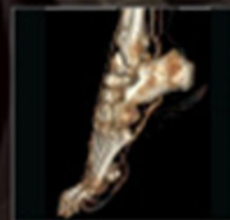
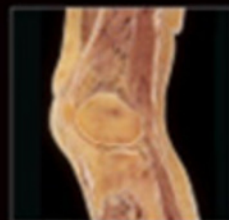
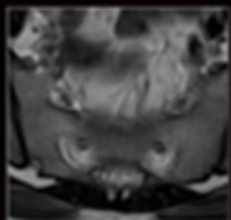
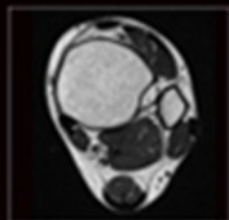


MCMINN'S COLOR ATLAS OF
LOWER LIMB
ANATOMY



FIFTH EDITION

Bari M. Logan
David J. Bowden
Original Photography by
Ralph T. Hutchings

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McMinn's Color Atlas of

Lower Limb Anatomy

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McMinn's Color Atlas of **Lower Limb Anatomy** Fifth Edition

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Dedications

To Arlette Herzig and Robert Logan
- *Bari Logan*

Anna, Jack, George and my parents
- *David Bowden*

Anne, Sam and Isabel
- *Ralph Hutchings*

And

To the Memory of an Esteemed Colleague

Professor R. M. H. (Bob) McMinn

Preface

This fifth edition of *McMinn's Colour Atlas of Foot and Ankle Anatomy*, heralds 35 years of publication and brings some significant changes and most immediate to note is the new title, ***McMinn's Color Atlas of Lower Limb Anatomy***, which we feel reflects more truly the overall direction and content of the book.

Originally intended as an illustrated reference book for chiropodists and podiatrists in training, over the ensuing years it has become equally popular with radiologists, physiotherapists, sports injury consultants, vascular and orthopaedic surgeons. The book has therefore become an accepted standard text on the subject and continues to fill an important niche on medical library bookshelves worldwide, producing eight language editions: English, Chinese, Japanese, French, German, Dutch, Russian and Spanish.

For this fifth edition, a third co-author David Bowden joins the team and adds his specialist clinical knowledge and expertise in the field of radiology by adding a new 30 page chapter dedicated

to ***Imaging of the Lower Limb***, using state-of-the-art technology. Thus providing the opportunity to visualise key anatomical structures as they appear in the living subject in comparison to the illustrations of bones and detailed anatomical preparations provided elsewhere in the book.

Bari Logan adds a scattering of nine new pages of annotated illustrations of anatomical preparations, with accompanying notes.

We hope that these new additions and overall review of the text will be appreciated and that the book will continue in its popularity as an important contribution to medical education at both pre-clinical and postgraduate level.

Bari M Logan
Siegershausen, Switzerland
David J Bowden
Cambridge, UK
March 2017



Ardfern – 5 April 2008

Professor R. M. H. McMinn, MD (Glas), PhD (Sheff), FRCS (Eng)
[b. Sept 23, 1923 – d. July 11, 2012, aged 88]

Robert 'Bob' McMinn was a medical graduate of the University of Glasgow. After leaving hospital posts and service with the Royal Air Force in Iraq and Africa, he began his anatomical career as a Demonstrator in Anatomy in Glasgow in 1950. He became a lecturer in the University of Sheffield and was later Reader and then Titular Professor at King's College, London. In 1970 he was appointed to the Chair of Anatomy at the Royal College of Surgeons of England. Among his publications, 'A Colour Atlas of Human Anatomy', with photographer R. T. Hutchings, was first published in 1977 and became a worldwide best seller, with translations into over 25 languages; more than 4 million copies were sold.

For this and other later atlases his co-authors added the name 'McMinn' to the titles in recognition of his contribution to anatomical teaching. He was editor of the eighth and ninth editions of 'Last's Anatomy Regional and Applied', which remains a standard work for surgical trainees. He was program secretary and later treasurer of the Anatomical Society of Great Britain and Ireland, and was a founder member and first secretary of the British Association of Clinical Anatomists. At the International Anatomical Congress held in Cambridge in 2000, he received a Special Presentation Award from the Anatomical Society for his teaching and research activities. His research interests were in wound healing and tissue repair and on the association between skin disease and the alimentary tract.

He retired in 1983 and moved with his wife back to their Scottish homeland settling on the west coast in Ardfarn, Lochgilphead.

McMinn's Legacy of Illustrated Anatomy Books

Bari Logan entered the academic post of Prosector to the department of Anatomy, The Royal College of Surgeons, of England, London, in January 1977. At that time, 'Bob' McMinn held the Chair as Sir William Collins Professor of Human and Comparative Anatomy and Ralph Hutchings was the Chief Medical Scientific Officer and departmental photographer.

In April of the same year, an evening reception was held at the College for a group of distinguished medical fraternity by Wolfe Medical Publications to launch a new book entitled ***A Colour Atlas of Human Anatomy*** by the authors McMinn & Hutchings who had spent the previous 2 years working on the project.

1977 - ISBN 0-7234-0709-6

2nd Ed—1988

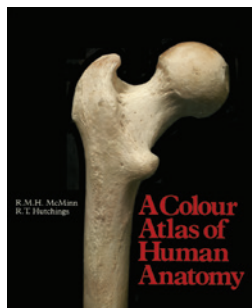
3rd Ed—1993

4th Ed—1998

5th Ed—2003

6th Ed—2008

7th Ed—2013



First Edition dust cover wrap

Instantly considered by many to be a visually stunning production, it was without doubt a pioneering book in the field of human anatomy, having many novel concepts in both composition and design that would later be adopted by other authors and become standard format in many new illustrated texts on the subject.

The book, 352 pages, was unusually large in size and contained over 700 high quality colour photographs of almost natural size, bones, detailed dissections (prosections), and exquisite anatomical preparations depicting the entire human body taken of specimens hitherto unseen beyond the closely guarded confines of the dissecting room and anatomical museum. Essentially designed as a general reference work for the medical profession, the book rapidly became a best-seller, quickly producing 25 foreign language editions and attaining over 4 million copies in sales worldwide, it won numerous awards and gained much international academic acclaim.

The book remains in print today, 40 years on and in its seventh edition (2013), but since the fourth edition, under entirely new

authorship, direction and content, although the name 'McMinn' remains in the title for posterity.

Following on from the enormous success of ***A Colour Atlas***, the publisher Peter Wolfe approached 'Bob' McMinn and Ralph Hutchings in early 1979 with the idea of producing a new illustrated text to suit the specific educational needs of dental students, for whom the Royal College of Surgeons ran popular postgraduate courses.

Wolfe's proposal was timely because, within the College, the renovation and reorganization of the Wellcome Museum of Anatomy and Physiology, founded by the famous Australian anatomist R. (Ray) J. Last in (1947), was well underway; a particular pressing need, identified by Bari Logan, was to prepare for display a range of detailed head and neck prosections and preparations, for which the collection was lacking.

Thus, the co-authorship trio of McMinn, Hutchings and Logan was formed and within a two-year period produced their first book together in 1981.

1981: ISBN 0-7234-0755-X

A Colour Atlas of Head and Neck Anatomy

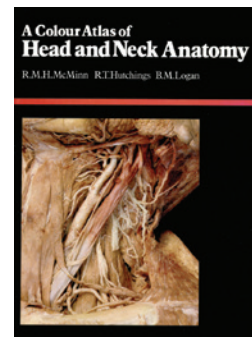
Wolfe Medical Publications:
McMinn/Hutchings/Logan
Designed for dental students
English, French, German, Italian,
Japanese, Korean, Portuguese, Spanish

2nd Ed—1994

3rd Ed—2004

4th Ed—2009

5th Ed—2017



Over the next 17 years, there followed a fairly rapid succession of books, despite the retirement of Ralph Hutchings in 1981, 'Bob' McMinn in 1983, academic career move of Bari Logan to Cambridge in 1987 and further complications along the way of various changes to publishers through company takeovers, each having additional authorship commitments on other new books.

Key to this speedy turnover was the ability to combine individual talent in a very harmonious way, work to a logical regime and keep within a strict timeframe whilst always maintaining an essential keen eye for detail.

1982: ISBN 0-7234-0782-7

A Colour Atlas of Foot and Ankle Anatomy

Wolfe Medical Publications:
McMinn/Hutchings/Logan
Designed for Podiatrists and Chiropodists

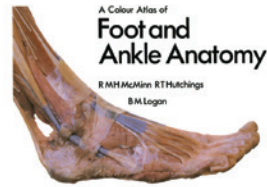
English, Chinese, Dutch,
French, German, Japanese,
Russian, Spanish

2nd Ed—1995

3rd Ed—2004

4th Ed—2012

5th Ed—2017 **Lower Limb Anatomy**

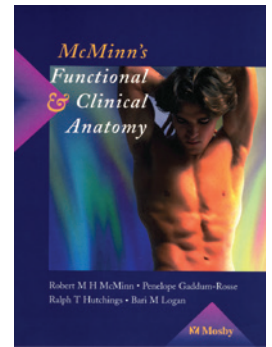


1995: ISBN 0-7234-0967-6

McMinn's Functional and Clinical Anatomy

Mosby: McMinn/Gaddum-Rosse/
Hutchings/Logan

Designed for medical students
English, Italian, Greek
Out of Print



1984: ISBN 0-7234-0831-9

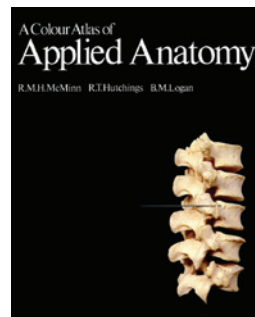
A Colour Atlas of Applied Anatomy

Wolfe Medical Publications: McMinn/
Hutchings/Logan

Designed for clinicians (The anatomy of approaches for surgical and clinical procedures.)

English, Japanese

Out of Print



1986: ISBN 0-7234-0911-0

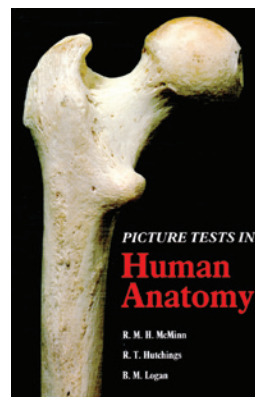
Picture Tests in Human Anatomy

Wolfe Medical Publications: McMinn/
Hutchings/Logan

Designed for medical students taking practical exams

English, French, German, Japanese,
Portuguese, Serbo-Croatian, Spanish

Out of Print



1998: ISBN 1-874545-52-9

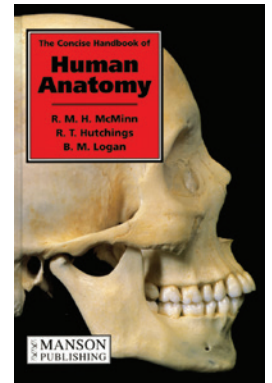
The Concise Handbook of Human Anatomy

Manson Publishing: McMinn/
Hutchings/Logan

Designed for sixth form students entering a medical career

English, German, Portuguese
2nd Ed—2017

McMinn's Concise Human Anatomy
CRC Press (Taylor & Francis)
Heylings/Carmichael/Leinster/Saada



1986: ISBN 0-7234-0958-7

The Human Skeleton: a Photographic Manual in Colour

Wolfe Medical Publications: McMinn/
Hutchings/Logan

Designed for medical students (fold down, full size skeleton pictures and individual bones)

English, Danish, French, German,
Greek, Japanese, Portuguese, Spanish

2nd Edition—2007



'Bob' was the inspirational driving force behind each book and, from start of the project, would clearly outline overall content and specific illustrative requirements for each chapter producing rough sketches or photocopies with accompanying detailed lists of all the most important anatomical structures needed to be clearly seen in the resulting pictures.

Bari would interpret this information, produce his own notes and drawings and carry out the various detailed dissections or anatomical preparations working to the specific camera lens angle and overall framed view required.



Bari M. Logan, Prosector

Sporadic photographic sessions were held, often late evenings and weekends, under the 'eagle eye' of 'Bob' who would advise on the camera angle and ensure that all the structures essential to identify were displayed in their correct anatomical positions.



Professor R. ('Bob') H. McMinn, Anatomist

Ralph spent infinite time setting-up lighting, establishing correct camera exposure settings and, by using full format colour film, produced images of exceptional quality and depth in detail.



Ralph T. Hutchings, Photographer

Since the first publication, over the ensuing 36 years to date (2017), the seven books produced by the trio, have thus far, created 17 English editions and 13 foreign language editions: Chinese, Danish, Dutch, French, German, Greek, Italian, Japanese, Korean, Portuguese, Russian, Serbo-Croatian and Spanish, with total sales exceeding well over 1 million copies worldwide.

Four of the books remain popular and still in print: *Head & Neck, 5th edition*; *Foot & Ankle, 5th edition*, now more appropriately retitled *Lower Limb Anatomy*; *Human Skeleton, 2nd edition*; and the *Concise Handbook – 2nd edition*, which now has a new publisher and authorship, and to conform with the other surviving publications 'McMinns' prefixed in the title.

Overall, a remarkable literary achievement in such a specialized field and only made possible by the unique visionary authorship and guidance of 'Bob' McMinn, whose legacy of Illustrated books on the subject of human anatomy has not only made a significant contribution to medical education in general, but also to the grateful appreciation and applause of thousands of aspiring students throughout the world.

*Bari Logan and Ralph Hutchings
June 2016*

Acknowledgements

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- Mel Lazenby, Lucie Whitehead and the late Martin Watson (2008), Department of Anatomy, University of Cambridge UK, for the preservation of anatomical material.
- Adrian Newman, Ian Bolton and John Bashford, Anatomy Visual Media Group (AVMG), Department of Physiology, Developmental Neuroscience, University of Cambridge UK, for new edition photographs and digital expertise.

Radiographs

- Dr Oscar Craig [p.21B](#).
- Dr Kate Stevens [p.31C](#).

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2016); and on [pages 34–37](#) from *Human Sectional Anatomy—Atlas of Body Sections, CT and MRI Images, 4th Edition*, H.Ellis, B.M.Logan, A.K.Dixon and D.J.Bowden (CRC Press 2015).

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The following individuals are credited for their skilled in preparing the following anatomical material illustrated in this book:

Mrs Carmen Bester: [page 90A](#).

Bari M Logan: [pages 2B, 4B, 6B, 8B, 10, 12, 14A, 16A, 17B, 20A, 24A, 25B, 26A, 27C, 28A, 29B, 31D, 34, 35A, 36B, 37C, 38A, 40ABC, 41DEF, 74A, 75BC, 76A, 77B, 78, 80A, 81B, 82A, 83B, 84, 86AB, 88, 92A, 93B, 94A, 95B, 96AB, 97C, 98A, 99B, 100A, 101B, 102A, 103B, 104ABC, 106AB, 108AB, 110AB, 111AB, and 112ABCDE](#).

Ms Lynette Nearn: [pages 91B, 166](#).

Dr David H Tompsett: [pages 30B, 33BC and 39D](#).

Terminology

The Greek adjective 'peroneal' is now replaced by the Latin 'fibular' for various muscles, vessels, nerves, and structures; For example: **Fibularis tertius** instead of *Peroneus tertius*; **Fibular artery** instead of *Peroneal artery*; **Common fibular nerve** instead of *Common peroneal nerve*; **Inferior fibular retinaculum** instead of *Inferior peroneal retinaculum*.

Again, for this new edition, to ease in the new terminology for those used to working from older texts, the term *peroneal* is included italicized in brackets, e.g., **Deep fibular (peroneal) nerve**.

Also note, *Flexor accessorius* is now known as **quadratus plantae**.

This terminology conforms to the International Anatomical Terminology—*Terminologia Anatomica*—created in 1988 by the Federative Committee on Anatomical Terminology (FCAT) and approved by the 56 Member Associations of the International Federation of Associations of Anatomists (IFAA). Stuttgart: Thieme ISBN 3-13-115251-6.

Preservation of Cadavers

Long-term preservation of the cadavers, utilized for the majority of anatomical dissections (prosections) illustrated in this book, was by standard embalming technique, using an electric motor pump set at a constant pressure rate of 15 p.s.i. Perfusion was achieved through the arterial system via femoral artery cannulation of one leg and return drainage of the accompanying vein.

On acceptance of 20 litres of preservative fluid by pump, local injection of those areas not visibly affected was carried out by automatic syringe.

On average, 30 litres of preservative fluid was used to preserve each cadaver.

Immediately following embalming, cadavers were encapsulated in thick-gauge, clear polythene bags and cold stored at a temperature of 10.6° C at 40 percent humidity for a minimum period of 16 weeks before dissection. This period of storage allowed preservative fluid to thoroughly saturate the body tissues, resulting in a highly satisfactory state of preservation.

The chemical formula for the preservative fluid (Logan *et al.*, 1989) is:

Methylated spirit 64 over proof	12.5 litres
Phenol liquefied 80%	2.5 litres
Formaldehyde solution 38%	1.5 litres
Glycerine BP	3.5 litres
Total = 20 litres	

The resultant working strength of each constituent is:

Methylated spirit	55%
Glycerine	12%
Phenol	10%
Formaldehyde solution	3%

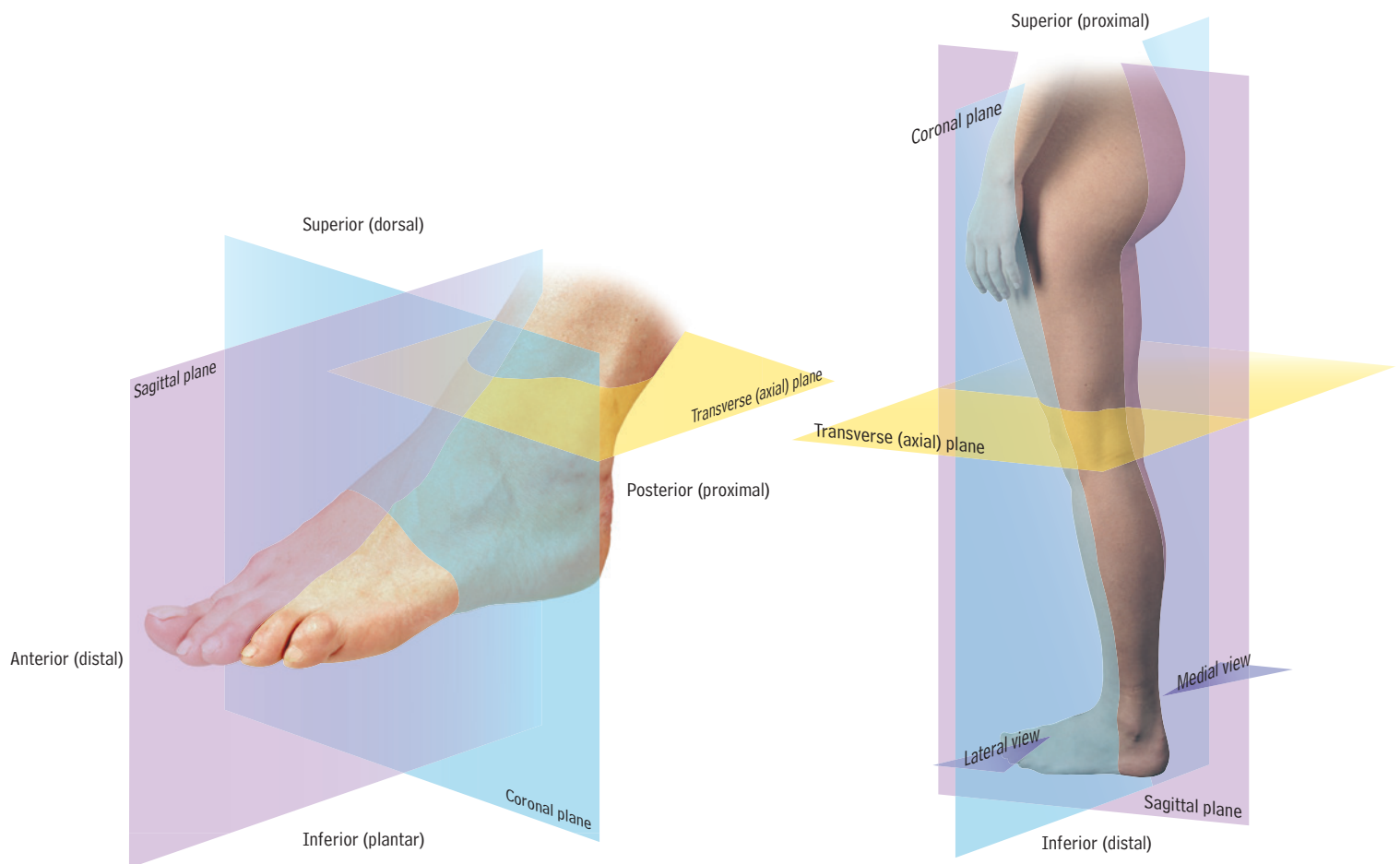
The advantages of using this particular preservative fluid are:

- (1) A state of soft preservation is achieved, benefiting dissection techniques.
- (2) The low formaldehyde solution content obviates excessive noxious fumes.
- (3) A degree of natural tissue colour is maintained, benefiting photography.
- (4) Mould growth does not occur on either whole cadavers thus preserved or their subsequent dissected (prosected) and stored parts.

SAFETY FOOTNOTE

Since the preparation of the anatomical material used in this book, there have been substantial major changes to health and safety regulations concerning the use of certain chemical constituents in preservative (embalming) fluids. It is essential, therefore, to seek official local health and safety advice and guidance if intending to adopt the above preservative fluid.

Orientation Guides



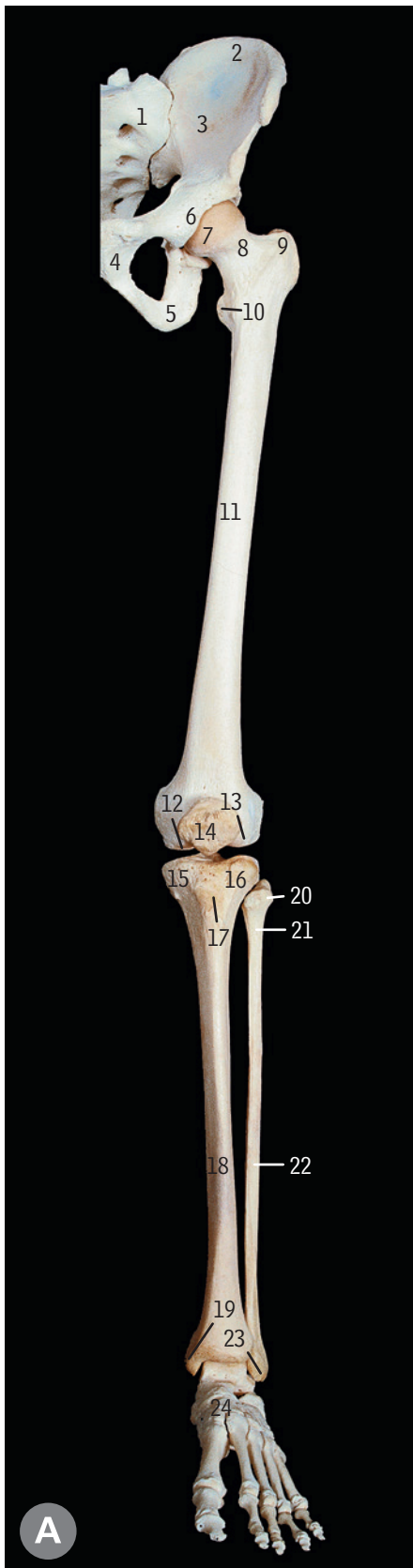
Lower limb, pelvis and hip



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Lower limb survey

Bones, muscles and surface landmarks of the left lower limb, from the front



- 1 Sacrum
- 2 Iliac crest
- 3 Ilium
- 4 Pubis
- 5 Ischium
- 6 Rim of acetabulum
- 7 Head
- 8 Neck
- 9 Greater trochanter
- 10 Lesser trochanter
- 11 Body (shaft)
- 12 Medial condyle
- 13 Lateral condyle
- 14 Patella
- 15 Medial condyle
- 16 Lateral condyle
- 17 Tuberosity
- 18 Body (shaft)
- 19 Medial malleolus
- 20 Head
- 21 Neck
- 22 Body (shaft)
- 23 Lateral malleolus
- 24 Foot
- 25 Inguinal ligament
- 26 Inguinal lymph nodes
- 27 Great saphenous vein
- 28 Femoral triangle, vessels and nerve
- 29 Tensor fasciae latae
- 30 Sartorius
- 31 Gracilis
- 32 Rectus femoris
- 33 Vastus lateralis
- 34 Vastus medialis
- 35 Quadriceps tendon
- 36 Patellar ligament
- 37 Tibialis anterior
- 38 Extensor digitorum longus
- 39 Extensor hallucis longus
- 40 Gastrocnemius
- 41 Soleus

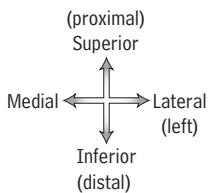
} of hip bone

} of femur

} of tibia

} of fibula

- A** Bones of the left lower limb, from the front
- B** Muscles of the left lower limb, from the front
- C** Surface landmarks of the left lower limb, from the front



- The main parts or regions of the lower limb are the gluteal region (consisting of the hip at the side and the buttock at the back), the thigh, the knee, the leg, the ankle and the foot. The term *leg* properly refers to the part between the knee and the foot, although it is commonly used for the whole lower limb.
- The hip bone consists of three bones fused together—the ilium (3), ischium (5) and pubis (4)—and forms a pelvic girdle. The two hip bones or girdles unite with each other in front at the pubic symphysis (p. 18, B33), and at the back they join the sacrum at the sacro-iliac joints (p. 18, A7 and p. 19, C6), so forming the bony pelvis.
- The femur (11) is the bone of the thigh; the tibia (18) and fibula (22) are the bones of the leg.
- The acetabulum (6) of the hip bone and the head of the femur (7) form the hip joint (p. 18, A12 and 14, B18 and 20, C18 and 20).
- The condyles of the femur (12 and 13) and tibia (15 and 16) together with the patella (14) form the knee joint.
- The head of the fibula (20) forms a small joint with the tibia, the superior tibiofibular joint. The inferior tibiofibular joint, properly called the tibiofibular syndesmosis (a type of fibrous joint), is a fibrous union between the tibia and fibula just above the ankle joint.
- The ankle is the lower part of the leg in the region of the ankle joint (pp. 60, 62, 64 and 66).
- The lower ends of the tibia (18) and fibula (22) articulate with the talus of the foot to form the ankle joint (pp. 60 and 62).
- The body of a long bone is commonly called the shaft.
- The adjective 'peroneal' (Greek, see p. 49) is now replaced by the Latin 'fibular' for various vessels and nerves, e.g., common fibular nerve instead of common peroneal nerve. See notes on New Terminology on p. xiii.

- For details of limb muscles, nerves and arteries, see the Appendix:

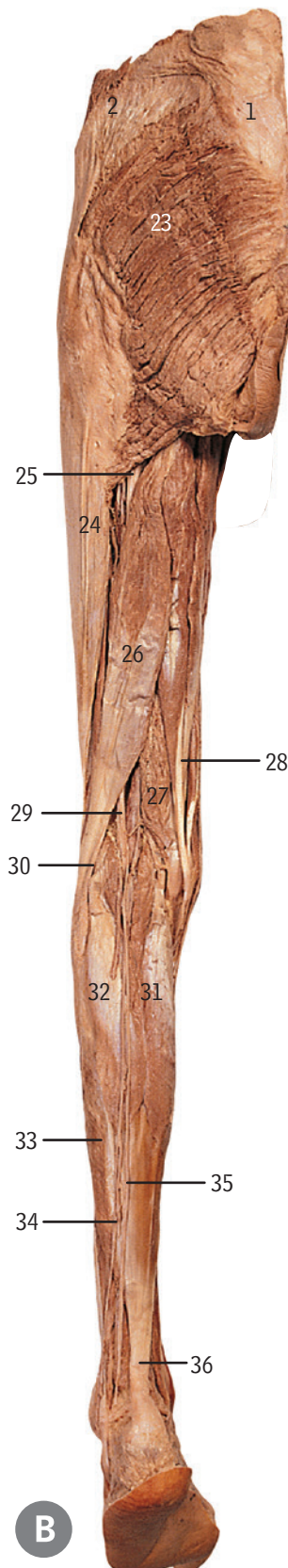
Muscles—pp. 116–121, including Figs 2–7.

Nerves—pp. 122–123, including Figs 8 and 9.

Arteries—pp. 136 and 137, including Figs 27 and 28.

Lower limb survey

Bones, muscles and surface landmarks of the left lower limb, from behind



- 1 Sacrum
- 2 Iliac crest
- 3 Ilium
- 4 Pubis
- 5 Ischium
- 6 Rim of acetabulum
- 7 Head
- 8 Neck
- 9 Greater trochanter
- 10 Lesser trochanter
- 11 Body
- 12 Lateral condyle
- 13 Medial condyle
- 14 Lateral condyle
- 15 Medial condyle
- 16 Body
- 17 Medial malleolus
- 18 Head
- 19 Neck
- 20 Body
- 21 Lateral malleolus
- 22 Foot
- 23 Gluteus maximus
- 24 Iliotibial tract
- 25 Sciatic nerve
- 26 Biceps femoris
- 27 Semimembranosus
- 28 Semitendinosus
- 29 Tibial nerve
- 30 Common fibular (*peroneal*) nerve
- 31 Medial head
- 32 Lateral head
- 33 Soleus
- 34 Sural nerve
- 35 Small saphenous vein
- 36 Tendo calcaneus
- 37 Fold of buttock (gluteal fold)
- 38 Hamstring muscles
- 39 Popliteal fossa

} of femur

} of tibia

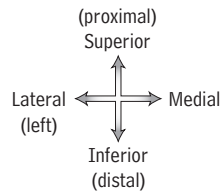
} of fibula

- The curved fold of the buttock (37) does not correspond to the straight (but oblique) lower border of gluteus maximus (23).
- The tendons of gastrocnemius (31 and 32) and soleus (33) join to form the tendo calcaneus (36), known commonly as the Achilles' tendon.
- The muscles on the back of the thigh with prominent tendons—semimembranosus (27), semitendinosus (28) and biceps femoris (long head, 26)—are known commonly as the hamstrings (see the note on p. 29).

A Bones of the left lower limb, from behind

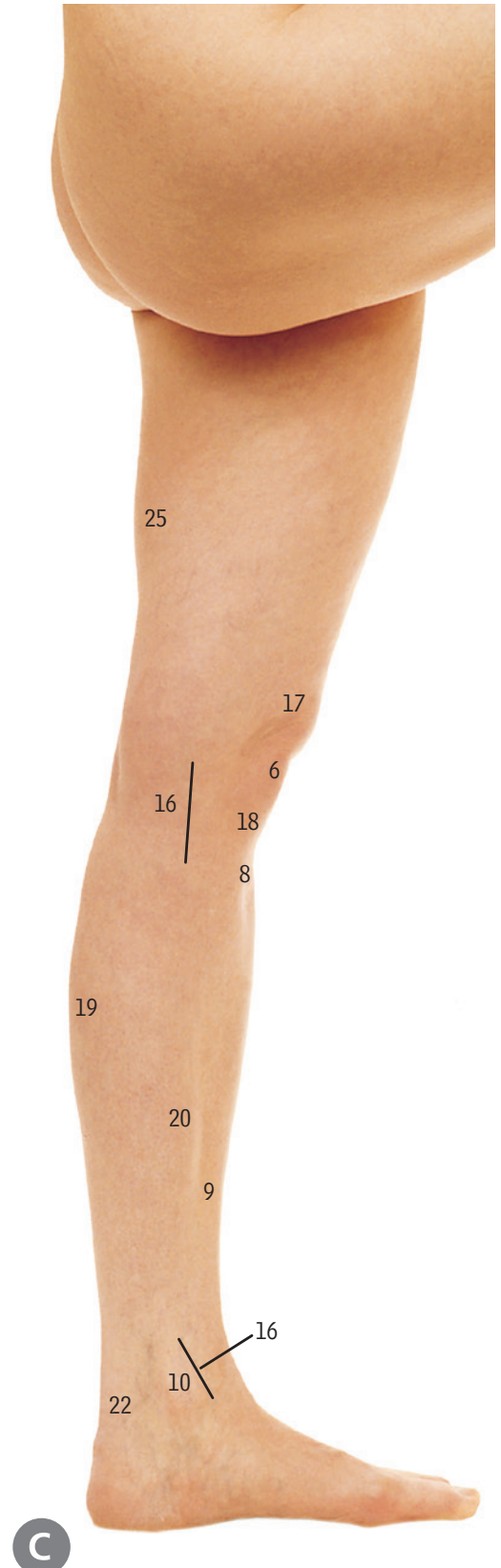
B Muscles of the left lower limb, from behind

C Surface landmarks of the left lower limb, from behind

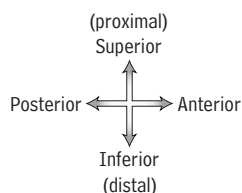


Lower limb survey

Bones, muscles and surface landmarks of the left lower limb, from the medial side



- 1 Sacrum
- 2 Hip bone
- 3 Body
- 4 Medial epicondyle
- 5 Medial condyle
- 6 Patella
- 7 Medial condyle
- 8 Tuberosity
- 9 Body
- 10 Medial malleolus
- 11 Foot
- 12 Semitendinosus
- 13 Semimembranosus
- 14 Gracilis
- 15 Sartorius
- 16 Great saphenous vein
- 17 Vastus medialis
- 18 Patellar ligament
- 19 Gastrocnemius
- 20 Soleus
- 21 Saphenous nerve
- 22 Tendo calcaneus
- 23 Tibialis posterior
- 24 Flexor digitorum longus
- 25 Hamstrings

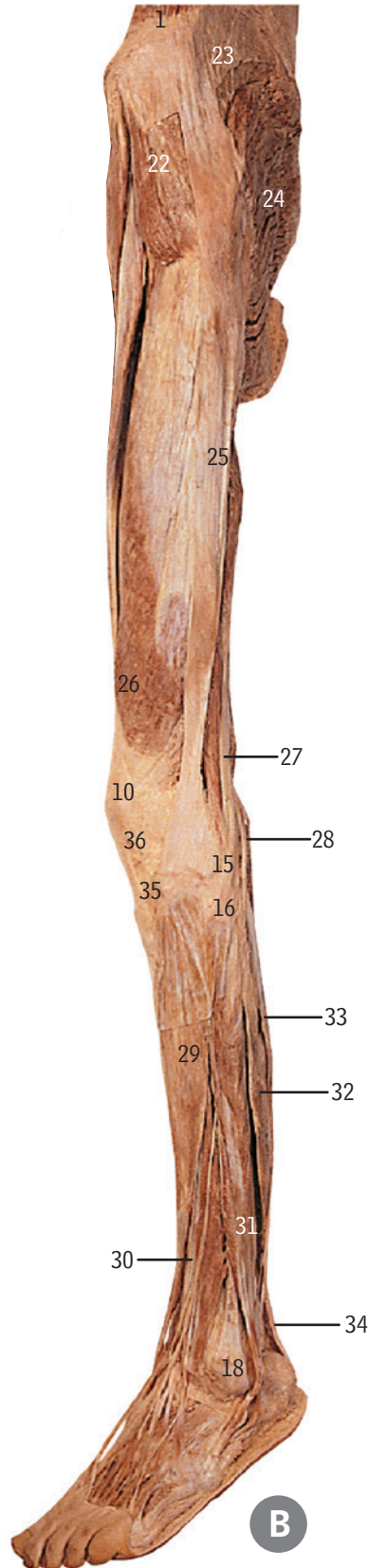


- At the ankle the great saphenous vein (16), the longest vein in the body, passes upwards in front of the medial malleolus (10). At the knee it lies a hand's breadth behind the medial border of the patella (6). It ends by draining into the femoral vein (p. 24, 12 and 18).

- A** Bones of the left lower limb, from the medial side
- B** Muscles of the left lower limb, from the medial side
- C** Surface landmarks of the left lower limb, from the medial side

Lower limb survey

Bones, muscles and surface landmarks of the left lower limb, from the lateral side



- 1 Iliac crest
- 2 Sacrum
- 3 Hip bone
- 4 Hip joint
- 5 Head
- 6 Greater trochanter
- 7 Body
- 8 Lateral epicondyle
- 9 Lateral condyle
- 10 Patella
- 11 Knee joint
- 12 Superior tibiofibular joint
- 13 Lateral condyle
- 14 Body
- 15 Head
- 16 Neck
- 17 Body
- 18 Lateral malleolus
- 19 Inferior tibiofibular joint
- 20 Ankle joint
- 21 Foot
- 22 Tensor fasciae latae
- 23 Gluteus medius
- 24 Gluteus maximus
- 25 Iliotibial tract
- 26 Vastus lateralis
- 27 Biceps femoris
- 28 Common fibular (*peroneal*) nerve
- 29 Tibialis anterior
- 30 Extensor digitorum longus
- 31 Fibularis (*peroneus*) longus
- 32 Soleus
- 33 Gastrocnemius
- 34 Tendo calcaneus
- 35 Tibial tuberosity
- 36 Patellar ligament

} of femur

} of tibia

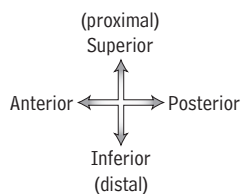
} of fibula

- The common fibular (*peroneal*) nerve (28), the only *palpable* major nerve of the lower limb, can be felt as it passes downward and forward across the neck of the fibula (16).

A Bones of the left lower limb, from the lateral side

B Muscles of the left lower limb, from the lateral side

C Surface landmarks of the left lower limb, from the lateral side



Male pelvic viscera and vessels

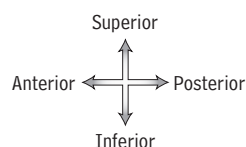
Seen on the right side in a sagittal section, after removal of most of the peritoneum (serous membrane)



The section is mostly in the midline; small bowel, large bowel and peritoneum (serous membrane) have been removed but the whole of the anal canal and the lower part of the left levator ani muscle have been preserved to show the external anal sphincter (as in the female section, [p. 12](#)).

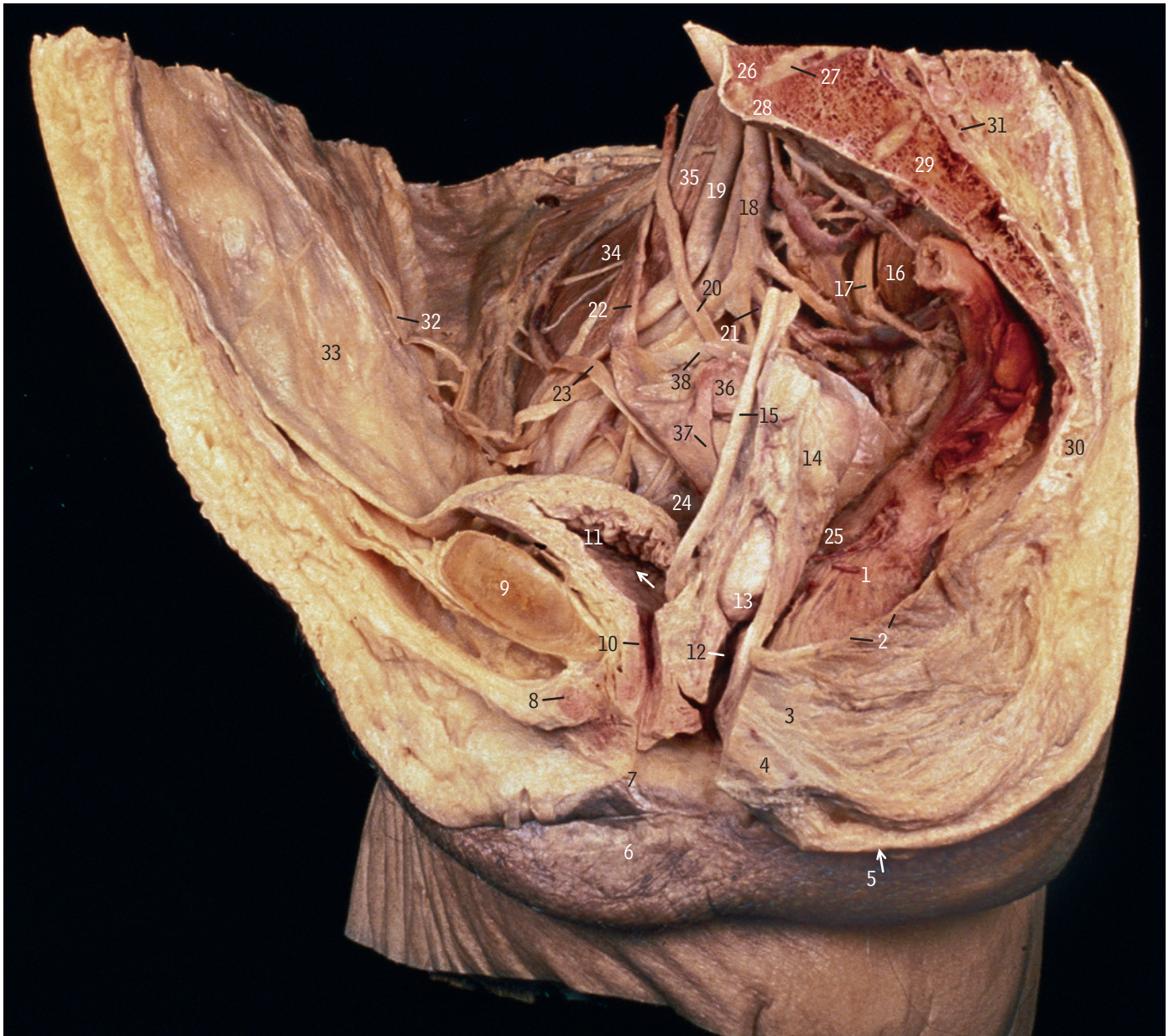
- | | |
|---|--|
| <p>1 Rectum
 2 Cut edge of levator ani
 3 External anal sphincter covering anal canal
 4 Anus, above arrowhead
 5 Perineal body
 6 Bulbospongiosus overlying corpus spongiosum
 7 Corpus spongiosum, the part of the penis containing the urethra
 8 Spongy part of urethra, within the corpus spongiosum
 9 Corpus cavernosum of penis
 10 Deep dorsal vein of penis, draining back to the vesicoprostatic venous plexus, the sponge-like tissue sectioned here in front of the prostate
 11 Pubic symphysis
 12 Superior vesical artery
 13 Corpus cavernosum of penis
 14 Prostate and prostatic part of urethra
 15 Left seminal vesicle, cut in section
 16 Bladder, with urethral openings marked with arrows</p> | <p>17 Left ureter
 18 Left ductus (vas) deferens
 19 Right ductus (vas) deferens
 20 Inferior epigastric vessels
 21 External iliac artery
 22 External iliac vein
 23 Internal iliac artery
 24 Internal iliac vein
 25 Ureter
 26 Body of fifth lumbar vertebra
 27 Fifth lumbar intervertebral disc
 28 Promontory of sacrum
 29 Sacrum
 30 Coccyx
 31 Cauda equina within sacral canal
 32 Posterior wall of rectus sheath
 33 Rectus abdominis
 34 Rectovesical pouch</p> |
|---|--|

- The ureters (**17, 25**) conduct urine from the kidneys to the bladder (**16**) where it is stored until sensation of volume dictates expulsion via the single tube of the urethra (**8**), the extent of its full length seen here laying within the bisected shaft of the penis (**7**).
- The single prostate gland (**14**) and the paired seminal vesicles (**15, left**) are accessory secretory sex glands, which produce most of the volume of seminal fluid.
- The prostate gland (**14**), normally the size of a chestnut, lies just below the bladder (**16**) and opens into the urethra (**8**); the seminal vesicles (**15, left**) open into the ductus (vas) deferens (**18, 19**), which conduct sperm from the epididymis of each testis to the urethra (**8**) on ejaculation.
- The rectum (**1**) is the terminal part of the large intestine (colon) where faeces collect prior to defecation via the anus (**4**), the opening and closing of which is controlled by the muscles that form the external sphincter (**3**). The space between the rectum (**1**), prostate gland (**14**) and seminal vesicles (**15, left**) is known as the rectovesical pouch (**34**).



