

with

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Aim of the book
The primary aim of this book is to provide a detailed reference for the basic radiographic anatomy of the dog and cat. This is achieved by the inclusion of both radiographs and drawings.

The immature animal and, where relevant, a spectrum of breeds have been included.

A selection of anatomical variants and a few of the more common radiographic ‘pitfalls’ are also to be found following the ‘normal’ radiograph.

Following the anatomical sections of plain radiography is a series of the more commonly employed contrast studies. Confusion can occur when trying to interpret such techniques, and many anatomical features can only be seen with the aid of contrast agents. Hence these have been included, hoping they aid evaluation of the studies performed more regularly in general practice. In addition a few of the less common studies are found for anatomical understanding.

From personal experience in teaching and examining veterinary surgeons for post-graduate radiology certification it is clear that a good basic knowledge of radiographic anatomy is essential. Unfortunately, all too often ‘normality’ is not recognised, especially where breed variation has to be considered.

A short bibliography is in the last few pages of this book. The list includes only books and publications consulted, and relevant, for the figures and text of this manuscript. No individual references are cited in the text.

No index has been included as the atlas is intended to be used as a visual reference for normality. To facilitate this a comprehensive contents list, divided into anatomical regions for plain and contrast radiography, is provided.

Although initially it would appear that the book is mainly for the benefit of veterinary surgeons wanting to obtain additional radiology qualifications, basic radiographic anatomy will be of value to both undergraduates and veterinary surgeons in general practice. It is hoped that this atlas will become a useful and well used reference book for both the specialising and non-specialising veterinary audience.

Drawings
The drawings follow tracings of the radiographs. Only shadows seen in the radiograph have been traced, even if anatomically more detail should have been present. Each drawing has a detailed key.

It is hoped that the radiographic reproduction is of a sufficient standard to allow recognition of all the radiographic shadows that have been traced.

Where the shadows are complex, as in the skull, a number of drawings have been made to avoid interpretative confusion of numerous lines within small regions.

Every effort has been made not to overdraw or over-label the drawings correlating to the radiographs. In this way it is hoped that the reader will quickly recognise the important shadows and become familiar with radiographic anatomy.

Separate line drawings have also been included of soft tissue structures surrounding bony shadows. These structures are often overlooked when attention is focused on the more obvious opaque shadows. Much valuable information can be gained from the soft tissue surrounding, for example, the stifle joint.

In addition to the line drawings, schematic drawings of many projections have been made to familiarise the reader with anatomical features not visible on the radiograph. In this way the reader will be more able to make logical diagnosis/differential diagnosis when faced with radiographs demonstrating abnormal features.

Animals
Most of the radiographs in this book are original and for the exclusive use of the authors. The remainder have been given to the authors by generous colleagues.

The radiographs have been obtained over a period of five to six years and a brief summary of their source follows.

The ‘normal’ dog radiographs are mainly from a group of Beagle Hounds while the ‘normal’ cat radiographs are from a number of individual British Domestic Short Haired cats.
In both cases the radiographs were obtained specifically for the book, radiography taking place in conjunction with routine surgery or dentistry requiring general anaesthesia.

The different breeds, anatomical variants and radiographic ‘pitfall’ radiographs were either obtained primarily for this book or were taken from veterinary college files. This was probably one of the most difficult sections to complete for publication as radiographs falling into ‘variant’ or ‘pitfall’ are not usually recorded.

The dog juvenile section was commissioned for this book and radiography was performed on the same dog (Samoyed Crossbred entire male) from 1 month to 15 months of age at intervals of one month. This is probably the ideal situation for a juvenile study as individual, feeding and housing variations are all under control.

The study was based at University of Guelph in Ontario Canada under the watchful eye of Professor Sumner-Smith.

The cat juvenile section usually involved a different cat at each monthly age. Individuals from a breeding group were radiographed specifically for this book, during studies on clinical anaesthesia in Newcastle, England.

Although this is not ideal as some individual variation is present, variations with feeding and housing were eliminated. The significant advantage of undertaking the work in this manner has been to ensure consistent anaesthetic and radiographic techniques in producing the final radiographs. Radiography was from four weeks to 96 weeks of age at four-weekly intervals.

All cats were entire and it was interesting to see the differences in bone size between male and female cats. The latter is especially relevant with the skull section.

The contrast study section radiographs were obtained from college files spanning over 20 years from 1975 to 1995. It was not thought to be ethical to introduce contrast medium, of any type, into a normal animal for the sole purpose of this book.

Radiography

All radiography performed in England, specifically for this book, was under the Ionising Radiation Regulations of 1985.

Every effort has been made to include only radiographs of a high radiographic quality.

As a variety of X-ray machines and accessory equipment have been used, no specific details of the equipment, nor exposure details are included in this book.

A comprehensive description of radiographic positioning of the animal has purposely been excluded as there are a number of excellent books on this subject. In addition it is not the main objective of this atlas to teach positioning.

Instead a line drawing, from a photograph of the live ‘normal’ dog being radiographed, is to be found below the relevant radiograph. Positioning for the ‘normal’ cat will be similar.

The centre point for the primary beam has been indicated on each drawing by a symbol varying with the photographic exposure angle.

Normality

The quest for radiographs showing classic and completely ‘normal’ radiographic anatomy proved to be very difficult in a number of skeletal regions. So much so that it was decided to include some radiographs which demonstrated normal radiographic shadows of the bones which were to be detailed in the keys but had evidence of degenerative signs elsewhere.

In every case the bony degenerative changes were causing no clinical signs. The reader is reminded that during radiological analysis of clinical cases, over interpretation of obvious chronic bony degeneration can result in failure to observe active bony changes elsewhere. In their early stages acute skeletal lesions are soft tissue alterations followed by subtle bony changes.

In the case of the stifle joint of the cat the absence of a bony shadow for the medial fabella of the m.gastrocnemius was commonplace. A craniocaudal shadow of the femur has been included for the sole purpose of showing this medial sesamoid bone.

With regards to the soft tissue radiographs of particular note is the cat thorax which showed considerable cardiac shadow variation. As it proved to be such a frequent finding a number of these ‘anomalies’ have been included in the thoracic section.

In addition to the cardiac shadow abnormal lung opacities were commonly seen, especially affecting the right middle lung lobe.

Radiographs of these lung opacities have not been included in the book as it was considered to be too close to disease patterns, but unexpected radiographic findings in seemingly clinically normal animals are something of which the reader should be aware.

Care has been taken to indicate variation of ‘normal’ radiographic anatomy, plus bony degenerative changes. Also a full range of what would be expected as ‘normal’ is included in the book.
Acknowledgements

This book could not have been possible without the support of a vast number of people.

An enormous thank you to Dr Ray Ashdown, East Sussex, UK, our anatomical and terminological consultant, for his vast knowledge which has made such a vital and valuable contribution to this book and which has been offered so patiently during the preparation of this material.

Mr Jonathan Clayton-Jones, London, UK, has prepared the numerous drawings, line and schematic, based on the original tracings prepared by the authors. These represent the culmination of many drafts and re-drafts to reproduce satisfactorily for publication. Without his skill and patience the interpretation of many of the radiographs to the satisfaction of the authors would not have been possible.

Janet Butler at the Animal Health Trust, Newmarket, UK has provided her expertise in preparing photographs from many of the original radiographs.

Mr David Gunn at the Royal Veterinary College, London, UK has kindly allowed line drawings to be prepared from photographs of radiographic positioning prepared at the College.

Our special thanks are extended to a number of veterinary surgeons in general practice and academia who at the time persevered with obtaining normal radiographs to fill the gaps for the book.

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This atlas is dedicated to Odette Rebecca Coulson, Arlene’s young daughter who died in April 2001. Her good humour, artistic suggestions and flexibility in demands on her mother’s time were as invaluable as the encouragement of her husband Andrew.
**Figure 1** Caudocranial projection of scapula. Beagle dog 2.5 years old, entire male.

**Figure 2** Line drawing of photograph representing radiographic positioning for Figure 1.

**Figure 3** Caudocranial projection of scapula.

A Scapula
1 Spine
2 Acromion
3 Subscapular fossa
4 Supraglenoid tubercle
5 Glenoid cavity

B Humerus
6 Greater tubercle
7 Head
8 Lesser tubercle
9 Intertubercular groove

C 1st. rib
D 4th. rib
**Figure 4** Mediolateral projection of shoulder joint. Beagle dog 2.5 years old, entire male.

**Figure 5** Line drawing of photograph representing radiographic positioning for Figure 4.

**Figure 6** Mediolateral projection of shoulder joint.

A Scapula
1 Spine
2 Supraspinous fossa
3 Infraspinous fossa
4 Acromion
5 Supraglenoid tubercle
6 Glenoid cavity
7 Infraglenoid tuberosity

B Humerus
8 Head
9 Neck
10 Lesser tubercle
11 Intertubercular groove
12 Greater tubercle
13 Crest of the lesser tubercle
14 Tricipital line
15 Deltoid tuberosity

C Manubrium of sternum
**Figure 7** Schematic drawing of mediolateral projection of shoulder joint to demonstrate the extent of joint capsule.

- = Joint capsule

- = Synovial space

**Figure 8** Schematic drawing of mediolateral projection of shoulder joint to demonstrate the ligaments and biceps brachii tendon.

1 = Biceps brachii tendon (found on medial aspect of joint)

2 = Transverse humeral ligament (found on medial aspect of joint)

3 = Thickening of inner surface of joint capsule forming the medial and lateral glenohumeral ligaments
Figure 9  Caudocranial projection of shoulder joint. Beagle dog 2.5 years old, entire male.

Figure 10  Line drawing of photograph representing radiographic positioning for Figure 9.

Figure 11  Caudocranial projection of shoulder joint.

A  Scapula
   1  Spine
   2  Acromion
   3  Supraglenoid tubercle including coracoid process medially
   4  Glenoid cavity
   5  Subscapular fossa

B  Humerus
   6  Greater tubercle
   7  Head
   8  Lesser tubercle
   9  Intertubercular groove

C  Clavicle. Often seen in this projection.
Figure 12  Schematic drawing of caudocranial projection of shoulder joint to demonstrate extent of joint capsule.

= Joint capsule

= Synovial space

Figure 13  Schematic drawing of caudocranial projection of shoulder joint to demonstrate ligaments and biceps brachii tendon.

1 = Biceps brachii tendon
2 = Transverse humeral ligament
3 = Medial glenohumeral ligament
4 = Lateral glenohumeral ligament
Figure 14  Mediolateral projection of humerus. Beagle dog 2.5 years old, entire male.

Figure 15  Line drawing of photograph representing radiographic positioning for Figure 14.
Figure 16 Mediolateral projection of humerus.

A Scapula
1 Spine
2 Acromion
3 Supraglenoid tubercle
4 Glenoid cavity

B Humerus
5 Head
6 Neck
7 Lesser tubercle
8 Intertubercular groove
9 Greater tubercle
10 Condyle. Anatomically only one condyle is present in the dog but frequently the terms lateral and medial condyle are used.
10(a) Capitulum (lateral aspect)
10(b) Trochlea (medial aspect)
11 Medial epicondyle
12 Lateral epicondyle
13 Supratrochlear foramen. This foramen lies between the radial fossa and the olecranon fossa which houses the anconal process of the ulna.

C Radius
14 Head
15 Neck

D Ulna
16 Olecranon
17 Anconeal process
18 Lateral coronoid process
19 Medial coronoid process

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Figure 17  Craniocaudal projection of humerus. Beagle dog 2.5 years old, entire male.

Figure 18  Line drawing of photograph representing radiographic positioning for Figure 17.
Figure 19  Craniocaudal projection of humerus.

A Scapula
1 Spine
2 Acromion
3 Supraglenoid tubercle
4 Glenoid cavity

B Humerus
5 Greater tubercle
6 Intertubercular groove
7 Head
8 Lesser tubercle
9 Tricipital line
10 Deltoid tuberosity
11 Trochlea. Medial aspect of the dog’s single condyle.
12 Capitulum. Lateral aspect of the dog’s single condyle.

C Radius
13 Medial epicondyle
14 Lateral epicondyle
15 Supratrochlear foramen

D Ulna
16 Head
17 Olecranon
18 Anconeal process
19 Medial coronoid process
20 Lateral coronoid process
21 Trochlear notch
22 Lateral cortical margin

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 20  Caudocranial projection of humerus. Beagle dog 2.5 years old, entire male (same dog as in craniocaudal projection of humerus, Figure 17).

Figure 21  Line drawing of photograph representing radiographic positioning for Figure 20.
Figure 22  Mediolateral projection of the extended elbow joint. Beagle dog 2.5 years old, entire male.

Figure 23  Line drawing of photograph representing radiographic positioning for Figure 22.

Figure 24  Mediolateral projection of extended elbow joint.

A Humerus
1 Condyle. Only one condyle is present.
1(a) Capitulum. Lateral aspect.
1(b) Trochlea. Medial aspect.
2 Medial epicondyle
3 Lateral epicondyle
4 Supratrochlear foramen
5 Radial fossa
6 Olecranon fossa

B Radius
7 Head
8 Neck
9 Eminence for attachment of lateral collateral ligament of the elbow joint

C Ulna
10 Medial coronoid process
11 Lateral coronoid process
12 Anconeal process
13 Olecranon
14 Trochlear notch
15 Proximal articulation of radius and ulna
Figure 25  Schematic drawing of mediolateral projection of the extended elbow joint to demonstrate extent of joint capsule.

= Joint capsule
= Synovial space

Additional soft tissue shadows relating to interosseous area
a = Interosseous membrane
b = Interosseous ligament. Irregular cortical radial and ulnar margins are often seen in this region, sometimes involving extensive periosteal new bone creating cortical thickening with smoothly undulating cortical bone margins.

Figure 26  Schematic drawing of mediolateral projection of the extended elbow joint to demonstrate ligaments at joint capsule.

1 = Lateral and medial collateral ligaments. Both distally divide into two crura to attach to the radius and ulna and on a lateral projection are almost superimposed. Cranial crus attaches to the radial tuberosity medially and radial eminence laterally.

2 = Annular ligament of the radius. Lies under collateral ligaments. Attached to lateral and medial aspects of the radial notch of the ulna, it forms a ‘loop’ in which the head of the radius can rotate around its long axis.
**Dog – Forelimb**

**Figure 27** Mediolateral projection of the flexed elbow joint. Beagle dog 2.5 years old, entire male.

**Figure 28** Line drawing of photograph representing radiographic positioning for Figure 27.

**Figure 29** Mediolateral projection of the flexed elbow joint.

- **A** Humerus
  1. Condyle. Only one condyle is present.
  1(a) Capitulum. Lateral aspect.
  1(b) Trochlea. Medial aspect.
  2. Medial epicondyle
  3. Lateral epicondyle
  4. Supratrochlear foramen
  5. Radial fossa
  6. Olecranon fossa

- **B** Radius
  7. Head

- **C** Ulna
  8. Medial coronoid process. Note that in this projection the lateral coronoid process cannot be seen as a distinct shadow. The extended mediolateral projection of the elbow joint does show the lateral coronoid process.
  9. Anconean process
  10. Olecranon
  11. Trochlear notch
  12. Cranial cortical margin
Figure 30  Schematic drawing of mediolateral projection of the flexed elbow joint to demonstrate the extent of joint capsule.

= Joint capsule
= Synovial space. There is a voluminous sac of synovial cavity in the cranial and caudal parts of this joint but these do not communicate through the supratrochlear foramen. On the lateral and medial aspects the joint capsule is taut with no sac formation.
**Figure 31** Craniocaudal projection of elbow joint. Beagle dog 2.5 years old, entire male.

**Figure 32** Line drawing of photograph representing radiographic positioning for Figure 31.

**Figure 33** Craniocaudal projection of elbow joint.

A Humerus
1 Condyte. Only one condyle is present.
  1(a) Trochlea. Medial aspect.
  1(b) Capitulum. Lateral aspect.
2 Medial epicondyle
3 Lateral epicondyle
4 Supratrochlear foramen

B Radius
5 Head
6 Lateral eminence
7 Position of radial tuberosity

Numbers 6 and 7 are landmarks for collateral ligaments

C Ulna
8 Olecranon
9 Medial coronoid process
10 Lateral coronoid process
11 Lateral cortical margin
12 Medial cortical margin
**Figure 34** Schematic drawing of craniocaudal projection of elbow joint to demonstrate extent of joint capsule.

- ○ = Joint capsule
- ○ = Synovial space

**Figure 35** Schematic drawing of craniocaudal projection of elbow joint to demonstrate ligaments at joint capsule.

1 = Lateral collateral ligament
2 = Medial collateral ligament
3 = Annular ligament of the radius
Figure 36  Craniolateral–caudomedial oblique projection of elbow joint. Beagle dog 2.5 years old, entire male.

Figure 37  Line drawing of photograph representing radiographic positioning for Figure 36.

Figure 38  Craniolateral–caudomedial oblique projection of elbow joint.

A Humerus
1  Condyle. Only one condyle is present.
   1(a)  Trochlea. Medial aspect.
   1(b)  Capitulum. Lateral aspect.
2  Medial epicondyle
3  Lateral epicondyle
4  Supratrochlear foramen

B Radius
5  Head
6  Lateral eminence for attachment of lateral collateral ligament

C Ulna
7  Olecranon
8  Anconal process
9  Trochlear notch
10  Medial coronoid process
11  Lateral coronoid process (seen as a very opaque linear shadow on the lateral edge of the trochlear notch)
12  Lateral cortical margin
13  Medial cortical margin
**Figure 39** Mediolateral projection of radius and ulna. Beagle dog 2.5 years old, entire male.

**Figure 40** Line drawing of photograph representing radiographic positioning for Figure 39.
Figure 41  Mediolateral projection of radius and ulna.

A Humerus
  1 Condyle. Only one condyle is present.
  1(a) Capitulum, LateraI aspect.
  1(b) Trochlea, Medial aspect.
  2 Lateral epicondyle
  3 Medial epicondyle
  4 Supratrochlear foramen

B Radius
  5 Head
  6 Nutrient foramen
  7 Medial styloid process

  Both proximal and distal growth plate ‘scars’ are visible

C Ulna
  8 Olecranon
  9 Anconeal process
  10 Trochlear notch
  11 Lateral coronoid process
  12 Medial coronoid process
  13 Cranial cortical margin
  14 Head
  15 Lateral styloid process

D Radial carpal bone
E Ulnar carpal bone
F Accessory carpal bone
Figure 42  Craniocaudal projection of radius and ulna. Beagle dog 2.5 years old, entire male.

Figure 43  Line drawing of photograph representing radiographic positioning for Figure 42.
**Figure 44**  Craniocaudal projection of radius and ulna.

A  Humerus
1  Condyle. Only one condyle is present.
   1(a) Trochlea. Medial aspect.
   1(b) Capitulum. Lateral aspect.
2  Medial epicondyle
3  Lateral epicondyle
4  Supratrochlear foramen

B  Radius
5  Head
6  Growth plate scars
7  Medial styloid process

C  Ulna
8  Olecranon
9  Medial coronoid process
10 Lateral coronoid process
11 Lateral cortical margin
12 Lateral styloid process

D  Radial carpal bone
E  Ulnar carpal bone
F  Accessory carpal bone
**Figure 45** Dorsopalmar projection of carpus. Beagle dog 2.5 years old, entire male.

**Figure 46** Line drawing of photograph representing radiographic positioning for Figure 45.

**Figure 47** Dorsopalmar projection of carpus.

A Radius  
1 Growth plate scar  
2 Ulnar notch  
3 Carpal articular surface  
4 Medial styloid process  
B Ulna  
5 Distal articular facet for the radius  
6 Head  
7 Lateral styloid process  
C Radial carpal bone  
D Ulnar carpal bone  
E Accessory carpal bone  
F Sesamoid bone in the tendon of m. abductor pollicis longus  
G Carpal bone 1  
H Carpal bone 2  
I Carpal bone 3  
J Carpal bone 4  
K Metacarpal bone 1  
L Metacarpal bone 2  
M Metacarpal bone 3  
N Metacarpal bone 4  
O Metacarpal bone 5  
P Proximal phalanx  
Q Distal phalanx  
R Ungual process
Figure 48  Schematic drawing of dorsopalmar projection of carpus to demonstrate some clinically important ligaments of the carpus.

1 = Short radial collateral ligament. On medial surface.
2 = Radioulnar ligament. On dorsal surface.
3 = Short ulnar collateral ligament. On lateral surface.
4 = Accessorometacarpal ligaments. On palmar surface.
Figure 49  Mediolateral projection of carpus. Beagle dog 2.5 years old, entire male.

Figure 50  Line drawing of photograph representing radiographic positioning for Figure 49.

Figure 51  Mediolateral projection of carpus.

A  Radius
   1  Growth plate scar
   2  Groove for the m.extensor carpi radialis
   3  Medial styloid process
B  Ulna
   4  Growth plate scar
   5  Lateral styloid process
C  Radial carpal bone
D  Ulnar carpal bone
E  Accessory carpal bone
F  Carpal bone 1
G  Carpal bone 2
H  Carpal bones 3 and 4 (superimposed shadows)
   I  Metacarpal bone 1
   J  Metacarpal bone 2
   K  Metacarpal bones 3 and 4 (superimposed shadows)
   L  Metacarpal bone 5
   M  Proximal sesamoid bones
   N  Proximal phalanx of digit 1
   O  Distal phalanx of digit 1
**Figure 52** Dorsolateral–palmaromedial oblique projection of carpus. Samoyed dog 6 years old, entire female.

**Figure 53** Line drawing of photograph representing radiographic positioning for Figure 52.

**Figure 54** Dorsolateral–palmaromedial oblique projection of carpus.

- **A** Radius
  1. Growth plate scar
  2. Groove for the tendon of m. abductor pollicis longus
  3. Medial styloid process
  4. Ulnar notch
- **B** Ulna
  5. Distal radial articular surface
  6. Articular surface for ulnar carpal bone
  7. Lateral styloid process
- **C** Radial carpal bone
- **D** Ulnar carpal bone
- **E** Accessory carpal bone
- **F** Carpal bone 1
- **G** Carpal bone 2
- **H** Carpal bone 3
- **I** Carpal bone 4
- **J** Metacarpal bone 1
- **K** Metacarpal bone 2
- **L** Metacarpal bone 3
- **M** Metacarpal bone 4
- **N** Metacarpal bone 5
**Figure 55** Dorsopalmar projection of manus. Beagle dog 2.5 years old, entire male.

**Figure 56** Line drawing of photograph representing radiographic positioning for Figure 55.
**Figure 57**  Dorsopalmar projection of manus.

A  Radius  
B  Ulna  
C  Radial carpal bone  
D  Ulnar carpal bone  
E  Accessory carpal bone  
F  Sesamoid bone in the tendon of the m. abductor pollicis longus  
G  Carpal bone 1  
H  Carpal bone 2  
I  Carpal bone 3  
J  Carpal bone 4  
K  Metacarpal bone 1  
L  Metacarpal bone 2  
M  Metacarpal bone 3  
N  Metacarpal bone 4  
O  Metacarpal bone 5  
P  Proximal sesamoid bones. These are present on palmar aspect of metacarpophalangeal joints in tendons of mm. interossei (2 to 5) and m. flexor pollicis brevis. Only one at digit 1 and two at digits 2 to 5.  
Q  Dorsal sesamoid bones. These are present on dorsal aspect of distal metacarpal bones 2 to 5 and lie within the metacarpophalangeal joint capsules.  
R  Proximal phalanges  
S  Middle phalanges  
T  Distal phalanges  
U  Ungual processes  

Metacarpal bones, proximal and middle phalanges divided into  
1  Base  
2  Body  
3  Head
Figure 58  Mediolateral projection of manus.
Beagle dog 2.5 years old, entire male.

Figure 59  Line drawing of photograph representing radiographic positioning for Figure 58.
Figure 60  Mediolateral projection of manus.

A  Radial carpal bone
B  Ulnar carpal bone
C  Carpal bone 1
D  Carpal bone 2
E  Carpal bones 2 and 4 (superimposed shadows)
F  Metacarpal bone 1
G  Metacarpal bone 2
H  Metacarpal bones 3 and 4 (superimposed shadows. The dorsal protuberance seen is metacarpal bone 3.)
I  Metacarpal bone 5
J  Proximal sesamoid bones. Two are present in the tendons of mm.interossei at palmar aspect of metacarpophalangeal joints 2 to 5. Only one is present in metacarpophalangeal joint 1.
K  Dorsal sesamoid bone. These are present in joint capsules at dorsal aspect of distal metacarpal bones 2 to 5.
L  Proximal phalanges
   L₁ Digit 1
   L₂ Digits 2 and 5 (superimposed shadows)
   L₃ Digits 3 and 4 (superimposed shadows)
M  Middle phalanges
   M₁ Digits 2 and 5 (superimposed shadows)
   M₂ Digits 3 and 4 (superimposed shadows)
N  Distal phalanges
   N₁ Digits 2 and 5 (superimposed shadows)
   N₂ Digits 3 and 4 (superimposed shadows)
O  Ungual processes
   O₁ Digits 2 and 5 (superimposed shadows)
   O₂ Digits 3 and 4 (superimposed shadows)
**Figure 61** Mediolateral projection of phalanges, digits stressed. Beagle dog 2.5 years old, entire male.

**Figure 62** Line drawing of photograph representing radiographic positioning for Figure 61.
Figure 63  Mediolateral projection of phalanges. digits stressed.

M Metacarpal bones
P1 Digit 1
P2 Digit 2
P3 Digit 3
P4 Digit 4
P5 Digit 5

Bones of digits
1 Proximal phalanx
2 Middle phalanx
   2(a) Base
   2(b) Body
   2(c) Head
3 Distal phalanx
   3(a) Flexor tubercle
   3(b) Solar foramen
   3(c) Ungual crest
   3(d) Ungual sulcus
   3(e) Ungual process

S1 Dorsal sesamoid bone. These are present in dorsal aspect of metacarpophalangeal joint capsules 2 to 5.

S2 Proximal sesamoid bone. Two are present in tendons of mm.interossei at palmar aspect of metacarpophalangeal joints 2 to 5. Metacarpophalangeal joint 1 has one sesamoid bone in the tendon of m.flexor pollicis brevis.
**Figure 64** Caudocranial projection of scapula. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

**Figure 65** Mediolateral projection of shoulder joint. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
Figure 66  Mediolateral projection of humerus. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

Figure 67  Caudocranial projection of humerus. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
Figure 68  Flexed mediolateral projection of elbow joint. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
**Figure 69** Caudo-cranial projection of elbow joint. The drawing has been included to indicate the presence of a lateral sesamoid bone (arrow) in the elbow joint. The sesamoid bone is more frequently seen on the lateral aspect and is thought to be within the tendon of the m.supinator. Occasionally a medial sesamoid bone is observed in the collateral ligament and joint capsule.

Although both the lateral and medial sesamoid bones have been cited as a cause of lameness by some authors, by most authorities they are not clinically significant. Indeed, sesamoid cartilage is often present but non-mineralised, and hence cannot be seen in a radiograph. In this particular dog there was no forelimb lameness.
Figure 70  Caudolateral-cranio medial oblique projection of elbow joint. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

Figure 71  Mediolateral projection of radius and ulna. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
Figure 72  Craniocaudal projection of radius and ulna. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

Figure 73  Dorsopalmar projection of carpus and phalanges. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
**Figure 74** Mediolateral projection of carpus and phalanges. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
Figure 75  Mediolateral projection of shoulder joint. Glenoid cavity variant. (Corresponds to radiograph not included in book.) Great Dane German Shepherd crossbred dog 5 months old, entire male.

The drawing demonstrates a separate ossification centre for the glenoid cavity (arrow). As the dog matures the centre often forms a separate bony shadow parallel to the glenoid cavity. This must not be mistaken for an osteochondrosis fragment.

The variant seen here is most commonly found in the giant breed of dog, in particular the Irish Wolfhound.

A similar, separate ossification centre may occasionally be seen at the acetabulum. Here the variant forms a separate bony shadow parallel to the cranial effective acetabular rim.

Care must be taken not to confuse this shadow with a fracture fragment or ossicle. The smooth cortical outline of the bony variant together with a normal acetabular shadow enables differentiation from abnormality.

Figure 76  Mediolateral projection of distal radius and ulna. Retained cartilaginous core. (Corresponds to radiograph not included in book.) Great Dane German Shepherd crossbred dog 5 months old, entire male.

The drawing shows a retained cartilaginous core (closed arrows) in the distal ulna metaphyseal region. The core is typically seen at this 5-month age, especially in the Great Dane, although other large and giant breeds can be affected.

Although at one time it was thought to retard growth its presence alone is not significant and the core will disappear as the dog matures. Note the normal growth plates in this dog with the core.

Also present on the drawing is the typical irregular cortical outline of the metaphyseal regions (open arrows). The latter is invariably seen in large and giant breeds of immature dogs. This, together with a relatively opaque appearance of the metaphyseal regions, seen in all immature dogs, must not be mistaken for a bony metabolic abnormality such as rickets. Examination of the bony cortical opacity, and thickness, is required to establish normality in the immature animal.
Figure 77  Dorsopalmar projection of manus. Multipartite sesamoid bones. Rottweiler dog 2 years old, entire male.

The radiograph shows the characteristic multiple bony shadows associated with multipartite sesamoid bones. The proximal sesamoid bones of the 2nd. and 5th. digits are affected in this dog, numbers 2 and 7, these also being the most commonly affected digits.

Multipartite sesamoid bones in the digits of immature, and young, large breeds of dogs, in particular the Rottweiler, have been reported to be involved with lameness. Such a lameness has been called sesamoid disease but the exact role of multipartite sesamoid bones remains unclear. In a number of these cases attributed to abnormal sesamoid bones, recovery was spontaneous and in others concurrent skeletal abnormalities, known to be a cause of lameness, were often present.

Reports of multipartite sesamoid bones affecting the proximal sesamoid bones of the feet conclude that the Rottweiler breed is commonly predisposed but other large breeds, such as the Labrador, can be affected.

Multipartite sesamoid bones are also found in the proximal sesamoid bones of the hind foot. The variant is often bilateral.

From the radiograph the smooth bony outline of the multipartite sesamoid bones can be seen. This together with the presence of a number of opaque bodies of irregular shape allows differentiation from fractures as seen in racing Greyhounds. Fractures of the 2nd. and 7th. proximal sesamoid bones are well recognised in racing Greyhounds.

Diagnosis of lameness due to proximal sesamoid bone abnormality, be it multipartite with degenerative changes or fractures, must be made with great caution. It is generally accepted that the multipartite condition is a normal variant of ossification and not clinically significant. In addition, even in fractures with racing Greyhounds it has been shown to be unassociated with lameness.

Multipartite sesamoid bones can also be seen in the stifle joint. The medial fabella of m.gastrocnemius, fabella of m.popliteus and the patella have all been reported to show multiple bony shadows replacing single sesamoid bodies.
The irregular, well-defined radiopacities caused by dirt between the metacarpal and digital pads, plus between individual digital pads, in this foot show how important patient preparation is.

Although the lumps of dirt in this case are large and unlikely to be overlooked during radiography of the foot, traces of dirt between the pads may easily be missed on a routine inspection of the animal prior to radiography.

Wherever there are unusual shadows in the region of the pads, careful examination of the skin’s surface must be undertaken. This also applies to any contamination of the hair by solid or liquid material.
Figures 79, 80, 81, 82, 83, 84, 85, 86  Mediolateral projection of shoulder joint. Samoyed crossbred dog—entire male, at 4, 8, 13, 17, 25, 30, 43 and 56 weeks of age.

A  Scapula
   1  Epiphysis of supraglenoid tubercle
   2  Growth plate
      2(a) Open
      2(b) Closing

B  Humerus
   3  Proximal epiphysis of humerus
   4  Proximal growth plate
      4(a) Open
      4(b) Closing
      4(c) Remnant
   5  Greater tubercle
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Dog – Forelimb

Figure 84

Figure 84 Age 30 weeks.

Figure 85

Figure 85 Age 43 weeks.

Figure 86

Figure 86 Age 56 weeks.
Figures 87, 88, 89, 90, 91, 92  Mediolateral projection of elbow joint. Samoyed crossbred dog, entire male, at 4, 8, 13, 17, 25 and 34 weeks of age.

A  Humerus
1  Distal epiphysis
2  Epiphysis of medial epicondyle
3  Distal growth plate and medial epicondyle growth plate
   3(a) Open
   3(b) Closing
   3(c) Remnant

B  Radius
4  Proximal epiphysis

C  Ulna
5  Proximal growth plate
   5(a) Open
   5(c) Remnant

6  Proximal epiphysis

7  Proximal growth plate
   7(a) Open
   7(b) Closing
   7(c) Remnant

Figure 87  Age 4 weeks.

Figure 88  Age 8 weeks.

Figure 89  Age 13 weeks.
Figure 90

Figure 90

Figure 91

Figure 91

Figure 92

Figure 92

Age 17 weeks.

Age 25 weeks.

Age 34 weeks.
Figures 93, 94, 95, 96, 97, 98  Craniocaudal projection of elbow joint. Samoyed crossbred dog, entire male, at 4, 8, 13, 17, 25 and 34 weeks of age.

A  Humerus
   1 Distal epiphysis
      1(a) Medial condylar centre
      1(b) Lateral condylar centre
   2 Epiphysis of medial epicondyle
   3 Distal growth plate
      3(a) Open
      3(b) Closing
      3(c) Remnant

B  Radius
   4 Proximal epiphysis
   5 Proximal growth plate
      5(a) Open
      5(c) Remnant

C  Ulna
   6 Proximal epiphysis
Figure 94

Figure 94  Age 8 weeks.

Figure 95

Figure 95  Age 13 weeks.
**Figures 93, 94, 95, 96, 97, 98** Craniocaudal projection of elbow joint. Samoyed crossbred dog entire male at 4, 8, 13, 17, 25, and 34 weeks of age.

A Humerus
1 Distal epiphysis
   1(a) Medial condylar centre
   1(b) Lateral condylar centre
2 Epiphysis of medial epicondyle
3 Distal growth plate
   3(a) Open
   3(b) Closing
   3(c) Remnant

B Radius
4 Proximal epiphysis
5 Proximal growth plate
   5(a) Open
   5(c) Remnant

C Ulna
6 Proximal epiphysis

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Figure 97

Figure 98

Figure 97  Age 25 weeks.

Figure 98  Age 34 weeks.
**Figures 99, 100, 101, 102, 103, 104**  Dorsopalmar projection of carpus, metacarpal bones and phalanges. Samoyed crossbred dog, entire male, at 4, 8, 13, 17, 25 and 34 weeks of age.

A Radius
  1 Distal epiphysis
  2 Distal growth plate
     2(a) Open
     2(b) Closing
B Ulna
  3 Distal epiphysis
  4 Distal growth plate
     4(a) Open
     4(c) Remnant
C Carpus
D Metacarpal bone 5 (2, 3 and 4 similar)
  5 Epiphysis.
Note that there is only a distal epiphysis in these metacarpal bones.
  6 Growth plate
     6(a) Open
  7 Proximal sesamoid bone (lateral identified)
E Proximal phalanx of digit 5 (2, 3 and 4 similar)
  8 Epiphysis.
Note that there is only a proximal epiphysis in the proximal phalanges.
  9 Growth plate
     9(a) Open
     9(c) Remnant
F Middle phalanx of digit 5 (2, 3 and 4 similar)
  10 Epiphysis.
Note that there is only a proximal epiphysis in the middle phalanges.
  11 Growth plate
     11(a) Open
G Distal phalanx of digit 5 (2, 3 and 4 similar)
H Metacarpal bone 1
  12 Epiphysis.
Note that there is only a proximal epiphysis in this metacarpal bone.
  13 Growth plate
     13(a) Open
I Proximal phalanx of digit 1
  14 Epiphysis.
Note that there is only a proximal epiphysis.
  15 Growth plate
     15(a) Open
J Distal phalanx of digit 1
Figure 99  Age 4 weeks.
Figure 100  Age 8 weeks.
Figure 101  Age 13 weeks.
Figure 102

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Figure 103

Figure 103  Age 25 weeks.
Figure 104

Figure 104  Age 34 weeks.
Figure 105


A Radius
1 Distal epiphysis
2 Distal growth plate
   2(a) Open
   2(b) Closing

B Ulna
3 Distal epiphysis
4 Distal growth plate
   4(a) Open
   4(c) Remnant

C Carpus
5 Epiphysis of accessory carpal bone
6 Accessory carpal bone growth plate
   6(a) Open

D Metacarpal bone 2 or 5 (3 and 4 similar but longer)
7 Epiphysis.
Note that there is only a distal epiphysis in these metacarpal bones.
8 Growth plate
   8(a) Open
   8(c) Remnant
9 Proximal sesamoid bone
10 Dorsal sesamoid bone associated with digits 3 and 4

E Proximal phalanx digits 2 or 5 (3 and 4 similar)
11 Epiphysis.
Note that there is only a proximal epiphysis in the proximal phalanges.
12 Growth plate
   12(a) Open
   12(c) Remnant
F Middle phalanx digits 2 or 5 (3 and 4 similar)
13 Epiphysis.
Note that there is only a proximal epiphysis in the middle phalanges.
14 Growth plate
   14(a) Open
G Distal phalanx digit 2 or 5 (3 and 4 similar)
H Metacarpal bone 1
15 Epiphysis.
Note that there is only a proximal epiphysis in this metacarpal bone.
16 Growth plate
   16(a) Open
17 Proximal sesamoid bone
I Proximal phalanx digit 1
18 Epiphysis.
Note that there is only a proximal epiphysis.
19 Growth plate
   19(a) Open
J Distal phalanx digit 1
Figure 105  Age 4 weeks.
Figure 106  Age 8 weeks.
Figure 107

Age 13 weeks.
Figure 108

Age 17 weeks.
Figure 109

Age 25 weeks.
**Figure 110** Age 34 weeks.

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 111  Ventrodorsal projection of hip joints and pelvis with full extension of femurs (stifle joints included for hip dysplasia evaluation). Beagle dog 2.5 years old, entire male.

Figure 112  Line drawing of photograph representing radiographic positioning for Figure 111.
Figure 113 Ventrodorsal projection of hip joints and pelvis with full extension of femurs. To simplify the labelling each structure has been numbered on one side or the other but not on both sides. Also, the vertebral column has not been fully labelled.

A Ilium
1 Crest
2 Gluteal surface
3 Tuber sacrale or dorsal iliac spine
3(a) Cranial dorsal iliac spine
3(b) Caudal dorsal iliac spine
4 Wing
5 Tuber coxae or ventral iliac spine
5(a) Cranial ventral iliac spine
5(b) Caudal ventral iliac spine
6 Body

B Pubis
7 Position of iliopubic eminence. Eminence is often seen as a distinct process where cranial pubic border joins ilium.
8 Pecten
9 Pubic symphysis. Part of symphysis of pelvis.

C Ischium
10 Ischiatic symphysis. Part of symphysis of pelvis.
11 Obturator foramen
12 Ischiatic spine
13 Ischiatic table
14 Ischiatic tuberosity
15 Ischiatic arch

D Acetabulum
16 Cranial acetabular edge
17 Cranial effective acetabular rim
18 Dorsal acetabular edge
19 Ventral acetabular edge
20 Acetabular fossa
20(a) Acetabular notch
20(b) Acetabular fissure

E Femur
21 Head
22 Neck
23 Greater trochanter
23(a) Trochanteric fossa
24 Lesser trochanter (more distinct in left leg)
25 Body
26 Lateral condyle
27 Medial condyle
28 Intercondylar fossa

F Sacrum
29 Wing
30 Lateral sacral crest
31 Median sacral crest
32 Articular surface with ilium wing
32(a) Synovial part of articular surface
32(b) Cartilaginous part of articular surface

G Tibia

H Patella

I Fabella of m.gastrocnemius (lateral and medial heads)

J Fabella of m.popliteus

K Coccygeal vertebra

L Lumbar vertebra. (Chronic degenerative changes are present on the left side of 6th. and 7th. vertebrae at disc space level. Please see ‘normality’ in the Introduction.)

M Os penis
Figure 114  Schematic drawing of ventrodorsal projection of hip joints and pelvis with full extension of femurs to demonstrate extent of joints and ligaments.

Sacroiliac joint
This is a combination of a synovial and cartilaginous joint. The joint capsule is very thin and the two wings are united by a layer of fibrocartilage. Both ventrally and dorsally wide bands of sacroiliac ligaments cover the joint capsule. The dorsal group is more substantial.

  a = Dorsal sacroiliac ligament
  b = Ventral sacroiliac ligament
  c = Sacrotuberous ligament

Hip joint
  d = Joint capsule
  e = Ligament of the head of the femur. Formerly called the round ligament. It extends from the fovea capitis of the femoral head to the acetabular fossa. The fovea capitus is not clearly seen in this radiograph but is often visible as a flattening on the medial aspect of the femoral head.
  f = Transverse acetabular ligament
  g = Soft tissue shadow of prepuce. This shadow often causes confusion if it is not identified and traced along its entire length. The increase in radiopacity created by its superimposition over bony structures may lead to misdiagnosis.
Figure 115  Ventrodorsal projection of hip joints and pelvis with abduction of femurs. The so-called ‘frog legged’ projection. Beagle dog 2.5 years old, entire male (same dog as in Figure 111).

Figure 116  Line drawing of photograph representing radiographic positioning for Figure 115.
Figure 117  Ventrodorsal projection of hip joints and pelvis with abduction of femurs. The so-called ‘frog legged’ projection.

A  Ilium
   1  Crest
   2  Tuber sacrale or dorsal iliac spine
      2(a) Cranial aspect of dorsal iliac spine
      2(b) Caudal aspect of dorsal iliac spine
   3  Wing
   4  Tuber coxae or ventral iliac spine
      4(a) Cranial ventral iliac spine
      4(b) Caudal ventral iliac spine
   5  Body

B  Pubis
   6  Position of iliopectineal eminence. (The eminence is more prominent in this projection than in the corresponding fully extended femora projection, Figure 113.)
   7  Pecten
   8  Pubic symphysis. Part of symphysis of pelvis.

C  Ischium
   9  Ischiatic symphysis. Part of symphysis of pelvis.
   10 Obturator foramen
   11 Ischiatic spine
   12 Ischiatic table
   13 Ischiatic tuberosity
   14 Ischiatic arch

D  Acetabulum
   15 Cranial acetabular edge
   16 Cranial effective acetabular rim
   17 Dorsal acetabular edge
   18 Ventral acetabular edge
   19 Acetabular fossa
      19(a) Acetabular notch
      19(b) Acetabular fissure

E  Femur
   20 Head
   21 Neck
   22 Greater trochanter
   23 Lesser trochanter
   24 Body

F  Sacrum
   25 Wing
   26 Lateral sacral crest
   27 Median sacral crest
   28 Sacroiliac articulation. Synovial part cranial to cartilaginous part of joint.

