase activity associated with tetracycline administration in a cat. *JAVMA*, **202**:628–30.

4.1.3 Alkaline phosphatase

INCREASED

Normal in young growing animals*

Artefact

Haemolysis
Hyperbilirubinaemia
Lipaemia

Hepatic disease

Cholangiohepatitis* *q.v.*
Chronic hepatitis* *q.v.*
Cirrhosis* *q.v.*
Copper storage disease (D)
Feline infectious peritonitis* (C)
Hepatic lipidosis (C)
Hepatic neoplasia*, e.g.
- Haemangiosarcoma
- Hepatocellular carcinoma
- Lymphoma
- Metastatic carcinoma

Extrahepatic disease

Bile duct neoplasia
Bone disease, e.g.
- Fracture
- Osteomyelitis

Cholecystitis*
Cholelithiasis
Diabetes mellitus*
Diaphragmatic hernia*
Ehrlichiosis
Gall bladder mucocoele
Hyperadrenocorticism
Hyperthyroidism (C)*
Pancreatic neoplasia
Pancreatitis*
Right-sided congestive heart failure*
Septicaemia*

Drugs/toxins

Aflatoxin
Barbiturates
Cimetidine
Colchicine
Cyclophosphamide
Danazol
Diazepam (C)
Glucocorticoids

Griseofulvin
Itraconazole
Ketoconazole
Methamizole
Methotrexate
Metronidazole
Mexiletine
Nandrolone
NSAIDs, e.g.
- Ibuprofen
- Paracetamol
- Phenylbutazone

Oxytetracycline
Phenobarbitone
Phenoxy acid herbicides
Phenylbutazone
Phenytoin
Primidone
Procainamide
Salicylates
Trimethoprim/sulphonamide

References

Foster, S. F., et al. (2000) Effects of phenobarbitone on serum biochemical tests in dogs. *Aust Vet J*, **78**:23–6.
Komnenou, A., et al. (2005) Correlation of serum alkaline phosphatase activity with the healing process of long bone fractures in dogs. *Vet Clin Pathol*, **34**:35–8.
Worley, D. R., et al. (2004) Surgical management of gallbladder mucocoeles in dogs: 22 cases (1999–2003). *JAVMA*, **225**:1418–23.

4.1.4 Ammonia

Decreased

Drugs
Diphenhydramine
Enemas
Lactulose
Oral antibiotics, e.g.
- Aminoglycosides
- Probiotics

Increased

Artefact
Delay in sample analysis
Fluoride/oxalate anti-coagulants
Strenuous exercise

Hepatic insufficiency, e.g.
Acquired portosystemic shunt
Congenital portosystemic shunt

Miscellaneous
High protein diet*
Intestinal haemorrhage
Portosystemic shunts
Urea cycle disorders

Drugs
Ammonium salts
Asparaginase
Diuretics

Reference

Winkler, J. T., et al. (2003) Portosystemic shunts: diagnosis, prognosis and treatment of 64 cases (1993–2001). *JAAHA*, **39**:169–85.

4.1.5 Amylase

INCREASED

Intestinal disease*

Pancreatic disease*

Necrosis
Neoplasia
Pancreatic duct obstruction
Pancreatitis*

Reduced glomerular filtration *q.v.*

Pre-renal disease*
Renal disease*
Post-renal disease*

Drugs/toxins

Azathioprine
Carbamate
Diazoxide
Frusemide
Glucocorticoids
L-asparaginase
Metronidazole
Oestrogens
Potassium bromide
Sulphonamides
Tetracyclines
Thiazide diuretics

Reference

Mansfield, C. S., et al. (2003) Assessing the severity of canine pancreatitis. *Res Vet Sci*, **74**: 137–44.

4.1.6 Aspartate aminotransferase

INCREASED

Artefact
Haemolysis
Lipaemia

Haemolysis*

Hepatic disease* *q.v.*

Muscle damage*
Exercise
Inflammation
Intramuscular injection
Ischaemia
Necrosis
Neoplasia
Trauma

Drugs/toxins
Barbiturates
Carbamate
Glucocorticoids
Griseofulvin
Ketoconazole
NSAIDs, e.g.
- Ibuprofen
- Paracetamol
- Phenobarbitone
- Phenylbutazone
- Primidone
- Salicylates

Reference
Evans, J., et al. (2004) Canine inflammatory myopathies: A clinicopathologic review of 200 cases. *JVIM*, **18**:679–91.

4.1.7 Bilirubin

Decreased

Artefact
Prolonged exposure to sunlight or fluorescent light

Increased (see also Jaundice)

Artefact
Haemolysis
Lipaemia

Pre-hepatic
Haemolysis*

Hepatic, e.g.
Cholestatic liver disease* *q.v.*

Post-hepatic, e.g.
Biliary obstruction* *q.v.*

Drugs/toxins
Barbiturates
Blue-green algae
Glucocorticoids
Glyphosphate
Griseofulvin
Ketoconazole
Metronidazole
Phenobarbitone
Plastic explosives
Primidone
NSAIDs, e.g.
- Ibuprofen
- Paracetamol
- Phenylbutazone

Salicylates

References
Mayhew, P. D., et al. (2002) Pathogenesis and outcome of extrahepatic biliary obstruction in cats. *JSAP*, **43**:247–53.
Worley, D. R., et al. (2004) Surgical management of gallbladder mucocoeles in dogs: 22 cases (1999–2003). *JAVMA*, **225**:1418–23.

4.1.8 Bile acids/dynamic bile acid test

Failure to stimulate
Cholestyramine
Delayed gastric emptying
Failure to feed a sufficiently high fat meal for bile acid stimulation test
Malabsorption
Rapid intestinal transit time
Normal

Increased
Artefact
- Haemolysis
- Lipaemia

Cholestatic disease* *q.v.*
Hepatic parenchymal disease* *q.v.*

Fig. 4.1 Ventrodorsal radiograph of an intraoperative mesenteric venogram, showing an extrahepatic portosystemic shunt. Reproduced with permission of Downs Referrals, Bristol.

Portosystemic shunt
- Acquired
- Congenital

Secondary hepatic disease*

Drugs
- Ursodeoxycholic acid

References

Charles, J. (2005) An update on bile acids. *Proceedings, BSAVA Congress, 2005*.

Winkler, J. T., et al. (2003) Portosystemic shunts: diagnosis, prognosis and treatment of 64 cases (1993–2001). *JAAHA*, **39**:169–85.

4.1.9 C-reactive protein

Increased

Inflammation*

Neoplasia*

Parturition*

Tissue trauma*

Reference

Kjelgaard-Hansen, M., et al. (2006) Measurement of serum interleukin-10 in the dog. *Vet J*, Feb 2006.

4.1.10 Cholesterol

Decreased

Artefact
Intravenous dipyrone

Gastrointestinal
Hepatic insufficiency* *q.v.*
Maldigestion/malabsorption* *q.v.*
Protein-losing enteropathy* *q.v.*

Drugs
Azathioprine
Oral aminoglycosides

Increased

Idiopathic hyperlipidaemia
Postprandial hyperlipidaemia

Artefact
Hyperbilirubinaemia
Lipaemia

Breed-related
Hypercholesterolaemia of the Briard, Rough Collie, Shetland Sheepdog (D)

Secondary hyperlipidaemia
Cholestatic disease* *q.v.*
Diabetes mellitus*
Hyperadrenocorticism
Hypothyroidism* (D)
Nephrotic syndrome

Drugs
Corticosteroids
Phenytoin
Thiazide diuretics

References

Jeusette, I., et al. (2004) Hypercholesterolaemia in a family of rough collie dogs. *JSAP*, **45**:319–24.
Sato, K., et al. (2000) Hypercholesterolemia in Shetland sheepdogs. *J Vet Med Sci*, **62**:1297–1301.

4.1.11 Creatinine

Decreased

Poor body condition

Increased

Heavily muscled dogs
Pre-renal azotaemia*
Renal failure*
- Acute renal failure
- Chronic renal failure
- Post-renal failure*

(see urea, *q.v.*)

Reference

Elliott, J. & Barber, P. J. (1998) Feline chronic renal failure: clinical findings in 80 cases diagnosed between 1992 and 1995. *JSAP*, **39**:78–85.

4.1.12 Creatine kinase

Mild increases

Intramuscular injections*
Muscle biopsy
Muscle damage
Physical activity*
Prolonged recumbency*
Restraint*

Moderate increases

Anorexia
Convulsions*
Masticatory myopathy
Muscle damage
Neuropathies
Trauma*
Tremors/shivering *q.v.*
Toxins, e.g.
- Carbamate
- Lily poisoning
- Phenoxy acid herbicides

Marked increases

Feline obstructive urethral syndrome*
Thromboembolic disease

Inherited myopathies

Hereditary Labrador Retriever myopathy
Muscular dystrophy
Myotonia

Myositis

Infectious
- Neurosporosis
- Toxoplasmosis

Immune-mediated
- Polymyosistis

Endocrine

Hyperadrenocorticism
Hypothyroidism* (D)

Toxic

Monensin

Nutritional myopathy
Selenium deficiency
Vitamin E deficiency

References

Fascetti, A. J., et al. (1997) Correlation between serum creatine kinase activities and anorexia in cats. *JVIM*, **11**:9–13.
Rumbeiha, W. K., et al. (2004) A comprehensive study of Easter lily poisoning in cats. *J Vet Diagn Invest*, **16**:527–41.

4.1.13 Ferritin

Decreased

Iron deficiency disorders *q.v.*

Increased

Haemolysis*
Inflammation*
Liver disease*
Neoplasia*
- Lymphoma

Repeated blood transfusions

References

Kazmierski, K. J., et al. (2001) Serum zinc, chromium, and iron concentrations in dogs with lymphoma and osteosarcoma. *JVIM*, **15**:585–8.
Sprague, W. S., et al. (2003) Hemochromatosis secondary to repeated blood transfusions in a dog. *Vet Pathol*, **40**:334–7.

4.1.14 Fibrinogen

Decreased

Artefact
- Clot
- Incorrect anticoagulant

Disseminated intravascular coagulation*
Excessive blood loss*
Hereditary fibrinogen deficiency
Severe hepatic insufficiency

Increased

Breed
- Cavalier King Charles Spaniels

Inflammation*
Parturition*
Pregnancy*
Renal disease*

References

McGrotty, Y. & Knottenbelt, C. (2002) Significance of plasma protein abnormalities in dogs and cats. *In Practice*, **24**:512–17.
Sjodahl-Essen, T. (2001) Fibrinogen deficiency and other haemostatic disorders in dogs. *Eur J Comp An Prac*, **XI**: 81–8.
Tarnow, I., et al. (2004) Assessment of changes in hemostatic markers in Cavalier King Charles Spaniels with myxomatous mitral valve disease. *Am J Vet Res*, **65**:1644–52.

4.1.15 Folate

Decreased

Dietary deficiency
Proximal small intestinal disease*

Increased

Dietary supplementation
Exocrine pancreatic insufficiency
Small intestinal bacterial overgrowth*

Reference

Rutgers, H. C., et al. (1995) Small intestinal bacterial overgrowth in dogs with chronic intestinal disease. *JAVMA*, **206**:187–93.

4.1.16 Fructosamine

Decreased

Hyperthyroidism (C)
Insulin overdosage
Persistent hypoglycaemia *q.v.*, e.g.
- Insulinoma

Increased

Hypothyroidism (D)*
Persistent hyperglycaemia, e.g.
- Diabetes mellitus*

References

Chastain, C. B. (2003) Serum fructosamine concentrations in dogs with hypothyroidism. *Sm Anim Clin Endocrinol*, **13**:11–12.
Mellanby, R. J. & Herrtage, M. E. (2002) Insulinoma in a normoglycaemic dog with low serum fructosamine. *JSAP*, **43**:506–508.

4.1.17 Gamma-glutamyl transferase

INCREASED

Artefact
Lipaemia

Hepatic disease
Cholangiohepatitis* *q.v.*
Chronic hepatitis* *q.v.*
Cirrhosis* *q.v.*
Copper storage disease (D)
Feline infectious peritonitis* (C)
Hepatic lipidosis (C)
Hepatic neoplasia*, e.g.
- Haemangiosarcoma
- Hepatocellular carcinoma
- Lymphoma
- Metastatic carcinoma

Extrahepatic disease
Bile duct neoplasia
Cholecystitis*
Cholelithiasis
Diabetes mellitus*
Diaphragmatic hernia*
Gall bladder mucocoele
Hyperadrenocorticism
Hyperthyroidism (C)*
Pancreatic neoplasia
Pancreatitis*
Right-sided congestive heart failure*
Septicaemia*

Drugs
Barbiturates
Glucocorticoids
Griseofulvin
Ketoconazole
NSAIDs, e.g.
- Ibuprofen
- Paracetamol
- Phenylbutazone

Phenobarbitone
Primidone
Salicylates

Reference
Aitken, M. M., et al. (2003) Liver-related biochemical changes in the serum of dogs being treated with phenobarbitone. *Vet Rec*, **153**:13–16.

4.1.18 Gastrin

Increased

Antral G-cell hyperplasia
Atrophic gastritis
Chronic omeprazole administration
Gastric outlet obstruction
Gastrinoma
Hyperparathyroidism
Renal failure* *q.v.*
Short bowel syndrome

Reference

Fukushima, R., et al. (2004) A case of canine gastrinoma. *J Vet Med Sci*, **66**:993–5.

4.1.19 Globulins

INCREASED

Polyclonal

Dehydration

Infectious

Bacterial disease*, e.g.
- Bacterial endocarditis
- Brucellosis
- Pyoderma*

Fungal disease, e.g.
- Blastomycosis
- Coccidioidomycosis
- Histoplasmosis

Parasitic disease*, e.g.
- Demodicosis*
- Dirofilariasis
- Scabies*

Protozoal disease

Rickettsial disease, e.g.
- Ehrlichiosis

Viral disease*, e.g.
- Feline immunodeficiency virus* (C)
- Feline infectious peritonitis* (C)
- Feline leukaemia virus* (C)

Immune-mediated/inflammatory

Acute inflammatory response, e.g.
- Hepatitis*
- Nephritis *
- Suppurative diseases*

Allergies*
Autoimmune polyarthritis
Bullous pemphigoid
Immune-mediated haemolytic anaemia
Immune-mediated thrombocytopenia
Pemphigus complex
Systemic lupus erythematosus

Neoplasia
Lymphoma

Monoclonal/Oligoclonal

Cutaneous amyloidosis
Idiopathic
Macroglobulinaemia
Plasmacytic gastroenterocolitis

Infectious
Ehrlichiosis
Leishmaniasis

Neoplastic
Extramedullary plasmacytoma
Lymphoma*
Multiple myeloma

DECREASED
Normal in greyhounds
External haemorrhage, e.g.
- Coagulopathy *q.v.*
- Gastrointestinal neoplasia
- Gastrointestinal ulceration
- Trauma*

Hepatic insufficiency* *q.v.*
Neonate*
Protein-losing enteropathies* *q.v.*

References

McGrotty, Y. & Knottenbelt, C. (2002) Significance of plasma protein abnormalities in dogs and cats. *In Practice*, **24**:512–17.
Savary, C. M., et al. (2001) Chylous abdominal effusion in a cat with feline infectious peritonitis. *JAAHA*, **37**:35–40.

4.1.20 Glucose

Decreased

Polycythaemia *q.v.*

Renal failure* *q.v.*
Sepsis*

Artefact
Prolonged contact of serum/plasma with erythrocytes

Endocrine
Hypoadrenocorticism (D)
Hypopituitarism
Insulinoma

Hepatic
Hepatic failure
- Cirrhosis*
- Hepatic necrosis, e.g.
  - Infection
  - Toxin
  - Trauma
- Portosystemic shunts (acquired or congenital)

Idiopathic
Juvenile
Neonatal

*Neoplastic**
Hepatic leiomyoma/leiomyosarcoma
Hepatic/splenic haemangiosarcoma
Hepatocellular carcinoma
Pancreatic

Substrate deficiency
Glycogen storage disease
Hunting dog hypoglycaemia
Juvenile hypoglycaemia
Neonatal hypoglycaemia
Reduced dietary intake of glucose or its precursors

Drugs/toxins
Anabolic steroids
Beta blockers, e.g.
- Propranolol

Ethanol
Ethylene glycol
Insulin
Salicylates

Sulfonylurea
Xylitol

Increased

Pancreatitis*
Parenteral nutrition
Post-prandial
Renal insufficiency* *q.v.*
Stress hyperglycaemia*

Artefact
Azotaemia

Endocrine
Acromegaly
Diabetes mellitus*
Hyperadrenocorticism
Phaeochromocytoma

Progesterone-induced, e.g.*
Dioestrus
Lactation
Pregnancy

Drugs/toxins
Daffodil
Glucocorticoids
Hydrochlorothiazide
Megestrol acetate
Oestrogens
Phenytoin
Progestagens
Snake venom
Thiazide diuretics
Xylazine

References

Dunayer, E. K. (2004) Hypoglycaemia following canine ingestion of xylitol-containing gum. *Vet Hum Toxicol*, **46**:87–8.
Segev, G., et al. (2004) *Vipera palaestinae* envenomation in 327 dogs: a retrospective cohort study and analysis of risk factors for mortality. *Toxicon*, **43**:691–9.

4.1.21 Iron

Decreased

Acute phase inflammatory reactions*
Chronic inflammatory disease*
Hypothyroidism (D)

Portosystemic shunt
Renal disease* *q.v.*

*Chronic external blood loss**
Chronically bleeding external masses*
External parasites, e.g.
- Heavy flea burden*

Gastrointestinal*, e.g.
- Clotting disorder *q.v.*
- Neoplasia
- Parasitism
- Ulceration

Decreased intake
Milk-only diet in immature animals

Neoplasia
Lymphoma
Osteosarcoma

Increased
Haemolysis* *q.v.*
Ingestion of iron supplements/parental overdose
Liver disease* *q.v.*
Refractory anaemia

References
Bunch, S. E., et al. (1995) Characterization of iron status in young dogs with portosystemic shunt. *Am J Vet Res*, **56**:853–8.
Kazmierski, K. J., et al. (2001) Serum zinc, chromium, and iron concentrations in dogs with lymphoma and osteosarcoma. *JVIM*, **15**:585–8.

4.1.22 Lactate dehydrogenase

INCREASED

Artefact
Haemolysis
Sample ageing

Cardiac muscle disorders
Degeneration
Ischaemia
- Aortic thromboembolism*
- Bacterial endocarditis
- Dirofilariasis
- Myocardial infarction

Neoplasia
Trauma

Respiratory disease*
Necrosis
Thromboembolism

Skeletal muscle disorders

Exertional rhabdomyolysis
Neoplasia*
Seizures*
Trauma*

Endocrine

Hyperadrenocorticism*
Hypothyroidism* (D)

Inflammatory/infectious

Bacterial*
Protozoal*

Idiopathic

Idiopathic polymyositis
Masticatory myopathy

Inherited myopathies

Hereditary Labrador Retriever myopathy
Muscular dystrophy
Myotonia

Metabolic

Glycogen storage diseases
Mitochondrial myopathy

Nutritional

Vitamin E deficiency

Vascular

Aortic thromboembolism* (C)

Miscellaneous

Hepatocellular damage* *q.v.*
Hyperthyroidism* (C)

References

Alleman, A. R. (2003) Laboratory profiling in dogs/cats. *Western Veterinary Conference, 2003*.
Haynes, J. S. & Wade, P. R. (1995) Hepatopathy associated with excessive hepatic copper in a Siamese cat. *Vet Pathol*, **32**:427–9.

4.1.23 Lipase

Decreased

Artefact

Haemolysis
Hyperbilirubinaemia
Lipaemia

Increased

Pancreatic disease
- Necrosis
- Neoplasia
- Pancreatic duct obstruction
- Pancreatitis*

Reduced glomerular filtration
- Pre-renal disease* *q.v.*
- Renal disease* *q.v.*
- Post-renal disease* *q.v.*

Drugs
- Azathioprine
- Diazoxide
- Frusemide
- Glucocorticoids
- L-asparaginase
- Metronidazole
- Oestrogens
- Potassium bromide
- Sulphonamides
- Tetracyclines
- Thiazide diuretics

References

Mansfield, C. S., et al. (2003) Assessing the severity of canine pancreatitis. *Res Vet Sci*, **74**: 137–44.

Mohr, A. J., et al. (2000) Acute pancreatitis: a newly recognised potential complication of canine babesiosis. *J S Afr Vet Assoc*, **71**:232–9.

4.1.24 Triglycerides

Decreased

- Artefact
  - Intravenous dipyrone
- Hyperthyroidism* (C)
- Protein-losing enteropathy*
- Drugs
  - Ascorbic acid therapy

Increased

- Artefact
  - Hyperbilirubinaemia
- Post-prandial*

Primary/idiopathic hyperlipidaemia
- Familial hyperchylomicronaemia in the cat

Idiopathic hyperchylomicronaemia of the Miniature Schnauzer
Idiopathic hypertriglyceridaemia
Lipoprotein lipase deficiency (C)
Transient hyperlipidaemia and anaemia in kittens (C)

Secondary hyperlipidaemia
Acute pancreatitis*
Cholestasis*
Diabetes mellitus*
Hepatic insufficiency* *q.v.*
Hyperadrenocorticism
Hypothyroidism* (D)
Nephrotic syndrome

Drugs
Glucocorticoids
Megestrol acetate

References

Chikamune, T., et al. (1998) Lipoprotein profile in canine pancreatitis induced with oleic acid. *J Vet Med Sci*, **60**:413–21.
Gunn-Moore, D. A., et al. (1997) Transient hyperlipidaemia and anaemia in kittens. *Vet Rec*, **140**:355–9.

4.1.25 Trypsin-like immunoreactivity

Decreased

Exocrine pancreatic insufficiency
Very low protein diet

Increased

High-protein diet
Pancreatitis*
Post-pancreatic obstruction
Reduced glomerular filtration rate

References

Carro, T. & Williams, D. A, (1989). Relationship between dietary protein concentration and serum trypsin-like immunoreactivity in dogs. *Am J Vet Res*, **50**:2105–2107.
Mansfield, C. S., et al. (2003) Assessing the severity of canine pancreatitis. *Res Vet Sci*, **74**:137–44.

4.1.26 Urea (see Plate 4.1(c) in colour plate section)

INCREASED

Pre-renal

Dehydration*

Gastro-intestinal haemorrhage
Heart failure*
High protein diet*
Hypoadrenocorticism (D)
Increased catabolic state, e.g.
- Fever*

Shock* *q.v.*
Tetracyclines

Renal (see Table 4.1)

Acute renal failure
Diabetes mellitus*
Hypercalcaemia
Immune-mediated diseases, e.g.
- Glomerulonephritis
- Systemic lupus erythematosus

Infection, e.g.
- Leptospirosis
- Pyelonephritis

Ischaemia
- Decreased cardiac output*
- Extensive burns
- Hyper-/hypothermia* *q.v.*
- Prolonged anaesthesia*
- Renal vessel thrombosis
- Shock, e.g.
  - Hypovolaemia
  - Sepsis*

Table 4.1 Differentiating acute and chronic renal failure.

	Acute	**Chronic**
Signalment	Any age, breed.	Usually older, unless breed predisposed to congenital kidney disease.
History	Toxin exposure, trauma, ischaemic insult, acute course.	PUPD, weight loss, chronic course.
Physical findings	Normal or large kidneys; other clinical signs often more severe than in CRF.	Often small irregular kidneys. Oral ulceration, mucous membrane pallor.
Clinical pathology	Hyperkalaemia may be seen, especially in oliguric or obstructed cases.	Potassium may be normal or low; non-regenerative anaemia often present; PTH may be elevated.
Urinalysis	Proteinuria, glucosuria, granular casts may be seen; may be anuric, oliguric or polyuric.	May be bacterial infection; polyuria usually seen unless 'acute on chronic'.

- Transfusion reactions
- Trauma*

Urinary tract obstruction*

Drugs/toxins

- ACE inhibitors
- Anaesthetics
- Antibiotics, e.g.
  - Aminoglycosides
  - Amphotericin B
  - Cephalosporins
  - Tetracyclines
- Borax
- Calcium edetate
- Chemotherapeutics, e.g.
  - Cisplatin
- Cimetidine
- Corticosteroids
- Dipyrone (metamizole)
- Heavy metals, e.g.
  - Arsenic
  - Lead
  - Mercury
- Hymenoptera stings
- Intravenous radiographic contrast agents
- Iron/iron salts
- Methylene blue
- NSAIDs
- Organic compounds, e.g.
  - Ethylene glycol
  - Herbicides
  - Pesticides
- Pigments, e.g.
  - Myoglobin/haemoglobin
  - Paraquat
  - Plastic explosives
  - Salt
  - Snake venom

Chronic renal failure, e.g.

Subsequent to acute renal failure

Glomerulonephritis*

Interstitial nephritis*

Nephrotoxins

Post-renal

Bladder obstruction*, e.g.

- Blood clot
- Neoplasia
- Polyp*
- Urolith*

Bladder trauma
Ureteral obstruction (may need to be bilateral to cause azotaemia)
Urethral obstruction, e.g.
- Neoplasia
- Urolith

Urethral trauma
Uroabdomen

DECREASED

Normal in neonates*
Dialysis/over-hydration
Diuresis, e.g.
- Fluid and drug therapy*

Liver failure, e.g.
- Cirrhosis
- Portosystemic shunt*

Low-protein diet/malnutrition*
Polyuria *q.v.*, e.g.
- Diabetes insipidus
- Hyperadrenocorticism

Pregnancy*
Urea cycle enzyme deficiency

References

Birnbaum, N., et al. (1998) Naturally acquired leptospirosis in 36 dogs: serological and clinicopathological features. *JSAP*, **39**:231–6.
Elliott, J. & Barber, P. J. (1998) Feline chronic renal failure: clinical findings in 80 cases diagnosed between 1992 and 1995. *JSAP*, **39**:78–85.
Spreng, D. (2004) Urinary tract trauma. *Proceedings, WSAVA World Congress, 2004*.

4.1.27 Vitamin B_{12} (cobalamin)

Increased

Vitamin B_{12} supplementation

Decreased

Exocrine pancreatic insufficiency
Hepatic lipidosis (C)
Inflammatory biliary tract disorders
Inherited defect of absorption
Intestinal mucosal disease*
Pancreatitis

Reference

Simpson, K. W., et al. (2001) Subnormal concentrations of serum cobalamin (vitamin b12) in cats with gastrointestinal disease. *JVIM*, **15**:26–32.

4.1.28 Zinc

Decreased

Decreased dietary intake
Zinc-responsive dermatosis

Increased

Ingestion of zinc-containing objects, e.g.
- Coins

Reference

Hammond, G. M., et al. (2004) Diagnosis and treatment of zinc poisoning in a dog. *Vet Hum Toxicol*, **46**:272–5.

4.2 Haematological findings

4.2.1 Regenerative anaemia (see Table 4.2(a))

HAEMORRHAGE

Internal

Bleeding tumour*
Coagulopathy *q.v.*
Traumatic injury*

External

Bleeding tumour*
Coagulopathy *q.v.*
Epistaxis *q.v.*

Table 4.2(a) Differentiating regenerative from non-regenerative anaemia.

	Regenerative	Non-regenerative	Iron deficiency
MCV	N/↑	N	↓
MCHC	↓	N	↓
RPI	>2	<1	<1

Key:
MCV = Mean corpuscular volume
MCHC = Mean corpuscular haemoglobin concentration
RPI = Reticulocyte production index

RPI is calculated according to the following formula:
RPI = [% reticulocytes × (patient haematocrit/species haematocrit)]/correction factor

Species haematocrit = 45% (dog), 35% (cat)
Correction factor: PCV > 35% = 1; PCV 25 – 35% = 1.5; PCV 15 – 25% = 2; PCV < 15% = 2.5

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4.1.28 Zinc

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Decreased dietary intake
Zinc-responsive dermatosis

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- Coins

Reference

Hammond, G. M., et al. (2004) Diagnosis and treatment of zinc poisoning in a dog. *Vet Hum Toxicol*, **46**:272–5.

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Haematemesis *q.v.*
Haematuria *q.v.*
Intestinal blood loss *q.v.*
Traumatic injury*

*Parasitism**
Ancylostoma spp
Fleas
Lice
Ticks
Uncinaria spp

HAEMOLYSIS

Immune-mediated

Primary (auto-immune haemolytic anaemia)*

Immunological
Anti-lymphocyte globulin therapy
Neonatal isoerythrolysis
Systemic lupus erythematosus
Transfusion reactions

Infectious
Ancylostoma spp
Babesiosis
Cytauxzoonosis
Dirofilariasis
Ehrlichiosis
Feline leukaemia virus* (C)
Haemobartonellosis
Leishmaniasis
Leptospirosis*
Trypanosomiasis (D)
Uncinaria spp

Neoplastic
Haemangiosarcoma
Lymphoproliferative disease, e.g.
- Leukaemia
- Lymphoma*

Drugs/toxins
Antiarrhythmics
Anticonvulsants
Cephalosporins
Chlorpromazine
Copper
Dipyrone
Levamisole

Methimazole
Methylene blue
NSAIDs, e.g.
- Paracetamol

Penicillins
Propylthiouracil
Quinidine
Trimethoprim/sulphonamide

Mechanical injury of red cells

Dirofilariasis
Disseminated intravascular coagulation*
Enlarged spleen
Glomerulonephritis
Haemolytic–uraemic syndrome
Neoplasia causing microangiopathic haemolytic anaemia, e.g.
- Splenic haemangiosarcoma*

Patent ductus arteriosus
Vasculitis

Genetic defects of red cells

Feline porphyria
Hereditary elliptocytosis
Hereditary haemolysis in Abyssinian and Somali cats (C)
Hereditary stomatocytosis
Methaemoglobin reductase deficiency
Non-spherocytic haemolytic anaemia of Beagles (D)
Phosphofructokinase deficiency (D)
Pyruvate kinase deficiency

Acquired defects of red cells

Hypophosphataemia

Chemical damage

Copper
Cyclic hydrocarbons
Heavy metals
Propylene glycol

Oxidative damage (Heinz body anaemia)

Benzocaine toxicity
D-L methionine toxicity
Garlic toxicity
Glycol toxicity
High doses of vitamin K
Lymphoma
Metabolic disease
- Diabetes mellitus*
- Hyperthyroidism* (C)
- Renal failure*

Methylene blue
Onion toxicity
Paracetamol toxicity
Phenazopyridine (C)
Phenolic-compound toxicity, e.g.
- Mothballs

Propylene toxicity
Vitamin K_3 toxicity
Zinc toxicity

References

DeLong, D., et al. (1990) Immune mediated hemolytic anemia associated with antilymphocyte globulin therapy in dogs. *Lab Anim Sci*, **40**, 415–18.
Lobettie, R. (2002) Infectious causes of anaemia. *Proceedings, WSAVA Congress, 2002*.
MacWilliams, P. (2003) Red cell responses in disease. *Proceedings, Western Veterinary Conference, 2003*.
Skibild, E. (2001) Haemolytic anaemia and exercise intolerance due to phosphofructokinase deficiency in related Springer spaniels. *JSAP*, **42**:298–300.

4.2.2 Poorly-/non-regenerative anaemia (see Table 4.2(a))

Normal

Young animals

Acute, pre-regenerative anaemia

Anaemia of chronic disease/associated with systemic disease

Chronic inflammatory disease*
Chronic renal failure* *q.v.*
Cytauxzoonosis
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Hepatic disease* *q.v.*
Histoplasmosis
Hypoadrenocorticism (D)
Hypothyroidism* (D)
Leishmaniasis
Malignant neoplasia
Trypanosomiasis (D)

Bone marrow disorders – reduced red cell production

Aplastic anaemia

Hyperoestrogenism, e.g.
- Iatrogenic
- Sertoli cell tumour

Infection
- Ehrlichiosis
- Viruses, e.g.