Female pelvic viscera and vessels

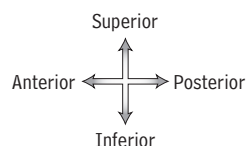
Seen on the right side in a sagittal section, after removal of most of the peritoneum (serous membrane)



The section is mostly in the midline; small bowel, large bowel and much of the peritoneum (serous membrane) have been removed but the whole of the anal canal and the lower part of the left levator ani muscle have been preserved to show the external anal sphincter (as in the male section, p. 10).

- | | |
|--|---|
| <p>1 Rectum
2 Cut edge of left levator ani
3 External anal sphincter covering anal canal
4 Perineal body (central perineal tendon)
5 Anus, above arrowhead
6 Labium majus
7 Labium minus
8 Clitoris
9 Pubic symphysis
10 Urethra, surrounded by sphincter urethrae
11 Bladder, arrow points to right ureter
12 Vagina
13 Cervix of uterus
14 Body of uterus
15 Left ureter
16 Piriformis
17 Anterior ramus of S1 nerve
18 External iliac vein
19 External iliac artery</p> | <p>20 Right ureter
21 Internal iliac vessels and branches
22 Ovarian vessels
23 Round ligament of uterus
24 Vesico-uterine pouch
25 Recto-uterine pouch (of Douglas)
26 Body of fifth lumbar vertebra
27 Fifth lumbar intervertebral disc
28 Promontory of sacrum
29 Sacrum
30 Coccyx
31 Sacral canal
32 Inferior epigastric vessels
33 Peritoneum overlying rectus abdominis [see 32–33, p. 10]
34 Iliacus
35 Psoas major
36 Right ovary
37 Right uterine (fallopian tube)
38 Right broad ligament</p> |
|--|---|

- The vagina (12) is the lower part of the female reproductive tract and lies in a central position between, anteriorly, the bladder (11) and, posteriorly, the rectum (1); superiorly, it connects the lower end of the uterus (the cervix) (13) with, inferiorly, the margin of the vaginal orifice and the labium majus (6) and labium minus (7).
- The urethra (10) in the female is much shorter in length, being only 4 cm, compared to that in the male, usually 18 cm; from the bladder it opens into the vaginal vestibule a few centimetres behind the clitoris (8). The space between the bladder (11) and the uterus (14) is known as the vesico-uterine pouch (24) and between the uterus (14) and the rectum (1) the recto-uterine pouch (of Douglas) (25).
- The body of the uterus (14) is pear shaped and normally lies over the bladder (11); from its sides the broad ligament (38, right) extends to the lateral walls of the pelvis. These help to keep the uterus in a central position.
- The ovaries (36, right) are suspended by part of the broad ligament (mesovarium) close to the lateral walls of the pelvis and are the main female reproductive organs; they produce cyclic steroid hormones as well as ovum (egg cells). The open ends of the uterine (fallopian) tubes (37, right) are positioned close to the ovaries, thus enabling discharged ova to freely enter them.

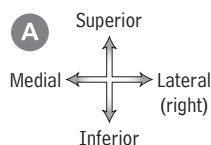


Gluteal region *Sciatic nerve and other gluteal structures of the right side*

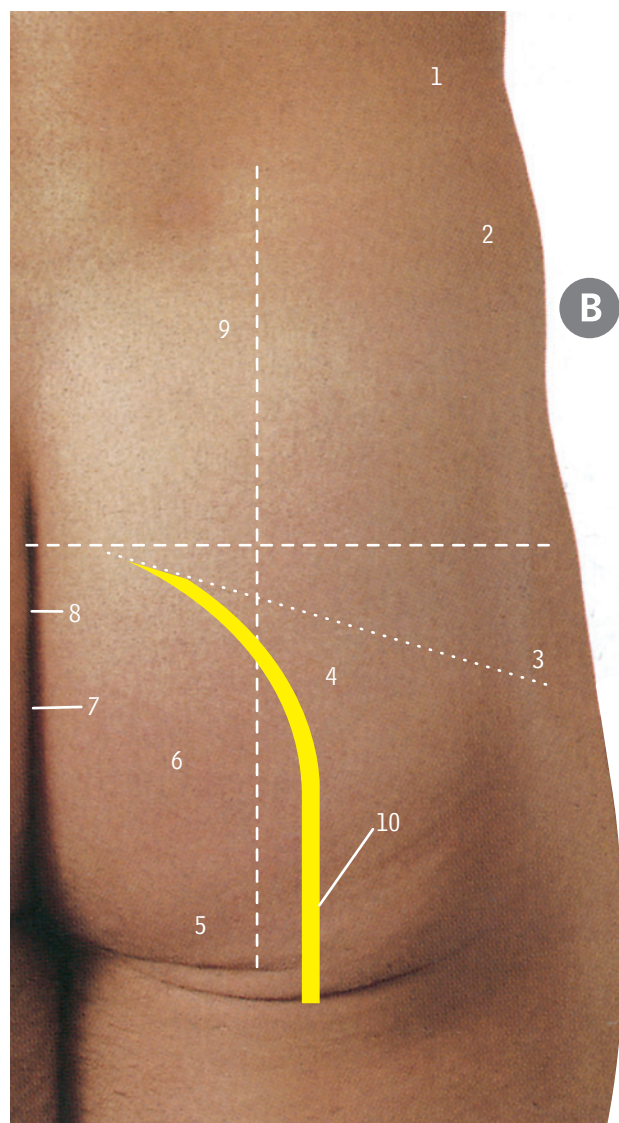


Most of gluteus maximus (1) has been removed (as have the veins that accompany arteries) to show the underlying structures, the most important of which is the sciatic nerve (14 and 15). The key to the region is the piriformis muscle (2): the superior gluteal artery (3) and nerve (4) emerge from the pelvis above piriformis, while all other structures leave the pelvis below piriformis. Apart from the sciatic nerve (14 and 15), these include the inferior gluteal nerve (6) and artery (22) and the posterior femoral cutaneous nerve (16).

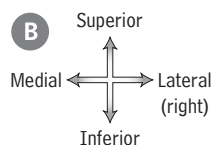
- 1 Gluteus maximus
- 2 Piriformis
- 3 Superior gluteal artery
- 4 Superior gluteal nerve
- 5 Gluteus medius
- 6 Inferior gluteal nerve
- 7 Gluteus minimus
- 8 Greater trochanter of femur
- 9 Gemellus superior
- 10 Obturator internus
- 11 Gemellus inferior
- 12 Obturator externus
- 13 Quadratus femoris
- 14 Common fibular (peroneal) } part of sciatic nerve
- 15 Tibial }
- 16 Posterior femoral cutaneous nerve
- 17 Ischial tuberosity
- 18 Sacrotuberous ligament
- 19 Nerve to obturator internus
- 20 Internal pudendal artery
- 21 Pudendal nerve
- 22 Inferior gluteal artery



Gluteal region *Surface features of the right gluteal region*



- 1 Iliac crest
- 2 Gluteus medius
- 3 Greater trochanter of femur
- 4 Gluteus maximus
- 5 Fold of buttock
- 6 Ischial tuberosity
- 7 Tip of coccyx
- 8 Natal cleft
- 9 Posterior superior iliac spine
- 10 Sciatic nerve



The interrupted lines divide the gluteal region into four quadrants. The surface marking of the lower border of piriformis (the dotted line) is on a line drawn from the midpoint between the posterior superior iliac spine (9) and the coccyx (7) to the top of the greater trochanter of the femur (3). From the midpoint of this line, a curved line (convex laterally) to midway between the ischial tuberosity (6) and the greater trochanter (3) indicates the course of the upper part of the sciatic nerve, indicated here in yellow.

- The superior gluteal nerve runs between gluteus medius and minimus and ends in tensor fasciae latae, supplying all three muscles.
- The inferior gluteal nerve passes straight back into gluteus maximus, supplying that muscle only.
- In the gluteal region the sciatic nerve is a flattened band about 1 cm broad. Its two parts (A14 and 15) are usually closely bound together in the gluteal region and the back of the thigh (p. 27, B10). In the popliteal fossa at the back of the knee (p. 32, A) they separate into the common fibular (*peroneal*) nerve, which supplies the front of the leg and dorsum of the foot, and the tibial nerve, which supplies the back of the leg and sole of the foot.

Gluteal region

Left gluteal region and ischio-anal region, with gluteus maximus and gluteus medius cut through and portions reflected laterally



- | | | |
|---|---|--|
| 1 Posterior layer of lumbar fascia overlying erector spinae | 13 Quadratus femoris | 24 Tibial part of sciatic nerve |
| 2 Sacrum | 14 Vastus lateralis | 25 Posterior femoral cutaneous nerve |
| 3 Coccyx | 15 Iliotibial tract | 26 Internal pudendal artery |
| 4 Gluteus maximus | 16 Upper part of adductor magnus (adductor minimus) | 27 Pudendal nerve |
| 5 Gluteus medius | 17 Biceps femoris (long head) | 28 Levator ani |
| 6 Gluteus minimus | 18 Semitendinosus | 29 External anal sphincter |
| 7 Piriformis | 19 Adductor magnus | 30 Anal margin |
| 8 Gemellus superior | 20 Gracilis | 31 Anococcygeal body |
| 9 Obturator internus | 21 Ischial tuberosity | 32 Superior gluteal artery, vein and nerve |
| 10 Gemellus inferior | 22 Sacrotuberous ligament | 33 Inferior gluteal artery, vein and nerve |
| 11 Greater trochanter of femur | 23 Common fibular (peroneal) part of sciatic nerve | 34 Pudendal canal (arrowed) |
| 12 Obturator externus | | 35 Inferior rectal artery, vein and nerve |

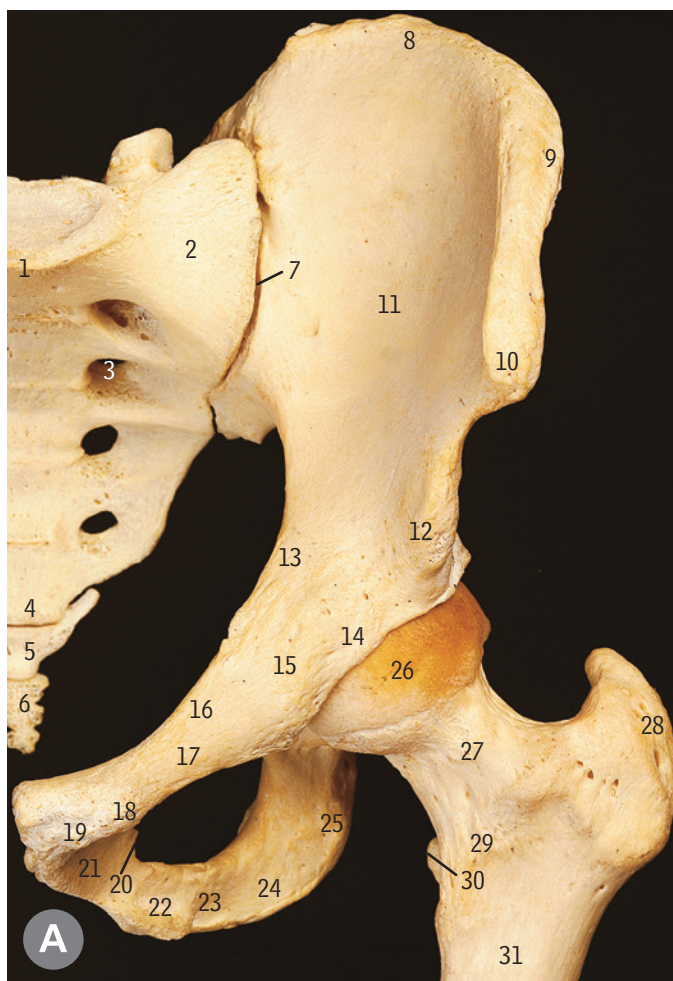
Gluteal region

Right gluteal region and ischio-anal region, with most of gluteus maximus removed



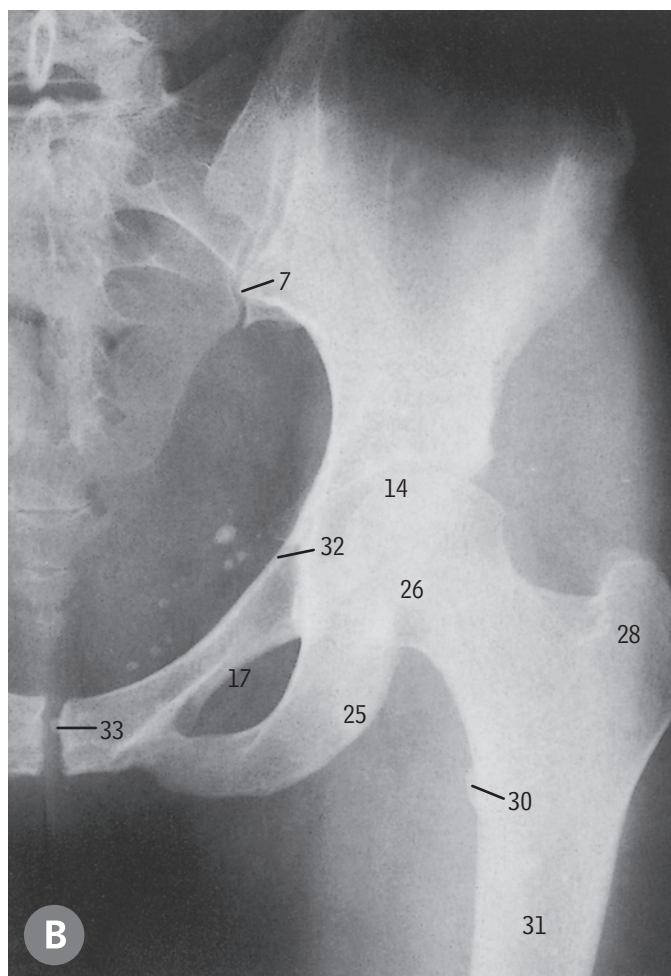
- | | | |
|--|--|--|
| 1 Posterior layer of lumbar fascia overlying erector spinae | 13 Quadratus femoris | 23 Common fibular (<i>peroneal</i>) part of sciatic nerve |
| 2 Sacrum | 14 Vastus lateralis | 24 Tibial part of sciatic nerve |
| 3 Coccyx | 15 Iliotibial tract | 25 Posterior femoral cutaneous nerve |
| 4 Gluteus maximus | 16 Upper part of adductor magnus (adductor minimus) | 26 Internal pudendal artery |
| 5 Gluteus medius | 17 Biceps femoris (long head) | 27 Pudendal nerve |
| 6 Gluteus minimus | 18 Semitendinosus | 28 Levator ani |
| 7 Piriformis | 19 Adductor magnus | 29 External anal sphincter |
| 8 Gemellus superior | 20 Gracilis | 30 Anal margin |
| 9 Obturator internus | 21 Ischial tuberosity | 31 Anococcygeal body |
| 10 Gemellus inferior | 22 Sacrotuberous ligament cut and turned down | 32 Inferior rectal artery, vein and nerve |
| 11 Greater trochanter of femur | | |
| 12 Obturator externus | | |

Hip joint *Left hip bone and femur, with sacrum and coccyx*



A Left hip bone and femur, with sacrum and coccyx, from the front

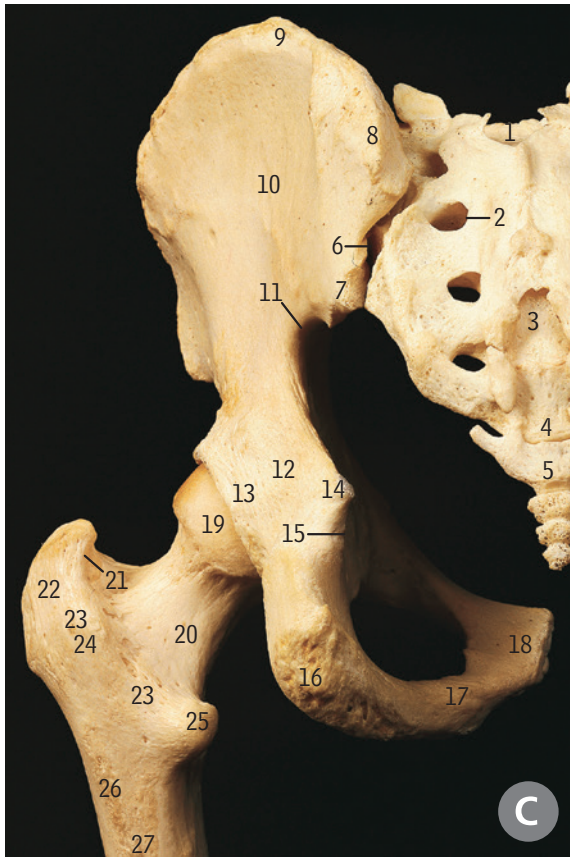
- 1 Sacral promontory
- 2 Ala of sacrum
- 3 Second anterior sacral foramen, for anterior ramus of S2 nerve
- 4 Apex of sacrum
- 5 First coccygeal vertebra, with transverse process
- 6 Fused coccygeal vertebrae
- 7 Sacroiliac joint
- 8 Iliac crest, palpable throughout its whole length, and a possible site (like the sternum) for bone marrow biopsy
- 9 Tubercle of iliac crest
- 10 Anterior superior iliac spine, for inguinal ligament and sartorius
- 11 Iliac fossa, a term also applied to the lower lateral region of the anterior abdominal wall
- 12 Anterior inferior iliac spine, for part of rectus femoris
- 13 Arcuate line of ilium, forming part of the pelvic brim
- 14 Rim of acetabulum, the socket for the head of the femur (26)
- 15 Iliopubic eminence, site of union between ilium and superior ramus of the pubis (17)
- 16 Pectineal line (pecten) of pubis
- 17 Superior ramus of pubis



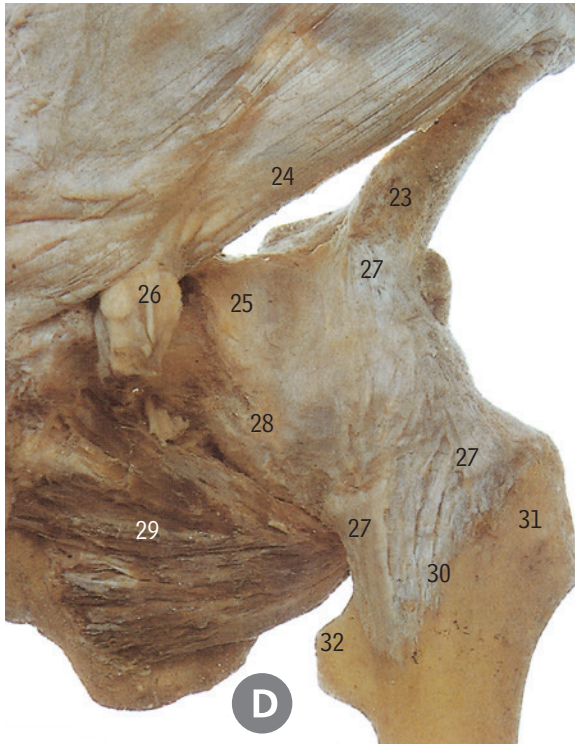
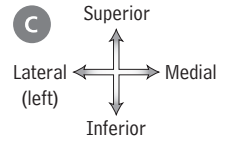
B Radiograph. (The translucent areas are gas shadows in the large intestine.)

- 18 Pubic tubercle, a palpable landmark
- 19 Pubic crest, for rectus abdominis
- 20 Obturator foramen
- 21 Body of pubis
- 22 Inferior ramus of pubis
- 23 Site of union of pubic and ischial rami (22 and 24)
- 24 Ramus of ischium
- 25 Ischial tuberosity, best seen from behind (C16)
- 26 Head of femur
- 27 Neck, the part of the femur most commonly fractured
- 28 Greater trochanter. Gluteus medius and minimus are attached to its front and lateral side
- 29 Intertrochanteric line, for the capsule of the hip joint and not to be confused with the intertrochanteric crest on the back of the bone (C23)
- 30 Tip of lesser trochanter, best seen from behind (C25)
- 31 Shaft of femur
- 32 Ischial spine
- 33 Pubic symphysis

C Left hip bone and femur, with sacrum and coccyx, from behind

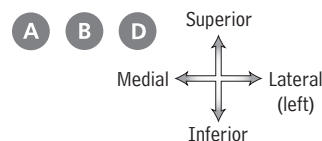


- 1 Sacral canal
- 2 Second posterior sacral foramen, for posterior ramus of S2 nerve
- 3 Sacral hiatus, the lower opening of the sacral canal and here unusually high
- 4 Apex of sacrum
- 5 First coccygeal vertebra, with below it the fused second to fourth coccygeal vertebrae
- 6 Sacroiliac joint
- 7 Posterior inferior iliac spine
- 8 Posterior superior iliac spine
- 9 Iliac crest
- 10 Ilium, outer surface
- 11 Greater sciatic notch
- 12 Site of fusion of ilium and ischium
- 13 Rim of acetabulum, the socket which receives the head of the femur (19)
- 14 Ischial spine, separating the greater and lesser sciatic notches (11 and 15)
- 15 Lesser sciatic notch
- 16 Ischial tuberosity, which bears the weight when sitting
- 17 Ramus of ischium joining inferior ramus of pubis
- 18 Body of pubis
- 19 Head of femur, making the hip joint with the acetabulum of the hip bone (13)
- 20 Neck, labeled along the site of attachment of the capsule of the hip joint, which does not extend as far as the intertrochanteric crest (23)
- 21 Trochanteric fossa for obturator externus
- 22 Greater tuberosity whose curved upper margin receives piriformis and obturator internus
- 23 Intertrochanteric crest
- 24 Quadrate tubercle, for quadratus femoris
- 25 Lesser trochanter, for psoas major with fibers from iliacus just below it
- 26 Gluteal tuberosity, receiving part of the attachment of gluteus maximus (the rest is attached to the fascia lata, the deep fascia of the thigh)
- 27 Shaft of femur



D Left hip joint capsule (male), from the front, with all surrounding muscles removed except for obturator externus

- 23 Anterior inferior iliac spine
- 24 Inguinal ligament
- 25 Iliopubic eminence
- 26 Spermatic cord
- 27 Iliofemoral ligament, like an inverted V, reinforcing and blending with the front of the capsule
- 28 Pubofemoral ligament, reinforcing and blending with the more medial part of the capsule
- 29 Obturator externus
- 30 Intertrochanteric line
- 31 Greater trochanter
- 32 Lesser trochanter

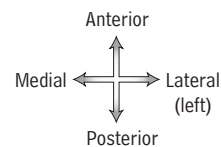


Hip joint

Axial section through the left hip joint at the level of the last, fifth segment of the sacrum, from below

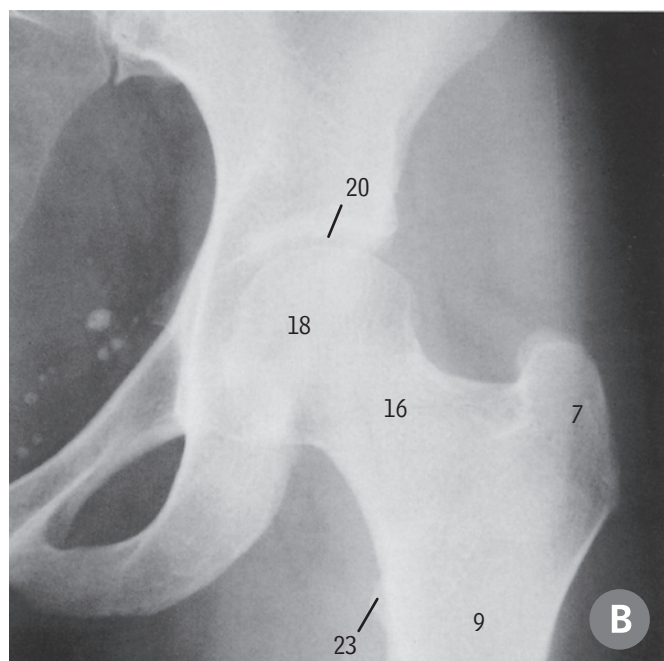


- 1 Sartorius
- 2 Tensor fasciae latae
- 3 Rectus femoris
- 4 Iliacus
- 5 Femoral nerve
- 6 Psoas major
- 7 Pectineus
- 8 Femoral vein
- 9 Femoral artery
- 10 Spermatic cord
- 11 Vas deferens
- 12 Acetabulum (pubic portion)
- 13 Ligamentum teres
- 14 Femoral head
- 15 Obturator internus
- 16 Ischium
- 17 Ischial spine
- 18 Gemellus superior
- 19 Obturator internus tendon
- 20 Greater trochanter
- 21 Gluteus minimus
- 22 Gluteus medius
- 23 Gluteus maximus
- 24 Trochanteric bursa
- 25 Sacrum fifth segment
- 26 Rectum
- 27 Seminal vesicle
- 28 Bladder
- 29 Rectus abdominis
- 30 Linea alba
- 31 Sciatic nerve
- 32 Inferior gluteal artery and vein
- 33 Pudendal nerve and internal pudendal artery and vein



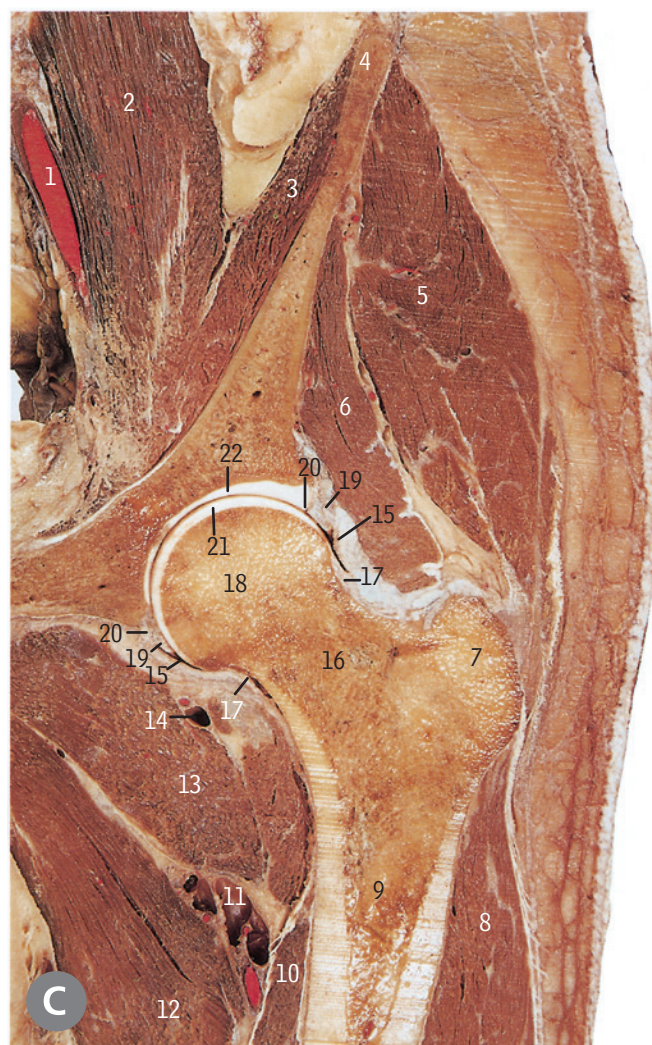
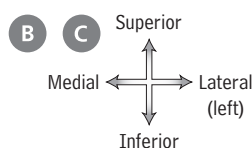
Muscles producing movements at the hip joint consist of the following:

- **Flexion** (moving the thigh forward and upward toward the abdomen): psoas and iliacus, with rectus femoris, sartorius, tensor fasciae latae, pectineus, adductor longus and adductor brevis.
- **Extension** (moving the thigh backward): gluteus maximus, semimembranosus, semitendinosus, long head of biceps and ischial part of adductor magnus.
- **Abduction** (moving the thigh laterally away from the midline): gluteus medius, gluteus minimus, with tensor fasciae latae and piriformis.
- **Adduction** (moving the thigh medially toward the midline): adductor longus, adductor brevis, adductor magnus, pectineus, gracilis and quadratus femoris.
- **Medial rotation** (rotating the thigh inward in the long axis of the limb): anterior fibres of gluteus medius and gluteus minimus, with tensor fasciae latae. (Electromyography does not support the long-held view that psoas major is a medial rotator.)
- **Lateral rotation** (rotating the thigh outward in the long axis of the limb): obturator externus, obturator internus and gemelli, piriformis, quadratus femoris, gluteus maximus and sartorius.
- The coronal section of the joint in C demonstrates the thickness of the capsule (C15) but does not of course show the ligaments that reinforce the outside of the capsule (iliofemoral at the front, and pubofemoral and ischiofemoral below and behind).



B Radiograph

- 1 External iliac artery
- 2 Psoas major
- 3 Iliacus
- 4 Iliac crest
- 5 Gluteus medius
- 6 Gluteus minimus
- 7 Greater trochanter of femur
- 8 Vastus lateralis
- 9 Shaft of femur
- 10 Vastus medialis
- 11 Profunda femoris vessels
- 12 Adductor longus
- 13 Pectineus
- 14 Medial circumflex femoral vessels
- 15 Capsule of hip joint
- 16 Neck of femur
- 17 Zona orbicularis of capsule
- 18 Head of femur
- 19 Acetabular labrum
- 20 Rim of acetabulum
- 21 Hyaline cartilage of head of femur
- 22 Hyaline cartilage of acetabulum
- 23 Lesser trochanter of femur



C Coronal section of the left hip joint, from the front

The head of the femur (18) sits in the hip bone's acetabulum (20), which is deepened at the periphery by the fibrous acetabular labrum (19). Note the hyaline cartilage on the joint surfaces (21 and 22), and the capsule (15) whose circular fibers (zona orbicularis, 17) keep it close to the neck of the femur (16). Gluteus medius (5) and gluteus minimus (6) converge on to the greater trochanter (7), and below the head and neck of the femur (18 and 16), the tendon of psoas major (2) and some muscle fibres of iliacus (3) are passing backward to reach the lesser trochanter on the back of the bone. Compare major features in the section with the radiograph.

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Thigh, knee and leg

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Thigh

Front of the right thigh (female), superficial structures of the femoral triangle



- 1 Patella
- 2 Tendon of quadriceps femoris
- 3 Vastus medialis
- 4 Rectus femoris
- 5 Vastus lateralis
- 6 Sartorius
- 7 Gracilis
- 8 Great saphenous vein
- 9 Adductor longus
- 10 Adductor brevis
- 11 Pectineus
- 12 Femoral vein
- 13 Femoral artery
- 14 Femoral canal (arrowed)
- 15 Femoral nerve
- 16 Iliacus
- 17 Tensor fascia latae
- 18 Iliotibial tract
- 19 Anterior superior iliac spine
- 20 Position of inguinal ligament
- 21 External oblique aponeurosis

The inguinal ligament (20):

- Attaches (like a bow string) taut between the anterior superior iliac spine (superolaterally) and the pubic tubercle (inferomedially) of that side of the pelvis
- Has an adult length between 12–14 cm
- Inclines at an angle between 35–40 degrees

The femoral triangle:

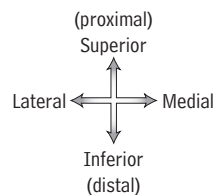
- **Boundaries** are the inguinal ligament (20), medial border of sartorius (6) and medial border of adductor longus (9)
- Is shaped like a gutter
- From lateral to medial, contains the key structures, femoral nerve (15), artery (13), vein (12) and canal (14)

The femoral canal (14):

- Opens into the peritoneal cavity via the femoral ring behind the inguinal ligament
- Is approximately 4 cm in length in adults
- Forms the most medial compartment of the femoral sheath
- Gives passage for lymphatic channels from the lower limb into the pelvis
- By providing space, allows the femoral vein to expand and thus increase venous drainage to the lower limb

The femoral pulse:

- Can be located and palpated below the inguinal ligament and midway between the anterior superior iliac spine and the pubic symphysis (p. 26 B)



Thigh

Back of the right thigh (female) and gluteal region



- 1 Common fibular (peroneal) nerve
- 2 Tibial nerve
- 3 Popliteal vein
- 4 Popliteal artery
- 5 Semitendinosus
- 6 Semimembranosus
- 7 Adductor magnus
- 8 Gracilis
- 9 Long head } of biceps femoris
- 10 Short head }
- 11 Iliotibial tract
- 12 Posterior cutaneous femoral nerve
- 13 Gluteus maximus
- 14 Position of sciatic nerve
- 15 Site for intramuscular injection (the upper outer quadrant)

Gluteal intramuscular injection

The bulky gluteus maximus muscle (13) with gluteus medius underneath is a possible site for *intramuscular injections*, but it is of course absolutely vital to choose the correct position for injection in order to avoid damaging the sciatic nerve (14).

The proper site is usually described as **the upper outer quadrant** of the gluteal region (15).

In estimating the four quadrants by vertical and horizontal lines through the midpoint of the region, it must be remembered that the most **upper** boundary of the region is the **iliac crest**, not the most prominent part of the bulge of the buttock or a suntanned bikini line, which are both far too low.

Only by choosing the properly defined quadrant can injury to the sciatic nerve be avoided. (See p. 15 for detailed description.)

The needle should enter either gluteus maximus or the adjacent part of gluteus medius.

The popliteal fossa:

- Is a diamond-shaped area at the back of the knee

Upper boundaries are:

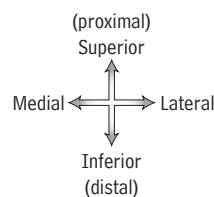
- Lateral side, biceps femoris (with common fibular (peroneal) nerve behind it)
- Medial side, semimembranosus (with tendon of semitendinosus behind it)

Lower boundaries are:

- Laterally, the lateral head of gastrocnemius and plantaris
- Medially, the medial head of gastrocnemius

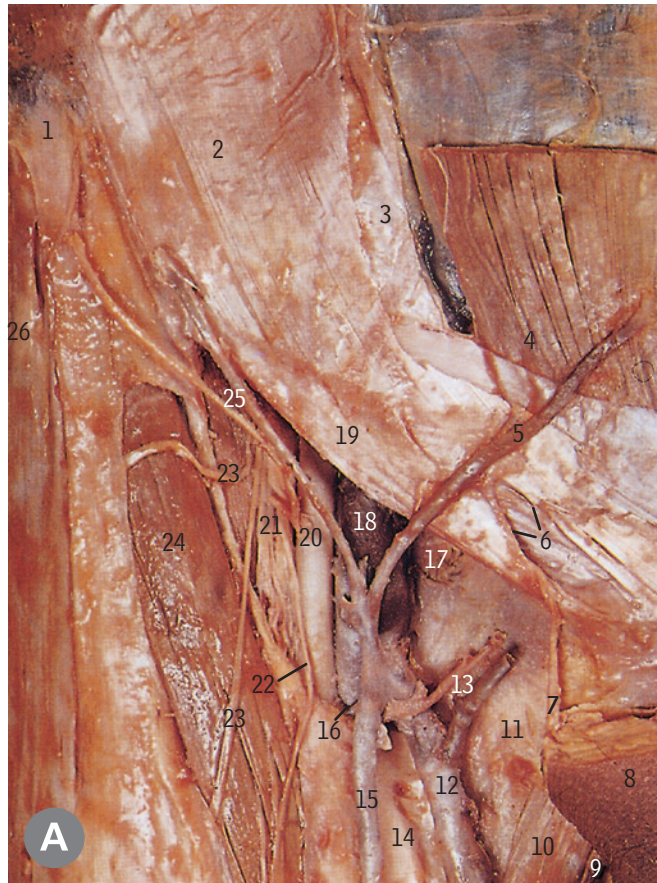
Key structures within the fossa are:

- Superficial to deep, the tibial nerve, popliteal vein and popliteal artery (See also p. 38.)



Thigh *Front of the right upper thigh (female)*

Part of the fascia lata (deep fascia of the thigh, 14) has been removed to display the femoral vessels and nerve and the adjacent muscles. The femoral nerve (21), artery (20), vein (18) and canal (17) lie in that order from lateral to medial beneath the inguinal ligament



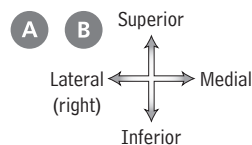
(19). The great saphenous vein (12) passes through the saphenous opening (16) in the fascia lata to enter the femoral vein (18); a number of smaller veins enter the great saphenous just before it joins the femoral.



A Inguinal and femoral regions, in the female

B Palpation of femoral pulse

- The femoral pulse can be felt midway between the anterior superior iliac spine and the midline pubic symphysis (the midinguinal point or femoral point).



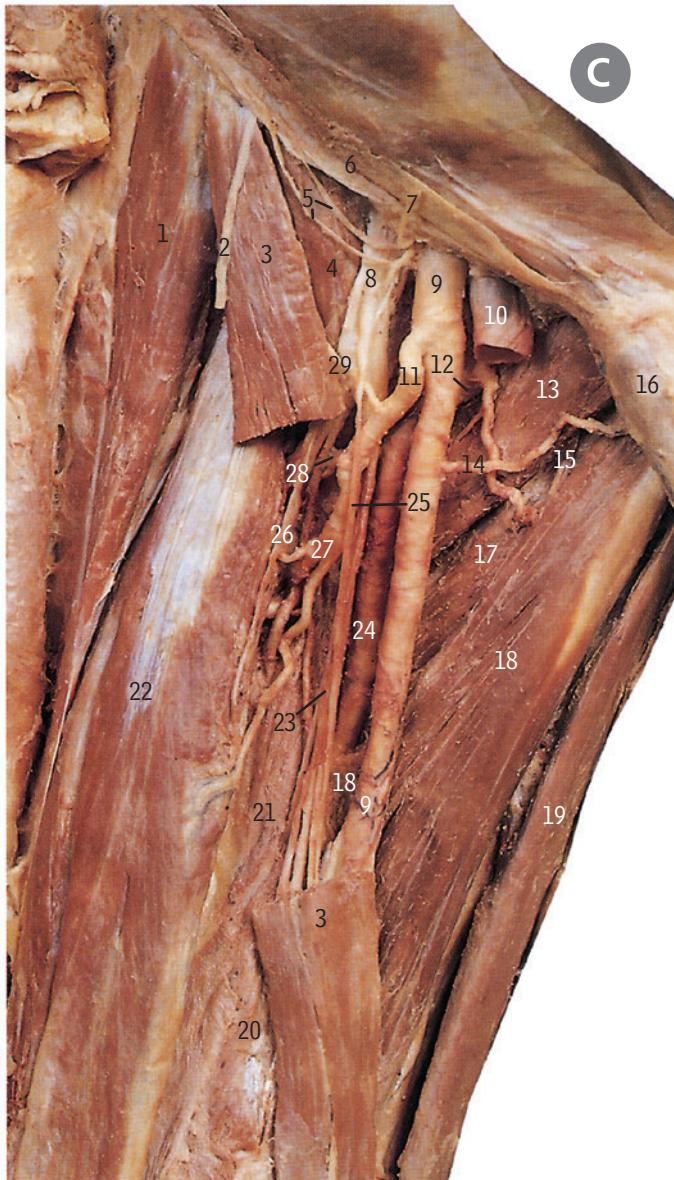
- Various superficial veins (5, 13, 15, 25) run into the great saphenous vein (12); this helps to distinguish the great saphenous from the femoral vein (18), which superficially at this level receives only the great saphenous itself. See p. 76 for further details of the great saphenous vein.
- Although arising at the *front* of the thigh, the profunda femoris artery (C24) is the main supply to muscles on the *back* of the thigh as well as those on the front.
- The adductor canal, which is triangular in cross section, is bounded in front by sartorius (24), laterally by vastus medialis, and behind by adductor longus (10) (above) and adductor magnus (below). The contents of the adductor canal are the femoral artery and vein (20 and 18), the saphenous nerve (C25) and the nerve to vastus medialis (C20).

- Anterior superior iliac spine
- External oblique aponeurosis
- Cut edge of rectus sheath
- Rectus abdominis
- Superficial epigastric vein
- Superficial inguinal ring
- Round ligament of uterus
- Mons pubis
- Gracilis
- Adductor longus
- Pectineus
- Great saphenous vein
- Superficial external pudendal vessels
- Fascia lata
- Accessory saphenous vein
- Lower edge of saphenous opening
- Position of femoral canal
- Femoral vein
- Inguinal ligament
- Femoral artery
- Femoral nerve
- Medial femoral cutaneous nerve
- Intermediate femoral cutaneous nerve
- Sartorius
- Superficial circumflex iliac vessels
- Fascia lata overlying tensor fasciae latae

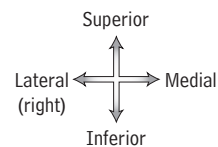
Thigh *Front of the right upper thigh (male)*

In this deeper dissection, the removal of part of sartorius (3) displays the profunda femoris artery (24). The femoral artery (9) passes in front of adductor longus (18); the profunda (24) passes behind it. Separation of the adjacent borders of pectineus (13) and adductor longus (18) allows the anterior division of the obturator nerve (15) to be seen in front of adductor brevis (17). The medial circumflex femoral artery (12) disappears backward between pectineus

(13) and the tendon of psoas (hidden behind the uppermost part of the femoral artery (upper 9). The lateral circumflex femoral artery (11, which often arises directly from the femoral artery, as here, and not from the profunda) courses laterally and supplies adjacent muscles. Branches of the femoral nerve (8) include the saphenous nerve (25), which will run as far as the medial side of the foot.