G  Coccygeal vertebra

H  Lumbar vertebra (see comments on fully extended femora projection, Figure 113)

I  Os penis
Figure 118  Lateral projection of hip joints and pelvis. Beagle dog 2.5 years old, entire male.

Figure 119  Line drawing of photograph representing radiographic positioning for Figure 118.
Figure 120  Lateral projection of hip joints and pelvis.

A Ilium
1 Crest
2 Tuber sacrale or dorsal iliac spine
2(a) Cranial aspect of spine
2(b) Caudal aspect of spine
3 Caudal ventral iliac spine. (Cranial ventral iliac spine is not visible in this film.) Cranial and caudal ventral iliac spines form the tuber coxae or ventral iliac spine.
4 Wing
5 Body

B Pubis
6 Iliopubic eminence
7 Pecten of pubis

C Ischium
8 Pelvic symphysis
9 Obturator foramen
10 Ischiatic spine
11 Ischiatic tuberosity
12 Ischiatic table

D Acetabulum

E Femur
13 Head
14 Neck
15 Greater trochanters (shadows are not clearly visible but they will extend almost, if not quite, as far proximal as do the femoral heads on a truly lateral projection)
16 Lesser trochanter

F Sacrum
17 Sacroiliac articulation
18 Sacral lamina (dorsal surface is not clearly distinguishable)
19 Vertebral canal

G Coccygeal vertebra

H Lumbar vertebra
Figure 121  Lateral oblique projection of hip joints and pelvis. Beagle dog 7 years old, entire male.

Figure 122  Line drawing of photograph representing radiographic positioning for Figure 121.
Figure 123  Lateral oblique projection of hip joints and pelvis.

A  Ilium
   1  Crest
   2  Tuber sacrale or dorsal iliac spine
      2(a) Cranial dorsal iliac spine
      2(b) Caudal dorsal iliac spine
   3  Tuber coxae or ventral iliac spine
      3(a) Cranial ventral iliac spine
      3(b) Caudal ventral iliac spine

B  Pubis
   4  Iliopubic eminence
   5  Pecten

C  Ischium
   6  Ischiatic tuberosity
   7  Pelvic symphysis

   8  Obturator foramen
      8(a) Obturator foramen recumbent side
      8(b) Obturator foramen non-recumbent side
   9  Ischiatic spine

D  Acetabulum

E  Femur
   10 Head
   11 Neck
   12 Greater trochanter
   13 Lesser trochanter

F  Sacrum
   G  Coccygeal vertebra

H  Lumbar vertebra
Figure 124  Mediolateral projection of femur. Beagle dog 7 years old, entire male.

Figure 125  Line drawing of photograph representing radiographic positioning for Figure 124.
Figure 126  Mediolateral projection of femur.

A  Ilium  
B  Acetabulum  
C  Pubis  
D  Ischium  
1  Obturator foramen  
E  Femur  
2  Head  
3  Neck  
4  Greater trochanter  
5  Lesser trochanter  
6  Trochanteric fossa  
7  Body  
7(a)  Nutrient foramen (just visible as a radiolucent track through cortex)  
8  Trochlear groove  
9  Trochlear ridge  
10  Lateral condyle  
11  Medial condyle  
12  Base of intercondylar fossa  
13  Lateral condyle  
14  Medial condyle  
15  Intercondylar eminence. More caudal shadow is lateral.  
16  Tibial tuberosity  
17  Cranial border or 'tibial crest' as formerly known  
G  Fibula  
H  Patella  
I  Fabella of m.gastrocnemius  
I₁  Lateral fabella  
I₂  Medial fabella  
J  Fabella of m.popliteus  
K  Os penis  
L  Scrotal shadow
Figure 127  Craniocaudal projection of femur. Beagle dog 2.5 years old, entire male.

Figure 128  Line drawing of photograph representing radiographic positioning for Figure 127.
Figure 129  Craniocaudal projection of femur.

A  Ilium
B  Pubis
C  Acetabulum
   Acetabular features:
   1  Cranial acetabular edge
   2  Dorsal acetabular edge
   3  Ventral acetabular edge
   4  Acetabular notch
   5  Acetabular fissure
D  Ischium
   6  Obturator foramen
   7  Ischiatic tuberosity
E  Femur
   8  Head
   9  Neck
   10 Greater trochanter
   11 Lesser trochanter
   12 Trochanteric fossa
   13 Body
   14 Medial condyle
   15 Lateral condyle
   16 Intercondylar fossa
   17 Medial trochlear ridge
   18 Lateral trochlear ridge
F  Tibia
   19 Medial condyle
   20 Lateral condyle
   21 Intercondylar eminence
G  Fibula
H  Patella
I  Fabella of m.gastrocnemius
J  Fabella of m.popliteus
Figure 130  Mediolateral projection of stifle joint. Beagle dog 7 years old, entire male.

Figure 131  Line drawing of photograph representing radiographic positioning for Figure 130.
**Figure 132** Mediolateral projection of stifle joint.

A Femur
1. Trochlear ridges. Medial is more dorsal than lateral
2. Trochlear groove
3. Medial trochlear ridge
4. Lateral trochlear ridge
5. Base of intercondylar fossa
6. Lateral condyle (indentation of extensor fossa only just visible)
7. Medial condyle

B Tibia
8. Lateral condyle
9. Medial condyle
10. Intercondylar eminence or intercondylar tubercles. More caudal is lateral.
11. Tibial tuberosity
12. Cranial border or ‘tibial crest’ as formerly known

C Fibula
13. Head

D Patella

E Lateral fabella of m.gastrocnemius
F Medial fabella of m.gastrocnemius
G Fabella of m.popliteus

**Figure 133** Line drawing of mediolateral projection of stifle joint to demonstrate soft tissue shadows seen in radiograph Figure 130.

1. Skin at cranial aspect of limb
2. Patellar ligament
3. Infrapatellar fat pad. Reduction of this grey shadow is normally seen with joint enlargement, most commonly secondary to effusion.
4. Soft tissue opacity from joint capsule, synovial fluid, menisci, ligaments and tendons in this region
5. Fat tissue shadow from adipose tissue within fascial planes in this region. Disturbance of this shadow usually reflects joint enlargement most commonly due to effusion.
Figure 134  Schematic drawing of mediolateral projection of stifle joint to demonstrate extent of joint capsule.

-  = Joint capsule

-  = Synovial space

a = Distolateral extension around tendon of the m.extensor digitorum longus where it traverses the extensor groove of the lateral tibial condyle.

Note that the stifle joint cavity extends into the synovial joints made by the patella, lateral and medial fabellae and the fibula as well as the femorotibial joint.

Figure 135  Schematic drawing of mediolateral projection of stifle joint. The positions of ligaments and tendons on the axial and lateral aspects are indicated.

1 = Lateral femoropatellar ligament
2 = Tendon insertion of m.quadriceps femoris into the patella
3 = Patellar ligament
4 = Tendon of m.extensor digitorum longus
5 = Lateral collateral ligament
6 = Tendon of m.popliteus plus sesamoid bone
7 = Ligament of fibular head

Meniscal and cruciate ligaments not shown but will be found in the femorotibial joint between the tendons of m.extensor digitorum longus and m.popliteus.

Figure 136  Schematic drawing of mediolateral projection of stifle joint. The positions of ligaments and tendons on the axial and medial aspects are indicated.

1 = Medial femoropatellar ligament
2 = Tendon insertion of m.quadriceps femoris into the patella
3 = Patellar ligament
4 = Medial collateral ligament
5 = Region of menisci

Meniscal and cruciate ligaments not shown but will be found in the region of menisci.
**Figure 137** Caudocranial projection of stifle joint. Beagle dog 2.5 years old, entire male.

**Figure 138** Line drawing of photograph representing radiographic positioning for Figure 137.

**Figure 139** Caudocranial projection of stifle joint.

A Femur
1 Medial trochlear ridge
2 Lateral trochlear ridge
3 Medial condyle
4 Lateral condyle
5 Intercondylar fossa

B Tibia
6 Medial condyle
7 Lateral condyle
8 Intercondylar eminence or medial and lateral intercondylar tubercles
9 Tibial tuberosity
10 Cranial border or ‘tibial crest’ as formerly known

10(a) Outline for the extensor muscles, especially m.cranialis tibialis
C Fibula
11 Head

D Patella
E Lateral fabella of m.gastrocnemius
F Medial fabella of m.gastrocnemius
G Fabella of m.popliteus

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**Figure 140** Line drawing of caudocranial projection of stifle joint to demonstrate soft tissue shadows seen in radiograph Figure 137.

1 Fat tissue shadow from adipose tissue within fascial planes. Disturbances of these shadows usually reflect joint enlargement, most commonly due to joint effusions.

2 Skin limits

**Figure 141** Schematic drawing of caudocranial projection of stifle joint. Extent of the joint capsule on the cranial aspect of the joint has been indicated.

- = Joint capsule
- = Synovial space. Note that patella is not in synovial space.

a = Distal extension surrounding tendon of m.extensor digitorum longus. Only present on cranial aspect.

**Figure 142** Schematic drawing of caudocranial projection of stifle joint. Extent of the joint capsule on the caudal aspect of the joint has been indicated.

- = Joint capsule
- = Synovial space. Note that fabellae are not in the synovial space but the joint cavity extends into the joints between fabellae and femur.
Figure 143  Schematic drawing of caudocranial projection of stifle joint. Positions of ligaments of the medial, lateral and cranial aspects are indicated. Positions of the menisci are also shown.

1 = Femoropatellar ligaments
2 = Collateral ligaments
  2(a) = Medial
  2(b) = Lateral
3 = Cranial fibular ligament
4 = Cranial cruciate ligament
5 = Caudal cruciate ligament
6 = Transverse or intermeniscal ligament
7 = Medial meniscus
8 = Lateral meniscus

Meniscal ligaments attaching menisci to tibia and femur not shown. Patellar ligament excluded to avoid confusion.

Figure 144  Schematic drawing of caudocranial projection of stifle joint. Positions of ligaments of the medial, lateral and caudal aspects are indicated. Positions of the menisci are also shown.

1 = Collateral ligaments
  1(a) = Medial
  1(b) = Lateral
2 = Caudal fibular ligament
3 = Cranial fibular ligament
4 = Caudal cruciate ligament.
  Extends from axial surface of medial femoral condyle to tibial popliteal notch. It is longer and heavier than cranial.
5 = Cranial cruciate ligament.
  Extends from caudal part of axial surface of lateral femoral condyle to cranial intercondylar area of tibia.
6 = Meniscofemoral ligament
7 = Medial meniscus
8 = Lateral meniscus

Meniscal ligaments attaching menisci to tibia and intermeniscal ligament not shown. Patellar ligament excluded to avoid confusion.
Figure 145  Mediolateral projection of tibia and fibula.
Beagle dog 7 years old, entire male.

Figure 146  Line drawing of photograph representing
radiographic positioning for Figure 145.
Figure 147  Mediolateral projection of tibia and fibula.

A Femur
1 Lateral condyle
2 Medial condyle
3 Base of intercondyloid fossa
4 Lateral condyle
5 Medial condyle
6 Intercondyloid eminence or intercondyloid tubercles. The more caudal shadow is the lateral tubercle
7 Tibial tuberosity
8 Cranial border or ‘tibial crest’ as formerly known
9 Medial malleolus
10 Distal articular border
11 Nutrient foramen (only just visible but can mimic a fracture if the tibia is slightly rotated on exposure)

B Tibia

C Fibula
12 Head
13 Lateral malleolus
D Lateral fabella of m.gastrocnemius
E Medial fabella of m.gastrocnemius
F Fabella of m.popliteus

G Tibial tarsal bone or talus
14 Lateral trochlear ridge
15 Medial trochlear ridge
16 Trochlear groove

H Fibular tarsal bone or calcaneus
17 Sustentaculum tali
18 Calcaneal tuber
**Figure 148** Caudocranial projection of tibia and fibula. Beagle dog 2.5 years old, entire male.

**Figure 149** Line drawing of photograph representing radiographic positioning for Figure 148.
Figure 150  Caudocranial projection of tibia and fibula.

**A** Femur
1 Medial condyle
2 Lateral condyle
2(a) Extensor fossa. Origin of m.flexor digitorum longus.
3 Intercondyloid fossa

**B** Tibia
4 Medial condyle
5 Lateral condyle
6 Intercondyloid eminence or intercondyloid tubercles
7 Tibial tuberosity
8 Cranial border or ‘tibial crest’ as formerly known
8(a) Outline of concavity in the tibia which houses extensor muscles
9 Medial malleolus
10 Distal articular border

**C** Fibula
11 Head
12 Lateral malleolus

**D** Medial fabella of m.gastrocnemius. (Note the unusual position of this fabella in relationship to the medial femoral condyle. This is an anatomical variant which is not to be misdiagnosed as a rupture of the m.gastrocnemius.)

**E** Fabella of m.popliteus

**F** Tibial tarsal bone or talus
13 Medial trochlear ridge
14 Lateral trochlear ridge

**G** Fibular tarsal bone or calcaneus
15 Sustentaculum tali
16 Calcaneal tuber
**Figure 151** Plantarodorsal projection of tarsus. Beagle dog 2.5 years old, entire male.

**Figure 153** Plantarodorsal projection of tarsus.

A Tibia
1 Medial malleolus
2 Distal articular border. (Medial and lateral grooves.)
2(a) Distal articular border. (Cranial aspect.)

B Fibula
3 Lateral malleolus. (Note the relatively proximal position of the lateral malleolus compared to the medial malleolus. In many dogs the malleoli are at an equal distal level.)

C Tibial tarsal bone or talus
4 Medial trochlear ridge
5 Lateral trochlear ridge
6 Head

D Fibular tarsal bone or calcaneus
7 Sustentaculum tali
8 Calcaneal tuber

E Central tarsal bone
9 Tarsal sinus. (Radiolucent shadow which is the space between talus and calcaneus extends more distally than can be seen in this projection.)

10 Plantar process
F Tarsal bone 1
G Tarsal bone 2
H Tarsal bone 3
I Tarsal bone 4
J Metatarsal bone 1
K Metatarsal bone 2
L Metatarsal bone 3
M Metatarsal bone 4
N Metatarsal bone 5

**Figure 152** Line drawing of photograph representing radiographic positioning for Figure 151.
Figure 154  Extended mediolateral projection of tarsus. Beagle dog 2.5 years old, entire male.

Figure 155  Line drawing of photograph representing radiographic positioning for Figure 154.

Figure 156  Extended mediolateral projection of tarsus.

A Tibia
  1 Medial malleolus
  2 Distal articular border

B Fibula
  3 Lateral malleolus

C Tibial tarsal bone or talus
  4 Lateral trochlear ridge
  5 Medial trochlear ridge
  6 Trochlear groove

D Fibular tarsal bone or calcaneus
  7 Sustentaculum tali
  8 Calcaneal tuber

E Central tarsal bone
  9 Plantar process

F Tarsal bone 1
G Tarsal bone 2
H Tarsal bone 3
I Tarsal bone 4
J Metatarsal bone 1
K Metatarsal bone 3
L Combined shadows of metatarsal bones 2, 4 and 5
M Metatarsal bone 2
N Metatarsal bone 5
Figure 157  Schematic drawing of extended mediolateral projection of tarsus. Positions of ligaments of the lateral aspect are indicated.

1 = Lateral collateral ligament. Long part.
2 = Lateral collateral ligament. Short part.
3 = Lateral collateral ligament. Calcaneometatarsal part.
4 = Plantar ligament

Figure 158  Schematic drawing of extended mediolateral projection of tarsus. Positions of ligaments of the medial aspect are indicated. Position of the Achilles’ tendon is also shown.

1 = Achilles’ tendon or calcanean tendon. Components are mainly superficial digital flexor and m.gastrocnemius. Also present are the m.biceps femoris, m.semitendinosus and m.gracilis.

2 = Medial collateral ligament. Long part.
3 = Medial collateral ligament. Short part.
3(a) To tibial tarsal bone
3(b) To sustentaculum tali
3(c) To long part of medial collateral ligament
3(d) From sustentaculum tali to base of metatarsal bones 2, 3 and 4

4 = Origin of long plantar ligament

Dorsal tarsal ligaments not shown. Intertarsal ligaments, proximal extensor retinaculum and distal extensor retinaculum not shown.
Figure 159  Flexed mediolateral projection of tarsus. Beagle dog 2.5 years old, entire male.

Figure 160  Line drawing of photograph representing radiographic positioning for Figure 159.

Figure 161  Flexed mediolateral projection of tarsus.
A  Tibia
   1 Medial malleolus
   2 Distal articular border
B  Fibula
   Lateral malleolus cannot be identified as a separate structure
C  Tibial tarsal bone or talus
   3 Lateral trochlear ridge
   4 Medial trochlear ridge
   5 Trochlear groove
D  Fibular tarsal bone or calcaneus
   6 Sustentaculum tali
   7 Calcaneal tuber
E  Central tarsal bone
   8 Plantar process
F  Tarsal bone 1
G  Tarsal bone 2
H  Tarsal bone 3
I  Tarsal bone 4
J  Metatarsal bone 1
K  Metatarsal bone 3
L  Combined shadows of metatarsal bones 2, 4 and 5
M  Metatarsal bone 2
N  Metatarsal bone 5
**Figure 162** Plantaromedial-dorsolateral oblique projection of tarsus. Beagle dog 2.5 years old, entire male.

**Figure 163** Line drawing of photograph representing radiographic positioning for Figure 162.

**Figure 164** Plantaromedial-dorsolateral oblique projection of tarsus.

A Tibia  
1 Medial malleolus  
2 Distal articular border  
B Fibula  
3 Lateral malleolus  
C Tibial tarsal bone or talus  
4 Lateral trochlear ridge  
5 Medial trochlear ridge  
D Fibular tarsal bone or calcaneus  
6 Calcaneal tuber  
E Central tarsal bone  
7 Plantar process  
F Tarsal bone 1  
G Tarsal bone 2  
H Tarsal bone 3  
I Tarsal bone 4  
8 Tuberosity on plantar aspect  
J Metatarsal bone 1  
K Metatarsal bone 2  
L Metatarsal bone 3  
M Metatarsal bone 4  
N Metatarsal bone 5
**Figure 165** Dorsoplantar projection of calcaneus and talus (flexed). Beagle dog 2.5 years old, entire male.

**Figure 166** Line drawing of photograph representing radiographic positioning for Figure 165.

**Figure 167** Dorsoplantar projection of calcaneus and talus (flexed).

- **A** Tibia
  - 1 Medial malleolus
  - 2 Distal articular border
- **B** Fibula
  - 3 Lateral malleolus
- **C** Tibial tarsal bone or talus
  - 4 Lateral trochlear ridge
  - 5 Medial trochlear ridge
  - 6 Medial surface of head
- **D** Fibular tarsal bone or calcaneus
  - 7 Sustentaculum tali
  - 8 Calcaneal tuber
  - 9 Tuberosity on plantar surface
  - 10 Groove for tendon of m.fibularis longus
- **E** Central tarsal bone
- **F** Proximal tarsal bones 1, 2 and 3
- **G** Tarsal bone 4
- **H** Metatarsal bones
Figure 168  Plantarodorsal projection of metatarsus and phalanges. Beagle dog 2.5 years old, entire male.

Figure 169  Line drawing of photograph representing radiographic positioning for Figure 168.
Figure 170  Plantarodorsal projection of metatarsus and phalanges.

A  Tibia
B  Fibula
C  Tibial tarsal bone or talus
D  Fibular tarsal bone or calcaneus
E  Central tarsal bone (Note bony shadow of plantar process which appears as a radiopaque body)
F  Tarsal bone 1
G  Tarsal bone 2
H  Tarsal bone 3
I  Tarsal bone 4
J  Metatarsal bone 1
  1  Base
  2  Body
  3  Head
K  Metatarsal bone 2
L  Metatarsal bone 3
M  Metatarsal bone 4
N  Metatarsal bone 5
O  Proximal sesamoid bones. Present on plantar aspect.
P  Dorsal sesamoid bones (Just visible)
Q  Proximal phalanges or 1st. phalanges
  4  Base
  5  Body
  6  Head
The metatarsal pad is seen as a distinct soft tissue shadow superimposed on the proximal phalanges
R  Middle phalanges or 2nd. phalanges
Divided into base, body and head as proximal phalanges
  7  Proximal articular border
  8  Distal articular border
S  Distal phalanges or 3rd. phalanges
  9  Ungual crest
  10  Ungual process
Figure 171  Mediolateral projection of metatarsus and phalanges. Beagle dog 7 years old, entire male.

Figure 172  Line drawing of photograph representing radiographic positioning for Figure 171.
Figure 173  Mediolateral projection of metatarsus and phalanges.

A  Tibial tarsal bone or talus
B  Fibular tarsal bone or calcaneus
C  Central tarsal bone
D  Tarsal bone 1
E  Tarsal bone 2
F  Tarsal bone 3
G  Tarsal bone 4
H  Metatarsal bone 1
I  Metatarsal bone 2
J  Metatarsal bone 3
K  Metatarsal bone 4
L  Metatarsal bone 5
1 Superimposed heads of metatarsal bones 2 and 5
2 Superimposed heads of metatarsal bones 3 and 4
M  Proximal sesamoid bones.
   Two in number at plantar aspect of each proximal interphalangeal joint.
N  Dorsal sesamoid bones.
   One in number at dorsal aspect of each proximal interphalangeal joint.
O  Proximal phalanges or 1st phalanges
P  Middle phalanges or 2nd phalanges
Q  Distal phalanges or 3rd phalanges
3 Ungual crest
4 Ungual process
5 Flexor tuberosity
6 Extensor tuberosity
7 Nutrient canal
Figure 174  Ventrodorsal projection of pelvis and hip joints. Toy breed of dog. Yorkshire Terrier dog 2 years old, entire female.
Figure 175 Ventrodorsal projection of pelvis and hip joints. Chondrodystrophic breed of dog. Standard Dachshund dog 7 years old, entire male.
Figure 176  Ventrodorsal projection of pelvis and hip joints. Giant breed of dog. English Bull Mastiff dog 21 months old, entire male.
**Figure 177** Mediolateral projection of femur. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

**Figure 178** Mediolateral projection of stifle joint. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
Figure 179  Caudocranial projection of stifle joint. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

Figure 180  Mediolateral projection of tibia and fibula. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.
**Figure 181** Mediolateral projection of tarsus and phalanges. Chondrodystrophic breed of dog. Miniature Dachshund dog 6 years old, neutered female.

**Figure 182** Plantarodorsal projection of tarsus and phalanges. Giant breed of dog. Pyrenean Mountain dog 4 years old, entire female. The radiograph demonstrates the unusual bony appendage of the central tarsal bone that can be found in a number of giant breeds of dog. More obvious for the Pyrenean Mountain dog is the congenital development of the 1st. digit which is a breed point for showing.
**Figures 183, 184, 185, 186, 187, 188, 189, 190** Ventrodorsal projection of pelvis and craniocaudal projection of proximal femur. Samoyed Crossbred dog, entire male, at 4, 8, 13, 17, 21, 25, 34 and 47 weeks of age.

- **A** Ilium
- **B** Pubis
- **C** Ischium
  - 1 Iliopubic growth plate
    - 1(a) Open
  - 2 Ilioischial growth plate
    - 2(a) Open
    - 2(b) Closing
  - 3 Acetabular bone
  - 4 Ischiopubic growth plate
    - 4(a) Open
    - 4(c) Remnant
  - 5 Symphysis of pelvis
    - 5(a) Open
  - 6 Ischiatic tuberosity
  - 7 Ischiatic tuberosity growth plate
    - 7(a) Open
    - 7(b) Closing
  - 8 Ischial arch centre
  - 9 Ischial arch growth plate
    - 9(a) Open
    - 9(b) Closing
  - 10 Median ischial arch centre
  - 11 Median ischial arch growth plate
    - 11(a) Open

- **D** Femur
  - 12 Head
  - 13 Proximal growth plate
    - 13(a) Open
    - 13(b) Closing
  - 14 Greater trochanter
  - 15 Greater trochanter growth plate
    - 15(a) Open
    - 15(b) Closing
  - 16 Lesser trochanter

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*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
Figure 184

Figure 184  Age 8 weeks.
Dog – Hindlimb

Figure 185
Figure 185  Age 13 weeks.
Figure 186
Figure 186  Age 17 weeks.
Dog – Hindlimb

Figure 187
Figure 187  Age 21 weeks.
Figure 188
Figure 188  Age 25 weeks.
Figure 189

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 189  Age 34 weeks.
Figure 190
Figure 190  Age 47 weeks.
Figures 191, 192, 193, 194, 195, 196, 197, 198  Mediolateral projection of stifle joint. Samoyed crossbred dog, entire male, at 4, 8, 13, 17, 21, 25, 34 and 43 weeks of age.

A Femur
1 Distal epiphysis
2 Distal growth plate
   2(a) Open
   2(b) Closing
   2(c) Remnant

B Tibia
3 Proximal epiphysis
4 Proximal growth plate
   4(a) Open
   4(c) Remnant
5 Tibial tuberosity
6 Tibial tuberosity growth plate to diaphysis
   6(a) Open
   6(b) Closing

7 Tibial tuberosity growth plate to proximal
   epiphysis
   7(a) Open
   7(b) Closing
   7(c) Remnant

C Fibula
8 Proximal epiphysis
9 Proximal growth plate
   9(a) Open
   9(c) Remnant

D Patella
E Fabellae of m.gastrocnemius
F Fabella of m.popliteus

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 192  Age 8 weeks.
Figure 193

Figure 193 Age 13 weeks.
Figure 194  Age 17 weeks.
Figure 195

Figure 195  Age 21 weeks.
Figure 196

Figure 196  Age 25 weeks.
Figure 197

Age 34 weeks.
Figure 198  Age 43 weeks.
Figures 199, 200, 201, 202, 203, 204, 205, 206  
Craniocaudal projection of stifle joint. Samoyed Crossbred dog, entire male, at 4, 8, 13, 17, 21, 25, 34 and 43 weeks of age.

A  Femur
   1  Distal epiphysis
   2  Distal growth plate
      2(a) Open
      2(b) Closing
      2(c) Remnant

B  Tibia
   3  Proximal epiphysis
   4  Proximal growth plate
      4(a) Open
      4(c) Remnant
   5  Tibial tuberosity

C  Fibula
   6  Proximal epiphysis
   7  Proximal growth plate
      7(a) Open
      7(c) Remnant

D  Patella

E  Fabella of m.gastrocnemius

Fabella of m.popliteal is not visible on any of these films.

Figure 199  
Age 4 weeks.
Figure 200  Age 8 weeks.
Figure 201  Age 13 weeks.
Figure 202

Figure 202  Age 17 weeks.
Figure 203

A – Hindlimb

Figure 203  Age 21 weeks.
Figure 204  Age 25 weeks.
Figure 205

Figure 205  Age 34 weeks.
Figure 206

Age 43 weeks.
**Figures 207, 208, 209, 210, 211, 212**  
Dorsoplantar projection of tarsus, metatarsal bones and phalanges. Samoyed Crossbred dog, entire male, at 4, 8, 13, 21, 25 and 34 weeks of age.

A Tibia
1 Distal epiphysis.  
Initially with separate ossification centre for medial malleolus.
2 Distal growth plate  
2(a) Open  
2(b) Closing  
2(c) Remnant

B Fibula
3 Distal epiphysis  
4 Distal growth plate  
4(a) Open  
4(b) Closing

C Tarsus.  
Only tibial tarsal bone, body of fibular tarsal bone, central tarsal bone and tarsal bone 4 are seen at 4 weeks of age.

D Metatarsal bone 5 (2, 3 and 4 are similar)  
5 Epiphysis.  
Note that there is only a distal epiphysis in these metatarsal bones.

E Proximal phalanx of digit 5 (2, 3 and 4 are similar)  
8 Epiphysis.  
Note that there is only a proximal epiphysis in the proximal phalanges.

F Middle phalanx of digit 5 (2, 3 and 4 are similar)  
10 Epiphysis.  
Note that there is only a proximal epiphysis in the middle phalanges.

G Distal phalanx of digit 5 (2, 3 and 4 are similar)

H Metatarsal bone 1

6 Growth plate  
6(a) Open  
6(b) Closing  
7 Proximal sesamoid bones  
9 Growth plate  
9(a) Open  
9(b) Closing  
11 Growth plate  
11(a) Open

*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
Figure 208

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 209

Age 13 weeks.

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 210

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 211

Age 25 weeks.

Figure 211
Figure 212

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat

Figure 212  Age 34 weeks.
**Figure 213**

**Figures 213, 214, 215, 216, 217, 218** Mediolateral projection of tarsus, metatarsal bones and phalanges. Samoyed Crossbred dog, entire male, at 4, 8, 13, 21, 25 and 34 weeks of age.

A Tibia
1 Distal epiphysis
2 Distal growth plate
   2(a) Open
   2(b) Closing
   2(c) Remnant

B Fibula
3 Distal epiphysis
4 Distal growth plate
   4(a) Open
   4(b) Closing

C Tarsus.
Only tibial tarsal bone, body of fibular tarsal bone, central tarsal bone and tarsal bone 4 are seen at 4 weeks of age.
5 Epiphysis of fibular tarsal bone
6 Fibular tarsal bone growth plate
   6(a) Open
   6(b) Closing
   6(c) Remnant

D Metatarsal bone 2 or 5 (3 and 4 are similar)
7 Epiphysis.
   Note that there is only a distal epiphysis in these metatarsal bones.

8 Growth plate
   8(a) Open
   8(b) Closing

9 Proximal sesamoids

E Proximal phalanx 2 or 5 (3 and 4 are similar)
10 Epiphysis.
   Note that there is only a proximal epiphysis in the proximal phalanges.
11 Growth plate
   11(a) Open
   11(b) Closing

F Middle phalanx 2 or 5
12 Epiphysis.
   Note that there is only a proximal epiphysis in the middle phalanges.

G Distal phalanx 2 or 5

H Metatarsal bone 1

I Dorsal sesamoid bone
Figure 214  Age 8 weeks.
Figure 215  Age 13 weeks.
Figure 216

Figure 216  Age 21 weeks.
Figure 217

Age 25 weeks.

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 218  Age 34 weeks.
**Figure 219** Lateral projection of skull. Beagle dog 2.5 years old, entire male.

**Figure 220** Line drawing of photograph representing radiographic positioning for Figure 219.
Figure 221  Lateral projection of skull with teeth shadows excluded for clarity.

A Atlas
B Stylohyoid bones
C Epiphyoid bones
D Ceratohyoid bones
E Basihyoid bone
  1 Incisive bone
  2 Nasal bone
  3 Maxilla or maxillary bone
  4 Frontal bone
  5 Parietal bone
  6 Occipital bone
  7 External occipital protuberance
  8 External occipital crest
  9 Interparietal process of occipital bone
  10 Occipital bone
  11 Paracondylar process of occipital bone or jugular process
  12 Petrous temporal bone or temporal bone; petrosal part.
  13 Tympanic bulla of temporal bone or temporal bone; tympanic part.
  14 External acoustic meatus of temporal bone
  15 Zygomatic process of temporal bone or temporal bone; squamous part.
  16 Retroarticular process of temporal bone
  17 Mandibular fossa of temporal bone
  18 Masseteric border of zygomatic bone
  19 Frontal process of zygomatic bone
  20 Palatine bone
  21 Vomer
  22 Maxillary sinus of maxilla
  23 Cribriform plate of ethmoid bone
  23(a) Rostral limit
  23(b) Caudal limit
  24 Ethmoturbinates of ethmoid bone
  25 Orbital margin
  26 Frontal sinuses. Total of six; three on each side.
  27 Dorsal nasal concha of ethmoid bone
  28 Ventral nasal concha of maxilla
  29 Lamina dura
  30 Basisphenoid bone
  31 Mandible
  32 Mandibular body
  33 Mandibular ramus
  34 Coronoid process of mandible
  35 Condyloid or articular process of mandible
  36 Angular processes of mandible
  37 Mandibular foramen
  38 Mental foramen
  39 Mandibular canal
  39(a) Ventral border
  40 Soft palate
  41 Nasopharynx
Figure 222  Lateral projection of skull to demonstrate details of teeth excluded in Figure 221.

1  Upper incisors. Total of six.
2  Lower incisors. Total of six.
3  Upper canines. Total of two.
4  Lower canines. Total of two.
5  Upper premolars. Total of eight.
6  Lower premolars. Total of eight.
7  Upper molars. Total of four.
8  Lower molars. Total of six.

A  Upper carnassial; 4th. premolar
B  Lower carnassial; 1st. molar

Line drawing only illustrates gross details of teeth as seen in radiograph, Figure 219. More detailed drawings are given in the section on dentition.
Figure 223  Line drawing of lateral projection of skull to demonstrate soft tissue shadows seen in radiograph, Figure 219.

External nose
1 Nostril
2 Nasal vestibule
3 Alar nasal fold
   3(a) Bulbous terminal enlargement
4 Dorsolateral nasal cartilage
5 Straight nasal fold
6 Dorsal nasal meatus
7 Middle nasal meatus
8 Ventral nasal meatus

External ear
9 Pinna
10 Ear canals
The superimposed shadows, 9 and 10, of the external ear can be confused as bony abnormalities.
11 Skin fold level with dorsal aspect of orbits
Figure 224  Ventrodorsal projection of skull. Beagle dog 2.5 years old, entire male (same dog as in dorsoventral projection of skull, Figure 230).

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Dog – Skull

**Figure 225** Line drawing of photograph representing radiographic positioning for Figure 224.

**Figure 226** Ventrodorsal projection of skull with teeth shadows excluded for clarity.

A Atlas
B Axis
  - Hyoid apparatus. The bony shadows are indistinct but all are visible except for the basihyoid.
C Stylohyoid bone
D Epipharyngeal bone
E Ceratohyoid bone
F Thyrohyoid bone
  1 Palatine fissure
  2 Vomer
  3 Maxillary teeth obscuring maxilla shadow
  4 Lamina dura
  5 Ventral nasal conchae and ethmoturbinates
  6 Frontal sinuses
    6(a) Frontal sinuses (lateral)
    6(b) Frontal sinuses (medial)
  7 Cribriform plate of ethmoid enclosing ethmoidal fossa
  8 Medial wall of orbit
  9 Border of choanae formed by palatine bone and pterygoid bone.
    (Hamulus seen as the more opaque shadow at caudal extremity.)
  10 Mandible
  11 Mandibular body
  12 Mandibular ramus
  13 Coronoid process of mandible
  14 Angular process of mandible
  15 Condyloid or articular process of mandible
  16 Temporal process of zygomatic bone
  17 Zygomatic process of temporal bone 16 and 17 form the zygomatic arch
  18 Retroarticular process of temporal bone
  19 Tympanic bulla of temporal bone; tympanic part
  20 External acoustic meatus of temporal bone; tympanic part
  21 Mastoid process of temporal bone; tympanic part
  22 Jugular foramen of temporal bone; tympanic part
  23 Paracondylar process of occipital bone or jugular process
  24 Occipital condyle
  25 External occipital protuberance
  26 Nuchal crest of occipital bone
Figure 227  Line drawing to demonstrate teeth shadows excluded in Figure 226. Ventrodorsal projection of skull.

1 Lower incisor teeth. Total of six
2 Upper incisor teeth. Total of six.
3 Lower canine teeth. Total of two.
4 Upper canine teeth. Total of two.
5 Lower premolar teeth. Total of eight.
6 Upper premolar teeth. Total of eight.
7 Lower molar teeth. Total of six.
8 Upper molar teeth. Total of four. (In this dog 2nd. molar on left side is missing.)

A Lower carnassial; 1st. molar
B Upper carnassial; 4th. premolar

The drawing only illustrates gross details of teeth as seen in radiograph. More detailed drawings are given in the section on dentition.

Figure 228  Line drawing of ventrodorsal projection of skull to demonstrate soft tissue shadows seen in radiograph, Figure 224

1 Nostril
2 Caudal limit of pinna
3 Internal folds of pinna
4 Vertical ear canal
5 Horizontal ear canal
6 External acoustic meatus
7 Neck skin fold
Figure 229  Schematic drawing of ventrodorsal projection of skull to demonstrate the temporomandibular joints and mandibular symphysis.

A = Capsule of temporomandibular joint
B = Lateral ligament

Between the cartilage covered bony articulations is found an articular disc.
C = Symphysis of mandible. (Fibrocartilage is seen as a radiolucent region in the radiograph.)
**Figure 230** Dorsoventral projection of skull. Beagle dog 2.5 years old, entire male (same dog as in ventrodorsal projection of skull, Figure 224).

**Figure 231** Line drawing of photograph representing radiographic positioning for Figure 230.
**Figure 232** Rostrocaudal oblique (45 degree nose tilt) projection of temporomandibular joints. Doberman dog 7 years old, entire male.

**Figure 234** Rostrocaudal oblique (45 degree nose tilt) projection of temporomandibular joints.

A Temporomandibular joint of recumbent side

B Position of temporomandibular joint of non-recumbent side obscured by petrous temporal bones

1 Mandibular body
2 Angular process of mandible
3 Condyloid or articular process of mandible
4 Coronoid process of mandible
5 Mandibular fossa of temporal bone
6 Retroarticular process of temporal bone
7 Tympanic bulla of temporal bone
8 External acoustic meatus of temporal bone
9 Basisphenoid bone
10 Temporal process of zygomatic bone
11 Condyle of occipital bone
12 Atlas
13 Axis
14 Stylohyoid bone
15 Epipharyngeal bone
16 Ceratohyoid bone

**Figure 233** Line drawing of photograph representing radiographic positioning for Figure 232.
Figure 235  Schematic drawing of rostrocaudal oblique (45 degree nose tilt) projection of temporomandibular joints to demonstrate joint capsule and disc.

= Joint capsule

= Articular disc. Divides joint into ventral and dorsal compartments.

Laterally the joint capsule is strengthened to form a fibrous lateral ligament.
Figure 236  Relaxed lateral (open mouth) projection of tympanic bullae. Beagle dog 2.5 years old, entire male.

Figure 237  Line drawing of photograph representing radiographic positioning for Figure 236.

Figure 238  Relaxed lateral (open mouth) projection of tympanic bullae.

1  Tympanic bulla of temporal bone
1(a)  Recumbent side (shaded in drawing)
2  External acoustic meatus of temporal bone
3  Zygomatic process of temporal bone
4  Temporozygomatic suture
5  External protuberance of occipital bone
6  External occipital crest
7  Occipital condyle
8  Paracondylar process of occipital bone or jugular process
9  Atlas
10  Axis
11  Mandible
12  Angular process of mandible
13  Coronoid process of mandible
14  Condyloid or articular process of mandible
15  Mandibular fossa of temporal bone
Note that 14 and 15 are superimposed, hence the temporomandibular joint is not demonstrated.
16  Retroarticular process of temporal bone

Hyoid apparatus
17  Tympanohyoid cartilage (seen as a radiolucent region between tympanic bulla and stylohyoid bone)
18  Stylohyoid bone
19  Epithyoid bone
20  Ceratohyoid bone
21  Basihyoid bone
22  Thyrohyoid bone
Figure 239  Rostroventral-caudodorsal oblique (open mouth) projection of tympanic bullae. Beagle dog 2.5 years old, entire male.

Figure 240  Line drawing of photograph representing radiographic positioning for Figure 239.
Figure 241  Rostroventraleudorsal oblique (open mouth) projection of tympanic bullae.

1 Temporal process of zygomatic bone  
2 Zygomatic process of temporal bone  
3 Mandibular body  
4 Angular process of mandible  
5 Condyloid or articular process of mandible  
6 Vertical ramus of mandible  
7 Retroarticular process of temporal bone  
8 Temporomandibular articulation  
9 Petrous temporal bone (seen as a radiopaque shadow)  
10 Tympanic bulla of temporal bone (shaded in drawing)  
  10(a) External acoustic meatus (characteristic lip at border of meatus which becomes larger with age)  
  10(b) Shadow formed by horizontal ear canal  
11 Canal of auditory tube  
12 Foramen magnum  
13 Caudal edge of palatine bones or hard palate  
14 Condyle of occipital bone  
15 Atlas  
16 Axis  
17 Spinous process of axis  
18 Dens or odontoid peg of axis  
19 Stylohyoid bone  
20 Epiphyoid bone  
21 Ceratothyroid bone  
22 Basihyoid bone  
23 Epiglottis  

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Figure 242  Rostroventral-caudodorsal oblique (open mouth) projection of dens or odontoid peg. Beagle dog 2.5 years old, entire male.

Figure 243  Line drawing of photograph representing radiographic positioning for Figure 242.
Figure 244  Rostroventraleadodorsal oblique (open mouth) projection of dens or odontoid peg.

1  Zygomatic process of temporal bone
2  Mandibular ramus
3  Coronoid process of mandible
4  Angular process of mandible
5  Condyloid or articular process of mandible
6  Temporomandibular articulation
7  Upper molar
8  Petrous temporal bone
9  Tympanic bulla of temporal bone
   9(a) External acoustic meatus (Characteristic lip’at border of meatus)
   9(b) Shadow formed by horizontal ear canal
10 Foramen magnum
  10(a) Dorsal part
  10(b) Ventral part
11 Caudal border of palatine bones or hard palate
12 Condyle of occipital bone
13 Atlas
14 Axis
15 Spinous process of axis
16 Dens or odontoid peg of axis
17 Stylohyoid bone
18 Epithyoid bone
19 Ceratohyoid bone
20 Thyrohyoid bone
21 Basihyoid bone
22 Epiglottis
Figure 245  Caudodorsal-rostroventral oblique projection of foramen magnum. Beagle dog 2.5 years old, entire male.

Figure 246  Line drawing of photograph representing radiographic positioning for Figure 245.
Figure 247  Caudodorsalrostroventral oblique projection of foramen magnum.

1  Parietal bone  
2  Lateral frontal sinus  
3  Septum of frontal sinuses  
4  Medial and rostral frontal sinuses  
5  Foramen magnum  
6  Zygomatic process of frontal bone  
7  Petrous temporal bone  
8  Tympanic bulla of temporal bone  
9  Zygomatic process of temporal bone  
10  Osseous nasal septum  
11  Ethmoturbinates  
12  Coronoid process of mandible  
13  Condyloid or articular process of mandible  
14  Margin of orbit  
15  Maxilla or maxillary bone
**Figure 248** Rostrocaudal projection of frontal sinuses. Beagle dog 2.5 years old, entire male.

**Figure 249** Line drawing of photograph representing radiographic positioning for Figure 248.
Figure 250  Rostrocaudal projection of frontal sinuses.