- Feline leukaemia virus* (C)
- Parvovirus*

Irradiation
Drugs/toxins
- Albendazole
- Anti-cancer chemotherapeutics
- Chloramphenicol
- Cyclic hydrocarbons
- DDT
- Diazoxide
- Oestrogens
- Phenylbutazone
- Sulpha drugs
- Trichloroethylene
- Trimethoprim-sulphadiazine

Myelodysplasia
Primary
Secondary
- Cobalamin or folate deficiencies
- Drug-induced toxicosis
- Immune-mediated diseases
- Neoplastic diseases

Myelophthisis
Granulomatous inflammation
- Fungi
- Histoplasmosis
- Tuberculosis

Myelofibrosis
- Idiopathic
- Lymphoproliferative
- Myeloproliferative
- Other types of neoplasia
- Prolonged marrow stimulation, e.g.
  - Chronic haemolytic anaemia
- Radiation

Neoplasia
- Leukaemia
- Metastatic neoplasia, e.g.
  - Carcinoma
  - Melanoma

Pure red cell aplasia
Feline leukaemia virus* (C)
Immune-mediated

Haematopoietic neoplasia
Lymphoproliferative
- Lymphoid leukaemia

    - Acute lymphoblastic leukaemia
    - Chronic lymphocytic leukaemia
  - Granular lymphocytic leukaemia
  - Multiple myeloma

Myeloproliferative
- Acute monocytic leukaemia
- Acute myeloid leukaemia
- Acute myelomonocytic leukaemia
- Chronic myeloid/granulocytic leukaemia

Defects in haemoglobin synthesis

Copper deficiency
Erythropoietic porphyria
Hereditary porphyria
Iron deficiency anaemia *q.v.*
Lead poisoning
Vitamin B_6 deficiency

Defects in nucleotide synthesis

Nutrient deficiencies
Cobalt
Folic acid
Vitamin B_{12}

Erythropoietin deficiency

Chronic renal failure* *q.v.*

Iron deficiency

Inadequate intake
Dietary deficiency, e.g.
- Milk diet

Inadequate stores
Neonates*

Chronic external haemorrhage
Bleeding tumour*
Coagulopathy *q.v.*
Epistaxis *q.v.*
Haematemesis *q.v.*
Haematuria *q.v.*
Intestinal blood loss *q.v.*
Parasitism*
- *Ancylostoma* spp
- Fleas
- Lice
- Ticks
- *Uncinaria* spp

Rapid erythropoiesis
Erythropoietin therapy of anaemia
Neonates

Repeat phlebotomy
Blood donors*
Frequent blood sampling of small patients*
Therapeutic phlebotomy, e.g.
- Polycythaemia

Traumatic injury

Sideroblastic anaemia

References

Comazzi, S., et al. (2004) Haematological and biochemical abnormalities in canine blood: frequency and associations in 1022 samples. *JSAP*, **45**:343–9.
Lobettie, R. (2002) Infectious causes of anaemia. *Proceedings, WSAVA Congress, 2002*.
Thrall, M, A, (2002) Interpretation of bone marrow aspirates. *Proceedings, Western Veterinary Conference, 2002*.
Weiss, D. J. (2005) Sideroblastic anemia in 7 dogs (1996–2002). *JVIM*, **19**:325–8.

4.2.3 Polycythaemia

Relative polycythaemia

*Dehydration**
Burns
Diarrhoea
Heat stroke
Polyuria without matching polydipsia
Vomiting
Water deprivation

*Splenic contraction**
Excitement
Exercise
Stress

Primary polycythaemia
Myeloproliferative disease (polycythaemia vera)

Secondary polycythaemia

Physiologically appropriate
Altitude
Chronic respiratory disease, e.g.
- Feline asthma*
- Neoplasia*

Haemoglobinopathies
Right-to-left congenital cardiac shunt, e.g.
- Atrial septal defect with pulmonic stenosis
- Pulmonary arteriovenous fistula
- Reverse-shunting patent ductus arteriosus
- Reverse-shunting ventricular septal defect
- Tetralogy of Fallot

Physiologically inappropriate
Extra-renal neoplasia
- Caecal leiomyosarcoma
- Hepatic carcinoma
- Hepatoblastoma
- Nasal fibrosarcoma

Hyperadrenocorticism
Hyperthyroidism* (C)
Non-neoplastic renal diseases
- Fatty infiltration of the kidney
- Hydronephrosis
- Renal capsular effusion
- Renal cysts

Renal neoplasia
- Adenocarcinoma
- Fibrosarcoma
- Lymphoma
- Nephroblastoma

Toxins, e.g.
- Carbamate

References

Couto, C. G. (1989) Tumor-associated erythrocytosis in a dog with nasal fibrosarcoma. *JVIM,* **3**:183–5.
Giger, U. (2003) Polycythemia: Is it P. vera? *Proceedings, ACVIM, 2003.*
Hasler, A. H. & Giger, U. (1996) Serum erythropoietin values in polycythemic cats. *JAAHA,* **32**:294–301.
Jarvinen, A. K. (2001) Leukaemias and myeloproliferative disorders in the dog. *Eur J Comp An Prac,* **XI**:53–8.
Sato, K., et al. (2002) Secondary erythrocytosis associated with high plasma erythropoietin concentrations in a dog with cecal leiomyosarcoma. *JAVMA,* **220**:486–90.

4.2.4 Thrombocytopenia

Decreased production

Bone marrow neoplasia, e.g.
Lymphoproliferative disease
Metastatic disease
Myeloproliferative disease

Infection
- Bacterial
  - Endotoxaemia*
- Fungal
  - Blastomycosis
  - Coccidioidomycosis
  - Cryptococcosis
  - Histoplasmosis
- Parasitic
  - Cytauxzoonosis
  - Hepatozoonosis
- Rickettsial
  - Ehrlichiosis
  - Rocky Mountain Spotted Fever
- Viral
  - Canine distemper virus* (D)
  - Canine parvovirus* (D)
  - Feline immunodeficiency virus* (C)
  - Feline infectious enteritis* (C)
  - Feline leukaemia virus* (C)

Drugs
- Albendazole
- Antibiotics, e.g.
  - Chloramphenicol
  - Trimethoprim/sulphonamide
- Chemotherapeutic/cytotoxic drugs
- Chloramphenicol
- Diazoxide
- Griseofulvin
- Methimazole
- Oestrogens
- Phenylbutazone
- Phenytoin
- Propylthiouracil
- Ribavirin
- Thiazide diuretics

Miscellaneous
- Haemophagocytic syndrome
- Myelofibrosis
  - Idiopathic
  - Neoplasia, e.g.
    - Myeloproliferative disease
  - Prolonged marrow stimulation
  - Secondary to sepsis

Immune-mediated destruction
- Primary immune-mediated thrombocytopenia
- Concurrent immune-mediated thrombocytopenia and immune-mediated haemolytic anaemia (Evan's syndrome)

Secondary immune-mediated thrombocytopenia
Infections
- Babesiosis
- Dirofilariasis
- Ehrlichiosis
- Feline immunodeficiency virus* (C)
- Feline leukaemia virus* (C)
- Leptospirosis

Neonatal alloimmune thrombocytopenia
Neoplasia, e.g.
- Lymphoma*
- Solid tumours

Systemic lupus erythematosus
Transfusion reactions

Drugs/toxins
Cephalosporins
Chlorpromazine
Colchicine
Cytotoxic drugs
Dipyrone
Heparin
Levamisole
Methimazole
Modified live vaccines
NSAIDs
Oestrogens
Penicillins
Propylthiouracil
Quinidine
Trimethoprim/sulphonamide

Increased utilisation/non-immune destruction

Disseminated intravascular coagulation
Haemolytic uraemic syndrome
Microangiopathic destruction
Septicaemia
Snake venom

Chronic/severe haemorrhage
Coagulopathy
Neoplasia

Vasculitis
Canine adenovirus-1
Canine herpes virus
Dirofilariasis
Ehrlichiosis
Feline infectious peritonitis* (C)
Neoplasia

Polyarteritis nodosa
Rocky Mountain Spotted Fever
Septicaemia
Systemic lupus erythematosus

Sequestration
Hepatomegaly* *q.v.*
Sepsis*

*Splenomegaly** q.v.
Chronic infection*
Haematoma*
Immune-mediated haemolytic anaemia*
Neoplasia
- Haemangioma
- Haemangiosarcoma
- Mast cell
- Metastatic

Portal hypertension
Splenic torsion
Splenitis
Systemic lupus erythematosus

References
Andrews, D. A. (2002) Primary platelet disorders. *Proceedings, Western Veterinary Conference, 2002*.
Dell'Orco, M., et al. (2005) Hemolytic-uremic syndrome in a dog. *Vet Clin Pathol,* **34**:264–9.
Feldman, B. F. (2003) Primary hemostasis: the vessel wall and platelets. *Proceedings, ACVIM, 2003*.
Prater, M. R. (2003) Focus on platelet problems: too few, too many, and too defunct. *Proceedings, ACVIM, 2003*.
Raskin, R. E. (2002) Hematologic parasites. *Proceedings, Western Veterinary Conference, 2002*.

4.2.5 Thrombocytosis

Normal
May be normal in older animals

Splenic contraction
Excitement*
Exercise*
Stress*

Post splenectomy

Primary
Essential thrombocytosis

Reactive

Bradycardia *q.v.*
Chronic haemorrhage* *q.v.*
Fractures*
Gastrointestinal disease* *q.v.*
Hyperadrenocorticism
Hypercoagulability/disseminated intravascular coagulation
Hyperviscosity syndromes
Hypotension*
Infection
Inflammation/immune-mediated disease*
Metastatic carcinoma
Non-specific bone marrow stimulation
Paraneoplastic
- Bronchoalveolar carcinoma
- Chronic myeloid leukaemia
- Gingival carcinoma
- Metastatic squamous cell carcinoma
- Osteosarcoma

Polycythaemia *q.v.*
Shock* *q.v.*

Rebound

Secondary to resolution of previous thrombocytopenia

References

Chisholm-Chait, A. (1999) Essential thrombocytopenia in dogs and cat. Part I. *Comp Cont Ed,* **21**:158–67.
Comazzi, S., et al. (2004) Haematological and biochemical abnormalities in canine blood: frequency and associations in 1022 samples. *JSAP,* **45**:343–9.
Favier, R. P. (2004) Essential thrombocythaemia in two dogs. *Tijdschr Diergeneeskd,* **129**:360–64.
Jarvinen, A. K. (2001) Leukaemias and myeloproliferative disorders in the dog. *Eur J Comp An Prac,* **XI**:53–8.
Prater, M. R. (2003) Focus on platelet problems: too few, too many, and too defunct. *Proceedings, ACVIM, 2003.*

4.2.6 Neutrophilia

Immunodeficiency syndromes

Canine leukocyte adhesion deficiency (D)
Weimaraner immunodeficiency (D)

Inflammatory conditions – acute or chronic*, e.g.

Chemical exposure

Immune-mediated disease, e.g.*

Haemolytic anaemia*
Polyarthritis
Systemic lupus erythematosus

Infections

Bacterial*
Fungal
Protozoal
Viral*

Neoplasia

Necrosis*
Secondary bacterial infection*
Ulceration*

Tissue necrosis, e.g.

Large tumours*
Pancreatitis*
Pansteatitis

Toxins

Endotoxin*
Snakebite

Physiological

Stress

- Adrenaline release
- Corticosteroid (endogenous or exogenous)

Reactive

Haemolysis* *q.v.*
Haemorrhage*
Neoplasia*
Oestrogen toxicity
Recent surgery*
Trauma*

Primary

Myeloproliferative disease

- Acute myeloid leukaemia
- Chronic myeloid leukaemia

References

Day, M. J. (2003) Recurrent infection in the Weimaraner. *Proceedings, Western Veterinary Conference, 2003*.

Jarvinen, A. K. (2001) Leukaemias and myeloproliferative disorders in the dog. *Eur J Comp An Prac,* **XI**:53–8.
Lobettie, R. G. & Joubert, K. (2004) Retrospective study of snake envenomation in 155 dogs from the Onderstepoort area of South Africa. *J S Afr Vet Assoc,* **75**:169–72.
Trowald-Wigh, G., et al. (2000) Clinical, radiological and pathological features of 12 Irish Setters with canine leucocyte adhesion deficiency. *JSAP,* **41**:211–17.

4.2.7 Neutropenia

Decreased neutrophil survival

Haemophagocytic syndromes
Immune-mediated neutropenia (D)
Parvovirus enteritis*

Sepsis/endotoxaemia, e.g.*
Acute salmonellosis*
Aspiration pneumonia*
Peritonitis*
Pyometra*
Pyothorax*

Reduced neutrophil production

Canine cyclic haematopoiesis

*Acute viral infections**
Canine parvovirus* (D)
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Feline panleukopenia virus* (C)
Infectious canine hepatitis* (D)

Bone marrow disease
Aplastic anaemia
- Ehrlichiosis
- Idiopathic
- Toxicity
  - Oestrogen
  - Phenylbutazone

Bone marrow neoplasia, e.g.
- Lymphoproliferative disease
- Metastatic neoplasia
- Myeloproliferative disease

Disseminated granulomatous disease
Immune-mediated destruction of neutrophil precursors
Myelodysplasia
Myelophthisis

Bone marrow suppression
Oestrogen toxicity, e.g.

- Iatrogenic
- Sertoli cell tumour

Radiation therapy

Drugs

- Albendazole
- Azathioprine
- Busulphan
- Carbimazole
- Carboplatin
- Chlorambucil
- Chloramphenicol
- Cyclophosphamide
- Cytarabine
- Diazoxide
- Doxorubicin
- Frusemide
- Griseofulvin
- Hydroxyurea
- Lomustine
- Melphalan
- Methimazole
- Phenobarbitone
- Phenylbutazone
- Trimethoprim/sulphonamide (C)
- Vinblastine

References

Jacobs, G., et al. (1998) Neutropenia and thrombocytopenia in three dogs treated with anticonvulsants. *JAVMA,* **212**:681–4.

McManus, P. M., et al (1999) Immune-mediated neutropenia in 2 dogs. *JVIM,* **13**:372–4.

4.2.8 Lymphocytosis

Physiological*

Excitement*

Exercise*

Immature animal*

Post vaccination*

Stress (adrenaline response)*

Neoplasia

Leukaemia

- Acute lymphoblastic leukaemia
- Chronic lymphocytic leukaemia

Stage V lymphoma

Miscellaneous

Chronic infection*

Hypoadrenocorticism (D)
Recent vaccination*

References

Comazzi, S., et al. (2004) Haematological and biochemical abnormalities in canine blood: frequency and associations in 1022 samples. *JSAP,* **45**:343–9.
Jarvinen, A. K. (2001) Leukaemias and myeloproliferative disorders in the dog. *Eur J Comp An Prac,* **XI**:53–8.

4.2.9 Lymphopenia

Physiological

Stress (corticosteroid response)*

Hyperadrenocorticism

Immunodeficiency syndromes

Loss of lymph

Chylothorax
Lymphangiectasia
Protein-losing enteropathy* *q.v.*

Infectious/inflammatory

Septicaemia*

Viral infections, e.g.
Canine distemper virus* (D)
Coronavirus*
Feline immunodeficiency virus* (C)
Feline leukaemia virus* (C)
Infectious canine hepatitis* (D)
Parvovirus

Drugs/therapy

Albendazole
Azathioprine
Busulphan
Carbimazole
Carboplatin
Chlorambucil
Chloramphenicol
Corticosteroids
Cyclophosphamide
Cyclosporine
Cytarabine

Diazoxide
Doxorubicin
Frusemide
Griseofulvin
Hydroxyurea
Lomustine
Melphalan
Phenylbutazone
Trimethoprim/sulphonamide (C)
Vinblastine

References

Adamo, F. P., et al. (2004) Use of cyclosporine to treat granulomatous meningoencephalitis in three dogs. *JAVMA*, **225**:1211–16.
Alleman, A. R. (2003) White cell responses in disease II. *Proceedings, Western Veterinary Conference, 2003*.
Faldyna, M., et al. (2001) Immunosuppression in bitches with pyometra. *JSAP*, **42**:5–10.

4.2.10 Monocytosis

Chronic inflammation

Granulomatous inflammation
Pyogranulomatous inflammation
Suppuration*
Tissue necrosis*

Corticosteroids

Hyperadrenocorticism
Iatrogenic
Stress

Infections

Viral, e.g.
Feline immunodeficiency virus* (C)

Fungal, e.g.
Coccidioidomycosis

Parasitic, e.g.
Leishmaniasis

Haemolytic/haemorrhagic diseases* *q.v.*

Immune-mediated disease, e.g.

Immune-mediated haemolytic anaemia*
Immune-mediated polyarthritis

Neoplasia
Tumours with necrotic centres*
Monocytic leukaemia
Myelomonocytic leukaemia

References
Johnson, L. R., et al. (2003) Clinical, clinicopathologic, and radiographic findings in dogs with coccidioidomycosis: 24 cases (1995–2000). *JAVMA*, **222**:461–6.
Leiva, M., et al. (2005) Therapy of ocular and visceral leishmaniasis in a cat. *Vet Ophthalmol*, **8**:71–5.

4.2.11 Eosinophilia

Immune-mediated
Allergies *
- Atopy*
- Feline asthma* (C)
- Flea allergy*
- Food allergies*

Canine panosteitis (D)
Eosinophilic gastroenteritis*
Eosinophilic granuloma complex*
Eosinophilic myositis
Feline hypereosinophilic syndrome (C)
Pemphigus foliaceus
Pulmonary infiltrate with eosinophilia (D)

Infection
*Bacterial**

Fungal, e.g.
Aspergillosis
Cryptococcosis

Parasites, e.g.*
Aelurostrongylus abstrusus
Ancylostoma spp
Angiostrongylus vasorum
Capillaria aerophila
Dirofilaria immitis
Oslerus osleri
Pneumonyssoides caninum
Trichuris vulpis

Hormonal
Oestrus in some bitches

Neoplastic
Eosinophilic leukaemia

Tumour-associated eosinophilia
Fibrosarcoma
Myeloproliferative disease
Lymphoma
Mast cell tumour
Mucinous carcinomas
Transitional cell carcinoma

References

Mackay, B. (2005) Eosinophils as a marker of systemic disease. *Proceedings, Australian College of Veterinary Scientists Science Week, 2005*.
Lilliehook, I., et al. (2000) Diseases associated with pronounced eosinophilia: a study of 105 dogs in Sweden. *JSAP,* **41**:248–53.

4.2.12 Eosinopenia

Acute infection*
Acute inflammation*
Glucocorticoid therapy*
Hyperadrenocorticism
Stress*

Reference

Huang, H., et al. (1999) Iatrogenic hyperadrenocorticism in 28 dogs. *JAAHA,* **35**:200–7.

4.2.13 Mastocythaemia

Disseminated mast cell neoplasia
Mast cell leukaemia
Mast cell tumour*, e.g.
- Intestinal tract
- Spleen

Severe inflammation

4.2.14 Basophilia

Chronic granulocytic leukaemia
Hyperlipoproteinaemia
Hypersensitivity reactions
Lymphoma
Lymphoplasmacytic gastroenteritis
Mast cell tumours*
Parasitism, especially dirofilariasis

Reference

Dennis, J. S., et al. (1992) Lymphocytic/plasmacytic gastroenteritis in cats: 14 cases (1985–1990). *JAVMA,* **200**:1712–18.

4.2.15 Increased buccal mucosal bleeding time (disorders of primary haemostasis) (see Table 4.2(b))

Thrombocytopenia *q.v.*

Thrombocytopathia

Inherited

Basset Hound thrombopathia (D)
Canine thrombasthenic thrombopathia of Otter Hounds and Great Pyrenees (D)
Chediak-Higashi syndrome (C)
Cocker Spaniel bleeding disorders (D)
Glanzmann's thrombasthenia (D)
von Willebrand's disease* (D)

Acquired

Chronic anaemia
Disseminated intravascular coagulation
Hepatic disease*
Infection
- Ehrlichiosis
- Feline leukaemia virus* (C)

Neoplasia*, e.g.
- Lymphocytic leukaemia
- Multiple myeloma

Paraproteinaemias
- Benign macroglobulinaemia
- Polyclonal gammopathies

Uraemia* *q.v.*
Drugs/toxins
- Antibiotics
- Barbiturates
- Calcium channel blockers
- Heparin
- Hetastarch
- NSAIDS, especially aspirin
- Propranolol
- Theophylline
- Snake venom

References

Prater, M. R. (2003) Focus on platelet problems: too few, too many, and too defunct. *Proceedings, ACVIM, 2003*.
Varela, F., et al. (1997) Thrombocytopathia and light-chain proteinuria in a dog naturally infected with *Ehrlichia canis*. *JVIM*, **11**:309–11.

4.2.16 Increased prothrombin time (disorders of extrinsic and common pathways) (see Table 4.2(b))

Artefact, e.g.
Deficiency of Factor II, V, VII or X
Disseminated intravascular coagulation
Hypo- or dysfibrinogenaemia
Liver disease*, e.g.
- Portosystemic shunt
- Vitamin K antagonism*

References

Andrews, D. A. (2002) Secondary hemostasis & coagulopathies. *Proceedings, Western Veterinary Conference, 2002.*

Niles, J. D., et al. (2001) Hemostatic profiles in 39 dogs with congenital portosystemic shunts. *Vet Surg*, **30**:97–104.

Table 4.2(b) Test profiles for common congenital and acquired bleeding disorders. Reproduced, with permission of the British Veterinary Association, from: Ian Johnstone (2002) Bleeding disorders in dogs. 1. Inherited disorders. *In Practice*, **24** (1), 2–10 and: Ian Johnstone (2002) Bleeding disorders in dogs. 2. Acquired disorders. *In Practice*, **24** (2), 62–68.

Condition	PC	BMBT	ACT	PTT	PT	TCT	Other
Vitamin K antagonism	N	N	↑	↑	↑	N	PIVKA
Immune-mediated thrombocytopenia	↓	↑	N/↑	N	N	N	
Disseminated intravascular coagulation	↓	↑	↑	↑	↑	↑	FDPs
Platelet dysfunction	N	↑	N	N	N	N	
Deficiencies of FVIII, FIX, FXI, FXII	N	N	↑	↑	N	N	
Deficiency of FVII	N	N	N	N	↑	N	
Deficiencies of FII, FX	N	N	↑	↑	↑	N	
Deficiency of FI	N	N	↑	↑	↑	↑	
von Willebrand's disease	N	↑	N/↑	N/↑	N	N	

Key:
PC = platelet count
BMBT = buccal mucosal bleeding time
ACT = activated clotting time
PTT = partial thromboplastin time
PT = prothrombin time
TCT = thrombin clotting time
PIVKA = proteins induced by vitamin K antagonism
FDPs = fibrin degradation products

4.2.17 Increased partial thromboplastin time or activated clotting time (disorders of intrinsic and common pathways) (see Table 4.2(b))

Colloid administration
Disseminated intravascular coagulation
Factor II, V, X, XI or XII deficiency
Haemophilia A (Factor VIII deficiency)
Haemophilia B (Factor IX deficiency)
Haemorrhage
Hypo- or dysfibrinogenaemia
Liver disease* *q.v.*
Vitamin K antagonism*
Vitamin K-dependent coagulopathy

References

Andrews, D. A. (2002) Secondary hemostasis & coagulopathies. *Proceedings, Western Veterinary Conference, 2002*.
Johnstone, I. (2002) Bleeding disorders in dogs: 1. Inherited disorders. *In Practice,* **24**:2–10.
Johnstone, I. (2002) Bleeding disorders in dogs: 2. Acquired disorders. *In Practice,* **24**:62–8.
Mason, D. J. (2002) Vitamin K-dependent coagulopathy in a black Labrador Retriever. *JVIM,* **16**:485–8.

4.2.18 Increased fibrin degradation products

Disseminated intravascular coagulation
Hepatic disease* *q.v.*
Internal haemorrhage
Thrombosis*
Vitamin K antagonism*

References

Scott-Moncrieff, J. C., et al. (2001) Hemostatic abnormalities in dogs with primary immune-mediated hemolytic anemia. *JAAHA,* **37**:220–7.
Wardrop, K. J. (2004) Diagnosis of bleeding disorders. *Proceedings*, *Western Veterinary Conference, 2004*.

4.2.19 Decreased fibrinogen levels

Artefact
- Clot
- Incorrect anticoagulant

Disseminated intravascular coagulation*
Excessive blood loss*

Hereditary fibrinogen deficiency
Immune-mediated haemolytic anaemia
Severe hepatic deficiency

Reference

Scott-Moncrieff, J. C., et al. (2001) Hemostatic abnormalities in dogs with primary immune-mediated hemolytic anemia. *JAAHA*, **37**:220–7.

4.2.20 Decreased antithrombin III levels

Heparin therapy
Hepatic disease* *q.v.*
Hypercoagulability, e.g.
- Disseminated intravascular coagulation

Protein-losing enteropathy* *q.v.*, e.g.
- Parvovirus enteritis

Protein-losing nephropathy* *q.v.*

Reference

Otto, C. M., et al. (2000) Evidence of hypercoagulability in dogs with parvoviral enteritis. *JAVMA*, **217**:1500–1504.

4.3 Electrolyte and blood gas findings

4.3.1 Total calcium

Increased (Table 4.3)
Acute renal failure *q.v.*
Artefact
- Lipaemia

Table 4.3 Differentiating causes of hypercalcaemia by laboratory methods. Table modified with permission from Elsevier from: Feldman, E.C. & Nelson, R.W. (2004) *Canine and Feline Endocrinology and Reproduction*, 3rd edn. WB Saunders Co, Philadelphia.

	PTH	PTHRP	iCa^{2+}	1,25DHCC
Primary hyperparathyroidism	↑/N	↓/N	↑	↑/N
Lymphoma	↓	↑	↑	↓
Chronic renal failure	↑/N	↑/N	↓/N	↓
Apocrine gland tumour of the anal sac	↓	↑	↑	↓
Hypervitaminosis D	↓	↓/N	↑	↑

Key:
PTH = parathyroid hormone
PTHRP = parathyroid hormone related peptide
iCa^{2+} = ionised calcium
1,25DHCC = 1,25 dihydroxycholecalciferol (Vitamin D)

Hereditary fibrinogen deficiency
Immune-mediated haemolytic anaemia
Severe hepatic deficiency

Reference

Scott-Moncrieff, J. C., et al. (2001) Hemostatic abnormalities in dogs with primary immune-mediated hemolytic anemia. *JAAHA*, **37**:220–7.

4.2.20 Decreased antithrombin III levels

Heparin therapy
Hepatic disease* *q.v.*
Hypercoagulability, e.g.
- Disseminated intravascular coagulation

Protein-losing enteropathy* *q.v.*, e.g.
- Parvovirus enteritis

Protein-losing nephropathy* *q.v.*

Reference

Otto, C. M., et al. (2000) Evidence of hypercoagulability in dogs with parvoviral enteritis. *JAVMA*, **217**:1500–1504.

4.3 Electrolyte and blood gas findings

4.3.1 Total calcium

Increased (Table 4.3)
Acute renal failure *q.v.*
Artefact
- Lipaemia

Table 4.3 Differentiating causes of hypercalcaemia by laboratory methods. Table modified with permission from Elsevier from: Feldman, E.C. & Nelson, R.W. (2004) *Canine and Feline Endocrinology and Reproduction*, 3rd edn. WB Saunders Co, Philadelphia.

	PTH	PTHRP	iCa^{2+}	1,25DHCC
Primary hyperparathyroidism	↑/N	↓/N	↑	↑/N
Lymphoma	↓	↑	↑	↓
Chronic renal failure	↑/N	↑/N	↓/N	↓
Apocrine gland tumour of the anal sac	↓	↑	↑	↓
Hypervitaminosis D	↓	↓/N	↑	↑

Key:
PTH = parathyroid hormone
PTHRP = parathyroid hormone related peptide
iCa^{2+} = ionised calcium
1,25DHCC = 1,25 dihydroxycholecalciferol (Vitamin D)

Chronic renal failure* *q.v.*
Dehydration/hyperalbuminaemia* *q.v.*
Granulomatous disease
Hypervitaminosis A
Hypervitaminosis D
Hypoadrenocorticism (D)
Idiopathic hypercalcaemia of cats (C)
Physiological
- Post prandial
- Young dog*

Tertiary hyperparathyroidism

Hypercalcaemia of malignancy (Fig. 4.3)
Carcinoma
- Bronchogenic
- Mammary
- Nasal cavity
- Prostatic
- Squamous cell
- Thyroid

Haematological malignancies
- Lymphoma*
- Multiple myeloma
- Myeloproliferative disease

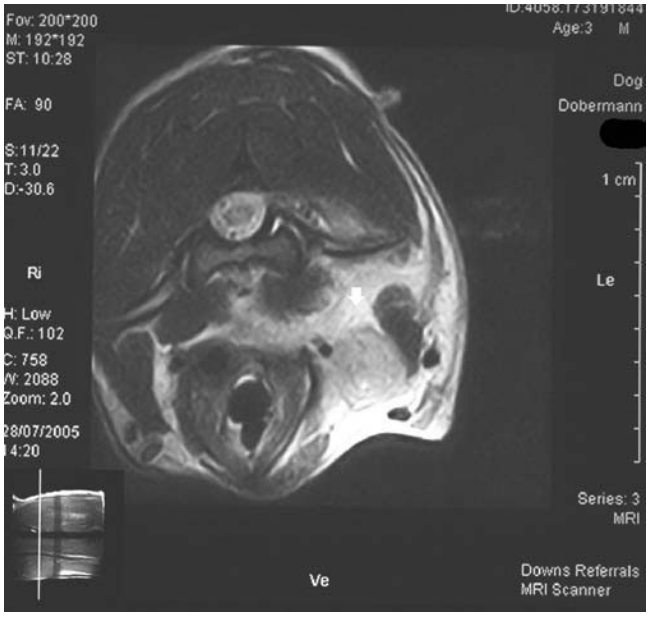

Fig. 4.3 Transverse T2 weighted MR scan of the neck of a dog, showing a thyroid carcinoma (arrow). Reproduced with permission of Downs Referrals, Bristol.

Metastatic or primary bone neoplasia *q.v.*
Pseudohyperparathyroidism
- Apocrine gland adenocarcinoma*
- Lymphoma*

Primary hyperparathyroidism
Hereditary neonatal hyperparathyroidism
Multiple endocrine neoplasia
Parathyroid gland adenoma
Parathyroid gland carcinoma
Primary hyperplasia of the parathyroid glands

Skeletal lesions
Bone metastases
Hypertrophic osteodystrophy
Osteomyelitis
Systemic mycoses

Drugs/toxins
Anabolic steroids
Calcipotriol
Cholecalciferol rodenticides
Hydralazine
Jasmine
Oestrogen
Oral or intravenous calcium
Oral phosphate binders
Paracetamol
Parenteral calcium administration
Progesterone
Testosterone
Trilostane
Vitamin D analogues

Decreased (see Plate 4.3 in colour plate section)
Acute pancreatitis*
Acute renal failure *q.v.*
Canine distemper virus* (D)
Chronic renal failure* *q.v.*
Hypoalbuminaemia* *q.v.*
Hypomagnesaemia *q.v.*
Hypoproteinaemia
Iatrogenic (post thyroidectomy)*
Idiopathic
Infarction of parathyroid gland adenomas
Intestinal malabsorption*
Medullary carcinoma of the thyroid (C-cell tumour)
Nutritional secondary hyperparathyroidism
Primary hypoparathyroidism
Puerperal tetany (eclampsia)*

Rhabdomyolysis
Tumour lysis syndrome

Artefact
Haemolysis
Incorrect anticoagulant

Drugs/toxins
Anticonvulsants
EDTA
Ethylene glycol
Frusemide
Glucagon
Intravenous phosphate administration
Mithramycin
Pamidronate
Phosphate-containing enemas
Sodium bicarbonate
Transfusion using citrated blood

References

Barber, P. (2001) Disorders of calcium homeostasis in small animals. *In Practice,* **23**:262–9.
Chastain, C. B. (2001) Eclampsia in dogs: 31 cases (1995–1998). *Sm Anim Clin Endocrinol,* **11**:9.
Fan, T. M., et al. (1998) Calcipotriol toxicity in a dog. *JSAP,* **39**:581–6.
Gear, R. N. A., et al. (2005) Primary hyperparathyroidism in 29 dogs: diagnosis, treatment, outcome and associated renal failure. *JSAP,* **46**:10–16.
Piek, C. J. & Teske, E. (1996) Tumor lysis syndrome in a dog. *Tijdschr Diergeneeskd*, **121**:64–6.
Rosol, T. J., et al. (1988) Acute hypocalcaemia associated with infarction of parathyroid gland adenomas in two dogs. *JAVMA,* **192**:212.
Tomsa, K., et al. (1999) Nutritional secondary hyperparathyroidism in six cats. *JSAP,* **40**:533–9.
Weisbrode, S. E. & Krakowka, S. (1979) Canine distemper-virus associated hypocalcemia. *Am J Vet Res,* **40**:147–9.

4.3.2 Chloride

Note: Most causes of hyperchloraemia also cause concurrent hypernatraemia, and if changes are proportionate it is usually easier to look for causes of hypernatraemia. Formulae to correct chloride to account for sodium changes have been suggested as follows:

Dogs: Cl^- (corrected) = Cl^- (measured) × [146/Na^+ (measured)]
Reference ranges: Cl^- (measured) = 100 – 116 mmol/l
Cl^- (corrected) = 107 – 113 mmol/l
Cats: Cl^- (corrected) = Cl^- (measured) × [156/Na^+ (measured)]
Reference ranges: Cl^- (measured) = 100 – 124 mmol/l
Cl^- (corrected) = 117 – 123 mmol/l

Note: Reference ranges may vary depending on the instruments used to perform the measurement.

Increased

Artefact
Hypotonic water loss
Lipaemia
Potassium bromide therapy
Pure water loss

Corrected hyperchloraemia
Chronic respiratory alkalosis *q.v.*
Diabetes mellitus*
Fanconi syndrome
Hyperaldosteronism
Hypoadrenocorticism (D)
Renal failure* *q.v.*
Renal tubular acidosis
Small intestinal diarrhoea*
Drugs/toxins
- Acetazolamide
- Fluid therapy with saline
- Potassium chloride supplementation
- Salt poisoning
- Spironolactone
- Total parenteral nutrition
- Urinary acidifiers, e.g. ammonium chloride

Decreased

Artefact
Lipaemia

Corrected hypochloraemia
Chronic respiratory acidosis *q.v.*
Exercise*
Hyperadrenocorticism
Vomiting*
Drugs
- Frusemide
- Sodium bicarbonate
- Thiazide diuretics

References

de Morais, H. S. A. (1992) Chloride ion in small animal practice: the forgotten ion. *J Vet Emerg Crit Care*, **2**:11–24.
Settles, E. L. & Schmidt, D. (1994) Fanconi syndrome in a Labrador Retriever *JVIM*, 8:390–3.