- 1 Tensor fasciae latae
- 2 Lateral femoral cutaneous nerve
- 3 Sartorius
- 4 Iliacus
- 5 Superficial circumflex iliac artery (double)
- 6 Inguinal ligament
- 7 Superficial epigastric artery
- 8 Femoral nerve
- 9 Femoral artery
- 10 Femoral vein
- 11 Lateral circumflex femoral artery
- 12 Medial circumflex femoral artery
- 13 Pectineus
- 14 Superficial external pudendal artery
- 15 Anterior branch of obturator nerve
- 16 Spermatic cord
- 17 Adductor brevis
- 18 Adductor longus
- 19 Gracilis
- 20 Vastus medialis
- 21 Vastus intermedius
- 22 Rectus femoris
- 23 Nerve to vastus medialis
- 24 Profunda femoris artery
- 25 Saphenous nerve
- 26 Nerve to rectus femoris
- 27 Descending } branch of lateral circumflex femoral
- 28 Transverse } artery
- 29 Ascending }

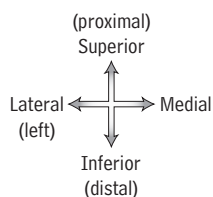


Thigh *Lower right thigh, medial side*

The lower part of sartorius (3) has been displaced medially to open up the lower part of the adductor canal and expose the femoral artery (4) passing through the opening in adductor magnus (6) to enter the popliteal fossa behind the knee and become the popliteal artery.



- 1 Gracilis
- 2 Adductor magnus
- 3 Sartorius
- 4 Femoral artery
- 5 Saphenous nerve
- 6 Opening in adductor magnus
- 7 Vastus medialis and nerve
- 8 Rectus femoris
- 9 Iliotibial tract
- 10 Quadriceps tendon
- 11 Patella
- 12 Medial patellar retinaculum
- 13 Lowest (horizontal) fibres of vastus medialis
- 14 Saphenous branch of descending genicular artery

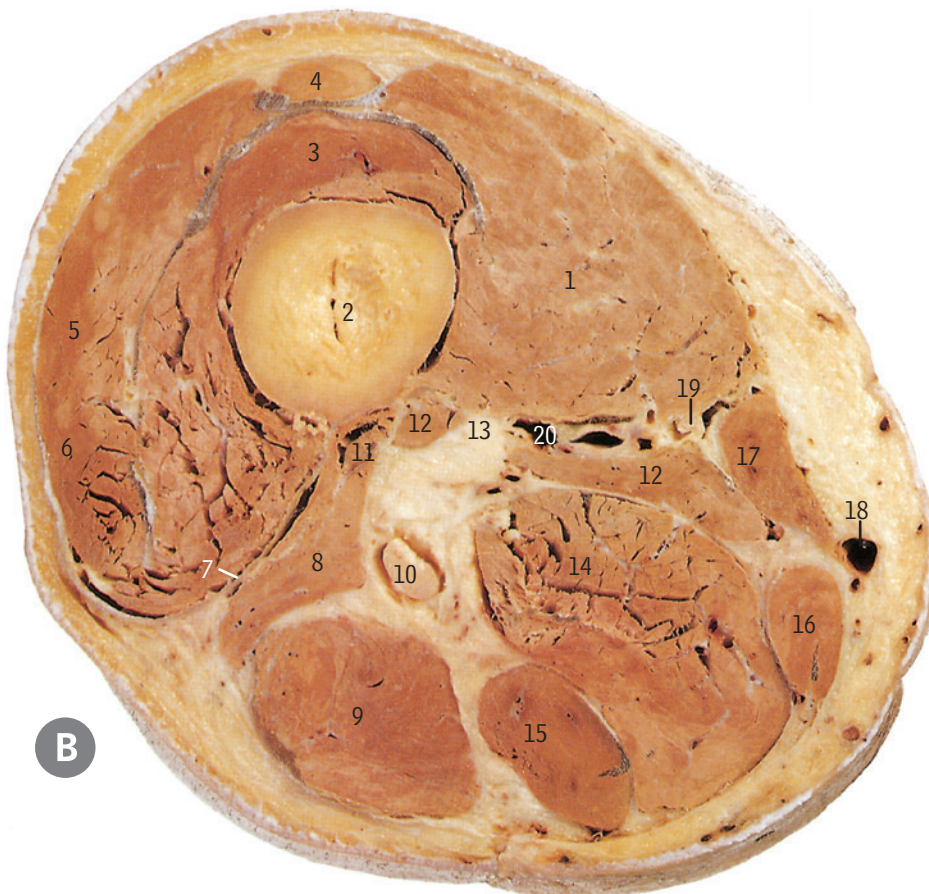


A From the front and medial side

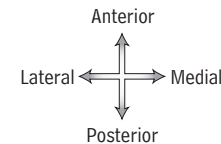
Thigh *Axial section through lower right thigh*

The section is viewed as when looking upward from knee to hip. The three vastus muscles (1, 3, 5) envelop the femur (2) at the front and sides, and rectus femoris (4) at this level is narrow and is becoming tendinous. The femoral vessels (20) are between vastus medialis (1) and adductor magnus (12), approaching the

adductor magnus opening (13), and the profunda femoris vessels (11) lie close to the back of the femur (2). The sciatic nerve (10) is deeply placed between biceps (8, 9) laterally and semimembranosus (14) and semitendinosus (15) medially.



- 1 Vastus medialis
- 2 Femur
- 3 Vastus intermedius
- 4 Rectus femoris
- 5 Vastus lateralis
- 6 Iliotibial tract
- 7 Lateral intermuscular septum
- 8 Short head } of biceps
- 9 Long head }
- 10 Sciatic nerve
- 11 Profunda femoris vessels
- 12 Adductor magnus
- 13 Opening in adductor magnus
- 14 Semimembranosus
- 15 Semitendinosus
- 16 Gracilis
- 17 Sartorius
- 18 Great saphenous vein
- 19 Saphenous nerve
- 20 Femoral vessels



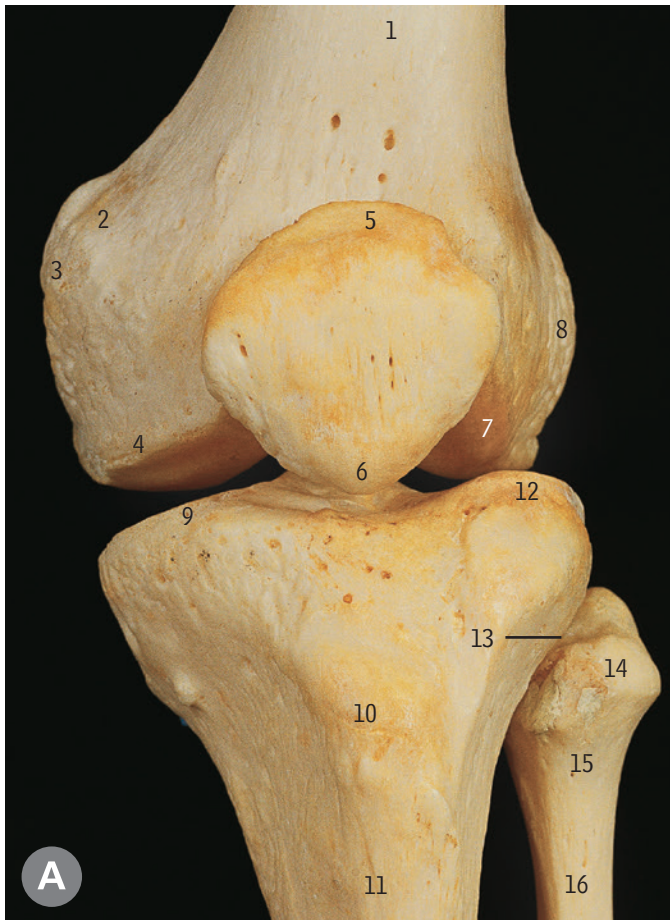
B Axial section at the level of the opening in adductor magnus

- The muscles commonly called the hamstrings span both the hip and knee joints: they arise from the ischial tuberosity and run to the upper end of the tibia and fibula, and consist of semitendinosus, semimembranosus, and the long head of biceps. The short head of biceps is not a hamstring; although it joins the long head, it arises from the back of the femur and hence does not span the hip joint. Semitendinosus is named from the long tendon at its lower end. Semimembranosus is named from the broad tendinous origin at its upper end.

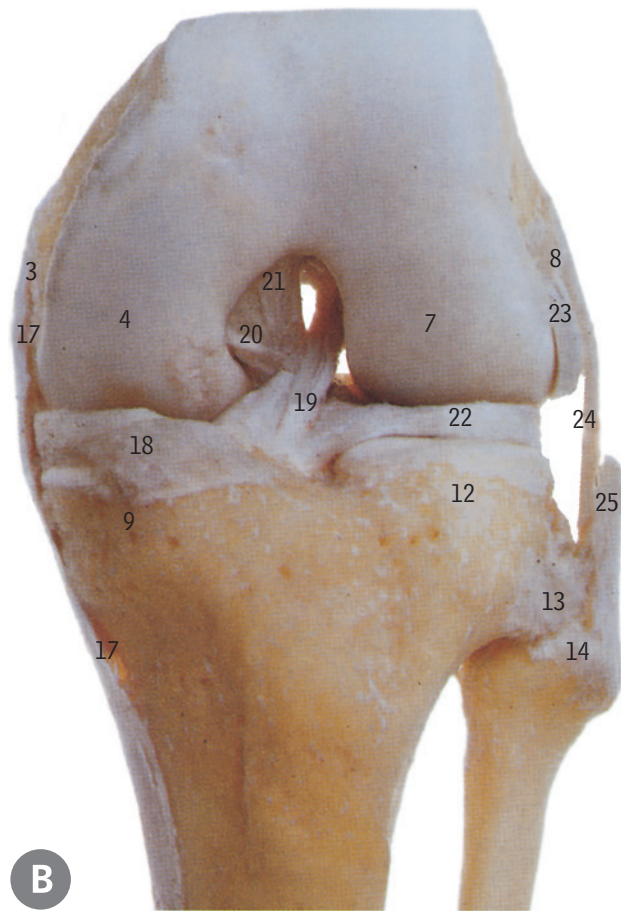
Knee joint *Left knee joint*

Flexion of the knee, as in B, exposes a much larger area of the femoral condyles (4, 7) than is seen in extension (as in A and C). In B the medial and lateral menisci (18, 22) lie between the condyles of the femur and tibia (4, 9; 7, 12), with the anterior cruciate ligament (19) passing backward and laterally from the upper surface of the tibia to the medial surface of the lateral condyle of the femur. Compare the MR image in C with the dissection in B.

In D the joint has been opened up by cutting through the quadriceps muscle (26) and the patellar ligament (30) and turning laterally the large flap which includes the patella (28), in order to show the joint cavity from the front and the margins of the suprapatellar bursa (27), which is in direct continuity with the cavity of the knee joint.



A Bones, with the knee joint in extension, from the front



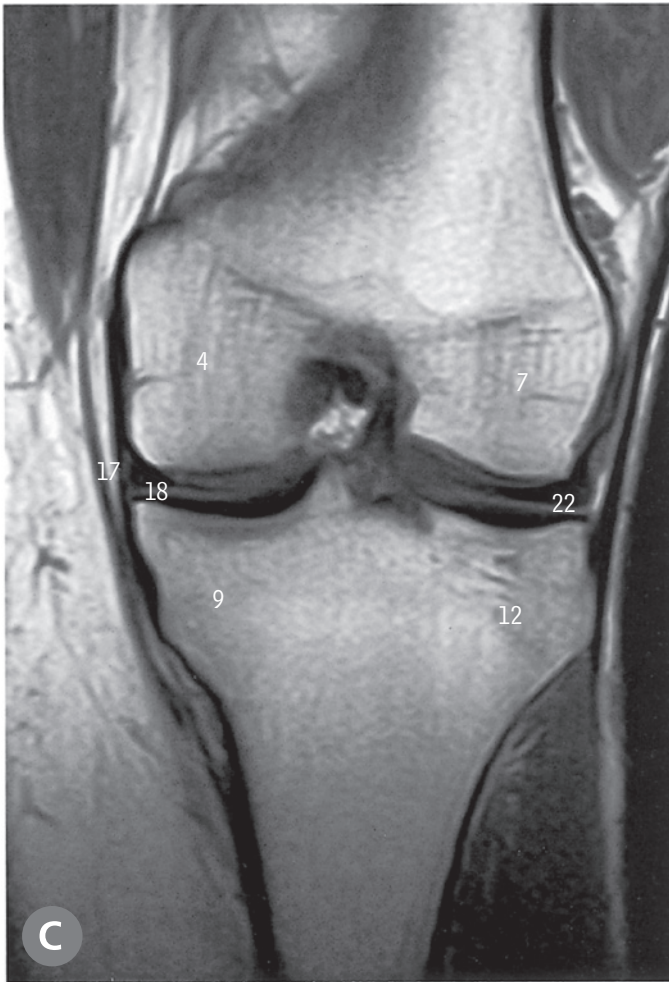
B Bones and ligaments, with the knee joint in flexion and the patella removed, from the front

- The **lateral ligament** (B24, properly called the fibular collateral ligament) is a rounded cord about 5 cm long, passing from the lateral epicondyle of the femur (B8) to the head of the fibula (B14).
- The **medial ligament** (B17, properly called the tibial collateral ligament) is a broad flat band about 12 cm long passing from the medial epicondyle of the femur (B3) to the medial side of the medial condyle of the tibia (B9) and to an extensive area of the medial surface below the condyle. At the side it fuses with the medial meniscus (B18; see also p. 33, B18 and 19); the lateral ligament (B24) does not fuse with the lateral meniscus (B22), to which the tendon of popliteus has an attachment (p. 33, C28).
- For notes on the cruciate ligaments and menisci, see p. 32.

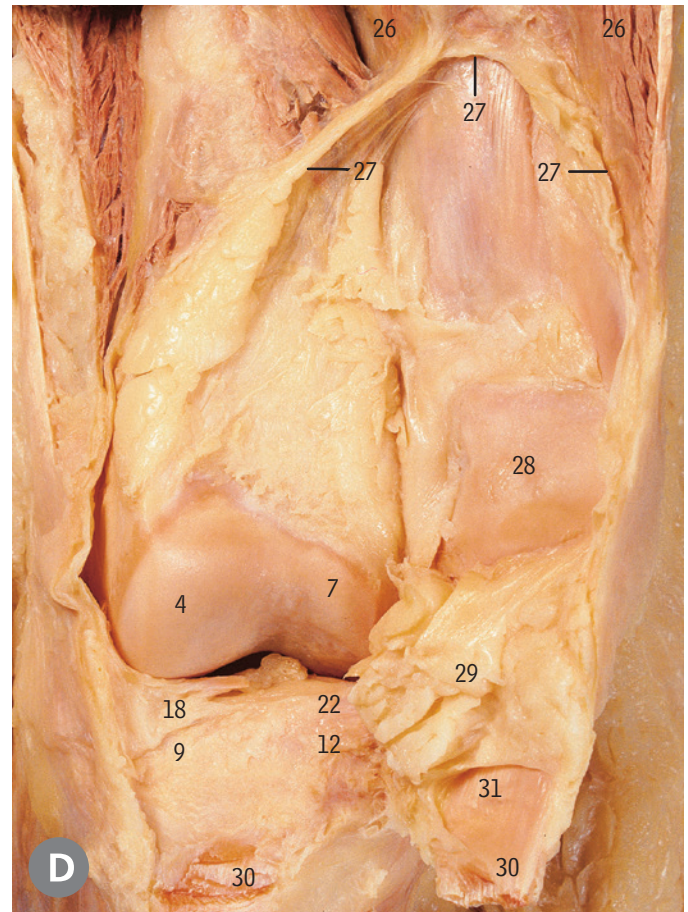
- 1 Shaft of femur
- 2 Adductor tubercle
- 3 Medial epicondyle
- 4 Medial condyle
- 5 Base of patella
- 6 Apex of patella
- 7 Lateral condyle
- 8 Lateral epicondyle
- 9 Medial condyle of tibia
- 10 Tibial tuberosity
- 11 Shaft
- 12 Lateral condyle
- 13 Superior tibiofibular joint (with capsule in B)
- 14 Head
- 15 Neck
- 16 Shaft

} of fibula

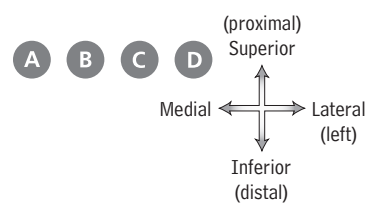
- 17 Medial ligament
- 18 Medial meniscus
- 19 Anterior cruciate ligament
- 20 Anterior meniscomfemoral ligament
- 21 Posterior cruciate ligament
- 22 Lateral meniscus
- 23 Popliteus tendon
- 24 Lateral ligament
- 25 Biceps tendon
- 26 Quadriceps femoris
- 27 Margins of suprapatellar bursa
- 28 Posterior surface of patella
- 29 Infrapatellar fat pad
- 30 Patellar ligament
- 31 Deep infrapatellar bursa



C Coronal magnetic resonance image (MRI)



D Opened up from the front, with the knee joint in extension and the patella turned laterally



Knee joint *Left knee joint*

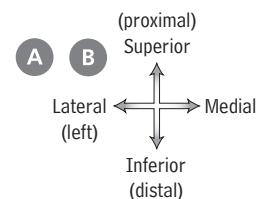
The joint in B is partly flexed, showing less of the articular surfaces of the femoral condyles (4, 6) than in A. In B the posterior cruciate ligament (20) spills over onto the uppermost part of the posterior surface of the tibia. The attachment of the medial meniscus (19) to the medial ligament (18) is clearly seen; the lateral meniscus (23) has no attachment to the lateral ligament (24) but gives rise to the posterior meniscomfemoral ligament (22), which lies on the

surface of the posterior cruciate ligament (20), here obscuring the anterior meniscomfemoral ligament (27).

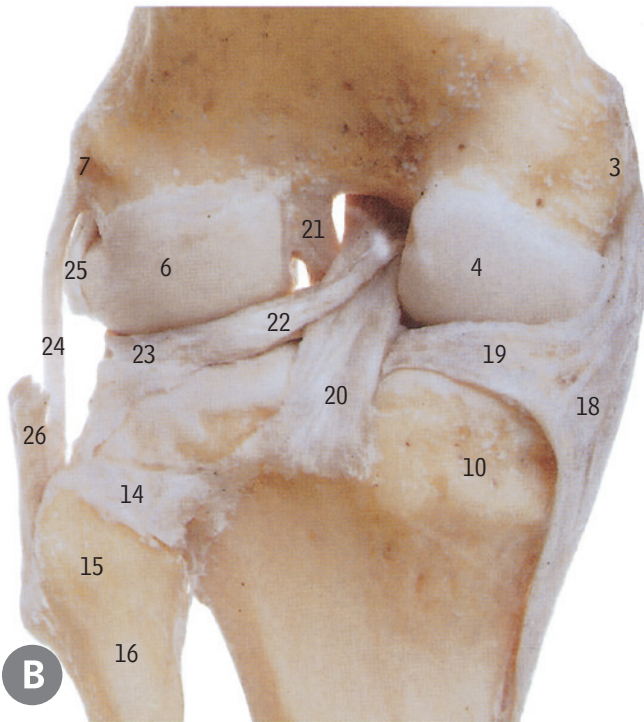
The view in C demonstrates the shapes of the medial and lateral menisci (19, 23), the tibial attachments of the anterior and posterior cruciate ligaments (21, 20) and the anterior and posterior meniscomfemoral ligaments (27, 22), which pass respectively in front of and behind the posterior cruciate ligament (20).



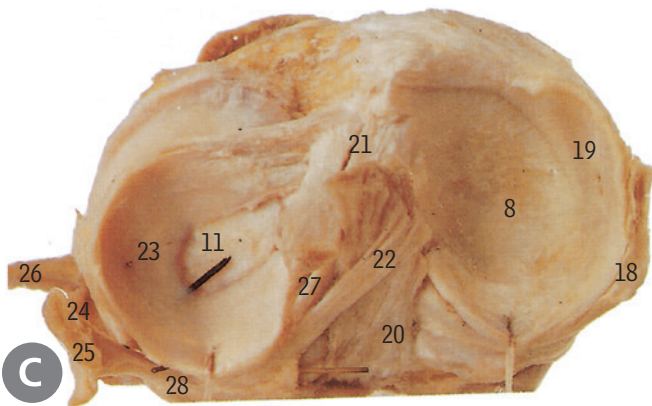
- 1 Popliteal surface of femur
- 2 Adductor tubercle
- 3 Medial epicondyle
- 4 Medial condyle
- 5 Intercondylar fossa
- 6 Lateral condyle
- 7 Lateral epicondyle
- 8 Medial condyle of tibia
- 9 Groove for semimembranosus insertion
- 10 Intercondylar eminence
- 11 Lateral condyle of tibia
- 12 Popliteal surface of tibia
- 13 Soleal line
- 14 Superior tibiofibular joint (with capsule in B)
- 15 Head
- 16 Neck
- 17 Shaft
- 18 Medial ligament
- 19 Medial meniscus
- 20 Posterior cruciate ligament
- 21 Anterior cruciate ligament
- 22 Posterior meniscomfemoral ligament
- 23 Lateral meniscus (with marker under medial margin in C)
- 24 Lateral ligament
- 25 Popliteus tendon
- 26 Biceps tendon
- 27 Anterior meniscomfemoral ligament
- 28 Attachment of popliteus to lateral meniscus



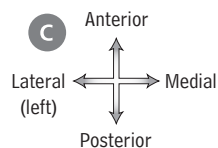
A Bones, from behind



B Ligaments, from behind



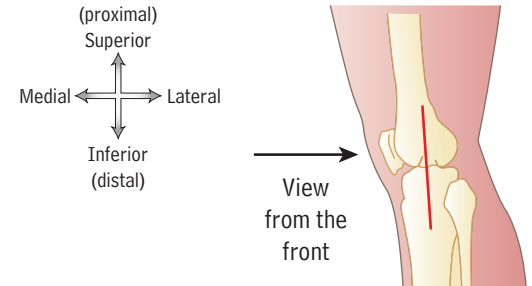
C Upper surface of tibia with ligaments, from above



- The cruciate ligaments are named from their attachments to the tibia.
- The anterior cruciate ligament (C21), from the front of the upper surface of the tibia, passes upward, backward and laterally to become attached to the medial side of the lateral condyle of the femur (p. 30, B19).
- The posterior cruciate ligament (C20), from the back of the upper surface and the very top of the posterior surface of the tibia, passes upward, forward and medially to become attached to the lateral side of the medial condyle of the femur (p. 30, B21).
- The anterior and posterior meniscofemoral ligaments (C27, C22) arise from the back of the lateral meniscus and run upward and forward like a two-pronged fork embracing the posterior cruciate ligament (C20) at its front and back and fusing with it.
- The C-shaped fibrocartilaginous menisci (C19 and C23) are attached by their ends (the horns of the menisci) to the intercondylar area of the upper surface of the tibia.
- **Muscles producing movements at the knee joint include the following:**
 - Flexion** (bending the leg backwards): semimembranosus, semitendinosus, biceps, gracilis, sartorius, gastrocnemius and popliteus.
 - Extension** (straightening the flexed knee): vastus medialis, vastus intermedius, vastus lateralis, rectus femoris, and tensor fasciae latae and gluteus maximus acting via the iliotibial tract.
 - Medial rotation of the flexed leg** (rotating the leg medially in the long axis of the leg): semimembranosus, semitendinosus, gracilis, sartorius and popliteus.
 - Lateral rotation of the flexed leg** (rotating the leg laterally in the long axis of the leg): biceps.
- Because of the shape of the articulating surfaces and the tension in the ligaments, there is some medial rotation of the femur on the tibia toward the end of extension (assuming the tibia to be fixed); this is the so-called 'locking of the knee joint'. To begin flexion, popliteus 'unlocks' the joint by causing some lateral rotation of the femur on the tibia (assuming the tibia to be fixed); the other flexors can then carry on the movement.

Knee joint

Coronal section through the left knee joint (male), from the front



- 1 Extensor digitorum longus
- 2 Tibialis anterior
- 3 Popliteus (most medial fibres)
- 4 Gracilis (tendon)
- 5 Sartorius (tendon)
- 6 Tibia
- 7 Medial condyle (plateau) of tibia
- 8 Tibial (medial) collateral ligament
- 9 Medial meniscus
- 10 Posterior } cruciate ligament
- 11 Anterior }
- 12 Medial } intercondylar tubercle of tibia
- 13 Lateral }
- 14 Articular cartilage
- 15 Lateral condyle (plateau) of tibia
- 16 Lateral meniscus
- 17 Lateral } condyle of femur
- 18 Medial }
- 19 Adductor tubercle of femur
- 20 Superior genicular artery
- 21 Fascia lata
- 22 Vastus lateralis
- 23 Shaft of femur
- 24 Vastus medialis

The knee joint:

- Is a hinge joint
- Is the largest synovial joint in the body
- Is formed by the unions of the two condyles of the femur (17, 18) and the two condyles of the tibia (7, 15) along with the patella, which articulates solely with the condyles of the femur
- Provides movements of flexion, extension and small degree of rotation

The tibial (medial) collateral ligament (8):

- Runs from the medial epicondyle of the femur to the upper part of the medial surface of the tibia
- Is a broad, flat, band-like structure approximately 12 cm in length (See p. 30 for a more detailed description.)

The fibular (lateral) collateral ligament:

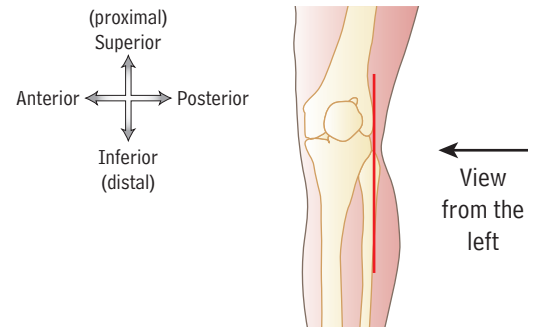
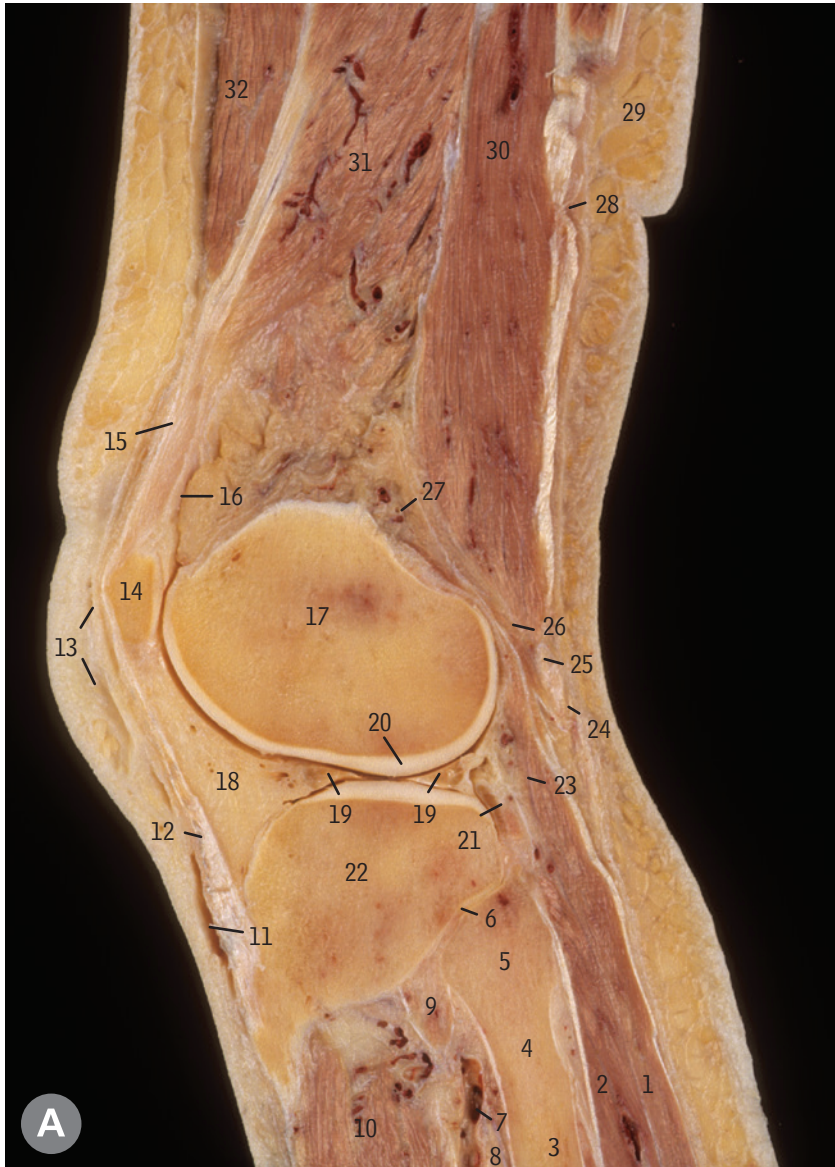
- Passes from the lateral epicondyle of the femur to the apex of the head of the fibula
- Is a rounded structure approximately 5 cm in length (See p. 30 for a more detailed description.)

The anterior and posterior cruciate ligaments (10, 11):

- Are main factors that hold the femur and tibia together within the knee joint
- Are strong bands which cross each other in the shape of an 'X' when viewed from the side as in a sagittal section
- Pass from the inside surfaces of the femoral condyles to the central intercondylar area on the upper surface of the tibia
- Are covered by synovial membrane at their fronts and sides but not at the back (See p. 33 for a more detailed description.)

Knee joint

Sagittal section I through the left knee joint (female), from the left



- 1 Gastrocnemius lateral head
- 2 Soleus
- 3 Shaft
- 4 Neck
- 5 Head
- 6 Superior tibiofibular joint
- 7 Anterior tibial artery and vein
- 8 Interosseous membrane
- 9 Tibialis posterior
- 10 Tibialis anterior
- 11 Infrapatellar bursa
- 12 Patellar ligament
- 13 Prepatellar bursa
- 14 Patella
- 15 Tendon of quadriceps femoris
- 16 Suprapatellar bursa
- 17 Lateral condyle of femur
- 18 Infrapatellar fat pad extending into infrapatellar fold
- 19 Lateral meniscus
- 20 Articular cartilage
- 21 Popliteus (tendon)
- 22 Lateral condyle (plateau) of tibia
- 23 Plantaris
- 24 Lateral cutaneous nerve of calf
- 25 Common fibular (peroneal) nerve
- 26 Fibrous capsule of knee joint
- 27 Lateral superior geniculate artery
- 28 Deep
- 29 Superficial
- 30 Biceps femoris
- 31 Vastus intermedius
- 32 Vastus lateralis

The fibrous capsule (26):

- Covers all aspects of the knee joint except at the front where its place is taken by the patella and patellar ligament
- Is lined by a synovial membrane

The infrapatellar fat pad (18):

- Pushes the synovial membrane backwards below the patella to fill up the gap between the femoral and tibial epicondyles

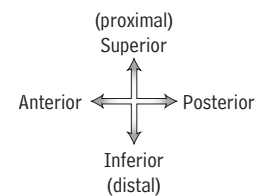
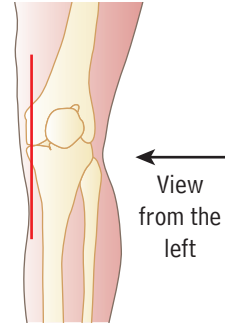
The medial and lateral (19) meniscus:

- Are main factors that hold the femur and tibia together outside the capsule of the knee joint
- Lay on top of the articular surfaces of the tibia
- Are C-shaped in appearance when viewed from above

- Are composed of fibrocartilage, which is thick at the periphery and very thin toward the centre
- Are not covered by synovial membrane
- Are attached by the 'horns' of their 'C' shape to the intercondylar area of the tibia near to the cruciate ligaments
- The medial meniscus is also firmly attached to the medial cruciate ligament
- The lateral meniscus is not attached to the lateral cruciate ligament
- Fill up space between the curved femoral condyles and flat articular surfaces of the tibia and help spread synovial fluid over the bones
- Act as shock absorbers and bear over half the weight transmitted across the joint

Knee joint

Sagittal section II through the left knee joint (female), from the left



- | | |
|---------------------------------|--|
| 1 Soleus | 17 Patella |
| 2 Plantaris (tendon) | 18 Tendon of quadriceps femoris |
| 3 Tibial nerve | 19 Suprapatellar bursa |
| 4 Popliteal vein | 20 Articular cartilage |
| 5 Popliteus | 21 Popliteal surface of femur |
| 6 Gastrocnemius | 22 Popliteal artery |
| 7 Deep } fascia | 23 Popliteal pad of fat |
| 8 Superficial } | 24 Shaft of femur |
| 9 Fibrous capsule of knee joint | 25 Infrapatellar fat pad extending into infrapatellar fold |
| 10 Shaft } of tibia | 26 Semitendinosus |
| 11 Tuberosity } | 27 Semimembranosus |
| 12 Medial meniscus | 28 Sciatic nerve |
| 13 Anterior } cruciate ligament | 29 Vastus intermedius |
| 14 Posterior } | 30 Rectus femoris |
| 15 Patellar ligament | |
| 16 Prepatellar bursa | |

The patella (17):

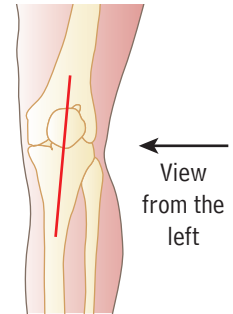
- Is situated within the tendon of quadriceps femoris (18)
- Is the largest sesamoid bone in the body
- Is held at a constant distance from the upper surface of the tibia by the patellar ligament (15)
- Slides over the femoral condyles as the knee joint bends
- Never comes into contact with the tibia

The suprapatellar bursa (19):

- Communicates with the synovial cavity of the knee joint
- Extends behind the tendon of quadriceps femoris (18) for three finger-breadths above the upper border of the patella
- May fill with excessive synovial fluid when the knee joint is injured resulting in 'fluid on the knee' that may be drained by needle aspiration

Knee joint

Sagittal section III through the left knee joint (female), from the left



The articular cartilage (6):

- Formed on the distal ends of the femoral and tibial condyles, is hyaline cartilage
- Is lubricated by synovial fluid within the knee joint cavity that is normally no more in quantity than a mere 0.5 ml

Principle muscles producing knee joint movement are:

Flexion (bending)

- Hamstrings, gastrocnemius and popliteus

Extension (straightening)

- Quadriceps femoris

Medial rotation

- of tibia, when semi-flexed: semimembranosus and semitendinosus

Lateral rotation

- of tibia, when semi-flexed: biceps femoris (See p. 33 for more detailed description.)

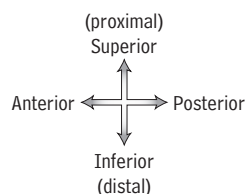
Arterial supply to the knee joint is from the:

- Descending genicular branches of the femoral artery
- Middle and inferior genicular branches of the popliteal artery
- Anterior and posterior branches of the anterior tibial artery
- Circumflex fibular artery
- Descending branch of the lateral circumflex femoral artery

Nerve supply to the knee joint is from the:

- Obturator nerve
- Femoral nerve
- Tibial nerve
- Common fibular (peroneal) nerve

- 1 Superficial } fascia
- 2 Deep }
- 3 Gastrocnemius medial head
- 4 Medial condyle (plateau) of tibia
- 5 Medial meniscus
- 6 Articular cartilage
- 7 Medial condyle of femur
- 8 Suprapatellar bursa
- 9 Fibrous capsule of knee joint
- 10 Tendon of medial head of gastrocnemius
- 11 Tendon of semitendinosus
- 12 Semimembranosus
- 13 Adductor magnus
- 14 Femoral artery
- 15 Vastus medialis



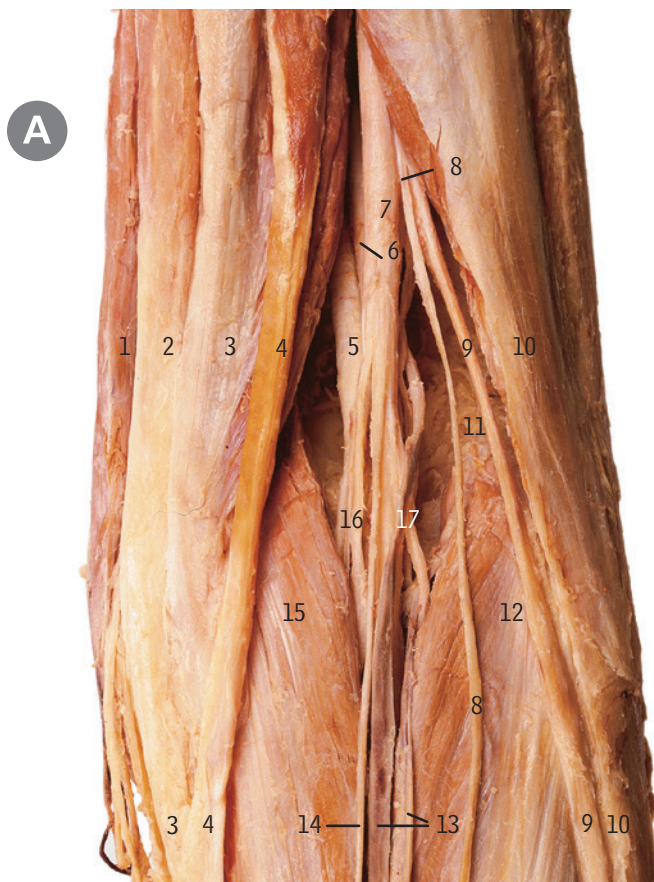
Knee joint

Popliteal fossa and back of the knee

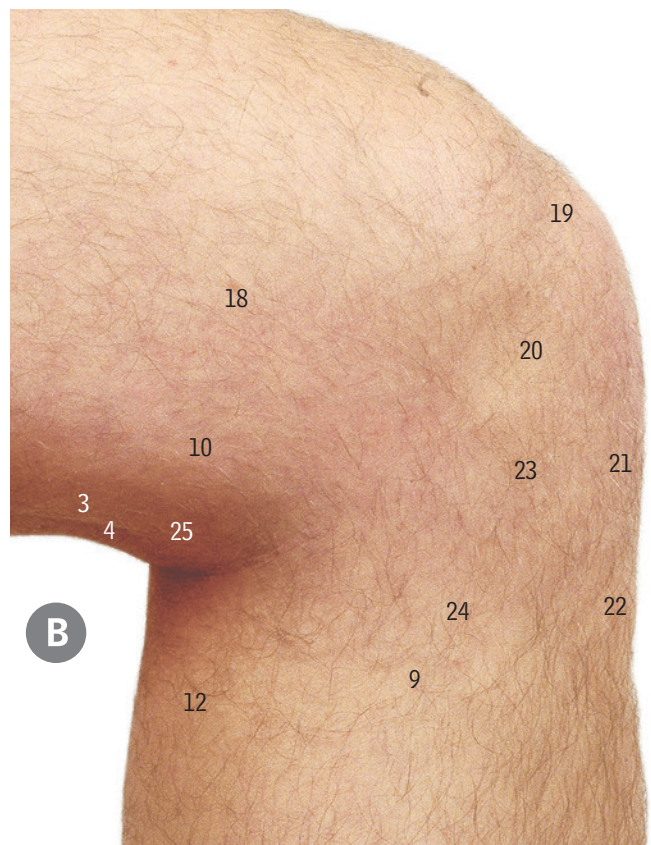
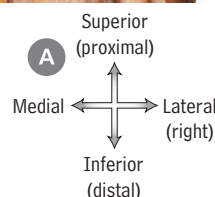
In A the fascia that forms the roof of the fossa and the fat within it have been removed. At the upper part of the fossa, biceps (10) is on the lateral side with the common fibular (*peroneal*) nerve (9) at its posterior border, and semimembranosus (3) with semitendinosus (4) overlying it are on the medial side. At the lower part of the fossa, the medial head of gastrocnemius (15) is on the medial side, whereas on the lateral side plantaris (11) lies just above the lateral head of gastrocnemius (12). Of the principal structures within the fossa, the tibial nerve (7) is the most superficial, with the popliteal vein (6) behind it and the popliteal artery (5) deep to the vein.

In the lateral view in B, the ridge formed by the iliotibial tract (18) lies above (anterior to) the tendon of biceps (10), at the lateral boundary of the popliteal fossa (25). Below the head of the fibula (24) the common fibular (*peroneal*) nerve (9) is palpable and can be rolled against the neck of the bone.

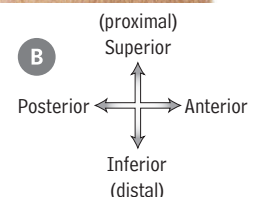
- 1 Sartorius
- 2 Gracilis
- 3 Semimembranosus
- 4 Semitendinosus
- 5 Popliteal artery
- 6 Popliteal vein
- 7 Tibial nerve
- 8 Lateral cutaneous nerve of calf
- 9 Common fibular (*peroneal*) nerve
- 10 Biceps
- 11 Plantaris
- 12 Lateral head of gastrocnemius
- 13 Small saphenous vein (double)
- 14 Sural nerve
- 15 Medial head of gastrocnemius
- 16 Nerve to medial head } of gastrocnemius
- 17 Nerve to lateral head }
- 18 Iliotibial tract
- 19 Patella
- 20 Margin of lateral condyle of femur
- 21 Patellar ligament
- 22 Tuberosity of tibia
- 23 Margin of lateral condyle of tibia
- 24 Head of fibula
- 25 Popliteal fossa



A Right popliteal fossa



B Surface landmarks of the flexed right knee, from the lateral side



Knee joint

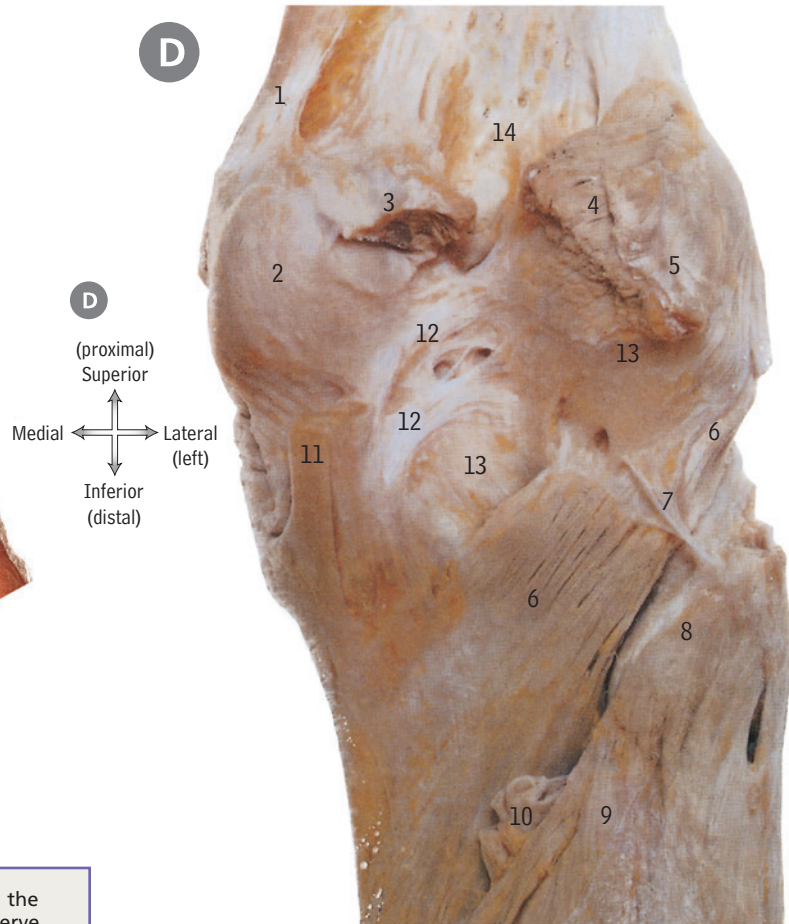
Popliteal fossa and back of the knee

Most of gastrocnemius, soleus and other muscles have been removed to display popliteus (6) and the posterior surface of the knee joint capsule (13), which is reinforced by the tendinous fibers of semimembranosus (11) that form the oblique popliteal ligament (12).