1 Frontal bone. The inner and outer tables are separated by the lateral frontal sinus.
2 Medial surface of frontal bone. The septum between the frontal sinuses.
3 Lateral surface of frontal bone; orbital part.
4 Zygomatic process of frontal bone
5 Septum between frontal sinuses. Formed by nasal parts of the frontal bones and septal processes of the nasal bones.
6 Frontal sinuses (shaded in drawing). Usually three separate compartments on each side. Compartments are distinct sinuses with their own openings between ethmoturbinates into nasal cavities.
6(a) Rostral frontal sinus and its associated ethmoturbinates. Frontal sinuses extend more rostrally at medial aspect of this region than at lateral aspect.
6(b) Frontal sinus containing ethmoturbinates
7 Parietal bone
8 Squamous part of temporal bone
9 Zygomatic process of temporal bone
10 Frontal process of zygomatic bone
11 Infraorbital margin of zygomatic bone
12 Osseous nasal septum. Perpendicular plate of the ethmoid. The cartilaginous nasal septum is also part of ethmoid bone and is formed by a rostral prolongation of osseous nasal septum. Articulation is with the vomer ventrally and septal processes of frontal and nasal bones dorsally. Note that the cartilaginous nasal septum is radiolucent.
13 Ethmoturbinates and turbinates of ventral nasal concha
14 Dorsal nasal meatus
15 Middle nasal meatus
16 Conchal crest of maxilla
17 Ventral nasal meatus
18 Vomer
19 Nasal bone
20 Maxilla or maxillary bone
**Figure 251**  Dorsoventral intraoral projection of nasal chambers. Beagle dog 2.5 years old, entire male.

**Figure 252**  Line drawing of photograph representing radiographic positioning for Figure 251.
Figure 253  Dorsoventral intraoral projection of nasal chambers.

1  Interincisive suture showing incisive canal
2  Incisive bone palatine process
3  Vomer
4  Suture between incisive bone and vomer
5  Palatine fissure
6  Nasal conchae. (Only ventral turbinates seen in this projection.)
7  Ethmoturbinates. Rostral extent at 2nd. and 3rd. premolar level, with bulk of ethmoturbinates ending at 3rd. and 4th. level. Rostral limit of ethmoidal fossa at 1st. molar level, also the position of the cribiform plate (7(a)).
8  Maxillary sinus or recess of maxilla
9  Frontal sinuses
10  Shadow of external surface of maxilla
11  Nasal bone
11(a)  Rostral limit

A radiolucent shadow is created within the nasal chambers by the lateral limits of the nasal and vomer bones.

I  Upper incisor. Total of six.
C  Upper canine. Total of two.
P  Upper premolar. Total of eight.
M  Upper molar. Total of four. (In this dog left 2nd. molar is missing.)

Note that the term 'upper’ can be replaced by 'superior’.

Figure 254  Line drawing of dorsoventral intraoral projection of nasal chambers to demonstrate soft tissue shadows seen in radiograph, Figure 251.

1  Vestibule of mouth
2  Gum
3  Cheek
4  Lip
5  Nostril (shaded in drawing)
6  Nasal plane
7  Ventral nasal meatus
8  Middle and dorsal nasal meatus
9  Cartilaginous nasal septum
Figure 255  Ventrodorsal oblique (open mouth) projection of nasal chambers. Samoyed dog 6 years old, entire female.

Figure 256  Line drawing of photograph representing radiographic positioning for Figure 255.
Figure 257  Ventrodorsal oblique (open mouth) projection of nasal chambers.

1 Interincisive suture showing incisive canal
2 Incisive bone palatine process
3 Vomer
4 Palatine fissure
5 Nasal conchae. Nasal and maxillary turbinates
   bones.

The radiolucent shadow created within the nasal chambers
by the lateral limits of the nasal and vomer bones is only
just visible on the right side (5(a)).
6 Ethmomaxillae
   6(a) Rostral limit of ethmoid fossa. This is also the
      position of the cribiform plate.
7 Maxillary sinus or recess of maxilla
8 Frontal sinuses
9 Medial wall of orbit
10 Border of choanae formed by palatine bone and
    pterygoid bone (Hamulus seen as the opaque shadow
    at the caudal extremity)
11 Temporal process of zygomatic bone
12 Zygomatic process of temporal bone
    The zygomatic arch is formed by 11 and 12.
13 Coronoid process of mandible
14 Soft tissue shadow of the tongue

I  Upper incisor. Total of six.
C  Upper canine. Total of two.
P  Upper premolar. Total of eight.
M  Upper molar. Total of four.

Note that the term 'upper' can be replaced by superior.'
Figure 258  Ventrodorsal oblique (open mouth) projection of maxilla right lateral recumbency. Beagle dog 2.5 years old, entire male.

Figure 259  Line drawing of photograph representing radiographic positioning for Figure 258.
**Figure 260** Ventrodorsal oblique (open mouth) projection of maxilla right lateral recumbency.

The drawing and labelling have been kept to a minimum to demonstrate teeth details.

1. Upper incisor. Total of six.
2. Upper canine. Total of two.
3. Upper premolar. Total of eight.
4. Upper molar. Total of four. (In this dog left 2nd. molar is missing.)
5. Lower premolar. Total of eight.

Note that the term ‘upper’ can be replaced by ‘superior’ and ‘lower’ by ‘inferior’.

Teeth are anchored in bony sockets or alveoli. Parallel to each tooth root is a region of clearly defined bony radiopacity called the lamina dura (A). With age the alveolar bone has radiopaque linear changes making the lamina dura less obvious in radiographs.

Between the lamina dura and the tooth root is a radiolucent shadow of the periodontal membrane (B).

A sharp angle is present at the junction of the lamina dura and the alveolar crest (C) adjacent to the dental cemento-enamel junction. With age, some vertical bone resorption can occur, reducing this sharp angle.

Anatomy of teeth
1. Neck
2. Crown
3. Tubercle
4. Root
5. Apex of root
6. Dentine. The periodontal membrane is attached on its dental surface to a thin layer of cement, but this is not radiographically distinguishable from the dentine.
7. Pulp cavity. In young dogs this is very large, reducing in size until 2 to 3 years of age and then slowly decreasing.
8. Enamel

D Rostral or mesial root of 3rd. premolar (upper right)
E Distal root of 3rd. premolar (upper right)
F Lingual surface root of 1st. molar (upper right). The apex of this root appears to have some increased lucency which would indicate resorption. However, idiopathic resorption of roots in this region has been noted in mature dogs.
G Vestibular surface roots of 1st. molar (upper right)

In young dogs (under 1 year of age) root apices are normally open.

To avoid confusion all roots have not been labelled. The 1st. premolar has only one root, the 2nd. and 3rd. have two roots (rostral and distal) while the 4th. upper premolar, or carnassial tooth, has three roots. Of the latter two roots are long and found on the vestibular surface, and the other is much shorter on the lingual surface. The 4th. lower premolar is similar to premolars 2 and 3.

Considering the molars, the upper have two small vestibular surface roots and one larger lingual surface roots. The lower molars all have two roots but the 1st. is very large and forms the lower carnassial tooth.
**Figure 261** Dorsoventral oblique (open mouth) projection of mandible right lateral recumbency. Beagle dog 2.5 years old, entire male.

**Figure 262** Line drawing of photograph representing radiographic positioning for Figure 261.
**Figure 263** Dorsoventral oblique (open mouth) projection of mandible right lateral recumbency.

The drawing and labelling have been kept to a minimum to demonstrate teeth details.

1. Lower incisor. Total of six.
2. Lower canine. Total of two.
3. Lower premolar. Total of eight.
4. Lower molars. Total of six.
5. Upper premolar. Total of eight.
6. Upper molar. Total of four. (In this dog left 2nd. molar is missing.)

    Note that the term lower‘can be replaced by inferior’and upper‘by superior.’

A. Lamina dura

B. Periodontal membrane

C. Cementoenamel junction

Please refer to ventrodorsal oblique (open mouth) projection of maxilla, Figure 260, for details of A, B and C.

Anatomy of teeth

1. Neck
2. Crown
3. Tubercle
4. Root
5. Apex of root
6. Dentine
7. Pulp cavity
8. Enamel

Please refer to ventrodorsal oblique (open mouth) projection of maxilla, Figure 260, for details of 1 to 8.
**Figure 264** Dorsoventral intraoral projection of maxillary bones. Beagle dog 2.5 years old, entire male.

**Figure 265** Line drawing of photograph representing radiographic positioning for Figure 264.
**Figure 266**  Dorsoventral intraoral projection of maxillary bones.

The drawing and labelling are to illustrate teeth details.

I  Upper incisors. Total of six.
C  Upper canines. Total of two.
P  Upper premolars. Total of eight.
M  Upper molars. Total of four. (In this dog left 2nd. molar is missing)

Note that the term 'upper' can be replaced by 'superior'.

Anatomy of teeth
1  Crown
2  Tubercle

3  Root
4  Apex of root
5  Dentine
6  Pulp cavity
7  Enamel

Anatomy of alveoli
8  Alveolar crest
9  Lamina dura
10  Periodontal membrane (seen as a radiolucent line between the lamina dura and tooth root)

Please refer to ventrodorsal oblique (open mouth) projection of maxilla, Figure 260, for details of 1 to 10.
Figure 267  Ventrodorsal intraoral projection of mandibular bodies. Beagle dog 2.5 years old, entire male.

Figure 268  Line drawing of photograph representing radiographic positioning for Figure 267.
Figure 269 Ventrodorsal intraoral projection of mandibular bodies.

The teeth have been excluded from the drawing of the right mandible so that bony features are more easily identified.

1 Lower incisors. Total of six.
C Lower canine. Total of two.
P Lower premolars. Total of eight.
M Lower molars. Total of six.

Note that the term lower can be replaced by inferior.

Anatomy of teeth
1 Crown
2 Tubercle
3 Root
4 Apex of root
5 Dentine
6 Pulp cavity
7 Enamel

Anatomy of alveoli
8 Alveolar crest
9 Bony sockets or alveoli
10 Lamina dura
11 Periodontal membrane (seen as a radiolucent line between the lamina dura and tooth root)

Please refer to ventrodorsal oblique (open mouth) projection of maxilla, Figure 260, for details of 1 to 11.

12 Mental foramen
Figure 270  Lateral projection of skull. Brachycephalic breed of dog. Pug dog 9 months old, entire male. The radiograph demonstrates the short nasal chambers of the brachycephalic breed of dog. In addition the extreme dome shape of the cranium in this Pug breed has resulted in a reduction of the frontal sinuses shadow.
Figure 271  Lateral projection of skull. Brachycephalic breed of dog. Bulldog 18 months old, entire female (same dog as in dorsoventral projection of skull, Figure 276). The radiograph demonstrates the short nasal chambers of the brachycephalic breed. Prognathism of the mandible is also present, a condition commonly seen in this type of breed.
Figure 272  Lateral projection of skull. Toy breed of dog. Yorkshire Terrier dog 2 years old, entire female. The radiograph has been included to show doming of the cranium in toy breeds with the consequent reduction of the frontal sinuses shadow. The sinuses in this particular dog are almost entirely lost.
Figure 273  Lateral projection of skull. Dolichocephalic breed of dog. Radiograph includes all skull bones. Rough Collie dog 7 years old, entire male.

Figure 274  Lateral projection of skull. Dolichocephalic breed of dog. The primary beam has been coned down and centred on the nasal chambers. Rough Collie dog 6 years old, neutered female.
Figure 275  Dorsoventral projection of skull. Brachycephalic breed of dog. Pug dog 9 months old, entire male.
Figure 276  Dorsoventral projection of skull. Brachycephalic breed of dog. Bulldog 18 months old, entire female (same dog as in lateral projection of skull, Figure 271). Prognathism of the mandibles is present, a condition commonly seen in the brachycephalic breed of dog.
**Figure 277**  Dorsoventral projection of skull. Toy breed of dog. Yorkshire Terrier dog 2 years old, entire female.
Figure 278  Dorsoventral projection of skull. Dolichocephalic breed of dog. Rough Collie dog 7 years old, entire male.
Figure 279  Dorsoventral intraoral projection of nasal chambers. Brachycephalic breed of dog. Boston Terrier dog 20 months old, entire female.

The radiograph demonstrates the severe reduction in the size of the nasal chambers found in this breed of dog. The right 4th. premolar tooth is congenitally absent in this particular dog. Such an abnormality is not uncommon in the brachycephalic breed of dog where the upper premolar teeth are usually affected. Lower molar teeth can also be congenitally absent.
Figure 280  Dorsoventral intraoral projection of nasal chambers. Brachycephalic breed of dog. Boxer dog 9.5 years old, entire male. Note that the right 3rd. premolar is missing in this dog. This was a result of extraction and not a congenital absence. The reduction of nasal chamber shadows is not as great as in the Boston Terrier (Figure 279).
Figure 281  Dorsoventral intraoral projection of nasal chambers. Toy breed of dog. Yorkshire Terrier dog 2 years old, entire female.
Figure 282  Dorsoventral intraoral projection of nasal chambers. Dolichocephalic breed of dog. Greyhound dog 2 years old, entire male.
Figure 283  Caudodorsal–rostroventral oblique projection of skull. Foramen magnum variant in toy breed of dog. Yorkshire Terrier dog 5 years old, entire female.

The radiograph demonstrates a dorsal extension of the foramen magnum. Such an extension is very common in the toy breed of dog, but has been termed ‘occipital dysplasia’, and hence an abnormality, by some authorities.

As ‘occipital dysplasia’ it has been linked to congenital or developmental neurological dysfunction. However, the appearance of the foramen magnum, as seen in this radiograph, can be found extensively in clinically normal dogs and its presence in dogs exhibiting abnormal neurological signs is not conclusive for a diagnosis. Hence great care must be taken with the interpretation of this radiographic shadow as it often reflects only a variant and other conditions must be eliminated.
Figure 284  Dorsoventral intraoral projection of nasal chambers. Nasal septum variant. Samoyed dog 6 years old, entire female.

The radiograph shows curvature of the nasal septum, to the left nasal chamber, at the mid chamber level. The bony shadows dividing the two nasal chambers can be seen midline and are intact. Positional variation of the nasal septum, and the vomer (also see Figure 653, Siamese cat), are sometimes seen and analysis of surrounding shadows must be made to ensure that the deviation is not part of a disease process such as neoplasia.

The left and right nasal chambers are symmetrical in this dog, i.e. are normal.

Figures 285a, 286a, 287a  Drawings to demonstrate frontal sinuses and ethmoidal region.

1  Frontal sinuses (region shaded)
2  Cribriform plate
   2(a) Caudal limit
   2(b) Rostral limit

Figures 285b, 286b, 287b  Drawings to demonstrate lower or inferior teeth within the central mandible. Deciduous teeth seen at 13 weeks of age only.

DPM  Premolars 3 and 4

Permanent teeth seen only as germs at 13 weeks of age

PPM  Premolars 3 and 4
PM   Molars 1, 2 and 3

Note the narrowing of pulp cavities in permanent teeth, with age. Overlying shadows of corresponding teeth in opposing mandibular bone are shown by dotted lines.

Dental formulae for the dog:

Deciduous teeth  I 3  C 1  PM 3
   3  1  3

Permanent teeth  I 3  C 1  PM 4  M 2
   3  1  4  3

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Figure 285  Age 13 weeks
Dog – Skull

Figure 286a

Figure 286b

Figure 287a

Figure 287b
Figure 286  Age 25 weeks

Figure 287  Age 38 weeks
Figure 288  Age 52 weeks
Figures 289, 290, 291, 292  Ventrodorsal projection of skull. Samoyed crossbred dog entire male at 13, 25, 38 and 52 weeks of age. Correlating line drawings at 13, 25 and 38 weeks of age. Drawings to demonstrate frontal sinuses (right side).

1  Frontal sinuses (region shaded)
2  Cribriform plate
3  Mandible
4  Vomer (midline)
Figure 290

Figure 290  Age 25 weeks
Figure 291  Age 38 weeks  

Figure 292  Age 52 weeks
Figures 293, 294, 295  Ventrodorsal oblique (open mouth) projection of maxilla. Samoyed crossbred dog entire male at 13, 38 and 52 weeks of age.
Figure 296  Dorsoventral oblique (open mouth) projection of mandible. Samoyed cross, dog entire male, at 13 weeks of age. Correlating line drawings at 13 weeks of age.

**Deciduous teeth**

D–I  Incisors  
D–C  Canine  
D–PM  Premolars 2, 3 and 4. Note no deciduous PM 1.

**Permanent teeth**

P–I  Incisors  
P–C  Canine  
P–PM  Premolars 1, 2, 3 and 4  
P–M  Molar 1 (other molar teeth not easily seen in these projections)

Note the narrowing of pulp cavities of permanent teeth with age.
Figure 297  Extended lateral projection of cervical vertebrae. Beagle dog 2.5 years old, entire male.

Figure 298  Line drawing of photograph representing radiographic positioning for Figure 297.
Figure 299  Extended lateral projection of cervical vertebrae.

A Skull
1 Occipital bone
2 Occipital condyle
2(a) Rostral edge
3 Typanic bullae

B Atlas
4 Dorsal arch
5 Lateral vertebral foramen
6 Articular surfaces
  6(a) Cranial articular surface or fovea
  6(b) Caudal articular surface or fovea
7 Wings. Transverse processes.
8 Body

C Axis
9 Dens or odontoid peg
10 Cranial articular surface
11 Caudal articular surface
12 Spinous process
13 Transverse processes

D 3rd. cervical vertebra
E 4th. cervical vertebra
F 5th. cervical vertebra
G 6th. cervical vertebra
H 7th. cervical vertebra
14 Transverse processes
15 Cranial articular surface of 4th. cervical vertebra
16 Cranial articular surface of 6th. cervical vertebra
17 Caudal articular surface of 3rd. cervical vertebra
18 Caudal articular surface of 5th. cervical vertebra
19 Spinous process
20 Body
21 Vertebral foramen
  21(a) Dorsal margin
  21(b) Ventral margin
I 1st. thoracic vertebra
J 2nd. thoracic vertebra
K 1st. rib
L Scapula
Figure 300  Schematic drawing of extended lateral projection of cervical vertebrae to demonstrate the extent of joint capsules of vertebrae.

= Joint capsule
= Synovial space. With the exception of the first two capsules this space is smaller than drawn.

The first two joint capsules communicate; atlanto-occipital with atlantoaxial.
**Figure 301** Schematic drawing of extended lateral projection of cervical vertebrae to demonstrate vertebral ligaments.

1 = Lateral atlanto-occipital ligament. Extends to jugular process of occipital bone.

2 = Transverse atlantal ligament. Connects both sides of atlantal ventral arch and so serves to hold dens against atlantal ventral arch.

3 = Apical ligament of dens. In three sections. Middle section to ventral part of foramen magnum with two lateral pillars. Lateral sections are heavier and attach to occipital bone medially at the caudal parts of occipital condyles.

4 = Nuchal ligament

5 = Yellow ligament

6 = Dorsal longitudinal ligament

7 = Ventral longitudinal ligament. Thinner than dorsal ligament.

Intervertebral discs are not shown but are found between the longitudinal ligaments in the intervertebral spaces from 2nd. to 3rd. cervical vertebrae caudally.

Dorsal atlanto-occipital and ventral atlanto-occipital membranes are not shown but act to reinforce the atlanto-occipital joint dorsally and ventrally.

Dorsal atlantoaxial membrane is not shown but it is the dorsal fibrous layer of the atlantoaxial joint capsule.
**Figure 302**  Extended lateral projection of cervical vertebrae in clinically normal dog. Beagle 2.5 years old, entire male (same dog as in Figures 305 and 308).

**Figure 303**  Line drawing of photograph representing radiographic positioning for Figure 302.
Figure 304  Extended lateral projection of cervical vertebrae in clinically normal dog.

A  Axis
B  3rd. cervical vertebra
C  4th. cervical vertebra
D  5th. cervical vertebra
E  6th. cervical vertebra
F  7th. cervical vertebra
   1  Spinous process. (Process on 3rd. cervical vertebra ill defined.)
   2  Caudal articular surface
   3  Cranial articular surface
   4  Vertebral foramen
      4(a) Dorsal margin
      4(b) Ventral margin
   5  Transverse processes
   6  Body
   7  Cranial ventral margin of foramen
   8  Cranial dorsal margin of foramen
   Distance between numbers 7 and 8 is the cranial sagittal diameter of the vertebral foramen.
   9  Caudal ventral margin of foramen
   10 Caudal dorsal margin of foramen

Distance between numbers 9 and 10 is the caudal sagittal diameter of the vertebral foramen.

Sagittal diameter measurements are used to evaluate possible stenosis of foramen. Note that measurements must always be
compared cranially to cranially, caudally to caudally, as cranial
diameters are often smaller than caudal ones in the normal dog.
This is especially true for the more caudal cervical vertebrae.

Evaluation of the relationship between adjacent ventral
foramen margins is also valuable. Measuring angles between
the margins is important to determine whether stenosis is pre-
sent. Where gross radiographic abnormality is present an
obvious dorsal elevation of the cranial margin with respect to
the caudal margin is seen.

Note that changes in lateral projection positions of the
cervical vertebrae will alter the relationship of all foramina
margins, as seen in the radiographs and line drawings,
Figures 305 to 310.

11 Dorsal extremity of intervertebral disc space.

G  1st. thoracic vertebra
H  1st. rib
I  Scapula
Figure 305  Hyperextended lateral projection of cervical vertebrae in clinically normal dog. Beagle dog 2.5 years old, entire male (same dog as in Figures 302 and 308).

Figure 306  Line drawing of photograph representing radiographic positioning for Figure 305.
**Figure 307** Hyperextended lateral projection of cervical vertebrae in clinically normal dog.

Cranial and caudal sagittal diameters are similar to the extended lateral projection of cervical vertebrae line drawing, Figure 304.

Cranial and caudal cervical ventral foramen margin angles are the same as in the extended lateral projection of cervical vertebrae line drawing, Figure 304.

There are no dorsal elevations of cranial ventral foramen margins.
Figure 308  Hyperflexed lateral projection of cervical vertebrae in clinically normal dog. Beagle dog 2.5 years old, entire male (same dog as in Figures 302 and 305).

Figure 309  Line drawing of photograph representing radiographic positioning for Figure 308.
Figure 310 Hyperflexed lateral projection of cervical vertebrae in clinically normal dog.

Sagittal diameters and ventral foramen margin angles in extended and hyperextended lateral projections of cervical vertebrae were similar (see line drawings Figures 304 and 307). A marked change is now seen in the hyperflexed lateral projection of cervical vertebrae.

Cranial and caudal cervical ventral foramen margin angles have increased.

There are obvious dorsal elevations of cranial ventral foramen margins at 3rd, 4th, and 5th cervical vertebrae. Dorsal elevations are less obvious at 6th and 7th cervical vertebrae.
Figure 311  Ventrodorsal projection of cervical vertebrae. Beagle dog 2.5 years old, entire male.

Figure 312  Line drawing of photograph representing radiographic positioning for Figure 311.
Figure 313  Ventrodorsal projection of cervical vertebrae.

A Skull
1  Squamous part of occipital bone
2  Occipital condyle

B Atlas
3  Cranial articular fovea
4  Caudal articular fovea
5  Dorsal arch
   5(a) Cranial border
   5(b) Ventral arch caudal border
6  Wing; transverse process
7  Transverse foramen

C Axis
8  Dens
9  Cranial articular surface
10 Caudal articular surface
11 Spinous process
12 Transverse process

D 3rd. cervical vertebra
E 4th. cervical vertebra
F 5th. cervical vertebra

G 6th. cervical vertebra
H 7th. cervical vertebra
13 Cranial articular surface
14 Caudal articular surface
15 Spinous process
16 Transverse foramen
17 Lateral margin of vertebral foramen
18 Dorsal cranial margin of body
19 Ventral caudal margin of body

I 1st. thoracic vertebra
J 1st. rib
K Clavicle
L Scapula
M Humerus
Figure 314  Schematic drawing of ventrodorsal projection of cervical vertebrae to demonstrate joint capsules.

- Joint capsule and synovial space of vertebral and costal articulations.

  Atlanto-occipital joint capsule communicates ventromedially with atlantoaxial joint capsule.

  a = Joint capsule of head of rib
  b = Joint capsule of tubercle of rib
**Figure 315**  Schematic drawing of ventrodorsal projection of cervical vertebrae to demonstrate vertebral ligaments.

1 = Lateral atlanto-occipital ligament
2 = Dorsal atlantoaxial ligament
3 = Apical ligament of dens. Centrally attaches to ventral foramen magnum. Laterally attaches to occipital condyles.
4 = Transverse atlantal ligament. Passes dorsally over dens. A bursa separates ligament and dens.
5 = Positions of dorsal and ventral longitudinal ligaments
6 = Yellow ligament. Laterally extends as far as the joint capsules surrounding articular processes. Ventral to ligament is epidural space.
7 = Nuchal ligament. Ligament is anatomically in the midline but is illustrated to the right of midline to differentiate it from (5).
8 = Supraspinous ligament. Ligament is anatomically in the midline but is illustrated to the right of the midline to differentiate it from (5).

Rib ligaments and intervertebral discs not shown.
Figure 316  Lateral projection of thoracic vertebrae. Beagle dog 2.5 years old, entire male.

Figure 317  Line drawing of photograph representing radiographic positioning for Figure 316.
Figure 318  Lateral projection of thoracic vertebrae with rib shadows excluded for clarity.

A  7th. cervical vertebra
B  1st. thoracic vertebra
C  2nd. thoracic vertebra
D  3rd. thoracic vertebra
E  4th. thoracic vertebra
F  5th. thoracic vertebra
G  6th. thoracic vertebra
H  7th thoracic vertebra
I  8th. thoracic vertebra
J  9th. thoracic vertebra
K  10th. thoracic vertebra
L  11th. thoracic vertebra. Anticlinal vertebra.
M  12th. thoracic vertebra
N  13th. thoracic vertebra

1  Spinous process
   1(a)  Spinous process of anticlinal vertebra. (Nearly perpendicular to axis)
2  Cranial articular process
3  Caudal articular process
4  Body
5  Transverse process. Includes mammillary process from 2nd. or 3rd. thoracic vertebra caudally.
6  Vertebral foramen
   6(a)  Dorsal margin
   6(b)  Ventral margin
7  Intervertebral foramen
8  First visible accessory process
9  Mammillary process
10 Accessory process
O  1st. lumbar vertebra
11 Transverse process
P  Crura of diaphragm
**Figure 319** Schematic drawing of lateral projection of thoracic vertebrae to demonstrate the extent of joint capsules.

- = Joint capsule and synovial space of vertebral articulation
- = Joint capsule and synovial space of costovertebral joint. Head of rib.
- = Joint capsule and synovial space of costovertebral joint. Tubercle of rib.

**Figure 320** Schematic drawing of lateral projection of thoracic vertebrae to demonstrate vertebral ligaments.

1 = Nuchal ligament
2 = Supraspinous ligament
3 = Yellow ligament
4 = Dorsal longitudinal ligament
5 = Ventral longitudinal ligament
6 = Intertransverse ligament
Interspinous ligaments and intervertebral discs not shown.
**Figure 321** Lateral projection of thoracic vertebrae to demonstrate the rib shadows not seen in Figure 318.

A Scapula  
1 Spine  
2 Caudal margins of right and left  
B 1st. rib  
C 2nd. rib  
D 3rd. rib  
E 4th. rib  
F 5th. rib  
G 6th. rib  
H 7th. rib  
I 8th. rib  
J 9th. rib  
K 10th. rib  
L 11th. rib  
M 12th. rib  
N 13th. rib  
3 Head  
4 Neck  
5 Tubercles (right and left)  
O Crura of diaphragm

**Figure 322** Schematic drawing of lateral projection of thoracic vertebrae to demonstrate rib ligaments.

1 = Ligament of head. Extends from head of rib to lateral part of intervertebral disc. Last three ribs are displaced and for these the ligament shifts to attach to the bodies of the vertebrae.

2 = Ligament of tubercle. Is distal to articular capsule. Crosses capsule and attaches to transverse process.

3 = Ligament of neck. Extends from neck to ventral surface of transverse process plus lateral body of vertebra.

Intercapital ligament not shown but is seen in a similar position to the head ligament. It runs across the ventral vertebral canal, at the level of the intervertebral disc, to attach to the head of the rib on the contralateral side. It is absent from 1st., 12th. and 13th. ribs.
**Figure 323** Ventrodorsal projection of thoracic vertebrae.
Beagle dog 2.5 years old, entire male.

**Figure 324** Line drawing of photograph representing radiographic positioning for Figure 323.
Figure 325 Ventrodorsal projection of thoracic vertebrae with ventral shadows of ribs excluded for clarity.

A 7th. cervical vertebra
B 1st. thoracic vertebra
C 2nd. thoracic vertebra
D 3rd. thoracic vertebra
E 4th. thoracic vertebra
F 5th. thoracic vertebra
G 6th. thoracic vertebra
H 7th. thoracic vertebra
I 8th. thoracic vertebra
J 9th. thoracic vertebra
K 10th. thoracic vertebra
L 11th. thoracic vertebra. Anticlinal vertebra.
M 12th. thoracic vertebra
N 13th. thoracic vertebra
O 1st. lumbar vertebra
  1 Spinous process of 1st. thoracic vertebra. These processes incline caudally from 1st. to 10th. thoracic vertebrae.
  2 Spinous process of 9th. thoracic vertebra
  3 Spinous process of 10th. thoracic vertebra
  4 Spinous process of 11th. thoracic vertebra
  5 Cranial margin of body
  6 Caudal margin of body
  7 Cranial articular margin of 13th. thoracic vertebra
  8 Mammillary process (seen as a distinct structure just caudal to the articular margin)
  9 Cranial articular margin found near the median plane from thoracic vertebrae 2 to 10
  10 Caudal articular margin of thoracic vertebra
  11 Caudal articular margin found near the median plane from thoracic vertebrae 1 to 9
  12 Transverse process
  13 Costal fovea of transverse process
  14 Body
  15 Cranial costal fovea
  16 Caudal costal fovea
  17 Lateral margin of vertebral foramen

P 1st. rib
Q 13th. rib
**Figure 326** Sketch drawing of ventrodorsal thoracic vertebrae to demonstrate anatomically the joint articulations of vertebrae and ribs.

a = Costovertebral joint. Head of rib.
b = Costovertebral joint. Tubercle of rib.
c = Cranial and caudal articular facets of vertebral joint
d = Transverse process of thoracic vertebra
e = Intervertebral disc space for vertebral bodies

Only (a) and (e) are consistently visible in ventrodorsal projection of thoracic vertebrae, Figure 323, from 1st. to 13th. thoracic vertebrae.
The transverse processes (d) are very unclear throughout the thoracic vertebrae in Figure 323, so making (b) impossible to see.
The vertebral joint (c) is just seen from 11th. to 13th. thoracic vertebrae.

**Figure 327** Schematic drawing of ventrodorsal projection of thoracic vertebrae to demonstrate vertebral ligaments.

1 = Nuchal ligament. Position is anatomically in the midline but it is drawn to the right side to differentiate it from (3).
2 = Supraspinous ligament. Position is anatomically the midline but it is drawn to the right side to differentiate it from (3).
3 = Position of dorsal and ventral longitudinal ligaments
4 = Yellow ligament
5 = Intertransverse ligament
Rib ligaments and intervertebral discs not shown.
**Figure 328**  Lateral projection of thoracolumbar vertebrae. Beagle dog 2 years old, entire female.

**Figure 329**  Line drawing of photograph representing radiographic positioning for Figure 328.

**Figure 330**  Lateral projection of thoracolumbar vertebrae.

- A 12th. thoracic vertebra
- B 13th. thoracic vertebra
- C 1st. lumbar vertebra
- D 2nd. lumbar vertebra
- E 3rd. lumbar vertebra
  1. Spinous process
  2. Mammillary process
  3. Cranial articular process
  4. Caudal articular process
  5. Body
- F 11th. rib
- G 12th. rib
- H 13th. rib
- 6 Transverse process
  6(a) Base
- 7 Vertebral foramen
  7(a) Dorsal margin
  7(b) Ventral margin
- 8 Intervertebral foramen
- 9 Accessory process
**Figure 331** Ventrodorsal projection of thoracolumbar vertebrae. Beagle dog 2 years old, entire female.

**Figure 332** Line drawing of photograph representing radiographic positioning for Figure 331.

**Figure 333** Ventrodorsal projection of thoracolumbar vertebrae.

A 12th. thoracic vertebra
B 13th. thoracic vertebra
C 1st. lumbar vertebra
D 2nd. lumbar vertebra
E 3rd. lumbar vertebra
   1 Spinous process
   2 Cranial margin of body
   3 Caudal margin of body

4 Cranial articular process including mammillary process
5 Caudal articular process
6 Transverse process
7 Costal fovea of vertebral body of 13th. thoracic vertebra
8 Lateral margin of vertebral foramen

F 12th. rib
G 13th. rib

*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
Figure 334  Lateral projection of lumbar vertebrae. Beagle dog 2 years old, entire female.

Figure 335  Line drawing of photograph representing radiographic positioning for Figure 334.
**Figure 336** Lateral projection of lumbar vertebrae.

A 12th. thoracic vertebra  
B 13th. thoracic vertebra  
C 1st. lumbar vertebra  
D 2nd. lumbar vertebra  
E 3rd. lumbar vertebra  
F 4th. lumbar vertebra  
G 5th. lumbar vertebra  
H 6th. lumbar vertebra  
I 7th. lumbar vertebra  
1 Spinous process  
2 Mammillary process  
2(a) Both processes seen  
3 Cranial articular process  
4 Caudal articular process  
5 Body  
6 Transverse process  
6(a) Base  
7 Vertebral foramen  
7(a) Dorsal margin  
7(b) Ventral margin  
8 Intervertebral foramen  
9 Accessory process  
J Ilium  
K Sacrum  
L 13th. rib  
M 12th. rib  
N 11th. rib

**Figure 337** Schematic drawing of lateral projection of lumbar vertebrae to demonstrate the extent of joint capsules.

a = Joint capsule and synovial space of vertebral articulation  
b = Joint capsule and synovial space of costovertebral joint. Head of rib.
Figure 338  Schematic drawing of lateral projection of lumbar vertebrae to demonstrate vertebral ligaments.

1 = Supraspinous ligament. Extends to 3rd. coccygeal vertebra.
2 = Yellow ligament
3 = Dorsal longitudinal ligament
4 = Ventral longitudinal ligament
5 = Intertransverse ligament

Intervertebral discs interspinous and rib ligaments are not shown.
**Figure 339** Ventrodorsal projection of lumbar vertebrae. Beagle dog 2 years old, entire female.

**Figure 340** Line drawing of photograph representing radiographic positioning for Figure 339.
Figure 341  Ventrodorsal projection of lumbar vertebrae.

A  12th. thoracic vertebra
B  13th. thoracic vertebra
C  1st. lumbar vertebra
D  2nd. lumbar vertebra
E  3rd. lumbar vertebra
F  4th. lumbar vertebra
G  5th. lumbar vertebra
H  6th. lumbar vertebra
I  7th. lumbar vertebra
   1  Spinous process
   2  Cranial margin of body
J  Ilium
K  Sacrum
L  13th. rib
M  12th. rib

3  Caudal margin of body
4  Cranial articular process including mammillary process
5  Caudal articular process
6  Transverse process (lateral aspects of some are obscured by soft tissue shadows making their appearance asymmetrical)
7  Costal fovea of vertebral body of 13th. thoracic vertebra
8  Lateral margin of vertebral foramen

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 342  Schematic drawing of ventrodorsal projection of lumbar vertebrae to demonstrate extent of joint capsules.

a = Joint capsule of vertebral articulation
b = Joint capsule of costovertebral articulation. Head of rib.
c = Fibrocartilaginous joint of sacroiliac joint
Figure 343  Schematic drawing of ventrodorsal projection of lumbar vertebrae to demonstrate vertebral ligaments.
1 = Supraspinous ligament. Shown drawn to the right of midline to separate it from longitudinal ligaments (2). True anatomical position is midline.
2 = Position of dorsal and ventral longitudinal ligaments.
3 = Yellow ligament
4 = Intertransverse ligament
Rib ligaments and intervertebral discs not shown.
Figure 344  Lateral projection of lumbosacral vertebrae. Beagle dog 2.5 years old, entire male.

Figure 345  Line drawing of photograph representing radiographic positioning for Figure 344.
Figure 346  Lateral projection of lumbosacral vertebrae.

A  6th. lumbar vertebra
B  7th. lumbar vertebra
   1 Spinous process
   2 Body
   3 Cranial articular process
   4 Caudal articular process
   5 Transverse processes
   6 Vertebral foramen
   7 Intervertebral foramen

C Sacrum
   8 Sacral canal
   9 Intermediate sacral crest
   10 Mammillary process of cranial articular process
   11 Wing
   12 Promontory

D Ilium
   13 Dorsal margins
   14 Cranial margins
   15 Ventral margins
   16 Sacroiliac articulation

E Coccygeal or caudal vertebra
**Figure 347**  Schematic drawing of lateral projection of lumbosacral vertebrae to demonstrate joint capsules.

- Joint capsule of vertebral articulation
- Joint capsule of sacroiliac articulation
  - a  Synovial part
  - b  Fibrocartilaginous part
- = Auricular surface of sacroiliac joint

**Figure 348**  Schematic drawing of lateral projection of lumbosacral vertebrae to demonstrate vertebral ligaments.

1 = Dorsal longitudinal ligament. Stops at 5th. coccygeal vertebra.
2 = Ventral longitudinal ligament. Stops at midsacral level.
3 = Yellow ligament
4 = Ventral sacroiliac ligament
5 = Dorsal sacroiliac ligament. Dorsal ligament is thicker than ventral.

**Figure 349**  Ventrodorsal projection of lumbosacral vertebrae. Beagle dog 2 years old, entire female.
Figure 350  Line drawing of photograph representing radiographic positioning for Figure 349.

Figure 351  Ventrodorsal projection of lumbosacral vertebrae.

A 6th. lumbar vertebra  
B 7th. lumbar vertebra  
   1 Spinous process  
   2 Cranial margin of body  
   3 Caudal margin of body  
   4 Cranial articular process including mamillary process  
   5 Caudal articular process  
   6 Transverse process  
   7 Lateral margin of vertebral foramen  
C Sacrum  
   8 Median sacral crest  
   9 Intermediate sacral crest  
D Ilium  
E Coccygeal or caudal vertebra  
   10 Lateral sacral crest  
   11 Wing  
   12 Position of synovial joint between bony articular margins  
   13 Base  
   14 Cranial articular process  
   15 Caudal articular process  
   16 Sacral foramina  
   17 Cranial articular process  
   18 Transverse process
Figure 352  Schematic drawing of ventrodorsal projection of lumbosacral vertebrae to demonstrate the extent of joints.

- = Joint capsule of vertebral articulation

Sacroiliac articulation

- a = Synovial part of sacroiliac joint capsule
- b = Fibrocartilaginous part of sacroiliac joint capsule

Figure 353  Schematic drawing of ventrodorsal projection of lumbosacral vertebrae to demonstrate vertebral ligaments.

1 = Position of supraspinous ligament. Shown drawn to the right of the midline to separate it from longitudinal ligaments (2). True anatomical position is midline.
2 = Position of dorsal and ventral longitudinal ligaments
3 = Continuation of dorsal longitudinal ligament
4 = Intertransverse ligament
5 = Yellow ligament
6 = Positions of sacroiliac ligaments
6(a) Dorsal position shown on right side
6(b) Ventral position shown on left side
Figure 354  Hyperflexed lateral projection of lumbosacral vertebrae including proximal coccygeal vertebrae. Beagle dog 2.5 years old, entire male.

Figure 355  Line drawing of photograph representing radiographic positioning for Figure 354.

Figure 356  Hyperflexed lateral projection of lumbosacral vertebrae including proximal coccygeal vertebrae.

A  7th. lumbar vertebra  
   1 Spinous process  
   2 Body  
   3 Cranial articular process  
   4 Caudal articular process  
   4(a) Process of 6th. lumbar vertebra  
   5 Transverse processes  
   6 Vertebral foramen  
   7 Intervertebral foramen

B  Sacrum  
   8 Sacral canal  
   9 Intermediate sacral crest  
   10 Median sacral crest (only just visible)  
   11 Cranial articular process

C  Ilium  
   12 Caudal articular process  
   13 Wing  
   14 Promontory  
   15 Body of 3rd. sacral segment

D  Coccygeal or caudal vertebra  
   16 Dorsal margins  
   17 Cranial margins  
   18 Ventral margins  
   19 Sacroiliac articulation  
   20 Cranial articular process  
   21 Caudal articular process  
   22 Transverse processes  
   23 Body  
   24 Vertebral foramen
Figure 357  Lateral projection of coccygeal or caudal vertebrae. Beagle dog 2 years old, entire female.

Figure 358  Line drawing of photograph representing radiographic positioning for Figure 357.
Figure 359  Lateral projection of coccygeal or caudal vertebrae.

A  2nd. coccygeal vertebra  
B  3rd. coccygeal vertebra  
C  4th. coccygeal vertebra  
D  5th. coccygeal vertebra  
E  6th. coccygeal vertebra  
F  7th. coccygeal vertebra  
G  8th. coccygeal vertebra  
H  9th. coccygeal vertebra  
I  10th. coccygeal vertebra  
J  11th. coccygeal vertebra  
K  12th. coccygeal vertebra  
L  13th. coccygeal vertebra  
M  14th. coccygeal vertebra  
N  15th. coccygeal vertebra  
O  16th. coccygeal vertebra  

P  17th. coccygeal vertebra  
Q  18th. coccygeal vertebra  
R  19th. coccygeal vertebra

1 Cranial articular process  
2 Caudal articular process  
Both processes gradually disappear so that by the 12th. vertebra they are no longer present.  
3 Mammillary process  
4 Transverse process  
5 Body  
6 Vertebreal foramen. Lumen gradually becomes smaller so that by the 6th. or 7th. vertebra it is only a groove.  
7 Haemal arches  
8 Haemal process  
9 Intervertebral foramen  
10 Position of intervertebral disc of the intervertebral symphysis
Figure 360  Ventrodorsal projection of coccycgeal or caudal vertebrae. Beagle dog 2 years old, entire female.

Figure 361  Line drawing of photograph representing radiographic positioning for Figure 360.
Figure 362  Ventrodorsal projection of coccygeal or caudal vertebrae.

A  3rd. coccygeal vertebra  
B  4th. coccygeal vertebra  
C  5th. coccygeal vertebra  
D  6th. coccygeal vertebra  
E  7th. coccygeal vertebra  
F  8th. coccygeal vertebra  
G  9th. coccygeal vertebra  
H  10th. coccygeal vertebra  
I  11th. coccygeal vertebra  
J  12th. coccygeal vertebra  
K  13th. coccygeal vertebra  
L  14th. coccygeal vertebra  
M  15th. coccygeal vertebra  
N  16th. coccygeal vertebra  
O  17th. coccygeal vertebra  
P  18th. coccygeal vertebra  
Q  19th. coccygeal vertebra  
R  20th. coccygeal vertebra. Last vertebra.

1  Transverse process
2  Position of intervertebral disc of the intervertebral symphysis
*Dog – Vertebrae*

**Figure 363**  Extended lateral projection of cervical vertebrae. Toy breed of dog. Yorkshire Terrier dog 5 years old, entire female (same dog as in Figures 364 and 365).