4.3.3 Magnesium

Increased

Artefact
- Sample haemolysis

Haemolysis
Hypoadrenocorticism (D)
Obstructive uropathy*
Renal failure* *q.v.*
Thoracic neoplasia/pleural effusion (C)
Drugs
- Oral antacids
- Parenteral administration
- Progesterones

Decreased

Acute pancreatitis*
Cholestasis* *q.v.*
Decreased intake
Hypercalcaemia *q.v.*
Hypokalaemia *q.v.*

Artefact
Haemolysis

Endocrine
Diabetic ketoacidosis*
Hyperthyroidism* (C)
Hypoparathyroidism (ionised hypomagnesaemia)
Primary hyperaldosteronism
Primary hyperparathyroidism

Intestinal loss
Bowel resection
Enteropathies*

Redistribution
Hypothermia* *q.v.*
Sepsis*
Trauma*

Renal
Acute tubular necrosis
Drug-induced tubular injury
- Aminoglycosides
- Cisplatin

Post-obstructive diuresis*

Drugs/iatrogenic
Amino acids
Aminoglycosides
Blood transfusion
Cisplatin
Digitalis
Diuretics, e.g.
- Frusemide
- Thiazides

Haemodialysis
Insulin
Nasogastric suction
Pamidronate
Peritoneal dialysis
Prolonged intravenous fluid therapy
Total parenteral nutrition

References

Kimmel, S. E., et al. (2000) Hypomagnesemia and hypocalcemia associated with protein-losing enteropathy in Yorkshire terriers: five cases (1992–1998). *JAVMA,* **217**:703–6.

Schenck, P. A. (2005) Serum ionized magnesium concentrations in dogs and cats with hypoparathyroidism. *Proceedings, ACVIM, 2005*.

Toll, J., et al. (2002) Prevalence and incidence of serum magnesium abnormalities in hospitalized cats. *JVIM,* **16**:217–21.

4.3.4 Potassium

Increased

Artefact/pseudohyperkalaemia
Contamination of sample with potassium EDTA
Haemolysis (especially Japanese Akita)
Marked leukocytosis/thrombocytosis with delay in separating serum
Thrombocytosis

Decreased urinary excretion
Acute renal failure *q.v.*
Chylothorax with repeated drainage
Gastrointestinal diseases*
- Perforated duodenal ulcer
- Salmonellosis
- Trichuriasis

Hyporeninaemic hypoaldosteronism
Post-renal failure* *q.v.*
Ruptured bladder/uroperitoneum
Hypoadrenocorticism (D)

Increased intake
Iatrogenic

Translocation
Acidosis *q.v.*
Diabetes mellitus/diabetic ketoacidosis*
Reperfusion injury, e.g.
- Aortic thromboembolism
- Crush

Tumour lysis syndrome

Drugs/toxins
ACE inhibitors
Amiloride
Beta blockers
Cardiac glycosides
Ethylene glycol
NSAIDs
Oral or parenteral potassium supplementation
Paraquat
Prostaglandin inhibitors
Salbutamol
Spironolactone
Succinylcholine
Tricyclic antidepressants
Trilostane

Decreased

Diet
Decreased dietary intake
High protein acidifying diets

Endocrine
Diabetes mellitus*
Hyperadrenocorticism
Mineralocorticoid excess
Primary hyperaldosteronism

Increased loss
Chronic renal failure* *q.v.*
Diuresis, e.g.
- Diabetes mellitus*
- Diuretic therapy

Gastrointestinal loss (vomiting, diarrhoea)* *q.v.*
Post obstructive diuresis*
Renal tubular acidosis

Translocation
Alkalosis
Hypothermia* *q.v.*
Idiopathic hypokalaemia of Burmese cats (C)

Drugs/iatrogenic
Albuterol
Amphotericin B
Catecholamines
Dialysis

Diuretics, e.g.
- Frusemide
- Mineralocorticoids
- Penicillins
- Thiazides

Fludrocortisone
Frusemide
Glucose
Hydrochlorothiazide
Inadequate potassium supplementation during fluid therapy
Insulin
Terbutaline
Total parenteral nutrition

References

Hodson, S. (1998) Feline hypokalaemia. *In Practice*, **20**:135–44.
Rijnberk, A., et al. (2001) Hyperaldosteronism in a cat with metastasised adrenocortical tumour. *Vet Q*, **23**:38–43.

4.3.5 Phosphate

Decreased

Decreased dietary intake
Decreased intestinal absorption
Diarrhoea* *q.v.*
Eclampsia*
Hypercalcaemia of malignancy*
Hypothermia* *q.v.*
Hypovitaminosis D
Increased urinary excretion*
Metabolic acidosis* *q.v.*
Renal tubular defects, e.g.
- Fanconi syndrome

Respiratory alkalosis *q.v.*
Vomiting* *q.v.*

Endocrine disorders
Diabetic ketoacidosis*
Hyperadrenocorticism
Hyperinsulinism/insulinoma
Primary hyperparathyroidism

Drugs/iatrogenic
Bicarbonate
Diuretics
Fluid therapy
Glucocorticoids
Glucose
Insulin

Pamidronate
Phosphate binding antacids
Salicylates
Vitamin D deficiency

Increased

Acute or chronic renal failure* *q.v.*
Haemolysis* *q.v.*
Metabolic acidosis* *q.v.*
Muscle trauma/necrosis*
Normal juvenile animal
Osteolytic bone lesions
Pre-renal failure* *q.v.*
Post-renal failure *q.v.*
Tumour lysis syndrome

Artefact
Haemolysis

Endocrine disorders
Acromegaly
Hyperthyroidism* (C)
Nutritional secondary hyperparathyroidism
Primary hypoparathyroidism
Renal secondary hyperparathyroidism*

Drugs/toxins
Cholecalciferol rodenticides
Hypervitaminosis D
Jasmine toxicity
Phosphate-containing enemas
Phosphate supplementation

References

Comazzi, S., et al. (2004) Haematological and biochemical abnormalities in canine blood: frequency and associations in 1022 samples. *JSAP,* **45**:343–9.
Tomsa, K., et al. (1999) Nutritional secondary hyperparathyroidism in six cats. *JSAP,* **40**:533–9.

4.3.6 Sodium

Decreased

Congestive heart failure with effusion*
Diarrhoea*
Hyperglycaemia* *q.v.*
Hyperlipidaemia *q.v.*
Hypoadrenocorticism (D)
Liver disease with ascites* *q.v.*
Marked hyperproteinaemia *q.v.*

Nephrotic syndrome with effusion
Over-hydration
Pancreatitis*
Renal failure* *q.v.*
Vomiting* *q.v.*

Effusions
Peritonitis*
Pleural effusion* *q.v.*
Uroabdomen

Dehydration/hypovolaemia
Cutaneous loss, e.g.
- Burns

Gastrointestinal loss*
Hypoadrenocorticism (D)

Third space loss
Chylothorax with repeated drainage
Pancreatitis*
Peritonitis*
Uroabdomen

Normal hydration
Inappropriate antidiuretic hormone secretion
Inappropriate fluid therapy
Myxoedema coma of hypothyroidism
Psychogenic polydipsia*

Drugs
Cyclophosphamide
Diuretics, e.g.
- Amiloride
- Frusemide
- Mannitol
- Spironolactone
- Thiazides

NSAIDs
Vincristine

Increased

Hypotonic fluid loss
Cutaneous, e.g.
- Burns

Diabetes mellitus (secondary to osmotic diuresis)*
Gastrointestinal (vomiting, diarrhoea, small intestinal obstruction)* *q.v.*
Post-obstructive diuresis*
Renal failure* *q.v.*
Third space loss, e.g.

- Pancreatitis*
- Peritonitis*

Increased intake

Hyperadrenocorticism
Hyperaldosteronism
Iatrogenic
Salt poisoning

Pure water loss

Hypodypsia or adipsia, e.g.
- Cranial trauma
- Diabetes insipidus
- Inflammatory brain disease
- Intracranial neoplasia

Hyperthermia *q.v.*
Lack of free access to water with normal or increased insensible losses

Drugs/toxins

Fludrocortisone
Salt-containing products, e.g.
- Playdough

Sodium bicarbonate
Sodium phosphate enemas

References

Barr, J. M., et al. (2004) Hypernatremia secondary to homemade play dough ingestion in dogs: a review of 14 cases from 1998 to 2001. *J Vet Emerg Crit Care,* **14**:196–202.

Peterson, M. E., et al. (1996) Pretreatment clinical and laboratory findings in dogs with hypoadrenocorticism: 225 cases (1979–1993). *JAVMA,* **208**:85–91.

4.3.7 pH

ACIDAEMIA

Metabolic acidosis

Diabetic ketoacidosis*
Hypoadrenocorticism (D)
Post-hypocapnic metabolic acidosis
Renal failure* *q.v.*
Renal tubular acidosis

Lactic acid production

Diarrhoea* *q.v.*
Hypoxaemia
Pancreatitis*
Sepsis*
Shock* *q.v.*

Drugs/toxins
Acetazolamide
Ammonium chloride
Ethylene glycol
Methanol
Methionine
Paraldehyde
Salicylic acid

Respiratory acidosis

Cardiopulmonary arrest

CNS disease (brain stem/high cervical spinal lesion), e.g.
Intracranial space occupying lesion
Trauma

Neuromuscular defects
Botulism
Idiopathic hypokalaemia of Burmese (C)
Myasthenia gravis
Polymyositis
Polyradiculoneuritis
Tetanus
Tick paralysis

Severe respiratory disease
Acute respiratory distress syndrome
Airway obstruction*
Aspiration pneumonia
Chest wall trauma
Diaphragmatic hernia*
Haemothorax*
Neoplasia*
Pleural effusion* *q.v.*
Pneumonia* *q.v.*
Pneumothorax* *q.v.*
Pulmonary fibrosis
Pulmonary oedema* *q.v.*
Pulmonary thromboembolism
Pyothorax*
Smoke inhalation

Iatrogenic respiratory depression
Anaesthesia
Opiates
Organophosphates
Pancuronium
Succinylcholine

ALKALAEMIA

Metabolic alkalosis

Hyperadrenocorticism
Post hypercapnia
Primary hyperaldosteronism
Vomiting*

Drugs
Acetate
Bicarbonate
Citrate
Diuretics
Exogenous steroid therapy
Gluconate
Lactate

Respiratory alkalosis

Overzealous ventilator therapy

Hypoxaemia, e.g.
Congestive heart failure*
High altitude
Pulmonary disease*
Right-to-left cardiac shunts
Severe anaemia* *q.v.*

Panting/hyperventilation
Anxiety*
Fever*
Heat stroke*
Hyperthyroidism* (C)
Pain*

Direct stimulation of medullary respiratory centre (neurogenic hyperventilation)
CNS disease *q.v.*
Hepatic disease *q.v.*
Sepsis*
Drugs
- Methyl xanthines
- Salicylate intoxication

References

Elliott, J., et al. (2003) Assessment of acid-base status of cats with naturally occurring chronic renal failure. *JSAP,* **44**:65–70.
Shaffran, N. (2003) Blood gas interpretation. *Proceedings*, *ACVIM, 2003*.

4.3.8 paO_2

Decreased

CNS disease (brain stem/high cervical spinal lesion), e.g.
Intracranial space occupying lesion
Trauma

Heart disease
Pulmonary oedema* *q.v.*
Right-to-left shunting

Iatrogenic respiratory depression
Anaesthesia
Opiates
Organophosphates
Pancuronium
Succinylcholine

Inadequate oxygen in inspired air
Failure of oxygen supply during anaesthesia
High altitude

Neuromuscular defects
Botulism
Idiopathic hypokalaemia of Burmese cats (C)
Myasthenia gravis
Polymyositis
Polyradiculoneuritis
Tetanus
Tick paralysis

Severe respiratory disease
Acute respiratory distress syndrome
Airway obstruction*
Aspiration pneumonia*
Chest wall trauma*
Diaphragmatic hernia*
Haemothorax*
Neoplasia*
Pleural effusion* *q.v.*
Pneumonia* *q.v.*
Pneumothorax* *q.v.*
Pulmonary fibrosis
Pulmonary oedema* *q.v.*
Pulmonary thromboembolism
Pyothorax*
Smoke inhalation

Increased
Oxygen supplementation

Reference
Joubert, K. E. & Lobetti, R. (2002) The cardiovascular and respiratory effects of medetomidine and thiopentone anaesthesia in dogs breathing at an altitude of 1486 m. *J S Afr Vet Assoc*, **73**:104–10.

4.3.9 Total CO_2

Increased
Respiratory acidosis *q.v.*

Decreased
Respiratory alkalosis *q.v.*

4.3.10 Bicarbonate

Increased
Metabolic alkalosis *q.v.*

Decreased
Metabolic acidosis *q.v.*

4.3.11 Base excess

Increased
Metabolic alkalosis *q.v.*

Decreased
Metabolic acidosis *q.v.*

4.4 Urinalysis findings

4.4.1 Alterations in specific gravity

HYPOSTHENURIA

Increased water loss but no increased loss of solutes

Polyuria due to decreased ADH secretion
Insulinoma
Overhydration
Phaeochromocytoma
Primary central diabetes insipidus

Increased
Oxygen supplementation

Reference
Joubert, K. E. & Lobetti, R. (2002) The cardiovascular and respiratory effects of medetomidine and thiopentone anaesthesia in dogs breathing at an altitude of 1486 m. *J S Afr Vet Assoc*, **73**:104–10.

4.3.9 Total CO_2

Increased
Respiratory acidosis *q.v.*

Decreased
Respiratory alkalosis *q.v.*

4.3.10 Bicarbonate

Increased
Metabolic alkalosis *q.v.*

Decreased
Metabolic acidosis *q.v.*

4.3.11 Base excess

Increased
Metabolic alkalosis *q.v.*

Decreased
Metabolic acidosis *q.v.*

4.4 Urinalysis findings

4.4.1 Alterations in specific gravity

HYPOSTHENURIA

Increased water loss but no increased loss of solutes

Polyuria due to decreased ADH secretion
Insulinoma
Overhydration
Phaeochromocytoma
Primary central diabetes insipidus

Psychogenic polydipsia*
Drugs, e.g.
- Adrenaline
- Phenytoin

Polyuria due to ADH inhibition/resistance
Hyperadrenocorticism
Hypercalcaemia* *q.v.*
Hyperthyroidism* (C)
Hypokalaemia* *q.v.*
Liver disease* *q.v.*
Primary hyperparathyroidism
Primary nephrogenic diabetes insipidus
Toxaemia, e.g.
- Pyometra*

Drugs
Anticonvulsants
Carbonic anhydrase inhibitors
Corticosteroids
Frusemide
Spironolactone
Thiazide diuretics

Inability of kidneys to concentrate urine
Acute renal failure *q.v.*
Chronic renal failure* *q.v.*
Pyelonephritis

HYPERSTHENURIA

Polyuria with excess solute loss
Acromegaly
Diabetes mellitus*
Diet
- High protein
- High salt

Fanconi syndrome
Hyperviscosity
Osmotic diuretics
- Dextrose
- Mannitol

Primary renal glucosuria

Decreased loss of water and no decreased loss of solutes
Cardiac failure*
Dehydration*
Haemorrhage*
Renal infarction
Shock* *q.v.*

References

Feldman, E. C. (2004) Polyuria and polydipsia. *Proceedings*, *Western Veterinary Conference, 2004*.

Feldman, E. C. (2005) Diagnosis and treatment of canine and feline PD/PU. *Proceedings*, *Western Veterinary Conference, 2005*.

von Vonderen, I. K., et al. (2004) Vasopressin response to osmotic stimulation in 18 young dogs with polyuria and polydipsia. *JVIM*, **18**:800–806.

4.4.2 Abnormalities in urine chemistry

Glucose – increased

Hyperglycaemia q.v.
- Diabetes mellitus*
- Hyperadrenocorticism
- Iatrogenic
- Phaeochromocytoma
- Primary hyperaldosteronism
- Stress*

Renal tubular disorders
- Fanconi syndrome
- Primary renal glucosuria

Urinary tract haemorrhage with mild hyperglycaemia

References

Flood, S. M., et al. (1999) Primary hyperaldosteronism in two cats. *JAAHA*, **35**:411–16.

Hostutler, R. A. (2004) Transient proximal renal tubular acidosis and Fanconi syndrome in a dog. *JAVMA*, **224**:1611–14.

Blood

See Haematuria *q.v.*

Haemoglobin

Haematuria *q.v.*

Haemolysis q.v.
- Disseminated intravascular coagulation
- Haemoplasmosis
- Immune-mediated haemolytic anaemia*
- Incompatible blood transfusion
- Neonatal isoerythrolysis
- Physical causes
  - Burns
  - Intravenous hypotonic solutions
  - Radiation
- Splenic torsion

Toxins
- Benzocaine
- Chlorate
- Dimethyl sulphoxide
- Nitrate
- Paracetamol
- Propylthiouracil
- Snake venom

Reference

Klag, A. R., et al. (1993) Idiopathic immune-mediated hemolytic anemia in dogs: 42 cases (1986–1990). *JAVMA,* **202**:783–8.

Bilirubin

False positive, e.g. pigmenturia
Fever* *q.v.*
Hyperbilirubinaemia* *q.v.*
Normal in small quantities in dogs*
Starvation*

Myoglobin – muscle injury/necrosis

Athletic performance
Exercise-induced rhabdomyolysis
Heat stroke*
Ischaemia, e.g.
- Aortic thromboembolism*

Trauma
- Crush injury*

Toxins
- Snake bites

Reference

Taylor, R. A. (1988) Metabolic and physiologic effects of athletic competition in the Greyhound. *Companion Anim Pract,* **2**:7–11.

Urobilinogen

(*Note:* Of limited use in veterinary medicine.)
Re-establishment of bile flow after an episode of biliary obstruction

Reference

MacWilliams, P. (2003). Profiling the urinary system I. *Proceedings*, *Western Veterinary Conference, 2003*.

Nitrite

(*Note:* Many false negatives in dogs and cats.)
Gram negative bacteriuria

Reference

MacWilliams, P. (2003). Profiling the urinary system I. *Proceedings*, *Western Veterinary Conference, 2003*.

Protein – increased

False positives (strip test)

Contamination, e.g.
- Benzalkonium Chloride
- Cetrimide
- Chlorhexidine

Stale urine

False positives (20% sulphosalicylic acid test)

Cephalosporins
Penicillins
Radiographic contrast media
Sulphafurazole
Thymol
Tolbutamide

Pre-renal

Haemoglobinuria, e.g.
- Haemolytic anaemia*

Hyperproteinaemia *q.v.*
Myoglobinuria, e.g.
- Muscle trauma*
- Rhabdomyolysis

Physiological, e.g.
- Exercise*
- Stress*

Renal

Mild to moderate
- Acute renal failure *q.v.*
- Amyloidosis
- Breed-associated nephropathy (D)
- Chronic renal failure* *q.v.*
- Fanconi syndrome
- Glomerulonephritis
- IgA nephropathy
- Primary renal glucosuria
- Secondary glomerular disease
  - Bacterial endocarditis
  - Borreliosis
  - Brucellosis
  - Chronic bacterial infection*
  - Chronic skin disease* *q.v.*
  - Diabetic glomerulosclerosis
  - Dirofilariasis
  - Ehrlichiosis
  - Feline infectious peritonitis* (C)
  - Feline leukaemia virus* (C)
  - Hyperthermia* *q.v.*

- Hypothermia* *q.v.*
- Immune-mediated haemolytic anaemia*
- Infectious canine hepatitis* (D)
- Inflammatory bowel disease*
- Leishmaniasis
- Leptospirosis*
- Mycoplasma polyarthritis
- Pancreatitis*
- Polyarthritis
- Prostatitis*
- Pyometra*
- Pyrexia* *q.v.*
- Rocky Mountain Spotted Fever (D)
- Septicaemia*
- Sulphonamide hypersensitivity
- Systemic lupus erythematosus

Severe
- Amyloidosis
- Glomerulonephritis

Post-renal

Genital tract inflammation
- Prostatitis*
- Vaginitis*

Genital tract secretions

Urinary tract inflammation
- Trauma*
- Urinary tract infection*
- Urolithiasis*

Urogenital neoplasia
- Bladder neoplasia
- Ureteral neoplasia
- Urethral neoplasia
- Vaginal or prostatic neoplasia

References

Grauer, G. F. (2005) Canine glomerulonephritis: new thoughts on proteinuria and treatment. *JSAP*, **46**:469–78.

Jacob, F., et al. (2005) Evaluation of the association between initial proteinuria and morbidity rate or death in dogs with naturally occurring chronic renal failure. *JAVMA*, **226**:393–400.

Senior, D. F. (2005) Proteinuria. *Proceedings, WSAVA, 2005*.

pH

DECREASED (<7)

Acidifying diets*

Metabolic acidosis* *q.v.*

Respiratory acidosis* *q.v.*

Drugs

- Ammonium chloride
- Frusemide
- Methionine
- Sodium acid phosphate
- Sodium chloride

INCREASED

Diet
- Low protein*
- Post-prandial alkaline tide*

Metabolic alkalosis *q.v.*

Urinary tract disease
- Proximal renal tubular acidosis
- Urinary retention*
- Urinary tract infection with urea-producing bacteria*

Drugs
- Acetazolamide
- Chlorthiazides
- Potassium citrate
- Sodium bicarbonate
- Sodium lactate

Artefact

Contamination with ammonia, detergents

Old sample

Reference

Elliot, J., et al. (2003) Assessment of acid-base status of cats with naturally occurring chronic renal failure. *JSAP,* **44**:65–70.

Ketones – shift of energy production from carbohydrate to fat

Hypoglycaemia, e.g.
- Insulinoma *q.v.*

Low carbohydrate, high fat diet

Starvation

Uncontrolled diabetes mellitus/diabetic ketoacidosis*

Reference

Bruskiewicz, K. A., et al. (1997) Diabetic ketosis and ketoacidosis in cats: 42 cases (1980–1995). *JAVMA,* **211**:188–92.

4.4.3 Abnormalities in urine sediment

Increased white blood cells

Low numbers normal

Neoplasia

Urinary tract infection*

Urinary tract inflammation*

Urolithiasis*

Increased red blood cells

Haematuria *q.v.*

Casts

Bilirubin
- Bilirubinuria

Broad casts
- Chronic pyelonephritis
- Dilated renal tubules

Epithelial cell, fatty, granular and waxy casts
- Acute renal failure *q.v.*
- Chronic renal failure* *q.v.*
- Degeneration/necrosis of tubular epithelial cells
- Degeneration of white cells
- Glomerulopathy

Haemoglobin
- Haemoglobinuria *q.v.*

Hyaline
- Associated with proteinuria *q.v.*

Myoglobin
- Myoglobinuria *q.v.*

Red blood cell
- Renal tubular haemorrhage

White cell
- Tubulointerstitial inflammation

Reference

Morton, L. D., et al. (1990) Juvenile renal disease in miniature schnauzer dogs. *Vet Pathol*, 27:455–8.

Crystals (predisposing factors)

Bilirubin

(see Bilirubinuria, Hyperbilirubinaemia)

Calcium oxalate

Diet
- Excess calcium
- Excess oxalic acid
- Excess Vitamin C
- Excess Vitamin D

Ethylene glycol poisoning

Hyperadrenocorticism

Hypercalcuria
- Hypercalcaemia *q.v.*

Calcium phosphate

Alkaline urine

Primary hyperparathyroidism

Renal tubular acidosis

Cystine
Acid pH
Inherited defect of renal tubular cells

Silica
Dietary
- Gluten
- Soya bean hulls

Soil ingestion

Xanthine
Allopurinol administration
Hereditary

Struvite
Alkaline urine*
Urinary bladder foreign body
Urinary tract infection*

Urate
Acid urine
Breed-associated
- Dalmatian*
- English Bulldog

Portosystemic shunts
Urinary tract infection*

References

Feldman, E. C., et al. (2005) Pretreatment clinical and laboratory findings in dogs with primary hyperparathyroidism: 210 cases (1987–2004). *JAVMA,* **227**:756–61.
Hess, R. S., et al. (1998) Association between hyperadrenocorticism and development of calcium-containing uroliths in dogs with urolithiasis. *JAVMA,* **212**:1889–91.
Houston, D. M., et al. (2004) Canine urolithiasis: A look at over 16 000 urolith submissions to the Canadian Veterinary Urolith Centre from February 1998 to April 2003. *Can Vet,* **45**:225–30.

4.4.4 Infectious agents

Bacteria

Contamination*
- Catheterised sample*
- Failure of sterile collection technique
- Voided sample*

Urinary tract infection*

Fungi

Blastomycosis
Candidiasis
Contaminants*

Cryptococcosis
Prolonged antibiotic therapy

Parasites

Capillaria ova
Dioctophyma renale ova
Dirofilaria microfilaria
Faecal contamination*

Predisposing factors to urinary tract infection

Alteration of urothelium

Changes in normal flora of distal urogenital tract
Metaplasia
- Oestrogens
  - Exogenous
  - Sertoli cell tumours*

Neoplasia*
Trauma
- External*
- Iatrogenic, e.g.
  - Catheterisation*
  - Palpation
  - Surgery*
- Urolithiasis*

Drugs
- Cyclophosphamide
- Oestrogens

Alterations in urine

Decreased frequency of urination
- Involuntary retention*
- Voluntary retention*

Decreased volume
- Decreased water consumption*
- Increased fluid loss*
- Oliguric/anuric renal failure *q.v.*

Dilute urine*
Glucosuria*

Anatomic defects

Acquired
- Chronic lower urinary tract disease*
- Secondary vesicoureteral reflux
- Surgical procedures

Congenital
- Ectopic ureters
- Persistent urachal diverticula
- Primary vesicoureteral reflux
- Urethral

Immunodeficiency
Congenital diseases
Hyperadrenocorticism
Iatrogenic, e.g.
- Corticosteroids*

Uraemia* *q.v.*

Interference with normal micturition
Outflow obstruction
- Neoplasia*
- Prostatic disease*
- Strictures
- Urinary bladder herniation
- Urolithiasis*

Incomplete emptying of bladder
- Anatomic defects
  - Diverticula
  - Vesicoureteral reflux
- Neurogenic
  - Reflex dyssynergia*
  - Spinal disease

References
Hitt, M. E. (1986) Hematuria of renal origin. *Compend Contin Educ Pract Vet*, 8:14–19.
Torres, S. M. F. (2005) Frequency of urinary tract infection among dogs with pruritic disorders receiving long-term glucocorticoid treatment. *JAVMA*, **227**:239–43.

4.5 Cytological findings

4.5.1 Tracheal/bronchoalveolar lavage

Increased neutrophils
Aspiration pneumonia*
Bacterial bronchitis*
Bronchopneumonia*
Canine tracheobronchitis* (D)
Chronic bronchitis*
Foreign body*
Parasites, e.g.
- *Angiostrongylus vasorum*

Increased eosinophils (see Plate 4.5 in colour plate section)
Drugs
- Potassium bromide (C)T

Eosinophilic bronchitis*
Feline asthma* (C)

Immunodeficiency
Congenital diseases
Hyperadrenocorticism
Iatrogenic, e.g.
- Corticosteroids*

Uraemia* *q.v.*

Interference with normal micturition
Outflow obstruction
- Neoplasia*
- Prostatic disease*
- Strictures
- Urinary bladder herniation
- Urolithiasis*

Incomplete emptying of bladder
- Anatomic defects
  - Diverticula
  - Vesicoureteral reflux
- Neurogenic
  - Reflex dyssynergia*
  - Spinal disease

References
Hitt, M. E. (1986) Hematuria of renal origin. *Compend Contin Educ Pract Vet*, 8:14–19.
Torres, S. M. F. (2005) Frequency of urinary tract infection among dogs with pruritic disorders receiving long-term glucocorticoid treatment. *JAVMA*, **227**:239–43.

4.5 Cytological findings

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Canine tracheobronchitis* (D)
Chronic bronchitis*
Foreign body*
Parasites, e.g.
- *Angiostrongylus vasorum*

Increased eosinophils (see Plate 4.5 in colour plate section)
Drugs
- Potassium bromide (C)T

Eosinophilic bronchitis*
Feline asthma* (C)

Parasites
- *Aelurostrongylus abstrusus*
- *Angiostrongylus vasorum*
- *Capillaria aerophila*
- *Crenosoma vulpis*
- *Oslerus* spp

Pulmonary infiltrate with eosinophils/eosinophilic bronchopneumonopathy

Organisms visible on microscopy/detectable on culture

Upper respiratory tract

Aelurostrongylus abstrusus
Bordetella bronchiseptica
Capillaria aerophila
Malassezia pachydermatis
Mycobacteria spp
Mycoplasma spp
Oslerus osleri

Lower respiratory tract

Aelurostrongylus abstrusus
Aspergillus spp
Blastomyces dermatitidis
*Bordetella bronchiseptica**
Capillaria aerophila
Coccidioides immitis
Crenosoma vulpis (D)
Cryptococcus neoformans
Eucoleus aerophilus
Haemophilus felis
Histoplasma capsulatum
Mycobacteria spp
Mycoplasma spp
Opportunist bacteria*
- *Pasteurella* spp
- *Pseudomonas* spp
- *Salmonella* Typhimurium

Oslerus spp
Paragonimus kellicotti (D)
Penicillium spp
Pneumocystis carinii (D)
Toxocara canis
Toxoplasma gondii
Yersinia pestis

References

Chapman, P. S., et al. (2004) *Angiostrongylus vasorum* infection in 23 dogs (1999–2002). *JSAP,* **45**:435–40.

Clercx, C., et al. (2000) Eosinophilic bronchopneumopathy in dogs. *JVIM,* **14**:282–91.

Foster, S. F., et al. (2004) A retrospective analysis of feline bronchoalveolar lavage cytology and microbiology (1995–2000). *J Feline Med Surg*, **6**:189–98.

4.5.2 Nasal flush cytology

Neoplasia

Adenocarcinoma*
Chondrosarcoma
Esthesioneuroblastoma
Fibrosarcoma
Haemangiosarcoma
Histiocytoma
Leiomyosarcoma
Liposarcoma
Lymphoma*
Malignant fibrous histiocytoma
Malignant melanoma
Malignant nerve sheath tumour
Mast cell tumour
Myxosarcoma
Neuroendocrine tumour
Osteosarcoma
Paranasal meningioma
Rhabdomyosarcoma
Squamous cell carcinoma*
Transitional cell carcinoma
Transmissible venereal tumour
Undifferentiated carcinoma*
Undifferentiated sarcoma

Inflammation

Acute or chronic inflammation secondary to foreign body or dental disease*
Allergic rhinitis*
Granulomatous rhinitis
Lymphoplasmacytic rhinitis*
Nasopharyngeal polyp*
Oronasal fistula

Organisms visible on microscopy/detectable on culture

Fungal disease
Aspergillosis
Cryptococcosis
Penicillium spp
Rhinosporidium spp

Bacterial/mycoplasmal disease
*Bordetella bronchiseptica**
*Chlamydophila felis** (C)

Haemophilus felis
Mycoplasma spp*

Parasites
Capillaria aerophila
Cuterebra spp
Eucoleus böehmi
Linguatula serrata
Pneumonyssoides caninum (D)

References

Ballwener, L. R. (2004) Respiratory parasites. *Proceedings*, *Western Veterinary Conference, 2004*.
Windsor, R. C., et al. (2004) Idiopathic lymphoplasmacytic rhinitis in dogs: 37 cases (1997–2002). *JAVMA*, **224**:1952–7.

4.5.3 Liver cytology

Amyloidosis

Hyperplasia
Nodular hyperplasia*

Increased bile pigment
Cholestasis* *q.v.*

Increased copper
Copper-associated hepatopathy

Infectious hepatopathies
Babesiosis
Bacillus piliformis
Bacterial cholangiohepatitis*
Canine adenovirus-1* (D)
Canine herpes virus (D)
Capillaria hepatica
Cytauxzoonosis
Ehrlichiosis
Extrahepatic sepsis
Feline coronavirus* (C)
Hepatozoon canis
Leishmaniasis
Leptospirosis*
Liver abscess
Metorchis conjunctus
Mycobacteriosis
Neosporosis
Opisthorchis felineus

Rhodococcus equi
Toxoplasmosis
Yersiniosis

Inflammatory hepatopathies

Cholangiohepatitis* *q.v.*
Chronic hepatitis* *q.v.*
Copper retention/storage disease
Granulomatous hepatitis
- *Bartonella henselae*
- Fungal disease
- Intestinal lymphangitis/lymphangiectasia
- Leishmaniasis

Idiosyncratic drug reaction
Lobular dissecting hepatitis
Drugs
- Anticonvulsants
- NSAIDs

Neoplastic cells, e.g.