C Palpation of the right popliteal pulse

- The deep position of the popliteal artery (A5)—deep to the popliteal vein (A6), which in turn is deep to the tibial nerve (A7)—makes feeling the popliteal pulse difficult. It is best felt from the front, grasping the sides of the knee with both hands, placing the thumbs beside the patella and pressing the tips of the fingers deeply into the midline of the fossa.



D Right popliteus muscle and knee joint capsule, from behind

- The slender arcuate popliteal ligament (D7) arches over popliteus (D6) as it enters the joint capsule to reach the lateral side of the lateral condyle of the femur.

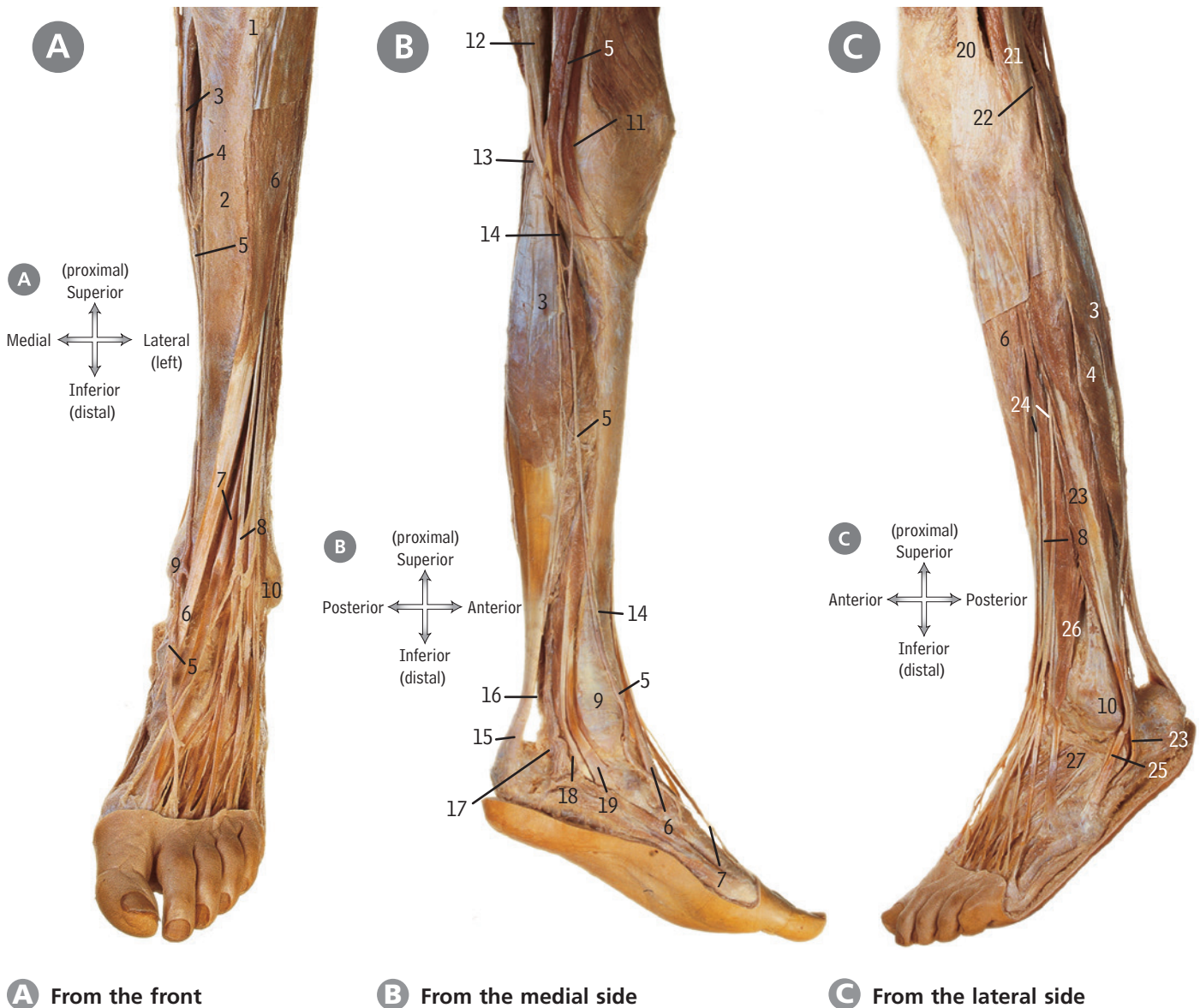
- 1 Adductor magnus
- 2 Capsule overlying medial condyle of femur
- 3 Medial head of gastrocnemius
- 4 Plantaris
- 5 Lateral head of gastrocnemius
- 6 Popliteus
- 7 Arcuate popliteal ligament
- 8 Head of fibula
- 9 Soleus
- 10 Popliteal vessels and tibial nerve
- 11 Semimembranosus
- 12 Oblique popliteal ligament
- 13 Capsule of knee joint
- 14 Popliteal surface of femur

Leg and foot survey

Muscles and superficial vessels and nerves of the left leg and foot

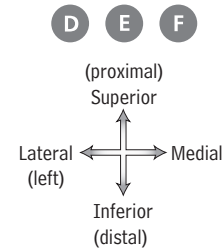
Skin, subcutaneous tissue and most of the deep fascia have been removed, and different aspects of the same specimen are shown. Lateral to the medial (subcutaneous) surface (A2) and anterior border of the tibia is the largest muscle of the front of the leg, *tibialis anterior* (A6, C6), which becomes tendinous in the lower part of the leg and has the tendons of *extensor hallucis longus* (A7) and *extensor digitorum longus* (A8) lateral to it. On the medial side the bulk of *gastrocnemius* (A3, B3) and the underlying *soleus* (A4) overlie the flexor muscles whose tendons pass behind the medial malleolus (B9)—*tibialis posterior* (B19),

flexor digitorum longus (B18) and *flexor hallucis longus* (B16), in that order from front to back. On the lateral side, *fibularis (peroneus) longus* (C23) largely overlies *fibularis (peroneus) brevis* (C25); their tendons pass behind the lateral malleolus (C10). At the back *gastrocnemius* (D3) has been detached at its upper end to show the underlying *soleus* (E4), which in turn has been detached with *plantaris* (E31) in F to display the underlying flexor muscle—*tibialis posterior* (F19), the deepest muscle, which is overlapped by *flexor hallucis longus* (F16) on the lateral side and *flexor digitorum longus* (F18) on the medial side.



- 1 Patellar ligament (lower edge)
- 2 Medial surface of tibia
- 3 Gastrocnemius
- 4 Soleus
- 5 Great saphenous vein
- 6 Tibialis anterior
- 7 Extensor hallucis longus
- 8 Extensor digitorum longus
- 9 Medial malleolus
- 10 Lateral malleolus
- 11 Sartorius
- 12 Gracilis
- 13 Semitendinosus
- 14 Saphenous nerve
- 15 Tendo calcaneus
- 16 Flexor hallucis longus
- 17 Tibial nerve and posterior tibial vessels

- 18 Flexor digitorum longus
- 19 Tibialis posterior
- 20 Iliotibial tract
- 21 Biceps femoris
- 22 Common fibular (*peroneal*) nerve
- 23 Fibularis (*peroneus*) longus
- 24 Superficial fibular (*peroneal*) nerve
- 25 Fibularis (*peroneus*) brevis
- 26 Fibularis (*peroneus*) tertius
- 27 Extensor digitorum brevis
- 28 Semimembranosus
- 29 Small saphenous vein
- 30 Sural nerve
- 31 Plantaris
- 32 Tibial nerve
- 33 Popliteal vein overlying artery
- 34 Fascia over popliteus



D From behind



E From behind, with gastrocnemius detached



F From behind, with gastrocnemius, plantaris and soleus detached

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Foot

3

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Surface landmarks of the foot *Surface landmarks of the left foot*





- 1 Medial malleolus
- 2 Great saphenous vein and saphenous nerve
- 3 Tibialis anterior
- 4 Extensor hallucis longus
- 5 Extensor digitorum longus
- 6 Lateral malleolus
- 7 Extensor digitorum brevis
- 8 Dorsalis pedis artery
- 9 Dorsal venous arch
- 10 Fibularis (*peroneus*) longus and brevis
- 11 Small saphenous vein and sural nerve
- 12 Tendo calcaneus
- 13 Flexor hallucis longus
- 14 Posterior tibial artery and tibial nerve
- 15 Flexor digitorum longus and tibialis posterior
- 16 Tuberosity of calcaneus
- 17 Sesamoid bones under head of first metatarsal
- 18 Base of first metatarsal
- 19 Head of fifth metatarsal
- 20 Tuberosity of base of fifth metatarsal
- 21 Tuberosity of navicular

Definitions of movements are as follows:

- **Extension:** from the Latin for straightening out, but as far as the ankle and foot are concerned it means bending the foot and/or toes upwards, which also known as dorsiflexion.
- **Flexion:** from the Latin for bending. In the ankle and foot it means bending the foot and/or toes downwards, which is also known as plantarflexion.
- **Abduction:** from the Latin for moving away. In the foot it means spreading the toes apart (the corresponding movement of the fingers is much more extensive).
- **Adduction:** from the Latin for moving toward. In the foot it means drawing the toes together.
- **Inversion:** from the Latin for turning in—turning the foot so that the sole faces more inwards (medially).
- **Eversion:** from the Latin for turning out—moving the foot so that the sole faces more outwards (laterally) (a more limited movement than inversion).

For further details see [pp. 85 and 107](#).

- A** From the front and above (dorsal surface, dorsum)
- B** From behind
- C** From the front, in inversion
- D** From the front, in eversion with abduction of toes
- E** From below (plantar surface, sole)
- F** Imprint of sole when weight-bearing (viewed through a glass plate)

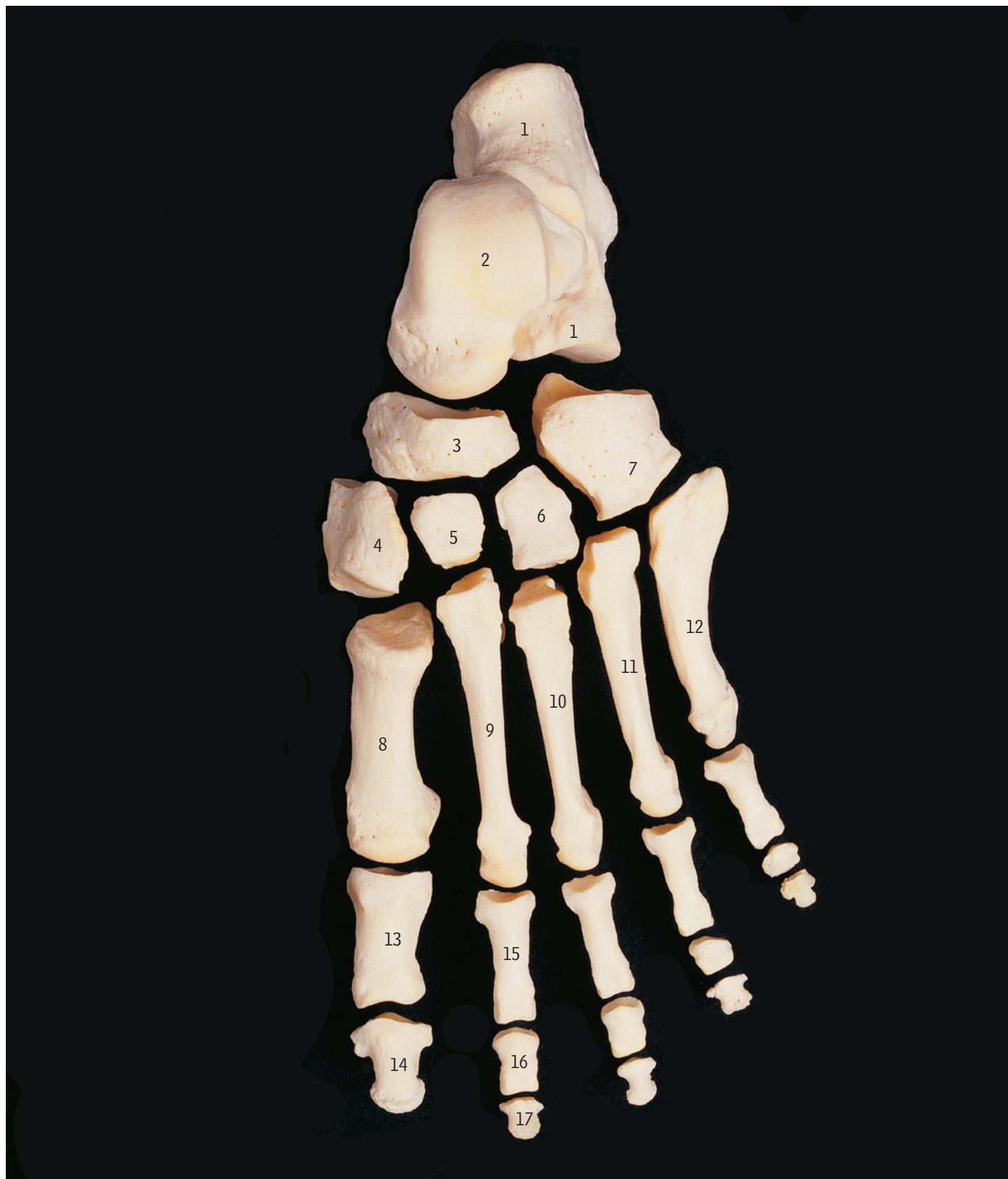
Surface landmarks of the foot *Surface landmarks of the left foot*





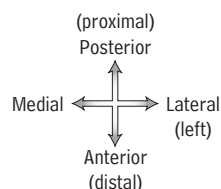
- Pulsation in the dorsalis pedis artery (p. 80, 14) is normally palpable between the tendons of extensor hallucis longus (8) and extensor digitorum longus (18), on a line from the midpoint between the medial and lateral malleoli to the proximal end of the first intermetatarsal space. However, the artery is absent in about 12% of feet (see p. 85).
- Pulsation in the posterior tibial artery (3) is normally palpable behind the medial malleolus (5), 2.5 cm in front of the medial border of the tendo calcaneus.
- The sustentaculum tali (12) is palpable about 2.5 cm below the tip of the medial malleolus (5).

Skeleton of the foot *Bones of the left foot, from above*



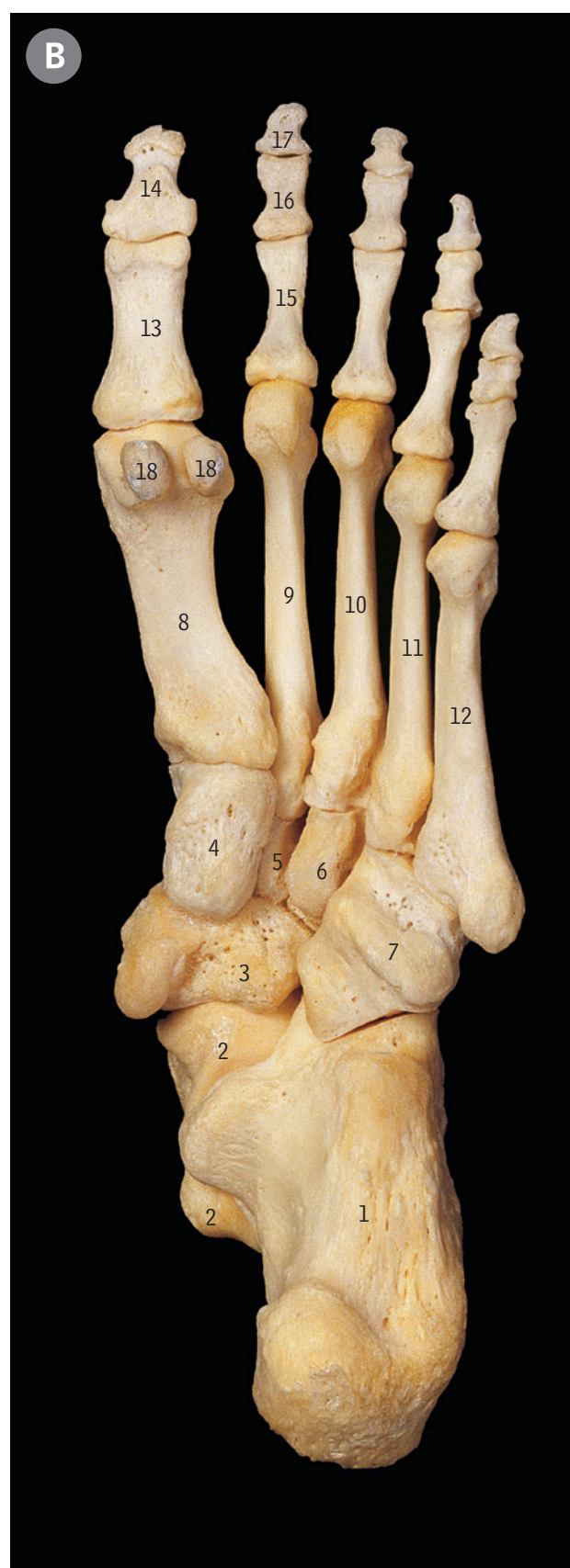
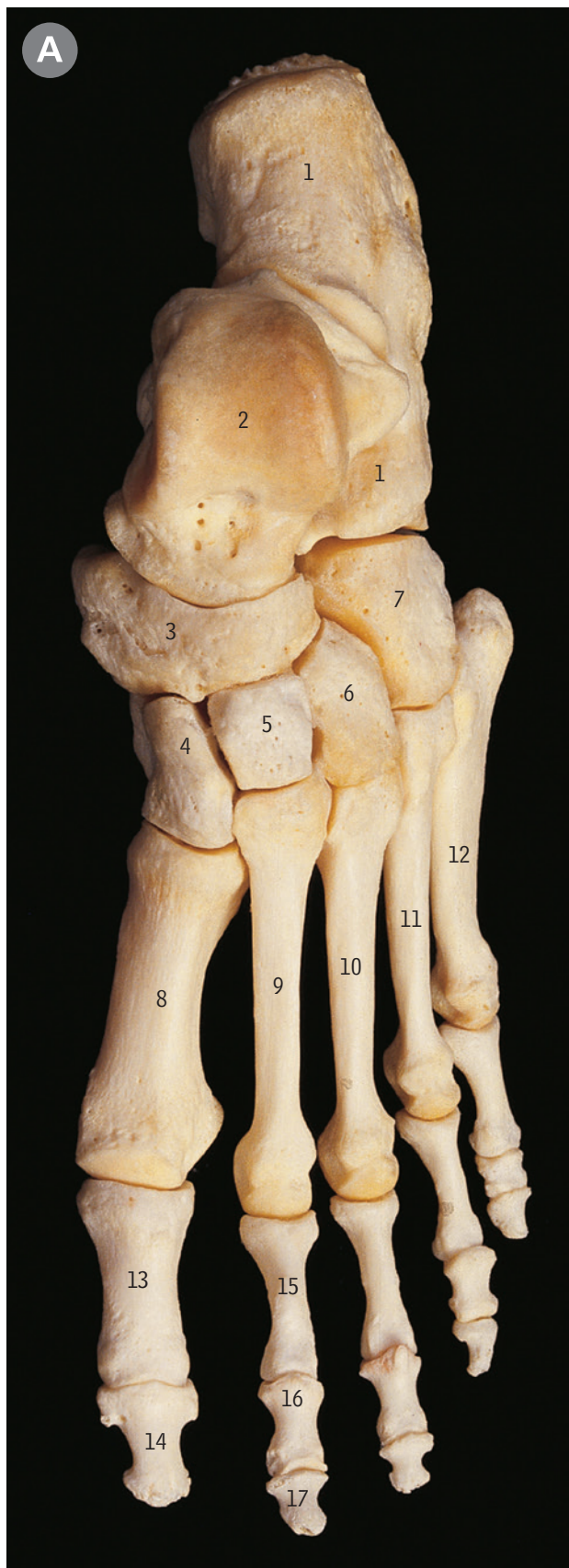
The talus and calcaneus remain articulated with each other but the remainder have been disarticulated.

- 1 Calcaneus
- 2 Talus
- 3 Navicular
- 4 Medial cuneiform
- 5 Intermediate cuneiform
- 6 Lateral cuneiform
- 7 Cuboid
- 8 First metatarsal
- 9 Second metatarsal
- 10 Third metatarsal
- 11 Fourth metatarsal
- 12 Fifth metatarsal
- 13 Proximal phalanx } of great toe
- 14 Distal phalanx }
- 15 Proximal phalanx } of second toe
- 16 Middle phalanx }
- 17 Distal phalanx }

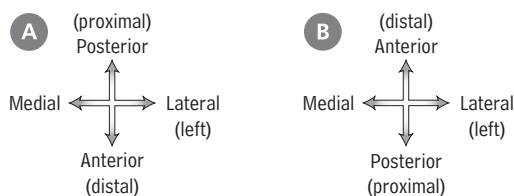


- **Bones of the tarsus**
Calcaneus
Talus
Navicular bone
Cuboid bone
Medial, intermediate and lateral cuneiform bones
- **Bones of the metatarsus**
First to fifth metatarsal bones, numbered from medial to lateral
- **Bones of the toes or digits**
Phalanges—a proximal and a distal phalanx for the great toe; proximal, middle and distal phalanges for each of the second to fifth toes
- The **hindfoot** consists of the talus and calcaneus.
- The **midfoot** consists of the navicular, cuboid and cuneiform bones.
- The **forefoot** consists of the metatarsal bones and phalanges.
- **Sesamoid bones**—two always present in the tendons of flexor hallucis brevis. For others see pp. 50, 52.
- **Origin and meaning of some names associated with the foot** are as follows (some older names for bones are given in parentheses):
 - Tibia:* Latin for a flute or pipe; when held upside down, the shin bone has a fanciful resemblance to this wind instrument.
 - Fibula:* Latin for a pin or skewer; the long thin bone of the leg. Adjective fibular or peroneal, which is from the Greek for pin (see the last note on p. 3).
 - Tarsus:* Greek for a wicker frame, in the basic framework for the back of the foot.
 - Metatarsus:* Greek for beyond the tarsus; the forepart of the foot.
 - Talus:* Latin (Greek) for one of a set of dice; viewed from above the main part of the talus has a rather square appearance.
 - Calcaneus:* (os calcis, calcaneum) From the Greek for heel; the heel bone.
 - Navicular:* (scaphoid) Latin (Greek) for boat-shaped; the navicular bone roughly resembles a saucer-shaped coracle.
 - Cuboid:* Greek for cube-shaped.
 - Cuneiform:* Latin for wedge-shaped.
 - Phalanx:* Greek for a row of soldiers; a row of bones in the toes. Plural phalanges.
 - Sesamoid:* Greek for shaped like a sesame seed.
 - Digitus:* Latin for finger or toe. Digiti and digitorum are the genitive singular and genitive plural—of the toe(s).
 - Hallux:* Latin for the great toe. Hallucis is the genitive singular—of the great toe.
 - Dorsum:* Latin for back; the upper surface of the foot. Adjective dorsal.
 - Plantar:* Adjective from planta, Latin for the sole of the foot.

Skeleton of the foot *Articulated bones of the left foot*



- 1 Calcaneus
- 2 Talus
- 3 Navicular
- 4 Medial cuneiform
- 5 Intermediate cuneiform
- 6 Lateral cuneiform
- 7 Cuboid
- 8 First metatarsal
- 9 Second metatarsal
- 10 Third metatarsal
- 11 Fourth metatarsal
- 12 Fifth metatarsal
- 13 Proximal phalanx } of great toe
- 14 Distal phalanx }
- 15 Proximal phalanx } of second toe
- 16 Middle phalanx }
- 17 Distal phalanx }
- 18 Sesamoid bones



- A** From above (dorsal surface)
- B** From below (plantar surface)

Ossification of foot bones

All the tarsal bones are ossified from one primary center: calcaneus at the third fetal month, talus at the sixth fetal month, cuboid just before or just after birth, lateral cuneiform at 1 year, medial cuneiform at 2 years, intermediate cuneiform and navicular at 3 years.

The calcaneus is the only tarsal bone to have a secondary center: a thin plate of bone on the posterior surface, appearing at about 7 years and fusing during puberty.

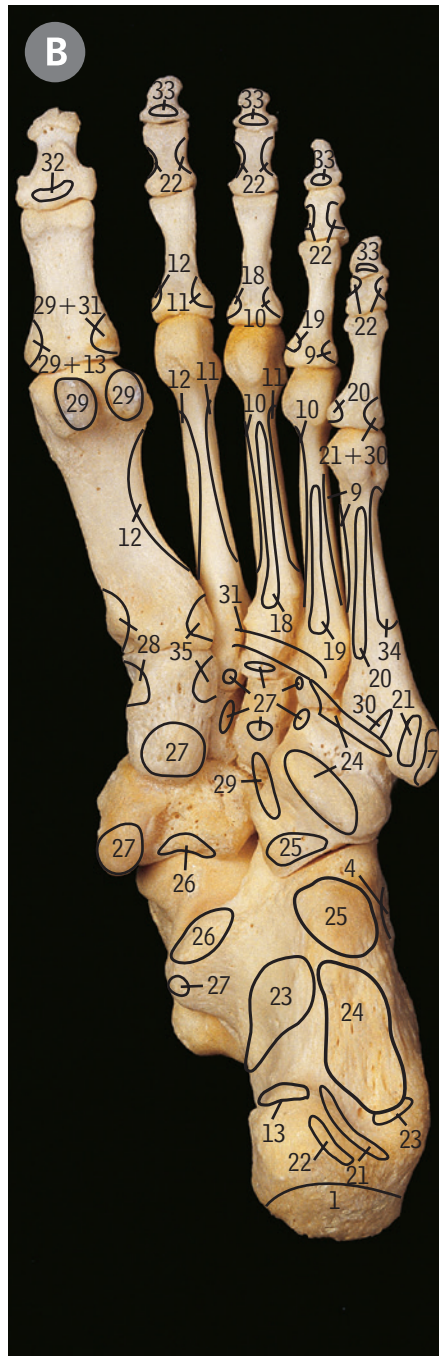
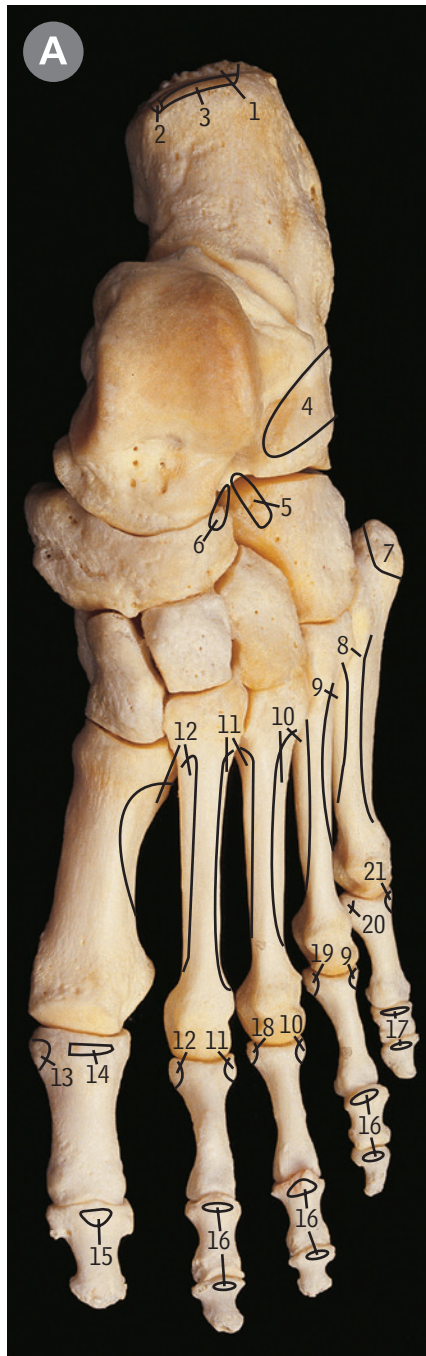
The metatarsal bones and phalanges have primary centers for their shafts at the second to fourth fetal months, and one secondary center at the base of the first metatarsal and bases of all the phalanges but at the heads of the other metatarsals. These begin to ossify at 2 to 6 years and fuse at about 18 years.

All dates given are subject to considerable variation, and ossification tends to occur earlier in females.

- During the preparation of dried bones, the hyaline cartilage on articulating surfaces is lost, so that when rearticulating bones an exact fit is not possible. The thickness of the cartilage on joint surface is best appreciated in sections of bones, as on pp. 20, 21 and 100–112.
- The **talus** (2) is the uppermost foot bone, forming the ankle joint with the tibia and fibula. For details see pp. 58, 67.
- The **calcaneus** (1) is the most posterior and the largest foot bone, forming the heel. For details see pp. 68, 69.
- The **navicular bone** (3) lies in front of the talus, on the medial side of the foot. For details see p. 70.
- The **cuboid bone** (7) lies in front of the calcaneus, on the lateral side of the foot. For details see p. 70.
- The **three cuneiform bones**—medial, intermediate and lateral (4, 5 and 6)—lie in front of the navicular bone. For details see p. 71.
- The first, second and third **metatarsal bones** (8, 9 and 10) are in front of the three cuneiforms, and the fourth and fifth metatarsal bones (11 and 12) are in front of the cuboid bone. For details see pp. 72, 73.
- The **phalanges** (13–17) are the bones of the toes. Each proximal phalanx articulates with the head of a metatarsal bone. Each phalanx has a base (at the proximal end), body and head (at the distal end). The body is convex on the dorsal (upper) surface, and concave on the plantar surface. See pp. 48, 56.

Skeleton of the foot

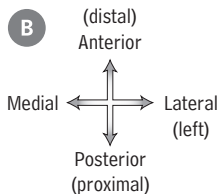
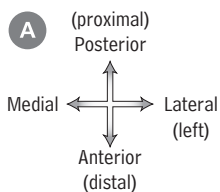
Attachments of muscles and major ligaments to the bones of the left foot



- 1 Tendo calcaneus
- 2 Plantaris
- 3 Area for bursa
- 4 Extensor digitorum brevis
- 5 Calcaneocuboid part
- 6 Calcaneonavicular part
- 7 Fibularis (*peroneus*) brevis
- 8 Fibularis (*peroneus*) tertius
- 9 Fourth
- 10 Third
- 11 Second
- 12 First
- 13 Abductor hallucis
- 14 Extensor hallucis brevis
- 15 Extensor hallucis longus
- 16 Extensor digitorum longus and brevis
- 17 Extensor digitorum longus
- 18 First
- 19 Second
- 20 Third
- 21 Abductor digiti minimi
- 22 Flexor digitorum brevis
- 23 Quadratus plantae
- 24 Long plantar ligament
- 25 Plantar calcaneocuboid (short plantar) ligament
- 26 Plantar calcaneonavicular (spring) ligament
- 27 Tibialis posterior
- 28 Tibialis anterior
- 29 Flexor hallucis brevis
- 30 Flexor digiti minimi brevis
- 31 Adductor hallucis
- 32 Flexor hallucis longus
- 33 Flexor digitorum longus
- 34 Opponens digiti minimi (occasional part of 30)
- 35 Fibularis (*peroneus*) longus

A From above (dorsal surface)

B From below (plantar surface)



Sesamoid and accessory bones

Sesamoid bones

The patella is by far the largest sesamoid bone in the lower limb, and its close association with tendons and a bony joint (the knee) gives a conceptual focus as to the function of sesamoid bones.

In the foot:

- They usually vary in shape and size but in general are ovoid and normally only a few millimeters in diameter (p. 50, B18).
- They are not always ossified but may consist of fibrous tissue or cartilage, or a combination of all three.
- They are usually found embedded in tendons at the point where the tendons angle acutely around bony surfaces to their point of insertion (p. 100, 16 and p. 101, 33).
- Sesamoids have articular cartilage on the surface which is in direct relationship to the bone that they are proximate to.

Although not proved, it is thought that sesamoid bones protect tendons from wear and, by their strategic position to joints, alter the angle of insertion of a tendon into bone and thus provides a greater mechanical advantage to the joint.

Accessory bones

Bones within the human body gradually begin to form during the early developmental phases of the fetus by the initial formation of central areas of ossification within the cartilaginous and membranous skeleton. These ossified areas continue to grow, unite and eventually form solid adult bones, some during late childhood and some as late as early adulthood.

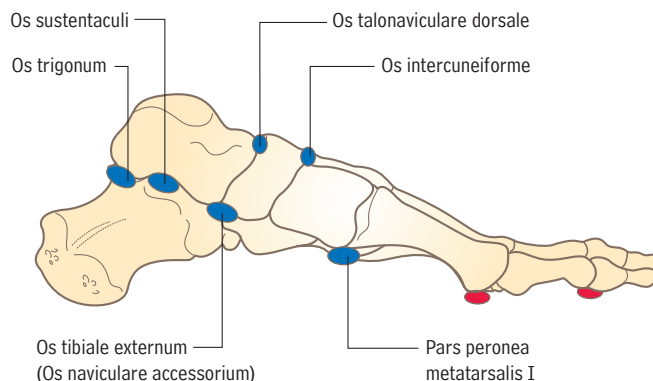
On occasions, however, the centres of ossification fail to fuse completely, often at the ends of bones, and thus a separate (accessory or supernumerary) bone is formed.

The foot is a common place for accessory bones to form, and there are common sites for them to occur. It is important to be aware of their possible presence because on a radiographic image they can be easily mistaken for a fractured bone or 'chip'.

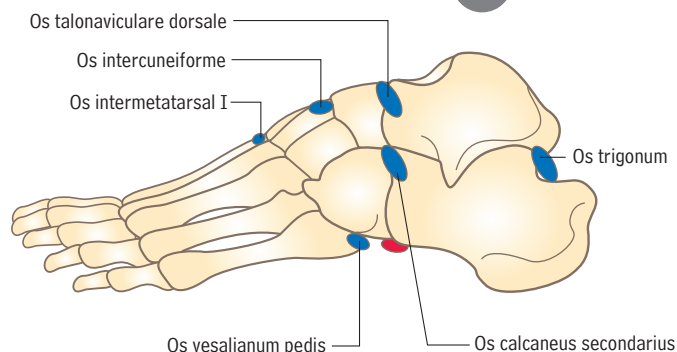
Common accessory bones in the foot are:

- **Dorsum of foot**
 - Os intercuneiforme
 - Os talonaviculare dorsale
 - Os calcaneus secundarius
 - Os intermetatarsal I
- **Posterior part of foot**
 - Os trigonum
- **Lateral part of foot**
 - Os calcaneus secundarius
 - Os vesalianum pedis
- **Medial part of foot**
 - Os tibiale externum (Os naviculare accessorium)
 - Os sustentaculi
- **Plantar aspect (sole) of foot**
 - Pars peronea metatarsalis I
 - Os cuboides secundarius

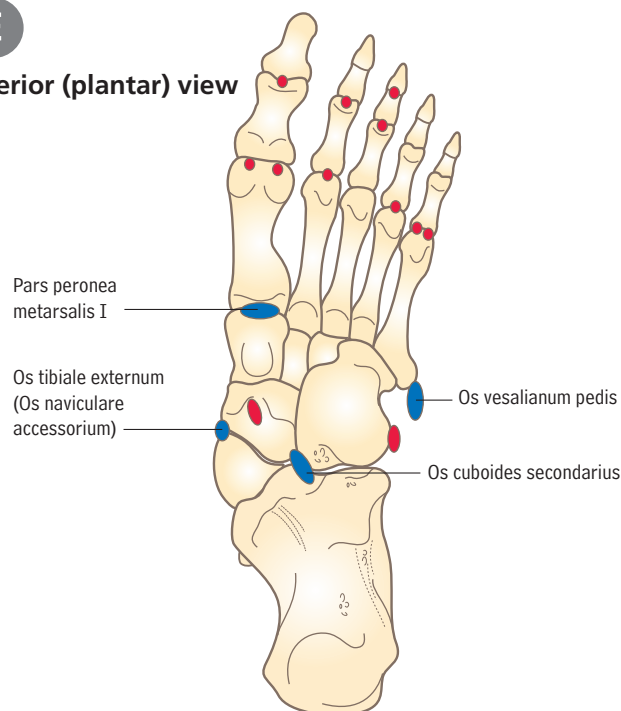
C Medial view



D Lateral view



E Inferior (plantar) view



C D E Common locations of sesamoid (red) and accessory (blue) bones

Skeleton of the foot *Articulated bones of the left foot*



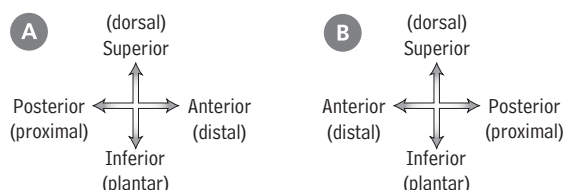
A From the medial side



B From the lateral side

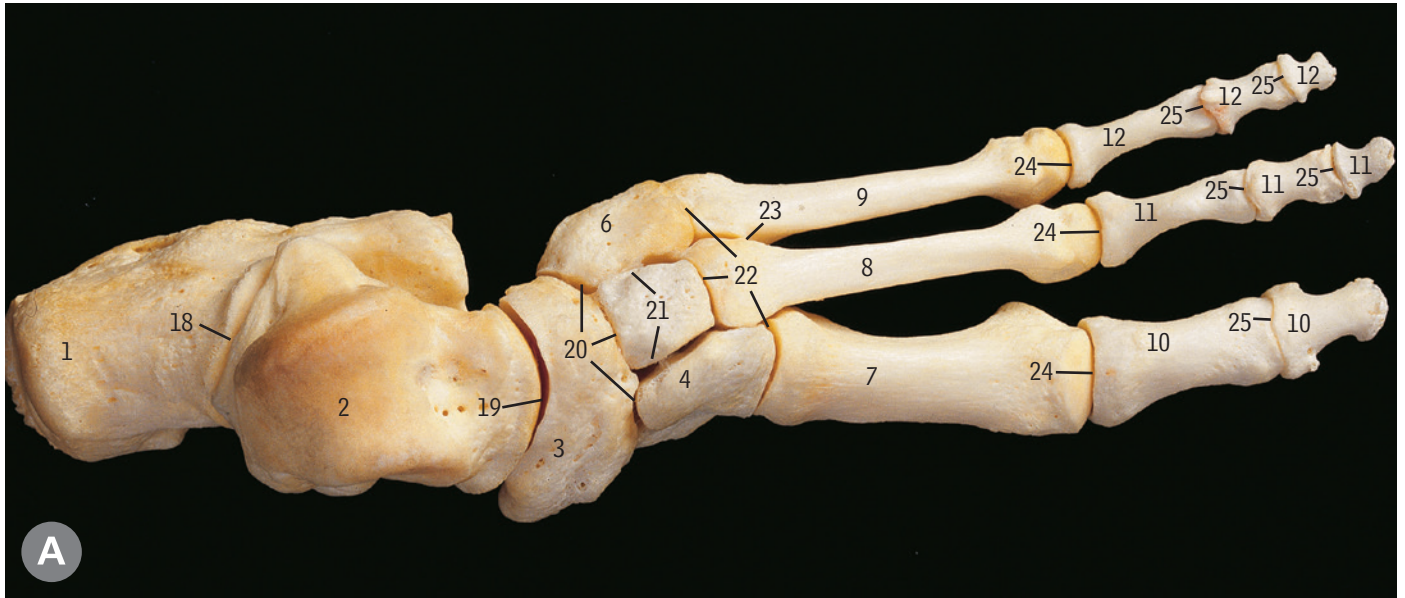
- 1 Body of calcaneus
- 2 Sustentaculum tali part of calcaneus
- 3 Body of talus
- 4 Head of talus } of talus
- 5 Navicular
- 6 Tuberosity of navicular
- 7 Medial cuneiform
- 8 Intermediate cuneiform
- 9 Base
- 10 Body } of first metatarsal
- 11 Head }
- 12 Base
- 13 Body } of proximal phalanx of great toe
- 14 Head }
- 15 Base
- 16 Body } of distal phalanx of great toe
- 17 Head }
- 18 Sesamoid bone
- 19 Lateral cuneiform
- 20 Cuboid
- 21 Base
- 22 Tuberosity } of fifth metatarsal
- 23 Body }
- 24 Head }
- 25 Tarsal sinus

- When standing (as can be seen from the imprint of a wet foot on the floor or when viewed through a glass plate—see p. 45, F) the parts of the foot in contact with the ground are the heel, the lateral margin of the foot, the pads under the metatarsal heads and the pads under the distal part of the toes.
- The medial margin of the foot is not normally in contact with the ground because of the height of the medial longitudinal arch (see pp. 56 and 57). In flat foot the medial arch is lower with an increasingly large imprint on the medial side.
- The body weight when standing is borne by the tuberosity of the calcaneus and the heads of the metatarsals, especially the first (with the sesamoid bones underneath it) and the fifth. As the foot bends forward in walking the other metatarsal heads take increasingly more of the load. With further raising of the heel the toe pads become pressed to the ground and so take some of the weight off the metatarsals.
- Although the forearm and hand have many muscles similar in name and action to those of the leg and foot, their normal use in everyday life is different. In the upper limb the muscles work from above to produce intricate movements of the thumb and fingers in a free limb. In the lower limb the toes must be stabilized on the ground so that muscles can work from below to produce the propulsive movements of walking.