**Figure 364**  Hyperextended lateral projection of cervical vertebrae. Toy breed of dog. Yorkshire Terrier dog 5 years old, entire female (same dog as in Figures 363 and 365).
Figure 365  Hyperflexed lateral projection of cervical vertebrae. Toy breed of dog. Yorkshire Terrier dog 5 years old, entire female (same dog as in Figures 363 and 364).

This series of three radiographs has been included to demonstrate the normal relationship between the 1st. and 2nd. cervical vertebrae during extreme flexion and extension of the neck. Note the dorsal space between the 1st. and 2nd. cervical vertebrae, or atlas and axis, which shows little variation in the three projections. Also observe the dorsal borders of the first two vertebrae to be parallel to one another. The dens of the axis remains in a ventral position within the vertebral canal in all the projections.

The atlas, axis and occipital condyle of the skull are all of a normal size and conformation. Analysis of these anatomical characteristics is very important for this particular region as abnormalities of this area, in toy breeds, are well recognised. The atlas and the dens of the axis are not reduced in size. The occipital condyle can be seen to be a normal size and in the correct articular position.

Figure 366  Lateral projection of lumbar vertebrae. Toy breed of dog. Yorkshire Terrier dog 1 year old, entire male. Note the appearance of the bodies of the lumbar vertebrae. They are comparatively long for a dog and could be mistaken for cat lumbar vertebrae.
Figure 367  Lateral projection of lumbar vertebrae. Chondrodystrophic breed of dog. Standard Dachshund dog 7 years old, entire male.

Figure 368  Lateral projection of sacrum and coccygeal vertebrae. Corkscrew tail. Bulldog 1 year old, entire female.

The radiograph shows the spiral curvature of the corkscrew tail formed by the congenitally abnormal coccygeal vertebrae. Distally there is fusion of the bodies (block vertebrae) as seen by the long length of these vertebrae. Proximally the 1st. and 2nd. coccygeal vertebrae are congenitally malformed having wedge-shaped bodies (hemi-vertebrae).

Incomplete fusion of the 3rd. sacral segment is also present.
Figure 369  Ventrodorsal projection of sacrum and coccyeal vertebrae. Corkscrew tail. Bulldog 1 year old, entire female.

The radiograph shows the spiral curvature of the corkscrew tail as formed by the congenitally deformed coccyeal vertebrae. Distally the vertebral bodies are fused (block vertebrae), while proximally the bodies are much shorter and broader. The body of the 2nd. coccyeal vertebra has a wedge shape (hemivertebra).

Incomplete fusion of the 3rd. sacral segment is also seen.

This particular Bulldog has severe hip dysplasia with secondary joint degeneration (see Figure 145 for normal chondrodystrophic breed of dog hip joints).
Figure 370  Age 13 weeks.


A  Atlas; 1st. cervical vertebra
B  Axis; 2nd. cervical vertebra
   1  Proatlas. Centrum for apex of dens
   2  Intercentrum
   3  Centrum for dens
   4  Intercentrum
   5  Centrum for cranial body equivalent to cranial epiphysis
   6  Cranial growth plate
   7  Caudal epiphysis
   8  Caudal growth plate

C  3rd. cervical vertebra
   9  Cranial epiphysis
   10  Cranial growth plate
   10(a)  Open
   10(b)  Closing
   11  Caudal epiphysis
   12  Caudal growth plate
   12(a)  Open
   12(b)  Closing

For clarity transverse process shadows have been excluded from all drawings.
Figure 371  Age 25 weeks.
Figure 372  Age 38 weeks.
Figure 373  Age 52 weeks.
Figures 374, 375, 376, 377  Lateral projection of thoracic vertebrae. Samoyed crossbred dog entire male at 13, 25, 38 and 52 weeks of age. Correlating line drawings for all ages except 52 weeks.

A  2nd. thoracic vertebra
B  3rd. thoracic vertebra
   1 Cranial epiphysis
   2 Cranial growth plate
   2(a) Open
   3 Caudal epiphysis
   4 Caudal growth plate
      4(a) Open
      4(b) Closing
C  4th. thoracic vertebra

For clarity rib shadows have been excluded from all drawings.

Figure 374

Figure 375  Age 25 weeks.
Figure 376  Age 38 weeks.
Figure 377  Age 52 weeks.
Figures 378, 379, 380, 381  Lateral projection of lumbar vertebrae. Samoyed crossbred dog entire male at 13, 25, 38 and 52 weeks of age. Correlating line drawings for all ages except 52 weeks.

A  3rd. lumbar vertebra
B  4th. lumbar vertebra
   1  Cranial epiphysis
   2  Cranial growth plate
      2(a) Open
   3  Caudal epiphysis
   4  Caudal growth plate
      4(a) Open
      4(b) Closing
C  5th. lumbar vertebra

For clarity transverse process shadows have been excluded from all drawings.
At 25 weeks of age the 3rd. sacral segment, or sacral vertebra, can be seen as a separate segment.
By 38 weeks of age fusion of the 3rd. sacral segment has taken place.
At 25, 38 and 52 weeks of age the iliac crest of the pelvis can be seen as a separate ossification centre. This ossification centre was not visible on the ventrodorsal projections of the pelvis.
Figure 379  Age 25 weeks.
Figure 380  Age 38 weeks.
The radiograph has been included to demonstrate the appearance of the atlas and axis after 1 week of age but before 13 weeks of age.

The atlas still has a distinct separate ossification centre for its body. This centre is not seen in the lateral projection of cervical vertebrae of the 13 week old Samoyed crossbred dog, Figure 370.

Great care must be taken with the interpretation of radiographs from young animals. Knowledge of ossification centres is essential. The ossification centre of the atlas body is sometimes misdiagnosed as a fracture causing neurological signs in dogs under 3 months of age.
Figure 383  Lateral projection of thorax (exposure for ribs). Beagle dog 2.5 years old, entire male.

Figure 384  Line drawing of photograph representing radiographic positioning for Figure 383.
Figure 385  Lateral projection of thorax (exposure for ribs) to demonstrate rib details.

A  1st. pair of ribs  J to M are asternal ribs. 13th asternal ribs are the floating ribs.
B  2nd. pair of ribs  1  Head of rib
C  3rd. pair of ribs  2  Neck of rib
D  4th. pair of ribs  3  Tubercle of rib
E  5th. pair of ribs  4  Angle of rib
F  6th. pair of ribs  5  Costal cartilages. Cartilages are calcified except for
g  7th. pair of ribs  their most dorsal aspects. 1st.rib cartilages are poorly
H  8th. pair of ribs  calcified. Cartilages 10, 11 and 12 form the costal arch.
I  9th. pair of ribs  N  Manubrium of sternum
   A to I are sternal ribs
J  10th. pair of ribs  O  2nd. sternebra
K  11th. pair of ribs  P  3rd. sternebra
L  12th. pair of ribs  Q  4th. sternebra
M  13th. pair of ribs  R  5th. sternebra
  S  6th. sternebra
  T  7th. sternebra
  U  Xiphoid process
Figure 386  Dorsoventral projection of thorax (exposure for ribs). Beagle dog 2.5 years old, entire male.
Figure 387  Line drawing of photograph representing radiographic positioning for Figure 386.

Figure 388  Dorsoventral projection of thorax (exposure for ribs) to demonstrate rib details.

A  1st. pair of ribs
B  2nd. pair of ribs
C  3rd. pair of ribs
D  4th. pair of ribs
E  5th. pair of ribs
F  6th. pair of ribs
G  7th. pair of ribs
H  8th. pair of ribs
I  9th. pair of ribs
A to I  are sternal ribs
J  10th. pair of ribs
K  11th. pair of ribs
L  12th. pair of ribs
M  13th. pair of ribs
J to M are asternal ribs. 13th. asternal ribs are the floating ribs.

1  Body of rib
2  Costal cartilage (calcified)

2(a) Costal cartilage of last 9th. sternal rib
3  Costal cartilages of asternal ribs 10, 11 and 12 which make up the costal arch.

Rotation of the thorax has allowed sternal shadows to be seen separately from vertebral shadows. See Figures 400, 414 and 420 for evaluation of thoracic structures in non-rotated films.

N  Manubrium of sternum
O  2nd. sternebra
P  3rd. sternebra
Q  4th. sternebra
R  5th. sternebra
S  6th. sternebra
T  7th. sternebra

Xiphoid process is not discernible.
Figure 389  Lateral projection of sternum. Beagle dog 2.5 years old, entire male.

Figure 390  Line drawing of photograph representing radiographic positioning for Figure 389.
Figure 391  Lateral projection of sternum.

A  Manubrium of sternum
   1  Lateral prominence. Site of articular facet for costal cartilages of 1st. rib.

B  2nd. sternebra

C  3rd. sternebra

D  4th. sternebra

E  5th. sternebra

F  6th. sternebra

G  7th. sternebra

H  Xiphoid process. Xiphoid cartilage extending caudally is not calcified.

  2  Intersternebral cartilage (non-calcified)
  3  Costal cartilage (poorly calcified at 1st. and 2nd. ribs)
  4  Costal cartilages of the asternal 10th. ribs

I  2nd. pair of ribs

J  3rd. pair of ribs

K  4th. pair of ribs

L  5th. pair of ribs

M  6th. pair of ribs

N  7th. pair of ribs

O  8th. pair of ribs

P  9th. pair of ribs
Figure 392  Lateral projection of pharynx and larynx. Beagle dog 2.5 years old, entire male. (See Figure 424 for brachycephalic breed of dog)

Figure 393  Line drawing of photograph representing radiographic positioning for Figure 392.

Notes for Figure 394
A Mandibles
  1 Angular processes
B Temporomandibular joints
C Tympanic bullae
D Occipital condyle
E Atlas
F Axis
G 3rd. cervical vertebra
H Stylohyoid bones
I Epiphyoid bones
J Ceratohyoid bones
K Basihyoid bone

L  Thyrohyoid bones
  2 Soft palate
  3 Epiglottis
  4 Arytenoid cartilage
     4(a) Cuneiform process
     4(b) Corniculate process
  5 Thyroid cartilage. (Some calcification of cartilage is present at ventral aspect (5(a).)
  6 Cricoid cartilage. (Some calcification of cartilage is seen especially at dorsal aspect (6(a).)

Calcification of laryngeal cartilages is a normal ageing process in the dog but can be present as early as 6 to 12 months of age. The calcification pattern and opacity vary between the different cartilages and individual dogs. As in this dog, thyroid and cricoid cartilages are the most commonly affected and opacity will increase with age.

  7 Tracheal cartilages
  8 Tracheal lumen
  9 Lateral ventricle of larynx
 10 Nasopharynx
 11 Oropharynx
 12 Laryngopharynx
 13 Laryngeal vestibule
 14 Laryngeal glottis
 15 Infrafllottic cavity
 16 Thyro- and cricopharyngeal muscles obliterating the lumen of laryngopharynx dorsal to the arytenoid and cricoid cartilage regions
 17 Oesophageal lumen

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
**Figure 394** Lateral projection of pharynx and larynx.

**Figure 395** Schematic drawing of lateral projection of pharynx and larynx to illustrate positions of lymphatic structures and thyroid gland.

- a = Palatine tonsil
- b = Mandibular lymph nodes
- c = Medial retropharyngeal lymph node
- d = Cranial deep cervical lymph node
- e = Thyroid gland
Figure 396  Right lateral recumbent projection of thorax. Projection to highlight cardiovascular system. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 2.5 years old, entire male (same dog as in dorsoventral projection of thorax, Figure 400).

Figure 397  Line drawing of photograph representing radiographic positioning for Figure 396.
**Pericardium and heart**

Cranial border
1. Right auricle
2. Right ventricle

In this radiograph the aortic arch is not visible but it can often be seen as a separate structure. Very rarely the cranial border of the pulmonary artery is seen.

Note that the aortic arch can be seen in the respiratory system radiographs and drawings, Figures 404 and 406.

A small indentation can sometimes be seen in the craniodorsal border of the cardiac shadow representing the junction of the cranial vena cava and the cranial border. This is known as the cranial waistline. In this radiograph the pulmonary vessels are obscuring the waistline level.

Caudal border
3. Left atrium. Dorsally obscured by pulmonary vessels.
4. Left ventricle

The junction between the atrium and ventricle is marked by a definite sulcus in the caudal border as it curves cranially. This is known as the caudal waistline and is found at the level of the ventral border of the caudal vena cava. Unlike the cranial waistline it is a consistent finding in the normal cardiac shadow.

5. Dorsal base
6. Apex

The pericardium, the fibroserous sac surrounding the heart, is not seen as a separate structure. In very obese dogs fat can accumulate within the sac and the middle mediastinum. Even so, the fat density may not be readily interpreted as a different tissue and without careful evaluation of the cardiac shadow a misdiagnosis of ‘cardiac enlargement’ can be made.

Note that the right lateral recumbent projection of thorax is preferred for the cardiac shadow as the phrenicopericardial ligament acts to anchor the apex. Although small there are noticeable differences in the cardiac, caudal vena cava and aortic silhouettes in right and left lateral recumbencies (see respiratory system radiographic Figures 404 and 408).

**Vascular**
7. Aortic arch. Occasionally an ill-defined shadow representing an outflow vessel from this arch is seen in the right lateral recumbent projection of thorax (not present in this radiograph).
8 Thoracic aorta
9 Level of cranial vena cava

The cranial vena cava cannot be seen as a separate structure but will be found at the ventral level of the cranial mediastinal shadow. It is formed at a level cranial to the thoracic inlet.

10 Caudal vena cava. (In this projection it is seen entering the central tendon of the diaphragm just right of the midline.) In most right lateral recumbent projections of thorax the entry is clearly defined as right sided and can be used to confirm recumbency.

11 Right cranial lobe artery
12 Right cranial lobe vein
13 Left cranial lobe vein

The left cranial lobe artery cannot be clearly seen in this radiograph but it will be present just ventral to the right cranial lobe vein.

Radiolucent shadows between the paired cranial vessels are the corresponding lobe bronchial lumen. These should not be mistaken for the abnormal air bronchograms. Often the bronchial walls are also visible and in this radiograph the most dorsal portions are just seen as fine radiopaque lines (14).

15 Artery and vein of caudal segment of left cranial lobe cranially
16 Artery and vein of right middle lobe caudally
17 Right pulmonary artery and veins. Right pulmonary artery, when seen as a separate structure, passes ventral to the tracheal bifurcation and is a round/oval soft tissue opacity in its end-on projection.
18 Left pulmonary artery and veins. Left pulmonary artery crosses the trachea, passing cranial to the tracheal bifurcation.

The left vascular trees are located just dorsal to the right but identification is very difficult. Also, differentiating between artery and vein is hard. However, arteries usually are more opaque, often slightly curved and are more well defined. Veins are usually shorter and stubbier. In addition arteries are located following the bronchial tree whereas veins travel to the left atrium via the shortest route.

Non-cardiovascular structures

19 Tracheal lumen
20 Tracheal walls
21 Level of tracheal bifurcation; carina
   21(a) Left cranial bronchus at bifurcation into bronchi for cranial and caudal segments. This shadow is often incorrectly named ‘carina’.
22 Cranial mediastinum occupied by large veins and arteries cranial to the heart, especially the cranial vena cava and brachiocephalic trunk
23 Pleural cupola. Area of lung extending cranial to 1st. rib
24 Sternum
24(a) Manubrium of sternum
24(b) Xiphoid process
25 1st. thoracic vertebra
26 11th. thoracic vertebra
27 Diaphragmatic shadow
27(a) Left ‘crus’
27(b) Right ‘crus’
28 Calcified costal cartilages
29 Gas-filled gastric fundus

Fluid-filled oesophagus can often be seen in the caudodorsal thoracic cavity in the right lateral recumbent projection of thorax. (Not present in this radiograph but can be seen in the mediastinal structures section, Figures 417 and 418.)
Figure 399  Schematic drawing of right lateral recumbent projection of thorax to illustrate cardiac chambers and major vessels (corresponds to line drawing Figure 398 but with the exclusion of some thoracic cavity details seen in the radiograph).

Left side with associated vessels
a = Left atrium with pulmonary veins (1)
b = Left auricle
c = Left ventricle (drawing does not indicate wall thickness)
d = Aorta with left subclavian artery (2) and brachiocephalic trunk (3)
M = Left atroventricular valve; mitral
A = Aortic valve

Right side with associated vessels
e = Right atrium with cranial vena cava (4), and caudal vena cava (5), plus azygous vein (6)
f = Right auricle
g = Right ventricle (drawing does not indicate wall thickness)
h = Pulmonary trunk. Main pulmonary artery or pulmonary artery segment.
L = Ligamentum arteriosum. Remnant of foetal ductus arteriosus.
P = Valve of pulmonary trunk
T = Right atroventricular valve; tricuspid.
Figure 400  Dorsoventral projection of thorax. Projection to highlight cardiovascular system. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 2.5 years old, entire male (same dog as in right lateral recumbent projection of thorax, Figure 396).
Figure 401  Line drawing of photograph representing radiographic positioning for Figure 400.

Figure 402  Dorsoventral projection of thorax. Drawing to highlight cardiovascular system.

Pericardium and heart

Right side
1  Right atrium
2  Right ventricle. Shadow of ventricle just crosses the midline.

Left side
3  Left auricle
4  Left ventricle
5  Apex. Formed by the wall of left ventricle.

Please see right lateral recumbent projection of thorax to highlight cardiovascular system, Figure 398, for more details.

Vascular
6  Aortic arch
7  Aorta
8  Pulmonary trunk. Main pulmonary artery or pulmonary artery segment.
9  Level of cranial vena cava within cranial mediastinum soft tissue shadow.
10  Caudal vena cava
11  Arteries to caudal lung lobes. Originate cranial to tracheal bifurcation level, carina, and travel lateral to principal caudal lobe bronchus (12). The carina is not clearly seen in this radiograph but will be located at (13).
Dog – Thorax

(402 continued.)

14 Veins to caudal lung lobes. Located caudal to tracheal
bifurcation level, carina, and travel medial to main caudal
lobe bronchi. In this radiograph the right vein is obscured
by the shadow of the caudal vena cava. Veins are slightly
smaller than arteries.

Care must be taken in identifying arteries and veins in this
projection as the calcified costal cartilage shadows ‘mimic’
vessels. To distinguish between the two sets of shadows one
must trace the full course of the shadows. Shadows of
the calcified costal cartilages will be seen to travel
caudally then curve cranially at, or near, the costochondral
junctions.

To avoid confusion the calcified costal cartilages and
bony rib shadows have been excluded from the drawing
but the reader should now identify these shadows.
A line drawing of the calcified cartilages and ribs,
Figure 388, can be found in the axial skeleton
section.

Non-cardiovascular structures
15 Tracheal lumen
16 Tracheal wall
17 Right cranial bronchial lumen
18 Cranial mediastinum. The right border is formed by the
cranial vena cava while the left is formed by the left
subclavian artery. In addition, both the trachea and
oesophagus lie within the cranial mediastinum.
19 Pleural cupola
20 1st. rib
21 8th. rib
22 Diaphragmatic shadow
23 Gas-filled lumen of gastric fundus
24 Phrenicopericardial ligament. Ligament is a fibrous
thickening of the ventral portion of caudal mediastinum.

Although the phrenicopericardial ligament is usually seen at
the cardiac apex a more lateral position can sometimes occur,
as in this radiograph. The attachment of the ligament is
pericardial not heart.
Figure 403  Schematic drawing of dorsoventral projection of thorax to illustrate cardiac chambers and major vessels. (corresponds to line drawing Figure 402 but with the exclusion of some thoracic cavity details seen in radiograph).

Left side with associated vessels
  a  = Left atrium
  b  = Left auricle
  c  = Left ventricle (drawing does not indicate wall thickness)
  d  = Aorta, root plus arch, with brachiocephalic trunk (1)
  A  = Aortic valve
  M  = Left atrioventricular valve; mitral

Right side with associated vessels
  e  = Right atrium with cranial vena cava (2) and caudal vena cava (3)
  f  = Right auricle
  g  = Right ventricle (drawing does not indicate wall thickness)
  h  = Main pulmonary artery
  P  = Valve of pulmonary trunk
  T  = Right atrioventricular valve; tricuspid
Figure 404  Left lateral recumbent projection of thorax. Projection to highlight respiratory system. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 7 years old, entire male (same dog as in all projections of thorax to highlight respiratory system, Figures 408, 411 and 414).

Figure 405  Line drawing of photograph representing radiographic positioning for Figure 404.
Figure 406  Left lateral recumbent projection of thorax.
Drawing to highlight respiratory system.

1 Cranial limit of the left cranial lung lobe. Extends beyond the 1st. pair of ribs into pleural cupola in well-inflated lung lobes.
2 Cranial limit of the right cranial lung lobe
3 Lucent shadow created by right middle lung lobe. This lung lobe is larger than the corresponding caudal segment of the left cranial lung lobe. Its presence at full inflation between the cardiac and sternal shadows should not be mistaken for free pleural gas. Pulmonary opacities can be seen in the lucent region, so confirming lung tissue.

Note that there is no left middle lung lobe in the dog.

4 Dorsal limit of caudal lung lobes. (The limit is more doral than normal, caused by positional rotation of the dog during radiographic exposure, as seen by rib shadows superimposed over vertebral canal.)

In a non-rotated lateral projection of the thorax the limit is at the level of the dorsal edge of vertebral body.

5 Ventral border of caudal lung lobe

From plain radiographs of the thorax it is not possible to identify many individual lung lobes due to extensive superimposition. The above labels the peripheral extents of some of the lobes which can be recognised and the schematic drawing attempts to demonstrate the areas covered by the individual lobes.

6 Pleural fissure line between middle and caudal lobes
7 Cervical tracheal lumen
8 Thoracic tracheal lumen
9 Tracheal walls
10 Level of tracheal bifurcation into right and left principal bronchi; carina
11 Radiolucent circular shadow demonstrating end-on projection of left cranial lobe bronchus at bifurcation into bronchus for cranial and caudal segments
Dog – Thorax

(406 continued.)

This shadow is often incorrectly labelled ‘carina’. The carina cannot be seen as a distinct shadow on lateral thorax projections.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Right cranial bronchial lumen</td>
</tr>
<tr>
<td>13</td>
<td>Right cranial bronchial wall</td>
</tr>
<tr>
<td>14</td>
<td>Left cranial bronchial lumen</td>
</tr>
<tr>
<td>15</td>
<td>Left cranial bronchial wall</td>
</tr>
<tr>
<td>16</td>
<td>Linear opacities representing bronchial walls</td>
</tr>
<tr>
<td>17</td>
<td>Circular opacities representing bronchial walls</td>
</tr>
</tbody>
</table>

Bronchial markings, as labelled above, are a normal feature in older dogs. Also, the appearance of the pleura is not uncommon. In addition nodular, linear and circular interstitial opacities will be found, as in this 7-year-old dog. The lung shadows in this figure should be compared with the ones found in the cardiovascular system right lateral recumbent radiograph, Figure 396. In the latter the dog is 2.5 years old.

Opacity changes will start to appear from approximately 4 years of age but environmental factors have to be considered e.g. town versus country (urban/rural). The opacity changes represent fibrous tissue and/or calcification of bronchial and interstitial tissues. They are more pronounced, and occur at a younger age, in the chondrodystrophic breeds.

Note that this radiograph has been taken at full inflation to avoid radiographic error of ‘increased lung opacity’.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>Cranial mediastinum occupied by large veins and arteries cranial to the heart, especially cranial vena cava and brachiocephalic trunk</td>
</tr>
<tr>
<td>19</td>
<td>Cardiac shadow including aortic arch at cranial border and at dorsal and ventral extremities the extensions of the pericardium</td>
</tr>
<tr>
<td>20</td>
<td>Aorta</td>
</tr>
<tr>
<td>21</td>
<td>Caudal vena cava seen entering the central tendon of the diaphragm at a level just right of the midline</td>
</tr>
<tr>
<td>22</td>
<td>1st. thoracic vertebra</td>
</tr>
<tr>
<td>23</td>
<td>11th. thoracic vertebra</td>
</tr>
<tr>
<td>24</td>
<td>Manubrium of sternum</td>
</tr>
<tr>
<td>25</td>
<td>Xiphoid process</td>
</tr>
<tr>
<td>26</td>
<td>Calcified costal cartilages</td>
</tr>
<tr>
<td>27</td>
<td>Diaphragmatic shadow</td>
</tr>
<tr>
<td>27(a)</td>
<td>Left ‘crus’</td>
</tr>
<tr>
<td>27(b)</td>
<td>Right ‘crus’</td>
</tr>
<tr>
<td>27(c)</td>
<td>Cupola</td>
</tr>
<tr>
<td>28</td>
<td>Lumbodiaphragmatic recess</td>
</tr>
<tr>
<td>29</td>
<td>Ventral skin folds superimposed on thorax shadows</td>
</tr>
<tr>
<td>30</td>
<td>Caudal border of scapula</td>
</tr>
<tr>
<td>31</td>
<td>Caudal angle of scapula</td>
</tr>
<tr>
<td>32</td>
<td>Spine of scapula</td>
</tr>
</tbody>
</table>
Figure 407  Schematic drawing of left lateral recumbent projection of thorax to illustrate lung lobes (corresponds to line drawing Figure 406 but with the exclusion of thoracic cavity details seen in the radiograph).

--- = Left lung. Cranial (cranial and caudal segments) and caudal lobes

A = Medial borders of the lobes of the left lung

--- = Right lung. Cranial, middle and caudal lobes

B = Medial borders of the lobes of the right lung

--- = Accessory lobe of right lung obscured by caudal lung lobe

The terms apical, cardiac, diaphragmatic and intermediate lung lobes are no longer in common usage.
**Figure 408**  Right lateral recumbent projection of thorax. Projection to highlight respiratory system. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 7 years old, entire male (same dog as in all projections of thorax to highlight respiratory system, Figures 404, 411 and 414).

The right lateral recumbent projection has been included in this section to illustrate the subtle but definite difference of the right and left recumbencies. Notice the obvious diaphragmatic shadow changes but also the more obvious oesophageal fluid in the right lateral and the pleural fissure line seen in the left lateral (labelled (6) on line drawing Figure 406).

Both left and right recumbent laterals should be performed for full evaluation of lung tissue. Radiographic changes in the more recumbent lobes can easily be overlooked or even be not evident on one recumbent projection.

Cardiac shadow also changes depending on the recumbency. As rotation is present in both of these projections the cardiac shadow cannot be critically analysed but as a routine the right lateral recumbency is superior for cardiac shadow evaluation.

If lung pathology is suspected in one hemithorax, radiography must ensure that in the lateral projection that hemithorax is uppermost. To perform both recumbencies may prove impractical if respiratory distress is severe.
Figure 409  Line drawing of photograph representing radiographic positioning for Figure 408.

Figure 410  Line drawing of photograph representing radiographic positioning for Figure 411.
Figure 411  Ventrodorsal projection of thorax. Projection to highlight respiratory system. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 7 years old, entire male (same dog as in all projections of thorax to highlight respiratory system, Figures 404, 408 and 414).
Figure 412  Ventrodorsal projection of thorax. Drawing to highlight respiratory system.

1 Cranial limit of the left cranial lung lobe. Extends beyond the 1st. pair of ribs into pleural cupola in well-inflated lung lobes. Just visible in this radiograph.
2 Cranial limit of the right cranial lung lobe
3 Caudal limit of the left caudal lung lobe
4 Caudal limit of the right caudal lung lobe
5 Thickened, fibrotic, pleural tissue at caudal border of right cranial lung lobe. Medially more distinct and demonstrates the pleural fissure line between right cranial and right middle lung lobes.
6 Phrenicopericardial ligament. Represents ventral portion of the caudal mediastinum.
7 Tracheal lumen at thoracic inlet
Dog – Thorax

(412 continued.)

8 Tracheal lumen within the cranial mediastinum just right of the midline
9 Right cranial bronchial lumen
10 Right cranial bronchial walls
11 Right middle bronchial lumen
12 Right caudal bronchial lumen
13 Right caudal bronchial walls
14 Caudal segment of left cranial bronchial lumen

Note that there is no left middle lung lobe.
15 Left caudal bronchial lumen
16 Left caudal bronchial walls
17 Linear opacities representing a portion of the bronchial walls to the caudal segment of the left cranial lung lobe
18 Circular opacities representing bronchial walls seen end-on

The same comments on bronchial markings apply to this projection as in the left lateral recumbent projection of thorax, Figure 406.

In addition, with the ventrodorsal projection the more lateral areas often appear more opaque due to the presence of skin folds (19). Skin folds are distinguished from thoracic cavity structures by following their continuous shadows beyond the cavity limits. Folds must not be mistaken for abnormal lung lobes.

20 Cranial mediastinum
21 Cardiac shadow including aortic arch at cranial border.
   (Shadow is narrower, with an elongated shape, in this ventrodorsal projection than in the corresponding dorsoventral projection, Figure 414.)

22 Caudal vena cava
23 Diaphragmatic shadow. (Triple shadow in this ventrodorsal projection compared to the corresponding dorsoventral projection, Figure 414.)

24 Right ‘crus’ of diaphragm
25 Left ‘crus’ of diaphragm
26 Cupola of diaphragm
27 Costodiaphragmatic recess
28 1st. rib
29 10th. rib
30 Spine of scapula
Figure 413  Schematic drawing of ventrodorsal projection of thorax to illustrate lung lobes (corresponds to line drawing Figure 412 but with the exclusion of thoracic cavity details seen in the radiograph).

---  1 = Right cranial lung lobe
    2 = Right middle lung lobe
    3 = Right caudal lung lobe

--------  4 = Left cranial lung lobe, cranial segment

-----  5 = Left cranial lung lobe, caudal segment
    6 = Left caudal lung lobe
    7 = Accessory lung lobe

A = Dorsal border of caudal lung lobes
Figure 414  Dorsoventral projection of thorax. Projection to highlight respiratory system. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle Dog 7 years old, entire male (same dog as in all projections of thorax to highlight respiratory system, Figures 404, 408 and 411).

The dorsoventral projection has been included in this section to show that even with fully inflated lungs, the area of lung exposed is less in this projection compared with the ventrodorsal. This effect is smaller in the cat but with this species the thoracic cavity is greatly reduced, and appears more triangular, when the front limbs are not extended forwards.

The dorsoventral projection should always be used for cardiovascular evaluation as cardiac position is not altered. Also the caudal pulmonary vessels are more clearly defined.

The ventrodorsal projection is preferable for lung tissue evaluation. It also shifts pleural fluid dorsally and cranial mediastinal shadows are clearer. However, this position may be clinically contraindicated.

It must also be remembered that the ventrodorsal and/or dorsoventral projection(s) should be performed first, before the recumbent lateral projections. Hypostatic congestion/lung lobe collapse occurs rapidly in recumbent animals suffering from cardiovascular or respiratory problems. Even in clinically normal animals hypostatic congestion will develop during lateral recumbency (see Figure 432).
**Figure 415**  Line drawing of photograph representing radiographic positioning for Figure 414.

**Figure 416**  Line drawing of photograph representing radiographic positioning for Figure 417.
**Figure 417** Right lateral recumbent projection of thorax. Projection to highlight mediastinal structures. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 2 years old, entire female (same dog as in dorsoventral projection of thorax, Figure 421).
**Cranial mediastinum. Portion cranial to cardiac shadow.**

1. Ventral border of cranial vena cava. (Seen in this dog but often it is not present as a distinct shadow.)
2. Tracheal lumen
3. Tracheal walls
4. Longus colli muscle shadow
5. Gas-filled oesophagus extending caudally. Gas filled oesophagus is also seen at thoracic inlet (6).
6. Gas-filled oesophagus

**Middle mediastinum. Portion containing cardiac shadow.**

7. Cardiac shadow
8. Level of tracheal bifurcation; carina. Note that the carinal shadow cannot be seen on lateral projections.
8(a) Origin of right cranial lobe bronchus
8(b) Origin of left cranial lobe bronchus

Slight rotation of this lateral recumbent projection has allowed both cranial lobe bronchi to be seen. Often only one radiolucent circular shadow can be seen at this level, the end-on projection of left cranial lobe bronchus at bifurcation into bronchi for cranial and caudal segments. This shadow is often incorrectly named the ‘carina’.

9. Aortic arch

**Caudal mediastinum**

10. Caudal vena cava
11. Fluid-filled lumen of oesophagus
12. Descending aorta

The mediastinum can be further subdivided into dorsal and ventral portions. The dorsal portion is simple from 1st rib to diaphragm, but the ventral portion contains the pericardium and the heart. In the dog the mediastinum is incomplete but the pleural coating is non-fenestrated.

13. Pulmonary vessels
14. Caudal vena cava seen entering diaphragm at caval foramen
15. Diaphragmatic shadow
   15(a) Left ‘crus’
   15(b) Right ‘crus’
   15(c) Cupola
16. Lumbo-diaphragmatic recess
17. Ventral skin folds superimposed on thoracic cavity shadows
18. Cranial limit of left cranial lung lobe
19. Cranial limit of right cranial lung lobe
20. 1st. thoracic vertebra
21. 12th. thoracic vertebra
22. Manubrium of sternum
23. Xiphoid process
24 Calcified costal cartilages

The presence of fat within the middle mediastinum has been noted in the cardiovascular drawing, Figure 398. Large fat deposits can also be found in the cranial mediastinum in obese old dogs. Dogs of the smaller breeds, and especially the brachycephalic breeds, are prone to accumulate fat in the cranial mediastinum. Fat may also develop in the cranio-

ventral mediastinum resulting in a dorsal elevation of the cardiac shadow.

Fat accumulation, as referenced above, must not be misdiagnosed as a pathological condition. Knowledge of breed variation, plus radiographic opacity evaluation, is required for correct interpretation of thoracic radiographs.

A number of radiographs follow the ‘normal’ dog radiographs to illustrate the above comments.

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Figure 419  Schematic drawing of right lateral recumbent projection of thorax to illustrate mediastinal structures.

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A = Thymus seen in young dog. As dog ages glandular tissue reduces and is replaced by fat.
B = Sternal lymph nodes. Usually one each side of thoracic cavity.
C = Cranial mediastinal lymph nodes. Left side: one to six in number. Right side: two to three, maximum of six.
D = Tracheobronchial lymph nodes. Right and left lie in the angle between the lateral surface of each cranial principal bronchus and the trachea. Middle (V shaped) is dorsally at the angle of tracheal bifurcation.

1 = Left subclavian artery
2 = Brachiocephalic trunk
3 = Azygous vein
4 = Thoracic duct
Figure 420  Line drawing of photograph representing radiographic positioning for Figure 421.
Figure 421  Dorsoventral projection of thorax. Projection to highlight mediastinal structures. Radiograph taken during general anaesthesia with full inflation of lung lobes. Beagle dog 2 years old, entire female (same dog as in right lateral recumbent projection of thorax, Figure 417).
Figure 422  Dorsoventral projection of thorax. Drawing to highlight mediastinal structures (pleura excluded and diaphragm included in respiratory system drawings).

Cranial mediastinum. Portion cranial to cardiac shadow.
1 Right border of cranial vena cava
2 Left border of left subclavian artery
3 Tracheal lumen. Thoracic portion lies slightly to the right until its termination when it is midline.

Middle mediastinum. Portion containing cardiac shadow.
4 Cardiac shadow
5 Aortic arch
6 Descending aorta

Caudal mediastinum. Portion caudal to cardiac shadow.
7 Caudal vena cava
8 Descending aorta
9 Phrenicopericardial ligament. Ligament is a fibrous thickening in the ventral portion of the caudal mediastinum.
10 Diaphragmatic shadow
10(a) Cupola
11 Costodiaphragmatic recess
12 Cardiophrenic angle
13 Skin folds superimposed on thoracic cavity shadows
14 Cranial limit of cranial lung lobes
15 1st. rib
16 11th. rib
17 Spine of scapula
Figure 423  Schematic drawing of dorsoventral projection of thorax to illustrate mediastinal structures.

---  A = Thymus seen in young dogs. As dog ages, lymphoid tissue reduces but in older dogs a vestigial thymus is often seen (B). This shadow is known as the 'sail sign'.

C = Sternal lymph nodes
D = Cranial mediastinal lymph nodes. Ventral and dorsal positions.
E = Tracheobronchial lymph nodes
F = Pulmonary lymph nodes. Often absent.

1 = Left subclavian artery
2 = Brachiocephalic trunk
3 = Thoracic duct
Figure 424  Lateral projection of larynx and pharynx. Brachycephalic breed of dog. Radiograph taken during general anaesthesia with endotracheal tube removed for clarity of radiographic shadows. Bulldog 5 years old, entire female.

The radiograph shows the vertical position of the hyoid bones together with a much reduced oropharynx and very large soft palate shadow. The nasopharynx is also small and the endotracheal intubation has caused the epiglottis (closed arrow) to lie ventrocranially.

On recovery from the general anaesthetic, when swallowing reflexes return, the epiglottis will rotate dorsocranially and come to rest just ventrocranially to the soft palate.

Note the large retropharyngeal space (open arrow) which is normal in this type of breed but does create an apparent ventral displacement of the laryngeal cartilages.
Figure 425  Right lateral recumbent projection of thorax. Short, barrel chested breed of dog. Radiograph taken during general anaesthesia with full inflation of lung lobes. Samoyed dog 6 years old, entire female (same dog as in Figure 427)

The radiograph demonstrates the rounded cardiac shadow, with increase in sternal contact, caused by the horizontal position of the heart within the thoracic cavity. Cardiac measurements, when compared to a normal or intermediate chested breed of dog, are greater in the craniocaudal direction.

The comparatively large craniocaudal measurement together with rounding of cranial cardiac border and increase in sternal contact must not be misdiagnosed as right-sided cardiac enlargement (atrial and ventricular).

The lung opacities in this dog are due to ‘age’ changes within the bronchial walls and interstitial tissue (see Figure 433 for ‘age’ changes).
Figure 426  Right lateral recumbent projection of thorax. Deep, narrow chested breed of dog. Radiograph taken during general anaesthesia with full inflation of lung lobes. Afghan Hound dog 2 years old, entire female.

The radiograph shows the ‘upright’ appearance of the cardiac shadow. This is caused by the position of the heart within the thoracic cavity being almost perpendicular to the thoracic spine. Cardiac measurements, compared to a normal or intermediate chested breed of dog, are less in the craniocaudal direction and greater in the dorsoventral direction.

Care must be taken when analysing this type of cardiac shadow as the upright appearance, especially of the caudal border, may be misdiagnosed as left-sided cardiac enlargement. In particular, an enlarged left atrium could be interpreted.
Figure 427  Dorsoventral projection of thorax. Short, barrel chested breed of dog. Radiograph taken during general anaesthesia with full inflation of lung lobes. Samoyed dog 6 years old, entire female (same dog as in Figure 425).

The radiograph shows the rounded left and right cardiac borders seen in this type of chested breed of dog.
Rounded cardiac apex is more left of the midline compared to the normal or intermediate chested breed of dog. The apical level is due to the oblique position of the heart across the thoracic cavity’s midline.

As with the right lateral recumbent projection of thorax, the appearance of the cardiac shadow in the short, barrel chested breed of dog must not be confused with right-sided cardiac enlargement (atrial and ventricular).
Also note the fat deposition mimicking a wide cranial mediastinum and right-sided cardiac enlargement (see fat deposition within thoracic cavity, Figure 435).
Figure 428  Dorsoventral projection of thorax. Deep, narrow chested breed of dog. Radiograph taken during general anaesthesia with full inflation of lung lobes. Doberman Pinscher dog 4 years old, entire female.

The radiograph shows the short-rounded appearance of the cardiac shadow typical in this type of chested dog. The cardiac shadow is more midline than in the normal or intermediate chested breed of dog.

Also of note are the deep costophrenic angles.
**Figures 429 and 430** Radiographs to illustrate poor technique in thoracic radiography.

**Figure 429** Right lateral recumbent projection of thorax. Radiograph taken while dog conscious using sandbag restraint.

**Figure 430** Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes.

Both radiographs were taken using the same radiographic equipment, exposure values and film focal distance.

Bulldog 18 months old, entire female. Same dog as in Figure 431.

In the conscious dog note the very opaque appearance of all the lung tissue, especially cranially; also the apparent narrowing of the trachea at the thoracic inlet and the ‘large globular’ cardiac shadow.

In the anaesthetised dog, which is now more properly positioned with full inflation of lung lobes, the lung tissue has lost its extremely opaque appearance. Also, the trachea is normal in width, and the cardiac shadow has reduced in size and is less rounded in outline.

Unfortunately, due to rotation of the chest full analysis of the cardiac shadow is not possible. However, the bulldog will have a cardiac shadow typical of a short, barrel chested breed of dog.
Figure 430
Figure 431  Ventrodorsal projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Bulldog 18 months old, entire female (same dog as in Figures 429 and 430).

The radiograph confirms that lung density is normal in both right and left lung lobes, as indicated in the right lateral recumbent projection of thorax with full inflation of lung lobes.

Note the rudimentary clavicles which are commonly seen in the ventrodorsal and dorsoventral projections of thorax. Also, at the 12th rib level shadows of right and left nipples can be seen as distinct soft tissue shadows superimposed on lung and liver shadows. Care must be taken to ensure that nipple shadows are not misdiagnosed as neoplastic masses.
Figure 432 Ventrodorsal projection of thorax. Hypostatic congestion of lung tissue. Radiograph taken during general anaesthesia with full inflation of lung lobes. German Shepherd dog 7 years old, entire female.

The radiograph demonstrates the radiopaque appearance caused by hypostatic congestion of the left cranial lung lobe (cranial and more especially caudal parts). The congestion is collapsing of dependent lung tissue while in left lateral recumbency prior to the ventrodorsal projection being taken.

Once collapse has occurred full reinflation for a normal lung appearance is very difficult to achieve.

Although this radiograph demonstrates a normal phenomenon that will occur in any dependent lung tissue following prolonged lateral recumbency, hypostatic congestion of abnormal lung tissue can occur within minutes of lateral recumbency. Hence in radiography of clinical cases ventrodorsal or dorsoventral projections should precede lateral recumbent projections (remember that ventrodorsal projection may be contraindicated in cases of severe dyspnoea).
**Figure 433**  Right lateral recumbent projection of thorax. ‘Age’ changes in dog’s lung tissue. Radiograph taken during general anaesthesia with full inflation of lung lobes. Golden Labrador dog 8 years old, entire female.

The radiograph shows changes within the bronchial walls and interstitial lung tissue creating an opaque mixed bronchial–interstitial pattern. The pattern is both linear and circular opacities associated with bronchial wall thickening and/or mineralisation. Interstitial involvement is also present in the form of linear and micronodular opacities. The vascular pattern is somewhat obscured by the increased interstitial radiopacity.

Such changes can commonly be seen in dogs over 4 years of age (so-called ‘ageing’ of lungs). ‘Ageing’ is progressive and in dogs over 10 years of age the radiographic appearance can be very dramatic. The latter may be difficult to differentiate from severe disease.