Bile duct carcinoma
Haemangiosarcoma
Hepatocellular adenocarcinoma*
Leiomyosarcoma
Lymphoma*
Mast cell
Metastatic tumour*

Vacuolar hepatopathies

Chronic infections, e.g.
- Dental disease*
- Pyelonephritis

Diabetes mellitus*
Exogenous glucocorticoid administration*
Hyperadrenocorticism
Hyperlipidaemia
Hypothyroidism* (D)
Inflammatory bowel disease*
Lipid storage disease
Neoplasia*
Pancreatitis*

References

Rutgers, H. C. & Haywood, S. (1988) Chronic hepatitis in the dog. *JSAP,* **29**:679–90.
Thrall, M. A. (2002) Cytology of intra-abdominal organs and masses. *Proceedings, Western Veterinary Conference, 2002.*
Washabau, R. J. (2004) Common canine liver diseases *Proceedings*, *Western Veterinary Conference, 2004.*

4.5.4 Kidney cytology

Neoplastic cells

Adenocarcinoma
Chondrosarcoma
Haemangioma
Haemangiosarcoma
Lymphoma*
Metastatic thyroid adenocarcinoma
Osteosarcoma

Inflammatory cells

Chronic interstitial nephritis*
Glomerulonephritis
Leptospirosis*
Neoplasia
Pyelonephritis
Renal abscess

Reference

Thrall, M. A. (2002) Cytology of intra-abdominal organs and masses. *Proceedings, Western Veterinary Conference, 2002.*

4.5.5 Skin scrapes/hair plucks/tape impressions

Parasites

Cheyletiella spp*
Demodex spp*
Felicola subrostratus
Heterodoxus spiniger
Larval ticks*
*Linognathus setosus**
Lynxacarus radovsky
Notoedres cati
*Otodectes cyanotis**
*Sarcoptes scabiei** (D)
Tricodectes canis
Trombiculid mites*

Fungi

Dermatophytosis
Malassezia spp

Reference

Saevik, B. K., et al. (2004) Cheyletiella infestation in the dog: observations on diagnostic methods and clinical signs. *JSAP,* **45**:495–500.

4.5.6 Cerebrospinal fluid (CSF) analysis

RAISED CSF WHITE CELL COUNT AND/OR MICROPROTEIN LEVELS

Infectious

Algal
Protothecosis

Bacterial
Leptospirosis
Various aerobes and anaerobes, e.g.
- *Escherichia coli*
- *Klebsiella* spp
- *Streptococcus* spp

Fungal
Aspergillosis
Blastomycosis
Coccidioidomycosis
Cryptococcosis
Histoplasmosis
Hyalohyphomycosis
Phaeohyphomycosis

Parasitic
Ancylostoma caninum
Angiostrongylus cantonensis
Cuterebra spp
Dirofilaria immitis
Toxocara canis

Protozoal
Acanthamoebiasis
Babesiosis
Encephalitozoonosis
Neosporosis
Sarcocystis-like organism
Toxoplasmosis
Trypanosomiasis

Rickettsial
Ehrlichiosis
Rocky Mountain Spotted Fever (D)
Salmon poisoning disease (D)

Viral
Borna disease virus
Canine distemper* (D)
Canine herpes virus (D)

Canine parainfluenza (D)
Canine parvovirus* (D)
Central European tick-borne encephalitis
Feline immunodeficiency virus* (C)
Feline infectious peritonitis* (C)
Feline leukaemia virus* (C)
Infectious canine hepatitis* (D)
Pseudorabies
Rabies

Non-infectious (Fig. 4.5)
Eosinophilic meningoencephalitis
Fibrocartilaginous embolism
Fucosidosis
Globoid cell leukodystrophy
Granulomatous meningoencephalomyelitis
Idiopathic tremor syndrome
Intervertebral disc disease
Meningoencephalomyelitis in Pointers
Necrotizing encephalitis
Neoplasia
Periventricular encephalitis
Polioencephalomyelitis
Pug and Maltese encephalitis
Pyogranulomatous meningoencephalomyelitis
Steroid responsive meningoencephalomyelitis and polyarteritis
Yorkshire Terrier encephalitis

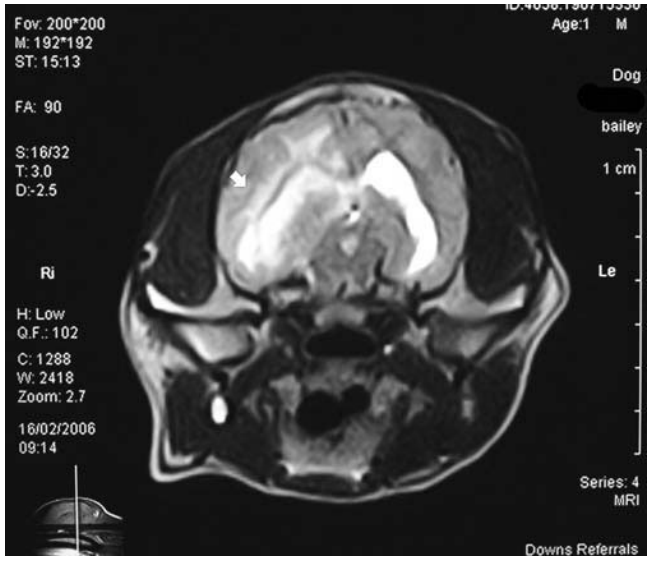

Fig. 4.5 Transverse T2 weighted MR scan of the brain of a dog with suspected granulomatous meningoencephalomyelitis, showing a high signal around the right lateral ventricle (arrow). Reproduced with permission of Downs Referrals, Bristol.

References

Cizinauskas, S., et al. (2000) Long-term treatment of dogs with steroid-responsive meningitis–arteritis: clinical, laboratory and therapeutic results. *JSAP,* **41**: 295–301.

Gandini, G., et al. (2003) Fibrocartilaginous embolism in 75 dogs: clinical findings and factors influencing the recovery rate. *JSAP,* **44**:76–80.

Kuwamura, M., et al. (2002) Necrotising encephalitis in the Yorkshire Terrier: a case report and literature review. *JSAP,* **43**:459–63.

Rusbridge, C. (1997) Collection and interpretation of cerebrospinal fluid in cats and dogs. *In Practice,* **19**:322–31.

4.5.7 Fine needle aspiration of cutaneous/subcutaneous masses

Neoplasia

Epithelial

Basal cell tumour
Papilloma
Perianal adenoma*
Sebaceous adenoma/hyperplasia*
Sebaceous gland tumours*
Squamous cell carcinoma*
Sweat gland tumours

Round cell

Histiocytoma* (D)
Lymphoma
Mast cell tumour*
Plasmacytoma
Transmissible venereal tumour (D)

Mesenchymal

Haemangiopericytoma
Lipoma*
Melanoma
Sarcoma*, e.g.
- Chondrosarcoma
- Fibrosarcoma
- Haemangiosarcoma
- Osteosarcoma

Inflammatory cells

Abscess*
Cellulitis*
Panniculitis
Pyoderma*

Reference

McEntee, M. C. (2001) Evaluation of superficial masses: diagnostic and treatment considerations. *Proceedings, Atlantic Coast Veterinary Conference, 2001.*

Raskin, R. E. (2002) Cytologic features of discrete cells/round cells. *Proceedings, Western Veterinary Conference, 2002.*

4.6 Hormones/endocrine testing

4.6.1 Thyroxine

Increased

Diet
- Soy

Hyperthyroidism* (C)
Juvenile dogs*
Obesity*
Pregnant bitches*
Strenuous exercise*
Total T4 autoantibodies
Thyroid carcinoma
Drugs
- Excessive thyroid hormone supplementation
- Ipodate

Decreased

Neonatal cats*
Normal value is lower in sight hounds

Primary hypothyroidism
Acquired*
Congenital

Non-thyroidal illness (Sick euthyroid syndrome), Many conditions, e.g.*
Acute diseases
- Acute hepatitis* *q.v.*
- Acute pancreatitis*
- Acute renal failure *q.v.*
- Autoimmune haemolytic anaemia*
- Bacterial bronchopneumonia*
- Canine distemper virus* (D)
- Intervertebral disc disease* (D)
- Polyradiculoneuritis
- Sepsis*
- Systemic lupus erythematosus

Chronic diseases
- Cachexia
  - Cardiac*
  - Neoplasia*
- Chronic renal failure* *q.v.*
- Congestive heart failure*
- Dermatological disease* *q.v.*
- Diabetes mellitus*

Raskin, R. E. (2002) Cytologic features of discrete cells/round cells. *Proceedings, Western Veterinary Conference, 2002.*

4.6 Hormones/endocrine testing

4.6.1 Thyroxine

Increased

Diet
- Soy

Hyperthyroidism* (C)
Juvenile dogs*
Obesity*
Pregnant bitches*
Strenuous exercise*
Total T4 autoantibodies
Thyroid carcinoma
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- Autoimmune haemolytic anaemia*
- Bacterial bronchopneumonia*
- Canine distemper virus* (D)
- Intervertebral disc disease* (D)
- Polyradiculoneuritis
- Sepsis*
- Systemic lupus erythematosus

Chronic diseases
- Cachexia
  - Cardiac*
  - Neoplasia*
- Chronic renal failure* *q.v.*
- Congestive heart failure*
- Dermatological disease* *q.v.*
- Diabetes mellitus*

- Gastrointestinal disease* *q.v.*
- Hyperadrenocorticism
- Hypoadrenocortism (D)
- Liver disease* *q.v.*
- Lymphoma*
- Megaoesophagus
- Systemic mycoses

Drugs

Amiodarone
Anabolic steroids
Anaesthetics
Anticonvulsants
- Phenobarbitone
- Phenytoin

Frusemide
Glucocorticoids
Iodine supplementation
Methimazole
NSAIDs
- Carprofen
- Flunixin
- Phenylbutazone
- Salicylates

Progestagens
Propanolol
Propylthiouracil
Sulphonamides

References

Chastain, C. B. (2002) Thyroid function testing in greyhounds. *Sm Anim Clin Endocrinol,* **12**:4.

Frank, L. A., et al. (2005) Effects of sulfamethoxazole-trimethoprim on thyroid function in dogs. *Am J Vet Res,* **66**:256–9.

White, H. L., et al. (2004) Effect of dietary soy on serum thyroid hormone concentrations in healthy adult cats. *Am J Vet Res,* **65**:586–91.

4.6.2 Parathyroid hormone

Increased

Hyperadrenocorticism
Non-parathyroid causes of hypocalcaemia *q.v.*
Nutritional secondary hyperparathyroidism
Primary hyperparathyroidism
Renal secondary hyperparathyroidism*
Drugs that decrease serum calcium (see Hypocalcaemia)

Decreased

Artefact
- Prolonged storage/transport above freezing

Hypervitaminosis D
Non-parathyroid causes of hypercalcaemia

Primary hypoparathyroidism
Drugs that increase serum calcium (see Hypercalcaemia)

References

Barber, P. J. (2004) Disorders of the parathyroid glands. *J Feline Med Surg,* **6**:259–69.
Gear, R. N. A., et al. (2005) Primary hyperparathyroidism in 29 dogs: diagnosis, treatment, outcome and associated renal failure. *JSAP,* **46**:10–16.
Hendy, G. N., et al. (1989) Characteristics of secondary hyperparathyroidism in vitamin-D deficient dogs. *Am J Physiol,* **256**:E765–72.
Tomsa, K., et al. (1999) Nutritional secondary hyperparathyroidism in six cats. *JSAP,* **40**:533–9.

4.6.3 Cortisol (baseline or post-ACTH stimulation test)

Increased

Severe/chronic illness*
Stress*

Artefact
Cross-reaction with glucocorticoids (but *not* Dexamethasone)
- Cortisone
- Hydrocortisone
- Methylprednisolone
- Prednisolone
- Prednisone

Hyperadrenocorticism
Adrenal dependent
Pituitary dependent

Drugs
Anticonvulsants

Decreased

Artefact
Prolonged/improper storage

Hypoadrenocorticism (D)
Primary
Secondary

Drugs
Chronic androgen administration
Chronic glucocorticoid administration
Chronic progestagen administration
Megestrol acetate

References

Gieger, T. L. (2003) Lymphoma as a model for chronic illness: effects on adrenocortical function testing. *JVIM*, **17**:154–7.

Kintzer, P. P & Peterson, M. E. (1997) Diagnosis and management of canine cortisol-secreting adrenal tumors. *Vet Clin North Am Small Anim Pract*, **27**:299–307.

4.6.4 Insulin

With concurrent hyperglycaemia

Increased

Insulin-binding antibodies
Insulin resistance*

Decreased

Diabetes mellitus*

With concurrent hypoglycaemia

Increased

Insulinoma

Reference

Caywood, D. D., et al. (1988) Pancreatic insulin-secreting neoplasms : Clinical, diagnostic, and prognostic features in 73 dogs. *JAAHA*, **24**:577–84.

4.6.5 ACTH

Increased

Ectopic ACTH secretion
Insulin administration
Pituitary-dependent hyperadrenocorticism
Primary hypoadrenocorticism

Decreased

Adrenal-dependent hyperadrenocorticism
Iatrogenic hyperadrenocorticism
Spontaneous secondary hyperadrenocorticism

Artefact

Collecting into glass containers
Storing above freezing

Reference

Galac, S., et al. (2005) Hyperadrenocorticism in a dog due to ectopic secretion of adrenocorticotropic hormone. *Domest Anim Endocrinol*, **28**:338–48.

4.6.6 Vitamin D (1,25 dihydroxycholecalciferol)

Increased

Exogenous administration

Granulomatous disease
Humoral hypercalcaemia of malignancy
Primary hyperparathyroidism
Vitamin D based rodenticides

Decreased

Chronic renal failure
Lymphoma
Primary hyperparathyroidism
Vitamin D deficient diet

References

Boag, A. K., et al. (2005) Hypercalcaemia associated with *Angiostrongylus vasorum* in three dogs. *JSAP,* **46**:79–84.
Gerber, B., et al. (2004) Serum levels of 25-hydroxycholecalciferol and 1,25-dihydroxycholecalciferol in dogs with hypercalcaemia. *Vet Res Commun,* **28**:669–80.

4.6.7 Testosterone

Increased (post GnRH or hCG)

Functional testicular tissue
Ovarian thecoma

Decreased

Castrated male
Sertoli cell tumour*
Drugs
- Exogenous androgen treatment

Artefact

Collection into EDTA
Storage at room temperature
Storage with red blood cells

References

Cellio, L. M. & Degner, D. A. (2000) Testosterone-producing thecoma in a female cat. *JAAHA,* **36**:323–25.
Chastain, C. B., et al. (2004) Sex hormone concentrations in dogs with testicular diseases. *Sm Anim Clin Endocrinol,* **14**:41–2.

4.6.8 Progesterone

Increased

Adrenocortical carcinoma
Granulosa cell tumour
Luteal cysts
Normal luteal function
Ovarian remnant syndrome
Prostaglandin therapy
Recent ovulation

Decreased

Artefact

- Storage at room temperature
- Storage in whole blood

Exogenous progestagen administration
Failure to maintain normal luteal function
Failure to ovulate
Imminent parturition
Normal anoestrus

Reference

Boord, M. & Griffin, C. (1999) Progesterone secreting adrenal mass in a cat with clinical signs of hyperadrenocorticism. *JAVMA,* **214**:666–9.

4.6.9 Oestradiol

Increased

Follicular ovarian cysts
Ovarian remnant syndrome
Seminoma*
Sertoli cell tumour*

Reference

Kim, O. & Kim, K. S. (2005) Seminoma with hyperestrogenemia in a Yorkshire Terrier. *J Vet Med Sci,* **67**:121–3.

4.6.10 Atrial natriuretic peptide

Increased

Atrial stretch
- Congenital diseases
- Dilated cardiomyopathy*
- Hypertrophic cardiomyopathy* (C)
- Myxomatous degeneration of the AV valves* (D)
- Other cardiomyopathies

Congestive heart failure*
Fluid overload
Renal failure* *q.v.*

Reduced

Dehydration*

References

Boswood, A., et al. (2003) Clinical validation of a proANP 31–67 fragment ELISA in the diagnosis of heart failure in the dog. *JSAP,* **44**:104–8.

Vollmar, A. M., et al. (1991) Atrial natriuretic peptide concentration in dogs with congestive heart failure, chronic renal failure, and hyperadrenocorticism. *Am J Vet Res,* **52**:1831–4.

Vollmar, A. M., et al. (1994). Atrial natriuretic peptide and plasma volume of dogs suffering from heart failure or dehydration. *Zentralbl Veterinarmed [A],* **41**:548–57.

4.6.11 Modified water deprivation test (in the investigation of polyuria/polydipsia)

Urine fully concentrated post water deprivation (see 6.13 for technique)

Normal*
Psychogenic polydipsia*

Urine mildly submaximally concentrated post water deprivation

Normal*
Partial diabetes insipidus
Psychogenic polydipsia*

Urine submaximally concentrated post water deprivation and fully concentrated following DDAVP administration

Central diabetes insipidus

Urine submaximally concentrated following water deprivation and DDAVP administration

Hyperadrenocorticism
Medullary washout

Nephrogenic diabetes insipidus

Primary
Secondary

- Acromegaly
- Hyperadrenocorticism
- Hypercalcaemia*
- Hyperthyroidism* (C)
- Hypoadrenocorticism (D)
- Hypokalaemia*
- Liver disease*
- Pyelonephritis
- Pyometra*
- Renal failure*
- Very low protein diet

Reference

Behrend, E. N. (2003) Diabetes insipidus and other causes of polyuria/polydipsia. *Proceedings*, *Western Veterinary Conference, 2003*.

4.7 Faecal analysis findings

4.7.1 Faecal blood

(See Haematochezia *q.v.* and Melaena *q.v.*)
Note: Tests for occult blood may be positive if red meat has been fed in the previous five days.

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Urine fully concentrated post water deprivation (see 6.13 for technique)

Normal*
Psychogenic polydipsia*

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Primary
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- Acromegaly
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- Hypercalcaemia*
- Hyperthyroidism* (C)
- Hypoadrenocorticism (D)
- Hypokalaemia*
- Liver disease*
- Pyelonephritis
- Pyometra*
- Renal failure*
- Very low protein diet

Reference

Behrend, E. N. (2003) Diabetes insipidus and other causes of polyuria/polydipsia. *Proceedings*, *Western Veterinary Conference, 2003*.

4.7 Faecal analysis findings

4.7.1 Faecal blood

(See Haematochezia *q.v.* and Melaena *q.v.*)
Note: Tests for occult blood may be positive if red meat has been fed in the previous five days.

4.7.2 Faecal parasites

Flukes
Alaria spp

Hookworms
*Ancylostoma** spp
*Uncinaria** spp

Protozoa
*Cryptosporidium** spp
*Giardia** spp
Toxoplasma gondii
Tritrichomonas foetus

Respiratory parasites shed in faeces
Aelurostrongylus abstrusus
Capillaria aerophila
Crenosoma vulpis (D)
Eucoleus boehmi
Paragonimus kellicotti (D)

Roundworms
Toxascaris leonina
Toxocara canis
Toxocara cati

Tapeworms
*Taenia** spp

Threadworm
Strongyloides spp

Whipworms
*Trichuris vulpis**

References
Ballweber, L. R. (2003) Respiratory parasites. *Proceedings, Western Veterinary Conference, 2002*.
Ballweber, L. R. (2004) Internal parasites of dogs & cats. *Proceedings, Western Veterinary Conference, 2004*.

4.7.3 Faecal culture

Culture for specific enteropathogenic bacteria
Campylobacter spp*
*Clostridium difficile**
*Clostridium perfringens**

*Escherichia coli**
- Enterohaemorrhagic
- Enteropathogenic
- Enterotoxigenic

Salmonella spp*
Yersinia spp

Non-selective culture
Non-selective culture is thought to be of limited diagnostic use.

Reference
Hackett, T., & Lappin, M. R. (2003) Prevalence of enteric pathogens in dogs of north-central Colorado. *JAAHA,* **39**:52–6.
Sykes, J. E. (2003) Canine infectious diarrhoea. *Proceedings, Australian College of Veterinary Scientists Science Week, 2003.*

4.7.4 Faecal fungal infections

Histoplasma capsulatum

Reference
Clinkenbeard, K. D. (1988) Disseminated histoplasmosis in dogs : 12 cases (1981–1986). *JAVMA,* **193**:1443–7.

4.7.5 Undigested food residues

Note: Trypsinogen-like immunoreactivity is a more sensitive test for exocrine pancreatic insufficiency than is the presence of undigested food residues.

Fat
Bile acid deficiency
Exocrine pancreatic insufficiency
Malabsorption*

Starch
Exocrine pancreatic insufficiency
High starch diet
Increased intestinal transit time

PART 5
ELECTRODIAGNOSTIC TESTING

5.1 ECG findings

Note: Changes in ECG measurements are relatively insensitive indicators of chamber size.

5.1.1 Alterations in P wave

Tall P wave (P pulmonale)

Right atrial enlargement, e.g.
- Chronic respiratory disease*
- Dilated cardiomyopathy*
- Tricuspid regurgitation*

Wide P wave (P mitrale)

Left atrial enlargement*, e.g.
- Dilated cardiomyopathy*
- Mitral regurgitation*

Variable height of P wave (wandering pacemaker)

Increased vagal tone*

Absent P wave

*Atrial fibrillation**
Acute atrial stretch
- Volume overload

Atrial pathology
Excessive vagal stimulation
Large atria*

Persistent atrial standstill
Artefact
Atrial pathology
Hyperkalaemia

Sinus arrest/sinoatrial block
Normal in brachycephalics
Atrial disease, e.g.
- Cardiomyopathy*
- Dilation*

- Fibrosis
- Hypertrophy
- Necrosis

Electrolyte imbalances*
Increased vagal tone
- Chronic respiratory disease*
- Gastrointestinal disease*

Sick sinus syndrome
Stenosis of bundle of His
Drugs, e.g.
- Beta blockers
- Calcium channel blockers
- Digitalis glycosides

References

Gavaghan, B. J., et al. (1999) Persistent atrial standstill in a cat. *Aust Vet J*, 77:574–9.
Gelzer, A. (2002) The challenges of atrial fibrillation. *Proceedings, ACVIM, 2002*.
Moneva-Jordan, A., et al. (2001) Sick sinus syndrome in nine West Highland White terriers. *Vet Rec*, **148**:142–7.

5.1.2 Alterations in QRS complex

Tall R waves

Left ventricular enlargement, e.g.
- Cardiomyopathy*
- Hyperthyroidism* (C)
- Mitral regurgitation*

Small R waves

Acute haemorrhage
Pericardial effusion

Wide QRS

Supraventricular
Left bundle branch block
- Cardiomyopathy*
- Subaortic stenosis*
- Drugs/toxins, e.g.
  - Doxorubicin
  - Tricyclic antidepressants

Right bundle branch block
- Occasionally seen in normal animals
- Cardiac neoplasia
- Heartworm disease
- Inherited
- Post cardiac arrest
- Ventricular septal defect

Left ventricular hypertrophy*
Microscopic intramural myocardial infarction
Quinidine toxicity
Severe ischaemia

Ventricular
Accelerated idioventricular rhythm*
Ventricular ectopy*
Ventricular escape complexes
Ventricular premature complexes*
Ventricular tachycardia*

Slurred upstroke
Ventricular pre-excitation/Wolff-Parkinson-White syndrome
- Acquired heart defects, e.g.
  - Feline hypertrophic cardiomyopathy
- Congenital
- Idiopathic

Electrical alternans
Pericardial effusion

Deep S waves (Fig. 5.1(a–f))
Right ventricular enlargement, e.g.
- Pulmonary hypertension
- Pulmonic stenosis
- Reverse-shunting patent ductus arteriosus
- Tricuspid regurgitation

References
Della Torre, P. K., et al. (1999) Effect of acute haemorrhage on QRS amplitude of the lead II canine electrocardiogram. *Aust Vet J,* **77**:298–300.
Wright, K. N., et al. (1996) Supraventricular tachycardia in four young dogs. *JAVMA,* **208**:75–80.

5.1.3 Alterations in P-R relationship

Prolonged P-R interval (first degree atrioventricular block)
Occasionally seen in normal animals*
Age-related degeneration of atrioventricular conduction system
Feline dilated cardiomyopathy (C)
Heart disease*
Hyperkalaemia *q.v.*
Hypokalaemia* *q.v.*
Increased vagal tone*
Drugs/toxins
- Beta-blockers
- Calcium channel blockers

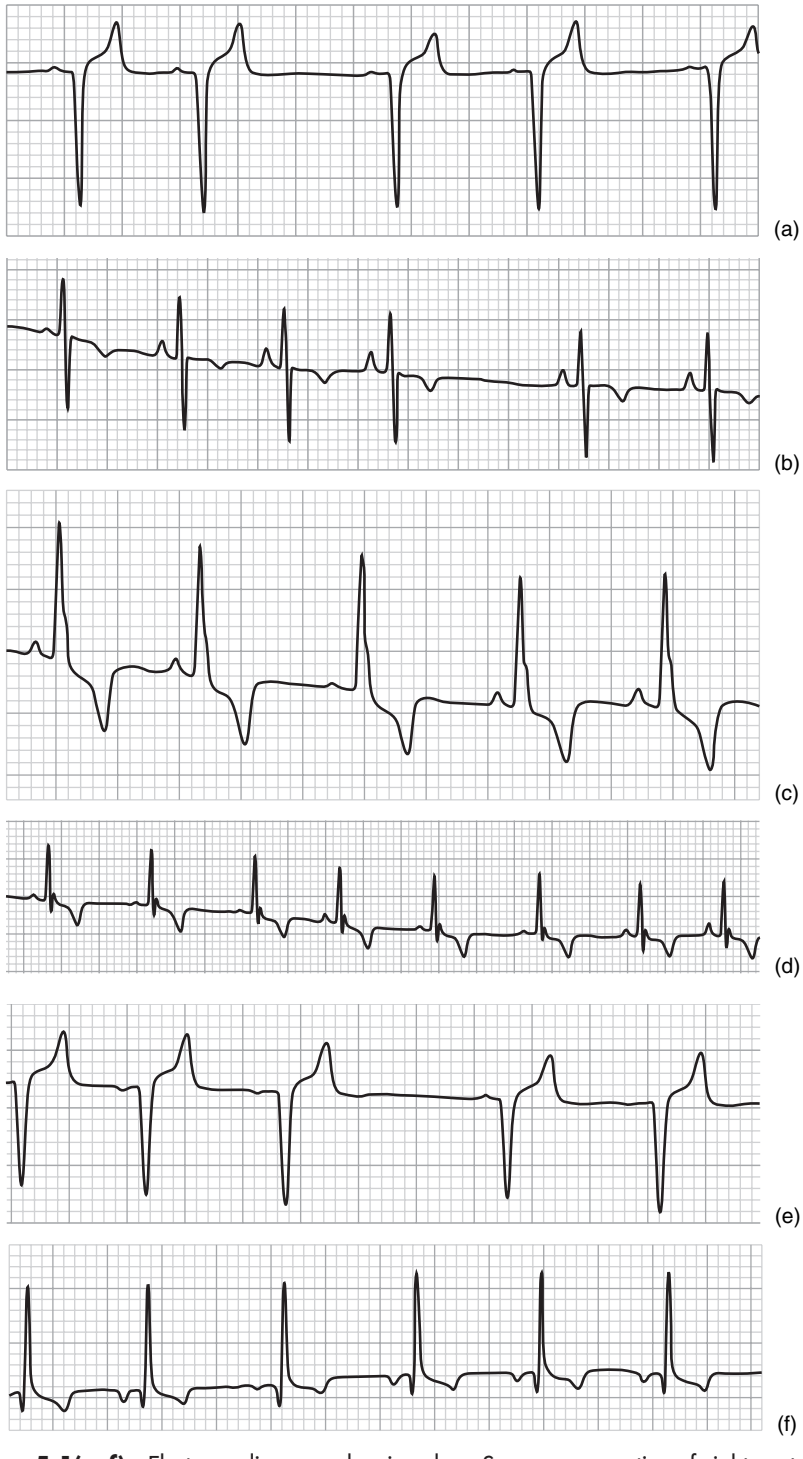


Figure 5.1(a–f) Electrocardiogram, showing deep S waves suggestive of right ventricular enlargement: (a) lead I; (b) lead II; (c) lead III; (d) aVF; (e) aVL; (f) aVR (25 mm/s, 10 mm/mV). Reproduced with permission of Downs Referrals, Bristol.

- Cardiac glycosides
- Quinidine
- Tricyclic antidepressants
- Vitamin D rodenticides

Short P-R interval

Ventricular pre-excitation/Wolff-Parkinson-White syndrome
- Acquired heart defects, e.g.
  - Feline hypertrophic cardiomyopathy
- Congenital
- Idiopathic

Intermittent failure of atrioventricular conduction (second degree atrioventricular block)

May be seen in normal animals
Juvenile puppies at rest
Physiological when seen associated with supraventricular tachycardia
Electrolyte imbalances* *q.v.*, e.g.
- Hyperkalaemia *q.v.*

Hyperthyroidism* (C)
Increased vagal tone, e.g.
- Chronic respiratory disease* *q.v.*
- Gastrointestinal disease* *q.v.*

Microscopic idiopathic fibrosis
Myocardial diseases
Stenosis of bundle of His
Drugs, e.g.
- Alpha-2 agonists
- Atropine
- Beta blockers
- Calcium channel blockers
- Cardiac glycosides

Complete atrioventricular block (third degree atrioventricular block)

Idiopathic
Bacterial endocarditis
Congenital heart defects, e.g.
- Aortic stenosis
- Ventricular septal defect

Hyperkalaemia
Isolated congenital atrioventricular block
Myocardial diseases including infiltrative disorders
Myocardial infarction
Myocarditis
Severe drug intoxication, e.g.
- Beta blockers
- Calcium channel blockers
- Cardiac glycosides

References

Atkins, C. E., et al. (1990) Efficacy of digoxin for treatment of cats with dilated cardiomyopathy. *JAVMA*, **196**:1463–9.
Atkins, C. E., et al. (1994) ECG of the Month. *JAVMA*, **205**:983–4.
Wright, K. N., et al. (1996) Supraventricular tachycardia in four young dogs. *JAVMA*, **208**:75–80.

5.1.4 Alterations in S-T segment

S-T segment depression/slur

Acute myocardial infarction
Cardiac trauma
Digitalis toxicity
Electrolyte disturbances* *q.v.*
Myocardial ischaemia

S-T segment elevation

Myocardial hypoxia
Myocardial infarction
Myocardial neoplasia
Pericarditis

Secondary changes to S-T segment following QRS abnormalities

Bundle branch block
Ventricular hypertrophy
Ventricular premature complexes*

Pseudo-depression of S-T segment (prominent atrial repolarisation wave)

Pathological atrial changes
Tachycardia *q.v.*

Reference

Krotje, L. J., et al. (1990) Intracardiac rhabdomyosarcoma in a dog. *JAVMA*, **197**:368–71.

5.1.5 Alterations in Q-T interval

Prolonged Q-T interval

Central nervous system disease *q.v.*
Exercise*
Hypocalcaemia *q.v.*
Hypokalaemia* *q.v.*
Hypothermia* *q.v.*
Drugs/toxins
- Amiodarone
- Ethylene glycol

- Quinidine
- Tick toxicity
- Tricyclic antidepressants

Shortened Q-T interval

Hypercalcaemia *q.v.*
Hyperkalaemia *q.v.*
Drugs/toxins
- Cardiac glycosides

Reference

Campbell, F. E. & Atwell, R. B. (2002) Long QT syndrome in dogs with tick toxicity *(Ixodes holocyclus). Aust Vet J,* **80**:611–16.

5.1.6 Alterations in T wave

Tall T waves

Anaesthetic complications
Bradycardia *q.v.*
Heart failure*
Hyperkalaemia *q.v.*
Hyperventilation during heat stroke
Left bundle branch block
Myocardial hypoxia
Myocardial infarction
Right bundle branch block

Small T waves

Hypokalaemia* *q.v.*

T wave alternans

Hypocalcaemia *q.v.*
Increased circulating catecholamines
Increased sympathetic tone

5.1.7 Alterations in baseline

Atrial fibrillation
Atrial flutter
Movement artefact*
Ventricular fibrillation
Ventricular flutter

References

Good, L., et al. (2002) ECG of the Month. *JAVMA,* **221**:1108–11.
Manohar, M. & Smetzer, D. L. (1992) Atrial fibrillation. *Compend Contin Educ Pract Vet,* **14**:1327–33.

5.1.8 Rhythm alterations

Atrial fibrillation

Anaesthesia
Gastrointestinal disease*
Hypothyroidism* (D)
Primary/'lone'
Rapid, large-volume pericardiocentesis
Severe atrial enlargement, e.g.
- Dilated cardiomyopathy*
- Mitral regurgitation*
- Patent ductus arteriosus

Volume overload

Atrial flutter

Cardiomyopathy
Iatrogenic
- Cardiac catheterisation

Severe atrial enlargement, e.g.
- Dilated cardiomyopathy*
- Mitral regurgitation*
- Patent ductus arteriosus

Drugs
- Quinidine

Atrioventricular block *q.v.*

Parasystole

Atrial
Ventricular

Persistent atrial standstill

Artefact
Atrial pathology
Hyperkalaemia

Sinus block/arrest

Atrial disease, e.g.
- Cardiomyopathy*
- Dilation*
- Fibrosis
- Hypertrophy
- Necrosis

Electrolyte imbalances* *q.v.*
Increased vagal tone
- Chronic respiratory disease*
- Gastrointestinal disease*

Sick sinus syndrome
Stenosis of bundle of His

Drugs, e.g.
- Beta blockers
- Calcium channel blockers
- Digitalis glycosides

Supraventricular premature complexes/supraventricular tachycardia (sinus, atrial or junctional tachycardia)

May be normal

Structural cardiac disease, e.g.

Atrial enlargement*
Myocardial disease

Systemic disease, e.g.