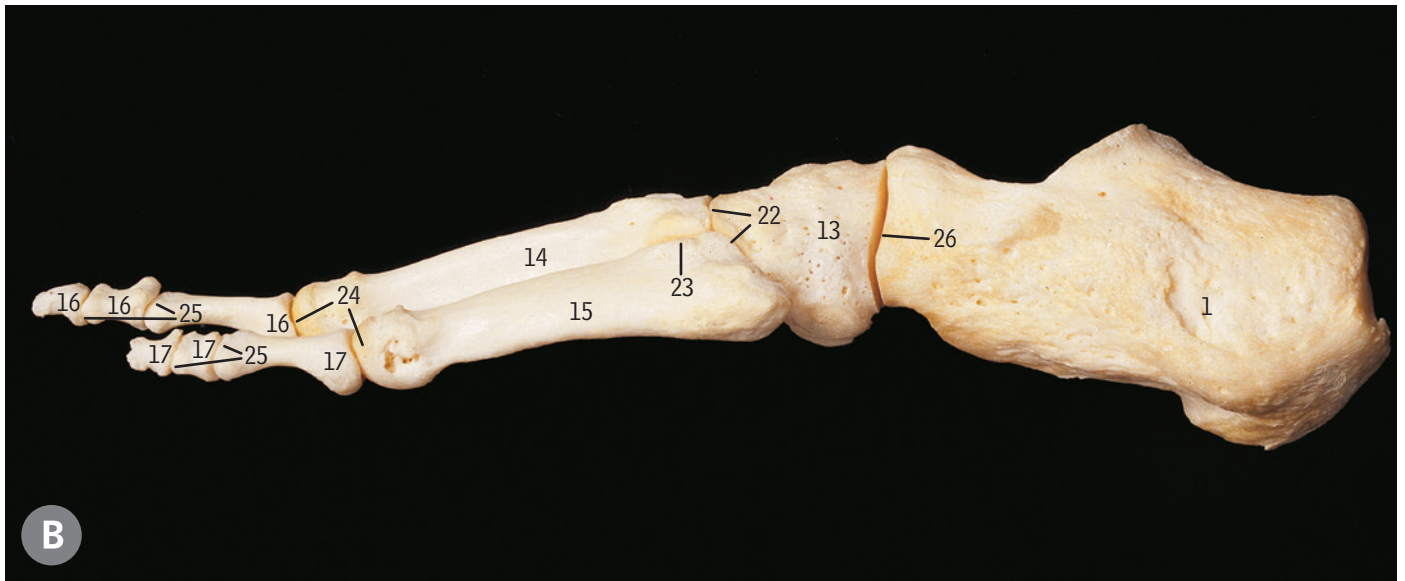


Skeleton of the foot

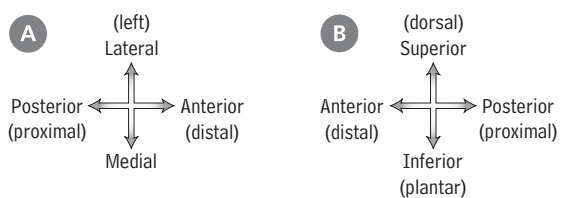
Bones of the left longitudinal arches, transverse tarsal joint and other joints

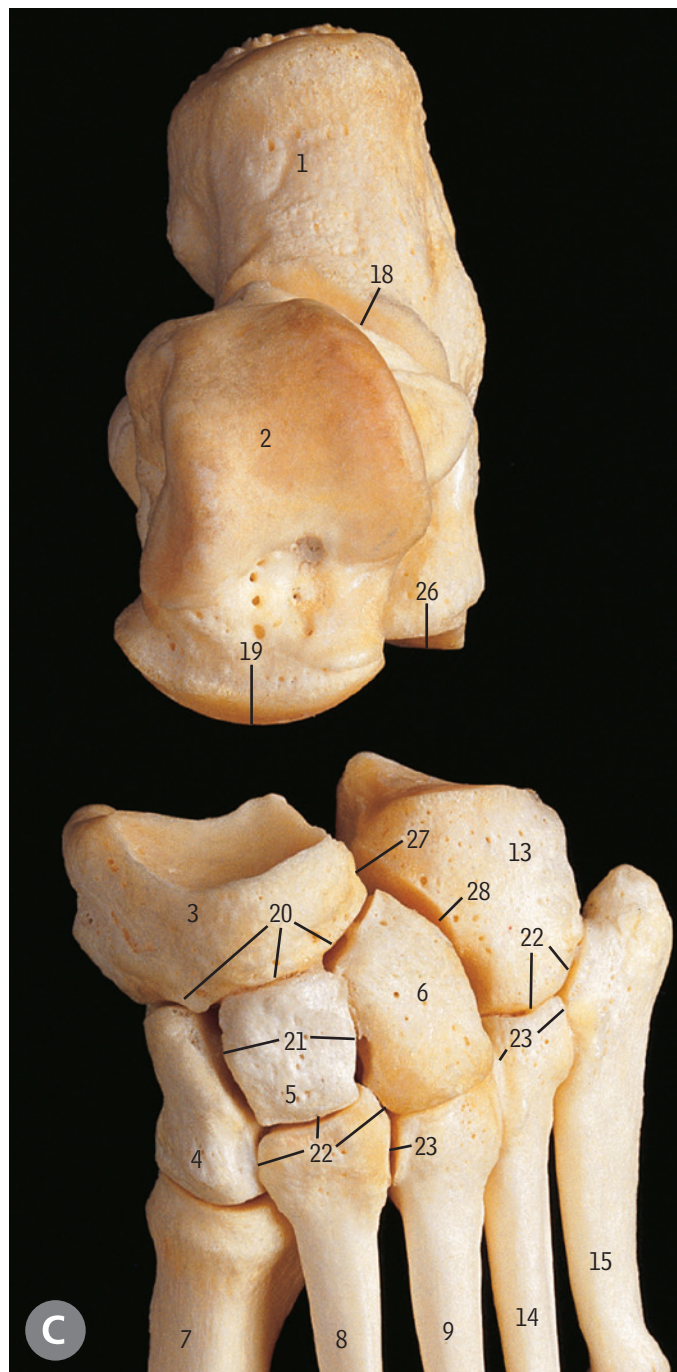


A Bones of the medial longitudinal arch, from above

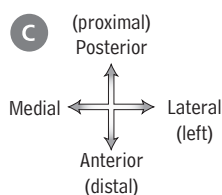


B Bones of the lateral longitudinal arch, from the lateral side





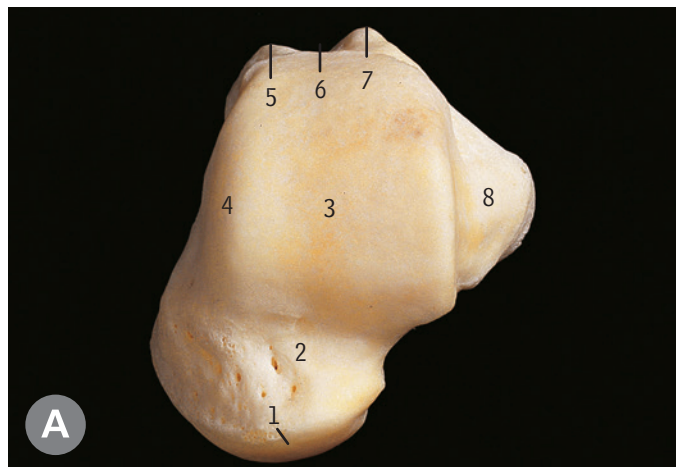
C The transverse tarsal joint, disarticulated, from above



- The bones of the medial longitudinal arch (A) are the calcaneus, talus, navicular, the three cuneiforms and the medial three metatarsal bones.
- The bones of the lateral longitudinal arch (B) are the calcaneus, cuboid and the two lateral metatarsal bones.
- The transverse arch is formed by the cuboid and cuneiform bones and the adjacent parts of the five metatarsals (those of each foot forming one half of the whole arch). At the level of the metatarsal heads the arched form is no longer present.
- The medial longitudinal arch is higher than the lateral.
- Although the shape of the individual bones determines the shapes of the arches, the *maintenance* of the arches in the *stationary* foot (standing in the normal upright position) depends largely on the ligaments in the sole (where they are larger and stronger than those on the dorsum). As soon as movement occurs the long tendons and small muscles of the sole assume importance in maintaining the curved forms.
- The many joints of the foot contribute to its function as a *flexible* lever, and the word arch suggests an architectural rigidity that does not exist.
- On the medial side the plantar calcaneonavicular ligament (spring ligament) is of particular importance in supporting the head of the talus, and other structures that help to maintain the medial arch include the plantar aponeurosis, flexor hallucis longus, tibialis anterior and posterior, and the medial parts of flexor digitorum longus and brevis.
- The transverse tarsal joint (midtarsal joint) is the collective name for two joints—the calcaneocuboid joint, and the talonavicular part of the talocalcaneonavicular joint.

- 1 Calcaneus
- 2 Talus
- 3 Navicular
- 4 Medial cuneiform
- 5 Intermediate cuneiform
- 6 Lateral cuneiform
- 7 First metatarsal
- 8 Second metatarsal
- 9 Third metatarsal
- 10 Phalanges of great toe
- 11 Phalanges of second toe
- 12 Phalanges of third toe
- 13 Cuboid
- 14 Fourth metatarsal
- 15 Fifth metatarsal
- 16 Phalanges of fourth toe
- 17 Phalanges of fifth toe
- 18 Talocalcanean joint
- 19 Talonavicular part of talocalcaneonavicular joint
- 20 Cuneonavicular joint
- 21 Intercuneiform joints
- 22 Tarsometatarsal joints (cuneometatarsal and cuboideometatarsal)
- 23 Intermetatarsal joints
- 24 Metatarsophalangeal joints
- 25 Interphalangeal joints
- 26 Calcaneocuboid joint
- 27 Cuboideonavicular joint
- 28 Cuneocuboid joint

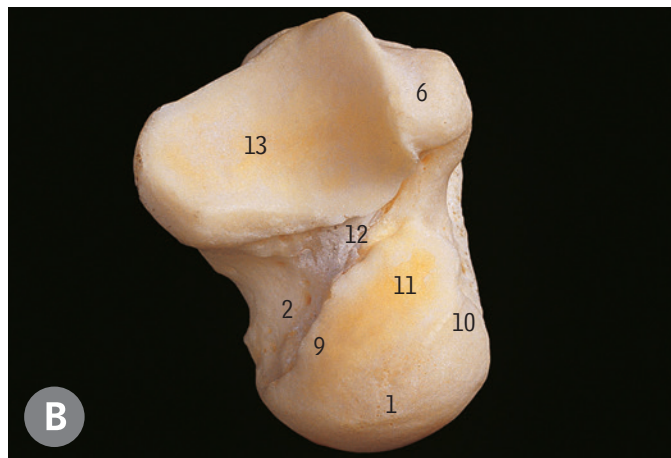
Foot bones *Left talus*



A From above

(proximal)
Posterior

Medial ← Anterior (distal) → Lateral (left)



B From below

(proximal)
Posterior

Lateral (left) ← Anterior (distal) → Medial

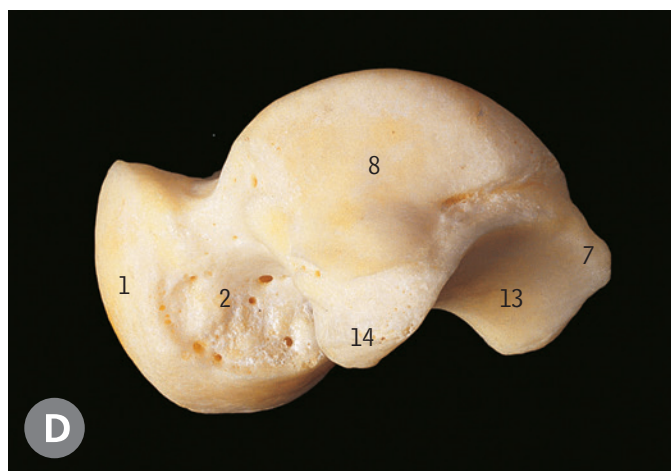


C From the medial side

(dorsal)
Superior

Posterior (proximal) ← Anterior (distal) →

Inferior (plantar)

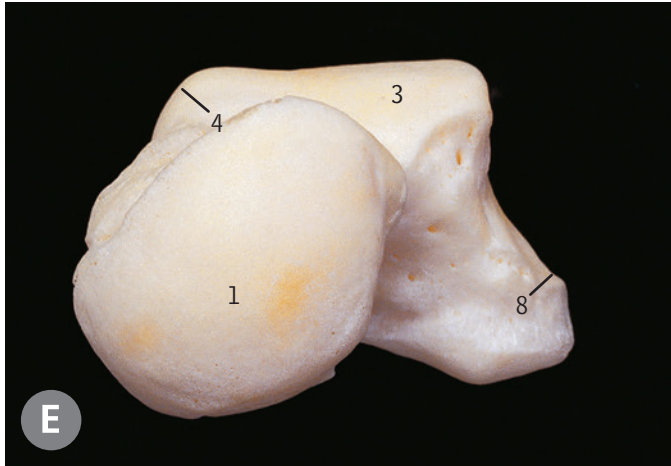


D From the lateral side

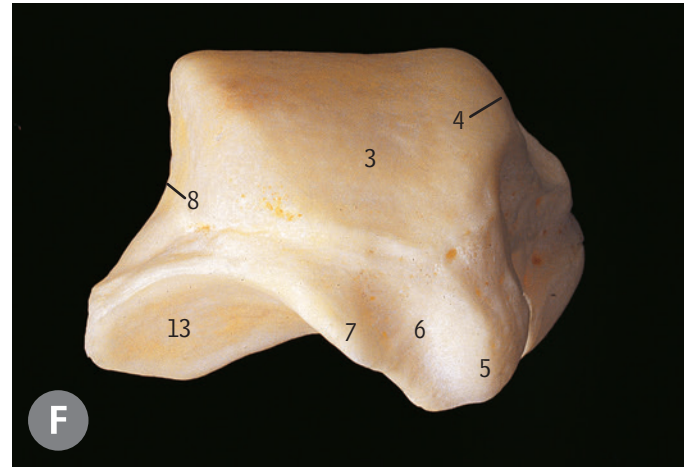
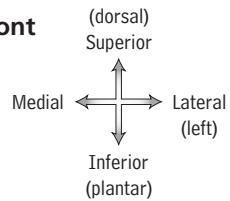
(dorsal)
Superior

Anterior (distal) ← Posterior (proximal) →

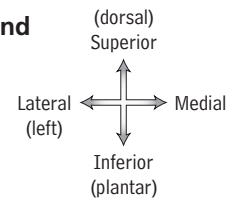
Inferior (plantar)



E From the front



F From behind



- 1 Head with articular surface for navicular
- 2 Neck
- 3 Trochlear surface of body, for inferior surface of tibia
- 4 Surface for medial malleolus
- 5 Medial tubercle
- 6 Groove for flexor hallucis longus tendon
- 7 Lateral tubercle
- 8 Surface for lateral malleolus
- 9 Anterior calcaneal articular surface
- 10 Surface for plantar calcaneonavicular (spring) ligament
- 11 Middle calcaneal articular surface
- 12 Sulcus tali
- 13 Posterior calcaneal articular surface
- 14 Lateral process

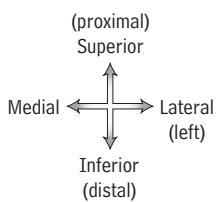
Talus

- The uppermost foot bone, forming the ankle joint with the tibia and fibula.
- Formerly known as the astragalus.
- Articular facets on the upper surface and sides for the tibia and fibula, on the under surface for the calcaneus, and on the anterior surface (head) for the navicular.
- Unique among the foot bones in having no muscles attached to it.

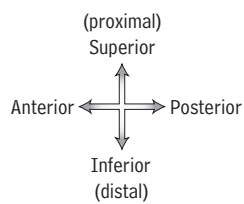
Foot bones *Left talus and the lower ends of the tibia and fibula*



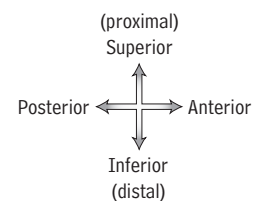
A The talus, tibia and fibula, articulated, from the front



B The tibia from the lateral side

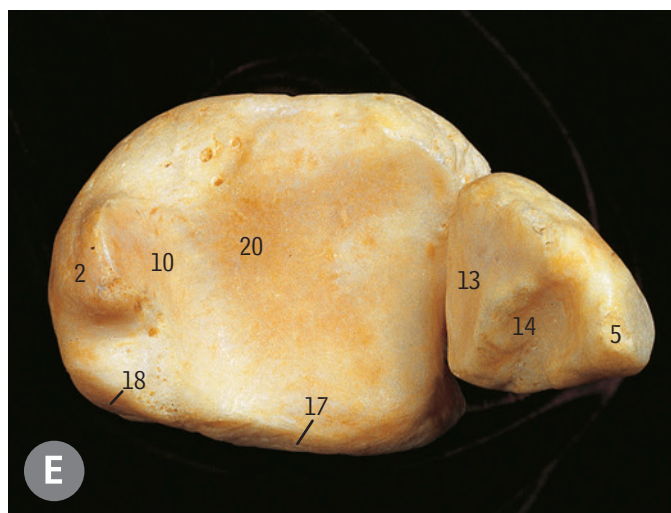
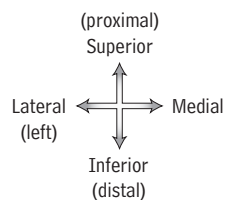


C The fibula from the medial side

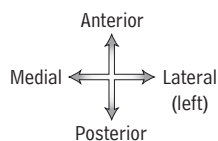




D The talus, tibia and fibula, articulated, from behind



E The tibia and fibula, articulated, from below



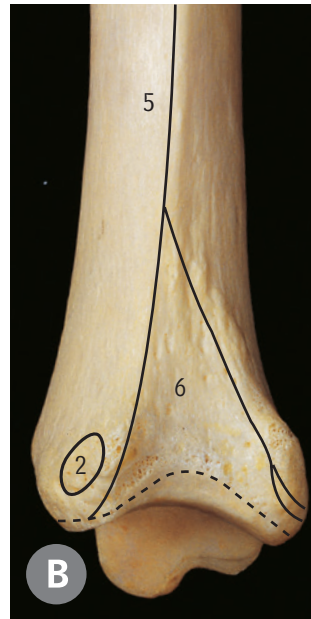
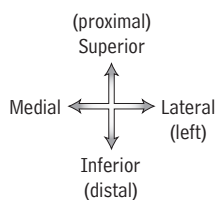
- 1 Anterior surface } of tibia
- 2 Medial malleolus }
- 3 Anterior border }
- 4 Triangular subcutaneous area } of fibula
- 5 Lateral malleolus }
- 6 Trochlear surface of body } of talus
- 7 Head }
- 8 Interosseous border }
- 9 Fibular notch }
- 10 Articular (lateral) surface of medial malleolus }
- 11 Interosseous border }
- 12 Surface for interosseous tibiofibular ligament }
- 13 Articular (medial) surface of lateral malleolus }
- 14 Malleolar fossa }
- 15 Posterior border }
- 16 Posterior surface of tibia }
- 17 Groove for flexor hallucis longus tendon }
- 18 Groove for tibialis posterior tendon }
- 19 Groove for fibularis (*peroneus*) brevis tendon }
- 20 Inferior surface of tibia }

Foot bones

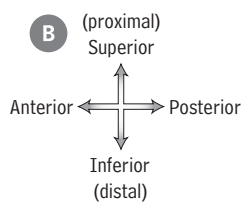
Left talus and the lower ends of the tibia and fibula, with ligamentous attachments in the ankle region



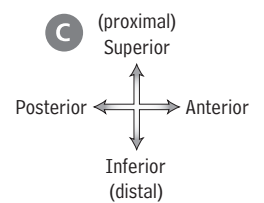
A The talus, tibia and fibula, articulated, from the front



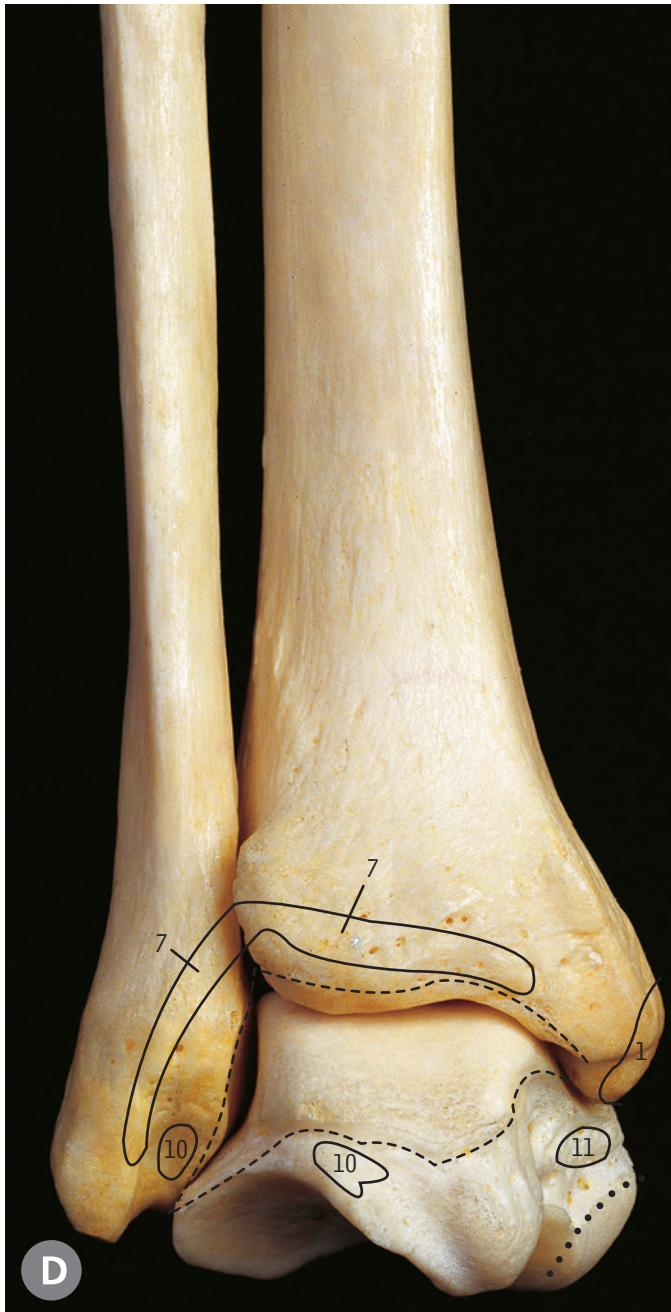
B The tibia from the lateral side



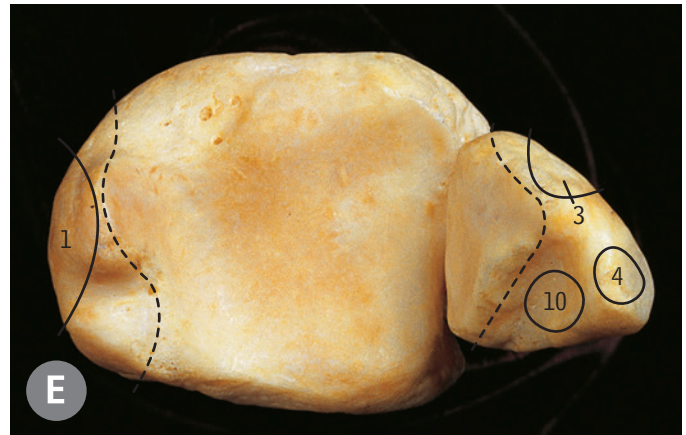
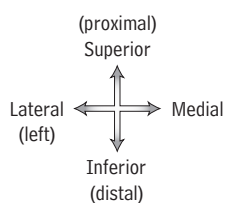
C The fibula from the medial side



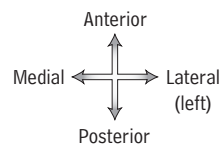
The attachment of the capsule of the ankle joint is indicated by the dashed line, and that of the talocalcaneonavicular joint is indicated by the dotted line.



D The talus, tibia and fibula, articulated, from behind



E The tibia and fibula, articulated, from below



- 1 Medial (deltoid) ligament
- 2 Anterior tibiofibular ligament
- 3 Anterior talofibular ligament
- 4 Calcaneofibular ligament
- 5 Interosseous membrane
- 6 Interosseous tibiofibular ligament
- 7 Posterior tibiofibular ligament
- 8 Fibularis (*peroneus*) tertius
- 9 Flexor hallucis longus
- 10 Posterior talofibular ligament
- 11 Deep part of medial (deltoid) ligament

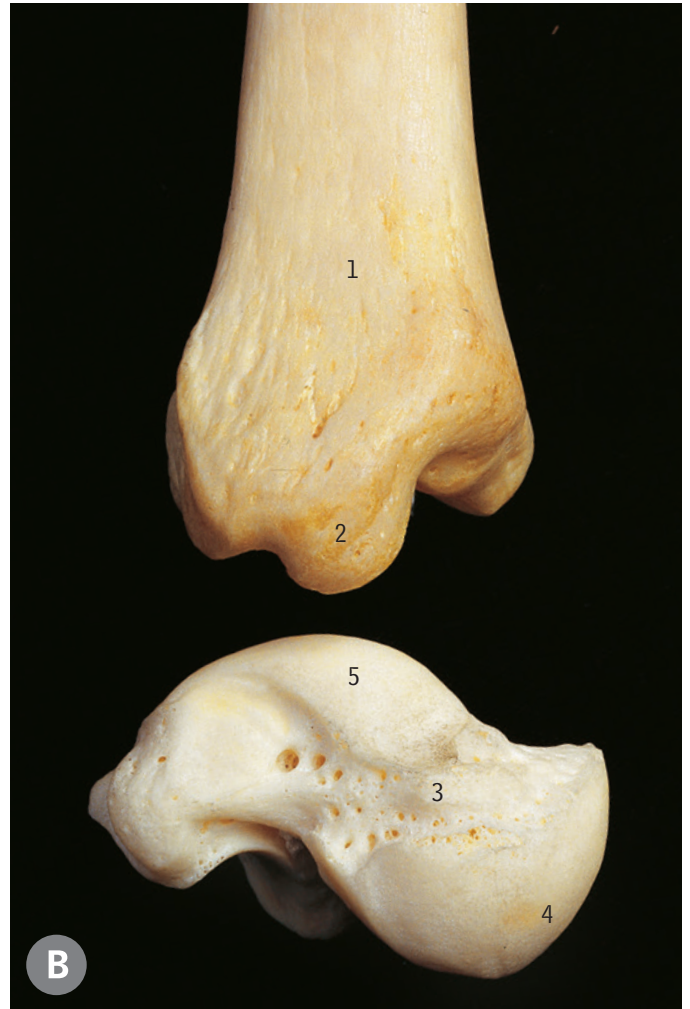
- The interosseous tibiofibular ligament (B and C, 6) is the main bond of union of the inferior tibiofibular joint.

Foot bones

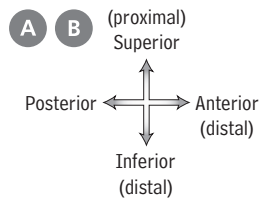
Left talus and the lower ends of the tibia and fibula



A The talus and tibia, articulated, from the medial side



B The talus and tibia, disarticulated, from the medial side



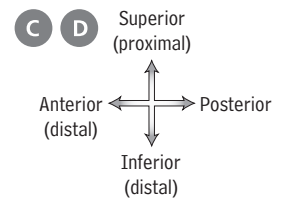


C The talus, tibia and fibula, articulated, from the lateral side

- 1 Medial surface } of tibia
- 2 Medial malleolus }
- 3 Neck } of talus
- 4 Head }
- 5 Surface for medial malleolus
- 6 Anterior surface of tibia
- 7 Triangular subcutaneous surface } of fibula
- 8 Lateral malleolus }
- 9 Surface for lateral malleolus

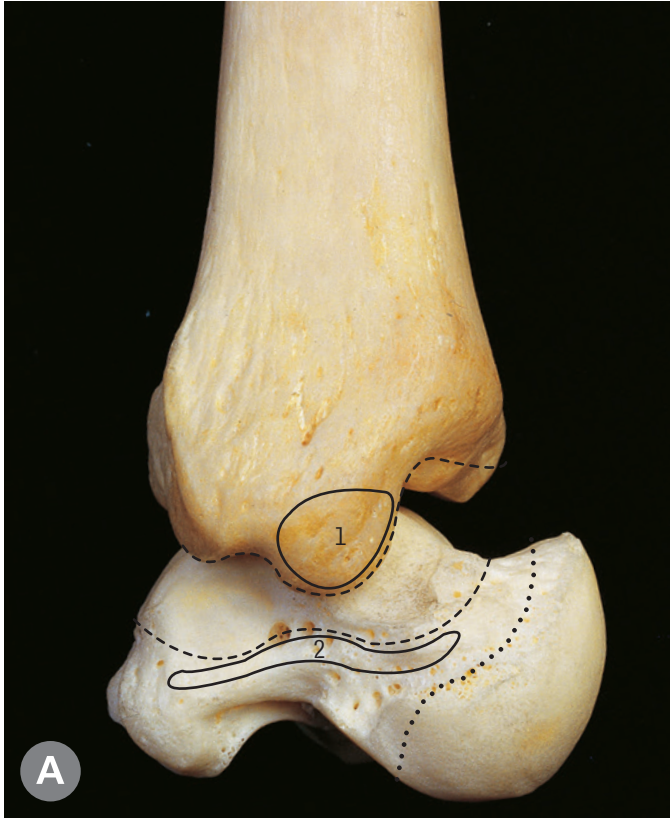


D The talus disarticulated from the tibia and fibula, from the lateral side

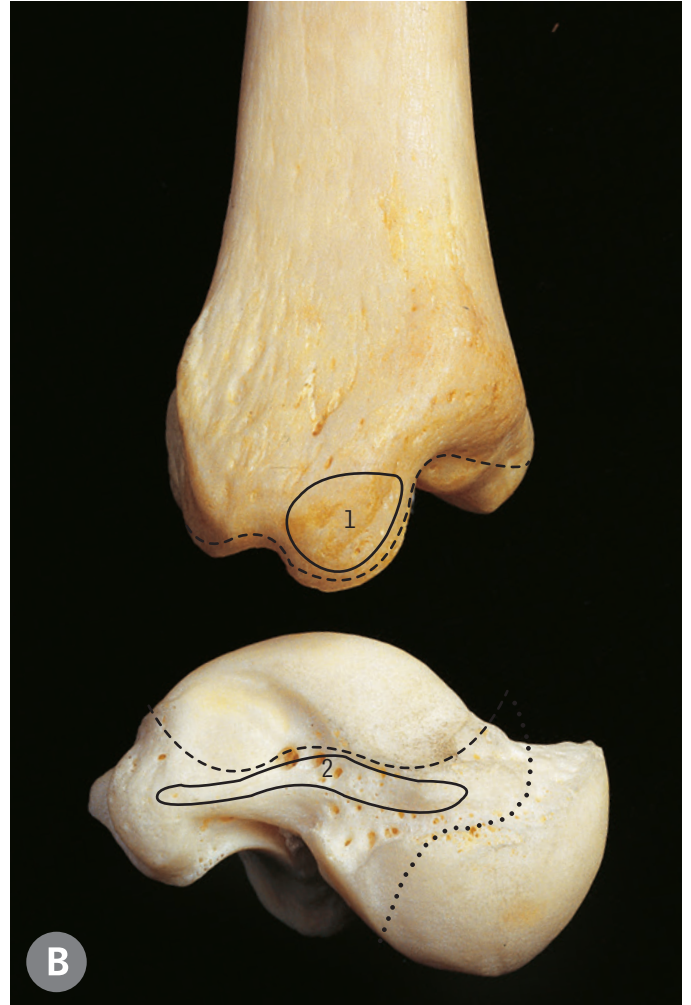
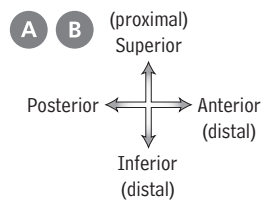


Foot bones

Left talus and the lower ends of the tibia and fibula, with ligamentous attachments in the ankle region



A The talus and tibia, articulated, from the medial side



B The talus and tibia, disarticulated, from the medial side

The attachment of the capsule of the ankle joint is indicated by the dashed line, and that of the talocalcaneonavicular joint is indicated by the dotted line.

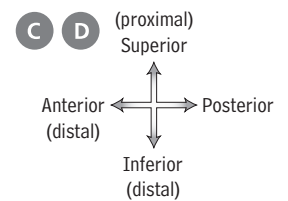


C The talus, tibia and fibula, articulated, from the lateral side

- 1 Medial (deltoid) ligament
- 2 Deep part of medial (deltoid) ligament
- 3 Anterior tibiofibular ligament
- 4 Anterior talofibular ligament
- 5 Calcaneofibular ligament
- 6 Posterior tibiofibular ligament



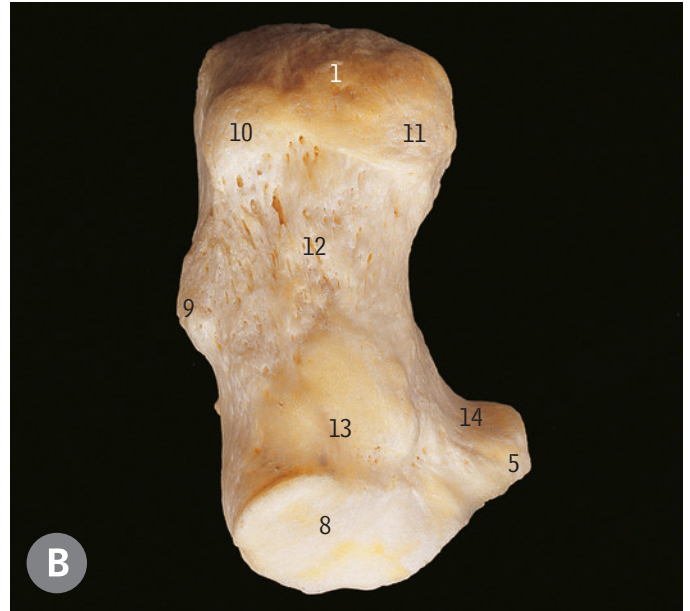
D The talus disarticulated from the tibia and fibula, from the lateral side by the dotted line.



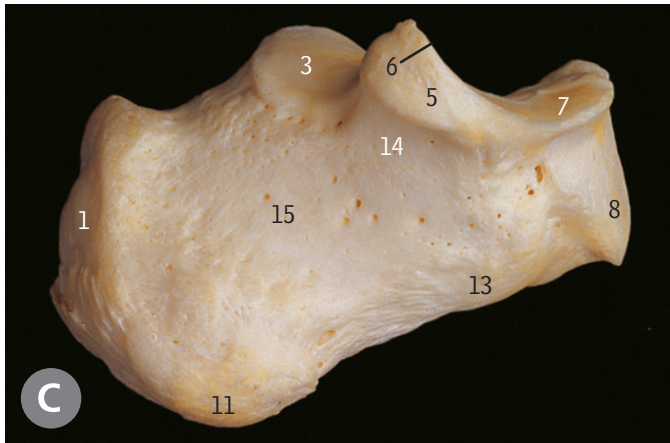
Foot bones *Left calcaneus*



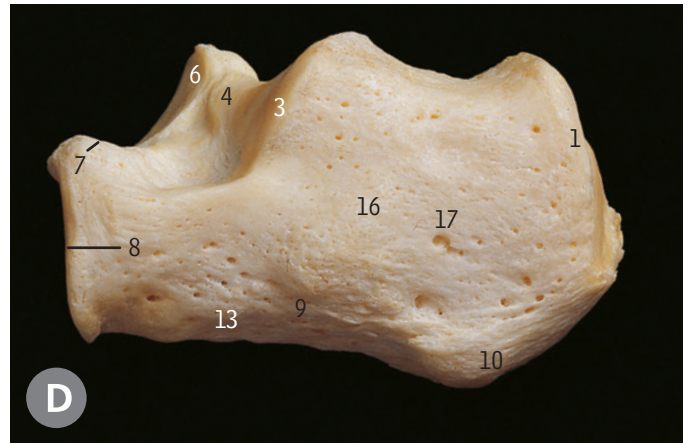
A From above



B From below



C From the medial side

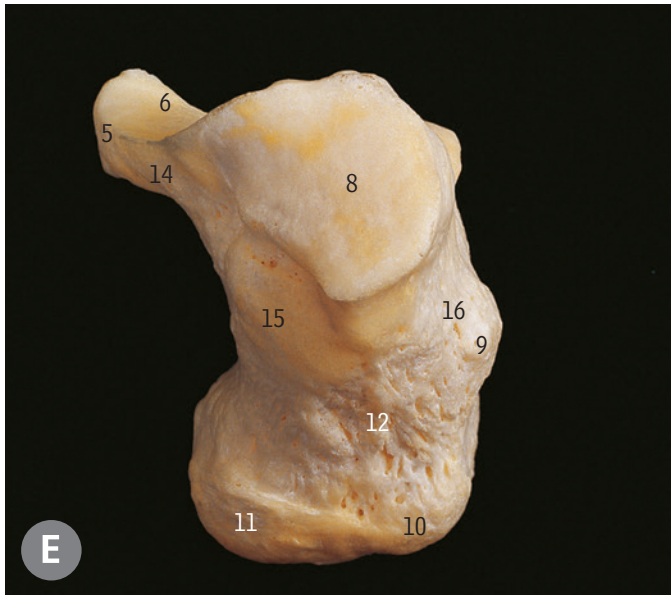


D From the lateral side

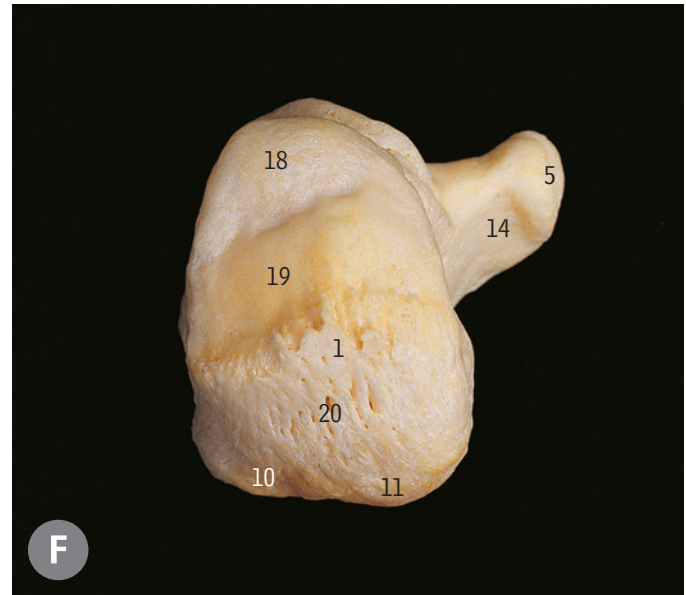
- 1 Posterior surface
- 2 Dorsal surface
- 3 Posterior articular surface for talus
- 4 Sulcus calcanei
- 5 Sustentaculum tali
- 6 Middle articular surface for talus
- 7 Anterior articular surface for talus
- 8 Articular surface for cuboid
- 9 Fibular (*peroneal*) trochlea
- 10 Lateral process
- 11 Medial process
- 12 Plantar surface
- 13 Anterior tubercle
- 14 Groove for flexor hallucis longus tendon
- 15 Medial surface

- 16 Lateral surface
- 17 Tubercle for calcaneofibular ligament
- 18 Surface for bursa
- 19 Surface for tendo calcaneus
- 20 Surface for fibrofatty tissue
- 21 Medial
- 22 Lateral
- 23 Tibiocalcaneal part of medial (deltoid) ligament
- 24 Interosseous talocalcaneal ligament
- 25 Inferior extensor retinaculum
- 26 Cervical ligament
- 27 Extensor digitorum brevis
- 28 Calcaneocuboid part
- 29 Calcaneonavicular part of bifurcate ligament

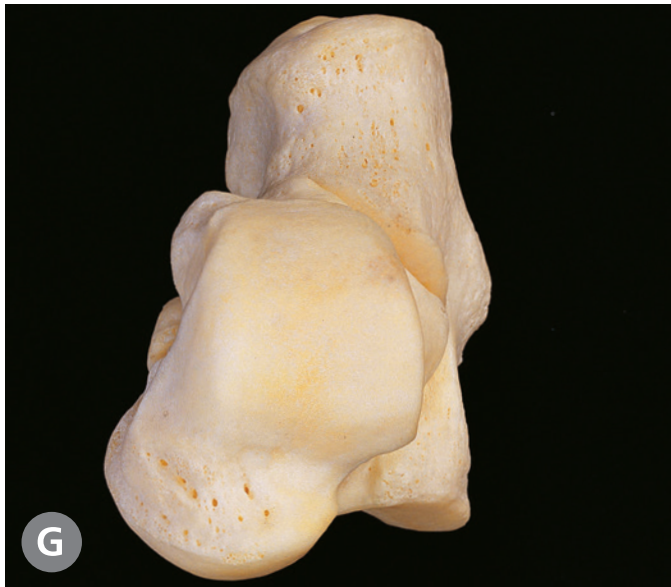
The capsule of the talocalcanean joint is indicated by the dashed line, and that of the talocalcaneonavicular joint is indicated by the dotted line.



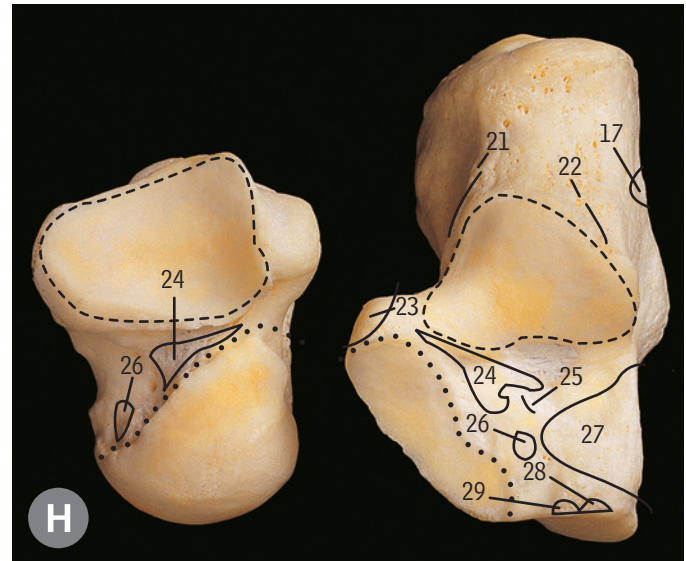
E From the front



F From behind



G Articulated with the talus, from above

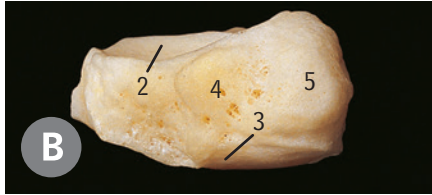
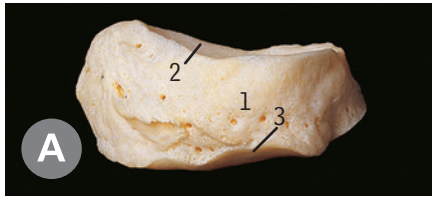


H With the talus disarticulated and turned upside down, with attachments

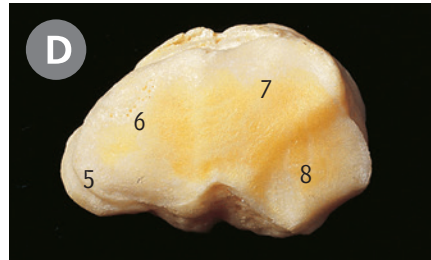
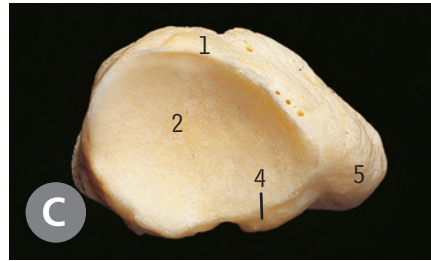
Calcaneus

- The largest foot bone, forming the heel.
- Formerly known as the calcaneum or os calcis.
- Articular facets on the upper surface for the talus and on the anterior surface for the cuboid.
- Prominent sustentaculum tali projecting medially.
- When the talus and calcaneus are articulated, the sulcus tali (see p. 52, B12) and sulcus calcanei (4) form the tarsal sinus (sinus tarsi).