Urban dogs are more prone to the bronchial–interstitial changes but certain breeds appear to be more predisposed. In particular, chondrodystrophic breeds have mineralisation of their bronchial walls as they age, but changes are often seen before 4 years of age and even at 1 year old (see Figure 437, Atonic oesophagus).

Although the cat does have some ‘ageing’ of lung tissue, the radiographic appearance is usually a few bronchial wall thickenings scattered throughout the lung lobes. Unlike the dog the cat ‘age’ changes often remain limited even into geriatric years.
Figure 434  Right lateral recumbent projection of thorax. Fat deposition within thoracic cavity. Radiograph taken during general anaesthesia with inflation of lung lobes. Old English Sheepdog 8 years old, entire male.

The radiograph demonstrates dorsal elevation of the cardiac shadow away from the bony sternum. Ventral to the cardiac shadow the grey opacity of fat tissue can be seen.

Loss of sternal contact of the cardiac shadow caused by fat deposition must not be mistaken for a pneumothorax. In the latter case the black shadow of air will be seen ventral to the cardiac shadow.

Dorsal elevation of the cardiac shadow by fat deposition is more frequently seen in the dog than the cat.
Figure 435  Dorsoventral projection of thorax. Fat deposition within thoracic cavity. Radiograph taken during general anaesthesia with inflation of lung lobes. Bulldog 1 year old, entire female.

The radiograph shows the effect of fat accumulation within the cranial mediastinum making this area appear wider than normal (closed arrows). The grey opacity of fat can be seen (1). The soft tissue opacity of the cranial mediastinum is labelled (2).

Also present is fat deposition in the ventral mediastinum and pericardial sac. This is seen to mimic cardiac ‘enlargement’. The grey fat opacity outline is labelled with open arrows, while the cardiac soft tissue outline is labelled with curved arrows.

Although this fat accumulation is seen more commonly in the chondrodystrophic breed of dog, any obese dog or cat can have fat deposits in the regions described above.

Of note is the cardiac shadow which is typical of a short, barrel chested breed of dog. The left and right borders are both rounded and the rounded cardiac apex is positioned to the far left. The apex site is caused by the oblique positioning of the heart across the midline in this type of chest (see Figure 427).
Figure 436  Hyperextended lateral projection of trachea. False tracheal collapse. Radiograph taken during general anaesthesia at full inspiration. Yorkshire Terrier dog 10 years old, neutered female.

The radiograph shows an apparent narrowing of the cervical tracheal lumen (arrow). The ‘narrowing’ is due to an overlying soft tissue shadow of the oesophagus and ventral neck muscles.

This soft tissue shadow at the dorsal aspect of the trachea commonly creates a ‘false’ tracheal collapse, especially with hyper-extension of the neck. Differentiation from abnormality is aided by studying the pharyngeal spaces and thoracic trachea. Pharyngeal air spaces and the thoracic trachea are of a normal size, i.e. are not enlarged, in this dog.

If there is doubt in interpretation of tracheal collapse further radiography must be undertaken. This includes lateral projections of the cervical and thoracic trachea, with the neck in a normal extended position, at both full inspiration and full expiration. In cases of tracheal collapse, collapse of cervical trachea will be seen at inspiration while thoracic trachea collapses at expiration.

Alternatively, or additionally, a cross section of the lower cervical tracheal shadow can be obtained by special tracheal positioning. While the dog is in sternal recumbency the neck is hyperflexed. The vertical primary beam is then directed tangentially to the trachea.
Figure 437  Left lateral recumbent projection of thorax. Atonic oesophagus caused by general anaesthesia. Radiograph taken during general anaesthesia with full inflation of lung lobes. Bull Terrier dog 18 months old, entire male.

The radiograph highlights the atonic effect of general anaesthesia on the oesophagus. This type of atony must not be misdiagnosed as an abnormality of the muscle, or even as an enlargement, i.e. megaoesophagus. The oesophagus will return to its normal size, and function, following recovery from the general anaesthetic.

Closed arrows = Dorsal wall of oesophagus
Open arrows = Ventral wall of oesophagus

Note the linear radiolucent area between the two types of arrow

Curved arrows = Tracheoesophageal stripe sign. This occurs normally when the oesophagus is distended with gas. It is not a thickening of the tracheal or oesophageal wall. The appearance is due to oesophageal luminal gas contrast allowing the soft tissue of the dorsal tracheal wall and the contacting oesophageal wall to be seen as a single shadow.

Also of note is the obvious bronchial pattern even though the dog is only 18 months old. This is due to calcification of the bronchial walls in a chondrodystrophic breed of dog. Micronodular calcified plaques are also present throughout the interstitial tissue.

Although cardiac shadow analysis should be made from the right lateral recumbent projection, the cardiac shadow here is typical of a short, barrel chested breed of dog (see Figure 425).

Cardiac shadow appears more horizontal in thoracic position with increase in sternal contact. This effect gives rounding of cardiac borders and the craniocaudal measurement of the heart is larger than compared with the normal or intermediate chested breeds of dog.

Most terrier breeds of dog have this type of cardiac shadow.
**Figure 438** Left lateral recumbent projection of thorax. Congenital oesophageal diverticulum. Radiograph taken during general anaesthesia with no inflation of lung lobes. Boston Terrier dog 20 months old, entire female.

The radiograph shows a gas pocket depicting a congenital oesophageal diverticulum at the thoracic inlet. Diverticula in this region of the oesophagus are not uncommon especially in the brachycephalic breed of dog. Usually they are of no clinical significance.

The presence of gas in the oesophagus is normal for an animal under a general anaesthetic. However, any evidence of oesophageal gas in the conscious animal must be treated with suspicion as it indicates abnormal oesophageal function.
Figure 439  Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Weimaraner dog 7 weeks old, entire female.

The radiograph shows the opaque appearance of lung tissue in the very young animal. This opacity is thought to be due to fluid within the interstitial tissue not present in the adult. It must not be misdiagnosed as disease.

Also of note is the large cardiac shadow. Young dogs of every breed, that is all type chested breeds, have comparatively large cardiac shadows with rounded borders and increase in sternal contact. Again the shadow must not be confused with an abnormality.

When adult, the Weimaraner cardiac shadow would be the normal or intermediate chested breed of dog (see Figure 396).
Figure 440  Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Golden Labrador dog 20 weeks old, entire female.

The radiograph demonstrates a linear radiopaque interstitial pattern which is normal for a dog of this age. Some bronchial markings are also present where the interstitial fluid has involved the peribronchial tissue.

The cardiac shadow appears to have enlargement, especially of the cranial border or right ventricle. A ventral indentation can be seen at the junction of the right and left ventricle. These signs must not be mistaken for cardiac abnormality as a dog of 20 weeks of age normally has a large cardiac shadow compared to the adult.

The Labrador dog is a normal or intermediate chested breed of dog and when mature this dog will lose its apparent right-sided cardiac enlargement.
Figure 441  Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Samoyed crossbred dog 25 weeks old, entire male (same dog as in Figure 442).

Although the radiograph shows the radiopaque appearance of the lung lobes, which is usually seen in the immature animal, the long woolly coat of this dog has caused an additional mottled soft tissue opacity over the entire thorax. However, the linear and circular lung opacity of the interstitial and bronchial tissue can still be identified.

The cardiac shadow appears abnormally rounded, especially the cranial border. This is normal for a short, barrel chested breed of dog at 25 weeks of age.
Figure 442  Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Samoyed crossbred dog 38 weeks old, entire male (same dog as in Figure 441).

The radiograph now shows that the cardiac shadow has become typical for a short, barrel chested breed of dog. The extreme rounding of the borders, especially the cranial border or right ventricle, has disappeared.

The lung tissue still appears opaque at this age, but repeat radiography of the same dog at 52 weeks old, showed overall reduction of both interstitial and bronchial patterns. Cardiac shadow at 52 weeks of age was similar in size and shape to this 38 week film.
Figure 443  Left lateral recumbent projection of abdomen. Beagle dog 2 years old, entire female (same dog as in all projections of the abdomen of the female).
Figure 444  Line drawing of photograph representing radiographic positioning for Figure 443.

Figure 445  Left lateral recumbent projection of abdomen.

1  Diaphragmatic shadow 4  Skin margin
  1(a) Left ‘crus’ 5  Subcutaneous fat
  1(b) Right ‘crus’ 6  M.rectus abdominis
  1(c) Cupola 7  Intraperitoneal fat
2  11th. thoracic vertebra 8  Calcified costal cartilages
3  Soft tissue shadows of nipples
Dog – Abdomen

9 Soft tissue shadow of liver

9(a) Caudoventral margin of liver. Normally seen just beyond costal arch forming an acute angle of 30 degrees or less.

Note that in aged and obese animals this shadow often projects beyond the costal arch due to stretching of the ligaments supporting the liver. A right lateral recumbent projection shows the dorsal extent of the liver to be less in these cases than in younger, non-obese dogs.

The liver shadow is slightly more caudally positioned during inspiration but most abdominl radiography is performed during expiration.

10 Spleen

10(a) Ventral extremity. Normally seen at this position but varies depending on gastric distention.

10(b) Dorsal extremity

11 Gas in gastric fundus. (In this radiograph there is an abnormally large volume of gas seen for left lateral recumbency.)

The fundus is dependent in this projection and is usually fluid filled. Normally most of the gastric gas will be found in the pyloric part, as this is uppermost in left lateral recumbency.

12 Gastric mucosa

13 Gastric body

14 Pyloric part, antrum and canal, of gastric shadow. (Some gas is present due to left lateral recumbency, see number 11.)

15 Position of pylorus (pylorus not seen in this film)

The term pylorus is often incorrectly used to mean pyloric antrum and canal.

16 Position of gastric cardia (cardia not seen in this film)

Contrast media normally required to demonstrate numbers 15 and 16.

17 Duodenal shadow (seen due to the presence of lumenal gas contrast)

18 Jejunum and ileum (seen due to the presence of lumenal gas contrast)

Loops of bowel are normally visible, their lumens filled with gas or fluid, or a mixture of both. The mixture of luminal gas and fluid can mimic wall ‘thickening’ when lateral recumbent projections are taken. This is caused by the fluid lining the lumen being in contact with the wall while gas is in the centre of the lumen. Fluid and soft tissue have the same radiographic opacity and hence cannot be differentiated in plain radiographs. A bowel fluid line, i.e. a gas and fluid interface, will only be seen in lateral standing projections of the abdomen.

In the dog radiographed for this film, very little abdominal intraperitoneal fat was present. This resulted in poor soft tissue contrast and has made the gas-filled gastrointestinal shadows most obvious.

The long jejunum is indistinguishable from the short ileum and generally the diameter of all the bowel is equal; the rule of thumb is, maximum width normally equal to the height of the lumbar vertebra’s body.

It has been noted that the terminal ileum can be greater in diameter as it approaches the caecum. The terminal ileum is usually located in the central abdomen, just to the right of the midline.

19 Caecal shadow (elongated comma shape is not clearly seen in this film)

20 Ascending colon

21 Transverse colon

22 Descending colon

23 Rectum

24 Left kidney

The left kidney is more mobile than the right. In obese dogs the craniocaudal axis often becomes more vertical than horizontal and fat opacity is present dorsally.

Kidney shape varies from bean to elliptical but the outline is always smooth. Size is 2.5 to 3.5 times the length of the 2nd lumbar vertebral body.

Kidneys and ureters, not visible in the normal dog in plain films, are retroperitoneal.

25 Region of urinary bladder

Although not seen in this film, the urine-filled bladder is usually clearly identifiable. It extends cranially in a ventral position.

The genital system of the non-pregnant normal female dog is not usually seen without contrast material.

26 Sublumbar muscles; m. psoas minor, m. iliopsoas and m. quadratus lumborum

Also included in this shadow are ureters, lymph nodes plus aorta, caudal vena cava and other vessels.

The shadow gradually decreases in opacity caudal to the 4th. lumbar vertebra as the m. iliopsoas diverge to insert on the proximal femora. The m. quadratus lumborum inserts on the wing of the ilium. The caudal vena cava forms from the iliac veins and the aorta divides to form the left and right internal and external arteries.

27 2nd. lumbar vertebra

28 7th. lumbar vertebra

29 Body of ilium

30 Iliopubic or iliopsoephaline eminence

31 Femoral bodies

32 Skin folds
Figure 446  Line drawing of photograph representing radiographic positioning for Figure 447.
Figure 447 Ventrodorsal projection of abdomen. Beagle dog 2 years old, entire female (same dog as in all projections of abdomen of the female).
Figure 448  Ventrodorsal projection of abdomen.
Dog – Abdomen

(448 continued.)

1  Diaphragmatic shadow
   1(a) Cupola

2  8th. thoracic vertebra

3  8th. rib

4  Skin folds

5  Skin margin

6  Subcutaneous fat. (Only just visible in this dog as a thin grey line between the outer skin and the first superficial muscle layer of the lateral abdominal wall.)

7  M.obliquis externus abdominis

8  Very thin layer of fat overlying the superficial surface of the caudal ribs.

   This layer usually serves to separate the m.obliquis externus abdominis from the m.obliquis internus abdominis and m.transversus abdominis. Unfortunately the fat layer is too thin to distinguish clearly between the two muscle layers in this female dog.

9  Intraperitoneal fat

10  Soft tissue shadow of liver

11  Dorsal extremity of spleen

12  Gastric fundus

13  Gastric mucosa

14  Gastric body. (Contains most of gas within the gastric structures due to the ventrodorsal positioning allowing gas to collect in the uppermost part of gastric shadow.)
   14(a) Lesser curvature
   14(b) Greater curvature

15  Pyloric part of gastric shadow; Pyloric antrum and canal.

16  Pylorus; pyloric sphincter muscle. The term pylorus is often misused to mean pyloric antrum and canal.

17  Ingesta within gastric lumen

18  Position of gastric cardia (cardia not visible in this film)

19  Duodenal shadow (seen due to the presence of gas in the lumen)

20  Jejunum and ileum (seen due to the presence of gas in the lumen)

   See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for additional information.

21  Caecal shadow. (Comma shape more obvious in this film than in the corresponding dorsoventral projection line drawing, Figure 451.)

22  Ascending colon

23  Transverse colon (superimposed in part by gastric shadow)

24  Descending colon

25  Rectum

26  Left kidney (only just visible)

   See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for more information.

   The right kidney is not visible in this film due to the small amount of perirenal fat contrast.

27  Soft tissue shadows representing nipples

28  2nd. lumbar vertebra
   28(a) Transverse process

29  7th. lumbar vertebra
   29(a) Transverse process

30  Body of ilium

31  Sacrum

32  Femoral bodies
Figure 449  Line drawing of photograph representing radiographic positioning for Figure 450
Figure 450  Dorsoventral projection of abdomen. Beagle dog 2 years old, entire female (same dog as in all projections of abdomen of the female).
Although the dorsoventral projection is not routinely used as a standard abdominal projection, comparison of the ventrodorsal and dorsoventral projections, in the same female dog, highlights how free gas within the gastrointestinal tract changes position. In addition, structures further away from the filmed cassette, e.g. kidneys (in the dorsoventral projection), are less well defined. Also note the shape of the pelvis in the dorsoventral projection, as opposed to the usual appearance in the ventrodorsal projection.

1 Diaphragmatic shadow
   1(a) Cupola
2 9th. thoracic vertebra
3 9th. rib
4 Skin folds
5 Skin margin
6 Subcutaneous fat
Dog – Abdomen

(451 continued.)

7 M. obliquus externus abdominis
8 Very thin fat layer
   See (8) in ventrodorsal projection of abdomen of female, Figure 448, for additional details.
9 Soft tissue shadow of liver
10 Lucent gas shadows of caudal lung lobes superimposed over soft tissue shadow of liver
11 Dorsal extremity of spleen (most of the triangular shadow lines are only just visible)
12 Gastric fundus. (Contains most of the gas in the stomach due to positioning causing gas to rise to the uppermost part of the stomach, i.e. fundus in dorsoventral projection.)
13 Gastric mucosa
14 Gastric body
   14(a) Lesser curvature
   14(b) Angular notch
   14(c) Greater curvature
15 Pyloric part of gastric shadow; Pyloric antrum and canal.
16 Pylorus; pyloric part of the stomach containing the pyloric sphincter muscle. The term pylorus is often misused to mean pyloric antrum and canal.
17 Position of gastric cardia (cardia not visible in this film)
18 Ingesta within gastric lumen
19 Duodenum. (Shadow seen due to the presence of gas in lumen and can be seen more extensively than in the corresponding ventrodorsal projection, Figure 448.)
20 Jejunum and ileum. See (18) in left lateral recumbent abdominal projection of female, Figure 445, for additional information.
   20(a) Terminal portion of ileum. Apart from this bowel shadow jejunum and ileum cannot be differentiated between in plain radiographs.
21 Caecal shadow
22 Ascending colon
23 Transverse colon. (Superimposition less in this film than the corresponding ventrodorsal projection in Figure 448.)
24 Descending colon
25 Rectum
26 Left kidney (only the cranialateral pole is visible with the aid of colonic gas contrast)
   See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for additional information.
   The right kidney is not visible in this film due to insufficient perirenal fat contrast and radiographic projection.
27 Soft tissue shadows representing nipples
28 2nd. lumbar vertebra
   28(a) Transverse process
29 7th. lumbar vertebra
   29(a) Transverse process
30 Body of ilium
31 Sacrum
32 Femoral bodies
Figure 452  Line drawing of photograph representing radiographic positioning for Figure 453.
Figure 453  Left lateral recumbent projection of abdomen. Cranially centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
Figure 454  Left lateral recumbent projection of abdomen. Cranially centred.

1 Diaphragmatic shadow
   1(a) Left ‘crus’
   1(b) Right ‘crus’
   1(c) Cupola
2 Caudal vena cava entering the central tendon just right of the midline
3 11th. thoracic vertebra
4 Skin margin
5 Subcutaneous fat
6 M. rectus abdominis
7 Fat in falciform ligament of the liver
8 Skin folds
9 Calcified costal cartilages
   9(a) Costal arch. (Formed by costal cartilages 10, 11 and 12.)

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Dog – Abdomen

(454 continued.)

10 Soft tissue shadow of liver. See (9) in left lateral recumbent projection abdomen of female, Figure 445, for more details. 10(a) Caudoventral margin. (Acute angle not clearly seen due to superimposition of fluid-filled intestinal shadow.)

11 Ventral extremity of spleen

12 Pyloric part, antrum and canal, of gastric shadow. (Large volume of gas present due to left lateral recumbency resulting in gas entering the uppermost part of the gastric shadow. No other part of the gastric shadow is seen in this film.)

13 Position of pylorus; sphincter at entrance of duodenum.

The term pylorus is often incorrectly used to mean the pyloric antrum and canal. (Not seen as a separate structure in this film.)

14 Jejunum and ileum. (Seen as fluid filled viscera with a few gas pockets in lumens.)

See (18) in left lateral recumbent projection abdomen of female, Figure 445, for more details.

15 Caecal shadow. (Contrast of gas in the lumen makes the comma shape of the caecum distinguishable from the surrounding intestinal shadows.)

16 Ascending colon

17 Transverse colon

18 Descending colon

19 Right kidney. See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for additional kidney information.

20 Position of left kidney. (Shadow cannot be seen as it is obscured by caecal and colonic shadows.)

See ventrodorsal and dorsoventral projections line drawing, Figures 464–469 and 471–475, for left kidney in this dog.

21 Sublumbar muscles. For more details see (26) in left lateral recumbent projection of abdomen of female, Figure 445.

22 2nd. lumbar vertebra

23 7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present on the ventral aspect of cranial endplate. See ‘normality’ in the Introduction.)

24 Iliac

25 Os penis

26 Preputial shadow
Figure 455  Line drawing of photograph representing radiographic positioning for Figure 456.
Figure 456  Left lateral recumbent projection of abdomen. Caudally centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
Figure 457  Left lateral recumbent projection of abdomen. Caudally centred.

1 2nd. lumbar vertebra
2 Caecal shadow
3 Ascending colon
4 Descending colon
5 Rectum
6 Jejunum and ileum. See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for more details.
7 Ventral extremity of spleen
8 Soft tissue shadow of nipple
9 Skin fold
10 M.rectus abdominis
11 Right kidney. See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for more kidney details.
12 Position of left kidney. (Shadow cannot be seen as it is obscured by caecal and colonic shadows.)

See ventrodorsal and dorsoventral projections line drawings, Figures 464–469 and 471–475, for left kidney in this dog.

13 Sublumbar muscles. For more details see (26) in left lateral recumbent projection of abdomen of female, Figure 445.
14 Region of urinary bladder. When distended with urine a distinct soft tissue shadow can be seen but when empty the urinary bladder lies almost entirely within the pelvis.
15 Soft tissue shadow of prostatic gland
16 7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present on the ventral aspect of the cranial endplate. See ‘normality’ in the Introduction.)
17 Body of ilium
18 Iliopubic or iliopineal eminence
19 Ischiatic tuberosity
20 Femoral bodies
21 Os penis
21(a) Roof of urethral sulcus
22 Preputial shadow
23 Soft tissue shadows of hind limb muscles
Figure 458  Right lateral recumbent projection of abdomen. Cranially centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).

Figure 459  Line drawing of photograph representing radiographic positioning for Figure 458.
Figure 460  Right lateral recumbent projection of abdomen. Cranially centred.

For a routine survey radiograph of the abdomen, a right lateral recumbency is often preferred by many radiographers/radio-
logists. The most important factor is being consistent with
one’s radiographic approach and hence radiographic appraisal
and interpretation.

1  Diaphragmatic shadow
   1(a) Left ‘crus’
   1(b) Right ‘crus’
   1(c) Cupola
2  Caudal vena cava entering the central tendon just right of
   the midline
3  11th. thoracic vertebra
4  Skin margin
5  Subcutaneous fat
6  M.rectus abdominis
7  Fat within the falciform ligament of the liver
8  Calcified costal cartilages
9  Soft tissue shadow of liver
10 Caudodorsal margin of liver. (Acute angle just visible.)

See (9) in left lateral recumbent projection of abdomen of
female, Figure 445, for additional information.

11 Ventral extremity of spleen
12 Gas in gastric fundus. (Large volume is present due to
   right lateral recumbency resulting in gas rising into
   uppermost part of gastric structure.)
13 Gas in gastric body
14 Pyloric part, antrum and canal, of gastric shadow.
   (Seen as a rounded soft tissue shadow due to the
   presence of fluid gravitating to this part in right lateral
   recumbency. The most ventral aspect of the shadow is the
   antrum.)

The pyloric part shadow in right lateral recumbency

However, the ‘ball’ appearance will disappear in left lateral
recumbency as fluid shifts to the dependent gastric
fundus.

Radiography of both lateral recumbencies is very important
for all gastric region analysis.

15 Jejunum and ileum. (Seen as fluid-filled viscera with a
   few lumenal gas shadows.)
Dog – Abdomen

(460 continued.)

See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for more details.

16 Caecal shadow. (Lumenal gas contrast showing its shape.)

17 Ascending colon

18 Transverse colon

19 Descending colon

Numbers 17 to 19 should be compared with the same shadows seen in left lateral recumbency line drawing, Figures 454 and 457. The different appearances are due to the shifting lumenal gas contrast. Identification of intestinal shadows may require both lateral recumbencies.

20 Right kidney. See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for more kidney details.

21 Position of left kidney in this dog. (Shadow cannot be seen as it is obscured by caecal and colonic shadows.) See ventrodorsal and dorsoventral projections line drawing, Figures 464–469 and 471–475, for the left kidney shadow in this dog.

22 Sublumbar muscles. See (26), left lateral recumbent projection of abdomen of female, Figure 445, for more details.

23 2nd. lumbar vertebra

24 7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present on the ventral aspect of the cranial endplate. See ‘normality’ in the Introduction.)

25 Iliac fovea

26 Os penis

27 Preputial shadow
Figure 461  Line drawing of photograph representing radiographic positioning for Figure 462.
Figure 462  Right lateral recumbent projection of abdomen. Caudally centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
Figure 463  Right lateral recumbent projection of abdomen. Caudally centred.

For a routine survey radiograph of the abdomen, a right lateral recumbency is often preferred by many radiographers/radiologists. The most important factor is being consistent with one’s radiographic approach and hence radiographic appraisal and interpretation.

1  2nd. lumbar vertebra  
2  Caecal shadow  
3  Ascending colon  
4  Transverse colon  
5  Descending colon  
6  Rectum  
7  Jejunum and ileum. See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for more details.  
8  Ventral extremity of spleen  
9  Soft tissue shadows of nipples  
10  Skin fold  
11  Right kidney. See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for additional kidney information.  
12  Position of left kidney. (Shadow cannot be seen as it is obscured by caecal and colonic shadows.)  

See ventrodorsal and dorsoventral projections line drawing, Figures 464–469 and 471–475, for the left kidney shadow in this dog.  
13  Sublumbar muscles. For more details see (26) in left lateral recumbent abdomen projection of female, Figure 445.  
14  Region of distended urinary bladder. (Distinct soft tissue shadow not seen in this film.)  
15  Soft tissue shadow of the prostatic gland  
16  7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present on the ventral aspect of the cranial endplate. See ‘normality’ in the Introduction.)  
17  Body of ilium  
18  Iliopubic or iliopectineal eminence  
19  Ischiatic tuberosity  
20  Femoral body  
21  Os penis  
21(a)  Roof of urethral sulcus  
22  Preputial shadow  
23  Soft tissue shadows of hind limb muscles  
24  Scrotal shadow
Figure 464 Ventrodorsal projection of abdomen. Cranially centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
**Figure 465** Line drawing of photograph representing radiographic positioning for Figure 464.

**Figure 466** Ventrodorsal projection of abdomen. Cranially centred.
Dog – Abdomen
(466 continued.)

1  Diaphragmatic shadow
2  8th. thoracic vertebra
3  8th. rib
4  Skin folds
5  Skin margin
6  Subcutaneous fat. (Only just visible in this dog as a grey line between the outer skin and first muscle layer of the lateral wall of the middle abdomen.)
7  M.obliques externus abdominis
8  Very thin layer of fat originating from superficial surface of caudal ribs. This layer usually serves to separate the m.obliques externus abdominis from the m.obliques internus abdominis and m.transversus abdominis. (The fat layer which differentiates these muscle layers of the lateral wall is only just visible in this dog.)
9  M.obliques internus abdominis and m.transversus abdominis. Seen as a single soft tissue linear shadow extending from the caudal margin of the rib cage. These muscles attach to the last two ribs and the medial aspect of the last four or five ribs and costal cartilage, respectively.
10  Fat layer of peritoneal cavity
11  Soft tissue shadow of liver
12  Dorsal extremity of spleen
13  Pyloric antrum. (Contains most of the gas within the gastric lumen due to ventrodorsal projection resulting in gas rising to the uppermost part. No other gastric part is clearly visible.)
13(a)  Lesser curvature
13(b)  Greater curvature
14  Jejunum and ileum. (Seen as fluid-filled viscerca with a few small gas shadows within the lumens.)

For more details on these structures see (18) Left lateral recumbent projection of abdomen of female Figure 445.

15  Caecal shadow
16  Ascending colon
17  Transverse colon
18  Descending colon
19  Left kidney. (Medial surface cannot be seen and in both lateral recumbencies, line drawings Figures 454/457 and 460/463, this kidney was not visible. Note that in this dog its position is relatively caudal, extending from mid 2nd. lumbar vertebra to cranial 5th. lumbar vertebral levels.)

See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for more kidney information.

The right kidney is not visible in this film due to insufficient perirenal fat contrast. The caudal pole of this kidney was visible in both lateral recumbencies, line drawings Figures 454/457 and 460/463, extending to cranial 3rd. lumbar vertebral level.

20  2nd. lumbar vertebra
20(a)  Transverse process
21  7th. lumbar vertebra (A degenerative bony change, spondylitis, is present left lateral aspect of cranial endplate. See ‘normality’ in the Introduction.)
21(a)  Transverse process
22  Ilium
23  Sacrum
24  Preputial shadow. (This shadow is only just visible but it can be seen clearly in the caudally centred projection, (13) in Figure 469. In this latter film the shadow may be mistaken as an abnormal vertebral bony opacity rather than a superimposed soft tissue opacity.)
Figure 467  Line drawing of photograph representing radiographic positioning for Figure 468.
Figure 468  Ventrodorsal projection of abdomen caudally centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
**Figure 469** Ventrodorsal projection of abdomen. Caudally centred.

1 2nd. lumbar vertebra  
1(a) Transverse process  
2 Skin folds  
3 Dorsal extremity of spleen  
4 Caecal shadow  
5 Ascending colon  
6 Transverse colon  
7 Descending colon  
8 Rectum  
9 Jejunum and ileum. (Seen as fluid-filled viscera with a few small gas shadows within the lumens.)

See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for more details.

10 Left kidney. (Medial surface can not be seen in this film and left kidney was not visible in either lateral recumbency line drawing Figures 454/457 and 460/463. Note the relatively caudal position of the kidney in this dog extending from mid 2nd. lumbar vertebra to cranial 5th. lumbar vertebral levels.)

See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for more kidney information. The right kidney is not visible in this film due to insufficient perirenal fat contrast. The caudal pole of this kidney is seen in both lateral recumbencies, line drawings Figures 454/457 and 460/463, extending to cranial 3rd. lumbar vertebral level.
Dog — Abdomen

(469 continued.)

11 Prostatic shadow
12 Os penis (shaded in drawing)
13 Preputial shadow
14 7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present in the left lateral aspect of the cranial endplate. See ‘normality’ in the Introduction.)
14(a) Transverse process

15 Body of ilium
16 Ischial tuberosity
17 Femoral body
18 Soft tissue shadows of hindlimb muscles

The individual lateral abdominal wall layers are not clearly seen with this caudally centred film. Please refer to the cranially centred film line drawing, Figure 466.
Figure 470  Line drawing of photograph representing radiographic positioning for Figure 471.
Figure 471  Dorsoventral projection of abdomen. Cranially centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
**Figure 472** Dorsoventral projection of abdomen. Cranially centred.

1. Diaphragmatic shadow
2. 8th. thoracic vertebra
3. 8th. rib
4. Skin folds
5. Skin margin
6. Subcutaneous fat
7. M.obliquus externus abdominis
8. Very thin layer of fat originating from superficial surface of caudal ribs
9. M.obliquus internus abdominis and m.transversus abdominis

Note that numbers (6) to (9) are seen more clearly in the ventrodorsal projection of abdomen, Figure 466. Please refer to the latter if numbers (6) to (9) in this film are confusing.

10. Fat layer of the peritoneal cavity
11. Soft tissue shadow of liver
12. Dorsal extremity of spleen
13. Gastric fundus. (Contains most of the gas within gastric lumen due to dorsoventral projection resulting in gas rising to the uppermost part. No other gastric part is clearly seen.)
14. Jejunum and ileum (seen as fluid-filled viscera).

See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for more details.
**Dog – Abdomen**

*(472 continued.)*

15 Caecal shadow

16 Ascending colon

17 Transverse colon

18 Descending colon

19 Left kidney. (Medial surface just visible in film but caudal pole obscured by colonic shadow. This kidney is not seen in either lateral recumbency line drawing, Figures 454/457 and 460/463, of this dog and does appear to be slightly more caudal in position than normal.)

   See (24) in left lateral recumbent projection of abdomen of female, Figure 445, for additional kidney information.

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The right kidney is not visible due to insufficient perirenal fat contrast. The caudal pole is seen in both lateral recumbencies line drawings Figures 454/457 and 460/463, extending to cranial 3rd. lumbar vertebral level.

20 2nd. lumbar vertebra
   20(a) Transverse process

21 7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present in the left lateral aspect of the cranial endplate. See ‘normality’ in the Introduction.)
   21(a) Transverse process

22 Ilium

23 Os penis (shaded in drawing)

24 Preputial shadow
Figure 473  Line drawing of photograph representing radiographic positioning for Figure 474.
**Figure 474**  Dorsoventral projection of abdomen. Caudally centred. Beagle dog 7 years old, entire male (same dog as in all projections of abdomen of the male).
Figure 475  Dorsoventral projection of abdomen. Caudally centred.

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1st. lumbar vertebra</td>
</tr>
<tr>
<td>2</td>
<td>Skin folds</td>
</tr>
<tr>
<td>3</td>
<td>Skin margin</td>
</tr>
<tr>
<td>4</td>
<td>Subcutaneous fat</td>
</tr>
<tr>
<td>5</td>
<td>M.obliquus externus abdominis</td>
</tr>
<tr>
<td>6</td>
<td>Very thin layer of fat</td>
</tr>
<tr>
<td>7</td>
<td>M.obliquus internus abdominis and m.transversus abdominis</td>
</tr>
<tr>
<td>8</td>
<td>Fat layer of peritoneal cavity</td>
</tr>
<tr>
<td>9</td>
<td>Dorsal extremity of spleen</td>
</tr>
<tr>
<td>10</td>
<td>Jejunum and ileum. (Seen as fluid-filled viscera with a few gas shadows within the lumens.)</td>
</tr>
<tr>
<td></td>
<td>See (18) in left lateral recumbent projection of abdomen of female, Figure 445, for more details.</td>
</tr>
<tr>
<td>11</td>
<td>Caecal shadow</td>
</tr>
<tr>
<td>12</td>
<td>Ascending colon</td>
</tr>
</tbody>
</table>
13 Transverse colon
14 Descending colon
15 Rectum
16 Left kidney. (Caudal pole just visible superimposed on colonic shadow. This kidney is not seen in either lateral recumbency line drawing, Figures 454/457 and 460/463, in this dog. In addition it does appear to be slightly more caudal than normal.)

Please see (24) Left lateral recumbent projection of abdomen of female Figure 445 for more kidney information.

The right kidney is not visible due to insufficient perirenal fat contrast. The caudal pole is seen in both lateral recumbency, line drawings Figures 454/457 and 460/463, extending to cranial 3rd. lumbar vertebral level.
17 Os penis (shaded in drawing)
18 Preputial shadow
19 7th. lumbar vertebra. (A degenerative bony change, spondylosis, is present in the left lateral aspect of the cranial endplate. See ‘normality’ in the Introduction.)
19(a) Transverse process
20 Body of ilium
21 Ischial tuberosity
22 Femoral body
23 Soft tissue shadows of hindlimb muscles
Figure 476  Line drawing of photograph representing radiographic positioning for Figure 477.
Figure 477  Lateral recumbent projection of urethra with hyperflexion of hindlegs. Beagle dog 7 years old, entire male.
**Figure 478** Lateral recumbent projection of urethra with hyperflexion of hindlegs.

1 Os penis (shaded in drawing). Ossification of the distal extremity of the corpora cavernosa penis. It is surrounded by the bulbus glandis and pars longa glandis.

1(a) Apex. Ends in cartilaginous tip attached by a ligament to the corona of the glans penis.

1(b) Body. Ventrally contains the urethral groove. The urethra, surrounded by corpus spongiosum penis, runs in this groove.

1(c) Base. Attaches to the fibrous tissues of the corpora cavernosa penis.

1(d) Roof of urethral sulcus

2 Prepuce

3 Scrotum

4 Extent of the external anal sphincter muscle

5 Rectum

6 Folds of skin encircling the anus

7 Ischiatic tuberosity

8 Pelvic symphysis

9 Popliteal fabella

10 Gastrocnemius fabella

11 Femoral bodies
Figure 479  Right lateral recumbent projection of abdomen. Breed of dog with deep, narrow chest and long, shallow abdomen. Afghan Hound dog 2 years old, entire female.

The radiograph shows the economical use of space for the gut viscera in this type of abdomen. This dog was also very lean, emphasising the narrow appearance of the abdomen.

The lack of fat contrast makes differentiation of soft tissue structures more difficult but in this type of abdomen left kidney shadow can sometimes be seen to cause 'ventral displacement' of the descending colon, e.g. in Great Danes. When seen in this type of breed, the colonic position is due to the long, shallow abdomen and not to disease.
Figure 480  Right lateral recumbent projection of abdomen. Colon variant. Samoyed dog 6 years old, entire female.

The radiograph shows extreme ventral positioning of the descending colon. Such a ventral deviation may be linked to displacement by an abnormal organ, especially a neoplastic left kidney. In this case the shadows dorsal to the colon are within normal radiographic limits and both kidneys are visible.

The large amount of abdominal fat in this dog has enhanced contrast making identification of soft tissue shadows easier.

The ventrodorsal projection of this dog has not been included but the descending colon was in the normal left abdominal position.

The descending colon commonly has another positional variation. This is to be found on the ventrodorsal or dorsoventral projections where the descending colon is curved towards the midline and not running parallel to the abdominal wall. Again, careful evaluation of radiographic shadows is necessary to ensure that a disease process is not the cause of the unusual colonic position.
In the juvenile section of the Samoyed crossbred dog radiography of the axial skeleton was not performed until 13 weeks of age. Note the appearance of the atlas and axis in this dog, especially the separate ossification centres for the atlas body and the axis dens. These must not be confused as fractures. Compare this figure with the 4-week whole body of puppy (Figure 481).
Figure 483  Dorsoventral projection of whole body of puppy. Bulldog 12 days old, entire male (same dog as in Figure 482).
The radiograph shows the effect of lack of abdominal fat which results in a marked reduction of contrast within the abdominal cavity. Most of the distinct inner surface of the abdominal wall and serosal surface of bowel are lost.

Differentiation of viscera is only possible in this radiograph by the presence of gas, ingesta and faecal material. A very small amount of grey opacity, fat, is seen outlining the caudoventral lobe of the liver separating it from the soft tissue opacity of the ventral abdominal wall.

This abdominal radiograph is typical of the young animal and must not be confused with disease. In this case the somewhat mottled appearance of the opaque abdomen may be misdiagnosed as peritonitis (also see Figure 735 of the mature animal with extreme loss of abdominal fat contrast).
Figure 485  Caudocranial projection of scapula. British domestic short haired cat 2 years old, neutered female.

Figure 486  Caudocranial projection of scapula.

A Scapula
   1 Spine
   2 Metacromion
   3 Acromion
   4 Subscapular fossa
   5 Supraglenoid tubercle
   6 Coracoid process
   7 Glenoid cavity

B Humerus
   8 Head
   9 Greater tubercle
  10 Lesser tubercle
  11 Intertubercular groove
  12 Fossa for m.infraspinatus
     insertion

C 1st. rib
   D 2nd. rib
   E 3rd. rib
   F 4th. rib
   G 5th. rib
   H 6th. rib
   I 3rd. thoracic vertebra
   J 4th. thoracic vertebra
   K 5th. thoracic vertebra
**Figure 487** Mediolateral projection of shoulder joint. Siamese cat 3 years old, neutered male.

**Figure 488** Mediolateral projection of shoulder joint.

A Scapula
1 Spine
2 Supraspinous fossa
3 Infraspinous fossa
4 Metacromion
5 Acromion
6 Supraglenoid tubercle
7 Coracoid process
8 Glenoid cavity
9 Head
10 Lesser tubercle
11 Greater tubercle
12 Intertubercular groove

C Clavicle
D 6th. cervical vertebra
E 7th. cervical vertebra
F 1st. thoracic vertebra
G 1st. rib
H Manubrium of sternum
**Figure 489** Caudocranial projection of shoulder joint. British domestic short haired cat 2 years old, neutered female.

**Figure 490** Caudocranial projection of shoulder joint

A Scapula  
1 Spine  
2 Metacromion  
3 Acromion  
4 Subscapular fossa  
5 Supraglenoid tubercle  
6 Coracoid process  
7 Glenoid cavity

B Humerus  
8 Head  
9 Greater tubercle  
10 Lesser tubercle

C Clavicle  
D 4th cervical vertebra  
E 5th cervical vertebra  
F 6th cervical vertebra  
G 7th cervical vertebra  
H 1st rib  
11 Intertubercular groove  
12 Fossa for m.infracapsular insertion
Figure 491  Mediolateral projection of humerus. British domestic short haired cat 2 years old, neutered female.

Figure 492  Mediolateral projection of humerus

A Scapula
1 Spine
2 Metacromion
3 Acromion
4 Supraglenoid tubercle
5 Coracoid process
6 Glenoid cavity

B Clavicle

C Humerus
7 Head
8 Lesser tubercle
9 Greater tubercle
10 Intertubercular groove
11 Condyle
11(a) Radiodense circular shadow formed by condylar groove
12 Supracondylid foramen
13 Trochlea of condyle. Trochlea is on the medial aspect of the condyle while the capitulum is lateral.

14 Medial epicondyle
15 Lateral epicondyle
16 Olecranon fossa

D Ulna
17 Olecranon
18 Anconeal process
19 Position of lateral coronoid process
20 Medial coronoid process

E Radius
21 Head
22 Tuberosity

F Manubrium of sternum
Figure 493  Caudocranial projection of humerus. British domestic short haired cat 2 years old, neutered female.

Figure 494  Caudocranial projection of humerus.

A Scapula
1 Spine
2 Metacromion
3 Acromion
4 Supragnoid tubercle
5 Coracoid process
6 Glenoid cavity
   6(a) Medial aspect of glenoid cavity
B Humerus
7 Head
8 Greater tubercle
9 Lesser tubercle
10 Intertubercular groove
11 Supracondylar foramen
12 Olecranon fossa
13 Medial epicondyle
14 Lateral epicondyle
15 Capitulum of condyle
16 Trochlea of condyle
C Ulna
17 Olecranon
18 Anconeal process
19 Medial coronoid process
20 Lateral coronoid process
D Radius
21 Head
E Clavicle
Figure 496  Extended mediolateral projection of elbow joint.

A  Humerus
1  Condyle
2  Groove of condyle
3  Trochlea of condyle.
   Trochlea is on the medial aspect of the condyle while the capitulum is lateral. The capitulum cannot be seen in this radiograph.
4  Medial epicondyle
5  Lateral epicondyle

B  Ulna
6  Olecranon
7  Anconeal process
8  Lateral coronoid process
9  Medial coronoid process

C  Radius
10  Head
11  Tuberosity

Figure 495  Extended mediolateral projection of elbow joint. British domestic short haired cat 6 years old, neutered female.
**Figure 497** Flexed mediolateral projection of elbow joint.
British domestic short haired cat 2 years old, neutered female.

**Figure 498** Flexed mediolateral projection of elbow joint.

<table>
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<tr>
<th>A</th>
<th>Humerus</th>
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<th>Lateral epicondyle</th>
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<tr>
<td>1</td>
<td>Condyle</td>
<td>6</td>
<td>Supracondyloid foramen</td>
</tr>
<tr>
<td>2</td>
<td>Groove of condyle</td>
<td>7</td>
<td>Olecranon fossa</td>
</tr>
<tr>
<td>3</td>
<td>Trochlea of condyle. The trochlea is on the medial aspect of the condyle while the capitulum is lateral. The capitulum cannot be seen in this radiograph. There is only one humeral condyle although the terms medial and lateral condyle are often incorrectly used.</td>
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<table>
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<th>8</th>
<th>Olecranon</th>
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<tr>
<td>9</td>
<td>Anconeal process</td>
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<tr>
<td>10</td>
<td>Position of lateral coronoid process</td>
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<tr>
<th>C</th>
<th>Radius</th>
<th>11</th>
<th>Medial coronoid process</th>
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<tr>
<td>12</td>
<td>Head</td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td>Tuberosity</td>
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*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
Figure 499  Caudocranial projection of elbow joint. British domestic short haired cat 2 years old, neutered female.