Hyperthyroidism* (C)
Inflammation*
Neoplasia*
Sepsis*
Drugs, e.g.
- Digoxin
- General anaesthesia

Ventricular premature complexes/ventricular tachycardia

[Figs 5.1(g–i)]

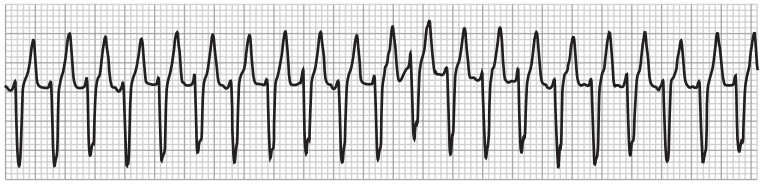
Cardiac disease

Congestive heart failure*
Endocarditis, e.g.
- Bacterial

Inherited, e.g.
- German Shepherd Dogs

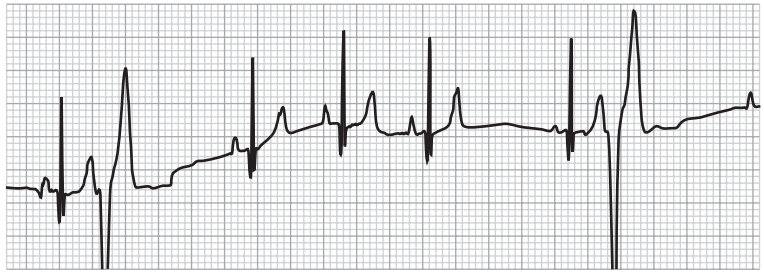
Myocardial infarction
Myocarditis, e.g.
- Idiopathic
- Traumatic
- Viral

Neoplasia
Pericarditis



(g)

Figure 5.1(g) Electrocardiogram showing ventricular tachycardia in a dog (lead II, 25 mm/s, 5 mm/mV). Reproduced with permission of Downs Referrals, Bristol.



(h)

Figure 5.1(h) Electrocardiogram showing intermittent ventricular premature complexes (lead II, 25mm/s, 5mm/mV). Reproduced with permission of Downs Referrals, Bristol.

(i)

Figure 5.1(i) Electrocardiogram showing ventricular trigeminy in a Boxer with arrhythmogenic right ventricular cardiomyopathy (lead II, 25mm/s, 5mm/mV). Reproduced with permission of Downs Referrals, Bristol.

Extra-cardiac disease

Anaemia* *q.v.*
Autonomic imbalances*
Coagulopathies *q.v.*
Disseminated intravascular coagulation
Endocrinopathies*
Gastric dilatation/volvulus*
Hypoxia
Nutritional deficiencies
Pancreatitis*
Sepsis*
Uraemia* *q.v.*
Drugs/toxins

- Atropine
- Anti-dysrhythmics, e.g.
  - Amiodarone
  - Digoxin
  - Lignocaine
  - Sotalol
- Dobutamine
- Dopamine
- Glycopyrronium bromide
- Halothane

- Propantheline bromide
- Theobromine
- Tricyclic antidepressants
- Xylazine
- Vitamin D rodenticides

Ventricular flutter/fibrillation

Ventricular asystole

Electrolyte/acid–base disorders
Severe sinoatrial block
Terminal systemic disease
Third degree atrioventricular block

References

Good, L., et al. (2002) ECG of the Month. *JAVMA,* **221**:1108–11.
Grubb, T. & Muir, W. W. (1999) Supraventricular tachycardias in dogs and cats *Compend Contin Educ Pract Vet,* **21**:843–56.
Manohar, M. & Smetzer, D. L. (1992) Atrial fibrillation. *Compend Contin Educ Pract Vet,* **14**:1327–33.
Moise, N. S. (1997) Diagnosis of inherited ventricular tachycardia in German shepherd dogs. *JAVMA,* **210**:403–10.

5.1.9 Alterations in rate

Tachycardia

Supraventricular tachycardia

Atrial fibrillation
Atrial flutter
Ectopic atrial tachycardia
Junctional tachycardia
- Automatic junctional tachycardia
- AV nodal re-entrant tachycardia
- Bypass-tract-mediated macro-re-entrant tachycardia

Sinus nodal re-entrant tachycardia
Ventricular pre-excitation/Wolff-Parkinson-White syndrome
Ventricular tachycardia *q.v.*

Sinus tachycardia

Physiological
- Excitement*
- Exercise*
- Fear*
- Pain*

Pathological
- Heart failure*
- Respiratory disease*
- Shock*

- Systemic disease
  - Anaemia* *q.v.*
  - Fever* *q.v.*
  - Hyperthyroidism* (C)
  - Hypoxia
  - Sepsis*

Drugs/toxins
- Adder bites
- Baclofen
- Blue-green algae
- Cannabis
- Ethylene glycol
- Glyphosphate
- Ibuprofen
- Metaldehyde
- Paracetamol
- Paraquat
- Petroleum distillates
- Phenoxy acid herbicides
- Pyrethrins/pyrethroids
- Salbutamol
- Selective serotonin reuptake inhibitors
- Terfenadine
- Theobromine
- Tricyclic antidepressants
- Vitamin D rodenticides

Bradycardia

Atrial standstill
- Atrioventricular myopathy
- Dilated cardiomyopathy*
- Hyperkalaemia *q.v.*

Heart block *q.v.*
Sick sinus syndrome
Sinus arrest

Sinus bradycardia

Normal in athletic dogs, during rest/sleep
Cardiac disease
- End-stage heart failure*
- Feline dilated cardiomyopathy (C)

Hypoglycaemia *q.v.*
Hypothyroidism*
Increased vagal tone, e.g.
- Gastrointestinal disease* *q.v.*
- Respiratory disease* *q.v.*

Neurological disease, e.g.
- Coma

Severe systemic disease*
Drugs/toxins
- Adder bites

Antidysrhythmics
- Beta blockers
- Calcium channel blockers
- Digoxin

Baclofen
Cannabis
Carbamate
Daffodil
Glyphosphate
Ivermectin
Loperamide
Organophosphates
Paraquat
Phenoxy acid herbicides
Rhododendron
Theobromine
Vitamin D rodenticides
Yew

References

Côté, E. (2002) Arrhythmias. *Proceedings, Tufts Animal Expo, 2002*.
Gavaghan, B. J., et al. (1999) Persistent atrial standstill in a cat. *Aust Vet J*, **77**:574–9.
Little, C. J. (2005) Hypoglycaemic bradycardia and circulatory collapse in a dog and a cat. *JSAP*, **46**:445–8.

5.2 Electromyographic findings

Spontaneous activity

Normal end-plate noise
Electrode-insertion artefact
Fibrillation potentials
- Denervation

Myotonic potentials (dive bomber sound)
- Myotonia

Pseudo-myotonic potentials
- Polymyositis
- Primary myopathies
- Steroid myopathy

Evoked activity

Decreased muscle action potential
Junctionopathies
- Botulism
- Tick paralysis

Neuropathies
Primary myopathies

Antidysrhythmics
- Beta blockers
- Calcium channel blockers
- Digoxin

Baclofen
Cannabis
Carbamate
Daffodil
Glyphosphate
Ivermectin
Loperamide
Organophosphates
Paraquat
Phenoxy acid herbicides
Rhododendron
Theobromine
Vitamin D rodenticides
Yew

References

Côté, E. (2002) Arrhythmias. *Proceedings, Tufts Animal Expo, 2002*.
Gavaghan, B. J., et al. (1999) Persistent atrial standstill in a cat. *Aust Vet J*, **77**:574–9.
Little, C. J. (2005) Hypoglycaemic bradycardia and circulatory collapse in a dog and a cat. *JSAP*, **46**:445–8.

5.2 Electromyographic findings

Spontaneous activity

Normal end-plate noise
Electrode-insertion artefact
Fibrillation potentials
- Denervation

Myotonic potentials (dive bomber sound)
- Myotonia

Pseudo-myotonic potentials
- Polymyositis
- Primary myopathies
- Steroid myopathy

Evoked activity

Decreased muscle action potential
Junctionopathies
- Botulism
- Tick paralysis

Neuropathies
Primary myopathies

Increased muscle action potential
Aged animals
Chronic neuropathies

Decremental decrease after repeated stimulation
Myasthenia gravis
Re-innervation

References

Blot, S. (2003) Clinical and genetic traits of hereditary canine myopathies. *Proceedings, ACVIM, 2003*.
Hickford, F. H., et al. (1998) Congenital myotonia in related kittens. *JSAP*, **39**:281–5.

5.3 Nerve conduction velocity findings

Increased velocity
Proximal part of extremity

Decreased velocity
Demyelinating neuropathies
Distal part of extremity
Hypothermia of adjacent tissues*
Protein malnutrition
Very old/young animals*

Reference

Harkin, K. R., et al. (2005) Sensory and motor neuropathy in a Border Collie. *JAVMA*, **227**:1263–5.

5.4 Electroencephalography findings

High voltage slow activity
Brain oedema
Chronic inflammatory conditions
Hepatic encephalopathy*
Hydrocephalus
Hypocalcaemia *q.v.*
Idiopathic epilepsy
Lead poisoning
Space occupying lesions
Trauma*

Low voltage fast activity
Acute inflammatory conditions, e.g.
- Bacterial encephalitis
- Canine distemper* (D)

Increased muscle action potential
Aged animals
Chronic neuropathies

Decremental decrease after repeated stimulation
Myasthenia gravis
Re-innervation

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Chronic inflammatory conditions
Hepatic encephalopathy*
Hydrocephalus
Hypocalcaemia *q.v.*
Idiopathic epilepsy
Lead poisoning
Space occupying lesions
Trauma*

Low voltage fast activity

Acute inflammatory conditions, e.g.
- Bacterial encephalitis
- Canine distemper* (D)

Low voltage slow activity

Ischaemic encephalopathy

References

Jaggy, A. & Bernardini, M. (1998) Idiopathic epilepsy in 125 dogs: a long term study. Clinical and electroencephalographic findings. *JSAP,* **39**:23–9.

Klemm, W. R. & Hall, C. L. (1974) Current status and trends in veterinary electroencephalography. *JAVMA,* **164**:529–32.

PART 6
DIAGNOSTIC PROCEDURES

Once a differential diagnosis list has been formulated, further diagnostic procedures are usually indicated in order to make a definitive diagnosis. The descriptions below give an overview of common diagnostic procedures, together with indications and guides to interpretation. However, many diagnostic procedures entail some risk to the animal, and the amount of diagnostic information that is obtained with some tests varies with the clinician's ability and experience. It is recommended, therefore, that clinicians not experienced in a procedure obtain experience or training with a more experienced colleague, on courses and/or by practising on cadavers. Of the tests described below, those incurring particularly significant risks to the patient are:

- Bronchoalveolar lavage
- Cerebrospinal fluid (CSF) tap
- Myelography
- Pericardiocentesis
- Peritoneal lavage
- Thoracocentesis
- Ultrasound-guided biopsy

6.1 Fine-needle aspiration (FNA)

Indications

Cytological diagnosis of accessible masses or organs

Equipment

5 or 10 ml syringe
21–25 g needle of a length suitable to reach the site of interest
Several slides
Surgical scrub

Technique

Restraint

For superficial lesions, sedation is not usually required. For deeper lesions, where it is vital that the animal does not move during the procedure, e.g. kidney and liver biopsies, sedation or general anaesthesia is recommended.

Special precautions

For aspiration of vascular organs such as kidney and liver, a pre-procedural coagulation profile is recommended. For deeper lesions, ultrasound guidance should be used wherever possible, in order to ensure that vital or vascular structures are not penetrated, and that the area of interest is sampled. More detailed texts on ultrasonography should be consulted for details of ultrasound-guided fine needle aspiration.

Procedure

The skin over the area of interest should be clipped and aseptically prepared. For superficial lesions, the mass should be fixed in position, with the fingers if possible. The syringe is emptied of air and attached to the appropriate needle. The mass should be punctured with a brisk motion. The syringe plunger is then withdrawn to apply 3–5 ml of vacuum. The needle should be moved while vacuum is applied. For a superficial or non-vascular mass, the needle can be partially withdrawn (making sure the tip stays beneath the skin so the vacuum is maintained), and redirected within the lesion several times. For vascular organs, the needle can be moved in and out along the same track it entered in. The plunger is then advanced to 0 ml to release the vacuum and the needle is withdrawn.

The needle is removed, and the plunger of the syringe is withdrawn until the syringe contains 3 ml of air. The needle is reattached, and the air in the syringe is expelled by sharply depressing the plunger, with the needle directed obliquely towards a slide. A preparation is immediately made of the sample, by the blood smear technique (*q.v.*) or by the pull-apart method. In the pull-apart method, a clean glass slide is placed on top of and at right angles to the slide onto which the aspirate has been expelled. The slides are then gently pulled apart horizontally. Slides should be air dried immediately.

Risk

Risks of this procedure include dissemination of infection or neoplasia, and haemorrhage.

Interpretation

Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

6.2 Bronchoalveolar lavage

Indications

Diagnosis of chronic lower respiratory tract disease

Equipment

Endoscope
Sterile bronchoalveolar lavage or other suitable catheter
Sterile saline
Syringe
Sterile collection container

Technique

Restraint

The animal is anaesthetised.

Special precautions

Attention should be paid to the oxygenation status of the animal by appropriate monitoring during this procedure, and the procedure paused or discontinued if it is suspected that oxygen saturation is dropping. A jet of oxygen supplied via the biopsy port can help maintain oxygen saturation.

Procedure
The skin over the area of interest should be clipped and aseptically prepared. For superficial lesions, the mass should be fixed in position, with the fingers if possible. The syringe is emptied of air and attached to the appropriate needle. The mass should be punctured with a brisk motion. The syringe plunger is then withdrawn to apply 3–5 ml of vacuum. The needle should be moved while vacuum is applied. For a superficial or non-vascular mass, the needle can be partially withdrawn (making sure the tip stays beneath the skin so the vacuum is maintained), and redirected within the lesion several times. For vascular organs, the needle can be moved in and out along the same track it entered in. The plunger is then advanced to 0 ml to release the vacuum and the needle is withdrawn.

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Endoscope
Sterile bronchoalveolar lavage or other suitable catheter
Sterile saline
Syringe
Sterile collection container

Technique

Restraint
The animal is anaesthetised.

Special precautions
Attention should be paid to the oxygenation status of the animal by appropriate monitoring during this procedure, and the procedure paused or discontinued if it is suspected that oxygen saturation is dropping. A jet of oxygen supplied via the biopsy port can help maintain oxygen saturation.

Procedure
An endoscope is passed into the trachea. The airways should be examined in a systematic manner for lesions, masses and foreign bodies, as well as to enable assessment of the level of mucosal hyperaemia and mucus.

Once the airways are examined, the endoscope is advanced to a region of interest, until it is gently wedged in a small bronchus. The sterile catheter is then advanced so it protrudes into the airway. Care should be taken not to advance the catheter too far blindly, as it is possible to penetrate the airway and cause a pneumothorax. Flush 0.5 ml/kg of saline down the catheter, following this by 3 ml of air to clear the tubing. Firm coupage is applied to the animal's chest and the fluid is then aspirated. Commonly only 20–30% of the saline is recovered. The procedure should be repeated 2–3 times, in different areas of the lungs if diffuse disease is suspected.

The fluid is placed in sterile containers. Samples are centrifuged and direct smears of the sediment are made, usually by the pull apart method (see Section 6.1) as the sediment is often very mucoid. The supernatant can be submitted for bacteriology.

Risks
Risks include iatrogenic pneumothorax and hypoxia due to the presence of the endoscope, the lavage fluid or the disease process itself.

Interpretation
Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

6.3 Gastrointestinal (GI) endoscopic biopsy

Indications
Investigation of chronic vomiting or diarrhoea

Equipment
Flexible endoscope of suitable size and length
Endoscopic biopsy forceps
Pots containing 10% buffered formal saline

Technique
Prior preparation
Food is withheld for 24 hours. For colonoscopy, it is essential to prepare the colon adequately prior to the procedure. This involves withholding food for 24 hours and administering a human oral bowel-cleansing solution 18 hours prior to the procedure. On the morning of the procedure, two warm water enemas should be given.

Restraint
The animal is anaesthetised.

Upper GI tract
Note: The reader is advised to consult specific texts on endoscopy for more detail on these procedures.

Procedure
An endoscope is passed into the trachea. The airways should be examined in a systematic manner for lesions, masses and foreign bodies, as well as to enable assessment of the level of mucosal hyperaemia and mucus.

Once the airways are examined, the endoscope is advanced to a region of interest, until it is gently wedged in a small bronchus. The sterile catheter is then advanced so it protrudes into the airway. Care should be taken not to advance the catheter too far blindly, as it is possible to penetrate the airway and cause a pneumothorax. Flush 0.5 ml/kg of saline down the catheter, following this by 3 ml of air to clear the tubing. Firm coupage is applied to the animal's chest and the fluid is then aspirated. Commonly only 20–30% of the saline is recovered. The procedure should be repeated 2–3 times, in different areas of the lungs if diffuse disease is suspected.

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Risks
Risks include iatrogenic pneumothorax and hypoxia due to the presence of the endoscope, the lavage fluid or the disease process itself.

Interpretation
Samples can be examined under a microscope with referral to appropriate cytological texts, or submitted to a cytologist.

6.3 Gastrointestinal (GI) endoscopic biopsy

Indications
Investigation of chronic vomiting or diarrhoea

Equipment
Flexible endoscope of suitable size and length
Endoscopic biopsy forceps
Pots containing 10% buffered formal saline

Technique
Prior preparation
Food is withheld for 24 hours. For colonoscopy, it is essential to prepare the colon adequately prior to the procedure. This involves withholding food for 24 hours and administering a human oral bowel-cleansing solution 18 hours prior to the procedure. On the morning of the procedure, two warm water enemas should be given.

Restraint
The animal is anaesthetised.

Upper GI tract
Note: The reader is advised to consult specific texts on endoscopy for more detail on these procedures.

Place the animal in left lateral recumbency. A dental gag is placed in the mouth to prevent damage to the endoscope, which is advanced into the stomach. The stomach is insufflated slightly with air, the endoscope is advanced into the pylorus and from there into the duodenum. It should be advanced down the small intestine as far as possible.

Biopsies are taken from any visible lesions. If no focal lesions are observed, multiple mucosal biopsies are taken. Endoscopic biopsy forceps are advanced down the biopsy channel. The forceps are opened as soon as they exit the instrument channel, and advanced to the mucosal surface, altering the angle of the scope so they are perpendicular to the surface. The forceps are gently pressed to the mucosa and closed. They are then withdrawn with a sharp tugging motion, avulsing a small piece of mucosa, and removed from the instrument channel.

There are several methods of transferring the biopsy sample. The author's preferred method is to use a needle to tease the sample gently into the pot, but it is possible to cause artefactual damage with this method. Others prefer to liberate the sample directly into the formalin by immersing the open forceps, but they must be rinsed thoroughly before being used again in order to avoid iatrogenic chemical damage to the gastrointestinal tract.

After obtaining multiple small-intestinal samples, the endoscope is withdrawn into the stomach and the stomach is fully insufflated with air. All regions of the stomach are carefully examined for lesions, masses and foreign bodies. Biopsies of lesions are taken, and if no lesions are seen, several gastric mucosal samples are taken from different stomach regions, as described above.

Colonoscopy

Biopsies can be collected during colonoscopy as above.

Risks

Risks include those associated with general anaesthesia, perforation of the gastrointestinal tract and aspiration of the oral cleansing preparation.

Interpretation

The samples should be submitted for histopathological examination by a pathologist experienced in examining gastrointestinal samples.

6.4 Electrocardiography (ECG) (see Fig. 6.4)

Indications

Detection of arrhythmias on auscultation
Syncope/collapse
Evaluation of congenital heart disease
Part of database for general cardiac investigations

Equipment

Electrocardiograph
Surgical spirit or coupling gel

Technique

The animal is placed in right lateral recumbency. The leads are connected to the animal in the following way: red lead on the right elbow, yellow lead on the left elbow, green

Place the animal in left lateral recumbency. A dental gag is placed in the mouth to prevent damage to the endoscope, which is advanced into the stomach. The stomach is insufflated slightly with air, the endoscope is advanced into the pylorus and from there into the duodenum. It should be advanced down the small intestine as far as possible.

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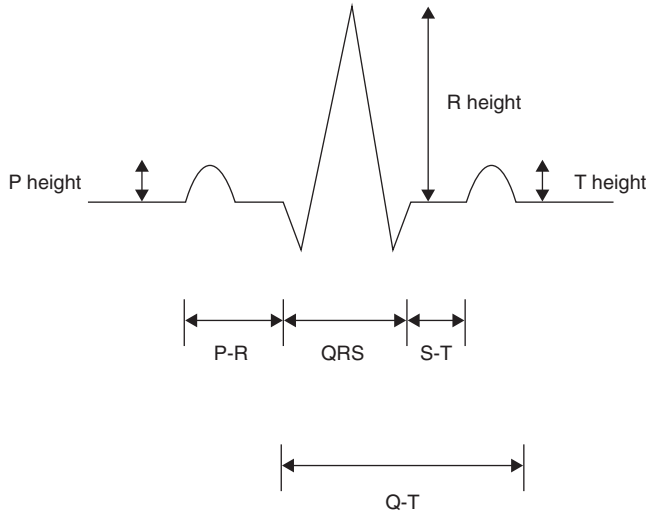


Fig. 6.4 Measurement of the normal P-QRS-T complex.

lead on the left stifle, black lead on the right stifle. Spirit or coupling gel is applied to each clip. ECG pads can be used on animals that resent the application of crocodile clips. A diagnostic ECG may also be obtained by attaching the crocodile clips to the fur close to the skin and liberally applying coupling medium.

Care should be taken not to use so much electrical coupling medium that a short circuit is created, and also that the lead clips are not touching each other. A standard trace should include 10 seconds at 25 mm/s and 10 mm/mV on leads I, II, III, aVR, aVL and aVF, and then 30 seconds at 50 mm/s on lead II. It may be necessary to alter the vertical scale depending on the complex sizes.

Interpretation

The clinician should analyse the ECG in a systematic manner. The heart *rate* should be calculated. The pattern of complexes should be examined to ascertain whether the *rhythm* is regular or irregular. The complexes should be examined to ascertain whether they are *supraventricular* (narrow, tall) or *ventricular* (wide, bizarre) in origin. Complex *sizes* and *intervals* should be measured. The mean electrical axis can also be calculated. A sample ECG recording chart can be found within the cardiac record chart in Appendix D.

6.5 Magnetic resonance imaging (MRI)

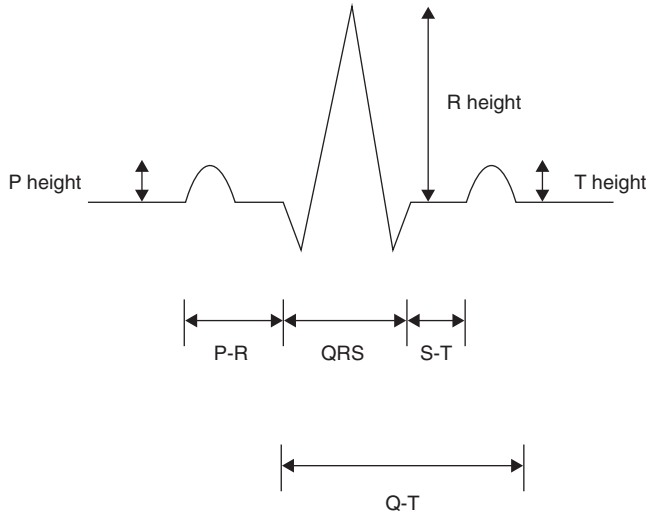
6.5.1 Brain

Indications

Suspected intracranial lesion

Technique

2.5–3 mm slices with 0.3 mm gap
Repeat in tranverse and sagittal planes



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6.5 Magnetic resonance imaging (MRI)

6.5.1 Brain

Indications

Suspected intracranial lesion

Technique

2.5–3 mm slices with 0.3 mm gap
Repeat in tranverse and sagittal planes

Series to run
T1W
T2W
FLAIR
T1 with gadolinium

6.5.2 Spine

Indications
Suspected spinal lesion

Technique
Use neurological examination to localise region of interest
2.0 mm to 3 mm slices with 0.2 to 0.3 mm gap
Repeat in tranverse and sagittal planes

Series to run:
T1W
T2W
T1 with gadolinium

6.5.3 Nasal passages

Indications
Suspected nasal disease, e.g.
- Mass
- Foreign body

Technique
2.5 to 3.0 mm slices with 0.3 mm gap
Repeat in tranverse and sagittal planes

Series to run:
T1W
T2W
T1 with gadolinium

6.6 Ultrasound-guided biopsy

Indications
Histological examination of deep organs or masses

Equipment
Ultrasound machine
Trucut biopsy needle
Pots containing 10% buffered formal saline

Series to run
T1W
T2W
FLAIR
T1 with gadolinium

6.5.2 Spine

Indications
Suspected spinal lesion

Technique
Use neurological examination to localise region of interest
2.0 mm to 3 mm slices with 0.2 to 0.3 mm gap
Repeat in tranverse and sagittal planes

Series to run:
T1W
T2W
T1 with gadolinium

6.5.3 Nasal passages

Indications
Suspected nasal disease, e.g.
- Mass
- Foreign body

Technique
2.5 to 3.0 mm slices with 0.3 mm gap
Repeat in tranverse and sagittal planes

Series to run:
T1W
T2W
T1 with gadolinium

6.6 Ultrasound-guided biopsy

Indications
Histological examination of deep organs or masses

Equipment
Ultrasound machine
Trucut biopsy needle
Pots containing 10% buffered formal saline

Scalpel blade
Surgical scrub

Technique

Prior preparation
A coagulation profile is performed, including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time (BMBT).

Restraint
The animal is sedated or anaesthetised.

Procedure
The region to be biopsied is identified by ultrasound examination, clipped and surgically prepared. Firm transducer pressure can be used to displace superficial visci, such as bowel loops, and bring the region to be biopsied closer to the surface. The clinician should ensure that the planned needle track will not disrupt major vessels or other vital structures.

The biopsy needle is inserted at an oblique angle to the probe, but within the plane of its field of view, so it can be visualised by the ultrasound image. Once it has been advanced to the region to be biopsied, the needle is triggered and withdrawn. It is then opened, and a scalpel blade can be used to liberate the sample gently into formalin. The biopsied area should be re-examined with ultrasound to ensure that no major haemorrhage has occurred. A small amount of self-limiting haemorrhage may be expected from vascular organs such as kidney and liver.

Risks
Risks include haemorrhage, dissemination of neoplasia or infection or rupture of a viscus. The reader is advised to consult specific texts on ultrasonography for more detail on this procedure.

Interpretation
Samples should be submitted for histopathological examination.

6.7 Cerebrospinal fluid (CSF) collection

Indications
Suspected central nervous system disease
- Infection
- Inflammation

Equipment
20–22 g spinal needle
Surgical scrub
Sterile collection pots

Technique
Two assistants will be need for this procedure.

Scalpel blade
Surgical scrub

Technique

Prior preparation
A coagulation profile is performed, including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time (BMBT).

Restraint
The animal is sedated or anaesthetised.

Procedure
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Interpretation
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Indications
Suspected central nervous system disease
- Infection
- Inflammation

Equipment
20–22 g spinal needle
Surgical scrub
Sterile collection pots

Technique
Two assistants will be need for this procedure.

Special precautions
Ideally, magnetic resonance imaging (MRI) of the brain is performed prior to CSF collection, to rule out the presence of raised intracranial pressure, which may lead to fatal cerebellar herniation on performing the tap. Raised intracranial pressure may be suspected clinically in the absence of brain imaging by a decreasing state of consciousness, head pressing, anisocoria and papilloedema.

Restraint
The animal is anaesthetised.

Procedure
The animal is placed in right lateral recumbency for a right-handed clinician. The atlanto-occipital area is clipped and surgically prepared. An assistant holds the animal's head so the nasal planum is at right angles to the neck, and parallel to the table, taking care that the endotracheal tube is not kinked.

The clinician palpates the occipital crest and the wings of the atlas. Under aseptic conditions, the needle is inserted through the skin in the dorsal midline at the level of the cranial border of the wings of the atlas. Once the skin has been penetrated, the stylet of the needle is removed. The needle is advanced very slowly, until cerebrospinal fluid is seen to flow into the hub. A popping sensation may be felt as the subarachnoid space is entered. If bone is encountered, the needle should be withdrawn and redirected. The stylet should be replaced before the needle is redirected if the needle is withdrawn from the skin.

Once cerebrospinal fluid is obtained, a second assistant should hold a collection pot beneath the hub of the needle, taking care not to touch the needle or the clinician, and the fluid is allowed to drop into the pot. One ml of CSF per 5 kg body weight can be collected safely.

Sample handling
The cells in cerebrospinal fluid are generally few in number and fragile. Centrifugation at normal speeds may cause cell rupture. Various techniques have been described for CSF cytology. One recommendation is to divide the sample into two: one sample is sent in a plain tube and one in a tube containing one drop of formalin. Alternatively, in-house preparations can be made using sedimentation chambers, constructed from the barrel of a syringe placed upright on a slide, secured in place with bulldog clips and sealed with vaseline or candle wax. Spare fluid, or supernatant, can be used for bacteriology, viral titres and PCRs.

Risks
Risks include iatrogenic damage to the spinal cord and cerebellar herniation.

Interpretation
The samples can be submitted for examination by a cytologist.

6.8 Bone marrow aspiration

Indications
Haematological diseases, e.g.
- Unexplained cytopenias

Special precautions
Ideally, magnetic resonance imaging (MRI) of the brain is performed prior to CSF collection, to rule out the presence of raised intracranial pressure, which may lead to fatal cerebellar herniation on performing the tap. Raised intracranial pressure may be suspected clinically in the absence of brain imaging by a decreasing state of consciousness, head pressing, anisocoria and papilloedema.

Restraint
The animal is anaesthetised.

Procedure
The animal is placed in right lateral recumbency for a right-handed clinician. The atlanto-occipital area is clipped and surgically prepared. An assistant holds the animal's head so the nasal planum is at right angles to the neck, and parallel to the table, taking care that the endotracheal tube is not kinked.

The clinician palpates the occipital crest and the wings of the atlas. Under aseptic conditions, the needle is inserted through the skin in the dorsal midline at the level of the cranial border of the wings of the atlas. Once the skin has been penetrated, the stylet of the needle is removed. The needle is advanced very slowly, until cerebrospinal fluid is seen to flow into the hub. A popping sensation may be felt as the subarachnoid space is entered. If bone is encountered, the needle should be withdrawn and redirected. The stylet should be replaced before the needle is redirected if the needle is withdrawn from the skin.

Once cerebrospinal fluid is obtained, a second assistant should hold a collection pot beneath the hub of the needle, taking care not to touch the needle or the clinician, and the fluid is allowed to drop into the pot. One ml of CSF per 5 kg body weight can be collected safely.

Sample handling
The cells in cerebrospinal fluid are generally few in number and fragile. Centrifugation at normal speeds may cause cell rupture. Various techniques have been described for CSF cytology. One recommendation is to divide the sample into two: one sample is sent in a plain tube and one in a tube containing one drop of formalin. Alternatively, in-house preparations can be made using sedimentation chambers, constructed from the barrel of a syringe placed upright on a slide, secured in place with bulldog clips and sealed with vaseline or candle wax. Spare fluid, or supernatant, can be used for bacteriology, viral titres and PCRs.

Risks
Risks include iatrogenic damage to the spinal cord and cerebellar herniation.

Interpretation
The samples can be submitted for examination by a cytologist.

6.8 Bone marrow aspiration

Indications
Haematological diseases, e.g.
- Unexplained cytopenias

- Thrombocytosis
- Leukocytosis
- Polycythaemia

Hypercalcaemia
Hypergammaglobulinaemia
Multifocal lytic bone lesions
Pyrexia of unknown origin

Equipment

Jamshidi biopsy needle (12 g for large dogs, 14 g for small dogs and cats)
Surgical scrub
10 ml syringe
Local anaesthetic
Scalpel handle and blade

Technique

Restraint
The animal is sedated or anaesthetised.

Procedure
Sites for aspiration and biopsy include the wing of the ilium, the proximal humerus and the greater trochanter of the femur.

The chosen site is clipped and aseptically prepared. Local anaesthetic is infiltrated into the skin and periosteum. A small stab incision is made through the skin at the site of the needle entry and the Jamshidi biopsy needle is advanced into the marrow cavity with a firm twisting motion. Immediately the needle is anchored in the cavity, the stylet is withdrawn, and the syringe attached. Bone marrow is aspirated with several firm suctions on the syringe plunger. The needle and syringe are then immediately removed, and the marrow is expelled onto slides.

Sample preparation
There are several techniques for preparing bone marrow aspirates for cytological examination, but in all cases rapid preparation and rapid air drying are vital, as the samples clot quickly and slow drying can lead to artefact. Techniques recommended include the blood-smear technique (*q.v.*) and the pull-away technique (*q.v.*). Another technique is to place a drop of aspirate at the top of a vertically placed slide, allowing the fluid to drain down the slide before making a squash preparation. If sufficient aspirate is obtained, a combination of preparations may be desirable.

Interpretation

After air drying, the samples can be submitted for staining and examination by a cytologist.