Foot bones



- A** From above
B From below
C Proximal aspect
D Distal aspect

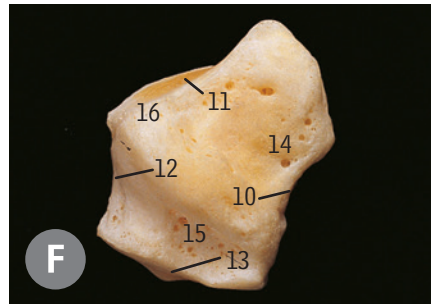
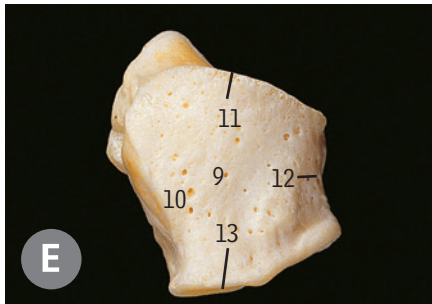


Left navicular bone

- 1** Dorsal surface
2 Proximal surface for talus
3 Distal surface for cuneiforms
4 Plantar surface
5 Tuberosity
6 Facet for medial cuneiform
7 Facet for intermediate cuneiform
8 Facet for lateral cuneiform
- } on distal surface

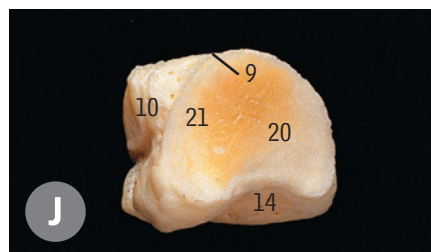
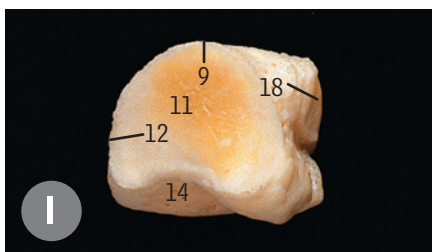
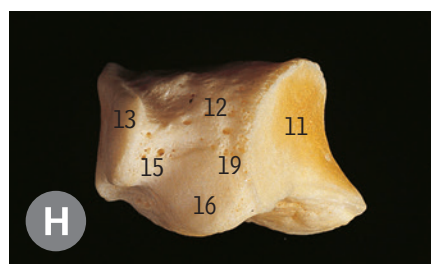
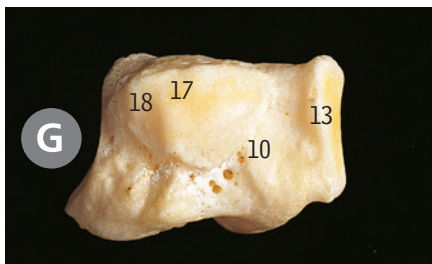
Navicular bone

- Formerly known as the scaphoid bone.
- Posterior articular facet for the talus; anterior articular facet for the three cuneiforms.



Left cuboid bone

- E** From above
F From below
G From the medial side
H From the lateral side
I Proximal aspect
J Distal aspect

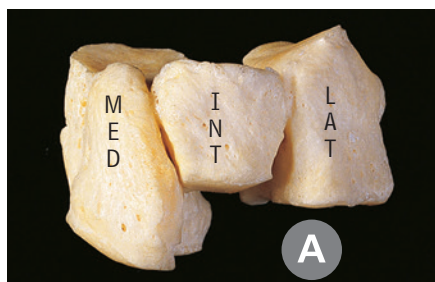


- 9** Dorsal surface
10 Medial surface
11 Proximal surface for calcaneus
12 Lateral surface
13 Distal surface
14 Plantar surface
15 Groove for fibularis (*peroneus*) longus tendon
16 Tuberosity
17 Surface for lateral cuneiform
18 Surface for navicular
19 Facet for sesamoid bone in fibularis (*peroneus*) longus tendon
20 Facet for fifth metatarsal
21 Facet for fourth metatarsal
- } on distal surface

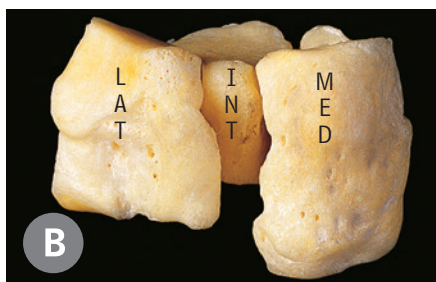
Cuboid bone

- Posterior articular facet for the calcaneus; anterior articular facet for the fourth and fifth metatarsals.
- Groove on the undersurface for the tendon of fibularis (*peroneus*) longus.

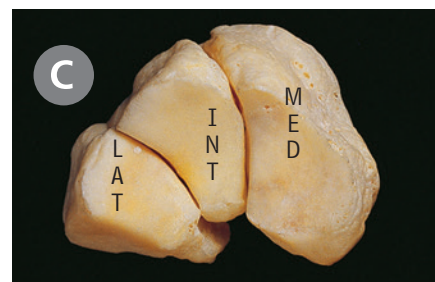
Articulated left cuneiform bones (medial, intermediate and lateral)



A From above

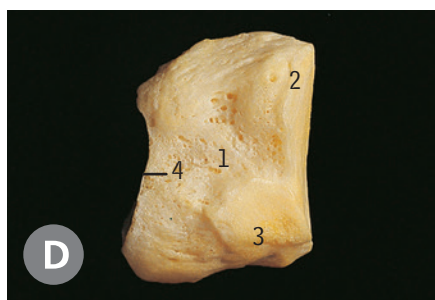


B From below

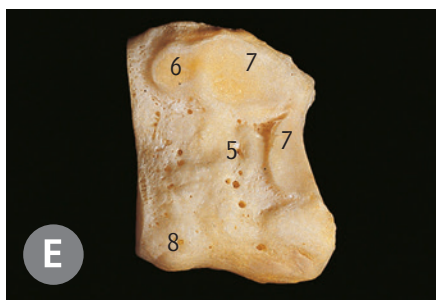


C Proximal (navicular) aspect (for distal aspect, see p. 72)

Left medial cuneiform bone



D From the medial side

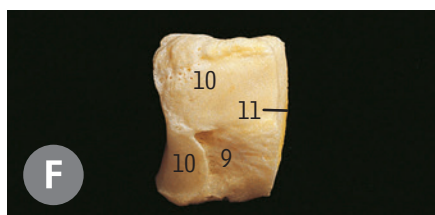


E From the lateral side

Cuneiform bones

- Medial (the largest), intermediate (the smallest) and lateral.
- Situated between the navicular and the first three metatarsals.

Left intermediate cuneiform bone

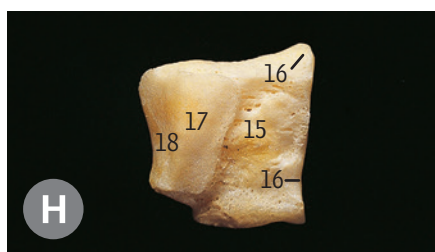


F From the medial side

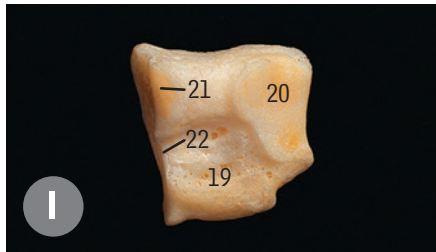


G From the lateral side

Left lateral cuneiform bone



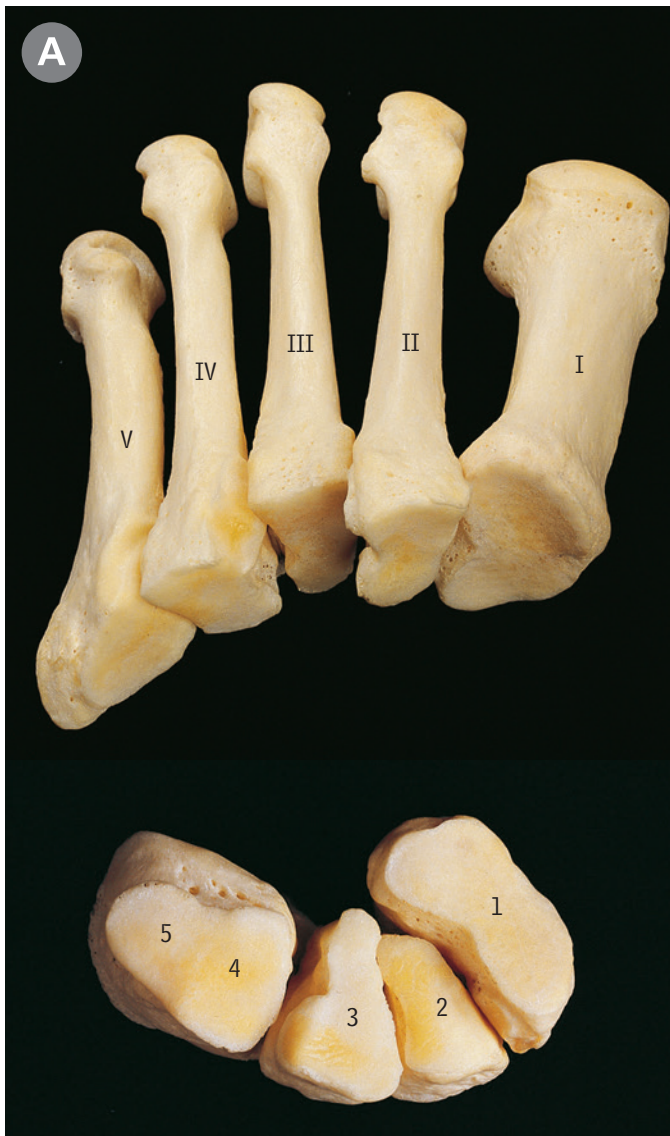
H From the medial side



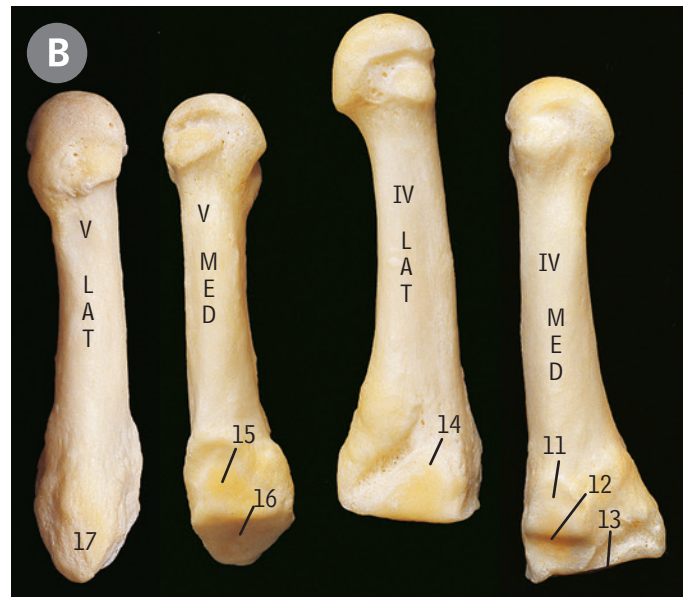
I From the lateral side

- 1 Medial surface
- 2 Distal surface for first metatarsal
- 3 Area for tendon of tibialis anterior
- 4 Proximal surface for navicular
- 5 Lateral surface
- 6 Surface for second metatarsal
- 7 Surface for intermediate cuneiform
- 8 Area for fibularis (*peroneus*) longus tendon
- 9 Medial surface
- 10 Surface for medial cuneiform
- 11 Distal surface for second metatarsal
- 12 Lateral surface
- 13 Surface for lateral cuneiform
- 14 Proximal surface for navicular
- 15 Medial surface
- 16 Surfaces for second metatarsal
- 17 Surface for intermediate cuneiform
- 18 Proximal surface for navicular
- 19 Lateral surface
- 20 Surface for cuboid
- 21 Surface for fourth metatarsal
- 22 Distal surface for third metatarsal

Foot bones



A Left cuneiform, cuboid and metatarsal bones articulated, from above and in front



The metatarsal bones are articulated with each other but have been disarticulated from the cuneiform and cuboid bones, which have been rotated to show the surfaces that articulate with the metatarsals. For orientation, see articulated foot (p. 50).

- 1 Surface of medial cuneiform for first metatarsal
- 2 Surface of intermediate cuneiform for second metatarsal
- 3 Surface of lateral cuneiform for third metatarsal
- 4 Surface of cuboid for fourth metatarsal
- 5 Surface of cuboid for fifth metatarsal

- The base of the third metatarsal articulates with the lateral cuneiform and the bases of the second and fourth metatarsals.
- The base of the fourth metatarsal articulates with the lateral cuneiform and the cuboid and the base of the fifth metatarsal.
- The base of the fifth metatarsal articulates with the cuboid and the base of the fourth metatarsal.



B C Left metatarsal bones—numbered I–V with their medial and lateral sides named

The bones are arranged on their sides so that the articular surfaces on the adjacent sides of their bases can be seen; for orientation see articulated foot (p. 50).

- 1 Groove on head for sesamoid bone
- 2 Surface for medial cuneiform
- 3 Area for bursa
- 4 Surface for medial cuneiform
- 5 Surface for intermediate cuneiform
- 6 Surfaces for third metatarsal
- 7 Surfaces for lateral cuneiform
- 8 Surfaces for second metatarsal
- 9 Surface for lateral cuneiform
- 10 Surface for fourth metatarsal
- 11 Surface for third metatarsal
- 12 Surface for lateral cuneiform
- 13 Surface for cuboid
- 14 Surface for fifth metatarsal
- 15 Surface for fourth metatarsal
- 16 Surface for cuboid
- 17 Tuberosity of base

Metatarsal bones

- First to fifth, leading to each toe and each with a base (at the proximal or ankle end), body or shaft, and head (at the toe end). Bases of first three articulate with cuneiform bones; bases of fourth and fifth articulate with the cuboid. Heads articulate with bases of proximal phalanges.
- The second, third and fourth metatarsals are longer than the first and fifth; the first is the shortest and the thickest.
- The second metatarsal is the longest bone and its base is recessed between the medial and lateral cuneiforms as well as articulating with the intermediate cuneiform (forming a Keystone). Thus, the second metatarsal is the most rigid of the metatarsals.
- The cuneiforms and bases of the metatarsals are wedge shaped to help form a bony arch.

- Refer to an articulated foot (p. 50) and note the following:
The base of the first metatarsal articulates with the medial cuneiform. There is normally a bursa but not a joint between the bases of the first and second metatarsals.
The base of the second metatarsal articulates with all three cuneiforms and with the base of the third metatarsal. This second metatarsal base extends more proximally than the first and third bases—an interlocking device that prevents side-to-side movement.

Lower leg and foot

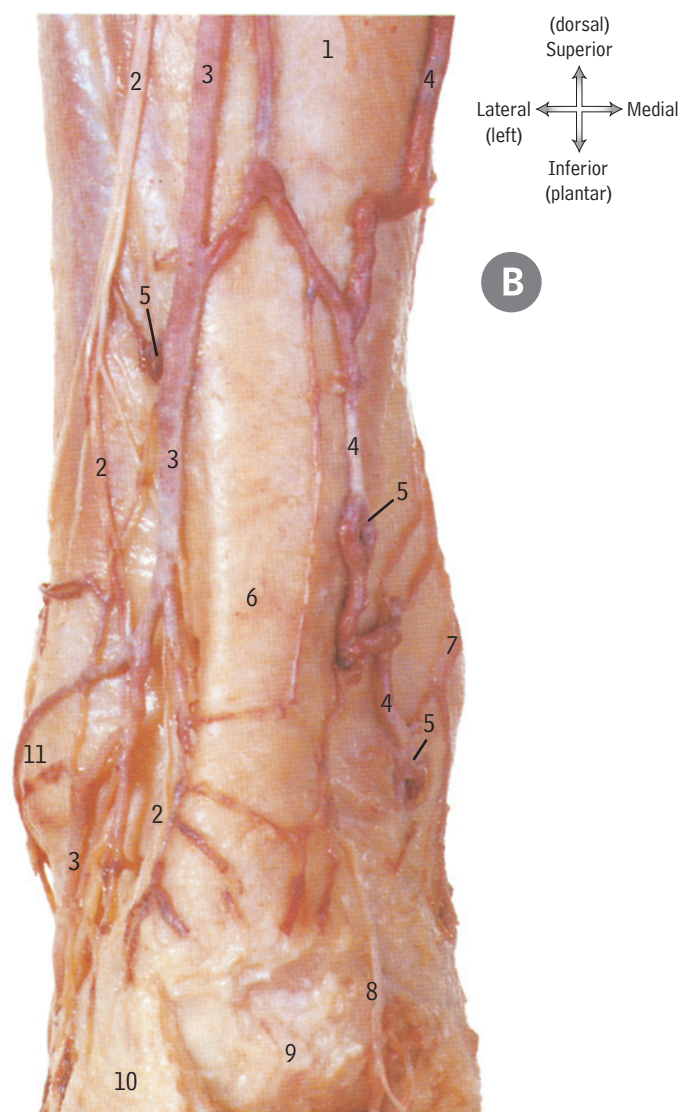


A Superficial vessels and nerves of the left lower leg and foot, from the front

Skin and superficial connective tissue have been removed to show the superficial vessels and nerves lying on the deep fascia (1). In A the medial side of the dorsal venous arch (14) joins the medial marginal vein of the foot to form the great saphenous vein (5), which runs up in front of the medial malleolus (7). The medial and lateral branches of the superficial fibular (*peroneal*) nerve (8 and 9) pass down on to the dorsum, supplemented on the medial side by the saphenous nerve (6) and on the lateral side by the sural nerve (18). The end of the deep fibular (*peroneal*) nerve (13) perforates the deep fascia to run to the first toe cleft.

- 1 Deep fascia
- 2 Tendon of tibialis anterior (under fascia)
- 3 Tendon of extensor digitorum longus (under fascia)
- 4 Medial surface of tibia (under fascia)
- 5 Great saphenous vein
- 6 Saphenous nerve
- 7 Medial malleolus
- 8 Medial branch } of superficial fibular (*peroneal*) nerve
- 9 Lateral branch }
- 10 Lateral malleolus
- 11 A perforating vein
- 12 Proper dorsal digital nerve of great toe
- 13 Medial terminal branch of deep fibular (*peroneal*) nerve
- 14 Dorsal venous arch
- 15 Dorsal digital nerve to second cleft
- 16 Dorsal digital nerve to third cleft
- 17 Dorsal digital nerve to fourth cleft
- 18 Sural nerve

- The skin of the first toe cleft is supplied by the *deep* fibular (*peroneal*) nerve (A13); the skin of the other clefts is supplied by the *superficial* fibular (*peroneal*) nerve (A8 and 9).
- The skin behind the ankle and at the back of the heel is supplied on the medial side by the saphenous nerve (A6, from the femoral nerve) and the medial calcaneal branches (B8) of the tibial nerve, and on the lateral side by the sural nerve (B2, also from the tibial nerve).
- The saphenous nerve (A6) on the medial side of the foot supplies skin as far forward as the metatarsophalangeal joint of the great toe.
- The sural nerve (A18) on the lateral side of the foot supplies skin as far forward as the side of the fifth toe.
- The skin of the medial side of the dorsum of the foot, including the region of the medial malleolus, is part of the fourth lumbar dermatome (Fig. 9, p. 153). The fifth lumbar dermatome includes the rest of the dorsum, and the first sacral dermatome includes the lateral side of the foot and the lateral malleolar region.
- The *great* saphenous vein (A5) passes upward in front of the medial malleolus (A7).
- The *small* saphenous vein (B3) passes upward behind the lateral malleolus (B11).



B

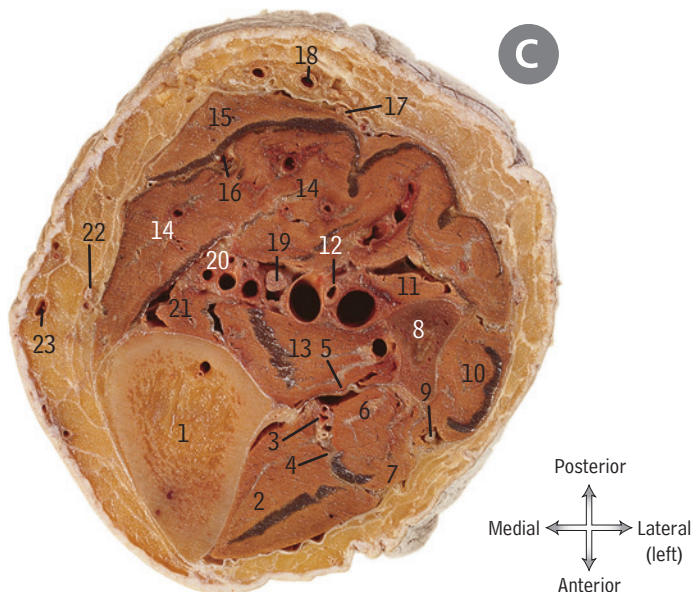
B Superficial vessels and nerves of the left lower leg and foot, from behind

In B the most obvious structure is the tendo calcaneus (Achilles tendon, 6), running down to be attached to the back of the calcaneus (9). The small saphenous vein (3) and sural nerve (2) with their tributaries and branches are behind the lateral malleolus (11). On both sides but especially the medial, there are some typical perforating veins (5), piercing the deep fascia to form communications between the superficial and deep veins. The posterior arch vein (4) unites several of the perforators on the medial side.

- 1 Deep fascia
- 2 Sural nerve
- 3 Small saphenous vein
- 4 Posterior arch vein
- 5 A perforating vein
- 6 Tendo calcaneus (under fascia)
- 7 Medial malleolus
- 8 Medial calcaneal nerve
- 9 Posterior surface of calcaneus
- 10 Fibrofatty tissue of heel
- 11 Lateral malleolus

C Axial cross section of the left leg above the level of the upper part of B

The section in C is viewed from below, looking from the ankle toward the knee. Tibialis posterior (13) is the deepest of the calf muscles (immediately behind the interosseous membrane, 5) with the tibial nerve (19) behind it and the posterior tibial vessels (20) more medially, between flexor digitorum longus (21) and soleus (14). The fibular (*peroneal*) artery (12) is adjacent to flexor hallucis longus (11) behind the fibula (8). Note the (unlabeled) dilated veins within and deep to soleus (14); they are the site for potentially dangerous deep venous thrombosis. In the anterior compartment, in front of the interosseous membrane (5), the anterior tibial vessels (3) and deep fibular (*peroneal*) nerve (4) are between tibialis anterior (2) and extensor hallucis longus (6).



C

- | | |
|--|---------------------------------------|
| 1 Tibia | 11 Flexor hallucis longus |
| 2 Tibialis anterior | 12 Fibular (<i>peroneal</i>) artery |
| 3 Anterior tibial vessels | 13 Tibialis posterior |
| 4 Deep fibular (<i>peroneal</i>) nerve | 14 Soleus |
| 5 Interosseous membrane | 15 Gastrocnemius |
| 6 Extensor hallucis longus | 16 Plantaris tendon |
| 7 Extensor digitorum longus | 17 Sural nerve |
| 8 Fibula | 18 Small saphenous vein |
| 9 Superficial fibular (<i>peroneal</i>) nerve | 19 Tibial nerve |
| 10 Fibularis (<i>peroneus</i>) longus and brevis | 20 Posterior tibial vessels |
| | 21 Flexor digitorum longus |
| | 22 Saphenous nerve |
| | 23 Great saphenous vein |

Lower leg and foot

This medial view emphasizes the position of the great saphenous vein (3) in front of the medial malleolus (5), with branches of the saphenous nerve (4) lying both in front of and behind the vein. There are perforating

veins (9) behind the malleolus and joining the posterior arch vein (12) and a large medial calcaneal branch (10) of the tibial nerve running down to the skin of the heel.

- In the specimen shown on pp. 74–77 some of the superficial veins are rather dilated and tortuous, but this has served to emphasize the posterior arch vein and perforating veins.
- The perforating veins (A9, B8) serve as communications between the superficial veins (above the deep fascia) and deep veins (below the fascia). Many of these communicating vessels possess valves that direct the flow of blood from superficial to deep; venous return from the limb is then brought about by the pumping action of the muscles (which are all below the deep fascia). If the valves become incompetent or the deep veins are blocked, pressure in the superficial veins increases and they become varicose (from the Latin for an enlarged and tortuous vessel).
- Perforating veins are variable in number and position but the most constant in the lower leg (A9) are near the posterior border of the tibia, one just below and one just above the medial malleolus (A5). The posterior arch vein (A12) unites these and perhaps other perforators and drains usually into the great saphenous vein below the knee.



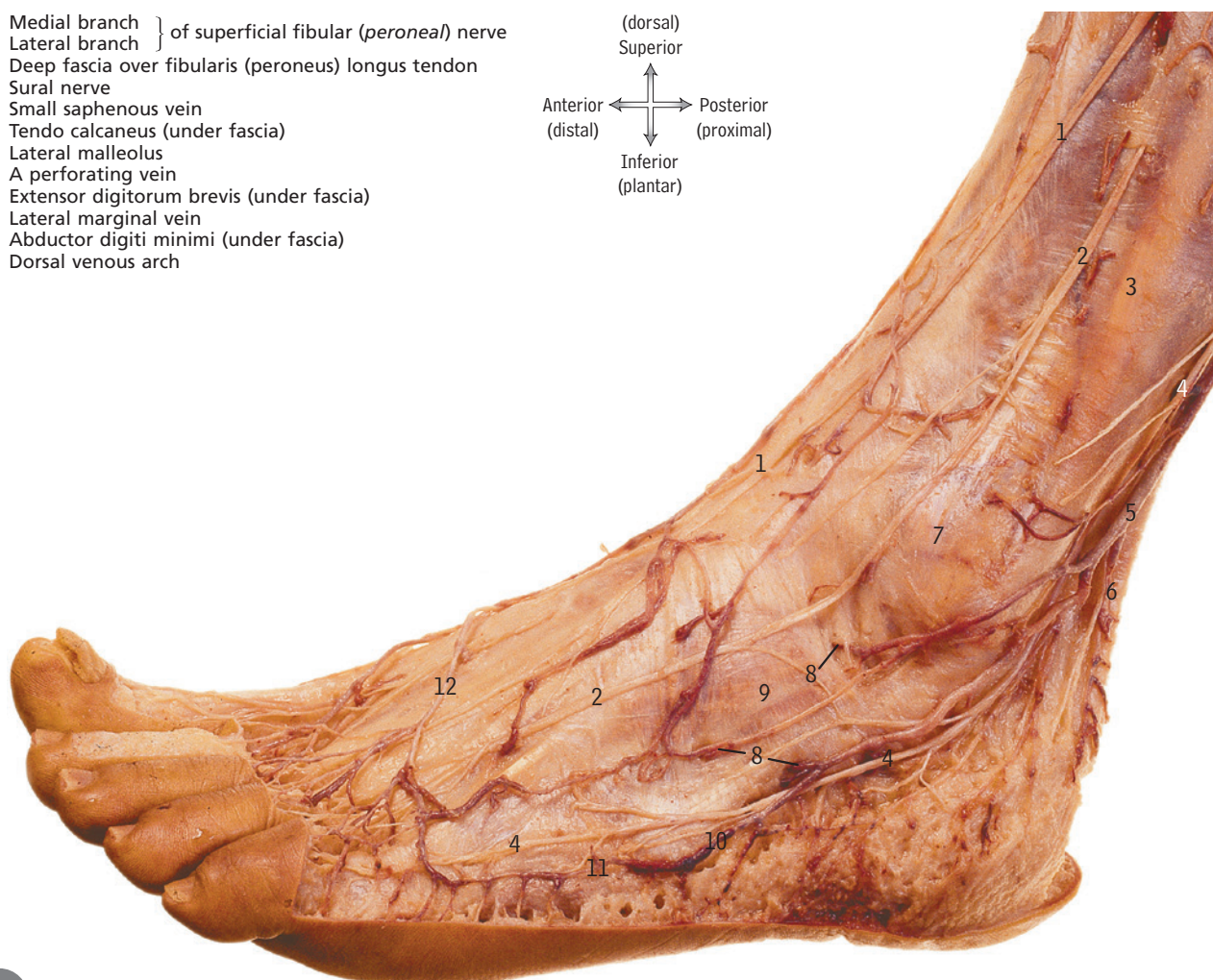
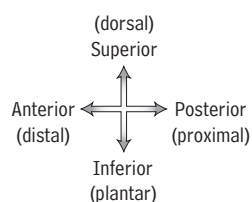
A

A Superficial vessels and nerves of the left lower leg and foot, from the medial side

The medial and lateral branches of the superficial fibular (*peroneal*) nerve (1 and 2) run on to the dorsum of the foot. Behind the lateral malleolus (7) are the small saphenous vein (5) and sural nerve (4). The tendon of fibularis (*peroneus*) longus (3) shines through the deep fascia above the malleolus.

- The superficial veins of the dorsum include dorsal digital and dorsal metatarsal veins, which join a dorsal venous arch (B12). The ends of the arch join medial and lateral marginal veins that run upward to become the great and small saphenous veins, respectively. (In A there is no obvious medial marginal vein, but there is a lateral marginal vein in B10.)
- The deep veins run with the deep arteries. The larger arteries in the leg are usually accompanied by a pair of veins (*venae comitantes*).
- Lymph vessels, resembling narrow, thin-walled veins, accompany many arteries and veins, both superficial and deep. There are no lymph nodes in the foot; most of the lymphatic drainage of the lower limb is to inguinal nodes, but some lymphatic vessels drain into six or seven nodes that lie in the fat of the popliteal fossa. (Occasionally there is a single node beside the upper end of the anterior tibial artery in front of the interosseous membrane.)
- For details of the lymphatic system of the lower Limb see pp. 163–167.

- 1 Medial branch } of superficial fibular (*peroneal*) nerve
- 2 Lateral branch }
- 3 Deep fascia over fibularis (*peroneus*) longus tendon
- 4 Sural nerve
- 5 Small saphenous vein
- 6 Tendo calcaneus (under fascia)
- 7 Lateral malleolus
- 8 A perforating vein
- 9 Extensor digitorum brevis (under fascia)
- 10 Lateral marginal vein
- 11 Abductor digiti minimi (under fascia)
- 12 Dorsal venous arch



B

B Superficial vessels and nerves of the left lower leg and foot, from the lateral side

Deep fascia of the foot

Deep fascia of the right lower leg and foot, from the front and the right



All superficial tissues, including vessels and nerves, have been removed to display the deep fascia. It is thickened in places to form the retinacula (2, 4—see notes), which keep tendons in their proper places; compare with the dissections on pp. 80–83 in which the fascia has been removed to leave only the retinacula. Here, with all the deep fascia intact, tendons and muscles can be seen shining through it.

- The retinacula of the ankle and foot are localized thickenings of deep fascia, which keep tendons in place.
- There are two extensor retinacula (superior and inferior), a flexor retinaculum and two fibular (*peroneal*) retinacula (superior and inferior).
- The superior extensor retinaculum (2) is a band about 4 cm broad and is attached to the lower ends of the anterior borders of the tibia and fibula (see pp. 80, A7 and 76, A12).
- The inferior extensor retinaculum (4) is shaped like a letter Y lying on its side (see pp. 80, A9; 82, A15; and 83, B13).
The common stem of the Y is on the lateral side and is attached to the upper surface of the calcaneus in front of the sulcus calcanei. The tendons of extensor digitorum longus and fibularis (*peroneus*) tertius (with a common synovial sheath) pass beneath it.
The upper band of the Y continues upward and medially from the common stem over the deep fibular (*peroneal*) nerve and anterior tibial vessels, then forms a loop to enclose the extensor hallucis longus tendon (within a synovial sheath), finally becoming attached to the medial malleolus after passing either superficial or deep to the tendon of tibialis anterior (within a synovial sheath).
The lower band of the Y continues downward and medially from the common stem, passing over the terminal branches of the deep fibular (*peroneal*) nerve, the dorsalis pedis vessels and the tendons of extensor hallucis longus (within a synovial sheath) and tibialis anterior, to blend with the plantar aponeurosis overlying abductor hallucis.
- For the flexor retinaculum, see p. 82.
- For the fibular (*peroneal*) retinacula, see p. 83.

Dorsum and back of the foot

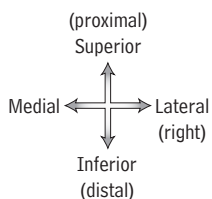
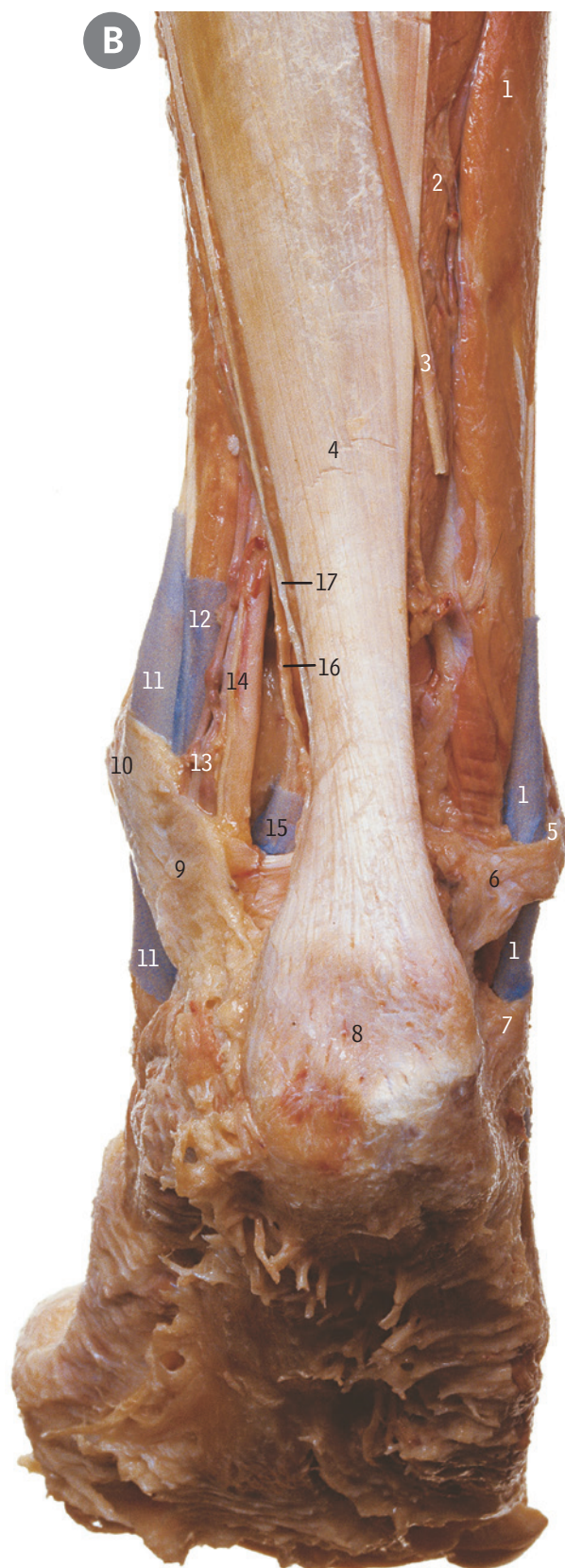


A Superficial dissection of the right lower leg and dorsum of the foot, from the front

Most of the deep fascia has been removed, leaving only the retinacula (7 and 9). The most prominent structures are the long tendons of the extensor muscles (2, 3 and 4) running down from the leg; the synovial sheaths surrounding the tendons in this specimen (which is also shown on pp. 82 and 83) have been emphasized by blue tissue. Extensor digitorum brevis (13, with extensor hallucis brevis, 12—see notes) is the only muscle to arise on the dorsum of the foot.

- Extensor digitorum longus (4) has four tendons that pass to the second, third, fourth and fifth toes.
- Extensor digitorum brevis (13) has four tendons that pass to the great, second, third and fourth toes. The part of the muscle that serves the great toe is known as extensor hallucis brevis (12).
- The dorsal digital expansions (extensor expansions, 20) are derived from the tendons of extensor digitorum longus (4) as they pass over the metatarsophalangeal joints onto the dorsum of the proximal phalanges. They are each triangular in shape with the apex directed distally.
On the second, third and fourth toes the basal angles of the expansions receive tendons from two interossei and one lumbrical muscle, and the central part of the base receives a tendon of extensor digitorum brevis (13). On the fifth toe one interosseus and one lumbrical tendon are attached. The central part of the apex is inserted into the base of the middle phalanx, while two collateral parts run farther forward to be inserted into the base of the distal phalanx (see p. 52, A16 and 17).
- The order of the structures that pass beneath the superior extensor retinaculum and in front of the ankle joint from the medial to the lateral side is:
Tibialis anterior tendon (with a synovial sheath) (2)
Extensor hallucis longus tendon (with no synovial sheath) (3)
Anterior tibial artery and venae comitantes } Hidden between
Deep fibular (*peroneal*) nerve } 3 and 4
Extensor digitorum longus tendon (with no synovial sheath) (4)
Fibularis (*peroneus*) tertius tendon (with no synovial sheath) (hidden by 4)

- | | |
|--|--|
| 1 Medial surface of tibia | 10 Medial malleolus |
| 2 Tibialis anterior | 11 Tibialis posterior |
| 3 Extensor hallucis longus | 12 Extensor hallucis brevis |
| 4 Extensor digitorum longus | 13 Extensor digitorum brevis |
| 5 Subcutaneous surface of fibula | 14 Dorsalis pedis artery |
| 6 Fibularis (<i>peroneus</i>) brevis | 15 First dorsal interosseus |
| 7 Superior extensor retinaculum | 16 Second dorsal interosseus |
| 8 Lateral malleolus | 17 Third dorsal interosseus |
| 9 Inferior extensor retinaculum | 18 Fourth dorsal interosseus |
| | 19 Fibularis (<i>peroneus</i>) tertius |
| | 20 Dorsal digital expansion |



B Superficial dissection of the back of the right lower leg and foot

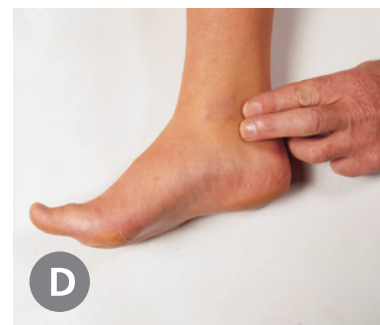
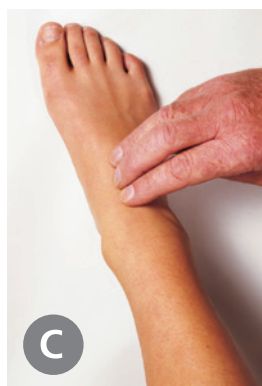
C Palpation of the dorsalis pedis pulse. The dorsalis pedis pulse can be felt on a line from midway between the malleoli (5 and 10) toward the first toe cleft

D Palpation of the posterior tibial pulse. The posterior tibial pulse can be felt behind the medial malleolus (10) and 2.5 cm in front of the Achilles tendon (4)

The deep fascia has been removed, leaving only the flexor and fibular (*peroneal*) retinacula (6, 7 and 9). The Achilles tendon (4) passes down to the back of the calcaneus (8). Flexor tendons (11, 12 and 15) lie behind the medial malleolus (10) and fibular (*peroneal*) tendons (1) behind the lateral malleolus (5).