Figure 500  Caudocranial projection of elbow joint.

A Humerus
1  Supracondylar foramen
2  Olecranon fossa
3  Medial epicondyle
4  Lateral epicondyle
5  Capitulum of condyle
6  Trochlea of condyle

B Ulna
7  Olecranon
8  Position of anconean process
9  Medial coronoid process
10  Lateral coronoid process

C Radius
11  Head
12  Tuberosity
13  Neck
14  Interosseous space
Figure 501  Mediolateral projection of radius and ulna. British domestic short haired cat 2 years old, neutered female.

Figure 502  Mediolateral projection of radius and ulna.

A Humerus
1 Condyle
2 Trochlea of condyle. Medial aspect of condyle.
3 Capitulum of condyle. Lateral aspect of condyle.
4 Medial epicondyle
5 Lateral epicondyle
6 Supracondylar foramen
7 Olecranon fossa

B Ulna
8 Olecranon
9 Anconal process

10 Trochlear notch
11 Lateral coronoid process
12 Medial coronoid process
13 Cranial cortical margin
14 Lateral styloid process

C Radius
15 Head
16 Tuberosity
17 Medial styloid process

D Accessory carpal bone

E Radial carpal bone

F Ulnar carpal bone
**Figure 503** Craniocaudal projection of radius and ulna. British domestic short haired cat 2 years old, neutered female.

**Figure 504** Craniocaudal projection of radius and ulna.

A Humerus
1 Supracondyloid foramen
2 Olecranon fossa
3 Medial epicondyle
4 Lateral epicondyle
5 Capitulum of condyle
6 Trochlea of condyle

B Ulna
7 Olecranon
8 Anconeal process
9 Medial coronoid process
10 Medial cortical margin
11 Lateral styloid process

12 Circular lucency often present in region of growth plate scar
13 Growth plate scar

C Radius
14 Head
15 Growth plate scar
16 Medial styloid process

D Accessory carpal bone

E Ulnar carpal bone

F Radial carpal bone

G Sesamoid bone of the tendon of the m. abductor pollicis longus
Figure 505  Dorsopalmar projection of manus. British domestic short haired cat 6 years old, neutered female.

Figure 506  Dorsopalmar projection of manus.

A  Radius  
   1 Medial styloid process  
   2 Radiocarpal articulation  

B  Ulna  
   3 Lateral styloid process  
   4 Radioulnar articulation  
   5 Ulnarcarpal articulation  

C  Radial carpal bone  

D  Ulnar carpal bone  

E  Accessory carpal bone  

F  Sesamoid bone in the tendon of the m.abductor pollicis longus  

G  Carpal bone 1  
H  Carpal bone 2  
I  Carpal bone 3  
J  Carpal bone 4  

K  Metacarpal bone 1  
L  Metacarpal bone 2  
M  Metacarpal bone 3  
N  Metacarpal bone 4  
O  Metacarpal bone 5  
P  Proximal sesamoid bones  
Q  Proximal phalanges  
R  Middle phalanges  
   6 Base  
   7 Body  
   8 Head  
S  Distal phalanges  
   9 Ungual crest  
   10 Ungual process  
   11 Flexor tubercle
Figure 507 Mediolateral projection of manus. British domestic short haired cat 2 years old, neutered female.

Figure 508 Mediolateral projection of manus.

A Radius
  1 Medial styloid process
B Ulna
  2 Lateral styloid process
C Radial carpal bone
D Ulnar carpal bone
E Accessory carpal bone
F Carpal bone 2
G Carpal bone 3
H Carpal bone 4 (Carpal bone 1 is superimposed but cannot be seen as a separate shadow)
I Metacarpal bone 1
J Metacarpal bone 2
K Metacarpal bones 3 and 4 (superimposed shadows)
L Metacarpal bone 5
M Proximal sesamoid bones
N Proximal phalanges
O Middle phalanges
P Distal phalanges
Q Ungual process
**Figure 509** Mediolateral projection of phalanges. Digits stressed. British domestic short haired cat 6 years old, neutered male.

**Figure 510** Mediolateral projection of phalanges. Digits stressed.

- **M** Metacarpal bones
- **P1** 1st. digit
- **P2** 2nd. digit
- **P3** 3rd. digit
- **P4** 4th. digit
- **P5** 5th. digit
- **1** Proximal phalanx
- **2** Middle phalanx
- **2(a)** Base
- **2(b)** Body
- **2(c)** Head
- **3** Distal phalanx
- **3(a)** Ungual crest
- **3(b)** Ungual process
- **3(c)** Flexor tuberosity
- **3(d)** Solar foramen
- **S** Proximal sesamoid bones
Figures 511, 512, 513, 514, 515, 516, 517, 518, 519, 520  Mediolateral projection of shoulder joint.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 24 weeks entire male, 46 weeks entire female, 68 weeks entire male, 80 weeks entire female, and 96 weeks entire female.

Correlating line drawings for all ages except 96 weeks.

A Scapula
   1 Epiphysis of supraglenoid tubercle
   2 Growth plate
   2(a) Open
   3 Coracoid process

B Humerus
   4 Proximal epiphysis
   5 Proximal growth plate
   5(a) Open
   5(b) Closing

C Clavicle

Figure 511  Age 4 weeks male
Figure 512  Age 8 weeks male

Figure 513  Age 12 weeks male

Figure 514  Age 16 weeks female
Cat – Forelimb

Figure 515  Age 20 weeks male

Figure 515

Figure 516  Age 24 weeks male

Figure 516

Figure 517  Age 46 weeks male

Figure 517
Figure 518  Age 68 weeks male

Figure 519  Age 80 weeks female

Figure 520  Age 96 weeks female

Cat – Forelimb
Figures 521, 522, 523, 524, 525, 526, 527, 528, 529, 530  Mediolateral projection of elbow joint.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 24 weeks entire male, 28 weeks entire female, 36 weeks entire female, 40 weeks entire female, and 46 weeks entire female.

Correlating line drawings for all ages except 46 weeks.

A Humerus
   1 Distal epiphysis.
      Initially two separate ossification centres for medial and lateral condylar centres.
   2 Medial epicondyle
   3 Distal growth plates
      3(a) Open
      3(b) Closing

B Radius
   4 Proximal epiphysis
   5 Proximal growth plate
      5(a) Open
      5(b) Closing

C Ulna
   6 Proximal epiphysis
   7 Proximal growth plate
      7(a) Open
      7(b) Closing
      7(c) Remnant
Figure 525  Age 20 weeks male

Figure 525

Figure 526  Age 24 weeks male

Figure 526

Figure 527  Age 28 weeks female

Figure 527
Figure 528  Age 36 weeks female

Figure 528

Figure 529  Age 40 weeks female

Figure 529

Figure 530  Age 46 weeks female
**Figures 531, 532, 533, 534, 535, 536, 537, 538, 539**  Craniocaudal projection of elbow joint.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 24 weeks entire male, 28 weeks entire female, 36 weeks entire female, and 46 weeks entire female.

Correlating line drawings for all ages except 46 weeks.

A  Humerus
1  Distal epiphysis.
   Initially two separate ossification centres for medial and lateral condylar centres.
2  Medial epicondyle
3  Distal growth plate
   3(a) Open
   3(b) Closing

B  Radius
4  Proximal epiphysis
5  Proximal growth plate
   5(a) Open
   5(b) Closing

C  Ulna
6  Proximal epiphysis
7  Proximal growth plate
   7(a) Open
   7(b) Closing
**Figure 532** Age 8 weeks male

**Figure 533** Age 12 weeks male

**Figure 534** Age 16 weeks female

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*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
**Figure 535** Age 20 weeks male

**Figure 535**

**Figure 536** Age 24 weeks male

**Figure 536**

**Figure 537** Age 28 weeks male

**Figure 537**
Figure 538  Age 36 weeks female

Figure 539  Age 46 weeks female
Figures 540, 541, 542, 543, 544, 545, 546, 547, 548, 549  Dorsopalmar projection of carpus, metacarpal bones and phalanges.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 24 weeks entire male, 32 weeks entire male, 46 weeks entire female, 54 weeks entire female, 68 weeks entire male, and 96 weeks entire female.

Correlating line drawings for all ages except 96 weeks.

A Radius
   1 Distal epiphysis
   2 Distal growth plate
      2(a) Open
      2(b) Closing
      2(c) Remnant

B Ulna
   3 Distal epiphysis
   4 Distal growth plate
      4(a) Open
      4(b) Closing
      4(c) Remnant

C Carpus

D Metacarpal bone 5 (2, 3 and 4 similar)
   5 Epiphysis.  
      Note that there is only a distal epiphysis in these metacarpal bones.
   6 Growth plate
      6(a) Open
      6(b) Closing
   7 Proximal sesamoid bone (lateral)

E Proximal phalanx of digit 2 (3, 4 and 5 similar)
   8 Epiphysis.  
      Note that there is only a proximal epiphysis in the proximal phalanx.
   9 Growth plate
      9(a) Open
      9(b) Closing
      9(c) Remnant

F Middle phalanx of digit 2 (3, 4 and 5 similar)  
   Epiphysis and growth plate similar to proximal phalanx

G Distal phalanx of digit 2 (3, 4 and 5 similar)

H Metacarpal 1
   10 Epiphysis.  
      Note that there is only a proximal epiphysis in this bone.
   11 Growth plate
      11(a) Open
      11(b) Closing

I Proximal phalanx of digit 1  
   Epiphysis and growth plate similar to proximal phalanx of digit 2

J Distal phalanx of digit 1

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 540  Age 4 weeks male

Figure 540

Figure 541  Age 8 weeks male

Figure 541
Figure 542  Age 12 weeks male

Figure 543  Age 16 weeks female
Figure 544  Age 24 weeks male

Figure 545  Age 32 weeks male
Figure 546  Age 46 weeks female

Figure 546

Figure 547  Age 54 weeks female

Figure 547

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 548  Age 68 weeks male

Figure 548

Figure 549  Age 96 weeks female
Figures 550, 551, 552, 553, 554, 555, 556, 557, 558, 559  Mediolateral projection of carpus, metacarpal bones and phalanges.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 24 weeks entire male, 32 weeks entire male, 46 weeks entire female, 54 weeks entire female, 68 weeks entire female, and 96 weeks entire female.

Correlating line drawings for all ages except 96 weeks.

A Radius
1 Distal epiphysis
2 Distal growth plate
   2(a) Open
   2(b) Closing
   2(c) Remnant

B Ulna
3 Distal epiphysis
4 Distal growth plate
   4(a) Open
   4(b) Closing
   4(c) Remnant

C Carpus
5 Epiphysis of accessory carpal bone
6 Accessory carpal bone growth plate
   6(a) Open

D Metacarpal bone 3 or 4 (2 and 5 similar but shorter)
7 Epiphysis.
   Note that there is only a distal epiphysis in these metacarpal bones.
8 Growth plate
   8(a) Open
   8(b) Closing
9 Proximal sesamoids

E Proximal phalanx of digits 3 or 4 (2 and 5 similar)
10 Epiphysis.
   Note that there is only a proximal epiphysis in the proximal phalanges.
11 Growth plate
   11(a) Open
   11(b) Closing

F Middle phalanx of digits 3 or 4 (2 and 5 similar)
   Epiphysis and growth plate are similar to proximal phalan.

G Distal phalanx of digits 3 or 4 (2 and 5 similar)

H Metacarpal bone 1
   Epiphysis and growth plate are proximal

I Proximal phalanx of digit 1

J Distal phalanx of digit 1

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 550  Age 4 weeks male

Figure 551  Age 8 weeks male
Cat – Forelimb

Figure 552  Age 12 weeks male

Figure 553  Age 16 weeks female

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 554  Age 24 weeks male

Figure 555  Age 32 weeks male
Figure 556  Age 46 weeks female

Figure 556

Figure 557  Age 54 weeks female

Figure 557
Figure 558  Age 68 weeks female

Figure 559  Age 96 weeks female
Figure 560  Ventrodorsal projection of hip joints and pelvis. British domestic short haired cat 6 years old, neutered male.
Figure 561 Ventrodorsal projection of hip joints and pelvis.

To simplify the labelling each structure has been numbered on one side or the other but not on both sides. Also the vertebral column has not been fully labelled.

A Ilium
   1 Crest
   2 Gluteal surface
   3 Cranial dorsal iliac spine
   4 Caudal dorsal iliac spine

Numbers 3 and 4 form the tuber sacrale or dorsal iliac spine

   5 Wing
   6 Cranial ventral iliac spine
   7 Caudal ventral iliac spine

Numbers 6 and 7 form the tuber coxae or ventral iliac spine

   8 Body

B Pubis
   9 Pecten

Pubic symphysis, part of the symphysis of the pelvis, is not recognisable due to superimposition of coccygeal or caudal vertebrae.

C Ischium
   10 Ischiatic symphysis, part of the symphysis of the pelvis
   11 Obturator foramen

D Acetabulum
   16 Cranial acetabular edge
   17 Dorsal acetabular edge
   18 Ventral acetabular edge
   19 Acetabular fossa
   20 Acetabular notch

E Femur
   21 Head
   22 Neck
   23 Greater trochanter
   23(a) Trochanteric fossa
   24 Lesser trochanter
   25 Body

F Sacrum
   26 Cranial articular process
   27 Wing
   28 Lateral sacral crest
   29 Intermediate sacral crest
   30 Median sacral crest
   31 Articular surface with ilium wing
   32 Sacroiliac joint
   32(a) Region of synchondrosis
   32(b) Region of synovial joint

G 7th. lumbar vertebra

H Coccygeal or caudal vertebra
Figure 562  Lateral projection of hip joints and pelvis. British domestic short haired cat 4 years old, neutered female.
Figure 563  Lateral projection of hip joints and pelvis.

A Ilium
1 Crest
2 Cranial dorsal iliac spine
3 Caudal dorsal iliac spine

Numbers 2 and 3 form the tuber sacrale or dorsal iliac spine
4 Cranial ventral iliac spine
5 Caudal ventral iliac spine

Numbers 4 and 5 form the tuber coxae or ventral iliac spine
6 Wing
7 Body

B Pubis
8 Iliopubic eminence
9 Pecten
10 Pubic tubercle. Cranial limit of the pubic part of the pelvic symphysis.

C Ischium
11 Pelvic symphysis
12 Obturator foramen
13 Ischiatic spine
14 Ischiatic tuberosity
15 Ischiatic table

D Acetabulum
E Femur
16 Head
17 Greater trochanter
18 Lesser trochanter

F Sacrum
19 Sacroiliac articulation
20 Spinal processes
21 Vertebral canal

G 7th. lumbar vertebra
H Coccygeal or caudal vertebra
**Figure 564** Mediolateral projection of femur. British domestic short haired cat 6 years old, neutered male.
Figure 565  Mediolateral projection of femur.

A Ilium
B Acetabulum
C Pubis
D Ischium
  1 Obturator foramen
E Femur
  2 Head
  3 Neck
  4 Greater trochanter
  5 Lesser trochanter
  6 Trochanteric fossa
  7 Body
  8 Trochlear groove
  9 Trochlear ridge
  10 Superimposed lateral and medial condyles
  11 Base of intercondylar fossa
F Tibia
  12 Lateral condyle
  13 Medial condyle
  14 Intercondylar fossa (more caudal shadow is that of the lateral intercondylar tubercle)
  15 Tibial tuberosity
  16 Cranial border or ‘tibial crest’ as formerly known
G Fibula
H Patella
I  Fabella of lateral head of m.gastrocnemius. (No ossified fabella visible on the medial side in this cat. This is a common finding in the cat. Figures 564 and 566 of the femur are of the same cat.)
J Fabella of m.popliteus

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat 401
Figure 567  Craniocaudal projection of femur.

A  Ilium
B  Pubis
C  Acetabulum
   1  Cranial acetabular edge
   2  Dorsal acetabular edge
   3  Ventral acetabular edge
   4  Acetabular fossa
      4(a) Acetabular fissure
D  Ischium
   5  Obturator foramen
   6  Ischiatic tuberosity
E  Coccygeal or caudal vertebrae
F  Femur
   7  Head
   8  Neck
   9  Greater trochanter
      9(a) Trochanteric fossa

10 Lesser trochanter
11 Body
12 Medial condyle
13 Lateral condyle
14 Intercondylar fossa

G  Tibia
15 Medial condyle
16 Lateral condyle
17 Intercondylar eminence (medial and lateral intercondylar tubercles are clearly seen)

H  Patella
I  Lateral fabella of m.gastrocnemius.
   (No ossified medial fabella is visible in this cat. This is a common finding in the cat. Figures 564 and 566 of the femur are of the same cat.)
J  Fabella of m.popliteus
**Figure 568**  Craniocaudal projection of femur. British domestic short haired cat 2 years old, neutered female.

The radiograph has been included to demonstrate the ossified medial fabella in the tendon of the m.gastrocnemius. The medial fabella is commonly not seen in radiographs. This is usually due to non-mineralisation of the sesamoid fibrocartilage rather than agenesis.
**Figure 569** Mediolateral projection of stifle joint. British domestic short haired cat 2 years old, neutered female.

**Figure 570** Mediolateral projection of stifle joint.

A Femur
1. Trochlear groove
2. Medial trochlear ridge
3. Lateral trochlear ridge
4. Medial condyle
5. Lateral condyle
6. Intercondylar fossa

B Patella

C Lateral fabella of m.gastrocnemius
(No ossified medial fabella is visible in this cat. Also not seen in radiograph and line drawing, Figures 571 and 572, of the 6-year-old cat.)

D Fabella of m.popliteus

E Tibia
1. Medial condyle
2. Lateral condyle
3. Intercondylar eminence
4. Tibial tuberosity
5. Cranial border or ‘tibial crest’ as formerly known.

F Fibula
1. Head
**Figure 571** Caudocranial projection of stifle joint. British domestic short haired cat 6 years old, neutered male.

**Figure 572** Caudocranial projection of stifle joint.

A Femur
1 Medial condyle
2 Lateral condyle
3 Intercondyloid fossa
4 Popliteal fossa

B Patella

C Lateral fabella of m.gastrocnemius
(No ossified medial fabella is visible in this cat. Also not seen in radiograph and line drawing, Figures 569 and 570, of the 2-year-old cat.)

D Fabella of m.popliteus

E Tibia
5 Medial condyle
6 Lateral condyle
7 Intercondyloid eminence
   (Medial and lateral intercondyloid tubercles)
8 Tibial tuberosity
9 Cranial border or ‘tibial crest’ as formerly known.

F Fibula
10 Head
**Figure 573** Mediolateral projection of tibia and fibula. British domestic short haired cat 2 years old, neutered female.

**Figure 574** Mediolateral projection of tibia and fibula.

A Femur
1 Lateral condyle
2 Medial condyle
3 Base of intercondylar fossa

B Tibia
4 Lateral condyle
5 Medial condyle
6 Intercondylar eminence
7 Tibial tuberosity
8 Cranial border or ‘tibial crest’ as formerly known
9 Medial malleolus

C Fibula
10 Head
11 Lateral malleolus

D Fabella of m.popliteus

E Tibial tarsal bone or talus
12 Medial trochlear ridge
13 Lateral trochlear ridge

F Fibular tarsal bone or calcaneus
14 Calcaneal tuber
15 Sustentaculum tali
Figure 575  Caudocranial projection of tibia and fibula. British domestic short haired cat 2 years old, neutered female.

Figure 576  Caudocranial projection of tibia and fibula.

A Femur
1 Medial condyle
2 Lateral condyle
3 Intercondyloid fossa

B Patella

C Lateral fabella of m.gastrocnemius.
(No ossified medial fabella is visible in this cat.)

D Fabella of m.popliteus

E Tibia
4 Medial condyle

F Fibula
5 Lateral condyle
6 Intercondyloid eminence
   (lateral and medial intercondyloid tubercles)
7 Medial malleolus
8 Head
9 Lateral malleolus

G Fibular tarsal bone or calcaneus

H Tibial tarsal bone or talus
Figure 577  Plantarodorsal projection of tarsus, metatarsus and phalanges. British domestic short haired cat 3 years old, neutered male.
**Figure 578** Plantarodorsal projection of tarsus, metatarsus and phalanges.

A Tibia
1 Medial malleolus
   1(a) Groove for tendon of m.flexor digitorum longus
2 Distal articular borders

B Fibula
3 Lateral malleolus
   3(a) Groove for tendon of m.fibularis longus
   3(b) Groove for tendon of m.fibularis brevis and m.extensor digitorum lateralis

C Tibial tarsal bone or talus
4 Medial trochlear ridge
5 Lateral trochlear ridge
6 Head

D Fibular tarsal bone or calcaneus
7 Calcaneal tuber
8 Sustentaculum tali

E Central tarsal bone
F Tarsal bone 1
G Tarsal bone 2

H Tarsal bone 3
I Tarsal bone 4
J Metatarsal bone 1
K Metatarsal bone 2
L Metatarsal bone 3
M Metatarsal bone 4
N Metatarsal bone 5
   9 Base
   10 Body
   11 Head
O Proximal sesamoids. Present on the plantar aspect.
P Proximal phalanges
Q Middle phalanges
   12 Base
   13 Body
   14 Head
R Distal phalanges
   15 Ungual crest
   16 Ungual process
   17 Flexor tuberosity
Figure 579  Mediolateral projection of tarsus, metatarsus and phalanges. British domestic short haired cat 3 years old, neutered male.
Figure 580  Mediolateral projection of tarsus, metatarsus and phalanges.

A  Tibia
   1  Medial malleolus
   2  Distal articular borders (lateral border is proximal to the medial)
B  Fibula
   3  Lateral malleolus
C  Tibial tarsal bone or talus
   4  Trochlear ridges (lateral ridge is proximal to the medial)
   5  Head
D  Fibular tarsal bone or calcaneus
   6  Calcaneal tuber
   7  Sustentaculum tali
   8  Depression for attachment of the short part of the lateral collateral ligament
E  Central tarsal bone
F  Tarsal bone 1
G  Tarsal bone 2
H  Tarsal bone 3
I  Tarsal bone 4
J  Metatarsal bone 1
K  Metatarsal bone 2
L  Metatarsal bone 3
M  Metatarsal bone 4
N  Metatarsal bone 5
   9  Superimposed heads of metatarsal bones 2 and 5
   10 Superimposed heads of metatarsal bones 3 and 4
O  Proximal sesamoids
P  Proximal phalanges
Q  Middle phalanges
R  Distal phalanges
   11  Ungual crest
   12  Ungual process
   13  Flexor tuberosity
   14  Solar foramen
**Figures 581, 582, 583, 584, 585, 586, 587, 588, 589, 590**  Ventrodorsal projection of pelvis and craniocaudal proximal femur. British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 24 weeks entire male, 32 weeks entire male, 36 weeks entire female, 40 weeks entire female, and 54 weeks entire female.

Correlating line drawings for all ages except 54 weeks.

**A Ilium**

1 Iliopubic growth plate
   1(a) Open
   1(b) Closing
   1(c) Remnant

2 Ilioschial growth plate
   2(a) Open
   2(b) Closing

**B Pubis**

**C Ischium**

3 Symphysis of pelvis
   3(a) Open

4 Ischiopubic growth plate
   4(a) Open
   4(b) Closing

5 Ischiatic tuberosity

6 Ischiatic tuberosity growth plate
   6(a) Open

**D Femur**

7 Femoral head

8 Proximal growth plate
   8(a) Open
   8(b) Closing
   8(c) Remnant

9 Greater trochanter

10 Greater trochanter growth plate
   10(a) Open
   10(b) Closing

11 Lesser trochanter
Cat – Hindlimb

**Figure 582** Age 8 weeks male

**Figure 583** Age 12 weeks male
Cat – Hindlimb

Figure 584  Age 16 weeks female

Figure 585  Age 20 weeks male

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 586  Age 24 weeks male

Figure 586

Figure 587  Age 32 weeks male

Figure 587
**Cat – Hindlimb**

**Figure 588**  Age 36 weeks female

**Figure 589**  Age 40 weeks female

*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
Figure 590  Age 54 weeks female
**Figure 591**  Age 4 weeks male

**Figure 591**

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**Figures 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601** Mediolateral projection of stifle joint.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 24 weeks entire male, 32 weeks entire male, 36 weeks entire female, 46 weeks entire female, 54 weeks entire female, and 80 weeks entire female.

Correlating line drawings for all ages except 80 weeks

A Femur
1 Distal epiphysis
2 Distal growth plate
   2(a) Open
   2(b) Closing
   2(c) Remnant

B Tibia
3 Proximal epiphysis
4 Proximal growth plate
   4(a) Open
   4(b) Closing
   4(c) Remnant
5 Tibial tuberosity
6 Tibial tuberosity growth plate to diaphysis
   6(a) Open
   6(b) Closing
   6(c) Remnant

C Fibula
7 Tibial tuberosity growth plate to proximal epiphysis
   7(a) Open
   7(b) Closing

D Patella
8 Proximal epiphysis
9 Proximal growth plate
   9(a) Open
   9(b) Closing
   9(c) Remnant

E Lateral fabella of m.gastrocnemius
   Note the apparent absence of the medial fabella. The fibrocartilage of this sesamoid bone often remains in a non-mineralised state (see adult section).

F Fabella of m.popliteal
An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
**Figure 598**  Age 36 weeks female

**Figure 599**  Age 46 weeks female

**Figure 600**  Age 54 weeks female

**Figure 601**  Age 80 weeks female
**Cat – Hindlimb**

**Figure 602** Age 4 weeks male

**Figure 602**

**Figures 602, 603, 604, 605, 606, 607, 608, 609, 610, 611** Craniocaudal projection of stifle joint.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire male, 20 weeks entire male, 28 weeks entire female, 36 weeks entire female, 46 weeks entire female, 54 weeks entire female, and 80 weeks entire female.

Correlating line drawings for all ages except 80 weeks.

**A Femur**
1 Distal epiphysis
2 Distal growth plate
   2(a) Open
   2(b) Closing
   2(c) Remnant

**B Tibia**
3 Proximal epiphysis
4 Proximal growth plate
   4(a) Open
   4(b) Closing
   4(c) Remnant
5 Tibial tuberosity

**C Fibula**
6 Proximal epiphysis
7 Proximal growth plate
   7(a) Open
   7(b) Closing
   7(c) Remnant

**D Patella**

**E Lateral fabella of m.gastrocnemius**
Note the apparent absence of the medial fabella. The fibrocartilage of this sesamoid bone often remains in a non-mineralised state (see adult section).

**F Fabella of m.popliteal**
**Cat – Hindlimb**

**Figure 603**  Age 8 weeks male

**Figure 604**  Age 12 weeks male

*An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat*
Figure 605  Age 16 weeks male

Figure 605

Figure 606  Age 20 weeks male

Figure 606
Figure 607  Age 28 weeks female

Figure 607

Figure 608  Age 36 weeks female

Figure 608
Cat – Hindlimb

**Figure 609** Age 46 weeks female

![Image](image1.png)

**Figure 609**

**Figure 610** Age 54 weeks female

![Image](image2.png)

**Figure 610**
Figure 611  Age 80 weeks female
Figures 612, 613, 614, 615, 616, 617, 618, 619, 620  Dorsoplantar projection of tarsus, metatarsal bones, and phalanges.

British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 28 weeks entire female, 36 weeks entire female, 40 weeks entire female, and 54 weeks entire female.

Correlating line drawings for all ages except 54 weeks.

A Tibia
1 Distal epiphysis
2 Distal growth plate
  2(a) Open
  2(b) Closing

B Fibula
3 Distal epiphysis
4 Distal growth plate
  4(a) Open
  4(b) Closing

C Tarsus

D Metatarsal bones 2 and 5 (3 and 4 similar)
5 Epiphysis.
  Note that there is only a distal epiphysis in these metatarsal bones.
6 Growth plate
  6(a) Open

E Proximal phalanx of digits 2 and 5 (3 and 4 similar)
8 Epiphysis.
  Note that there is only a proximal epiphysis in the proximal phalanx.
9 Growth plate
  9(a) Open

F Middle phalanx of digits 2 and 5 (3 and 4 similar)

Epiphysis and growth plate similar to proximal phalanx.

G Distal phalanx of digits 2 and 5 (3 and 4 similar)

H Metatarsal bone 1

Figure 612  Age 4 weeks male
Figure 613  Age 8 weeks male

Figure 614  Age 12 weeks male
Figure 615  Age 16 weeks female

Figure 616  Age 20 weeks male

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 617  Age 28 weeks female

Figure 618  Age 36 weeks female
Cat – Hindlimb

Figure 619  Age 40 weeks female

Figure 619

Figure 620  Age 54 weeks female
Figures 621, 622, 623, 624, 625, 626, 627, 628, 629  Mediolateral projection of tarsus, metatarsal bones and phalanges. British domestic short haired cats at 4 weeks entire male, 8 weeks entire male, 12 weeks entire male, 16 weeks entire female, 20 weeks entire male, 28 weeks entire female, 36 weeks entire female, 40 weeks entire female, and 54 weeks entire female.

Correlating line drawings for all ages except 54 weeks.

A  Tibia  
1  Distal epiphysis  
2  Distal growth plate  
   2(a) Open  
   2(b) Closing  

B  Fibula  
3  Distal epiphysis  
4  Distal growth plate  
   4(a) Open  
   4(b) Closing  

C  Tarsus  
5  Epiphysis of fibular tarsal bone  
6  Fibular tarsal bone growth plate  
   6(a) Open  
   6(b) Closing  

D  Metatarsal bones 2 or 5 (3 and 4 similar)  
7  Epiphysis.  
   Note that there is only a distal epiphysis in these metatarsal bones.  

8  Growth plate  
   8(a) Open  
   8(b) Closing  
   8(c) Remnant  
9  Proximal sesamoid bone  

E  Proximal phalanx of digit 2 or 5 (3 and 4 similar)  
10  Epiphysis.  
   Note that there is only a proximal epiphysis in the proximal phalanx.  

11  Growth plate  
   11(a) Open  

F  Middle phalanx of digit 2 or 5 (3 and 4 similar)  
Epiphysis and growth plate similar to proximal phalanx.  

G  Distal phalanx of digit 2 or 5 (3 and 4 similar)  

H  Metatarsal bone 1
**Cat – Hindlimb**

*Figure 622*  Age 8 weeks male

*Figure 623*  Age 12 weeks male

*Figure 622*  

*Figure 623*
Figure 624  Age 16 weeks female

Figure 625  Age 20 weeks male

Figure 624

Figure 625
Cat – Hindlimb

Figure 626  Age 28 weeks female

Figure 627  Age 36 weeks female

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 628  Age 40 weeks female

Figure 628

Figure 629  Age 54 weeks female

An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat

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**Figure 630** Lateral projection of skull. British domestic short haired cat 4 years old, neutered female.

**Figure 631** Lateral projection of skull with teeth shadows excluded for clarity.
(631 continued.)

A Atlas
B Axis
C Stylohyoid bone
D Epiphysoid bone
E Ceratohyoid bone
F Basihyoid bone
G Thyrohyoid bone
   1 Incisive bone
   2 Nasal bone
   3 Frontal bone
   4 Parietal bone
   5 Osseous tentorium of the cerebellum
   6 Interparietal bone
   7 Occipital bone
      7(a) External occipital protuberance or ‘Nuchal crest’
   8 Occipital condyle
   9 Jugular process of occipital bone
  10 Petrous temporal bone or temporal bone; petrosal part
  11 Tympanic bulla of temporal bone or temporal bone; tympanic part
  12 External acoustic meatus of temporal bone
  13 Zygomatic process of temporal bone or temporal bone; squamous part
  14 Retroarticular process of temporal bone
  15 Mandibular fossa of temporal bone
  16 Palatine process of maxilla. The vomer lies dorsally.
  17 Palatine bone. Rostrally the palatine process of maxilla is included.

18 Sphenoid sinus of presphenoid
19 Cribriform plate of ethmoid bone. Rostral limit only is visible.
20 Ethmoidal fossa
21 Ethmoidal conchae
22 Dorsal nasal conchae
   22(a) Dorsal nasal meatus
23 Middle nasal conchae
   23(a) Mass of conchae attached to the ethmoid bone, from the dorsal and middle conchae. Seen as a radiopaque region and must not be mistaken for a foreign body.
24 Ventral nasal conchae
   24(a) Ventral nasal meatus
25 Dorsal orbital margin
26 Basisphenoid bone
27 Frontal sinuses
28 Mandibular body
29 Mandibular ramus
30 Coronoid process of mandible
31 Condyloid or articular process of mandible
32 Angular process of mandible
33 Mandibular foramina
34 Mandibular canal
35 Mental foramen
36 Lamina dura
37 Soft palate
38 Nasopharynx
39 Epiglottis

*Figure 632* Lateral projection of skull to demonstrate details of teeth excluded in Figure 631.

1 Upper incisors. Total of six.
2 Lower incisors. Total of six.
3 Upper canines. Total of two.
4 Lower canines. Total of two.
5 Upper premolars. Total of six.
6 Lower premolars. Total of four.
7 Upper molars. Total of two.
8 Lower molars. Total of two.

Note that the term upper can be replaced by ‘superior’ and lower by ‘inferior’.
Figure 633  Dorsoventral projection of skull. British domestic short haired cat 1 year old, neutered male.
Figure 634  Dorsoventral projection of skull with teeth shadows excluded for clarity.

A  Atlas
B  Axis
C  Cartilaginous ear canal
D  Pinna
   1  Incisive bone
   2  Maxilla or maxillary bone
      2(a) Maxillary teeth obscuring bony shadows of maxillary bone (lamina dura seen as radiopaque lines)
   3  Vomer and nasal septum (the osseous part of the nasal septum contributes to the radiopaque line)
   4  Temporal process of zygomatic bone
   5  Frontal process of zygomatic bone
   6  Zygomatic process of frontal bone
   7  Zygomatic process of temporal bone. Forms zygomatic arch with (4).
   8  Frontal sinuses
   9  Sphenoidal sinuses
  10  Cribiform plate of ethmoid enclosing ethmoidal fossa
  11  Ethmoturbinates and dorsal nasal concha (dorsal nasal concha is not seen clearly on this projection)
  12  Border of choanae formed by palatine bone
  13  Medial wall of orbit
  14  Ventral margin of orbit
  15  Lamina dura
     15(a) Mandibular lamina dura
     15(b) Maxillary lamina dura
  16  Mandibular body
  17  Coronoid process of mandibular ramus
  18  Angular process of mandibular ramus
  19  Condyloid or articular process of mandibular ramus
  20  Retroarticular process of temporal bone
  21  Tympanic bulla of temporal bone
  22  External acoustic meatus of temporal bone
  23  Internal acoustic meatus of temporal bone
  24  Jugular foramen
  25  Petrous temporal bone
  26  Mastoid process of petrous temporal bone
  27  Occipital condyle
  28  Nuchal crest
  29  Hamulus of pterygoid bone
  30  Osseous tentorium of cerebellum
  31  Foramen magnum
Figure 635  Dorsoventral projection of skull to demonstrate details of teeth shadows excluded in Figure 634.

1 Lower incisors. Total of six.
2 Upper incisors. Total of six.
3 Lower canines. Total of two.
4 Upper canines. Total of two.
5 Lower premolars. Total of four.
6 Upper premolars. (The 1st. premolar in this cat appears to be present, making a total of eight instead of six. (This is unusual.)
7 Lower molars. Total of two.
8 Upper molars. Total of two.

Note that the term lower can be replaced by ‘inferior’ and upper by ‘superior’.
**Figure 636**  Relaxed lateral skull centred on temporomandibular joint. British domestic short haired cat 2 years old, neutered female.

**Figure 637**  Relaxed lateral skull centred on temporomandibular joint.

A  Temporomandibular joint of recumbent side

1  Body of mandible
2  Angular process of mandible
3  Condyloid or articular process of mandible
4  Coronoid process of mandible
5  Mandibular fossa of temporal bone
6  Retroarticular process of temporal bone
7  Tympanic bulla of temporal bone
8  External acoustic meatus of temporal bone
9  Cribriform plate
10 Petrous temporal bone

B  Temporomandibular joint of non-recumbent side

11 Cranial base
12 Occipital condyle
13 Atlas
14 Stylohyoid bone
15 Ephyoid bone
16 Ceratohyoid bone
17 Basihyoid bone
18 Thyrohyoid bone
19 Soft palate
20 Epiglottis
21 Rostral limit of arytenoid cartilage
22 Nasopharynx
23 Oropharynx
Figure 638  Rostroventral–caudodorsal oblique (open mouth) projection of skull centred on tympanic bullae. British domestic short haired cat 2 years old, neutered female.

Figure 639  Rostroventral-caudodorsal oblique (open mouth) projection of skull centred on tympanic bullae.

1  Zygomatic bone
2  Frontal process of zygomatic bone
3  Zygomatic process of temporal bone
4  Mandibular body
5  Coronoid process of mandible
6  Condyloid or articular process of mandible
7  Temporomandibular articulation
8  Petrous temporal bone
9  Tympanic bulla of temporal bone
10 External acoustic meatus of temporal bone
11 Canal of auditory tube
12 Foramen magnum
13 Condyle of occipital bone
14 Atlas
15 Axis
16 Dens of axis
17 Spinous process of axis
**Figure 640** Rostrocaudal projection of skull centred on frontal sinuses. Siamese Cat 15 years old, neutered male.

**Figure 641** Rostrocaudal projection of skull centred on frontal sinuses.

1 Frontal bone  
1(a) Squamous part of frontal bone  
2 Medial surface of frontal bone  
3 Lateral surface of frontal bone  
4 Zygomatic or supraorbital process of frontal bone. The size of the process varies as the orbital ligament is ossified. It is only 0.3 cm long in ‘immatures’ but 1.3 cm long in very old cats when it fuses with the zygomatic arch (Ray Ashdown, unpublished).  
5 Septum between right and left frontal sinuses  
6 Frontal sinus. The cat has only one sinus on each side.  
6(a) Medial part of frontal sinus containing ethmoidal ectoturbinates  
1 and 2  
6(b) Lateral part of frontal sinus extending into the base of the zygomatic or supraorbital process  
6(c) Dorsal part of frontal sinus  
The ventral limit of the frontal sinus is in the medial wall of the orbit. It does not reach as far as the sphenoid bone.  
7 Parietal bone
Figure 643  Dorsoventral intraoral projection of nasal chambers with teeth shadows excluded for clarity.

1 Incisive bone  8 Cribriform plate of ethmoid
2 Incisive bone palatine process  enclosing ethmoidal fossa
3 Vomer and osseous part of nasal 9 Maxillary recess of maxilla
septum. The nasal septum extends 10 Frontal sinus
rostrally from the ethmoid bone as 11 Medial wall of orbit
a perpendicular plate of osseous  Anatomy of alveoli
and cartilaginous tissues.
4 Palatine fissure  12 Lamina dura
5 Dorsal meatus of the nasal 13 Periodontal membrane. Appears
cavity lamina dura and tooth root.
6 Nasal conchae (dorsal, middle and  14 Alveolar crest
ventral turbinates)  15 Bony sockets or alveoli of lingual
7 Ethmoturbinates and dorsal nasal and vestibular roots of premolar 3
conchae

Figure 642  Dorsoventral intraoral projection of nasal chambers. British domestic short haired cat 7 months old, entire female.

Figure 644  Dorsoventral intraoral projection of nasal chambers to demonstrate details of teeth shadows excluded from Figure 643.

Teeth  Anatomy of teeth
1 Upper incisors. Total of six. 1 Crown
C Upper canine. Total of two. 2 Tubercles
P Upper premolar. Total of six. 3 Root

Upper molars, total of two, are not 4 Apex of root (still open at this age)
seen in this radiograph but can be seen 5 Dentine
in the same projection of a 2.5-year-old 6 Pulp cavity (Large in this 7-month-
cat, Figure 645. old cat but reduces considerably as cat
ages. Compare with the same projec-
Note that the term upper can be replaced 7 Enamel
by 'superior'.
**Figure 645** Dorsoventral intraoral projection of nasal chambers. British domestic short haired cat 2.5 years old, neutered female.

This radiograph has been included to illustrate the normal age changes that occur within the nasal chambers and teeth.

The definition of the nasal conchae is reduced as the cat ages but more dramatically teeth pulp cavities become much smaller with advancing years.

**Figure 646** Ventrodorsal intraoral projection of mandibular bodies. British domestic short haired cat 2 years old, neutered female.

**Figure 647** Ventrodorsal intraoral projection of mandibular bodies with teeth shadows excluded from the right mandibular body so that bony features are more easily identified.

<table>
<thead>
<tr>
<th>Teeth</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Lower incisors. Total of six.</td>
<td></td>
</tr>
<tr>
<td>C Lower canine. Total of two.</td>
<td></td>
</tr>
<tr>
<td>P Lower premolar. Total of four</td>
<td></td>
</tr>
<tr>
<td>M Lower molar. Total of two.</td>
<td></td>
</tr>
<tr>
<td>Anatomy of teeth</td>
<td></td>
</tr>
<tr>
<td>1 Crown</td>
<td></td>
</tr>
<tr>
<td>2 Tubercle</td>
<td></td>
</tr>
<tr>
<td>3 Root</td>
<td></td>
</tr>
<tr>
<td>4 Apex of root</td>
<td></td>
</tr>
<tr>
<td>5 Dentine</td>
<td></td>
</tr>
</tbody>
</table>

Anatomy of alveoli

6 Pulp cavity

7 Enamel

8 Alveolar crest

9 Bony sockets or alveoli

10 Lamina dura

11 Periodontal membrane. appears as a radiolucent line between lamina dura and tooth root.

12 Mandibular symphysis.

Note that this is seen as a radiolucent shadow due to the fibrocartilaginous union present.
Figure 648  Lateral projection of skull. Persian cat 9 months old, neutered male.

Figure 649  Lateral projection of skull. Siamese cat 9 years old, neutered male.
Figure 650  Dorsoventral projection of skull. Persian cat 9 months old, neutered male.
Figure 651  Dorsoventral projection of skull. Russian Blue cat.
**Figure 652** Dorsoventral intraoral projection of nasal chambers. Persian cat 6 months old, neutered male.

**Figure 653** Dorsoventral intraoral projection of nasal chambers. Siamese cat 9 years old, neutered male. The radiograph shows the vomer to have a wavy curvature throughout its entire length. Nasal septum and vomer variations are not uncommon, especially in the cat, but in this case the extent of the curvature is unusual (see also Figure 284, Samoyed dog).
Figures 654, 655, 656, 657, 658, 659  Lateral projection of skull.
British domestic short haired cats at 12 weeks entire male, 24 weeks entire male, 36 weeks entire female, 46 weeks entire female, 54 weeks entire female, and 68 weeks entire male.