Differential Diagnosis in Small Animal Medicine
Alex Gough

6.9 Thoraco-, pericardio-, cysto- and abdominocentesis

6.9.1 Thoracocentesis

Indications

Presence or suspicion of pleural fluid or pneumothorax

- Diagnosis
- Therapy

Equipment

22–24 g butterfly needle
20 ml syringe
3-way tap
Sterile collection containers
Surgical scrub

Technique

Special precautions

A dyspnoeic animal should be stabilised with five minutes of oxygen therapy prior to any stressful handling or procedures.

Restraint

Sedation and/or local anaesthesia is provided where it is necessary and safe to do so.

Procedure

The animal is placed in sternal recumbency and, where possible, the thorax is clipped and surgically prepared from intercostal spaces 5–11.

The butterfly needle, 3 way tap and syringe are connected. For suspected fluid, the needle is inserted just cranial to the 8th rib at a point low on the chest wall. For suspected air, the needle is inserted just cranial to the 9th rib, about 1/3 of the way down the chest wall. Negative pressure is maintained on the syringe by an assistant, so that as soon as the pleura are punctured, air or fluid will be aspirated. Samples of fluid should be placed in sterile collection pots for cytology and culture.

Risks

There is a risk with this technique of iatrogenic laceration of the lungs, and once the presence of pleural effusion or pneumothorax is confirmed, it is usually safer to place a chest drain in order to remove significant amounts of fluid or air.

Interpretation

Cytological and bacteriological analysis will be helpful in differentiating neoplastic, infectious, cardiac and other causes of pleural effusion (*q.v.*).

6.9.2 Pericardiocentesis

Indications

Drainage of a pericardial effusion
- Diagnosis
- Therapy

Equipment

Chest drain
Pericardiocentesis catheter or 14–16 g intravenous catheter
20 ml syringe
3-way tap
Sterile collection containers
Lignocaine without adrenaline

Technique

Special precautions
Connect an ECG monitor and provide supplemental oxygen if necessary.

Restraint
Provide sedation if necessary, e.g. with acepromazine and pethidine.

Procedure
Clip and surgically prepare both sides of the thorax. Place the animal in left lateral recumbency. Infiltrate the 5th intercostal space approximately 2/3 of the way down the thorax with 1% lignocaine. Maintaining sterile conditions, place a 3-way tap and 30 ml syringe on the syringe adaptor end of the chest drain or pericardiocentesis catheter. Pulling the skin laterally prior to the procedure can help to seal the entrance wound once the procedure is finished.

Make a stab incision at the site of the local anaesthesia, through the skin and partially through the intercostal muscle. Have an assistant maintain negative pressure as you advance the catheter through the chest wall. The first fluid retrieved may be pleural effusion. This can be drained at this stage, but if the animal is in cardiogenic shock/tamponade, continuing on to drain the pericardial space is preferable, with the pleural effusion being drained after the pericardiocentesis.

Continue to advance the needle perpendicular to the pericardium until the pericardial sac is felt. This may feel like an increase in resistance, or often a scratching sensation is felt as the needle tip contacts the pericardium. Advance the needle through the pericardial sac. Ultrasound guidance is helpful at this stage, but performing the procedure blind is appropriate in emergency situations.

Monitor the ECG. Ventricular premature complexes (VPCs) or changes in the S-T segment commonly occur if the needle contacts the myocardium, and if this occurs the needle should be withdrawn. Lignocaine may occasionally be required for the treatment of ventricular dysrhythmias.

Aspirate fluid. Benign pericardial effusions are usually port wine colour. Advance the needle a further 5 mm, then advance the sheath into the pericardial space. Continue to aspirate. Pausing at this stage to assess whether the fluid being aspirated is clotting is useful to confirm the heart has not been tapped accidentally. Comparing the packed cell

volume of the effusion to that of the blood is also useful in case of doubt. Continue to aspirate until no further fluid can be retrieved. Withdraw the catheter.

The pleural space can be drained at this point if you have not previously done so. Suture the skin incision. Record the volume, colour and consistency of the fluid. Measure its PCV and submit to a cytologist for evidence of neoplasia.

Risks

Risks include puncturing the heart and causing arrhythmias.

Interpretation

Cytology and culture can be useful to assess for causes of the effusion. However, many tumours do not exfoliate, leading to false negatives on cytology. It has previously been suggested that pH can be useful to differentiate neoplastic from idiopathic effusions, but this test is too non-specific to be diagnostically useful. Echocardiography prior to drainage of the effusion is the best non-invasive way to diagnose pericardial tumours, although cardiac MRI may become more widely available in the future. Pericardial infections are rare in small animals.

6.9.3 Cystocentesis

Indications

Sampling for suspected urinary tract infection

Sampling for urinalysis

- Dipstick
- Specific gravity
- Sediment examination
- Cytology

Equipment

21 g–23 g needle

10 ml syringe

Sterile collection pots

Technique

Restraint

Sedation is not usually required except for fractious animals.

Procedure

The animal is placed in lateral or dorsal recumbency. The caudal ventral abdomen is clipped and surgically prepared. The bladder is palpated and digitally fixed in position. If the bladder is not palpable, then ultrasound guidance should be used.

The needle with syringe attached is angled caudally, at approximately 45°, and advanced into the bladder with a firm smooth motion. The puncture site should be 3–5 cm cranial to the trigone area. If the bladder apex is used as the puncture site, then the needle will come out of the bladder lumen as the bladder deflates.

Risks

Cystocentesis is generally a safe technique, provided the bladder can be palpated and fixed easily, and that the animal is not suffering from a bleeding disorder.

Interpretation

Provided aseptic precautions have been taken, growth of a pathogenic organism from a cystocentesis sample is indicative of urinary tract infection. This is not necessarily the case for catheterised and free-catch samples, which can be contaminated with bacteria from the skin, genital tract, gastrointestinal tract and environment.

6.9.4 Abdominocentesis/diagnostic peritoneal lavage

Indications

Evaluation of free peritoneal fluid
Diagnosis of suspected peritonitis

Equipment

Scalpel blade
Chest drain or peritoneal dialysis catheter
Warmed sterile isotonic saline
10 or 20 ml syringe
Surgical scrub

Technique

The ventral abdomen is clipped and surgically prepared. If a large quantity of abdominal fluid is suspected or diagnosed with ultrasonography, abdominocentesis alone is a sufficient diagnostic test. If only a small amount of fluid or a localised peritonitis is suspected, then diagnostic peritoneal lavage is preferable.

Abdominocentesis

For abdominocentesis, a 1.5 inch 21–23 g needle attached to a 10–20 ml syringe is inserted into the ventral abdomen, just to the right of the umbilicus, and fluid is aspirated. If no fluid is obtained, despite knowing or strongly suspecting its presence, the needle may have been entrapped by omentum, and placing the needle elsewhere may be productive. If several 'dry' taps are obtained, it should be definitively confirmed that fluid is present by ultrasound. If so, ultrasound guidance can be used to obtain a fluid sample.

Diagnostic peritoneal lavage

For diagnostic peritoneal lavage, local anaesthetic is infiltrated into the site of catheter placement and sedation may also be required in some cases.

A stab incision is made into the skin with the scalpel blade, and the catheter/chest drain is advanced into the abdomen. The stylet is removed, and the syringe attached. If a large amount of fluid can be aspirated, lavage is probably not required. If not, 20 ml/kg of warmed, sterile, isotonic saline is connected to the catheter by an intravenous giving set and instilled into the abdomen by gravity flow or pressure on the bag. The animal is gently rolled and the abdomen balloted. As much fluid as possible is then withdrawn, and placed in a sterile collection pot.

Risks

Risks are minimal, but include haemorrhage and accidental viscus penetration.

Interpretation

A *PCV* of lavaged fluid greater than 5% is suggestive of significant haemorrhage. *Cloudiness* suggests peritonitis. *Increased creatinine* may suggest urinary tract rupture and uroabdomen. *Increased bilirubin* may suggest biliary tract rupture and bile peritonitis. *Increased amylase* may suggest pancreatitis.

Samples should also be submitted for bacteriology and cytology.

6.10 Blood pressure measurement

6.10.1 Central venous pressure

Indications

Monitoring fluid therapy
- Where large volumes are being used, e.g. shock
- Where urine production is poor, e.g. acute oliguric or anuric renal failure

Monitoring critical care and poor-anaesthetic risk patients

Monitoring animals with heart failure

Equipment

16–18 g jugular catheter
3-way tap
1 m ruler
Intravenous giving set
Intravenous extension tubing
500 ml normal saline

Technique

The animal is placed in lateral recumbency. The skin over the jugular vein is clipped and surgically prepared.

Maintaining strict asepsis, the jugular catheter is placed and advanced to the third intercostal space, which is roughly the level of the right atrium. The catheter is sutured or taped securely in place, with the hub of the catheter at the base of the ear. The 3-way tap is attached to the catheter, and the intravenous giving set, with bag of fluid, is connected to one of the 3-way tap ports, first ensuring that all the air has been flushed out of the tubing.

The extension tubing is attached to the last of the 3-way tap ports, taped vertically to a pole, and left with its upper end open, to create a manometer. The ruler is placed next to it, with the 0 mark at the midpoint of the trachea at the thoracic inlet. The stopcock on the 3-way tap is turned to connect the manometer to the saline bag, so that saline runs into the manometer to a level of 15 cm. The stopcock is then turned so the manometer is connected to the jugular catheter. The fluid in the manometer will then fall until it reflects the central venous pressure, measured in cm of water.

The jugular catheter can remain in place, and can be used for fluid administration, and administration of drugs for which central venous administration is recommended. Regular flushing with heparinised saline helps to maintain patency.

Risks

Risks are minimal.

Interpretation

A *PCV* of lavaged fluid greater than 5% is suggestive of significant haemorrhage. *Cloudiness* suggests peritonitis. *Increased creatinine* may suggest urinary tract rupture and uroabdomen. *Increased bilirubin* may suggest biliary tract rupture and bile peritonitis. *Increased amylase* may suggest pancreatitis.

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The jugular catheter can remain in place, and can be used for fluid administration, and administration of drugs for which central venous administration is recommended. Regular flushing with heparinised saline helps to maintain patency.

Risks

Risks are minimal.

Interpretation

Central venous pressure that is greater than 10 cm of water is abnormally elevated e.g. by overzealous fluid administration. Measurements over 15 cm of water may be seen in congestive heart failure.

6.10.2 Indirect blood pressure measurement by Doppler technique

Indications

Screening for hypertension in associated diseases (*q.v.*)
Assessing degree of hypotension
- Shock
- General anaesthesia
- Other associated conditions (*q.v.*)

Assessing success of treatment of hypertension or hypotension

Equipment

Doppler ultrasound unit
Ultrasound gel
Sphygmomanometer with various cuff sizes
Tape

Technique

Prior preparation

The animal is left to acclimatise to its surroundings for as long as possible. It is vital it is kept in as stress free an environment as possible, and that it is handled calmly and gently.

Procedure

Arteries that are suitable to detect with the Doppler ultrasound unit are the digital artery of any foot or the coccygeal artery. The pulse is palpated and the area of skin over it is clipped. In some sparsely haired animals, wetting down with spirit may be sufficient. This reduces the stress associated with the procedure and hence reduces false positive diagnosis of hypertension.

A cuff of the appropriate width (approximately 40% of the circumference of the selected limb), is placed proximally on the limb and inflated several times to ensure a secure and comfortable fit, and to ensure that there are no leaks in the cuff.

The selected limb is raised or lowered to heart level to prevent artefactual reductions or elevations in the readings. Ultrasound gel is applied to the probe. The probe is applied gently to the pulse and moved to obtain a good signal. The use of headphones can help reduce stress to the animal.

Once the pulse has been detected by the ultrasound unit, the probe is taped or held in place. The cuff is inflated until the signal is lost, then slowly deflated. The reading at which the signal is first re-obtained is the systolic blood pressure. Five readings should be obtained, the highest and lowest discarded and a mean taken of the other three.

Interpretation

Systolic blood pressure values greater than 180 mmHg are suggestive of systemic hypertension, provided the animal is not unduly stressed. Serial measurements and retinal examinations are recommended to confirm the presence of hypertension.

6.11 Dynamic testing

6.11.1 ACTH stimulation test

Indications

Diagnosis of suspected hypo- or hyperadrenocorticism
Monitor response to therapy of hyperadrenocorticism
Differentiate iatrogenic from naturally occurring hyperadrenocorticism

Equipment

ACTH
Needle and syringe
Plain blood tubes

Technique

Prior preparation

Withhold glucocorticoids for at least 24 hours prior to this test to avoid cross-reaction. Note however, that glucocorticoid administration in the previous two weeks, even topically, can suppress the pituitary–adrenal axis.

Procedure

Collect 3 ml of plasma or serum and label the tubes with the time. Inject ACTH (e.g. Synacthen) intravenously, 250 µg for most dogs, 125 µg for dogs weighing less than 5 kg and cats. In dogs, 3 ml of plasma or serum are collected 120 minutes after administration of the ACTH. In cats, samples are collected 60 and 180 minutes after administration of the ACTH. The tubes are again labelled with the time. The plasma or serum is separated, and submitted for cortisol assay.

Note: Different laboratories recommend different protocols regarding timing of samples. Check with your laboratory for their preferred protocol.

Interpretation

In hyperadrenocorticism, post-ACTH administration cortisol levels greater than 600 nmol/l are expected. In hypoadrenocorticism, pre- and post-ACTH administration cortisol levels should be less than 15 mmol/l.

False positives for hyperadrenocorticism commonly occur in the presence of non-adrenal illness. The test is 85% sensitive for pituitary-dependent hyperadrenocorticism and 50% sensitive for adrenal-dependent hyperadrenocorticism. The test is highly specific and sensitive for hypoadrenocorticism. ACTH stimulation results should be interpreted in the light of other clinical findings before making a definitive diagnosis of hyperadrenocorticism.

Interpretation
Systolic blood pressure values greater than 180 mmHg are suggestive of systemic hypertension, provided the animal is not unduly stressed. Serial measurements and retinal examinations are recommended to confirm the presence of hypertension.

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Indications
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Monitor response to therapy of hyperadrenocorticism
Differentiate iatrogenic from naturally occurring hyperadrenocorticism

Equipment
ACTH
Needle and syringe
Plain blood tubes

Technique
Prior preparation
Withhold glucocorticoids for at least 24 hours prior to this test to avoid cross-reaction. Note however, that glucocorticoid administration in the previous two weeks, even topically, can suppress the pituitary–adrenal axis.

Procedure
Collect 3 ml of plasma or serum and label the tubes with the time. Inject ACTH (e.g. Synacthen) intravenously, 250 µg for most dogs, 125 µg for dogs weighing less than 5 kg and cats. In dogs, 3 ml of plasma or serum are collected 120 minutes after administration of the ACTH. In cats, samples are collected 60 and 180 minutes after administration of the ACTH. The tubes are again labelled with the time. The plasma or serum is separated, and submitted for cortisol assay.

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6.11.2 Low-dose dexamethasone suppression test (LDDST)

Indication
Screening for suspected hyperadrenocorticism

Equipment
Dexamethasone
Plain blood tubes
Needle and syringe

Technique
A basal sample of 3 ml of plasma or serum is collected and labelled with the time. Dexamethasone is injected intravenously: 0.01 mg/kg for dogs; 0.1 mg/kg for cats. Blood samples are collected at 4 and 8 hours post administration, and labelled with the time. All samples are then submitted for cortisol assay.

Interpretation
The LDDST has a high sensitivity in dogs for both pituitary- and adrenal-dependent hyperadrenocorticism. As with the ACTH stimulation test, false positives can occur in non-adrenal illness. A cortisol concentration at 8 hours post dexamethasone administration of greater than 40 nmol/l is suggestive of hyperadrenocorticism. A cortisol concentration at 4 or 8 hours that declines by more than 50% from the pre-dexamethasone-administration level, combined with failure to suppress at 8 hours, is suggestive of pituitary-dependent hyperadrenocorticism.

6.11.3 Bile acid stimulation test

Indication
Assessment of liver function

Equipment
Plain blood sample tubes
Sunflower oil and dog or cat food
Needle and syringe

Technique

Prior preparation
The animal is fasted for 12 hours.

Procedure
A base level sample of 3 ml of serum is obtained, the tubes labelled with the time and the animal is fed a fatty meal to stimulate gall bladder contraction. The addition of sunflower oil to tinned pet food will usually provide adequate stimulation. Another 3 ml of serum are obtained 2 hours after feeding and the tubes labelled with the time. The tubes are then submitted for bile acid assay.

Interpretation

Normal values for the post-prandial sample in dogs and cats are 0–15 µmol/l. Values over 30 µmol/l are more consistent with hepatic dysfunction.

Bile acids are also elevated where there is hepatocellular disease (primary or secondary) or portosystemic shunting (acquired or congenital). Elevations due to secondary hepatic disease are usually mild, whereas elevations due to liver failure and portosystemic shunting are usually marked.

Bile acids will be elevated in icteric animals, and in these cases do not provide information on hepatic function.

6.12 Haematological techniques

6.12.1 In saline autoagglutination test

Indication

Suspected immune-mediated haemolytic anaemia

Equipment

Glass slide
Isotonic saline
Blood sample in EDTA

Technique

One drop of blood is placed in the middle of a clean glass slide and one drop of saline is added. The blood and saline are mixed by rocking the slide in a circular motion.

Interpretation

Addition of saline to a drop of blood interferes with rouleaux formation (which is normal) grossly and microscopically, but does not disrupt clumping caused by autoagglutination. (Rouleaux are chains of red blood cells resembling stacks of coins.) Clumping macroscopically is suggestive of autoagglutination. Examination under the microscope confirms that the clumping is not due to rouleaux formation.

6.12.2 Preparation of a blood smear

Indications

A blood smear should be examined whenever a blood sample is taken for a full blood count:

Confirmation of haematological values from automated counting equipment
Assess red and white cell morphology
Assess presence of circulating neoplastic cells

Equipment

Two glass slides
EDTA anticoagulated blood

Interpretation

Normal values for the post-prandial sample in dogs and cats are 0–15 µmol/l. Values over 30 µmol/l are more consistent with hepatic dysfunction.

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Confirmation of haematological values from automated counting equipment
Assess red and white cell morphology
Assess presence of circulating neoplastic cells

Equipment

Two glass slides
EDTA anticoagulated blood

Technique

The corner of one glass slide is broken off after pre-scoring with a glass cutter, to create a spreader slide.

A small drop of EDTA anticoagulated blood is placed near one end of the slide. The spreader slide is placed on the other slide in front of the drop at an angle of 20–40°. The spreader slide is slid backwards until it just touches the drop of blood. The blood spreads along the edge of the spreader slide, but as the spreader slide is narrower than the sample slide, it will not go over the edge. The spreader slide is advanced briskly and smoothly, leaving a smear with a feathered edge. The smear is rapidly air dried. If it is to be examined in the clinic, it should be stained, for example with one of the rapid staining kits available.

Interpretation

The feathered edge should be examined with the 100 × oil immersion objective lens. White cell and red cell *morphology* should be assessed, *platelet count* subjectively evaluated and a *differential white cell* count performed. At least 100 white cells should be counted, and the percentages of neutrophils, lymphocytes, monocytes, eosinophils and basophils should be calculated. Note that platelets tend to clump towards the feathered edge of the smear.

6.12.3 Buccal mucosal bleeding time (see Plate 6.12 in colour plate section)

Indications

Assessment of primary haemostasis

- Animals with suspected thrombocytopenia or thrombocytopathia
- Animals with unexplained bleeding disorders
- Pre-operative assessment for animals undergoing surgery
  - Conditions that may predispose to bleeding disorders
  - Breeds predisposed to von Willebrand's disease

Equipment

Bleeding time device, e.g. Simplate II
Stopwatch
Filter paper
Gauze bandage

Note: A scalpel blade can be used instead of the specific bleeding time device, but deeper-than-standard cuts may lead to overestimation of the bleeding time and shallower cuts may lead to underestimation.

Technique

Restraint

Sedation may be required in fractious animals.

Procedure

The animal is placed in lateral recumbency. The lateral part of the maxillary lip is reflected upwards and tied with bandage to produce moderate venous engorgement.

The bleeding time device is placed over an area of buccal mucosa that appears free of superficial vessels. The device is triggered, and a stopwatch started. The device produces two parallel cuts, of a standard size and depth, into the mucosa, triggering bleeding. Blood is blotted from *beneath* the cuts with the filter paper, taking care not to touch the incisions, thereby dislodging a forming clot. The time taken for bleeding to stop is recorded.

Interpretation

Normal times for dogs are 1.4–3.5 minutes, and for cats 1.5–2.5 minutes.

6.12.4 Arterial blood sampling

Indications

Arterial blood gas analysis
Assessment of acid–base status

Equipment

23 g needle
Pre-heparinised 1–2 ml syringe
Surgical scrub

Technique

The femoral artery can be used in dogs and cats, or the dorsal pedal or metatarsal arteries in dogs.

The area over the chosen artery is clipped and surgically prepared. The skin is stretched and the artery palpated. A 23 g needle with pre-heparinised 1–2 ml syringe attached is advanced into the artery with the bevel up. After the sample is obtained, pressure is applied to the artery with a sterile swab for 3–5 minutes.

If the sample is not to be used for immediate analysis, the needle end should be sealed with a rubber stop, and the sample packed in ice.

Interpretation

See Section 4.3 for blood gas and acid–base differentials.

6.13 Water deprivation test

Indications

Differentiation between:

Diabetes insipidus
- Central
- Nephrogenic

Psychogenic polydipsia

The test is contraindicated in known or suspected renal disease, and should only be performed after a thorough investigation of other causes of polyuria and polydipsia *(q.v.)*. If the animal is already clinically dehydrated, with a low urine specific gravity, then it has already proven unable to concentrate its urine and the test is unnecessary.

The bleeding time device is placed over an area of buccal mucosa that appears free of superficial vessels. The device is triggered, and a stopwatch started. The device produces two parallel cuts, of a standard size and depth, into the mucosa, triggering bleeding. Blood is blotted from *beneath* the cuts with the filter paper, taking care not to touch the incisions, thereby dislodging a forming clot. The time taken for bleeding to stop is recorded.

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Equipment

Refractometer
Scales
Urinary catheter
Desmopressin
Needle and syringe

Technique

Prior preparation

Water should be restricted gradually over the three days prior to the procedure (in order to prevent medullary washout from influencing the test) to 120 ml/kg, 90 ml/kg and 60 ml/kg on days –3, –2, and –1 respectively. Food is withheld from the night before, and water is withheld from the starting time of the test.

Procedure

The bladder is catheterised and emptied and the urine specific gravity is recorded. A blood sample is taken to check urea, creatinine and electrolytes. The patient is accurately weighed. The following measurements are made every 60 minutes: urine samples are taken and tested for specific gravity; blood samples are taken and tested for urea, creatinine and electrolytes; the animal is observed for signs of depression and dehydration. Measurement of serum osmolality is useful if available.

The test should be ended if urine specific gravity exceeds 1.030 or the animal shows signs of clinical dehydration or illness. If the animal loses greater than 5% of its body weight without showing a urine specific gravity greater than 1.030, a blood sample can be obtained for vasopressin concentration.

Aqueous desmopressin is then given at a dose of 2–5 units intramuscularly. Urine samples for specific gravity and blood samples for urea, creatinine and electrolytes are taken every 15–30 minutes for up to 2 hours or until the urine concentrates.

Once the test has finished, introduce small amounts of water every 30 minutes for 2 hours and monitor for vomiting, dehydration and depression. If the animal is well after 2 hours, it can be returned to ad lib water.

Risks

Dehydration and its consequences are risks for this test, but if the patient has previously been worked up correctly for polyuria and polydipsia, and hydration is monitored closely during the procedure, risks are low.

Interpretation

If a urine concentration of >1.035 is obtained prior to desmopressin administration, central or nephrogenic diabetes insipidus can be ruled out, and, assuming a thorough pre-procedure work up, the likely diagnosis is psychogenic polydipsia. A urine concentration of >1.030 prior to desmopressin administration is also likely to be consistent with psychogenic polydipsia, although partial diabetes insipidus is possible.

If the animal becomes 5% dehydrated without concentrating the urine to >1.030, then diabetes insipidus is likely. If urine specific gravity of >1.030 is achieved only after desmopressin administration, then central diabetes insipidus is likely. If urine specific gravity of >1.030 is not achieved despite desmopressin administration, then primary nephrogenic diabetes insipidus is likely. This result will also be seen with conditions such

as hyperadrenocorticism, medullary washout and renal dysfunction, but these conditions should have been ruled out prior to commencing the test.

6.14 Serial blood glucose curve

Indications

Investigation of causes of apparent insulin resistance in diabetes mellitus
Determination of correct timing and dosage of insulin

Equipment

Glucometer or point-of-care blood glucose analyser
Needle and syringe

Technique

Insulin is administered at the normal dose, and the animal follows its normal schedule of feeding. Blood samples are taken hourly, and the glucose concentration recorded on a chart and/or graph. If the animal receives insulin twice daily, the test should be continued for 12 hours. If the animal is dosed once daily, then ideally the test should be continued for 24 hours. The glucose curve can be generated by the owner at home with a portable glucometer, using the ear prick technique to obtain blood samples. This has the advantage of replicating the animal's normal daily routine.

Interpretation

Value of glucose curves

Note that a recent study showed significant variation in the findings of glucose curves on subsequent days in the same animals, casting doubt on the utility of glucose curves for determining the correct dosage of insulin. They are, however, important for: ruling out Somogyi overswing as a cause of apparent insulin resistance; assessing whether there is any significant response to insulin; assessing the duration of action of the administered insulin.

Specific interpretation of results

- If hypoglycaemia, or a rapid decrease in glucose level, is followed by a rapid elevation of glucose level, then insulin overdosage leading to Somogyi overswing is likely.
- If the duration of action of the insulin is less than 10 hours, then dosing three times daily or using a longer-acting insulin should be considered.
- If the duration of action is over 14 hours, then once daily dosing or a shorter-acting insulin should be considered.
- If the insulin did not significantly affect the glucose concentration, and the dosage is more than 1–2 IU/kg, then consideration should be given to finding a cause of true or apparent insulin resistance.

Reference

Fleedman, L. M. & Rand, J. S. (2003). Evaluation of day-to-day variability of serial blood glucose concentration curves in diabetic dogs. *JAVMA*, **222**: 317–21.

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Differential Diagnosis in Small Animal Medicine
Alex Gough

6.15 Skin scraping

Indications

Diagnosis of suspected mite infections e.g.

- Pyoderma
- Scaling
- Follicular disorders

Equipment

Liquid paraffin
Scalpel blade
Clean glass slides

Technique

Demodex mites

A drop of liquid paraffin is placed on the skin in the region of a new lesion. The skin is squeezed to extrude mites from the hair follicles. The skin is scraped with the scalpel blade until capillary bleeding is seen.

Sarcoptes mites

S*arcoptes* mites are much harder to find than *Demodex* mites. Multiple scrapings are necessary. Emphasis should be placed on the predilection sites of the pinnal margins and the elbows. More scrapings increase the chances of a positive result, with 15 scrapings being recommended by some dermatologists.

Interpretation

The slides are examined under the microscope using the low power lens.

Reference

Rosenkrantz (2002) Ten common pitfalls in dermatology–Part I. *Proceedings, Western Veterinary Conference, 2002.*

6.16 Schirmer tear test

Indications

Assessment of tear production

Equipment

Stopwatch
Schirmer tear test paper strips

Technique

The paper strip is folded at the level of the notch to an angle of 90°, and the folded part is placed beneath the lower eyelid. The number of millimetres the tear film has advanced down the strip after one minute is recorded.

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Interpretation
Readings of less than 15 mm may be indicative of reduced tear secretion.

6.17 Nasal flush cytology/nasal biopsy

Indications
Investigation of chronic nasal discharge or sneezing

Equipment
Moistened gauze swabs
Collection pots
Sterile saline
60 ml syringe
10F polyethylene catheter or protective outer sheath of an intravenous catheter

Nasal flush

Restraint
The animal is anaesthetised, an endotracheal tube is placed and the cuff inflated.

Procedure
The table is tilted so the animal's head is downwards. Two gauze swabs are placed at the back of the pharynx behind the soft palate. A 10F catheter is inserted into the nose. The saline is forcefully injected into the catheter, then suction is applied. Fluid is collected into sterile pots.

The gauze swabs are removed, and impression or squash smears of any dislodged material are made.

Nasal biopsy

Prior preparation
Prior to nasal biopsy, it is sensible to take a coagulation profile including haematology, platelet count, partial thromboplastin time (PTT), prothrombin time (PT) and a buccal mucosal bleeding time.

Procedure
Nasal biopsy may be performed subsequent to a nasal flush. The 10F polyethylene catheter or protective outer sheath of an intravenous catheter is cut at an angle to produce a sharp bevelled point. If a mass has been identified on endoscopy, radiography or MRI, then the catheter is advanced to the level of the mass. Otherwise it is first measured from the external nares so it is just short of the medial canthus of the eye, to avoid penetrating the cribriform plate. A syringe is attached and forcefully suctioned. Samples obtained can be made into squash preparations or placed in formalin.

Risks
Risks include haemorrhage, aspiration of flush fluids and accidental penetration of the cribriform plate.

Interpretation
Samples from both techniques can be submitted for cytological, histological and bacteriological examination.

Interpretation
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Interpretation
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Differential Diagnosis in Small Animal Medicine
Alex Gough

6.18 Contrast radiography

6.18.1 Barium meal/swallow

Indications

Suspected oesophageal disease
Suspected functional or mechanical upper gastrointestinal (GI) obstruction

Equipment

Barium suspension
- 60% for oesophagogram
- 20% for upper GI series

Technique

Prior preparation
The animal's coat should be free of dirt and foreign material. Survey abdominal and thoracic radiographs are taken first, if this has not already been done.

Restraint
Sedatives are best avoided, as they can alter intestinal transit times and delay gastric emptying. If necessary, a low dose of acepromazine can be given for dogs, or diazepam/ketamine for cats, with minimal effects on motility.

Oesophagogram
For an oesophagogram (barium swallow), the barium should be thick and pasty.

The patient is positioned for radiography, and a tablespoonful of barium is given by mouth. The exposure is made after the animal takes its second swallow. If megaoesophagus is diagnosed, the animals are monitored closely and kept upright following the procedure to avoid aspiration.

Upper GI tract
For an upper GI series, the animal is fasted for 12–24 hours prior to the procedure.

A colonic enema is given 2–4 hours before the study is to be started. A 20% suspension of barium suspension is given by mouth or by stomach tube at a dose of 10 ml/kg. Right lateral and ventrodorsal radiographs are taken at 0, 5, 15, 30 and 60 minutes, then hourly until the end of the study. The study is terminated when the stomach is empty of barium (the gastric emptying time) and the leading edge has reached the colon (the intestinal transit time).

Interpretation

For an oesophagogram, the oesophagus is evaluated for dilation, strictures and luminal or mucosal filling defects.

For an upper GI series, the radiographs are examined for luminal or mucosal filling defects or evidence of obstruction. A significant amount of barium remaining in the stomach after two hours for cats and four hours for dogs is suggestive of delayed gastric emptying. Contrast has usually reached the large intestine by 3–5 hours after administration.

Risk
The use of barium suspension is contra-indicated where intestinal perforation is suspected, and there is a risk of inhalation of contrast in the presence of a megaoesophagus.

6.18.2 Intravenous urography

Indications
To ascertain or confirm the presence, size and shape of the kidneys
To provide information about the internal renal architecture
To provide information on the patency and location of the ureters

Equipment
N*ote*: Non-ionic contrast agents are recommended in the presence of significant renal compromise.
Iodine-based contrast agent
Needle and syringe

Technique
Prior preparation
The patient is fasted for 12 hours. The animal's fluid intake is limited in the 12 hours prior to radiography if it is safe to do so. However, it is important that the animal is adequately hydrated prior to administering intravenous contrast medium.

A high colonic enema is administered at least two hours prior to the procedure. If there is dirt or debris on the animal's coat it is cleaned or bathed. The animal's bladder is emptied immediately prior to the procedure.

If plain survey radiographs have not already been taken, they should be taken now.

Restraint
The patient is anaesthetised and an intravenous catheter is placed into a peripheral vein. The animal is positioned in dorsal recumbency, prepared for a ventrodorsal (VD) radiograph.

High concentration, low volume (bolus)
An iodine preparation with a concentration of 300–400 mg/ml is used, at a dose rate of 850 mg iodine/kg. The dose rate should be doubled in the presence of significant azotaemia. Warming the iodine to blood temperature assists with rapid administration.

The iodine is injected rapidly via the intravenous catheter. A VD radiograph is taken immediately injection has finished, and VD and lateral radiographs are taken at 1, 3, 5, 10, 20 and 40 minutes post injection.

Low concentration, high volume (infusion)
This technique may give superior visualisation of the ureters.

An iodine preparation with a concentration of 150 mg/ml is used, at a dose rate of 1200 mg iodine/kg. The dose rate should be doubled in the presence of significant azotaemia. The iodine is injected slowly over 5–10 minutes. Radiographs are taken as required.

Risks
Risks are minimal, but include risks due to anaesthesia, radiography and reactions to the intravenous contrast agent.

Interpretation
Four phases are seen: the *arteriogram*, the *nephrogram*, the *pyelogram* and the *cystogram*. The arteriogram demonstrates renal blood flow, the nephrogram is used to evaluate the renal parenchyma, the pyelogram evaluates the urinary collecting system and ureters and the cystogram outlines the bladder (although other techniques are preferable for examining the bladder – see Section 6.18.3 below).