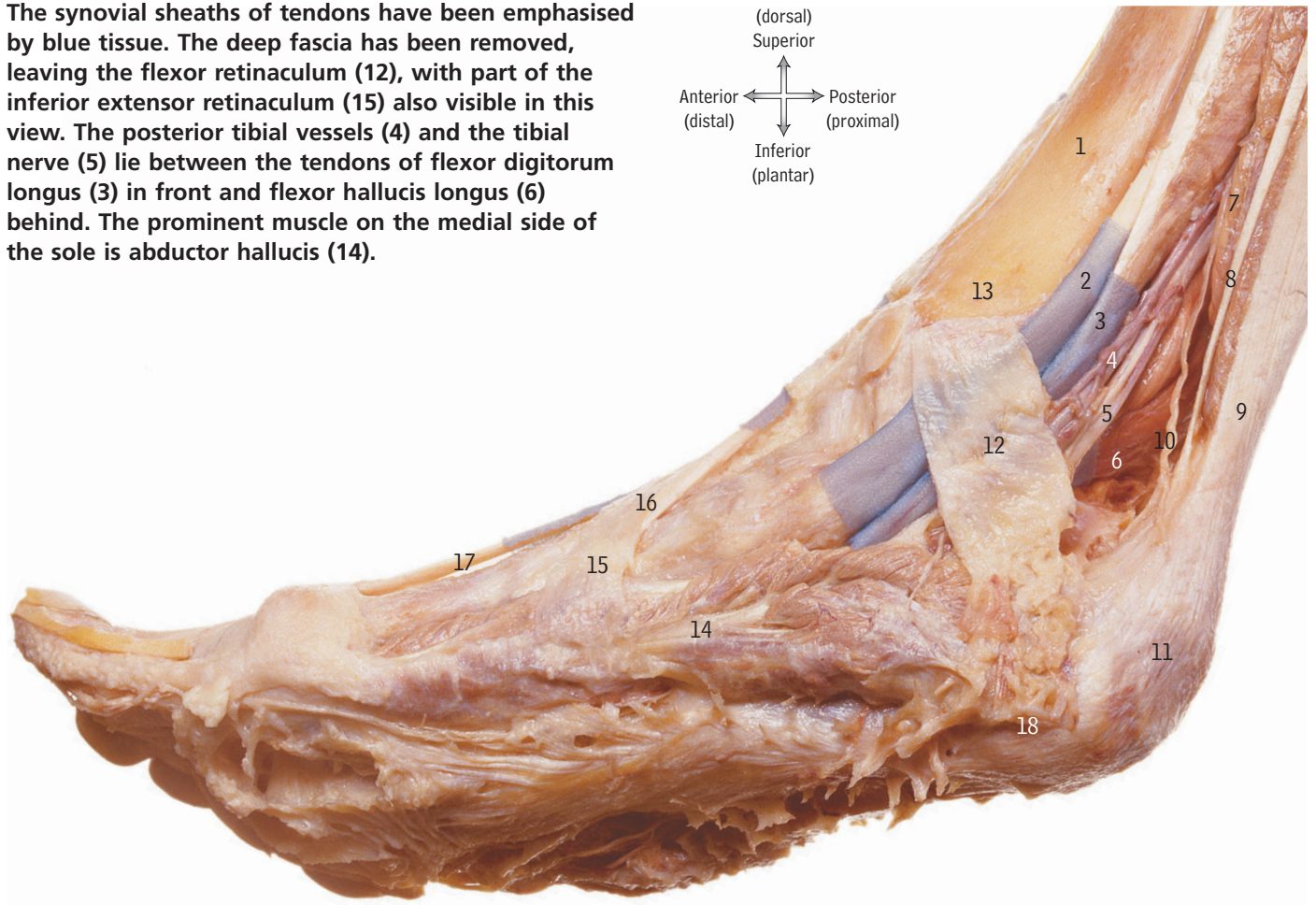
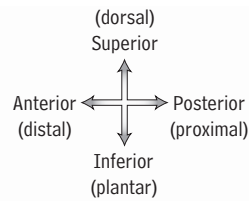
- 1 Fibularis (peroneus) longus overlapping fibularis (peroneus) brevis
- 2 Soleus
- 3 Sural nerve
- 4 Tendo calcaneus (Achilles tendon)
- 5 Lateral malleolus
- 6 Superior } fibular (*peroneal*) retinaculum
- 7 Inferior }
- 8 Posterior surface of calcaneus
- 9 Flexor retinaculum
- 10 Medial malleolus
- 11 Tibialis posterior
- 12 Flexor digitorum longus
- 13 Posterior tibial artery and venae comitantes
- 14 Tibial nerve
- 15 Flexor hallucis longus
- 16 Medial calcaneal nerve
- 17 Plantaris tendon

- For the order of the structures behind the medial malleolus, see the notes on the flexor retinaculum on [p. 82](#).



Dorsum and sides of the foot

The synovial sheaths of tendons have been emphasised by blue tissue. The deep fascia has been removed, leaving the flexor retinaculum (12), with part of the inferior extensor retinaculum (15) also visible in this view. The posterior tibial vessels (4) and the tibial nerve (5) lie between the tendons of flexor digitorum longus (3) in front and flexor hallucis longus (6) behind. The prominent muscle on the medial side of the sole is abductor hallucis (14).

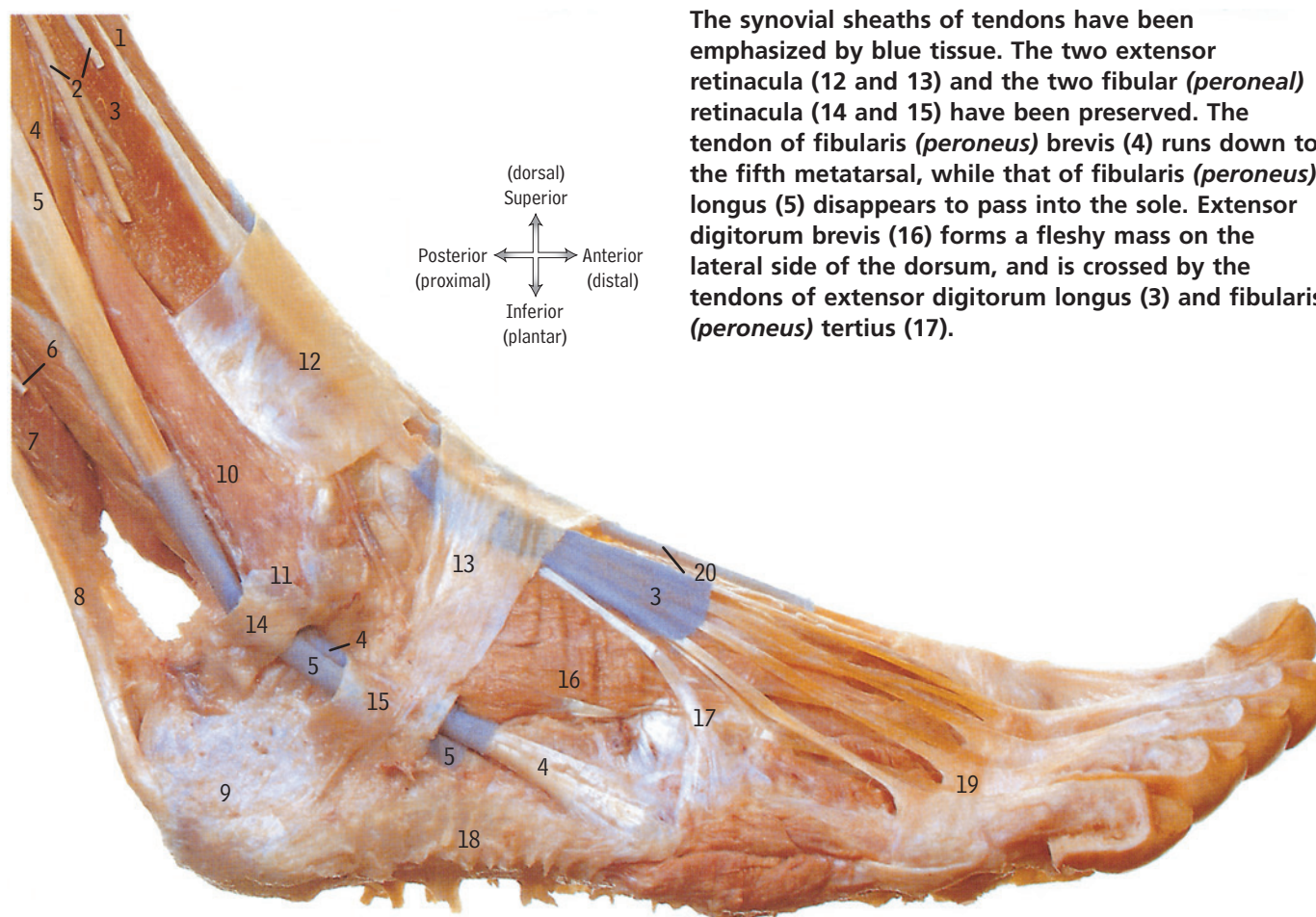


A Superficial dissection of the right lower leg and foot, from the medial side

- 1 Medial surface of tibia
- 2 Tibialis posterior
- 3 Flexor digitorum longus
- 4 Posterior tibial artery and venae comitantes
- 5 Tibial nerve
- 6 Flexor hallucis longus
- 7 Soleus
- 8 Plantaris tendon
- 9 Tendo calcaneus
- 10 Medial calcaneal nerve
- 11 Posterior surface of calcaneus
- 12 Flexor retinaculum
- 13 Medial malleolus
- 14 Abductor hallucis
- 15 Inferior extensor retinaculum
- 16 Tibialis anterior
- 17 Extensor hallucis longus
- 18 Medial process of tuberosity of calcaneus

- The flexor retinaculum (12) passes from the medial malleolus to the medial process of the tuberosity of the calcaneus (18). Deep to the retinaculum are four connective tissue compartments—three for tendons and one for neurovascular structures. The order of the structures behind the medial malleolus from before backwards is:

Tibialis posterior tendon (2, within a synovial sheath)
 Flexor digitorum longus tendon (3, within a synovial sheath)
 Posterior tibial artery and venae comitantes (4)
 Tibial nerve (5)
 Flexor hallucis longus tendon (6, within a synovial sheath).



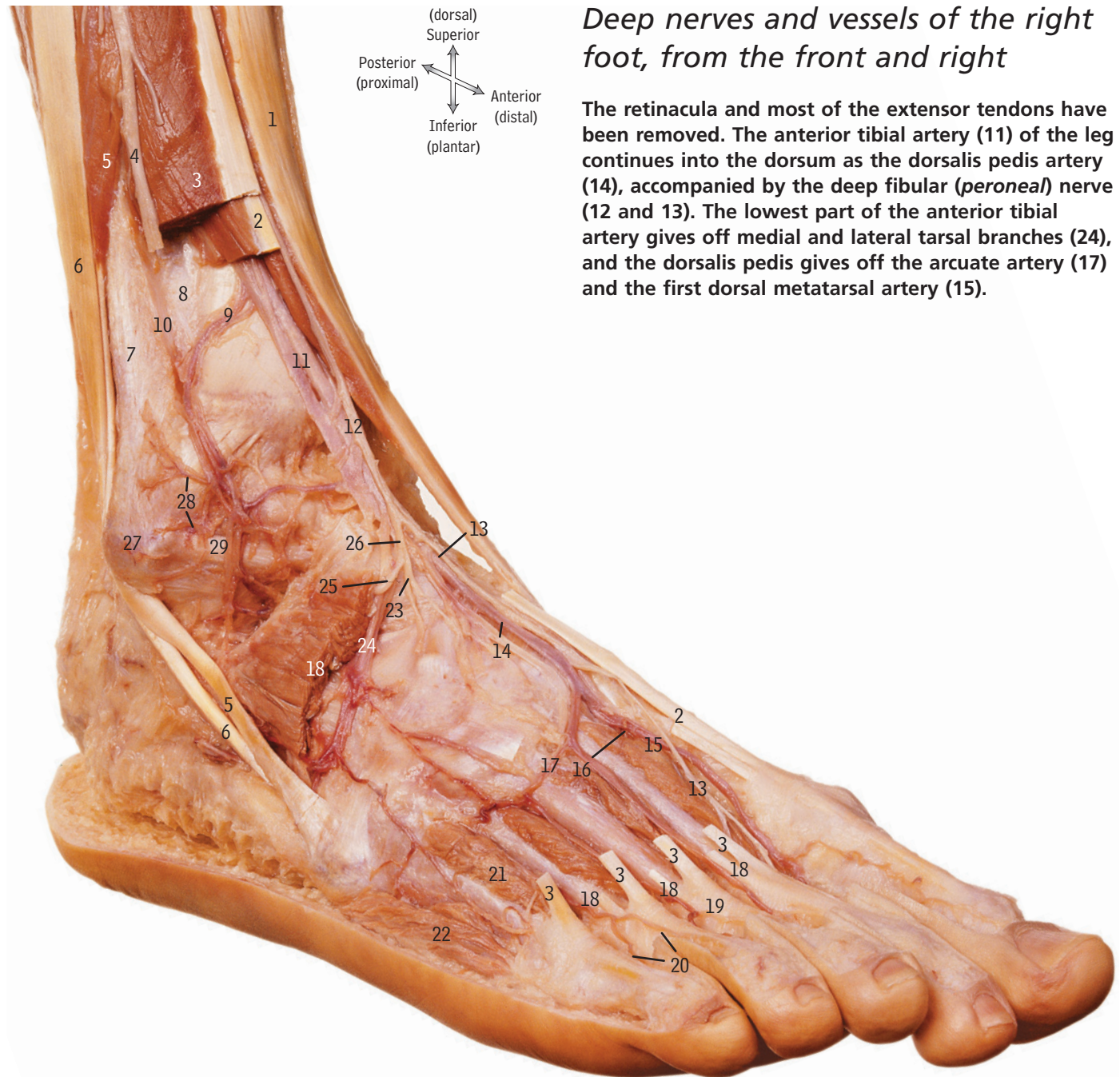
The synovial sheaths of tendons have been emphasized by blue tissue. The two extensor retinacula (12 and 13) and the two fibular (*peroneal*) retinacula (14 and 15) have been preserved. The tendon of fibularis (*peroneus*) brevis (4) runs down to the fifth metatarsal, while that of fibularis (*peroneus*) longus (5) disappears to pass into the sole. Extensor digitorum brevis (16) forms a fleshy mass on the lateral side of the dorsum, and is crossed by the tendons of extensor digitorum longus (3) and fibularis (*peroneus*) tertius (17).

B Superficial dissection of the right lower leg and foot, from the lateral side

- 1 Tibialis anterior
- 2 Medial and lateral branches of superficial fibular (peroneal) nerve
- 3 Extensor digitorum longus
- 4 Fibularis (peroneus) brevis
- 5 Fibularis (peroneus) longus
- 6 Sural nerve
- 7 Soleus
- 8 Tendo calcaneus
- 9 Lateral surface of calcaneus
- 10 Subcutaneous area of fibula
- 11 Lateral malleolus
- 12 Superior } extensor retinaculum
- 13 Inferior } extensor retinaculum
- 14 Superior } fibular (*peroneal*) retinaculum
- 15 Inferior } fibular (*peroneal*) retinaculum
- 16 Extensor digitorum brevis
- 17 Fibularis (peroneus) tertius
- 18 Abductor digiti minimi
- 19 A dorsal digital expansion
- 20 Extensor hallucis longus

- The superior fibular (*peroneal*) retinaculum (14) passes from the lateral malleolus (11) to the lateral surface of the calcaneus (9). Deep to the retinaculum are the tendons of fibularis (*peroneus*) brevis (4) and fibularis (*peroneus*) longus (5) (both within a single synovial sheath). The brevis tendon is in front of the longus tendon.
- The inferior fibular (*peroneal*) retinaculum (15) continues backwards and downwards from the common stem of the inferior extensor retinaculum (13) to the lateral surface of the calcaneus (9), with an intermediate attachment to the fibular (*peroneal*) trochlea (see p. 68, B9). Deep to the retinaculum above and in front of the trochlea is the fibularis (*peroneus*) brevis tendon (4, within its own synovial sheath), while below and behind the trochlea is the fibularis (*peroneus*) longus tendon (5, within its own synovial sheath).

Dorsum and sides of the foot

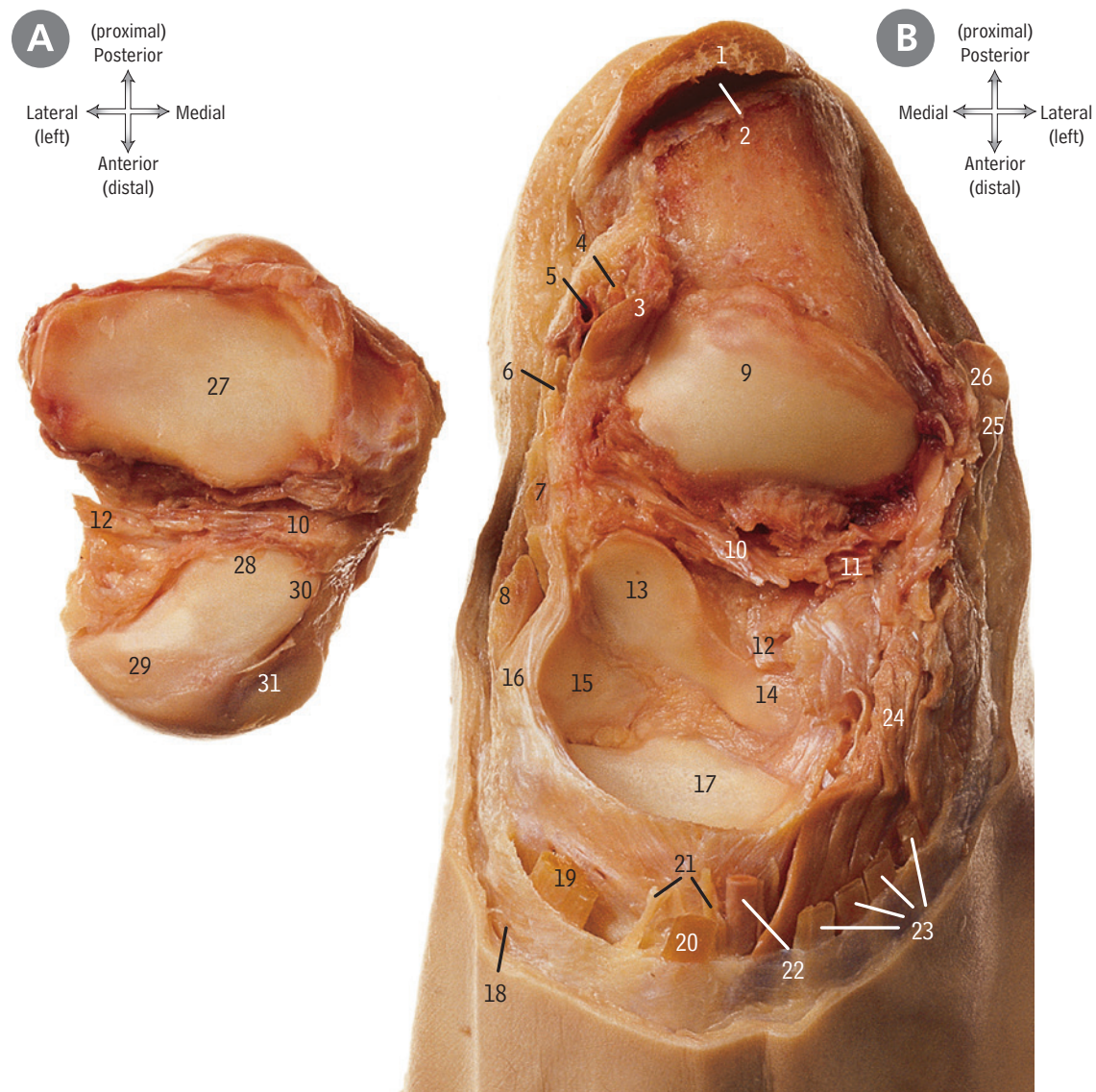


- | | |
|---|---|
| <p> 1 Tibialis anterior
 2 Extensor hallucis longus
 3 Extensor digitorum longus
 4 Lateral branch of superficial fibular (<i>peroneal</i>) nerve
 5 Fibularis (<i>peroneus</i>) brevis
 6 Fibularis (<i>peroneus</i>) longus
 7 Subcutaneous surface of fibula
 8 Interosseous membrane
 9 Lateral malleolar artery and venae comitantes
 10 Perforating branch of fibular (<i>peroneal</i>) artery
 11 Anterior tibial artery
 12 Deep fibular (<i>peroneal</i>) nerve
 13 Medial terminal branch of 12
 14 Dorsalis pedis artery
 15 First dorsal metatarsal artery </p> | <p> 16 Deep plantar artery
 17 Arcuate artery
 18 Extensor digitorum brevis (hallucis brevis to great toe)
 19 Dorsal digital expansion
 20 Dorsal digital artery
 21 Fourth dorsal interosseus
 22 Abductor digiti minimi
 23 Interosseous branch of 26
 24 Lateral tarsal vessels
 25 Nerve to extensor digitorum brevis
 26 Lateral terminal branch of 12
 27 Lateral malleolus
 28 Lateral malleolar arterial rete
 29 Anterior talofibular ligament </p> |
|---|---|

- As the anterior tibial artery (**11**) crosses the lower margin of the tibia at the ankle joint it becomes the dorsalis pedis artery (**14**).
- After giving off medial and lateral tarsal branches (**24**) the dorsalis pedis artery (**14**) ends by dividing into the first dorsal metatarsal and the arcuate arteries (**15** and **17**).
- The first dorsal metatarsal artery (**15**) gives off a deep plantar (perforating) branch (**16**) that passes into the sole between the two heads of the first dorsal interosseus muscle to complete the plantar arch with the deep part of the lateral plantar artery (see [p. 93](#), **B20**).
- The arcuate artery (**17**) gives off the other three dorsal metatarsal arteries, and all the metatarsal arteries give dorsal digital branches.
- Sometimes the perforating branch of the fibular (*peroneal*) artery (**10**), which anastomoses with the lateral tarsal and arcuate arteries (**24** and **17**), is large and replaces the dorsalis pedis artery, which is absent in about 12% of feet.
- Theoretically each side of each toe has a dorsal digital artery and a plantar digital artery but the individual vessels soon become merged into an anastomotic network.
- For a summary of the branches of the dorsalis pedis artery, see [p. 154](#).

Deep dissection of the dorsum

Joints beneath the talus of the left foot



The talus has been removed from the left foot and turned upside down to lie adjacent, so exposing the reciprocal joint surfaces. At the back the concave posterior articular surface of the talus (27) forms the talocalcaneal joint with the convex posterior articular surface of the calcaneus (9). At the front are the various parts of the talocalcaneonavicular joint (see notes). The convex middle and anterior surfaces of the

talus (28 and 29) articulate with the concave middle and anterior surfaces of the calcaneus (13 and 14), with part of the anterior surface of the talus (30) articulating with cartilage in the upper surface of the spring ligament (15). The convex head of the talus (31) articulates with the concave posterior surface of the navicular bone (17).

- 1 Tendo calcaneus
- 2 Bursa
- 3 Flexor hallucis longus
- 4 Lateral plantar nerve
- 5 Posterior tibial vessels
- 6 Medial plantar nerve
- 7 Flexor digitorum longus
- 8 Tibialis posterior
- 9 Posterior articular surface of calcaneus
- 10 Interosseous talocalcaneal ligament
- 11 Inferior extensor retinaculum
- 12 Cervical ligament
- 13 Middle } articular surface of calcaneus
- 14 Anterior }
- 15 Cartilage in plantar calcaneonavicular (spring) ligament
- 16 Medial (deltoid) ligament of ankle joint
- 17 Posterior articular surface of navicular
- 18 Great saphenous vein
- 19 Tibialis anterior
- 20 Extensor hallucis longus
- 21 Deep fibular (*peroneal*) nerve
- 22 Dorsalis pedis artery
- 23 Extensor digitorum longus
- 24 Extensor digitorum brevis
- 25 Fibularis (*peroneus*) brevis
- 26 Fibularis (*peroneus*) longus
- 27 Posterior } calcaneal articular surface of talus
- 28 Middle }
- 29 Anterior }
- 30 Surface for plantar calcaneonavicular (spring) ligament
- 31 Surface for navicular

- Apart from the joints of the toes, the most important joints of the rest of the foot are those related to the talus.
- Above the talus is the ankle joint (properly known as the talocrural joint), between the trochlear surface of the talus and the lower ends of the tibia and fibula.
- Below the talus there are two separate joints. Toward the back is the talocalcaneal joint (alternatively known as the subtalar joint—but see below), between the posterior articular surfaces of the lower part of the talus (27) and upper part of the calcaneus (9). In front is the talocalcaneonavicular joint, which is a two-part joint between the front of the head of the talus (31) and the navicular (17) (the talonavicular part of this joint), and the articulations of the undersurface of the talus (28–30) with the anterior and middle facets on the upper surface of the calcaneus (14 and 13) and the upper surface of the plantar calcaneonavicular (spring) ligament (15) (the talocalcaneal part of this joint).
- Unfortunately there is some confusion of terminology, for clinicians frequently use 'subtalar joint' as a collective name for *both* joints beneath the talus, not just the posterior one.

Sole of the foot *Plantar aponeurosis of the left foot*

Skin and subcutaneous tissue have been removed to show the thick central part of the plantar aponeurosis (9) and the thinner medial and lateral parts (10 and 11). The numerous strands and septa of fibrous tissue that attach the aponeurosis to the overlying tissues have not been removed to make a tidy dissection; they are an important part of the anatomy of the sole, binding adjacent tissues together.

- **Nerve supplies** in the sole include the following:
Cutaneous: the medial plantar nerve supplies the medial part of the sole and the medial three and a half toes; the lateral plantar nerve supplies the lateral part of the sole and lateral one and a half toes.
Muscular: the medial plantar nerve supplies abductor hallucis, flexor hallucis brevis, flexor digitorum brevis and the first lumbrical; the lateral plantar nerve supplies all the other small muscles of the sole.
 For details of nerve branches, see [pp. 152 and 153](#).
- The skin under the heel and on the lateral part of the sole is part of the first sacral dermatome, with the fifth lumbar dermatome including the rest of the sole ([Fig. 9, p. 153](#)).
- The superficial surface of the plantar aponeurosis is not smooth as in most textbook drawings, but roughened by the attachment of numerous fibrous septa forming loculations that hold the fatty subcutaneous tissues and skin in place when weight-bearing. They are well shown toward the back and sides of the dissection illustrated here.

- 1 Plantar digital nerve
- 2 Superficial transverse metatarsal ligament
- 3 Superficial layer } of digital band of aponeurosis
- 4 Deep layer }
- 5 Transverse fibres of aponeurosis
- 6 Proper plantar digital nerve of great toe
- 7 Common plantar digital branch of medial plantar nerve
- 8 Common plantar digital branch of lateral plantar nerve
- 9 Central part of aponeurosis overlying flexor digitorum brevis
- 10 Medial part of aponeurosis overlying abductor hallucis
- 11 Lateral part of aponeurosis overlying abductor digiti minimi
- 12 Medial calcaneal nerve
- 13 Medial process of tuberosity of calcaneus
- 14 Proper plantar digital nerve of fifth toe

Sole of the foot *First layer structures*



The plantar aponeurosis (2):

- Extends from the medial and lateral tubercles of the calcaneus
- Divides at the distal end and forms five slips at the front, one slip for each toe
- Fuses with the fibrous flexor sheaths and metatarsophalangeal joint capsules
- Helps to preserve the longitudinal arches of the foot

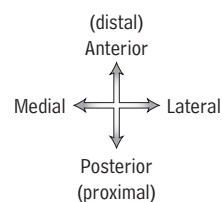
The medial plantar nerve (8):

- Supplies the medial part of the side of the foot and the medial three and a half toes

The lateral plantar nerve (5):

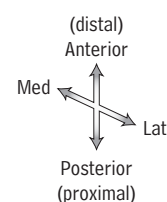
- Supplies the lateral part of the sole of foot and lateral one and a half toes

- 1 Medial process of tuberosity of calcaneus
- 2 Central part of plantar aponeurosis
- 3 Fibrous septi forming loculations
- 4 Flexor digitorum brevis
- 5 Lateral plantar nerve
- 6 Lateral plantar artery
- 7 Fourth common plantar digital nerve
- 8 Medial plantar nerve
- 9 Abductor hallucis
- 10 Flexor hallucis brevis
- 11 Flexor hallucis longus
- 12 First
- 13 Third } lumbrical
- 14 Fourth }
- 15 Flexor digiti minimi brevis
- 16 Abductor digiti minimi
- 17 Proper plantar digital nerve of fifth toe
- 18 Superficial digital branch of medial plantar artery
- 19 Proper plantar digital nerve of great toe
- 20 Fibrous flexor sheath
- 21 Proper plantar digital nerves of first cleft
- 22 Superficial transverse metatarsal ligament



Lower leg and sole of foot

Deep medial structures and second layer from the right and slightly below



- 1 Proper plantar digital nerve of great toe
- 2 Tendon of flexor hallucis longus
- 3 Medial plantar nerve
- 4 Flexor digitorum brevis
- 5 Plantar aponeurosis (reflected superiorly)
- 6 Dense subcutaneous fatty tissue of sole of foot within fibrous septi (loculations)
- 7 Posterior surface of calcaneus
- 8 Abductor hallucis
- 9 Flexor retinaculum
- 10 Dorsal venous arch
- 11 Medial malleolus of tibia
- 12 Posterior tibial artery and veins
- 13 Tibialis posterior
- 14 Great saphenous vein
- 15 Medial surface of tibia
- 16 Flexor digitorum longus
- 17 Flexor hallucis longus
- 18 Tendo calcaneus (Achilles tendon)
- 19 Tibial nerve
- 20 Gastrocnemius
- 21 Medial branch of superficial fibular (peroneal) nerve

The tendo calcaneus (Achilles tendon) (18):

- Is the thickest tendon in the body and receives muscle fibres from both gastrocnemius and soleus
- Inserts into the middle of the back of the calcaneus
- May be tested for ankle jerk just above its insertion into the calcaneus
- Under excessive exertion is prone to tear (rupture) usually above its insertion into calcaneus, producing a palpable gap as fibres of the tendon 'roll-up' like a window roller blind

The posterior tibial artery (12):

- Can be palpated behind the medial malleolus of the tibia approximately 2.5 cm in front of the medial border of the tendo calcaneus (Achilles tendon) (18)

The great saphenous vein (14):

- Runs in front of the medial malleolus of the tibia

The small saphenous vein:

- Runs behind the lateral malleolus of the fibula

Sole of the foot



- 1 Proper plantar digital nerve of great toe
- 2 Proper plantar digital nerves of first cleft
- 3 Superficial transverse metatarsal ligament
- 4 Fibrous flexor sheath
- 5 First lumbrical
- 6 Second lumbrical
- 7 Third lumbrical
- 8 Fourth lumbrical
- 9 Third plantar metatarsal artery
- 10 A superficial digital branch of medial plantar artery
- 11 Fourth common plantar digital nerve
- 12 Fourth dorsal interosseus

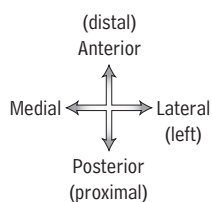
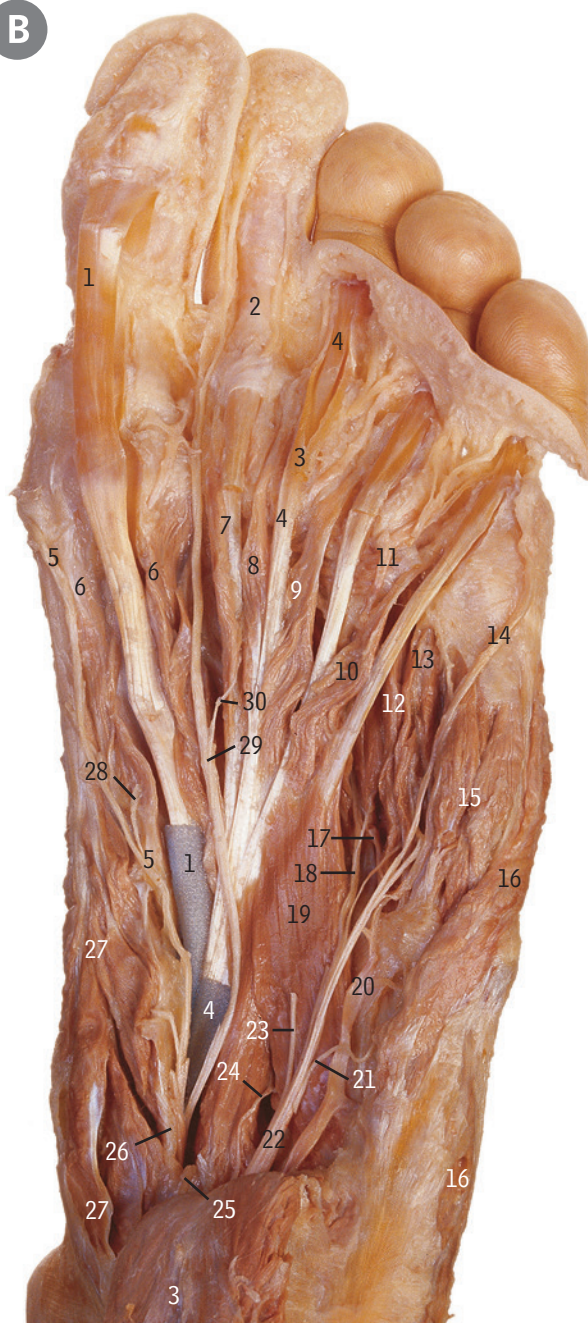
A First layer of muscles of the left sole

The plantar aponeurosis has been removed. The central muscle is flexor digitorum brevis (19), with abductor hallucis (21) on the medial side and abductor digiti minimi (16) on the lateral side. The most prominent tendon is that of flexor hallucis longus (23). Digital branches of the medial and lateral plantar nerves (1, 2, 10, 11 and 14) run forward toward the toes, and the deep branch of the lateral plantar nerve (17), which supplies many of the deeper muscles, curves deeply into the sole. See also Fig. 4, p. 150.

- The muscles of the sole are usually classified in **four layers**, as seen in progressively deep dissection:
First layer: abductor hallucis (A21), flexor digitorum brevis (A19) and abductor digiti minimi (A16).
Second layer: Quadratus plantae (B19) and the four lumbrical muscles (B7–10), with the tendons of flexor digitorum longus (B4) and flexor hallucis longus (B1).
Third layer: flexor hallucis brevis (p. 94, A8), adductor hallucis (p. 94, A6 and 7) and flexor digiti minimi brevis (p. 94, A14).
Fourth layer: three plantar and four dorsal interosseus muscles (p. 95, B5–11), with the tendons of tibialis posterior (p. 95, B27) and fibularis (*peroneus*) longus (p. 95, B24).
 The successive layers do not completely obscure one another; for example, the third plantar and fourth dorsal interossei (A13 and 12) are seen as soon as the plantar aponeurosis has been removed. (The layers refer to layers of *muscles*; the plantar aponeurosis is not itself the first layer but overlies it.)
- It may be functionally more useful to classify the muscles into **medial, lateral and intermediate groups**:
Medial group, for the great toe: abductor hallucis, flexor hallucis brevis, adductor hallucis and the tendon of flexor hallucis longus
Lateral group, for the fifth toe: abductor digiti minimi and flexor digiti minimi brevis
Intermediate group, for the second to fifth toes: flexor digitorum brevis, quadratus plantae, the tendons of flexor digitorum longus and the lumbricals, and the interossei

- 13 Third plantar interosseus
- 14 Proper plantar digital nerve of fifth toe
- 15 Flexor digiti minimi brevis
- 16 Abductor digiti minimi
- 17 Deep branch of lateral plantar nerve
- 18 Lateral plantar artery
- 19 Flexor digitorum brevis
- 20 Plantar aponeurosis
- 21 Abductor hallucis
- 22 Flexor hallucis brevis
- 23 Flexor hallucis longus
- 24 First common plantar digital nerve

B



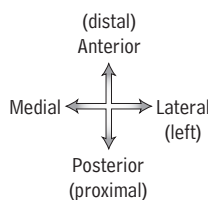
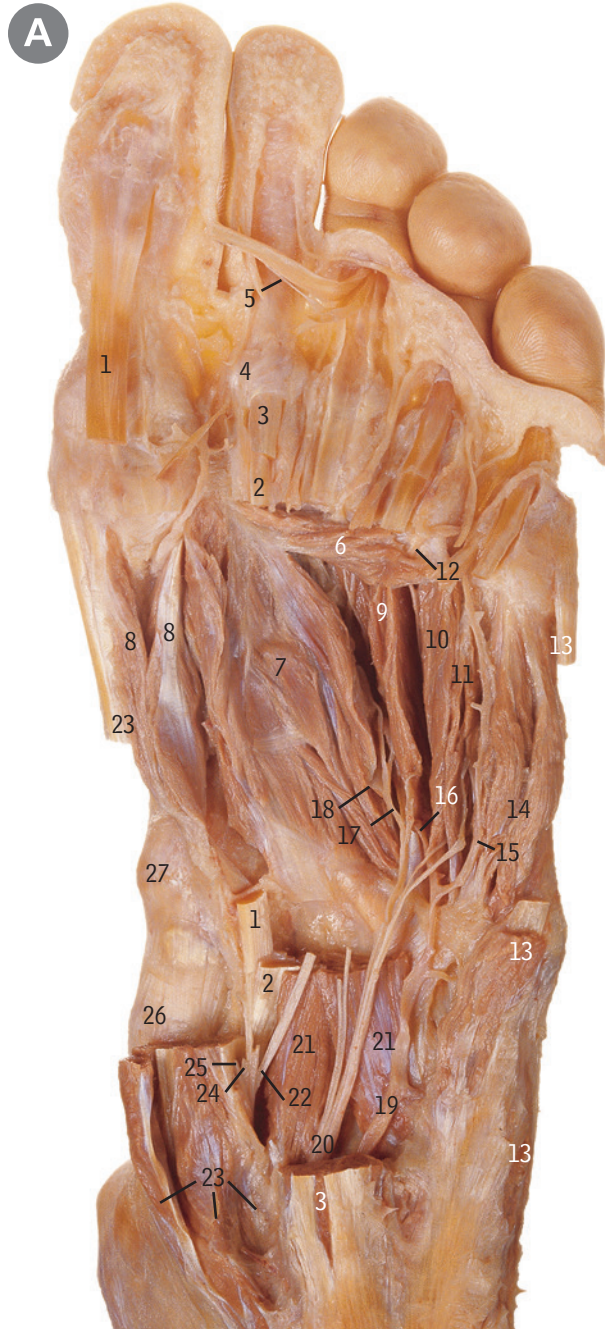
B Second layer of muscles of the left sole

Flexor digitorum brevis has been removed (but the abductors of the great and little toes, 27 and 16, remain) to display quadratus plantae (19) joining flexor digitorum longus (4) as it divides into its four tendons, from which the lumbrical muscles arise (7–10). The deep branch of the lateral plantar nerve (18) curls round the lateral side of quadratus plantae (19) to reach the deeper part of the sole, and numerous other muscular and digital (cutaneous) branches of the medial and lateral plantar nerves (26 and 22) are visible. Synovial sheaths of flexor tendons have been emphasized by blue tissue. See also [Fig. 5, p. 150](#).

- Although flexor hallucis longus (B1) passes to the great toe on the *medial* side of the foot, it arises from the *fibula* on the lateral side of the leg. The tendon crosses over in the sole, deep to flexor digitorum longus (B4, toward the back of the sole).
- The lateral and medial plantar nerves and vessels (B20, 22 and 26) pass between the first and second layers of muscles. The deep branch of the lateral plantar nerve (A17, B18) and the deep branch of the artery, which becomes the lateral plantar arch (B17), curl deeply round the lateral border of quadratus plantae (B19).

- 1 Flexor hallucis longus
- 2 Fibrous flexor sheath
- 3 Flexor digitorum brevis
- 4 Flexor digitorum longus
- 5 Proper plantar digital nerve of great toe
- 6 Flexor hallucis brevis
- 7 First lumbrical
- 8 Second lumbrical
- 9 Third lumbrical
- 10 Fourth lumbrical
- 11 Fourth plantar metatarsal artery
- 12 Fourth dorsal interosseus
- 13 Third plantar interosseus
- 14 Proper plantar digital nerve of fifth toe
- 15 Flexor digiti minimi brevis
- 16 Abductor digiti minimi
- 17 Plantar arch
- 18 Deep branch of lateral plantar nerve
- 19 Quadratus plantae
- 20 Lateral plantar artery
- 21 Nerve to abductor digiti minimi
- 22 Lateral plantar nerve
- 23 Fourth common plantar digital nerve
- 24 Nerve to quadratus plantae
- 25 Nerve to flexor digitorum brevis
- 26 Medial plantar artery overlying nerve
- 27 Abductor hallucis
- 28 Nerve to flexor hallucis brevis
- 29 First common plantar digital nerve
- 30 Nerve to first lumbrical

Sole of the foot

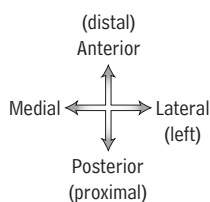
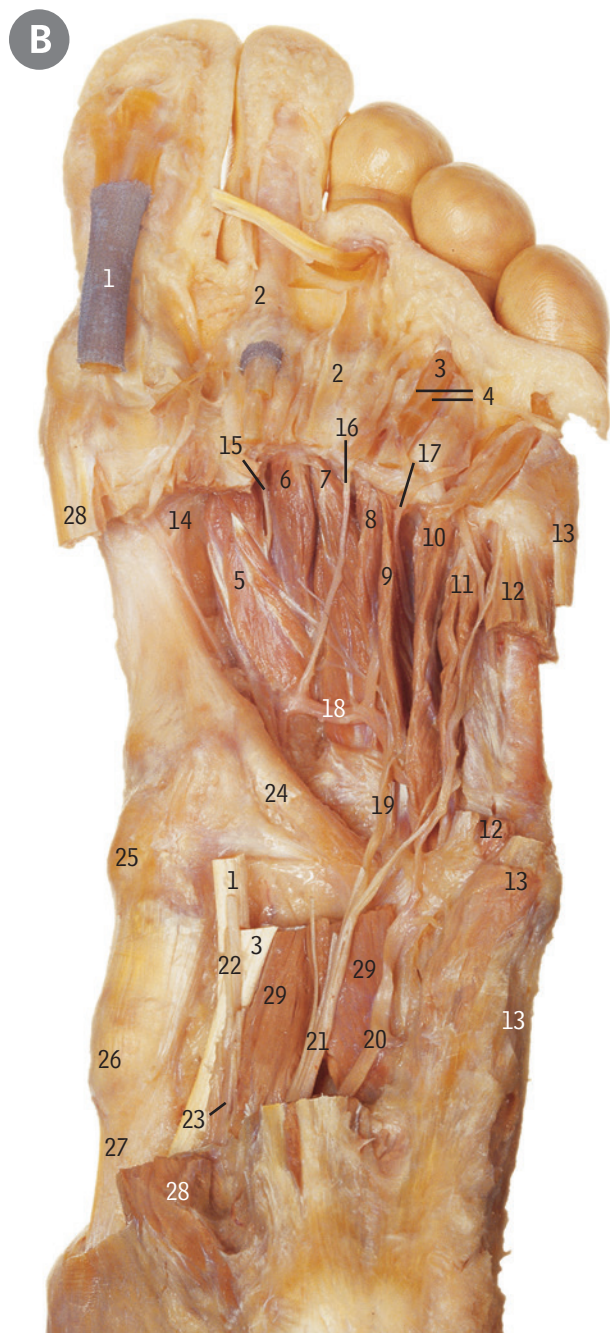


A Third layer of muscles of the left sole

Most of the flexors and abductors have been removed, displaying the two heads of adductor hallucis (6 and 7), flexor hallucis brevis (8, which divides to pass to either side of the great toe), flexor digiti minimi brevis (14) and interossei (9–11). The deep branch of the lateral plantar nerve (17) is accompanied by the plantar arch (16) (from the lateral plantar artery, 19). See also [Fig. 6, p. 151](#).

- For a summary of the medial and lateral plantar nerves, see [p. 153](#).
- The third common plantar digital nerve (from the medial plantar nerve) frequently has a communicating branch with the (fourth) common plantar digital branch of the lateral plantar nerve, but it was not present in the specimens dissected here.
- Branches of the lateral plantar nerve (A20, B21) to various interossei muscles (A9–11, B5–11) can be seen but have been left unlabeled.
- The plantar arch (B18) is the deep continuation of the lateral plantar artery (B20), which is the larger terminal branch of the posterior tibial artery. The arch is completed by anastomosis with the deep plantar (perforating) branch of the first dorsal metatarsal artery (see [p. 84, 15](#)).
The arch gives off four plantar metatarsal arteries (as in B15 and 16), which divide to give plantar digital branches to the sides of adjacent toes. There are separate branches for the medial side of the great toe and lateral side of the fifth toe.
- The medial plantar artery (A24, B23), smaller than the lateral and subject to considerable variation, does not take part directly in the formation of the arch. It usually anastomoses with the plantar digital branch to the medial side of the great toe, and gives off superficial digital branches that anastomose with the first three plantar metatarsal arteries.