Correlating line drawings for all males at 12, 24 and 68 weeks of age

1 Frontal sinuses (Shaded areas)

2 Cribiform plate

2(a) Caudal limit

2(b) Rostral limit

Drawing to demonstrate lower or inferior teeth within rostral portion of mandible

D Deciduous teeth

D.I. Incisors

D.C. Canine

D.PM. Premolars

P Permanent teeth seen as germs only at 12 weeks of age

P.I. Incisors

P.C. Canine

P.PM. Premolars

P.M. Molar

Dental formulae for the cat

Deciduous teeth  I3  C1  PM3

3  1  2

Permanent teeth  I3  C1  PM3  M1

3  1  2  1

The premolar teeth in the cat are the equivalent of premolars 2, 3, and 4 in the upper jaw and premolars 3 and 4 in the lower jaw of the dog.
Figure 656  Age 36 weeks female

Figure 657  Age 46 weeks female
Figure 658  Age 54 weeks female

Figure 659  Age 68 weeks male
**Figure 660**  Lateral projection of cervical vertebrae. British domestic short haired cat 18 months old, neutered female.
Cat – Vertebrae

**Figure 661** Lateral projection of cervical vertebrae.

A Skull
1 Occipital bone
2 Occipital condyle
3 Tympanic bullae

B Atlas
4 Dorsal arch
5 Lateral vertebral foramen
6 Vascular foramen
7 Articular foveae
   7(a) Cranial articular fovea rostral edge
   7(b) Caudal articular fovea caudal edge
8 Wings; transverse processes
9 Ventral arch; body

C Axis
10 Dens
11 Cranial articular surface
12 Caudal articular surface
13 Spinous process
14 Transverse foramen
15 Transverse process

D 3rd. cervical vertebra
E 4th. cervical vertebra
F 5th. cervical vertebra
G 6th. cervical vertebra
H 7th. cervical vertebra
   16 Transverse processes
   17 Cranial articular surface of 4th. cervical vertebra
   18 Cranial articular surface of 6th. cervical vertebra
   19 Caudal articular surface of 3rd. cervical vertebra
      19(a) Intervertebral synovial joint of 3rd. and 4th. cervical vertebrae
   20 Caudal articular surface of 5th. cervical vertebra
      20(a) Intervertebral synovial joint of 5th. and 6th. cervical vertebrae
21 Spinous process
22 Body
23 Vertebral foramen
      23(a) Dorsal margin
      23(b) Ventral margin
24 Intervertebral foramen
I 1st. thoracic vertebra
J 2nd. thoracic vertebra
K 1st. rib
L Scapulae
Figure 662 Ventrodorsal projection of cervical vertebrae. British domestic short haired cat 3 years old, neutered female.

Figure 663 Ventrodorsal projection of cervical vertebrae.

A Skull
1 Occipital bone
2 Occipital condyle

B Atlas
3 Cranial articular fovea
4 Caudal articular fovea
5 Ventral arch, body, cranial border
6 Ventral arch, body, caudal border
7 Wing; transverse process
8 Alar notch

C Axis
9 Dens
10 Cranial articular surface
11 Caudal articular surface
12 Spinous process
13 Transverse process

D 3rd. cervical vertebra
E 4th. cervical vertebra
F 5th. cervical vertebra
G 6th. cervical vertebra

H 7th. cervical vertebra
14 Cranial articular surface of 4th. cervical vertebra
15 Caudal articular surface of 4th. cervical vertebra
16 Spinous process
17 Transverse process
18 Lateral margin of vertebral foramen
19 Dorsal cranial margin of body of 3rd. cervical vertebra
20 Ventral caudal margin of body of 3rd. cervical vertebra

I 1st. thoracic vertebra
J 1st. rib
K Clavicle
L Scapula
M Manubrium of sternum
N 2nd. sternebra of sternum
Figure 664  Lateral projection of thoracic vertebrae. British domestic short haired cat 8 years old, neutered female.

Figure 665  Lateral projection of thoracic vertebrae with rib shadows excluded for clarity.
(665 continued)

A 7th. cervical vertebra
B 1st. thoracic vertebra
C 2nd. thoracic vertebra
D 3rd. thoracic vertebra
E 4th. thoracic vertebra
F 5th. thoracic vertebra
G 6th. thoracic vertebra
H 7th. thoracic vertebra
I 8th. thoracic vertebra
J 9th. thoracic vertebra
K 10th. thoracic vertebra
L 11th. thoracic vertebra. Anticlinal vertebra.
M 12th. thoracic vertebra
N 13th. thoracic vertebra

1 Spinous process
1(a) Spinous process of anticlinal vertebra; nearly perpendicular to axis
2 Cranial articular process of 4th. thoracic vertebra
3 Caudal articular process of 3rd. thoracic vertebra
4 Body
5 Transverse process
6 Vertebral foramen
6(a) Dorsal margin
6(b) Ventral margin
7 Intervertebral foramen
8 Accessory process
9 Mamillary process
O 1st. lumbar vertebra
10 Spinous process
11 Transverse process
P Trachea
Q Diaphragm

Figure 666  Lateral projection of thoracic vertebrae to demonstrate the rib shadows not seen in Figure 665.

A Scapula
   1 Spine
      2 Dorsal margins
B 1st. rib
C 2nd. rib
D 3rd. rib
E 4th. rib
F 5th. rib
G 6th. rib
H 7th. rib
I 8th. rib
J 9th. rib
K 10th. rib
L 11th. rib
M 12th. rib
N 13th. rib
3 Head
4 Neck
5 Tubercle
O Trachea
P Diaphragm
**Figure 668** Ventrodorsal projection of thoracic vertebrae with ventral ribs and sternal shadows excluded for clarity.

- A 7th. cervical vertebra
- B 1st. thoracic vertebra
- C 2nd. thoracic vertebra
- D 3rd. thoracic vertebra
- E 4th. thoracic vertebra
- F 5th. thoracic vertebra
- G 6th. thoracic vertebra
- H 7th. thoracic vertebra
- I 8th. thoracic vertebra
- J 9th. thoracic vertebra
- K 10th. thoracic vertebra
- L 11th. thoracic vertebra. Anticlinal vertebra.
- M 12th. thoracic vertebra
- N 13th. thoracic vertebra
  1 Spinous process of 1st. thoracic vertebra. These processes incline caudally from 1st. to 10th. thoracic vertebrae.
  1(a) Spinous process of 10th. thoracic vertebra
  1(b) Spinous process of 11th. thoracic vertebra
- 2 Body
  2(a) Cranial margin
  2(b) Caudal margin
- 3 Mamillary process of 11th. thoracic vertebra
- 4 Accessory process of thoracic vertebra
- 5 Transverse process
- 6 Cranial costal foramen of body
- 7 Caudal costal foramen of body
- 8 Lateral margin of vertebral foramen
- O 1st. lumbar vertebra
- P 1st. rib
- Q 13th. rib

**Figure 667** Ventrodorsal projection of thoracic vertebrae. British domestic short haired cat 8 years old, neutered female.
Figure 669  Ventrodorsal projection of thoracic vertebrae to demonstrate sternal shadows not seen in Figure 668.

A  Manubrium of sternum  
B  2nd. sternebra  
C  3rd. sternebra  
D  4th. sternebra  
E  5th. sternebra  
F  6th. sternebra  
G  7th. sternebra  
H  8th. sternebra  
I  1st. rib  
J  13th. rib
Figure 670  Lateral projection of lumbar vertebrae. British domestic short haired cat 6 years old, neutered male.
**Figure 671** Lateral projection of lumbar vertebrae.

A 13th. thoracic vertebra
B 1st. lumbar vertebra
C 2nd. lumbar vertebra
D 3rd. lumbar vertebra
E 4th. lumbar vertebra
F 5th. lumbar vertebra
G 6th. lumbar vertebra
H 7th. lumbar vertebra
   1 Spinous process
   2 Mamillary process
   3 Cranial articular process of 4th. lumbar vertebra
   4 Caudal articular process of 4th. lumbar vertebra
   5 Body
   6 Transverse process
      6(a) Base of transverse process
   7 Vertebral foramen
      7(a) Dorsal margin
      7(b) Ventral margin
   8 Intervertebral foramen
   9 Accessory process

I Sacrum
10 Sacral canal
11 Median sacral crest; spinous processes
12 Intermediate sacral crest; articular processes
13 Lateral sacral crest; cranial transverse processes,
   1st. and 2nd. sacral segments. Includes the wing
   which is thought to include two rib elements on
   each side
14 Lateral sacral crest; caudal transverse processes,
   3rd. sacral segment
15 Promontory
16 Cranial articular process of sacrum forming the
   lumbosacral synovial joint
17 Caudal articular process of sacrum forming the
   sacrococcygeal synovial joint

J 1st. coccygeal or caudal vertebra
K Ilium
L Femur
M 13th. ribs
N 12th. ribs
Figure 672  Ventrodorsal projection of lumbar vertebrae. British domestic short haired cat 6 years old, neutered male.
Figure 673  Ventrodorsal projection of lumbar vertebrae.

A 13th. thoracic vertebra
B 1st. lumbar vertebra
C 2nd. lumbar vertebra
D 3rd. lumbar vertebra
E 4th. lumbar vertebra
F 5th. lumbar vertebra
G 6th. lumbar vertebra
H 7th. lumbar vertebra
  1 Spinous process
  2 Cranial margin of body of 4th. lumbar vertebra
  3 Caudal margin of body of 4th. lumbar vertebra
  4 Cranial articular process of 2nd. lumbar vertebra
  5 Caudal articular process of 2nd. lumbar vertebra
  6 Accessory process of 2nd. lumbar vertebra
  7 Transverse process
  8 Lateral margins of vertebral foramen
I Sacrum
  9 Median sacral crest; spinous processes
  10 Intermediate sacral crest; articular processes of 1st., 2nd. and 3rd. sacral segments
  11 Lateral sacral crest; transverse process of 3rd. sacral segment. Those of 1st. and 2nd. form the sacral wing
  12 Lateral margin of sacral canal
  13 Wing
  14 Sacroiliac joint
    14(a) Ventral limit of sacroiliac joint
  15 Cranial articular process
  16 Caudal articular process
J Ilium
  17 Tuber sacrale; dorsal iliac spine
K 1st. coccygeal or caudal vertebra
L 13th. rib
M Costal cartilage of 10th. rib (calcified)
N Costal cartilage of 11th. rib (calcified)
O Costal cartilage of 12th. rib (calcified)
Figure 674  Lateral projection of coccygeal or caudal vertebrae. British domestic short haired cat 6 years old, neutered male.
Figure 675  Lateral projection of coccygeal or caudal vertebrae.

A  Sacrum
B  1st. coccygeal vertebra
C  13th. coccygeal vertebra
D  24th. coccygeal vertebra
   1  Cranial articular process
   2  Caudal articular process
   3  Transverse process
       3(a) Cranial transverse process
       3(b) Caudal transverse process
   4  Spinous process
   5  Vertebral foramen
   6  Haemal arch
   7  Haemal process

E  Ilium
F  Ischium

Although this projection would appear simple to achieve note the cranial position of the 1st. coccygeal vertebra. This cranial extent of the 1st. coccygeal vertebra creates an exposure problem when radiography of the whole coccygeal region is required. Often the caudal sacral/proximal coccygeal area is underexposed in order not to overexpose the thinner distal coccygeal vertebrae.

The most common error is to underestimate the cranial position of the 1st. coccygeal vertebra and hence not to include the caudal sacrum/proximal coccygeal area in the primary beam.
Figure 676  Ventrodorsal projection of coccygeal or caudal vertebrae. British domestic short haired cat 6 years old, neutered male.
**Figure 677**  Ventrodorsal projection of coccygeal or caudal vertebrae.

A  Sacrum  
B  1st. coccygeal vertebra  
C  13th. coccygeal vertebra  
D  24th. coccygeal vertebra  
   1  Cranial articular process  
   2  Caudal articular process  
   3  Transverse process  
      3(a) Cranial transverse process  
      3(b) Caudal transverse process  
   4  Haemal process  
E  Ilium  
F  Ischium  
G  Pubis  
H  Acetabulum  
I  Femur  

Please see notes about radiography of the lateral projection of coccygeal or caudal vertebrae, Figure 675, as the same applies to this ventrodorsal projection.
British domestic short haired cats at 12 weeks entire male, 24 weeks entire male, 36 weeks entire female, 46 weeks entire female, and 54 weeks entire female.

Correlating line drawings for all ages except 46 and 54 weeks.

A Atlas. 1st. cervical vertebra.
B Axis, 2nd. cervical vertebra.
1 Centrum for dens
2 Growth plate
   2(a) Open
3 Centrum for cranial epiphysis of body
4 Cranial growth plate
   4(a) Closing
5 Caudal epiphysis of body
6 Caudal growth plate
   6(a) Open
   6(b) Closing

C 3rd. cervical vertebra
7 Cranial epiphysis
8 Cranial growth plate
   8(a) Open
   8(b) Closing
9 Caudal epiphysis
10 Caudal growth plate
   10(a) Open
   10(b) Closing

For clarity transverse process shadows have been excluded from all drawings.
Figure 680  
Age 36 weeks male

Figure 681  
Age 46 weeks male

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Figure 682  Age 54 weeks female
**Figure 683** Age 12 weeks male

**Figures 683, 684, 685, 686, 687** Lateral projection of thoracic vertebrae.
British domestic short haired cats at 12 weeks entire male, 24 weeks entire male, 36 weeks entire female, 46 weeks entire female, and 54 weeks entire female.

Correlating line drawings for all ages except 46 and 54 weeks.

A 3rd. thoracic vertebra

B 4th. thoracic vertebra

1 Cranial epiphysis of body
2 Cranial growth plate
2(a) Open
2(b) Closing

3 Caudal epiphysis of body
4 Caudal growth plate
4(a) Open
4(b) Closing

C 5th. thoracic vertebra

For clarity the rib shadows have been excluded from all drawings.
Figure 684

Age 24 weeks male
Figure 685 Age 36 weeks female
Figure 686  46 weeks female

Figure 687  Age 54 weeks female
Figures 688, 689, 690, 691, 692  Lateral projection of lumbar vertebrae. British domestic short haired cats at 12 weeks entire male, 24 weeks entire male, 36 weeks entire female, 46 weeks entire female, 54 weeks entire female.

Correlating line drawings for all ages except 46 and 54 weeks.

A  4th. lumbar vertebra

B  5th. lumbar vertebra
   1  Cranial epiphysis of body
   2  Cranial growth plate
      2(a) Open
      2(b) Closing
   3  Caudal epiphysis of body
   4  Caudal growth plate
      4(a) Open
      4(b) Closing

C  6th. lumbar vertebra

   For clarity the transverse process shadows have been excluded from all drawings.
   At 24 weeks of age the 3rd. sacral segment, or sacral vertebra, can be seen as a separate segment.
   By 36 weeks of age fusion of the 3rd. sacral segment has taken place.
   At 36 weeks of age the iliac crest of the pelvis can be seen as a separate ossification centre. This ossification centre was not seen on the ventrodorsal projections of the pelvis.
Figure 689  Age 24 weeks male

Figure 690  Age 36 weeks female
Figure 691  Age 46 weeks female

Figure 692  Age 54 weeks female
Figure 693  Lateral projection of thorax. British domestic short haired cat 1 year old, neutered male.
Figure 694  Lateral projection of thorax to demonstrate rib shadows.

A  1st. pair of ribs
B  2nd. pair of ribs
C  3rd. pair of ribs
D  4th. pair of ribs
E  5th. pair of ribs
F  6th. pair of ribs
G  7th. pair of ribs
H  8th. pair of ribs
I  9th. pair of ribs
J  10th. pair of ribs
K  11th. pair of ribs
L  12th. pair of ribs
M  13th. pair of ribs

1st. to 9th. pairs of ribs are sternal while 10th. to 13th. are asternal. The 13th. pair of ribs is floating.

1 Head of rib
2 Neck of rib
3 Tubercle of rib
4 Angle of rib
5 Costal cartilages. Cartilages of 10, 11 and 12 form the costal arch. The cartilages are calcified except for the most dorsal aspects. 1st. and 13th. rib cartilages are poorly calcified in this cat.

N  Manubrium of sternum
O  2nd. sternebra
P  3rd. sternebra
Q  4th. sternebra
R  5th. sternebra
S  6th. sternebra
T  7th. sternebra
U  Xiphoid process
V  Diaphragm
Figure 695  Ventrodorsal projection of thorax. British domestic short haired cat 10 months old, entire female.
Figure 696  Ventrodorsal projection of thorax to demonstrate rib shadows.

A  1st. pair of ribs
B  2nd. pair of ribs
C  3rd. pair of ribs
D  4th. pair of ribs
E  5th. pair of ribs
F  6th. pair of ribs
G  7th. pair of ribs
H  8th. pair of ribs
I  9th. pair of ribs
J  10th. pair of ribs
K  11th. pair of ribs
L  12th. pair of ribs
M  13th. pair of ribs

1  Head of rib
2  Body of rib
3  Costal cartilage (calcified)
   3(a) Costal cartilage of 9th. rib, last sternal rib
4  Costal cartilages of aternal ribs 10, 11 and 12, which
   make up the costal arch

N  Manubrium of sternum
O  2nd. sternebra
P  3rd. sternebra
Q  4th. sternebra
R  5th. sternebra

6th., 7th. and xiphoid process, 8th. sternebra, are not
discernible
S  Diaphragm
Figure 697  Lateral projection of pharynx and larynx. British domestic short haired cat 6 years old, neutered male.
**Figure 698** Lateral projection of pharynx and larynx.

1. Mandibular bodies
2. Temporomandibular joints
3. Tympanic bullae of temporal bones
4. External acoustic meatus of temporal bone
5. Petrous temporal bone
6. Occipital condyle
7. Soft palate
8. Epiglottis
9. Cranial limit of laryngeal part of pharynx
10. Caudal limit of laryngeal part of pharynx. Caudal limit is the caudal border of the cricoid cartilage.
11. Caudal limit of larynx
12. Position of the rostral cornu of thyroid cartilage
13. Rostral limit of the arytenoid cartilage. The corniculate process of the arytenoid cartilage is missing in the cat.
14. Vestibular fold
15. Glottic cleft. The cat lacks lateral ventricles and has instead shallow depressions.
16. Infrafllottic cavity
17. Trachea
18. Oesophagus
19. Nasopharynx
20. Oropharynx
21. Intrapharyngeal ostium
22. Laryngeal vestibule
23. Thyropharyngeal muscle
24. Cricopharyngeal muscle
Figure 699  Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with inflation of lung lobes. British domestic short haired cat 6 years old, neutered male (same cat as in left lateral recumbent projection of thorax, Figure 713).
**Figure 700** Right lateral recumbent projection of thorax to highlight cardiovascular system.

**Pericardium and heart**

Cranial border
1  Right auricle
2  Right ventricle

In this projection the aortic arch is not visible but a large aortic arch is more commonly seen in the cat than the dog. It appears as a distinct bulge at the cranial border, at or below the right auricle level, extending into the cranial mediastinum. Where the aortic arch covers the cranial waist the cardiac shadow appears cranially tilted with an increase in sternal contact.

Caudal border
3  Left atrium
4  Left ventricle

Although the cat has a cranial and caudal waistline, as in the dog, using these as a guideline for cardiac enlargement is not as straightforward, particularly for the caudal waistline. Separation of left atrium and left ventricle is more difficult and enlargements often do not affect the waistline.

5  Dorsal base
6  Apex

Fat accumulation within the pericardial sac is only occasionally seen in the cat but care must be taken to differentiate between soft tissue and fat opacities. In this radiograph fat opacity is visible outside the pericardium on the ventral thoracic cavity wall (7).

The right lateral recumbency is preferred for the cardiac shadow, as discussed in the dog section. In addition, the projection should be at full inflation of the lung lobes.

This film is not as fully inflated as the left lateral recumbent projection of thorax of the same cat, Figure 713. As such, the vascular shadows are more prominent and the cardiac shadow is slightly cranially tilted. However, craniocaudal and dorsoventral cardiac measurements for both projections are the same.

Right and left lateral recumbent projections of thoracic cavity in forced inflation, or over-inflation, of lung lobes, Figures 705 and 706, have been included to show the effect of ‘loss’ of pulmonary radiographic opacity and ‘upright’ cardiac shadows caused by hyperinflation.
**Vascular**

8 Thoracic aorta. (Aortic arch is not clearly seen as a separate structure in this radiograph.)
9 Ventral limit of cranial vena cava
10 Caudal vena cava
11 Cranial lobe artery
12 Cranial lobe vein

The radiolucent shadow between the paired cranial vessels is the lumen of the cranial lobe bronchus. It should not be mistaken for an air bronchogram. An air bronchogram is a characteristic radiographic feature of an alveolar pattern. The latter occurs in diseases which cause an infiltration into the alveoli. Soft tissue opacity replaces the alveolar air lucency resulting in adjacent air-filled lumens of the bronchi to become visible.

Bronchial walls are not generally visible in the cat unless they are diseased.

13 Pulmonary artery and veins

The arrangement of pulmonary veins is different in the cat as compared to the dog. In the dog the veins are symmetrically arranged as left and right sets of lobar veins.

In the cat there are three groups draining: the two parts of the left cranial lobe; the middle and cranial lobes of the right side; and caudal lobes of the right and left lungs. Each of these groups is of two or three veins and they are not symmetrically arranged. Hence radiographic differentiation of veins in the cat is very difficult.

**Non cardiovascular structures**

14 Tracheal lumen
14(a) Endotracheal tube
15 Tracheal walls
16 Cranial mediastinum
17 Ventral mediastinum. (See juvenile section, Figure 721, for appearance in kittens when the thymus occupies the entire cranioventral mediastinum at a level ventral to the cranial vena cava. It also extends 1 to 2 cm cranial to the 1st. ribs into the neck.)
18 Diaphragmatic shadow
18(a) Right ‘crus’
18(b) Left ‘crus’
18(c) Cupola

In this radiograph the appearance of the right and left ‘crura’ would suggest left rather than right recumbency. Identification of lateral recumbency is more difficult in the cat than the dog. Often ‘crura’ are superimposed and, as in this radiograph, are misleading.

Entry of the caudal vena cava is usually unhelpful leaving only the gastric gas, caudal to the left ‘crura’, as a guide for recumbency analysis. In this radiograph insufficient gas was present to show the presence of the gastric fundus caudal to the left ‘crura’.

19 Caudal border of scapula
20 Humerus
21 Manubrium of sternum
22 Xiphoid process
23 1st. thoracic vertebra
24 11th. thoracic vertebra
25 Calcified costal cartilages
26 Skin and muscle masses of forelimbs

**Variations**

It is widely reported that the cat has a fairly standard shape and size for its cardiac shadow, compared to the breed variation seen in dogs.

With this assumption radiographically normal thoracic projections, from clinically normal cats with no evidence of cardiac abnormalities, should have been relatively easy to obtain (see ‘normality’ in the Introduction). This was not the case as many cats were found to have cardiac ‘enlargements’ from their radiographic shadows.

A series of radiographs, Figures 709–712, has been included to alert the reader to possible variation in cardiac shadows or, more seriously, latent cardiac disease.
Figure 701  Schematic drawing of right lateral recumbent projection of thorax to illustrate cardiac chambers and major vessels (corresponds to line drawing Figure 700, but with the exclusion of some thoracic cavity details seen in the radiograph).

Left side with associated vessels
a = Left atrium with pulmonary veins (1)
b = Left auricle
c = Left ventricle (drawing does not indicate wall thickness)
d = Aorta with left subclavian artery (2) and brachiocephalic trunk (3). Aortic arch forms the most cranial structure of the ‘heart and major vessels’.
e = Left atroventricular valve; mitral. Length is usually about 25% of the craniocaudal width of the heart.
f = Aortic valve

Right side with associated vessels
g = Right atrium with cranial vena cava (4) and caudal vena cava (5) and aygous vein (6)
h = Right auricle. Right auricle is in contact with aortic arch and almost forms the cranial border of the ‘heart’ mass at the cardiac base.
i = Right ventricle (drawing does not indicate wall thickness)
j = Pulmonary trunk; main pulmonary artery or pulmonary artery segment
k = Right atroventricular valve; tricuspid. Length is usually about 50% of the craniocaudal width of the heart. It overlaps both aorta and pulmonary artery.
l = Pulmonary valve
**Figure 702** Dorsoventral projection of thorax. Radiograph taken during general anaesthesia with inflation of lung lobes. British domestic short haired cat 10 months old, neutered female (same cat as in ventrodorsal projection of thorax, Figure 716).

**Figure 703** Dorsoventral projection of thorax to highlight cardiovascular system.

**Pericardium and heart**

Right side
1 Right atrium
2 Right ventricle

Left side
3 Left auricle
4 Left ventricle
5 Level of apex; formed by left ventricle. (Unfortunately the apex is not clearly visible in this film due to superimposition of bony shadows of vertebral bodies and ribs.)

**Vascular**

6 Level of aortic arch. (The aortic arch and the descending aorta cannot be seen in this film.) In young cats the aortic arch is often obscured by thymic tissue while in aged cats this structure may become enlarged and distorted (see Figure 708).
7 Pulmonary trunk; main pulmonary artery
8 Level of cranial vena cava within cranial mediastinum soft tissue opacity. (The soft tissue shadows have been obscured by bony shadows of the thoracic vertebrae, ribs and sternebrae.)
9 Level of caudal vena cava. (The vein is not seen as a separate shadow in this film.) It can be distinguished as a linear soft tissue shadow in the ventrodorsal projection of thorax radiograph, Figure 719.

10 Arteries to caudal lung lobe

11 Veins to caudal lung lobe

12 Right cranial lobe artery. Occasionally the corresponding lobar vein is seen medial to the artery. Between these paired vessels a linear radiolucent shadow is created. As in the lateral recumbent projections the lucent shadow must not be mistaken for an air bronchogram. (Air bronchograms appear in disease as a characteristic radiographic feature of an alveolar pattern. See (12) in right lateral recumbent projection of thorax, Figure 700.)

Non-cardiovascular structures

13 Tracheal lumen

14 Tracheal wall

15 Caudal lobe bronchus

16 Pleural cupola

17 1st. rib

18 8th. rib

19 Diaphragmatic shadow

Figure 704  Schematic drawing of dorsoventral projection of thorax to illustrate cardiac chambers and major vessels (corresponds to line drawing Figure 703, but with the exclusion of some thoracic cavity details seen in the radiograph).

Left side with associated vessels

a = Left atrium

b = Left auricle

c = Left ventricle (diagram does not indicate wall thickness)

d = Aorta with aortic arch (1)

e = Left atrioventricular valve; mitral

f = Aortic valve

Right side with associated vessels

g = right atrium with cranial vena cava (2) and caudal vena cava (3)

h = Right auricle

i = Right ventricle (diagram does not indicate wall thickness)

j = Pulmonary trunk; main pulmonary artery

k = Right atrioventricular valve; tricuspid

l = Pulmonary valve

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Figure 705  Forced or over-inflation of lungs. Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with forced or over-inflation of lung lobes. British domestic short haired cat 10 months old, entire female (same cat as in Figures 706 and 719).
Figure 706  Forced or over-inflation of lungs. Left lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with forced or over inflation of lung lobes. British domestic short haired cat 10 months old, entire female (same cat as in Figures 705 and 719).

These lateral recumbent projections have been included to demonstrate the effect of forced inflation on radiographic opacity and cardiac shadow.

Although when analysing pulmonary features good radiolucency is preferable to poor radiolucency for the lung lobes, the contrast with forced inflation is so high that soft tissue shadows of blood vessels, heart and bronchial walls are less distinct when compared to films in full inflation. The hyperlucency of the lung lobes require bright light illumination for full evaluation of all the lung fields and cardiac outline.

The effect on cardiac shadow is also worthy of note. The cardiac shadow appears overall smaller in area compared to the shadow in full inflation. Also, a caudal rotation occurs changing the cardiac outline to become ‘upright’ in appearance. This rotation results in an increased dorsoventral measurement, at the maximum cardiac depth, while decreasing the craniocaudal measurement at the maximum cardiac width.

In addition, the diaphragmatic shadow is flattened, especially ventrally, making the cupola indistinguishable as a distinct part of the diaphragmatic shadow.

Radiographic shadows in this cat are normal and the corresponding ventrodorsal projection of thorax can be found in Figure 719.
Figure 707  Line drawing to demonstrate cardiovascular changes associated with age in the cat. Left lateral recumbent projec-
tion of thorax (Corresponds to original radiograph not included in the book. The radiograph was taken during general anaesthesia
and at full inflation of lung lobes.), British domestic short haired cat 14 years old, neutered female. The line drawing corresponds
to a radiograph of the 14-year-old cat showing no clinical signs of cardiac disease which was radiographed as a routine in a study
of feline rhinitis.

Note the cranial rotation of the cardiac shadow despite full inflation of lung lobes and correct radiographic positioning for the
thoracic cavity. The rotation has created an abnormally large craniocaudal measurement for the cardiac shadow, with increase in
sternal contact (1).

In addition, the cranial rotation has caused apex (2) to be dorsally elevated. The latter is not a common feature of a diseased
heart resulting in left-sided enlargement. Left-sided cardiac enlargement more often shows the apex to be closer to the sternum
with an overall increase in cardiac sternal contact. The horizontal position of the cardiac shadow is further exaggerated in this
film by the enlarged aortic arch (3).

The cardiac and aortic shadows seen and described in this aged cat are thought to be normal variations in the geriatric cat.
However, care must be taken to ensure that cardiac disease is not present. This age group often shows cardiac abnormality, most
commonly hypertrophic cardiomyopathy.

The dorsoventral projection of thorax of this cat did not show any evidence of left-sided enlargement. A large, well-defined
aortic arch shadow was seen but there was no unusual curvature of the arch or descending aorta.
Figure 708  Line drawing to demonstrate cardiovascular changes associated with age in the cat. Dorsoventral projection of thorax (Corresponds to original radiograph not included in the book. The radiograph was taken during general anaesthesia and at full inflation of lung lobes.) British domestic short haired cat 11 years old, neutered male. The line drawing corresponds to a radiograph of the 11-year-old cat showing no clinical signs of cardiac disease which was radiographed as a routine in a study of feline rhinitis.

Note the aortic arch (1) which appears large. A knob or knuckle shape (2) is seen at the junction of the arch and descending aorta; aortic isthmus.

The appearance of the aorta, as above, is thought to be a normal variation of the aged cat.

The lateral recumbent projection of thorax of this cat showed similar changes to the 14-year-old cat (Figure 707) with respect to the cardiac and aortic shadows. In addition, a radiopaque appearance of the elongated aortic arch at the level of the aortic isthmus was present.
Figure 709  Cardiac ‘variations’. Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 7 years old, neutered male (same cat as in left lateral recumbent projection of thorax, Figure 710).
Figure 710  Cardiac ‘variations’. Left lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 7 years old, neutered male (same cat as in right lateral recumbent projection of thorax, Figure 709).

These projections have been included to illustrate the comments made about cardiac shadow ‘variations’ (see text of right lateral recumbent projection of thorax, Figure 700) with reference to latent clinical disease.

They were taken as a screening procedure for possible pulmonary metastasis prior to digital amputation of an osteosarcoma. It was noted that the cardiac shadow appeared larger than expected. No cardiac abnormalities were present from clinical signs and examination. Echocardiography and electrocardiography were not performed at this time.

Following digital amputation the cat made an uneventful recovery but within 18 months was involved in a road traffic accident. The cat was hospitalised after being presented to the emergency duty veterinary surgeon.

Hindlimb bony fractures were an obvious injury but clinical examination of the thorax revealed a systolic cardiac murmur which had not previously been present. The respiration was also abnormal and thoracic radiography revealed pleural effusion.

The pleural effusion obscured the cardiac and mediastinal shadows ventrally.

Diaphragmatic shadow appeared intact, although the shadow was lost more ventrally by the pleural effusion. No disturbance of abdominal shadows to suggest a rupture of the diaphragm was present. The rib shadows were intact.

Thoracocentesis showed the effusion to be serous and obstructive in nature. Cardiac failure was suspected as the cause of the effusion but neoplasia was also considered.

Echocardiography using 2D and M mode imaging confirmed that hypertrophic cardiomyopathy was present. No abnormal mediastinal echoes were seen to suggest neoplastic metastasis as the cause of the obstructive effusion. Diaphragmatic line was intact.
**Figure 711** Cardiac ‘variations’. Left lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Burmese cat 18 months old, neutered male (same cat as in Figure 712).
Figure 712  Cardiac ‘variations’. Dorsoventral projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. Burmese cat 18 months old, neutered male (same cat as in Figure 711). Further to the comments made on cardiac shadow ‘variation’ (see text of right lateral recumbent projection of thorax, Figure 700), the thoracic radiography performed on this young Burmese cat shows that classic normal parameters for cat cardiac shadows do not always apply.

In particular, the lateral projection has a rounded cardiac shadow, as demonstrated by the cranial border and apex. A degree of cardiac enlargement can also be argued although there is a small degree of positional thoracic rotation.

This Burmese cat was showing no clinical signs of cardiac abnormality, radiography being undertaken as part of an investigation into possible pulmonary changes following rhinitis. Unfortunately no further thoracic radiography or clinical history is available for this particular cat and one can only speculate on whether the cardiac shadow was normal or a precursor to overt cardiac disease.
Figure 713  Left lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 6 years old, neutered male (same cat as in right lateral recumbent projection of thorax, Figure 699).
Figure 714  Left lateral recumbent projection of thorax to highlight respiratory system.

1 Cranial limit of the right and left cranial lung lobes. Extension is beyond the 1st. pair of ribs into the pleural cupola in well-inflated lung lobes. Unlike in the dog, the right and left cranial lung lobes in the cat often extend to the same cranioventral level, as in both lateral recumbent projections of this cat, Figures 699 and 713.
2 Lucent shadow created by middle lobe of right lung. This must not be mistaken for free pleural gas or air. Pulmonary opacities can be seen in the lucent region confirming the identity of lung tissue.
3 Most dorsal parts of caudal lung lobes
4 Ventral limits of caudal lobe, right and left lung. The right caudal lobe extends further ventrally than the left.
5 Tracheal lumen
5(a) Endotracheal tube
6 Tracheal walls
7 Level of tracheal bifurcation into right and left principal bronchi
8 Radiolucent circular silhouette demonstrating end-on projection of left cranial lung lobe bronchus at bifurcation into bronchus for cranial and caudal parts. The caudal part is often incorrectly termed the middle lobe of the left lung. Only the right lung has a middle lobe.
9 Linear opacities indicating bronchial walls
10 Circular opacities with radiolucent centres indicating bronchial walls; end-on bronchial silhouettes

Although bronchial and interstitial markings are common in dogs from the age of 4 years, and often are dramatic at ages over 10 years, the same does not apply to the cat. A recognisable bronchial and interstitial pattern in the cat indicates present or previous clinical abnormality.

11 Cranial mediastinum
12 Cardiac shadow
13 Aorta
14 Caudal vena cava
15 M.longus colli shadow
16 1st. thoracic vertebra
17 11th. thoracic vertebra
18 Manubrium of sternum
19 Xiphoid process
20 Calcified costal cartilages
21 Diaphragm
22 Lumbodiaphragmatic recess. The position of the recess is very different to the dog and must not be mistaken for abnormality. In this radiograph the dorsal border of the caudal lung lobe is separated from the bony vertebrae by a soft tissue shadow extending from caudal 11th. thoracic vertebra to caudal 13th. thoracic vertebra levels. Such an appearance is normal in the cat and must not be confused with lung retraction due to the presence of pleural effusion.
23 Muscle masses of forelimbs
24 Caudal border of scapula
**Figure 715** Schematic drawing of left lateral projection of thorax to illustrate lung lobes (corresponds to line drawing Figure 714, but with the exclusion of thoracic cavity details seen in the radiograph).

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= Left lung. Cranial (cranial and caudal parts) and caudal lobes.

= Right lung. Cranial, middle and caudal lobes.

= Accessory lobe

The terms apical, cardiac, diaphragmatic and intermediate lung lobes are no longer in common usage.
Figure 716  Ventrodorsal projection of thorax.
Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 10 months old, neutered female (same cat as in dorsoventral projection of thorax, Figure 702).

Figure 717  Ventrodorsal projection of thorax to highlight respiratory system.
**Cat – Thorax**

(717 continued.)

1. Cranial limit of the left cranial lung lobe. Extends beyond the 1st pair of ribs into pleural cupola in well-inflated lung lobes.
2. Cranial limit of right cranial lung lobe
3. Caudal visible limit of left caudal lung lobe
4. Caudal visible limit of right caudal lung lobe
5. Tracheal wall
6. Tracheal lumen within the cranial mediastinum just right of the midline
7. Left caudal bronchial lumen
8. Right caudal bronchial lumen
9. Circular opacity with radiolucent centre indicating wall with central lumen; end-on bronchial shadow.

The comments on bronchial markings and interstitial opacities made for the left lateral recumbent projection of thorax, Figure 714, also apply to this projection.

Although skin folds do not usually create the same false effect of lung opacity, compared with the dog, it is worth noting that the extreme cranial, and correct, position of the forelimbs in this radiograph has caused superimposition of the bony scapulae over the cranial thoracic cavity. All bony shadows seen in a thoracic cavity radiograph must be traced to their origin to avoid misdiagnosis. The latter is extremely important for rib shadows with their associated calcified costal cartilages.

10. Cardiac shadow. Note the curvature of the right atrium (10a) created by the ventrodorsal positioning.
11. Costodiaphragmatic recess
12. Diaphragmatic shadow
13. 1st. rib
14. 10th. rib
15. Scapula

The cranial position of the forelimbs makes the thorax appear longer and less triangular than if the legs are positioned to the sides of the thorax.

The ventrodorsal position is the preferred projection for lung shadows but even so dorsoventral projection can show improvement by pulling the forelegs cranially.

A short, triangular thoracic cavity, and hence a reduction of lung shadow, is greatest in the dorsoventral projection with the forelegs at the sides of the thorax.
Figure 718  Schematic drawing of ventrodorsal projection of thorax to illustrate lung lobes (corresponds to line drawing Figure 717, but with the exclusion of some thoracic cavity details seen in the radiograph).

1 = Right cranial lung lobe
2 = Right middle lung lobe
3 = Right caudal lung lobe
4 = Left cranial lung lobe, cranial part
5 = Left cranial lung lobe, caudal part
6 = Left caudal lung lobe
7 = Accessory lung lobe

A = Most ventral parts of right and left lung lobes
B = Most lateral parts of right and left caudal lung lobes
C = Most dorsal parts of right and left caudal lung lobes

The terms apical, cardiac, diaphragmatic and intermediate lung lobes are no longer in common usage.
Figure 719  Ventrodorsal projection of thorax. Radiograph taken during general anaesthesia with forced or over-inflation of lung lobes. British domestic short haired cat 10 months old, entire female (same cat as in right and left lateral recumbent projections of thorax, Figures 705 and 706).
The effect of forced or over-inflation compared to full inflation was discussed in the right and left lateral recumbent projection of thorax, Figures 705 and 706. Considering the ventrodorsal projection note the increased radiolucency of the lung lobes and flattening of the central and peripheral parts of the diaphragmatic shadow.

Although the cardiac shadow is reduced in area with forced inflation, evaluation of this shadow cannot be accurately made on any ventrodorsal projection. This is because the heart rotates craniodorsally creating a space between the cardiac and diaphragmatic shadows. The rotation often distorts the position of the cardiac shadow within the thorax. Also, the curved cranial cardiac borders may become more prominent. Compare with Figures 702 and 716 of the same cat in dorsoventral and ventrodorsal projections.

**Figure 720** Ventrodorsal projection of thorax to highlight the effects of forced or over-inflation on cardiac and diaphragmatic shadows.

1. Pleural cupola
2. Tracheal wall
3. Cranial mediastinal shadow
4. Aortic arch
5. Aorta
6. Left auricle
7. Right atrium

Numbers 6 and 7 appear ‘enlarged’ due to positional effect

8. Cardiac apex; left ventricle wall
9. Caudal vena cava
10. Caudal bronchial lumen
11. Caudal limit of lung lobe
12. Diaphragmatic shadow. The central part of the diaphragm (12(a)) is markedly flattened due to forced or over-inflation of the lung lobes.
Figure 721  Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 12 weeks old, entire male.

The radiograph shows the opaque linear pattern seen in the young animal thought to be due to interstitial fluid not present in adults. The opacity in this cat has considerably reduced the clarity of the vascular pattern with the aorta being barely visible.

The cardiac shadow is typically large and rounding of the borders, especially the cranial, with increase in sternal contact is evident.

A diffuse soft tissue shadow with a well-defined ventral margin is seen in the cranial thorax, its caudal border merging with the cranial cardiac border. This opacity is the thymus within the ventral mediastinum. Radiographically the thymic presence is clearly defined in the lateral projection of the thoracic cavity of very young cats.
Figure 722 Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 24 weeks old, entire male.

The radiograph shows a reduction in lung opacity compared to 12 weeks of age (see Figure 721) but still a very fine linear interstitial pattern is present.

The cardiac shadow has changed little in appearance, with the rounded border still being visible.

The cranial thymic opacity seen at 12 weeks of age has almost disappeared. Only an indistinct soft tissue shadow is evident at the 1st. and 2nd. rib levels.

Figure 723 Right lateral recumbent projection of thorax. Radiograph taken during general anaesthesia with full inflation of lung lobes. British domestic short haired cat 36 weeks old, entire female.

The radiograph, compared to 24 weeks of age, Figure 722, now shows pulmonary, ventral mediastinal and cardiac shadows similar to those of an adult cat.

The lung opacity seen previously at the younger ages has been lost and lucent shadows of lung tissue replace the thymic soft tissue opacity at the 1st. and 2nd. rib levels. Reduction in the rounding of the cardiac shadow has given the cranial border a normal contour.
Figure 724  Left lateral recumbent projection of abdomen. British domestic short haired cat 8 years old, neutered female (same cat as in right lateral recumbent projection of abdomen, Figure 726).
**Figure 725** Left lateral recumbent projection of abdomen.

1 Diaphragmatic shadow
1(a) Left ‘crus’
1(b) Right ‘crus’
1(c) Cupola
2 12th. thoracic vertebra
3 13th. rib
4 Skin margin
4(a) Soft tissue shadows of nipples (only just visible)
5 Subcutaneous fat
6 M. rectus abdominis
7 Intraperitoneal fat
7(a) Falciorm ligament of liver, mainly fat
8 Calcified costal cartilages
9 Soft tissue shadow of liver. Caudally this shadow creates a positive silhouette sign with the soft tissue shadow of the pyloric part of the gastric shadow 9(a).
9(b) Caudoventral margin of liver; left lateral lobe
9(c) Caudodorsal margin of liver; caudate process of caudal lobe
10 Gastric fundus
11 Gastric body
12 Pyloric part of gastric shadow

The lack of gastric gas is causing poor definition of the gastric shadow parts numbers 10 to 12. Shadows of cardia and pylorus are not seen.