Note: The arteriogram and nephrogram phases are not seen with the low concentration high volume technique.

6.18.3 Contrast cystography

Indication
To examine the lower urinary tract
- Vagina/penis
- Urethra
- Bladder
- Distal ureters

Equipment
Foley catheter
Urinary catheter
Water soluble (iodine-based) contrast medium
50 ml syringe
3-way tap
KY jelly
Bowel clamps

Technique
Patient preparation
The patient is fasted for 12 hours.

A high colonic enema is administered at least 2 hours prior to the procedure, and if there is dirt or debris on the animal's coat it is cleaned or bathed. The animal's bladder is emptied immediately prior to the procedure.

If plain survey radiographs have not already been taken, they should be taken now.

Restraint
The patient is anaesthetised or sedated.

Pneumocystography
The bladder is catheterised and completely drained. Air is injected into the urinary catheter slowly using the syringe and 3-way tap. The abdomen is palpated periodically and air injection is stopped when the bladder becomes turgid or back pressure is felt on the syringe. The total amount injected is usually 4–10 ml/kg. Ventrodorsal and lateral radiographs are taken.

There is a theoretical risk of causing an air embolus with this technique, and carbon dioxide can be used instead of air to avoid this.

Positive contrast cystography
The bladder is catheterised and completely drained. Water-soluble iodine contrast medium, with a concentration of 150–200 mg iodine/ml (higher concentration preparations can be diluted with saline) is injected, using a syringe and 3-way tap. The abdomen is palpated periodically, and injection is stopped when the bladder becomes turgid or back pressure is felt on the syringe. The total amount injected is usually 4–10 ml/kg. Ventrodorsal and lateral radiographs are taken.

Double contrast cystography
The bladder is catheterised and completely drained. A small amount of water-soluble iodine contrast medium (2–20 ml, depending on the size of the animal), with a concentration of 150–200 mg iodine/ml (higher concentration preparations can be diluted with saline) is injected, using a syringe and 3-way tap. The abdomen is massaged and/or the animal rolled to distribute the contrast medium.

Air is then injected via the syringe and 3 way tap. The abdomen is palpated periodically, and injection is stopped when the bladder becomes turgid or back pressure is felt on the syringe. The total amount of air injected is usually 4–10 ml/kg. Ventrodorsal and lateral radiographs are taken.

Retrograde urethrography (males)
A pneumocystogram is first performed to provide back pressure, which will distend the urethra. The urethra is catheterised with the widest possible urinary catheter. The tip is advanced so that it is distal to the area under investigation, or to the distal end of the os penis. A contrast agent is prepared consisting of 150–200 mg iodine/ml, diluted 1 : 1 with sterile lubricating jelly. The sheath is held tightly around the catheter, and 1 ml/kg of the prepared contrast medium is injected, using a syringe and 3-way tap. Lateral and slightly oblique VD radiographs are taken immediately after injection.

Retrograde vaginourethrography (females)
A pneumocystogram is first performed to provide back pressure, which will distend the urethra. The end of a Foley catheter is cut off beyond the inflatable bulb and the catheter is inserted just beyond the vulval lips. The vulva is closed around the catheter using bowel clamps and the bulb is inflated. Water-soluble iodine contrast medium, with a concentration of 150–200 mg iodine/ml (higher concentration preparations can be diluted with saline) is injected gently over 5–10 seconds, at a dose of 1 ml/kg, using a syringe and 3-way tap. Lateral and slightly oblique VD radiographs are taken immediately.

Risks
Risks are minimal, but include introduction of infection and a theoretical risk of air embolus.

Interpretation
- Pneumocystography (negative contrast) is used to identify the position of the bladder.
- Positive contrast cystography is used to identify bladder ruptures.
- Double contrast cystography is useful in identification of calculi and mucosal lesions.

- Retrograde urethrography or vaginourethrography is used to assess vaginal and urethral lesions.

6.18.4 Myelography

Indications

Investigation of suspected spinal disease

Equipment

Non-ionic intravenous contrast medium
22 g spinal needle
Surgical scrub
Sterile collection pots
Diazepam

Technique

Restraint

The animal is anaesthetized.

Procedure

Survey spinal radiographs are taken, if this has not already been done.

For *cisternal myelography*, the animal is then placed in right lateral recumbency, for a right handed clinician. The atlanto-occipital area is clipped and surgically prepared. An assistant holds the animal's head so the nasal planum is at right angles to the neck, and parallel to the table, taking care that the endotracheal tube is not kinked.

The clinician palpates the occipital crest and the wings of the atlas. Under aseptic conditions, the needle is inserted through the skin in the dorsal midline at the level of the cranial border of the wings of the atlas. Once the skin has been penetrated, the stylet of the needle is removed and the needle is advanced very slowly, until cerebrospinal fluid is seen to flow into the hub. A popping sensation may be felt as the subarachnoid space is entered. If bone is encountered, the needle should be withdrawn and redirected. The stylet should be replaced before the needle is redirected if the needle is withdrawn from the skin.

For *lumbar myelography*, L4–5 or L5–6 can be used. Lumbar myelography is safer than cisternal myelography and may be superior at delineating severe compressive lesions, but is technically harder.

CSF is collected for analysis as described in Section 6.7. A test injection of a small amount (0.5 to 1.0 ml) of the contrast medium may be given and a radiograph taken to ensure the contrast is in the subarachnoid space, if there is any doubt of this. For a full spinal study, 0.3 to 0.5 ml/kg of a 240 mg/ml iodine preparation is injected. The contrast is injected slowly over several minutes.

Lateral and VD radiographs are taken as soon as possible after the injection has finished. It may be necessary to take oblique, contralateral and dynamic views (eg traction) to provide as much detail as possible. Tilting the animal may help pool the contrast medium in an area of interest if filling is inadequate. However, care should be taken to keep the head elevated to avoid contrast medium entering the brain.

Following the procedure, the animal should be observed carefully for evidence of fitting while it recovers, and diazepam should be readily available.

Interpretation
Four basic myelographic patterns seen. A normal pattern shows the contrast flowing in uninterrupted columns. Abnormal patterns are extradural, intradural/extramedullary and intramedullary.

6.19 Contrast echocardiography

Indications
Detection of a right-to-left cardiac shunt
- Intracardiac
- Extracardiac

Equipment
0.9% saline or a colloid
2 × 5 ml syringes
3-way tap
Intravenous catheter

Technique
An intravenous catheter is placed in a peripheral vein.

The medium that will bear the bubbles that provide the positive contrast can be saline, a colloid, 5% dextrose or saline mixed with a small amount of the patient's own blood.

The two syringes, one containing 3 ml of the medium and the other containing 1 ml of air, are connected to each other via the 3-way tap. The medium is then passed rapidly from one syringe to the other several times, producing a solution containing microbubbles.

A right parasternal long axis view of the heart is obtained by echocardiography. The medium is then injected (although any superficial froth, should *not* be injected) into the intravenous catheter, and the passage of contrast in the right heart, and any presence of contrast in the left heart, is observed.

The procedure is then repeated, but the descending aorta (best imaged dorsal to the bladder) is examined at the time of injection.

Interpretation
In a normal heart, the lungs remove the microbubbles, so contrast is seen only in the right heart and not the left. In a right-to-left intracardiac shunt, such as a ventricular septal defect, contrast bypasses the lungs and is seen in the left heart. If contrast is not seen in the left heart but is present in the descending aorta, an extracardiac shunt such as a patent ductus arteriosus, is suspected.

6.20 Cranial nerve (CN) examination

Indication
To assist in neurolocalisation of suspected intracranial disease

Equipment
Bright light source
Haemostats

Interpretation

Four basic myelographic patterns seen. A normal pattern shows the contrast flowing in uninterrupted columns. Abnormal patterns are extradural, intradural/extramedullary and intramedullary.

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6.20 Cranial nerve (CN) examination

Indication

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Equipment

Bright light source
Haemostats

Tests

Smelling non-irritant substance (CN I)
The animal is blindfolded or its vision obscured with a hand, and a strong-smelling substance such as food is placed near the nose. The animal is observed for sniffing movements. Note that an irritant substance may stimulate the nasal mucosal sensation, which is mediated by CN V.

Pupil size/anisocoria (retina, CNs II, III)
The sizes of the pupils and any difference between them are noted.

Pupillary light reflex (CNs II, III, sympathetic, retina)
The animal is placed in a darkened room and allowed to acclimatise. A bright light is then shone into one eye and the response of both pupils observed. This is repeated with the other eye.

Menace (retina, CNs II, VII, forebrain, cerebellum)
One eye is covered and a threatening movement is made towards the other eye. Care should be taken to avoid causing a draught which might stimulate the corneal reflex. The blink response is observed. The test is then repeated for the other eye.

Corneal reflex (CNs V, VI, VII)
Taking care not to touch the eyelids, the cornea is touched with a moistened cotton bud. The globe should retract and the third eyelid come across the eye.

Throw cotton wool (CN II)
Cotton wool balls should be thrown in front of the patient. A normal animal will follow their motion with head or eye movements. An assistant or a blindfold can cover one eye to test the vision of each eye individually.

Auditory response (CN VIII)
A loud clap or whistle from outside the animal's visual field is performed. The animal should start or look round.

Strabismus (permanent: CNs III, IV, VI; temporary: CN VIII)
Deviation of one or both eyes may indicate a deficit in one of the above cranial nerves.

Spontaneous nystagmus (horizontal, vertical, rotatory)
The eyes of the animal are observed for a drifting motion, while the head is in a neutral position. The direction of the fast phase is recorded.

Positional nystagmus (CNs III, VIII)
Placing the head in different positions, e.g. tilting it vertically, or placing the animal in dorsal recumbency, may elicit a nystagmus.

Oculovestibular reflex (CNs III, IV, VI, VIII)
Moving the head laterally left and right should elicit a nystagmus with the fast phase in the direction of the head's rotation.

Facial sensation, nasal stimulation (CN V, forebrain)
The eyes are covered by a hand or blindfolded and a blunt probe, such as a haemostat is used to touch the nasal mucosa. A normal animal will withdraw its head. Pinching the upper lip with haemostats will lead to a CN-VII-mediated facial twitch or lip curl.

Facial paralysis (CN VII)
Drooping of and inability to move the ear and lip, a widened palpebral fissure, absent blinking, absent abduction of the nostril during inspiration and deviation of the nose towards the normal side are consistent with motor dysfunction of CN VII.

Masticatory muscle atrophy (CN V)
The masticatory muscles are observed and palpated for atrophy and asymmetry.

Palpebral (CNs V, VII)
The medial and lateral canthus of each eye is touched lightly with a finger. A blink reflex is seen in a normal animal.

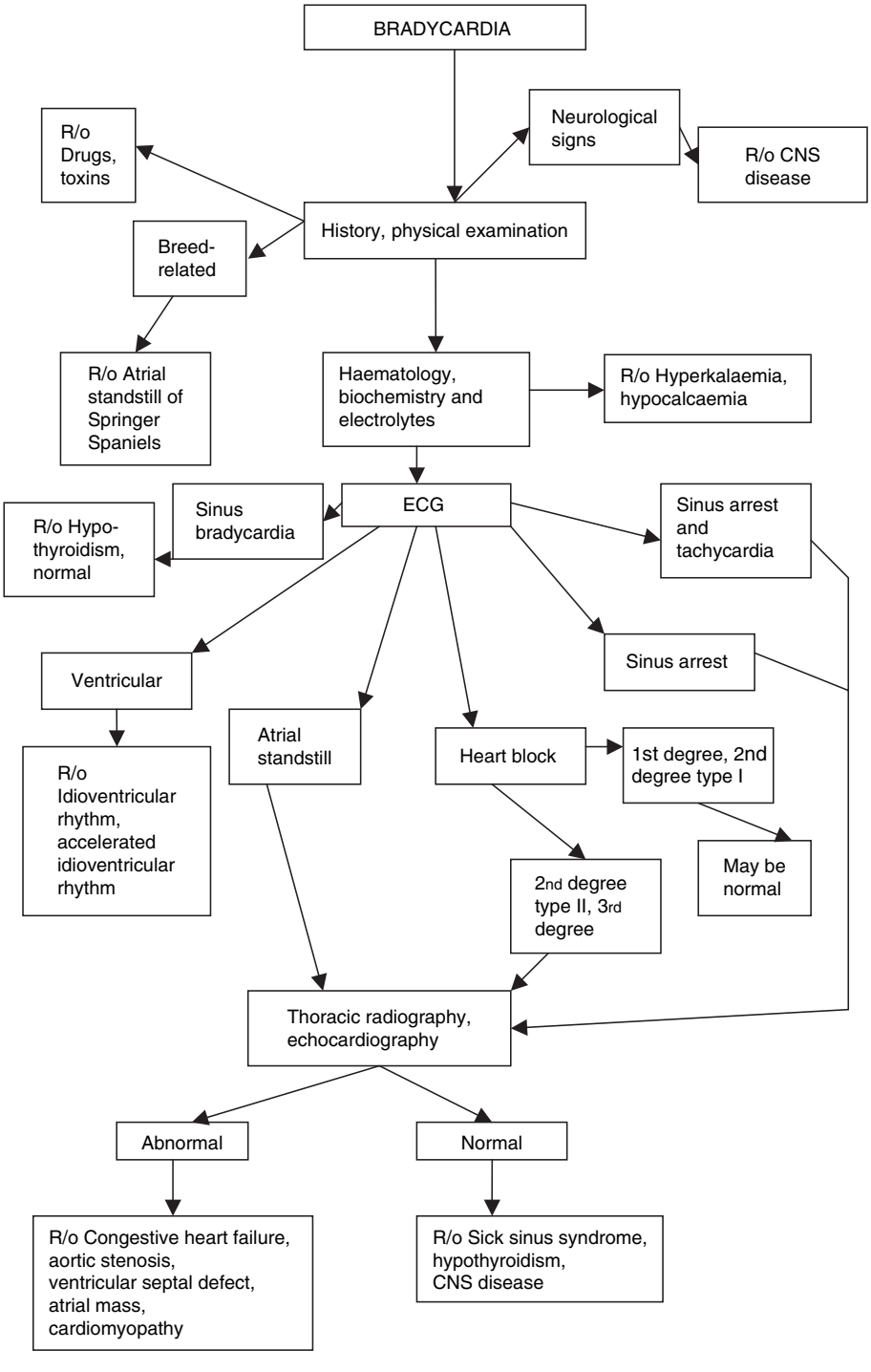
Swallowing/gag (CNs IX, X)
The left or right side of the caudal pharyngeal wall is stimulated with a finger or an applicator. A normal animal should elevate its palate and contract its pharyngeal muscles. However, some normal animals will not demonstrate this response. An asymmetric response is abnormal.

Tongue (CN XII)
The tongue is visually assessed and palpated for atrophy, asymmetry or deviation. A normal animal will also often lick its nose after the gag reflex is assessed. Observing an animal drinking will help assess tongue function.

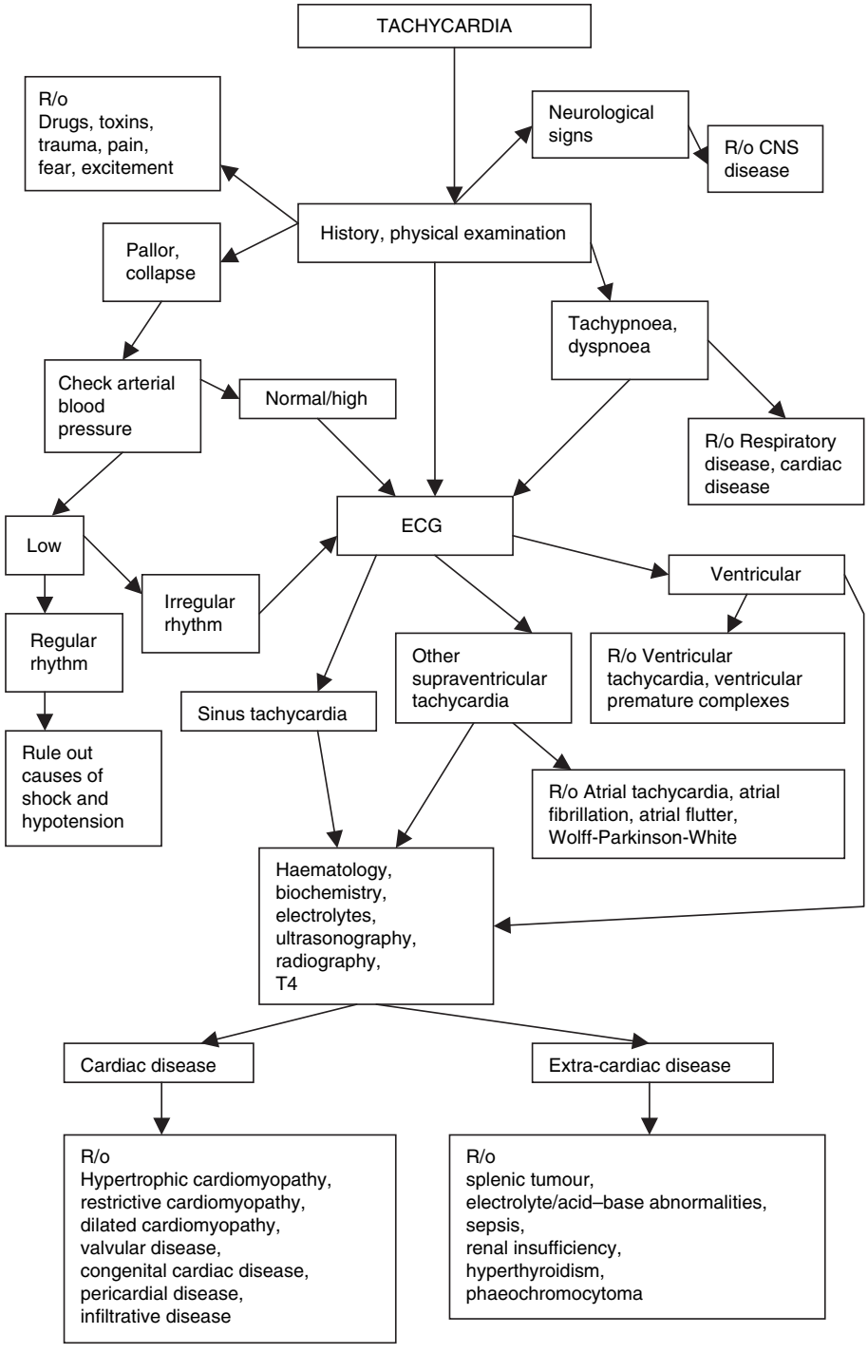
Oculocardiac (CNs V, X)
The heart is auscultated and the rate taken. The eyes are retropulsed, and the heart rate is immediately taken again. The expected response in a normal animal is for the heart to slow down, but many normal animals will not show this response.

Jaw tone (CN V)
The jaw is opened and assessed for normal tone.