13 Jejunum and ileum (seen as tubular soft tissue shadows)

Jejunum and ileum cannot be differentiated on non-contrast films, or even clearly on contrast studies. Generally the diameter of all small intestinal bowel is equal; ‘rule of thumb’ maximum diameter is normally equal to height of lumbar vertebral body.

14 Ascending colon (caecum cannot be seen as a separate structure on this film)
15 Transverse colon. In the cat it is a very small portion of bowel and is only rarely seen in abdominal projections.
16 Descending colon
17 Rectum
18 Anus
19 Right kidney
20 Left kidney

Cats’ kidneys are more variable in their location than dogs’ kidneys. They tend to be more caudoventral and overlap on the lateral projections. In addition, the most caudally located kidney is not always right, hence requiring a ventrodorsal or dorsoventral projection for an accurate kidney analysis. Kidney shape is similar to the dog but they are smaller in size, being twice the length of the 2nd lumbar vertebral body. Kidneys and ureters, not visible on plain radiographs, are retroperitoneal.

21 Urinary bladder.
21(a) Bladder neck. The cat bladder has a long narrow neck so that the bladder’s radiographic position is 2 to 3 cm cranial to the pubis. This is in contrast to the dog where the position is immediately cranial to the pubis in the female and cranial to the prostate in the male.
21(b) Urethra located in the fat caudal to the bladder neck. The urethra in the cat is very narrow and usually requires contrast material to demonstrate its position.

22 Sublumbar muscles. Although the muscles in the cat are similar to those in the dog their volume is greater, so creating a very distinct soft tissue shadow. In non-domestic predatory cats the muscle mass is very large at the 4th lumbar vertebral level.
23 7th. lumbar vertebra
24 Sacrum. Only two sacral segments are present in this cat.
25 Body of ilium
26 Pubic tubercle
27 Femoral bodies
28 Skin margin of hind leg
29 Muscles of hind leg
Figure 726  Right lateral recumbent projection of abdomen. British domestic short haired cat 8 years old, neutered female (same cat as in left lateral recumbent projection of abdomen, Figure 724).
Figure 727  Right lateral recumbent projection of abdomen.

For a routine survey radiograph of the abdomen, a right lateral recumbency is often preferred by many radiographers and radiologists. The most important factor is being consistent with one’s radiographic approach and hence radiographic appraisal and interpretation.

1 Diaphragmatic shadow
  1(a) Left ‘crus’
  1(b) Right ‘crus’
  1(c) Cupola
2 12th. thoracic vertebra
3 13th. rib
4 Skin margin
  4(a) Soft tissue shadows of nipples (just visible)
5 Subcutaneous fat
6 M.rectus abdominis
7 Intrapernitoneal fat
  7(a) Falciform ligament of the liver, mainly fat
8 Calcified costal cartilages
9 Soft tissue shadow of liver. Caudally creating a positive silhouette sign with the soft tissue shadow of the pyloric part of gastric shadow 9(a).
  9(b) Caudoventral margin of liver; left lateral lobe
  9(c) Caudodorsal margin of liver; caudate process of caudal lobe
10 Gastric fundus
11 Gastric body
12 Pyloric part of gastric shadow

Right lateral recumbency has caused gravitational filling of these ventrally positioned gastric areas (numbers 11 and 12).

Notice the large shadow compared to the left lateral recumbent projection line drawing, Figure 725.

13 Jejunum and ileum (Seen as tubular soft tissue shadows. See text in left lateral recumbent projection, Figure 725.)
14 Ascending colon. (Note the more ‘normal’ ventral position compared to left lateral recumbent projection line drawing, Figure 725.)
15 Transverse colon
16 Descending colon
17 Rectum
18 Anus
19 Right kidney. In the right lateral recumbency the right kidney is more caudally positioned than in the left lateral recumbency.
20 Left kidney
21 Urinary bladder
22 Sublumbar muscles

For numbers 19 to 22 see corresponding numbers in the left lateral recumbent projection of abdomen, Figure 725.

23 7th. lumbar vertebra
24 Sacrum. Only two sacral segments are present in this cat.
25 Body of ilium
26 Pubic tubercle
27 Femoral bodies
28 Skin margin of hind leg
29 Muscles of hind legs
Figure 728  Ventrodorsal projection of abdomen. British domestic short haired cat 8 years old, neutered female (same cat as in left and right lateral recumbent projections of abdomen, Figures 724 and 726).
Figure 729 Ventrodorsal projection of abdomen.

1 Diaphragmatic shadow
2 13th. thoracic vertebra
3 11th. rib
4 Skin margin
5 Subcutaneous fat
6 M.obliquus externus abdominis
7 Fat layer overlying the superficial surface of the caudal ribs. This layer usually serves to separate the m.obliquus externus abdominis from the m.obliquus internus abdominis and m.transversus abdominis.
8 M.obliquus internus abdominis and m.transversus abdominis. Seen as a single soft tissue line from the caudal margin of the rib cage.
9 Retroperitoneal fat surrounding kidney shadow
9(a) Fat in gastroscopetic part of greater omentum attaching greater curvature to spleen
9(b) Peritoneal cavity fat
10 Soft tissue shadow of liver
11 Right lateral lobe of liver
12 Dorsal extremity of spleen
13 Ventral extremity of spleen
14 Gastric fundus
15 Gastric body
15(a) Greater curvature

The lack of gastric gas is causing poor definition of the gastric shadow parts numbers 10 to 12. Gastric fundus is poorly defined and positions of cardia and pyloric parts are not seen.

16 Jejunum and ileum (seen as tubular soft tissue shadows)
17 Caecum. In the cat this structure is rarely seen without the aid of contrast media but in this cat a distinct caecal shadow is present. Unlike the dog the cat has no separate caecocolic junction or compartments.
18 Ascending colon
19 Transverse colon
20 Descending colon. Usually found on the left side not midline. In this cat it is on the right side of the abdomen. The distal third of the descending colon varies considerably in position.
21 Right kidney
22 Left kidney
23 Urinary bladder
24 Sublumbar muscles. The sublumbar muscle mass extends laterally to a greater degree than in the dog.
25 Skin folds
26 3rd. lumbar vertebra
26(a) Transverse process
27 Sacrum. Only two sacral segments are present in this cat.
28 Body of ilium
29 Femoral head

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An Atlas of Interpretative Radiographic Anatomy of the Dog and Cat
Figure 730  Dorsoventral projection of abdomen. British domestic short haired cat 4 years old, neutered female (same cat as in ventrodorsal projection of abdomen, Figure 732).
Figure 731  Dorsoventral projection of abdomen.

1  Diaphragmatic shadow
2  13th. thoracic vertebra
3  11th. rib
4  Skin margin
5  Subcutaneous fat
6  M.obliquus externus abdominis
7  Fat layer overlying the superficial surface of the caudal ribs
8  M.obliquus internus abdominis and m.transversus abdominis
9  Intraperitoneal fat
10 Soft tissue shadow of liver
11 Right lateral lobe of liver
12 Left lateral lobe of liver
13 Dorsal extremity of spleen
14 Ventral extremity of spleen
15 Gastric fundus
16 Gastric body
   16(a)  Lesser curvature
   16(b)  Greater curvature
17 Pyloric part
18 Jejunum and ileum (mainly seen as soft tissue shadows but a few gas-filled loops are present caudally)
19 Ascending colon
20 Transverse colon
21 Descending colon
22 Rectum
23 Right kidney
24 Left kidney
25 Urinary bladder
26 Sublumbar muscles
27 Hind limb muscles
28 1st. lumbar vertebra
28(a) Transverse process
29 Sacrum
30 Body of ilium
31 Femoral head
Figure 732  Ventrodorsal projection of abdomen. British domestic short haired cat 4 years old, neutered female (same cat as in dorsoventral projection of abdomen, Figure 730).

The radiographic shadows are very similar to the corresponding dorsoventral projection of abdomen in this cat. Kidney shadows are usually more well defined in the ventrodorsal projection while the dorsal extremity of the spleen is less clear.

Gastric and intestinal shadows are virtually unchanged in these ventrodorsal and dorsoventral projections of the abdomen. This is due to the absence of recognisable lumenal gas shifting with alterations of abdominal positioning.

Please see the differences in the dog ventrodorsal and dorsoventral projections of abdomen, Figures 464–469 and 471–475.
Figure 733  Right lateral recumbent projection of abdomen. British domestic short haired cat 6 years old, entire male (same cat as in dorsoventral projection of abdomen, Figure 734).

The gastric shadow shows gross distension of the gastric lumen with recent ingesta. Notice how large the cat’s stomach can stretch without clinical signs of dilation. The degree of distension has caused displacement of the ventral extremity of the spleen, making it appear more elongated and readily visible.
Figure 734  Dorsoventral projection of abdomen. British domestic short haired cat 6 years old, entire male (same cat as in right lateral recumbent projection of abdomen, Figure 733).

The gastric shadow is grossly distended with recent ingesta. The degree of lumenal distension has displaced the caudal body and pyloric parts of the stomach to the right side of the abdomen.

When the stomach is empty or moderately filled the body usually lies to the left and the pyloric parts lie in the midline of the abdomen. This radiograph demonstrates the changes brought about by normal gastric distension in the cat. Gastric enlargement has resulted in the splenic shadow being obscured at the ventral extremity but the dorsal extremity is highlighted.

The descending colon can be seen on the left side of the abdomen, which is the more frequent anatomical position in both the dog and cat.
Figure 735  Left lateral recumbent projection of abdomen. Extreme loss of abdominal fat contrast. British domestic short haired cat 13 years old, neutered female.

The radiograph shows gross loss of a well-defined inner surface of abdominal wall, serosal surface of bowel and organ soft tissue shadows such as liver, kidneys and bladder. Abdominal shadows are limited to gas-filled structures surrounded by a homogeneous soft tissue opacity. The appearance is due to excessive loss of the grey opacity fat tissue, in this case secondary to hyperthyroidism. Identification of different soft tissue shadows within the abdomen is only possible in the presence of fat tissue and hence fat is vital for abdominal contrast.

The reduction in abdominal contrast seen in this radiograph must not be mistaken for free abdominal fluid. The latter also causes a loss of contrast as the fluid has the same radiographic opacity as soft tissue. Differentiation from free abdominal fluid or ascites is aided by the long, shallow appearance of the abdomen, together with the absence of subcutaneous fat.
Figures 736–751  Barium meal; barium in the gastrointestinal tract. Comprises, routinely, serial lateral recumbent and ventrodorsal radiographs of the abdomen and shows the appearance of liquid barium sulphate passing through the gastrointestinal tract over a period of up to 24 hours.

Restraint is by positioning aids, e.g. sandbags, and tranquillisation where necessary.

Note that the appearance of the stomach can vary with species and dog breed conformation, the degree of distension and the ratio of fluid to gas. The distribution of fluid and gas depends on the radiographic projection being used.

Also, the gastric emptying and general transit times through the bowel can vary considerably according to the temperament of the animal, the type of any chemical restraint used and whether there is residual ingesta in the tract.

Right lateral recumbent and ventrodorsal projections of abdomen. Barium meal in the dog. Radiographs taken during restraint with sandbags before and following oral administration of liquid barium sulphate. Beagle dog adult, entire male (same dog in all figures for barium meal).
Figure 737  Ventrodorsal projection of abdomen. Plain survey film.
**Figure 738** Right lateral recumbent projection of abdomen. Immediately after barium administration.

Streaks of barium show within the mucosal folds of the oesophagus whilst barium is already passing along the descending portion of the duodenum.

Open arrows indicate ‘pseudoulcers’ in the duodenum (see also Figure 739).

1. Oesophagus
2. Cardia of the stomach
3. Fundus of the stomach
4. Body of the stomach
5. Pyloric antrum
6. Pyloric canal
7. Cranial flexure of the duodenum
8. Descending portion of the duodenum
9. Caudal flexure of the duodenum
Figure 739  Ventrodorsal projection of abdomen. Immediately after barium administration.

Streaks of barium within the oesophagus are more difficult to see in this projection because of the superimposition of the spine.

Barium is pooled in the fundus of the stomach (compared with a dorsoventral projection see Figure 754).

Open arrows indicate ‘pseudoulcers’ in the duodenum (see also Figure 738).

1 Oesophagus
2 Cardia of the stomach
3 Fundus of the stomach
4 Body of the stomach
5 Pyloric antrum
6 Pyloric canal
7 Cranial flexure of the duodenum
8 Descending portion of the duodenum
9 Caudal flexure of the duodenum
Figure 740  Right lateral recumbent projection of abdomen. 30 minutes after barium administration.

2 Cardia of the stomach
3 Fundus of the stomach
4 Body of the stomach
5 Pyloric antrum
6 Pyloric canal
7 Cranial flexure of the duodenum
8 Descending portion of the duodenum
9 Caudal flexure of the duodenum
10 Ascending portion of the duodenum
11 Duodenojejunal flexure
12 Loops of jejunum and ileum
**Figure 741** Ventrodorsal projection of abdomen. 30 minutes after barium administration.

Rugal folds of the stomach wall are well seen here, in cross-section (arrows).

Bubbles of gas are highlighted by the barium within jejunal loops.

3 Fundus of the stomach  
4 Body of the stomach  
5 Pyloric antrum  
7 Cranial flexure of the duodenum  
8 Descending portion of the duodenum  
9 Caudal flexure of the duodenum  
10 Ascending portion of the duodenum  
11 Duodenojejunal flexure  
12 Loops of jejunum and ileum
Figure 742  Right lateral recumbent projection of abdomen. 1 hour after barium administration.

The column of barium has reached the ileocolic junction.

3  Fundus of the stomach  
4  Body of the stomach  
5  Pyloric antrum  
10  Ascending portion of the duodenum  
12  Loops of jejunum and ileum  
13  Terminal portion of the ileum  
14  Ileocolic junction
Figure 743  Ventrodorsal projection of abdomen. 1 hour after barium administration.

The column of barium has reached the ileocolic junction.

3 Fundus of the stomach  
4 Body of the stomach  
7 Cranial flexure of the duodenum  
8 Descending portion of the duodenum  
10 Ascending portion of the duodenum  
12 Loops of jejunum and ileum  
13 Terminal portion of the ileum  
14 Ileocolic junction
**Figure 744** Right lateral recumbent projection of abdomen. 2 hours after barium administration.

Barium is starting to pass through the ileocolic sphincter.

3 Fundus of the stomach  
4 Body of the stomach  
7 Cranial flexure of the duodenum  
9 Caudal flexure of the duodenum  
10 Ascending portion of the duodenum  
12 Loops of jejunum and ileum  
16 Ascending portion of the colon
Figure 745 Ventrodorsal projection of abdomen. 2 hours after barium administration.

Barium is starting to pass into the ascending portion of the colon.

3 Fundus of the stomach  
5 Pyloric antrum  
7 Cranial flexure of the duodenum  
8 Descending portion of the duodenum  
9 Caudal flexure of the duodenum  
10 Ascending portion of the duodenum  
12 Loops of jejunum and ileum  
13 Terminal portion of the ileum  
14 Ileocolic junction  
16 Ascending portion of the colon
**Figure 746** Right lateral recumbent projection of abdomen. 4 hours after barium administration.

The caecum has filled as well as the ascending portion of the colon.

3 Fundus of the stomach  
12 Loops of jejunum and ileum  
15 Caecum  
16 Ascending portion of the colon  
17 Right colic flexure or hepatic flexure of the colon
Figure 747  Ventrodorsal projection of abdomen. 4 hours after barium administration.

Much of the barium has collected in the caecum, well demonstrated in this projection.

3 Fundus of the stomach
7 Cranial flexure of the duodenum
8 Descending portion of the duodenum
9 Caudal flexure of the duodenum
10 Ascending portion of the duodenum
12 Loops of jejunum and ileum
13 Terminal portion of the ileum
14 Ileocolic junction
15 Caecum
16 Ascending portion of the colon
17 Right colic flexure or hepatic flexure of the colon
18 Transverse portion of the colon
**Figure 748** Right lateral recumbent projection of abdomen. 6 hours after barium administration.

Most of the barium is now within the colon.

12 Loops of jejunum and ileum  
14 Ileocolic junction  
15 Caecum  
16 Ascending portion of the colon  
17 Right colic flexure or hepatic flexure of the colon  
19 Left colic flexure or splenic flexure of the colon
Figure 749  Ventrodorsal projection of abdomen. 6 hours after barium administration.

The caecum is emptying and barium has just reached the left colic flexure.

7 Cranial flexure of the duodenum
8 Descending portion of the duodenum
9 Caudal flexure of the duodenum
10 Ascending portion of the duodenum
12 Loops of jejunum and ileum
13 Terminal portion of the ileum
14 Ileocolic junction
15 Caecum
16 Ascending portion of the colon
17 Right colic flexure or hepatic flexure of the colon
18 Transverse portion of the colon
19 Left colic flexure or splenic flexure of the colon
**Figure 750**  Right lateral recumbent projection of abdomen. 24 hours after barium administration.

Some barium still remains in the descending portion of the colon and the rectum.

20 Descending portion of the colon  
21 Rectum
Figure 751  Ventrodorsal projection of abdomen. 24 hours after barium administration.
Some barium still remains in the descending portion of the colon and the rectum.
20 Descending portion of the colon
21 Rectum
**Figure 752**  Right lateral recumbent projection of thorax. Normal appearance of liquid barium sulphate within the thoracic oesophagus of the dog.

Radiograph taken during restraint with sandbags immediately following oral administration of liquid barium sulphate as part of a barium meal investigation.

German Shepherd dog 9 years old, entire male.

The normal striped appearance of barium in the longitudinal mucosal folds of the oesophageal wall is seen, together with the dorsal elevation of the oesophageal shadow at the 4th. intercostal space level over the base of the heart (dorsal to the circular radiolucent shadow of the left cranial lobe, caudal part, bronchus).

A repeat radiograph, approximately 10 minutes post-administration of the liquid barium, should reveal no traces of barium in the normal oesophagus.

The cardiac shadow appears an abnormal size and shape.
Accidental inhalation of the contrast material is shown.

Cranially the tracheal lumen is outlined, and more caudally the contrast has entered the right caudal lobe bronchus. The contrast has gravitated into the smaller bronchioles and traces of this will remain within the lung tissue for many years.

It is worth noting that compared with Figure 752, which shows contrast in the normal oesophagus, the deviation at the 4th. intercostal space level is a ventral dipping rather than a dorsal elevation. This anomaly has been caused by positional rotation of the thorax resulting in a ‘loss’ of the normal dorsal elevation of the oesophagus at the left cranial lung lobe, caudal part, bronchus.

Incidental findings are the shot gun pellets and their transit track fragments.
Figure 754  Dorsoventral projection of abdomen. Normal appearance of liquid barium sulphate within the stomach in the dorsoventral projection. Radiograph taken during restraint with sandbags immediately following oral administration of liquid barium sulphate as part of a barium meal investigation of the stomach. Miniature Poodle dog 7 years old, entire female.

Note the positional gravitation of the contrast medium into the body of the stomach and the pyloric antrum compared with the ventrodorsal projection, Figure 739, where it is in the fundus. The shape is more of a shallow ‘U’ with the pylorus more medial.

For a routine barium meal evaluation of the stomach, both right and left lateral recumbencies, ventrodorsal and dorsoventral projections of the abdomen are required.
Figure 755 Ventrodorsal projection of abdomen. Duodenal pseudoulecrs and small intestinal fimbriation in the dog. Radiograph taken during restraint with sandbags 5 minutes after oral administration of liquid barium sulphate as part of a barium meal investigation. Crossbred dog adult, entire female.

Small out-pouchings (arrows) of the barium column in the descending duodenum may sometimes be seen. They are termed pseudoulecrs and occur where the mucosa thins out over submucosal lymph follicles. They should not be confused with pathological ulcers.

A finely villous appearance of the mucosal surface, varying in extent along the small intestine, may also be evident. This is called fimbriation and is generally considered to be due to barium separating individual mucosal villi. Other factors are also involved. Fimbriation is reduced with increased bowel distension but mucus, clumping of villi and regional differences in mucosal movement all play a part.

Differentiation of normal fimbriation from diseased mucosa must be made by studying other radiographic signs and clinical history. Here the whole of the duodenal mucosal surface is involved.
Figure 756  Ventrodorsal projection of abdomen. Small intestinal stringing. Radiograph taken during restraint with sandbags 1 hour after oral administration of liquid barium sulphate as part of a barium meal investigation. Crossbred dog adult, entire female. Finely narrowed columns of contrast may be seen, caused by lengthy, segmental contractions of the small intestine. Serial radiographs will confirm their transient nature.
Figure 757  Right lateral recumbent projection of abdomen. Barium enema. Radiograph taken during general anaesthesia following rectal administration of liquid barium sulphate. Jack Russell Terrier dog 2 years old, entire female (same dog as in Figure 758).

1 Caecum
2 Ascending portion of the colon
3 Right colic flexure, or hepatic flexure of the colon
4 Transverse portion of the colon
5 Left colic flexure, or splenic flexure of the colon
6 Descending portion of the colon
7 Rectum

Note that repeat radiographs would demonstrate the temporary, peristaltic nature of the flexure apparently present here in the distal third of the descending portion of the colon.
Figure 758  Ventrodorsal projection of abdomen. Barium enema. Radiograph taken during general anaesthesia following rectal administration of liquid barium sulphate. Jack Russell Terrier dog 2 years old, entire female (same dog as in Figure 757).

1 Caecum
2 Ascending portion of the colon
3 Right colic flexure, or hepatic flexure of the colon
4 Transverse portion of the colon
5 Left colic flexure, or splenic flexure of the colon
6 Descending portion of the colon
7 Rectum

Note that repeat radiographs would demonstrate the temporary, peristaltic nature of the flexure apparently present here in the distal third of the descending portion of the colon.
Figure 759  Ventrodorsal projection of abdomen. Intravenous urography (I.V.U.). Radiograph taken during general anaesthesia. Plain survey film. Beagle dog adult, entire female (same dog as in Figures 760, 761 and 762). Right kidney not apparent, left kidney only partly discernible.
Figure 760  Ventrodorsal projection of abdomen. Intravenous urography (I.V.U.). Radiograph taken during general anaesthesia 1 minute after injection of an iodine-based, water-soluble contrast medium. Beagle dog adult, entire female (same dog as in Figures 759, 761 and 762).

Nephrogram phase of I.V.U.
Sufficient contrast has reached the kidneys to show their size, shape and position.
**Figure 761** Ventrodorsal projection of abdomen. Intravenous urography (I.V.U.). Radiograph taken during general anaesthesia 3 minutes after injection of an iodine-based, water-soluble contrast medium. Beagle dog adult, entire female (same dog as in Figures 759, 760 and 762).

Pyelogram phase of I.V.U.
The renal pelves, though in this case not the pelvic recesses (see Figure 763), and the cranial ureters are visible (arrows).
Figure 762  Ventrodorsal projection of abdomen. Intravenous urography (I.V.U.). Radiograph taken during general anaesthesia 8 minutes after injection of an iodine-based, water-soluble contrast medium. Beagle dog adult, entire female (same dog as in Figures 759, 760 and 761).

Pyelogram phase of I.V.U.
Normal peristaltic contractions cause segmental gaps (open arrows) in the contrast columns (closed arrows) of the ureters. Contrast is already appearing in the urinary bladder.
Figure 763  Lateral recumbent projection of abdomen. Intravenous urography (I.V.U.) with pneumocystography. Radiograph taken during general anaesthesia 10 minutes after injection of an iodine-based, water-soluble contrast medium with prior insertion of air into urinary bladder. Irish Setter adult, entire female.

Pyelogram phase of I.V.U.

The renal pelves and the pelvic recesses are outlined. Tracing, and identifying separately, the individual ureters along their length can be particularly difficult in the lateral projection because of the effects of peristalsis and superimposition. The right ureter is marked with thin arrows while the left ureter is labelled with thick arrows.

The ureterovesical junctions are more likely to be clearly seen than in the ventrodorsal projection where the pelvis overlies. Clarity may be enhanced by the use of pneumocystography.
Figure 764  Lateral recumbent projection of caudal abdomen. Pneumocystography. Radiograph taken during general anaesthesia after insertion of air into urinary bladder until full distension was reached. Crossbred dog adult, entire female.

The urinary bladder is distended with air; the urinary catheter is still in place and projecting from the urethra an acceptable distance into the bladder lumen. The catheter shaft is labelled with a black arrow while the catheter tip has a white arrow.

(A) Radiograph taken during general anaesthesia after insertion of 100 ml of air into the urinary bladder. The inadequate distension of the bladder results in a questionable shape cranially.

(B) Radiograph taken during general anaesthesia after insertion of 200 ml of air into the urinary bladder. The urinary bladder is more adequately distended, demonstrating a more normal shape than in radiograph 765A. However, the urinary catheter has now been inserted far too cranially so that it curves back on itself within the bladder lumen. Also, its tip is distorting the shape of the bladder neck ventrally. Ease of extraction could be a problem.

The catheter shaft is labelled with arrows. The catheter tip is marked with an open/white arrow.
Figure 766  Lateral recumbent projection of caudal abdomen. Double contrast cystography. Radiograph taken during general anaesthesia after insertion of an iodine-based, water-soluble contrast medium followed by air into the urinary bladder until full distension was reached. Miniature Dachshund adult, entire female.

This bladder lies more cranially than in the previous cases illustrated. Note the faecal boluses present in the descending colon and the rectum.

The linear opacity just visible parallel and dorsal to the urethra in the caudal abdomen is the cranial vagina containing a small amount of the positive contrast medium.
Radiography is performed immediately after filling the urethra with the contrast medium via a catheter whose tip is lodged in the distal urethral lumen. Distension of the lumen, particularly that of the prostatic portion of the urethra, is aided by a full bladder. An apparently narrow prostatic portion is not necessarily abnormal and contrast may show as longitudinal streaks within the folds of the lining mucous membrane.

In this radiograph some of the contrast medium has passed into the bladder. The prostatic portion (1) of the pelvic urethra is not as distended as the caudal portion (2). Globular lucencies within the latter are air bubbles.
Figure 768 (Please see text referring to Figures 768 and 769.) Right lateral recumbent projection of caudal abdomen. Retrograde vaginography with pneumocystography. Springer Spaniel crossbred dog 2 years old, entire female.

The caudal vagina is only moderately distended so that some of the longitudinal folds appear, dorsally, as filling defects. Further distension with contrast would eliminate them.

The cranial vagina is just apparent, with a suggestion of the shapes of the dorsomedian fold and the vaginal cervix (arrows).

Figures 768 and 769 Right lateral recumbent projections of caudal abdomen. Retrograde vaginography and vaginourethrography in the female dog.

Radiographs are taken after filling the vagina, or vestibule, vagina and urethra, with water-soluble contrast medium via a catheter whose tip is lodged at the vaginovestibular junction, or just within the vestibule. The length and the diameter of the vagina vary with the body size and breed of the subject as well as the hormonal status.

The caudal, or plicate, intrapelvic section has longitudinal folds and is easily distended, the folds smoothing out.

The cranial, or paracervical, intra-abdominal section is much more restricted with a ‘U’-shaped lumen and one fold always present, the dorsomedian fold, lying caudal to the vaginal cervix.

With only a small amount of contrast the cranial vagina may show simply as a fine horizontal line, whereas more complete filling will define, caudally, the crescent-shaped lower border of the dorsomedian fold and, cranially, the protrusion of the cervix into the vagina.

Radiography is performed during general anaesthesia.
Figure 769  (Please see text referring to Figures 768 and 769.) Right lateral recumbent projection of caudal abdomen. Retrograde vaginourethrography (urine left in bladder). Golden Labrador Retriever dog 4 years old, entire female.

The dorsomedian fold and the vaginal cervix are outlined in the cranial vagina (arrows).
Note that the diameter of the urethra widens considerably towards the external orifice.
Some contrast has passed into the bladder to mix with the urine.
Figure 770  Left lateral recumbent projection of cranial abdomen. Operative mesenteric vein portography in the dog. Radiograph taken during ventral midline laparotomy as the final millilitre of water-soluble contrast medium is injected into the portal vein via a catheter inserted into a contributory jejunal vein. Munsterlander dog 6 months old, entire male (same dog as in Figure 771).

Direction of flow of contrast in the portal vein is indicated by the arrow.
Figure 771 Ventrodorsal oblique projection of cranial abdomen. Operative mesenteric vein portography in the dog. Radiograph taken during ventral midline laparotomy as the final millilitre of water-soluble contrast medium is injected into the portal vein via a catheter inserted into a contributory jejunal vein. Munsterlander dog 6 months old, entire male (same dog as in Figure 770).

The direction of flow of the contrast in the portal vein is indicated by the arrow.
The rotation of the abdomen enhances the picture by avoiding superimposition of the spine.
Figure 772  Lateral projection (open mouth) of pharynx and larynx. Sialography of mandibular salivary gland. Radiograph taken during general anaesthesia after catheterisation of the mandibular salivary gland duct and injection of a water-soluble contrast medium into the gland. Bull Terrier dog 1.5 years old, entire male.
Figure 773  Lateral projection of pharynx and larynx. Sialography of parotid salivary gland. Radiograph taken during general anaesthesia after catheterisation of the parotid salivary gland duct and injection of a water-soluble contrast medium into the gland. Labrador dog 1 year old, entire male.
Figure 774  Lateral projection of pharynx and larynx. Sialography of sublingual salivary gland. Radiograph taken during general anaesthesia after catheterisation of the sublingual salivary gland duct and injection of a water-soluble contrast medium into the gland. Weimaraner dog 4 years old, entire male.
Figure 775  Right lateral recumbent projection of cervical and upper thoracic vertebrae (1st. cervical vertebra to 3rd. thoracic vertebra). Myelography in the dog. Radiograph taken during general anaesthesia immediately following the injection of water-soluble contrast medium into the cisterna magna. Labrador dog adult (same dog as in Figure 777).

The subarachnoid space is at its widest through the 1st. and 2nd. cervical vertebrae. The ventral column of contrast not infrequently bends slightly dorsally, as well as narrowing, at the 2nd. to 3rd. cervical intervertebral disc space. Slight narrowing of the ventral column with minor indentations may also occur over each of the subsequent intervertebral disc spaces.

The spinal cord is at its widest in the lower cervical region where it gives rise to the nerves of the brachial plexus. Through the 5th. and 6th. cervical vertebrae the ventral column often appears raised from the floor of the canal.

The use of a tilting table for this contrast technique enables positioning of the head and neck at an angle of 5 to 10 degrees from the horizontal in a dorsocranial–ventrocaudal direction, which encourages the caudal flow of the contrast medium along the subarachnoid space. In the absence of such a table temporarily placing the animal in sternal recumbency with the head moderately elevated has a similar effect.
Figure 776  Ventrodorsal projection of cervical vertebrae (2nd. to 7th. cervical vertebrae). Myelography in the dog. Radiograph taken during general anaesthesia following the injection of water-soluble contrast medium into the cisterna magna. Doberman dog. Linear opacities representing the walls of the endotracheal tube can be seen superimposed on the 2nd. and 3rd. cervical vertebrae and on the cranial part of the 4th. In some cases such shadows create confusion in the interpretation of the myelogram.

Figure 777  Right lateral recumbent projection of thoracic vertebrae (1st. to 13th. thoracic vertebrae). Myelography in the dog. Radiograph taken during general anaesthesia 3 minutes after injection of water-soluble contrast medium into the cisterna magna. Labrador dog adult (same dog as in Figure 775).

There is a gradual re-distribution of the contrast in the caudal thoracic subarachnoid space, resulting in a well-filled dorsal column and a thinner ventral column.

Considerable tilting of the long axis of the spine in a dorsocranial–ventrocaudal direction was necessary in this case to further the flow of contrast medium beyond the caudal cervical region.
In the caudal thoracic region the dorsal column of contrast is much wider than the ventral. Through the cranial lumbar vertebrae the ventral column increases again in width. From the 4th. lumbar vertebra the columns begin to converge as the spinal cord tapers into the cauda equina. Radioluent linear filling defects obliquely crossing the cord at the 4th. lumbar vertebra are caused by the emerging spinal nerve roots and confirm the subarachnoid distribution of the contrast medium (as opposed to epidural deposition; see lumbar puncture myelogram, Figure 781).

Shallow undulations of the ventral column, lifting over the intervertebral spaces, are frequently seen in the lumbar region, occasionally with a slight break in the contrast.

Some widening of the cord at the 4th. and 5th. lumbar vertebrae, the origin of the nerves of the sacral plexus, may be apparent.

The contrast tapers caudally through the 6th. and 7th. lumbar vertebrae around the cauda equina, to terminate within the spinal canal of the 1st. sacral segment.

The shape, length and position of the contrast image at the lumbosacral junction should not alter with either flexion or extension of the vertebrae.
Figure 780  Ventrodorsal projection of lumbosacral and upper coccygeal vertebrae (6th. lumbar vertebra to 5th. coccygeal vertebra). Myelography in the dog. Radiograph taken during general anaesthesia 20 minutes after the injection of water-soluble contrast medium into the cisterna magna (corresponding projection to right lateral recumbent projection of lumbosacral and upper coccygeal vertebrae, Figure 779).

Great Dane dog 2.5 years old, entire male (same dog as in Figures 778 and 779).

The subarachnoid contrast column tapers around the cauda equina to terminate within the sacrum.
Figure 781  Right lateral recumbent projection of lumbar vertebrae (13th. thoracic vertebra to 6th. lumbar vertebra). Myelography in the dog. Radiograph taken during general anaesthesia following lumbar puncture between the 5th. and 6th. lumbar vertebrae with the injection of water-soluble contrast medium. Labrador dog 8.5 years old, entire male.

Some contrast has entered the subarachnoid space to be seen as thin straight linear opacities along the spinal canal while the rest has been deposited epidurally, resulting in secondary, undulating and thicker linear opacities following the upper and lower bony limits of the spinal canal and lifting, ventrally, over the emerging spinal nerves at the intervertebral foramina. The resulting pattern is best seen on this film at the 3rd and 4th. lumbar vertebrae.

Such an epidural pattern, not uncommon with lumbar myelography, should not be mistaken for abnormality.
Figure 782  Right lateral recumbent projection of abdomen. Plain survey film. Faecal boluses are present in the colon.

Figures 782–787  Right lateral recumbent and ventrodorsal projections of abdomen. Barium meal in the cat. Radiographs taken during restraint with sandbags before and following oral administration of liquid barium sulphate. British domestic short haired cat adult (same cat in all figures for barium meal).

This barium meal series was not followed beyond the transverse colon. Note that the caecum is not identifiable in any of the films; in the cat it is a very small, simple sac compared with that of the dog.
Figure 783  Right lateral recumbent projection of abdomen. Immediately after barium administration.

Very little barium is left in the oesophagus and it is just beginning to pass down the descending portion of the duodenum.

1  Oesophagus
2  Cardia of the stomach
3  Fundus of the stomach
4  Body of the fundus
5  Pyloric antrum
6  Pyloric canal
7  Cranial flexure of the duodenum
Figure 784  Ventrodorsal projection of abdomen. 15 minutes after barium administration.

Rugal folds of the stomach wall are seen in cross-section (arrows) around the fundic pool of barium, with streaking of barium along their length.

Note that the cat stomach is more ‘J’ shaped in this projection than is the dog, with the pylorus closer to the midline.

Bubbles of gas are present within the jejunal loops and gas appears to be collecting within the colon, highlighting the faecal boluses.

3  Fundus of the stomach
4  Body of the stomach
5  Pyloric antrum
6  Pyloric canal
7  Cranial flexure of the duodenum
8  Descending portion of the duodenum
9  Caudal flexure of the duodenum
10  Ascending portion of the duodenum
11  Duodenojejunal flexure
12  Loops of jejunum and ileum
Figure 785  Right lateral recumbent projection of abdomen. 75 minutes after barium administration.

Only a trace of barium remains in the stomach and it is already collecting in the colon, coating the faecal boluses.

7 Cranial flexure of the duodenum  
8 Descending portion of the duodenum  
9 Caudal flexure of the duodenum  
12 Loops of jejunum and ileum  
13 Ileocolic junction  
14 Ascending colon  
15 Right colic flexure  
16 Transverse colon
Figure 786  Ventrodorsal projection of abdomen. 75 minutes after barium administration.

3  Fundus of the stomach
8  Descending portion of the duodenum
12 Loops of jejunum and ileum
13 Ileocolic junction
14 Ascending colon

See right lateral recumbent projection of abdomen, Figure 785, also at 75 minutes.
**Figure 787** Right lateral recumbent projection of abdomen. 3 hours after barium administration.

The barium is almost totally in the colon although transit has stopped at a similar level as in the 75 minute film. It is probably being held up by the faecal boluses and the accumulation of gas which has occurred.

13 Ileocolic junction  
14 Ascending colon  
15 Right colic flexure  
16 Transverse colon
**Cat – Barium Meal**

**Figure 788** Right lateral recumbent projection of thorax. Normal appearance of liquid barium within the thoracic oesophagus of the cat. Radiograph taken during restraint with sandbags immediately following oral administration of liquid barium sulphate as part of a barium meal investigation. British domestic short haired cat adult.

Caudal to the base of the heart longitudinal striations, up to this point similar to the dog, give way to a ‘herring bone’ pattern reflecting the obliquely directed folds of mucosa. The latter corresponds to the change to smooth muscle in the wall of this segment of the cat’s oesophagus.
Figure 789  Ventrodorsal projection of abdomen. Duodenal beading and pseudostringing in the cat. Radiograph taken during restraint with sandbags 5 minutes after oral administration of liquid barium sulphate as part of a barium meal investigation. British domestic short haired cat adult.

Short but strong segmental peristalsis may occur along the proximal duodenum, resulting in regularly spaced, rather globular expansions, ‘beads’, of the barium column.

Linear filling defects within the intervening contracted segments represent mucosal folds indenting the narrowed bowel lumen and are described as ‘pseudostringing’.

Note that the contracted portions of the bowel are symmetrically central to the expanded portions, in comparison with the asymmetric pattern seen in the presence of a linear foreign body.

A roundworm is highlighted by the contrast in the descending portion of the duodenum.
Figure 790  Ventrodorsal projection of abdomen. Intravenous urography (I.V.U.) with pneumocystography. Radiograph taken during general anaesthesia immediately after injection of an iodine-based, water-soluble contrast medium with prior insertion of air into urinary bladder. British domestic short haired cat young adult, neutered male (same cat as in Figures 791 and 792).

Nephrogram phase of I.V.U.
Sufficient contrast has reached the kidneys to show their size, shape, and position.
Figure 791 Ventrodorsal projection of abdomen. Intravenous urography (I.V.U.) with pneumocystography. Radiograph taken during general anaesthesia 5 minutes after injection of an iodine-based, water-soluble contrast medium with prior insertion of air into the urinary bladder. British domestic short haired cat young adult, neutered male (same cat as in Figures 790 and 792).

Pyelogram phase of I.V.U.
The renal pelves and their recesses are delineated and contrast is already beginning to collect in the urinary bladder, although this is not clearly seen because of superimposition of the right sacral wing.
Figure 792  Lateral recumbent projection of abdomen. Intravenous urography (I.V.U.) with pneumocystography. Radiograph taken during general anaesthesia 10 minutes after injection of an iodine-based, water-soluble contrast medium with prior insertion of air into the urinary bladder. British domestic short haired cat young adult, neutered male (same cat as in Figures 790 and 791).

Pyelogram phase of I.V.U.
The bladder and the ureterovesical junctions are more easily seen in this projection. Clarity is enhanced by pneumocystography.
Figure 793  Lateral recumbent projection of caudal abdomen. Positive contrast cystography. Radiograph taken during general anaesthesia after insertion of an iodine-based, water-soluble contrast medium into the urinary bladder until full distension was reached, catheter still in situ. British domestic short haired cat young adult, neutered female (same cat as in Figure 794).

Note the position of the bladder and the presence of faecal boluses in the colon and rectum compared to Figure 794 of a pneumocystogram in the same cat, taken 48 hours later.
Figure 794  Lateral recumbent projection of caudal abdomen. Negative contrast cystography; pneumocystography. Radiograph taken during general anaesthesia after insertion of air into the urinary bladder until full distension was reached, catheter still in situ. British domestic short haired cat young adult, neutered female (same cat as in Figure 793).
**Figure 795**  Lateral recumbent projection of caudal abdomen. Double contrast cystography. Radiograph taken during general anaesthesia after insertion of an iodine-based, water-soluble contrast medium followed by air into the urinary bladder until distension was reached. Burmese cat 7.5 years old, neutered female.

The bladder is moderately distended and the catheter has been removed.
Figure 796  Right lateral recumbent projection of cervical and upper thoracic vertebrae (1st. cervical vertebra to 3rd. thoracic vertebra). Myelography in the cat. Radiograph taken during general anaesthesia immediately following the injection of water-soluble contrast medium into the cisterna magna. British domestic short haired cat 10 months old (same cat in all figures for myelography).

The subarachnoid space filled with contrast is at its widest at the 1st. and 2nd. cervical vertebrae. Thinning and slight indentation of the ventral contrast column occur over each cervical intervertebral disc space.
Figure 797  Ventrodorsal projection of cervical and upper thoracic vertebrae (1st. cervical vertebra to 2nd. thoracic vertebra). Myelography in the cat. Radiograph taken during general anaesthesia immediately following the injection of water-soluble contrast medium into the cisterna magna. British domestic short haired cat 10 months old (same cat in all figures for myelography).
**Figure 798** Right lateral recumbent projection of thoracic vertebrae (7th. cervical vertebra to 1st. lumbar vertebra). Myelography in the cat. Radiography taken during general anaesthesia following the injection of water-soluble contrast medium into the cisterna magna. British domestic short haired cat 10 months old (same cat in all figures for myelography).

- Thinning and slight indentation of the ventral column over the intervertebral disc spaces can occur, as in the cervical vertebrae.

- In the caudal thoracic region the ventral contrast column becomes narrower and the dorsal column broader, as in the dog.

**Figure 799** Ventrodorsal projection of thoracic vertebrae (1st. thoracic vertebra to 1st. lumbar vertebra). Myelography in the cat. Radiograph taken during general anaesthesia following the injection of water-soluble contrast medium into the cisterna magna. British domestic short haired cat 10 months old (same cat in all figures for myelography).
The dorsal and ventral contrast columns start to converge through the 6th. lumbar vertebra, caudal to the lumbar enlargement of the cord, to taper around the cauda equina and finish in a fine point beyond the sacrum, much further caudal than in the dog.

Dorsocranial–ventrocaudal oblique radiolucent striations crossing the cord from the 4th. lumbar vertebra caudally indicate the roots of the spinal nerves.
Bibliography