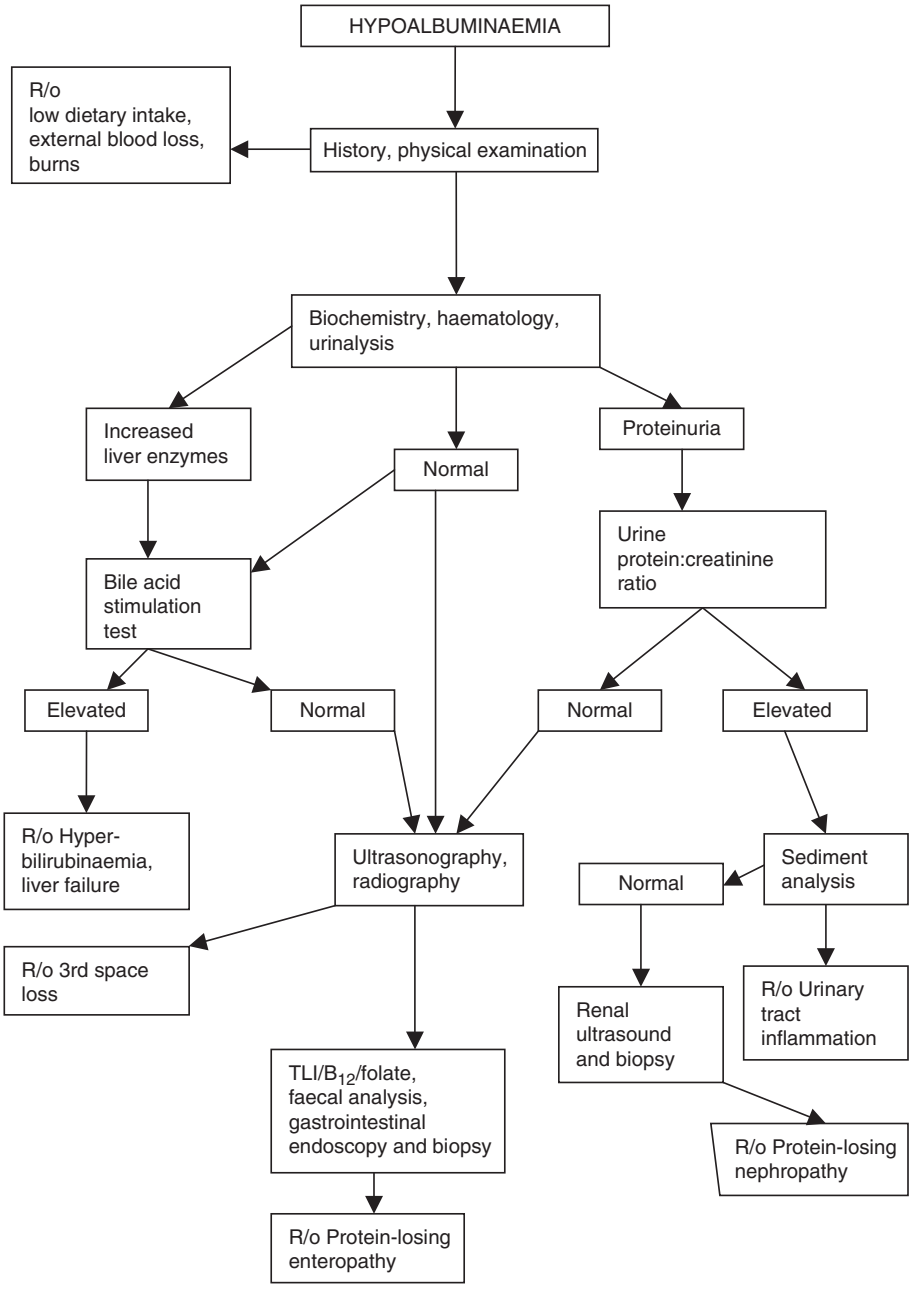
7.1 Bradycardia



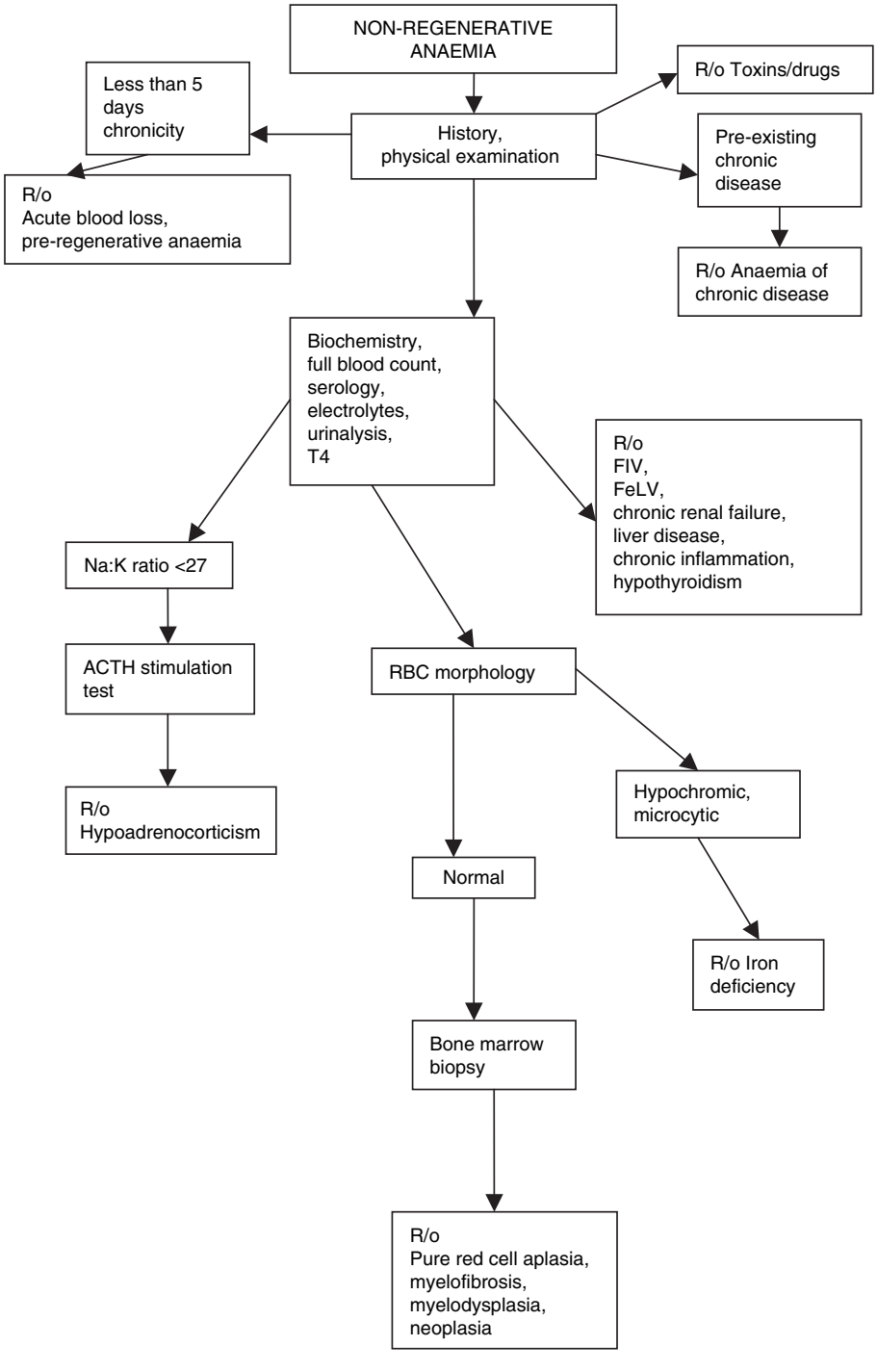
7.2 Tachycardia



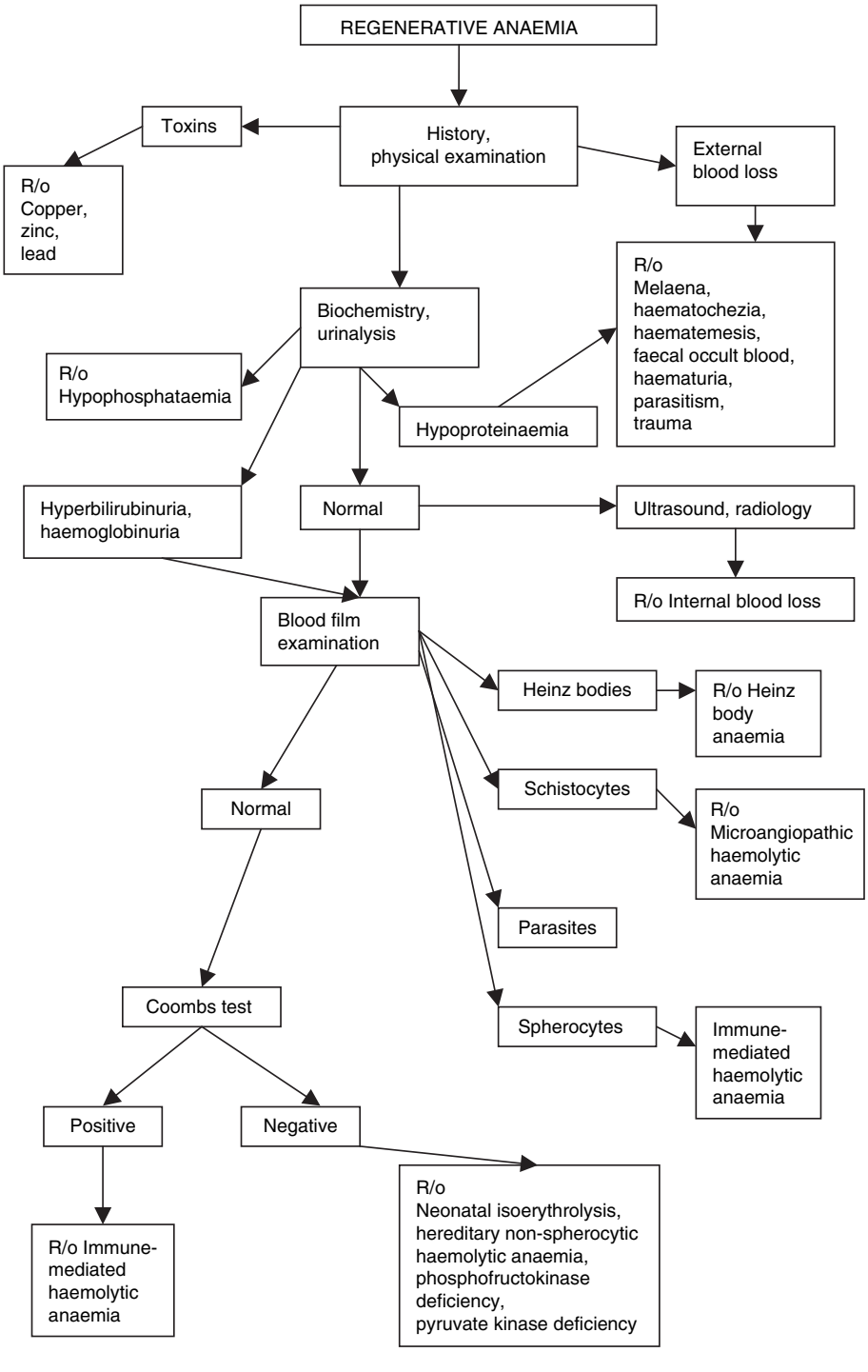
7.3 Hypoalbuminaemia



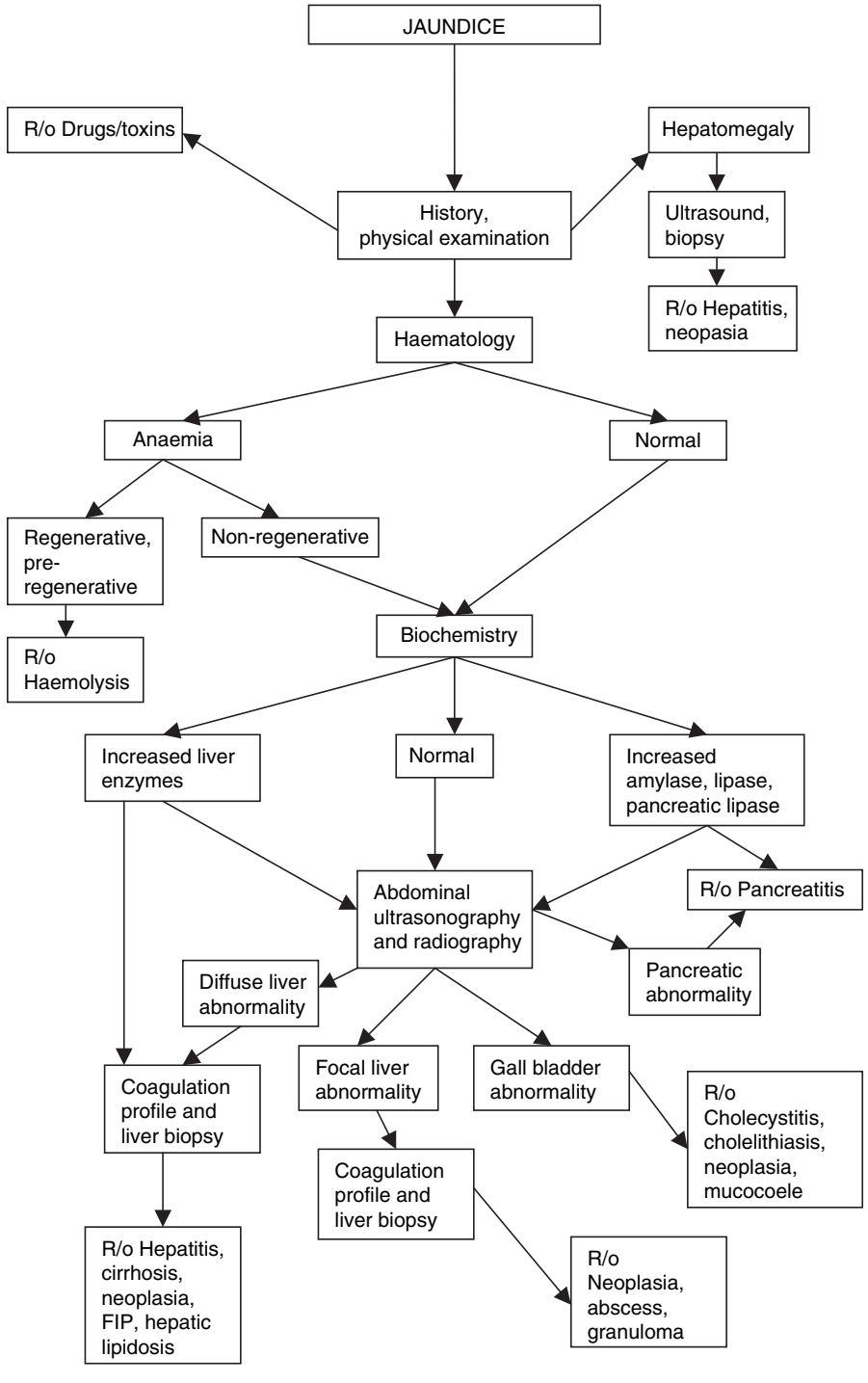
7.4 Non-regenerative anaemia



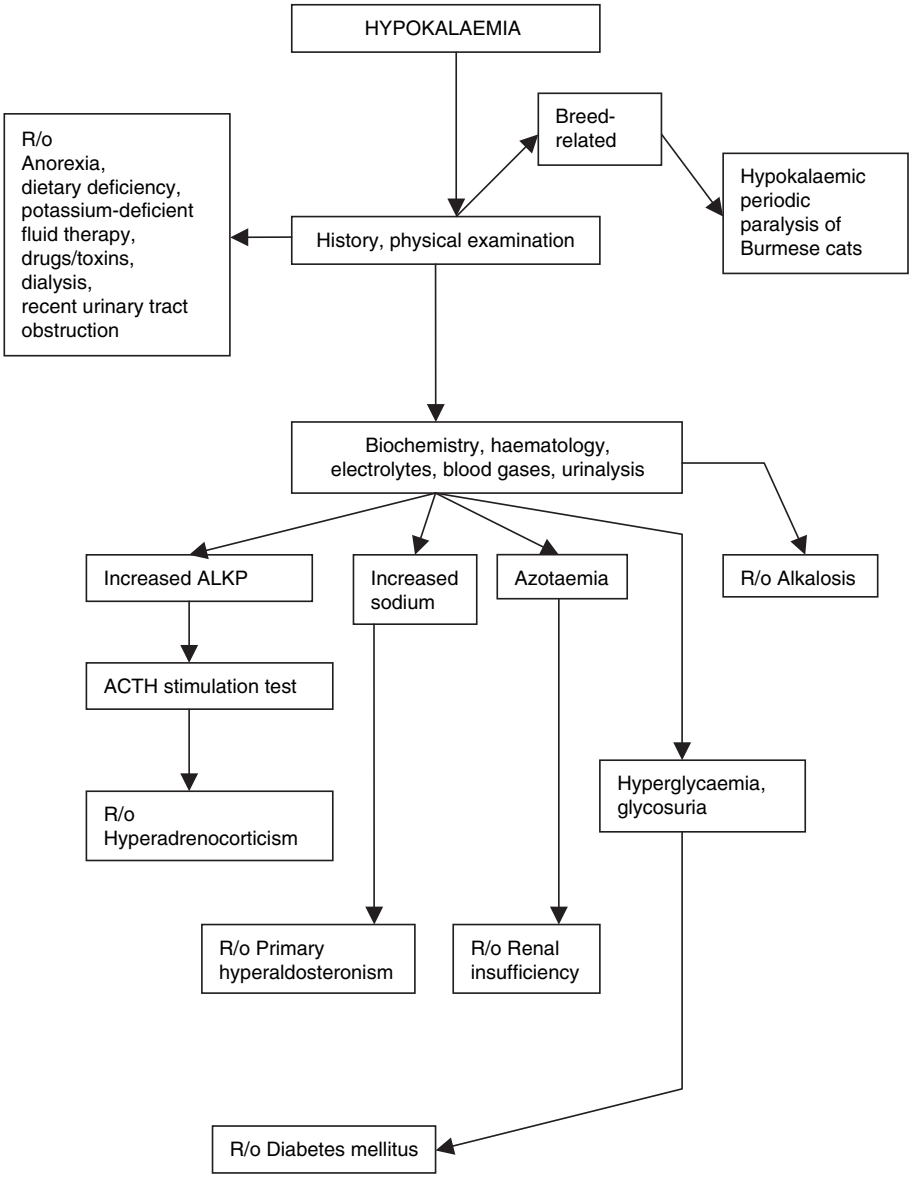
7.5 Regenerative anaemia



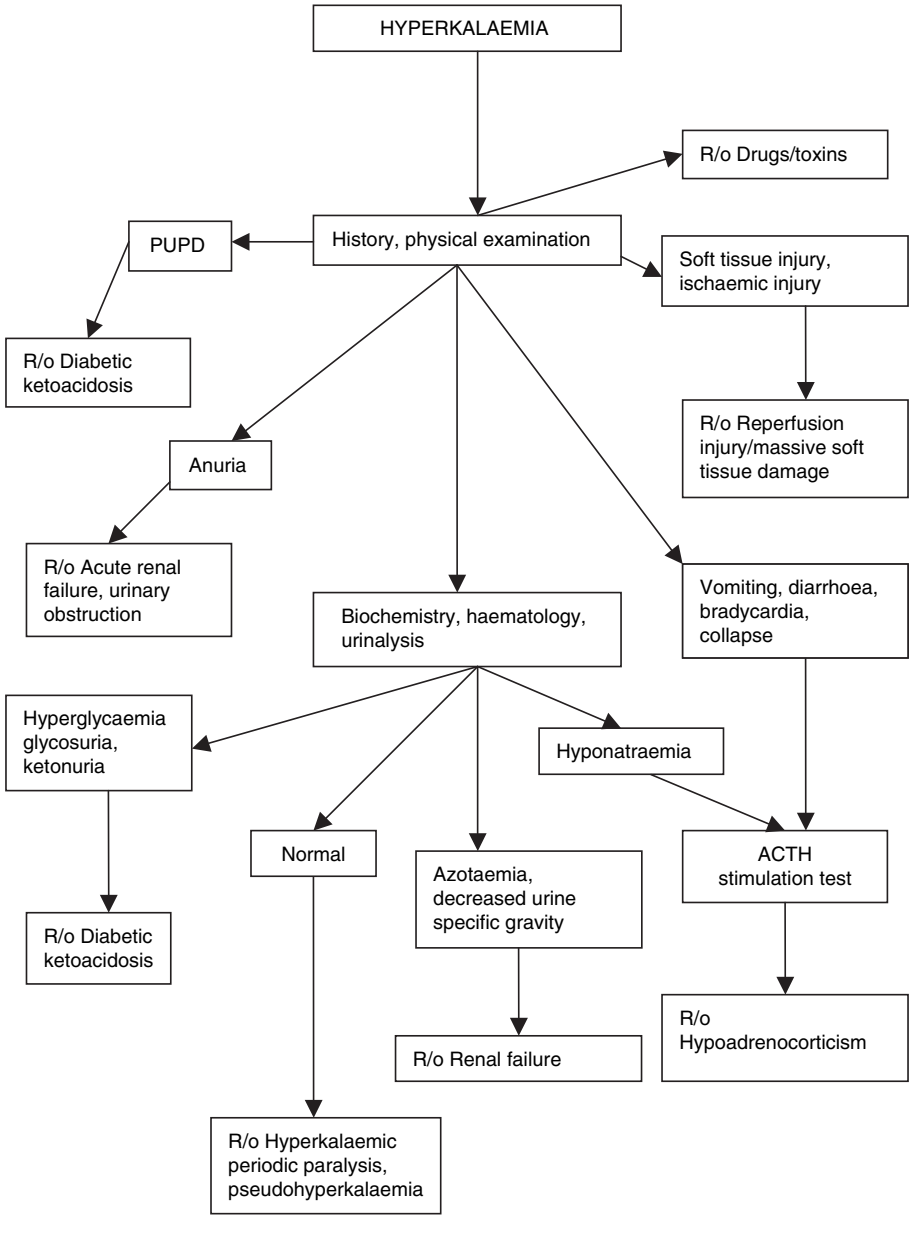
7.6 Jaundice


JAUNDICE
R/o Drugs/toxins
Hepatomegaly
History, physical examination
Ultrasound, biopsy
R/o Hepatitis, neopasia
Haematology
Anaemia
Normal
Regenerative, pre-regenerative
Non-regenerative
R/o Haemolysis
Biochemistry
Increased liver enzymes
Normal
Increased amylase, lipase, pancreatic lipase
Abdominal ultrasonography and radiography
R/o Pancreatitis
Pancreatic abnormality
Diffuse liver abnormality
Coagulation profile and liver biopsy
Focal liver abnormality
Gall bladder abnormality
R/o Cholecystitis, cholelithiasis, neoplasia, mucocoele
Coagulation profile and liver biopsy
R/o Hepatitis, cirrhosis, neoplasia, FIP, hepatic lipidosis
R/o Neoplasia, abscess, granuloma

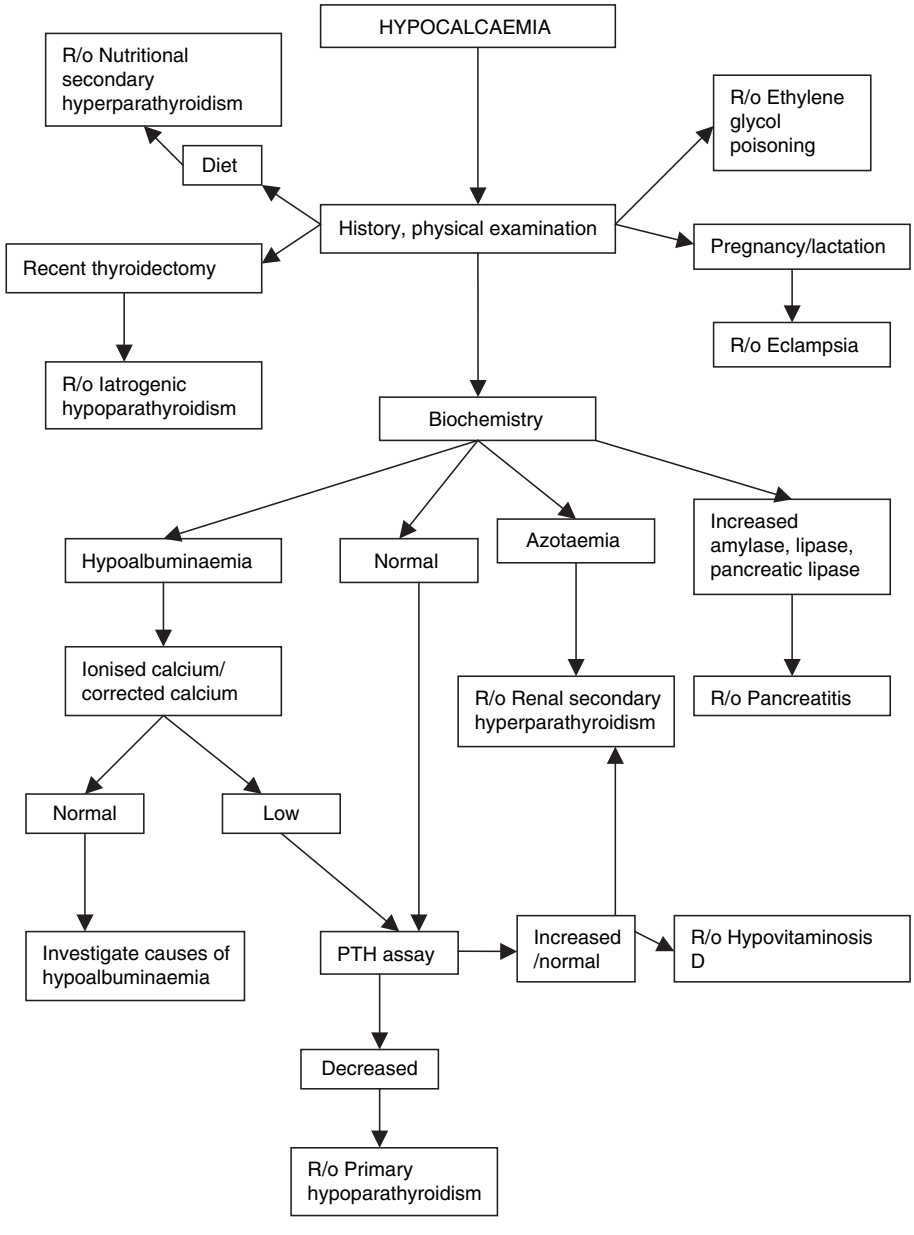
7.7 Hypokalaemia



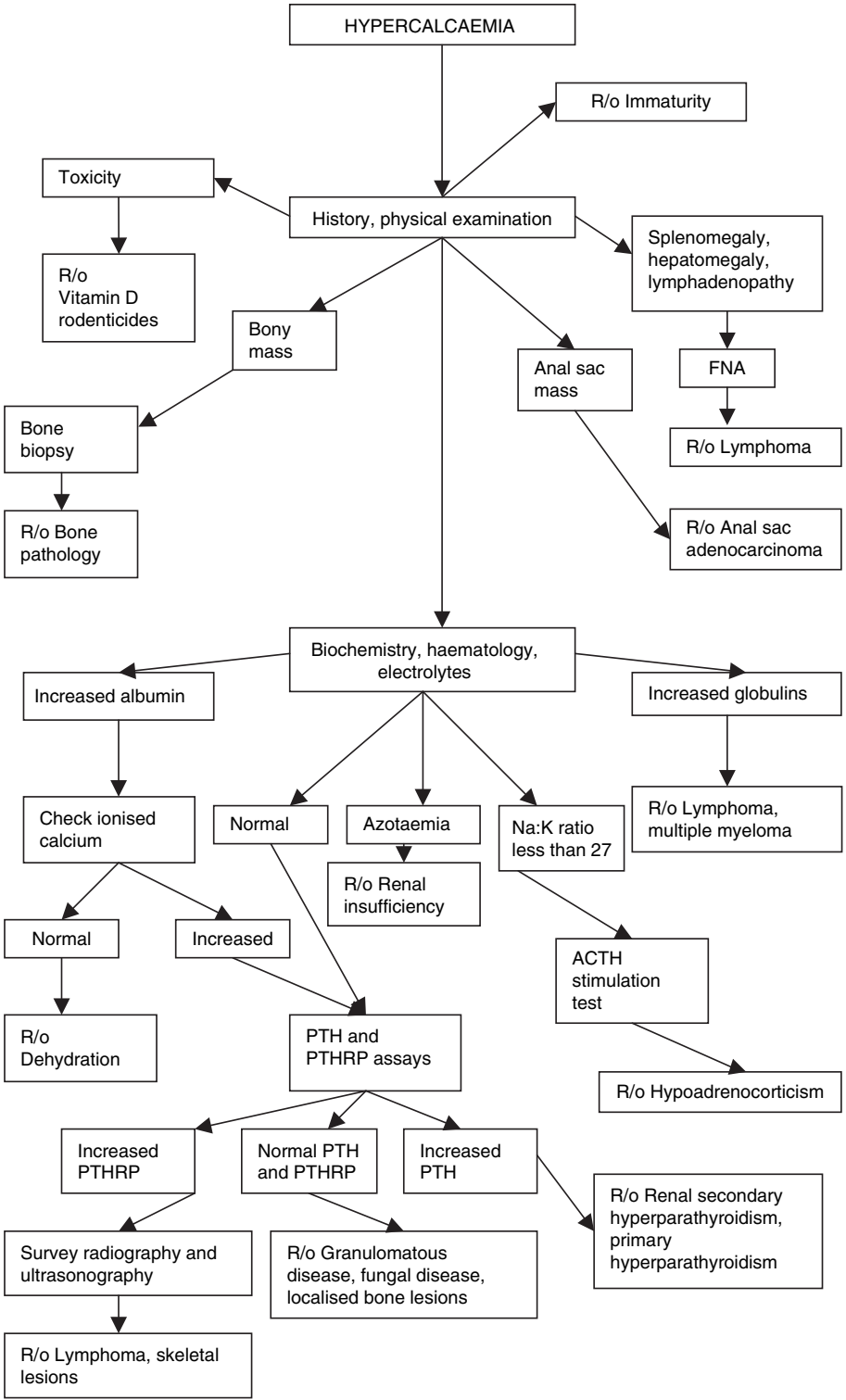
7.8 Hyperkalaemia



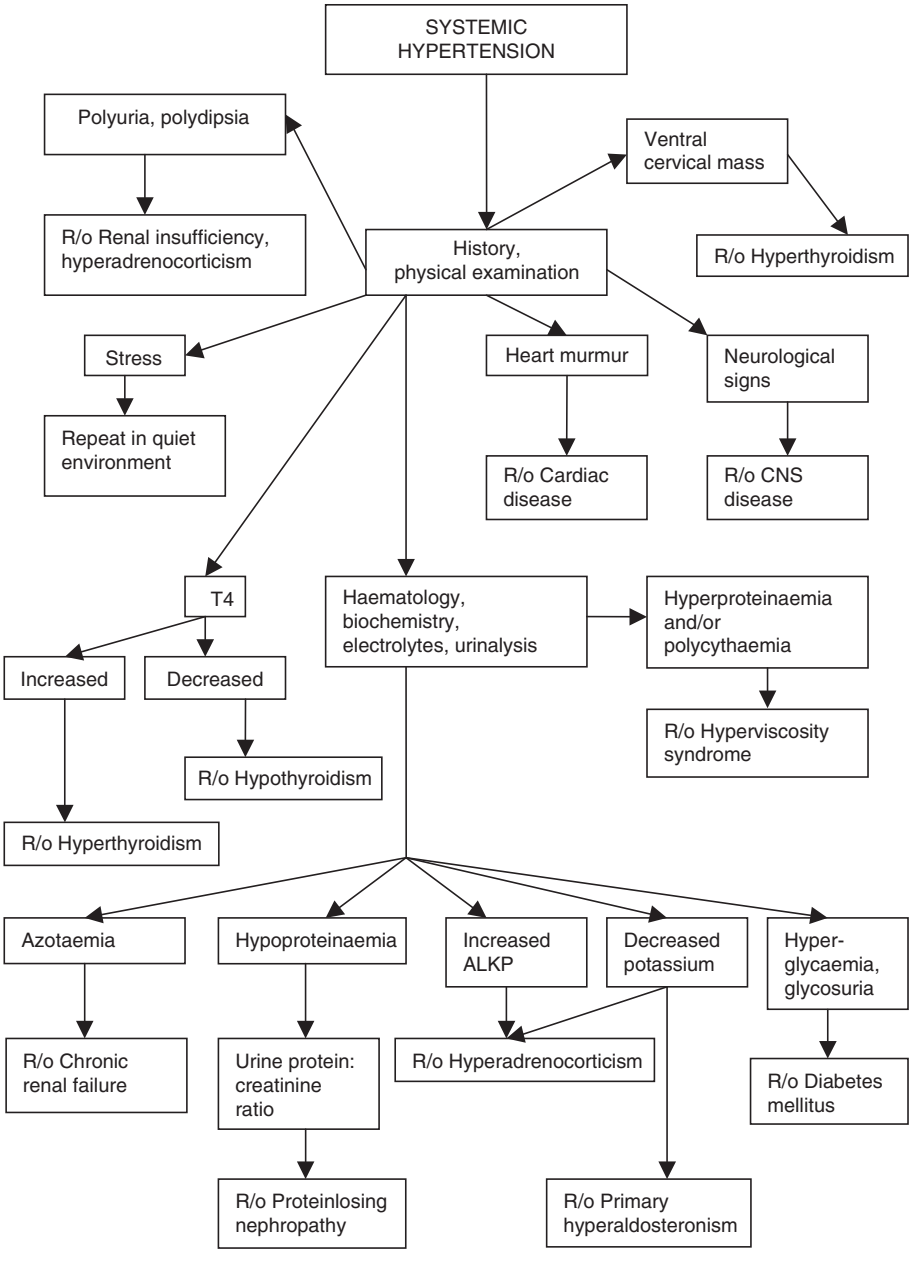
7.9 Hypocalcaemia



7.10 Hypercalcaemia



7.11 Systemic hypertension



Appendix A: History Record

Animal	Owner	
Date		
Breed	Age	Sex
Length of time in owner's possession		

Main presenting problem

Duration of problem

Weight loss/gain

Demeanor

Appetite/prehension/swallowing

Drinking (quantify)

Urination

Dysuria
Pollakiuria
Haematuria
Polyuria

Respiratory signs

Cough

- Character (harsh, soft)
- Frequency
- When occurring (night, excitement, exercise)

Vomiting/regurgitation

Frequency
True vomiting or regurgitation?
How long after feeding?
Fresh blood? Haematemesis?

Diarrhoea

Frequency
Consistency
Volume
Mucus
Blood/melaena

Reproductive status/length and cycle of seasons

Exercise tolerance

Collapsing/fitting episodes

Prodromal and aural behaviour
Frequency
- Clustering?
- History of status epilepticus?

Type
- Generalised (tonic–clonic, clonic, myoclonic, atonic)
- Focal (sensory, motor)

Urination/defecation
Loss of consciousness
Timing and relationship to feeding and exercise

Behavioural changes

Previous drug/anaesthetic reactions

Worming history

Vaccination history

Diet

History of exposure to toxins

Any recent changes in environment

History of travel abroad

Previous medical problems

Previous or current drug therapy

History of similar problems in littermates/housemates

Appendix B: Physical Examination Record

Vital signs
Temperature
Pulse
Respiration

Demeanour

Hydration status

Mucous membranes
Cyanosis
Pallor
Hyperaemia

Oral examination
Gums
Teeth
Other lesions

Eyes
Conjunctiva
Eyelids
Pupils
Anterior chamber
Lens
Iris
Posterior chamber
Retina

Ears
Auditory canal
Tympanic membrane

Nose
Discharge
Pigmentation changes
Airflow
Upper respiratory noise

Cervical palpation
Ventral cervical mass
Tracheal pinch

Skin
Alopecia
Pyoderma

Skin tumours
Other lesions

Lymph nodes
Enlargement – generalised, regional or single node

Abdominal palpation
Pain
Liver
Spleen
Kidneys
Bladder
Abdominal masses
Ascites

Thoracic auscultation
Heart rhythm
Murmurs
- Grade
- Timing
- Intensity
- Localisation
- Character
- Radiation

Gallop sounds
Lung sounds

Pulse
Strength
Pulse deficits

Rectal
Anal glands
Prostate

Urogenital
Penis/prepuce/testes
Vulva/vagina

Musculoskeletal
Lameness
Muscular atrophy – generalised/localised

Neurological
See Appendix C

Other findings

Appendix C: Neurological Examination Chart

Animal		Owner
Date		
Breed	Age	Sex
Length of time in owner's possession		

Key:
– = reflex or sign absent
+ = reflex or sign reduced
++ = reflex or sign normal
+++ = reflex or sign exaggerated

History

Owner's main complaint
Date of onset
Speed of onset
Evolution (progressive, waxing/waning, regressive, static, episodic)

Collapsing/fitting episodes?
Prodromal and aural behaviour
Frequency
- Clustering?
- History of status epilepticus?

Type
- Generalised (tonic–clonic, clonic, myoclonic, atonic)
- Focal (sensory, motor)

Urination/defecation
Loss of consciousness
Timing and relationship to feeding and exercise

Abnormal behaviour
Head pressing
Dementia
Circling
Other

Ataxia

Exercise tolerance

General medical history
Note: A full general history should be taken (see Appendix A).

Observation

Mental status (normal, confused, depressed, stuporous, comatose)

Limbs

	LF	RF	LH	RH
Paresis				
Paralysis				
Superficial pain				
Deep pain				
Muscle strength				

	C1–C5	C6–T2	T3–L3	L4–L7
Thoracic limb	UMN	LMN	–	–
Pelvic limb	UMN	UMN	UMN	LMN

Posture
- Head tilt (left or right)
- Stance
- Circling

Lameness

Ataxia

Paresis

Gait

Involuntary movement

Palpation/manipulation

Pain
- Spinal – localise
- Joints
- Muscle

Neck movement

Postural reactions

	LF	RF	LH	RH
Hopping				
Knuckling				
Wheelbarrowing				
Hemiwalking				
Extensor postural thrust				
Placing (tactile)				

Cranial nerves – Normal? Reduced? Absent? Left or right?
- Smelling non-irritant substance (I)
- Pupil size/anisocoria (retina, II, III)
- PLR (II, III, sympathetic, retina)
- Menace (retina, II,VII, forebrain, cerebellum)
- Corneal reflex (V, VI, VII)
- Throw cotton wool (II)
- Auditory response (VIII)
- Strabismus (permanent: III, IV, VI; temporary: VIII)
- Spontaneous nystagmus (horizontal, vertical, rotatory)
- Positional nystagmus (III,VIII)
- Oculovestibular (III, IV, VI, VIII)
- Facial sensation, nasal stimulation (V, forebrain)
- Facial paralysis (VII)
- Masticatory muscle atrophy (V)
- Palpebral (V+VII)
- Swallowing/gag (IX and X)
- Tongue (XII)
- Oculocardiac (V, X)
- Jaw tone (V)

Spinal reflexes
- Thoracic withdrawal (C6–T2)
- Pelvic withdrawal (L6–T2)
- Patellar (L4–6)
- Gastrocnemius (L6–S1)
- Perineal (S1–S2)
- Extensor carpi radialis (C7–T2)
- Tail movement?
- Panniculus

Urinary function
- Voluntary urination?
- Full bladder?
- Easily expressed?

Appendix D: Cardiology Consultation Form

Note: For history-taking see Appendix A, and physical examination see Appendix B.

Animal	Owner	
Date		
Breed	Age	Sex
Length of time in owner's possession		

Blood pressure

Electrocardiography

Table D.1 Electrocardiography results recording form.

Parameter	Result	Normal value canine	Normal value feline
Rhythm			
Rate		70–160	120–240
P height (mV)		<0.4	<0.2
P width (s)		<0.04	<0.04
R height (mV)		<2.5–3.0	<0.9
QRS width (s)		<0.06	<0.04
P-R interval (s)		0.06–0.13	0.05–0.09
Q-T interval (s)		0.15–0.25	0.12–0.18
T height (mV)		<¼ height of R	<0.3 mV
S-T segment		depression <0.2 mV	no marked depression
P for every QRS?			
QRS for every P?			

Other comments on trace

ECG diagnosis

Radiography

Non-heart/lung structures

Lateral

Vertebral heart score
Cardiac silhouette width
Cardiac silhouette height
Chamber enlargement
Lung pattern
Cranial lobar arteries
Cranial lobar veins
Caudal vena cava width and position
Tracheal elevation
Mainstem bronchial splitting

Dorsoventral
- Heart width
- Chamber enlargement
- Splitting of bronchi (cowboy sign)
- Lung pattern
- Caudal lobar arteries
- Caudal lobar veins

Echocardiography

(Consult published tables for weight-adjusted normal values)

2D
- IVSd
- IVSs
- LVd
- LVs
- LVFWd
- LVFWs
- LA
- Ao
- LA:Ao

Systolic function
- FS%
- EF
- EPSS
- PEP
- LVET
- PEP:LVET
- Index of sphericity

Diastolic function
- Mitral inflow velocities
- E peak
- A peak

Valvular velocities
- Mitral regurgitation
- Tricuspid regurgitation
- Aortic outflow
- Pulmonic outflow

Colour Doppler
- LA regurgitation
- RA regurgitation
- ASD?
- VSD?

Contrast ('Bubbleogram') findings

Pericardial effusion
Tamponade?
Neoplasia?
Other findings

Bibliography and Further Reading

The following texts were used as sources of information, and are also recommended for further reading on the diseases listed in this book.

Bainbridge, J. & Elliott, J. (1996) *Manual of Canine and Feline Nephrology and Urology*. BSAVA, Cheltenham.

Bistner, S. I., Ford, R. B. & Raffe, M. R. (2000) *Kirk and Bistner's Handbook of Veterinary Procedures and Emergency Treatment,* 7th edn. WB Saunders, Philadelphia.

Bonagura, J. D. & Kirk, R. W. (1995) *Kirk's Current Veterinary Therapy XII Small Animal Practice*. WB Saunders, Philadelphia.

Braund, K. G. (1986) *Clinical Syndromes in Veterinary Neurology*. Williams & Wilkins, Baltimore.

Bush, B. M. (1991) *Interpretation of Laboratory Results for Small Animal Clinicians*. Blackwell Science, Oxford.

Campbell, A. & Chapman, M. (2000) *Handbook of Poisoning in Dogs and Cats*. Blackwell Science, Oxford.

Chrisman, C. L. (1991) *Problems in Small Animal Neurology*, 2nd edn. Lea & Febiger, Philadelphia.

Crispin, S. M. (2005) *Notes on Veterinary Ophthalmology*. Blackwell Science, Oxford.

Davidson, M. G., Else, R. W. & Lumsden, J. H. (1998) *BSAVA Manual of Small Animal Clinical Pathology.* BSAVA, Cheltenham.

Day, M. J., Mackin, A. & Littlewood, J. D. (2000) *BSAVA Manual of Canine and Feline Haematology and Transfusion Medicine*. BSAVA, Cheltenham.

Dennis, R., Kirberger, R. M., Wrigley, R. H. & Barr, F. J. (2001) *Handbook of Small Animal Radiological Differential Diagnosis*. WB Saunders, London.

Dewey, C. W. (2003) *A Practical Guide to Canine and Feline Neurology*. Iowa State Press, Ames.

Dunn, J. K. (1999) *Textbook of Small Animal Medicine*. WB Saunders, London.

Ettinger, S. J. & Feldman, E. C. (2005) *Textbook of Veterinary Internal Medicine*, 6th edn. Elsevier Saunders, St Louis.

Feldman, B. F., Zinkl, J. G. & Jain, N. C. (2000) *Schalm's Veterinary Haematology,* 5th edn. Lippincott, Williams & Wilkins, Philadelphia.

Ford, B. R. (1988) *Clinical Signs and Diagnosis in Small Animal Practice*. Churchill Livingstone, New York.

Foster, A. P. & Foil, C. S. (2003) *BSAVA Manual of Small Animal Dermatology*, 2nd edn. BSAVA, Gloucester.

Fox, P. R., Sisson, D. & Moise, N. S. (1999) *Textbook of Canine and Feline Cardiology: Principles and Clinical Practic*, 2nd edn. W.B. Saunders, Philadelphia.

Gelatt, K. N. (2000) *Essentials of Veterinary Ophthalmology*. Lippincott, Williams & Wilkins, Philadelphia.

Hall, E. J., Simpson, J. W. & Williams, D. A. (2005) *BSAVA Manual of Canine and Feline Gastroenterology* (2nd edn). BSAVA, Gloucester.

Harvey, R. G., Harari, J. & Delauche, A. J. (2001) *Ear Diseases of the Dog and Cat*. Manson Publishing, London.
Hoerlein, B. F. (1978) *Canine Neurology: Diagnosis and Treatment*. WB Saunders Co, Philadelphia.
Houlton, J. E. F. (1994) *BSAVA Manual of Small Animal Arthrology*. BSAVA, Cheltenham.
Kaneko, J. J., Harvey, J. W. & Bruss, M. L. (1997) *Clinical Biochemistry of Domestic Animals,* 5th edn. Academic Press, San Diego.
Kealy, J. K. (1987) *Diagnostic Radiology of the Dog and Cat* (2nd edn)., WB Saunders Co, Philadelphia.
Kittleson, M. D. & Kienle, R. D. (1998) *Small Animal Cardiovascular Medicine*. Mosby, St Louis.
Nelson, R. W. & Couto, C. G. (2003) *Small Animal Internal Medicine*, 3rd edn. Mosby, St Louis.
Nyland, G. T. & Mattoon, J. S. (2002) *Small Animal Diagnostic Ultrasound*, 2nd edn. WB Saunders Co, Philadelphia.
Osborne, C. A. & Stevens, J. B. (1999) *Urinalysis: A Clinical Guide to Compassionate Patient Care*. Bayer, Leverkusen.
Paterson, S. (1998) *Skin diseases of the dog*. Blackwell Science, Oxford.
Petersen-Jones, S. & Crispin, S. (2002) *BSAVA Manual of Small Animal Ophthalmology*. BSAVA, Gloucester.
Pfeiffer, R. L. & Petersen-Jones, S. M. (1997) *Small Animal Ophthalmology: A Problem-oriented Approach*. WB Saunders Co, London.
Ramsey, I. & Tennant, B. R. (2001) *Manual of Canine and Feline Infectious Diseases*. BSAVA, Gloucester.
Scott, D. W., Miller, W. H. & Griffin, C. E. (2001) *Muller & Kirk's Small Animal Dermatology*, 6th edn. WB Saunders Co, Philadelphia.
Sharp, N. J. H. & Wheeler, S. J. (2005) *Small Animal Spinal Disorders – Diagnosis and Surgery*, 2nd edn. Elsevier Mosby, Edinburgh.
Tennant, B. (2005) *BSAVA Small Animal Formulary*, 5th edn. BSAVA, Gloucester.
Thrall, D. E. (2002) *Textbook of Veterinary Diagnostic Radiology*, 4th edn. WB Saunders Co, Philadelphia.
Veterinary Information Network. www.vin.com. Accessed 30.12.05.
White, M. E., Consultant. www.vet.cornell.edu/consultant/consult.asp. Accessed 3.12.05
Note: this website provides large numbers of differential diagnoses – categorised in alphabetical order – for many common historical and physical signs.
Willard, M. D. & Tvedten, H. (2004) *Small Animal Clinical Diagnosis by Laboratory Methods*, 4th edn. Saunders, St Louis.

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