- 1 Flexor hallucis longus
- 2 Flexor digitorum longus
- 3 Flexor digitorum brevis
- 4 Fibrous flexor sheath
- 5 Long vinculum
- 6 Transverse head } of adductor hallucis
- 7 Oblique head }
- 8 Flexor hallucis brevis
- 9 Second plantar interossei
- 10 Fourth dorsal interossei
- 11 Third plantar interossei
- 12 Fourth plantar metatarsal artery
- 13 Abductor digiti minimi
- 14 Flexor digiti minimi brevis
- 15 Nerve to flexor digiti minimi brevis
- 16 Plantar arch
- 17 Deep branch of lateral plantar nerve
- 18 Nerve to adductor hallucis
- 19 Lateral plantar artery
- 20 Lateral plantar nerve
- 21 Quadratus plantae
- 22 Medial plantar nerve
- 23 Abductor hallucis
- 24 Medial plantar artery
- 25 Nerve to abductor hallucis
- 26 Tuberosity of navicular
- 27 Tibialis anterior



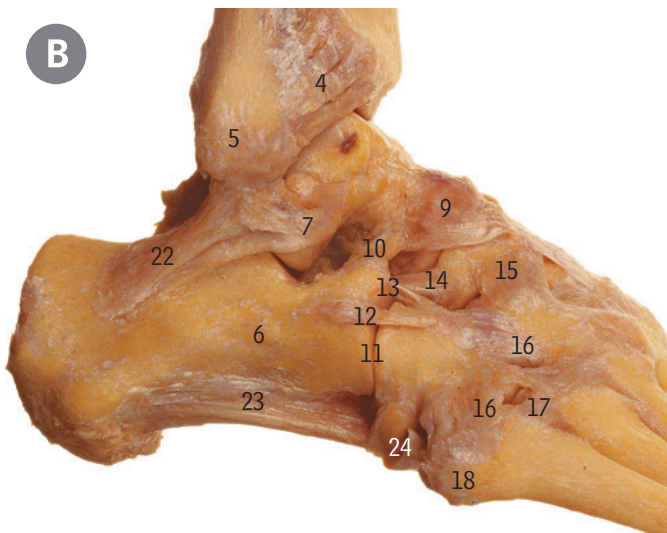
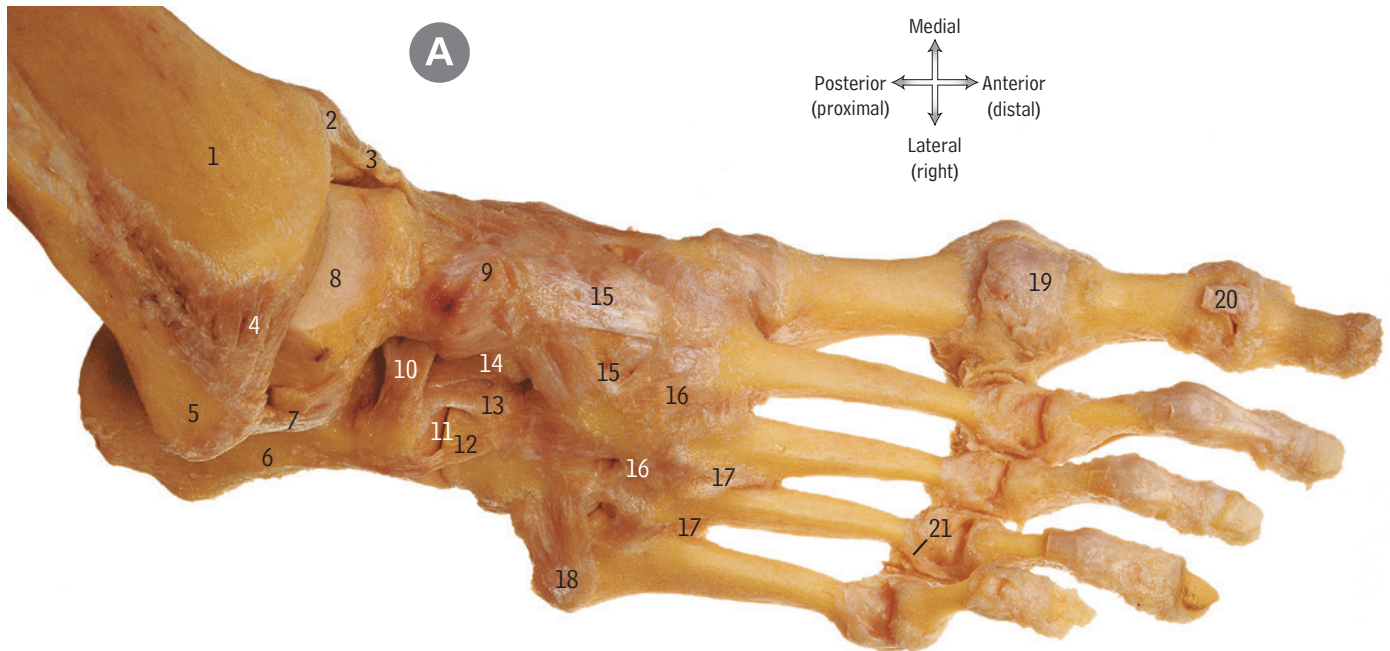
B Fourth layer of muscles of the left sole

Most of the smaller muscles have been removed, leaving only the three plantar interossei (7, 9 and 11) and the four dorsal interossei (5, 6, 8 and 10). The tendon of *tibialis posterior* (27) passes mainly to the tuberosity of the navicular (26), and the tendon of *fibularis (peroneus) longus* (24) crosses the sole obliquely from the lateral to the medial side. The end of the synovial sheath of *flexor hallucis longus* (1) has been emphasized by blue tissue. See also [Fig. 7, p. 151](#).

- Viewed from the sole, both plantar *and* dorsal interossei (85–11) are visible; they lie side by side, not (as might be expected from their names) with the plantar group completely overlying and obscuring the dorsal. (But, on the dorsum only dorsal interossei are seen between the metatarsals—as on [p. 80, A15–18](#).)
The plantar interossei *adduct* toes and the dorsal interossei *abduct* them at the metatarsophalangeal joints, the reference line or axis for these movements being the line of the second toe. The mnemonics PAD and DAB are the usual aids to recalling which group does what.
The great toe and the fifth toe each have their own abductor muscle; the great toe also has its own adductor to draw it nearer the second toe. It follows that there must be a plantar interosseus for each of the third, fourth and fifth toes so that they can be adducted toward the axial line.
The second toe has no plantar interosseus, but it has two dorsal interossei, one on each side so that it can be abducted to either side of its own neutral position. The third and fourth toes both have one of each interosseus.
- For other and probably more important actions of the interossei, see [p. 107](#).
- For a summary of the medial and lateral plantar arteries, see [p. 169](#).

- 1 Flexor hallucis longus
- 2 Fibrous flexor sheath
- 3 Flexor digitorum longus
- 4 Flexor digitorum brevis
- 5 First dorsal
- 6 Second dorsal
- 7 First plantar
- 8 Third dorsal
- 9 Second plantar
- 10 Fourth dorsal
- 11 Third plantar
- 12 Flexor digiti minimi brevis
- 13 Abductor digiti minimi
- 14 First plantar metatarsal artery
- 15 Second plantar metatarsal artery
- 16 Third plantar metatarsal artery
- 17 Fourth plantar metatarsal artery
- 18 Plantar arch
- 19 Deep branch of lateral plantar nerve
- 20 Lateral plantar artery
- 21 Lateral
- 22 Medial
- 23 Medial plantar artery
- 24 Fibularis (*peroneus*) longus
- 25 Tibialis anterior
- 26 Tuberosity of navicular
- 27 Tibialis posterior
- 28 Abductor hallucis
- 29 Quadratus plantae

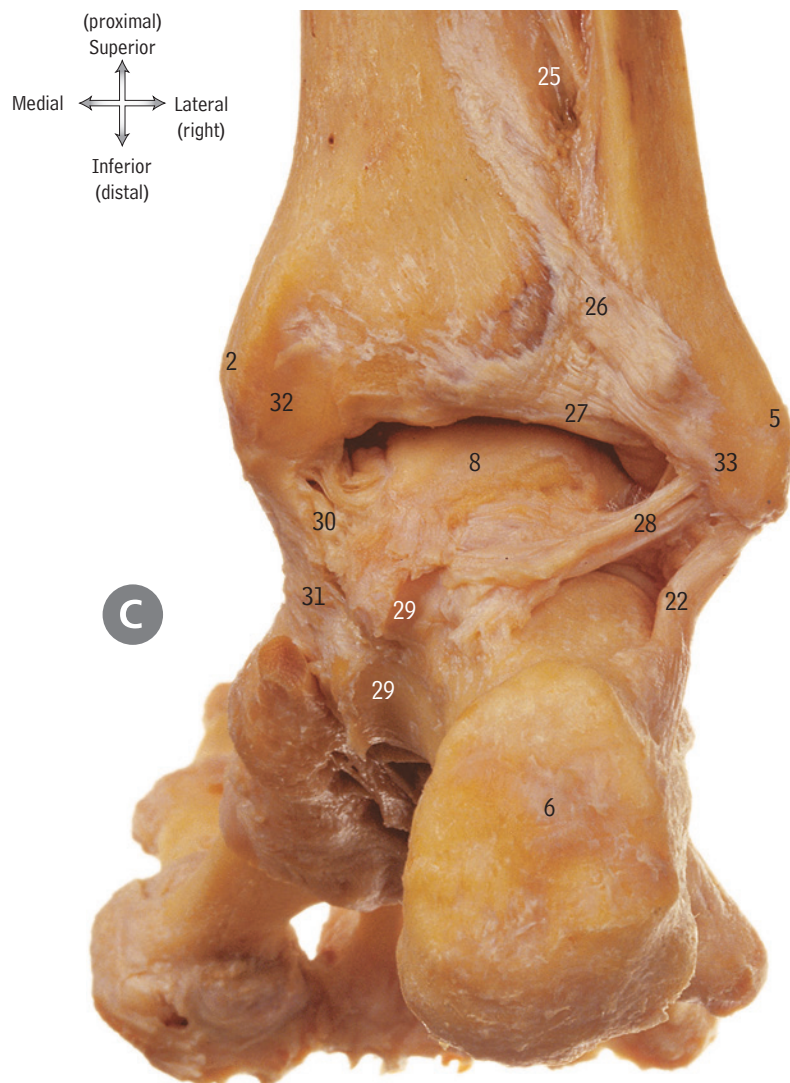
Ligaments of the foot *Ligaments of the right foot*



A From the right and above

B From the lateral side

- 1 Tibia
- 2 Medial malleolus
- 3 Medial (deltoid) ligament of ankle joint
- 4 Anterior tibiofibular ligament
- 5 Lateral malleolus
- 6 Calcaneus
- 7 Anterior talofibular ligament
- 8 Trochlear surface of talus (ankle joint capsule removed)
- 9 Head of talus (under capsule of talonavicular part of talocalcaneonavicular joint)
- 10 Cervical ligament
- 11 Calcaneocuboid joint
- 12 Dorsal calcaneocuboid ligament
- 13 Calcaneocuboid part
- 14 Calcaneonavicular part
- 15 Dorsal cuneonavicular ligaments
- 16 Dorsal tarsometatarsal ligaments
- 17 Dorsal metatarsal ligaments
- 18 Tuberosity of base of fifth metatarsal
- 19 Capsule of first metatarsophalangeal joint
- 20 Tendon of extensor hallucis longus
- 21 Collateral ligament
- 22 Calcaneofibular ligament
- 23 Long plantar ligament
- 24 Tendon of fibularis (*peroneus*) longus
- 25 Interosseous membrane
- 26 Posterior tibiofibular ligament
- 27 Tibial slip of 28
- 28 Posterior talofibular ligament
- 29 Groove for flexor hallucis longus tendon on talus and sustentaculum tali
- 30 Posterior tibiotalar part
- 31 Tibiocalcaneal part (deltoid)
- 32 Groove for tibialis posterior tendon
- 33 Groove for fibularis (*peroneus*) brevis tendon



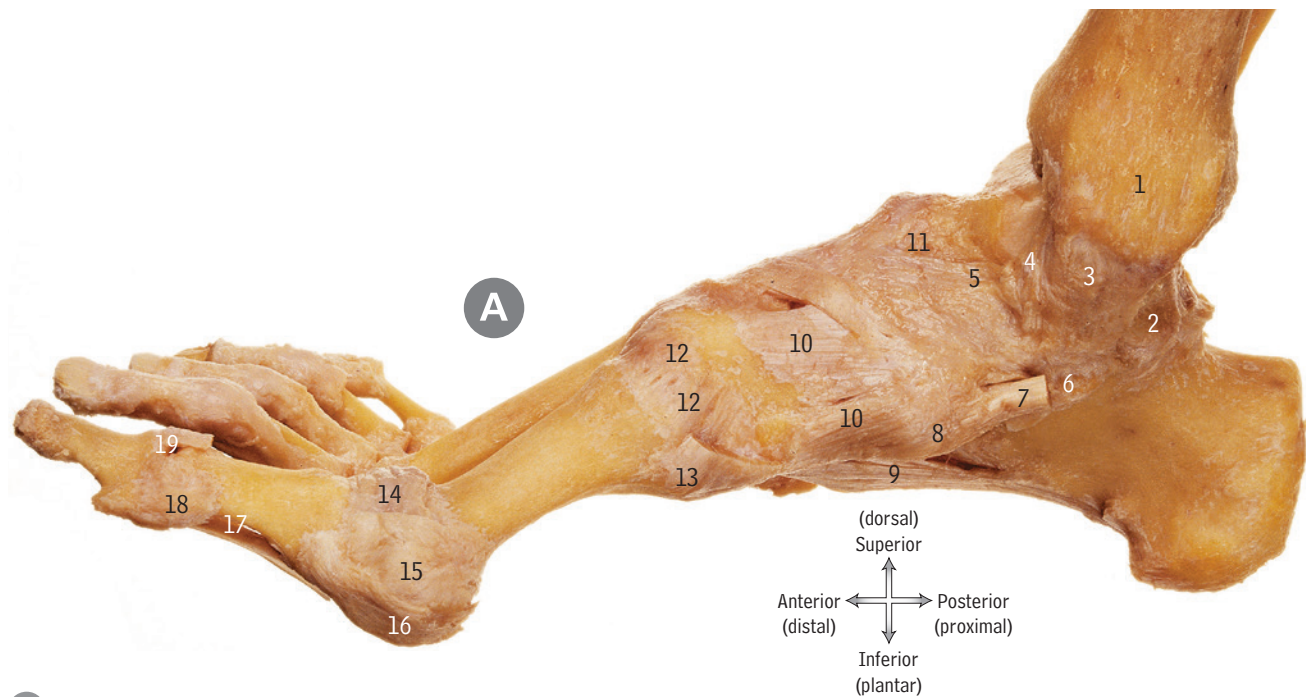
In A the foot is plantarflexed, showing part of the trochlear (superior articular) surface of the talus (8), with the front of the deltoid ligament (3) on the medial side and the anterior tibiofibular ligament (4) on the lateral side. The cervical ligament (10) passes upward and medially from the upper surface of the calcaneus to the undersurface of the talus, and in front of it are the two parts of the bifurcate ligament (13 and 14) with a small dorsal calcaneocuboid ligament (12) more laterally. Other dorsal ligaments (15, 16 and 17) connect adjacent bones.

In B the anterior talofibular ligament (7) and calcaneofibular ligament (22) are seen, with some of the smaller dorsal ligaments (12–17), and so is the posterior part of the long plantar ligament (23) in the sole.

In C the posterior talofibular ligament (28) runs transversely (so it is not seen in the lateral view in B); it has a tibial slip (27), which merges with the inferior transverse ligament, the name given to the lower part of the posterior tibiofibular ligament (26).

- On the medial side of the ankle joint there is a single medial (deltoid) ligament (A3) (although it has several parts, as on p. 98, A2–5), but on the lateral side there is no single lateral ligament but three separate ligaments: the anterior and posterior talofibular ligaments (A7 and B7, C28) and the calcaneofibular ligament (B22 and C22).

Ligaments of the foot



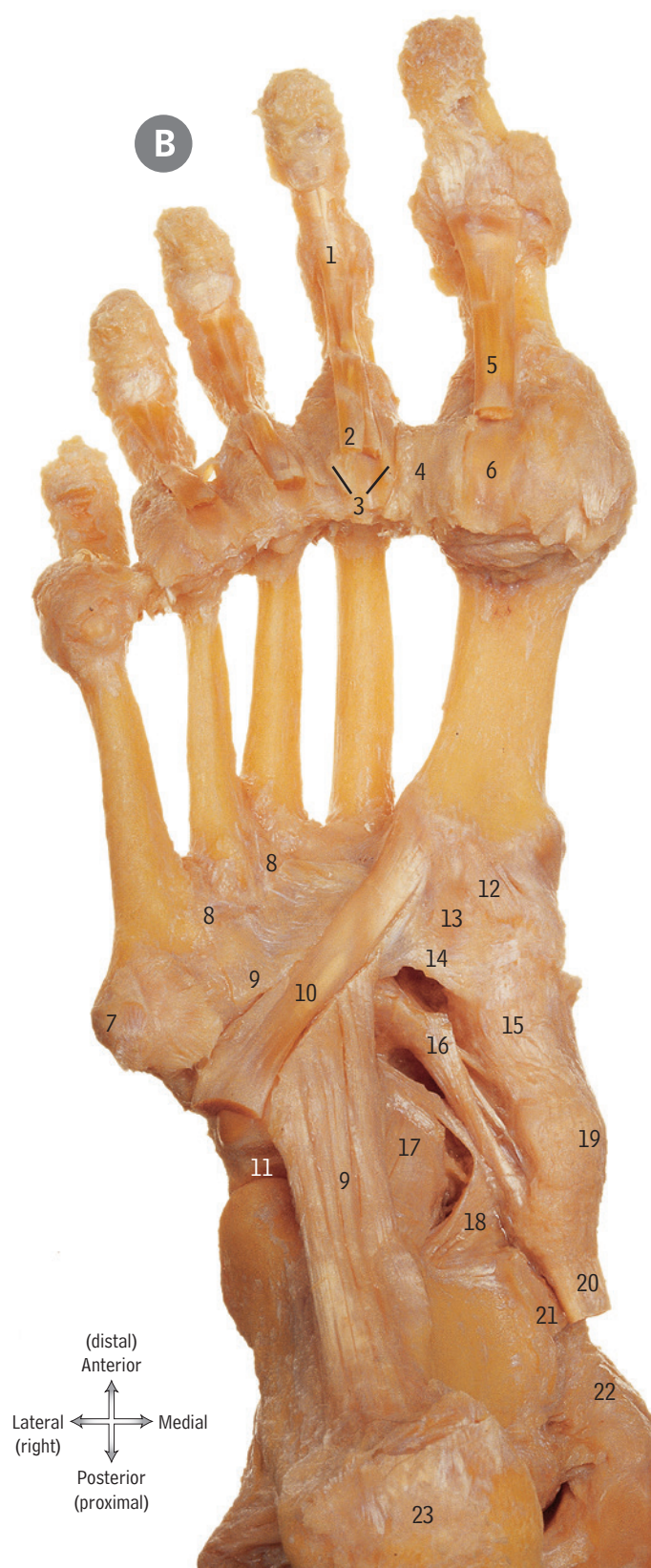
A Ligaments of the right foot, from the medial side

On the medial side of the ankle the various parts of the medial (deltoid) ligament (2–5) merge with one another. The tendon of tibialis posterior (7) is mainly

attached to the tuberosity of the navicular (8), while that of tibialis anterior (13) runs to the medial cuneiform and the base of the first metatarsal.

- 1 Medial malleolus
 - 2 Posterior tibiotalar part
 - 3 Tibiocalcaneal part
 - 4 Anterior tibiotalar part
 - 5 Tibionavicular part
 - 6 Sustentaculum tali
 - 7 Tibialis posterior
 - 8 Tuberosity of navicular
 - 9 Long plantar ligament
 - 10 Dorsal cuneonavicular ligament
- } of medial (deltoid) ligament

- 11 Talonavicular ligament
 - 12 Dorsal ligaments of first tarsometatarsal joint
 - 13 Tibialis anterior
 - 14 Capsule
 - 15 Collateral ligament
 - 16 Sesamoid bone
 - 17 Flexor hallucis longus
 - 18 Collateral ligament of interphalangeal joint
 - 19 Extensor hallucis longus
- } of first metatarsophalangeal joint



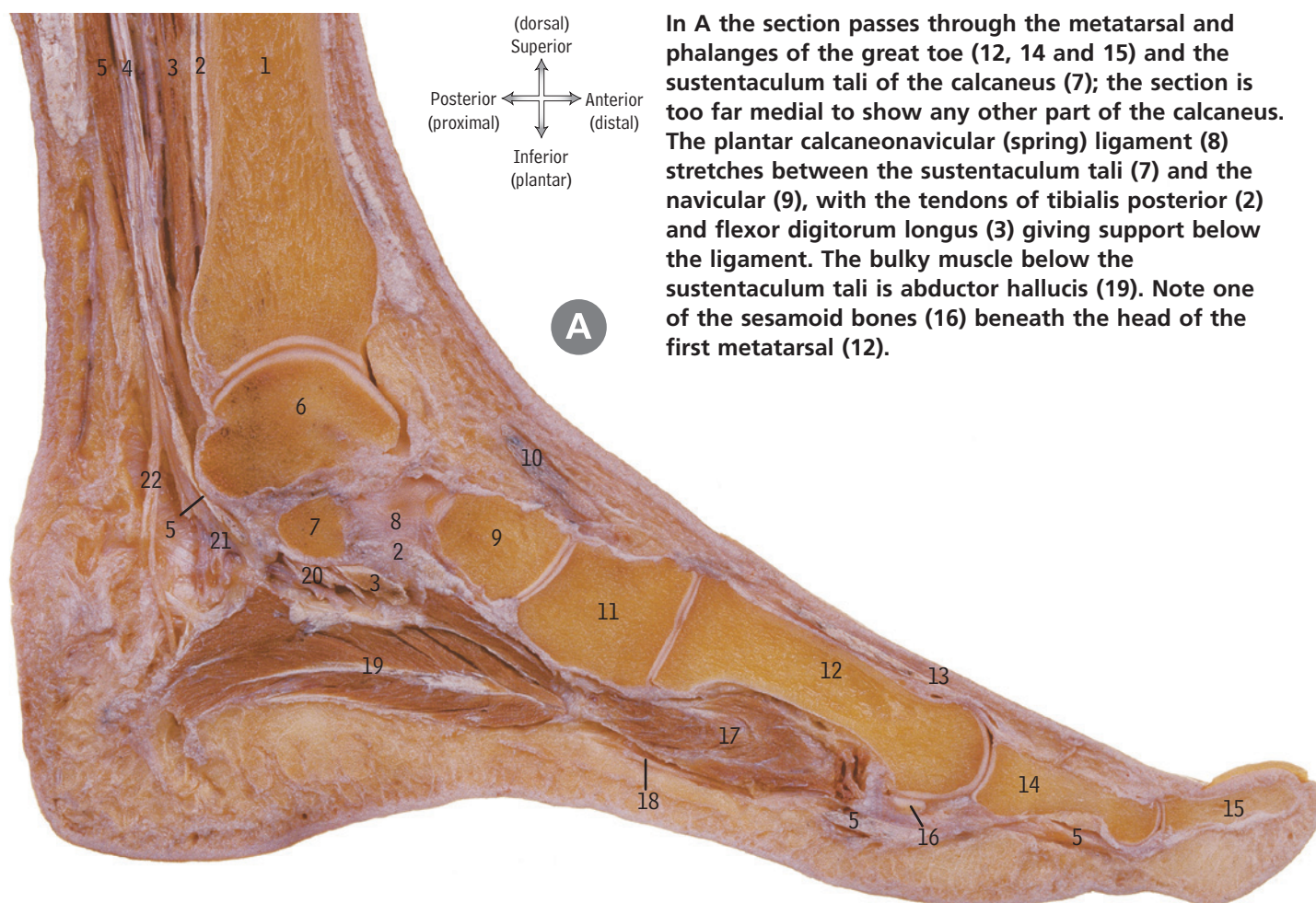
B Ligaments of the sole of the right foot

Part of the long plantar ligament (9) has been cut away to show the tendon of fibularis (*peroneus*) longus (10) lying in the groove on the cuboid. Medial to the posterior part of the long plantar ligament is the short plantar (plantar calcaneocuboid) ligament (17), and medial to that is the spring (plantar calcaneonavicular) ligament (18). At the anterior part of the foot the deep transverse metatarsal ligaments (4) keep the heads of the metatarsals and the bases of the toes from spreading apart.

- 1 Flexor digitorum longus
- 2 Flexor digitorum brevis
- 3 Fibrous flexor sheath
- 4 Deep transverse metatarsal ligament
- 5 Flexor hallucis longus
- 6 Plantar ligament of first tarsometatarsal joint
- 7 Tuberosity of base of fifth metatarsal
- 8 Plantar metatarsal ligaments
- 9 Long plantar ligament
- 10 Tendon of fibularis (*peroneus*) longus in groove on cuboid
- 11 Calcaneocuboid joint
- 12 Plantar tarsometatarsal ligament
- 13 Medial cuneiform
- 14 Cuneometatarsal ligament
- 15 Plantar cuneonavicular ligament
- 16 Fibrous slip from tibialis posterior overlying a cuneometatarsal ligament
- 17 Plantar calcaneocuboid (short plantar) ligament
- 18 Plantar calcaneonavicular (spring) ligament
- 19 Tuberosity of navicular
- 20 Tendon of tibialis posterior
- 21 Sustentaculum tali and groove for flexor hallucis longus
- 22 Medial (deltoid) ligament of ankle joint
- 23 Tuberosity of calcaneus

- The *medial* sides of the medial cuneiform and the base of the first metatarsal receive the attachment of the tibialis anterior tendon (A13); the *lateral* sides of the same two bones receive the attachment of the fibularis (*peroneus*) longus tendon (B10).
- The plantar calcaneocuboid ligament (B17), commonly called the short plantar ligament, is largely under cover of the long plantar ligament (B9), which with the groove on the cuboid bone forms an osseofibrous tunnel for the fibularis (*peroneus*) longus tendon (B10).
- The plantar calcaneonavicular ligament (B18), passing from the sustentaculum tali of the calcaneus to the navicular and commonly called the spring ligament although it is not elastic, is an important support for the head of the talus in the talocalcaneonavicular joint (p. 87, 15).

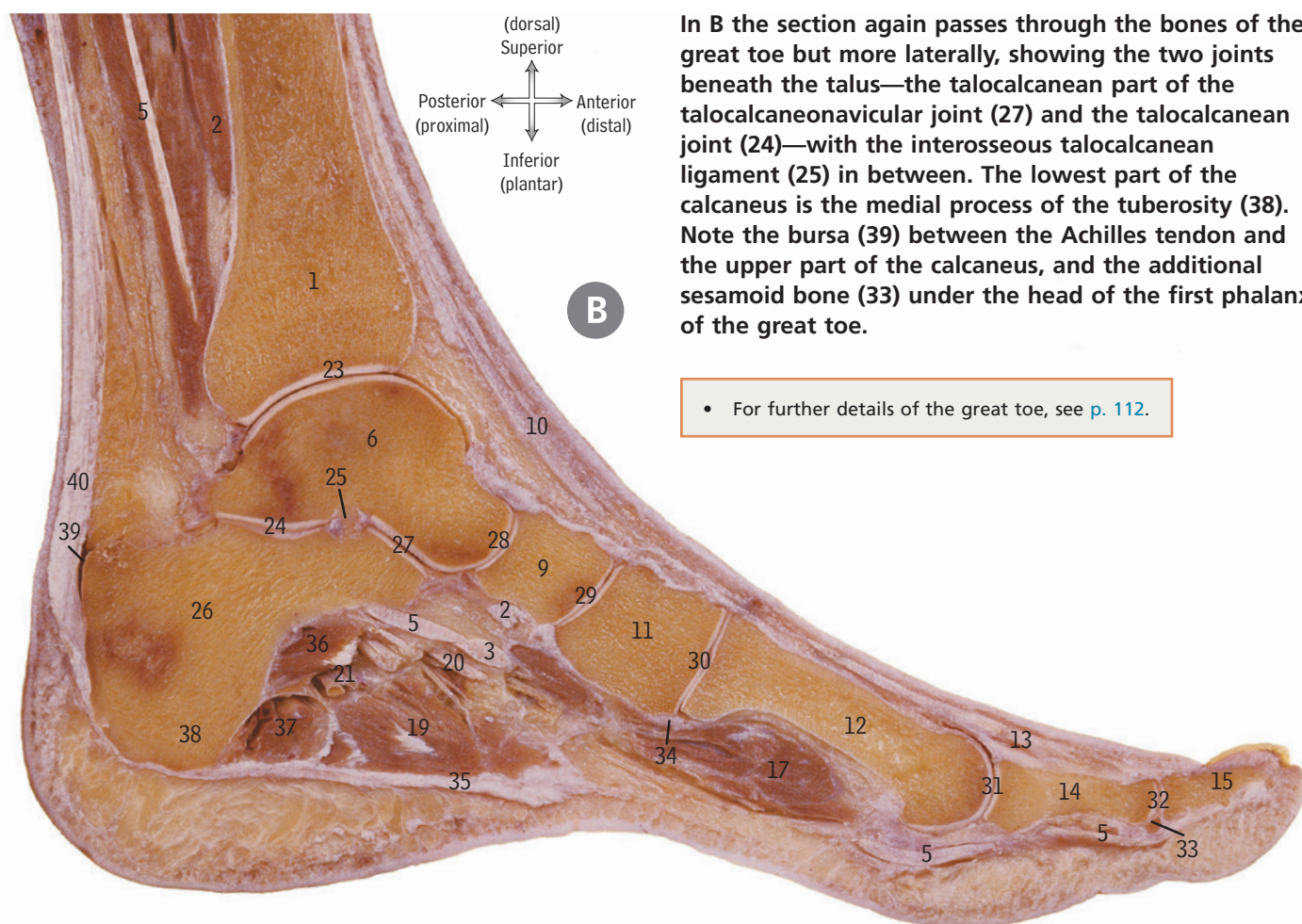
Sections of the foot *Sagittal sections of the right foot*



A Through the medial part of the talus, sustentaculum tali of the calcaneus and the great toe, from the lateral side

- 1 Tibia
- 2 Tibialis posterior
- 3 Flexor digitorum longus
- 4 Tibial nerve
- 5 Flexor hallucis longus
- 6 Talus
- 7 Sustentaculum tali
- 8 Plantar calcaneonavicular (spring) ligament
- 9 Navicular
- 10 Tibialis anterior

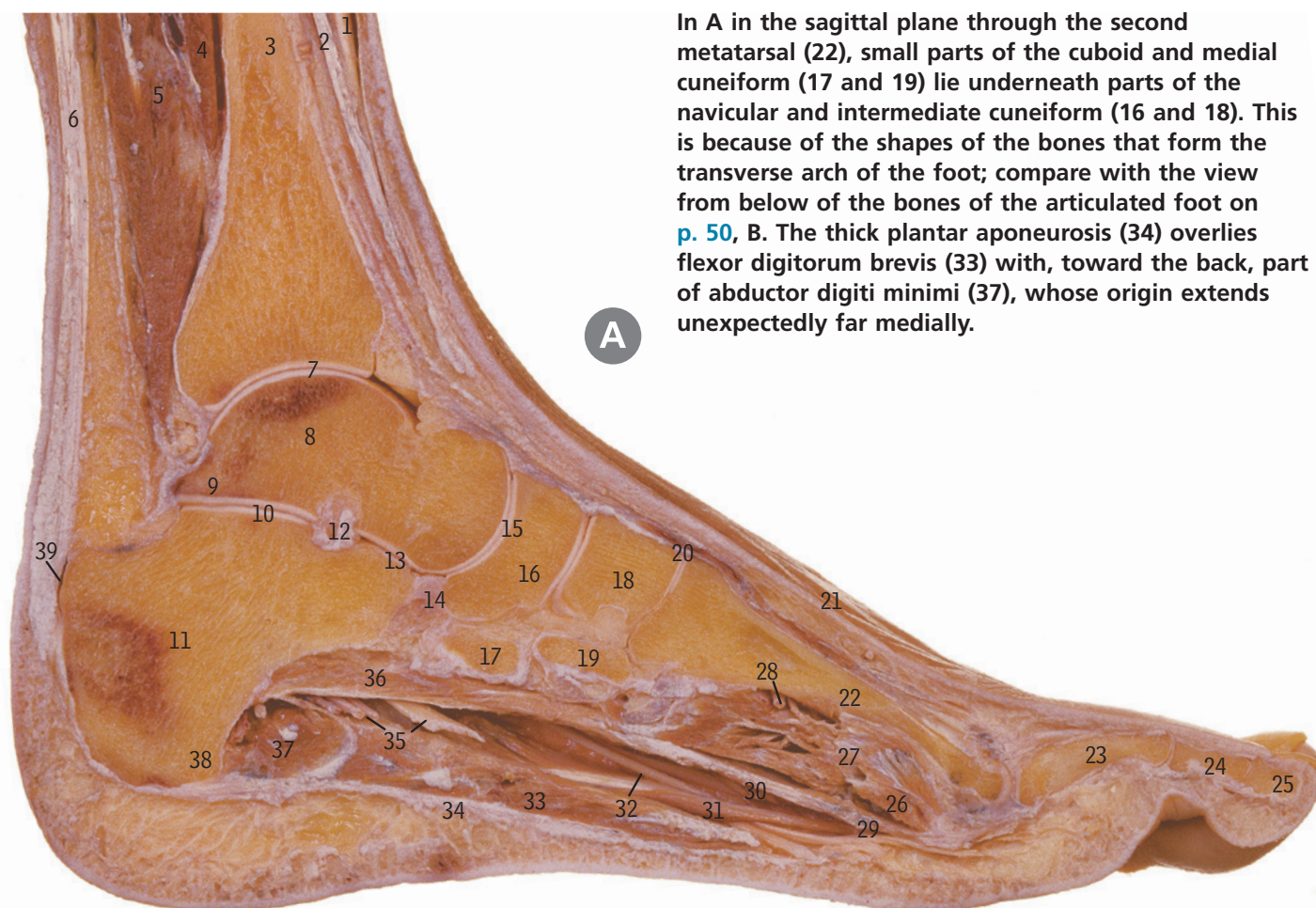
- 11 Medial cuneiform
- 12 First metatarsal
- 13 Extensor hallucis longus
- 14 Proximal phalanx
- 15 Distal phalanx
- 16 Sesamoid bone
- 17 Flexor hallucis brevis
- 18 Proper plantar digital nerve of great toe
- 19 Abductor hallucis
- 20 Medial plantar nerve and vessels



B Through the center of the talus, medial part of the calcaneus and the great toe, from the lateral side (in a different foot from that in A)

- | | | | |
|----|-------------------------------------|----|---|
| 21 | Lateral plantar nerve and vessels | 31 | Metatarsophalangeal joint |
| 22 | Medial calcaneal nerve | 32 | Interphalangeal joint |
| 23 | Ankle joint | 33 | Additional sesamoid bone |
| 24 | Talocalcanean joint | 34 | Fibularis (peroneus) longus |
| 25 | Interosseous talocalcanean ligament | 35 | Plantar aponeurosis |
| 26 | Calcaneus | 36 | Quadratus plantae |
| 27 | Talocalcanean part | 37 | Abductor digiti minimi |
| 28 | Talonavicular part | 38 | Medial process of tuberosity of calcaneus |
| 29 | Cuneonavicular joint | 39 | Bursa |
| 30 | Cuneometatarsal joint | 40 | Tendo calcaneus |

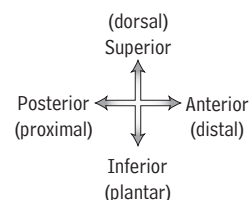
Sections of the foot *Sagittal sections of the right foot*



In A in the sagittal plane through the second metatarsal (22), small parts of the cuboid and medial cuneiform (17 and 19) lie underneath parts of the navicular and intermediate cuneiform (16 and 18). This is because of the shapes of the bones that form the transverse arch of the foot; compare with the view from below of the bones of the articulated foot on p. 50, B. The thick plantar aponeurosis (34) overlies flexor digitorum brevis (33) with, toward the back, part of abductor digiti minimi (37), whose origin extends unexpectedly far medially.

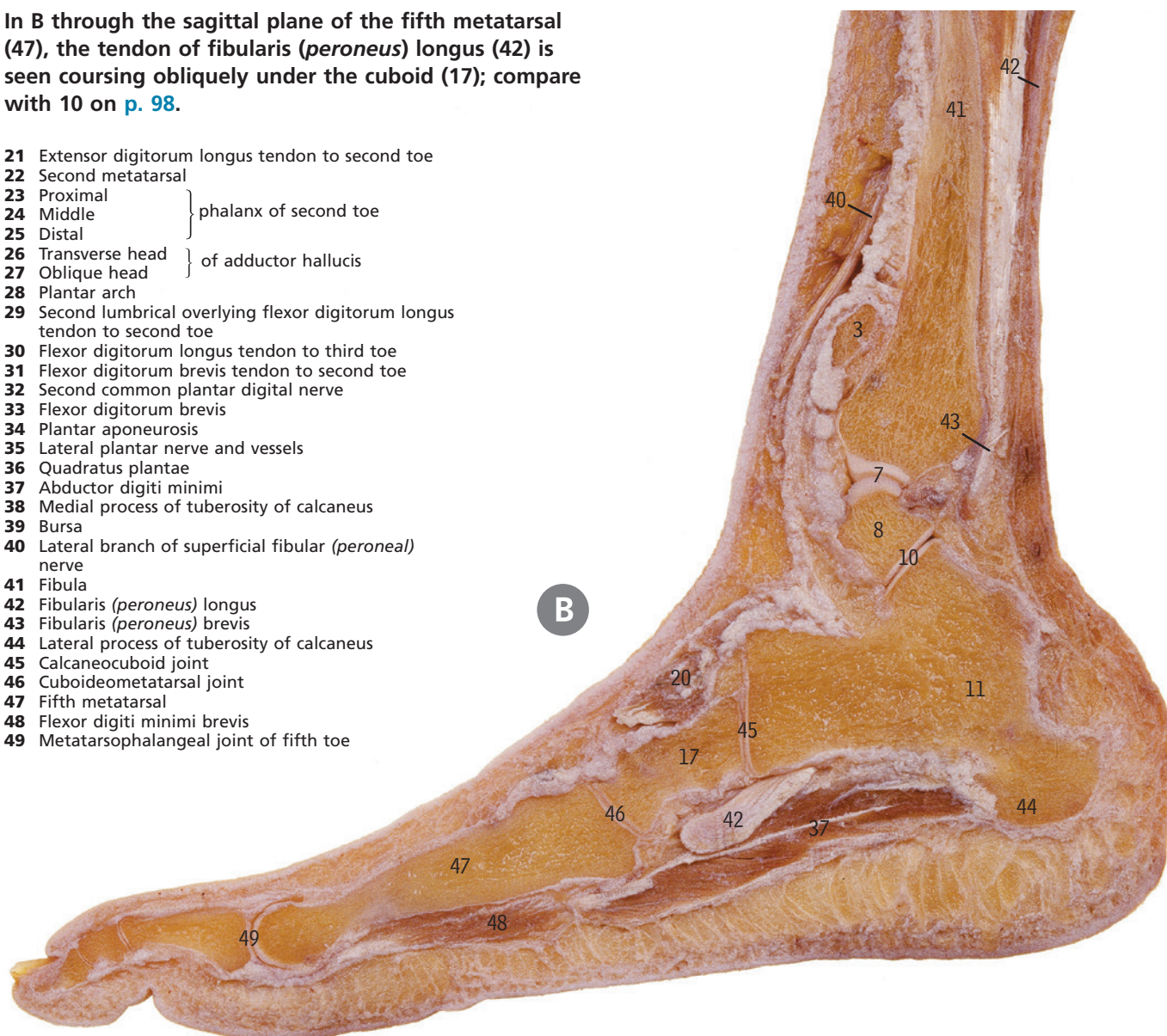
A Through the second toe, from the lateral side

- | | |
|-----------------------------|--|
| 1 Tibialis anterior | 11 Calcaneus |
| 2 Extensor hallucis longus | 12 Interosseous talocalcaneal ligament |
| 3 Tibia | 13 Talocalcaneal part of talocalcaneonavicular joint |
| 4 Tibialis posterior | 14 Plantar calcaneonavicular (spring) ligament |
| 5 Flexor hallucis longus | 15 Talonavicular part of talocalcaneonavicular joint |
| 6 Tendo calcaneus | 16 Navicular |
| 7 Ankle joint | 17 Cuboid |
| 8 Talus | 18 Intermediate cuneiform |
| 9 Lateral tubercle of talus | 19 Medial cuneiform |
| 10 Talocalcaneal joint | 20 Extensor digitorum brevis |

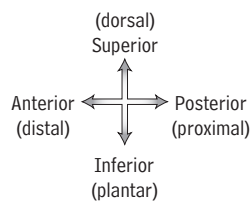


In B through the sagittal plane of the fifth metatarsal (47), the tendon of fibularis (*peroneus*) longus (42) is seen coursing obliquely under the cuboid (17); compare with 10 on p. 98.

- 21 Extensor digitorum longus tendon to second toe
- 22 Second metatarsal
- 23 Proximal
- 24 Middle
- 25 Distal
- 26 Transverse head
- 27 Oblique head
- 28 Plantar arch
- 29 Second lumbrical overlying flexor digitorum longus tendon to second toe
- 30 Flexor digitorum longus tendon to third toe
- 31 Flexor digitorum brevis tendon to second toe
- 32 Second common plantar digital nerve
- 33 Flexor digitorum brevis
- 34 Plantar aponeurosis
- 35 Lateral plantar nerve and vessels
- 36 Quadratus plantae
- 37 Abductor digiti minimi
- 38 Medial process of tuberosity of calcaneus
- 39 Bursa
- 40 Lateral branch of superficial fibular (*peroneal*) nerve
- 41 Fibula
- 42 Fibularis (*peroneus*) longus
- 43 Fibularis (*peroneus*) brevis
- 44 Lateral process of tuberosity of calcaneus
- 45 Calcaneocuboid joint
- 46 Cuboideometatarsal joint
- 47 Fifth metatarsal
- 48 Flexor digiti minimi brevis
- 49 Metatarsophalangeal joint of fifth toe

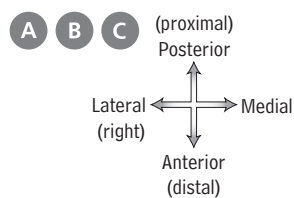
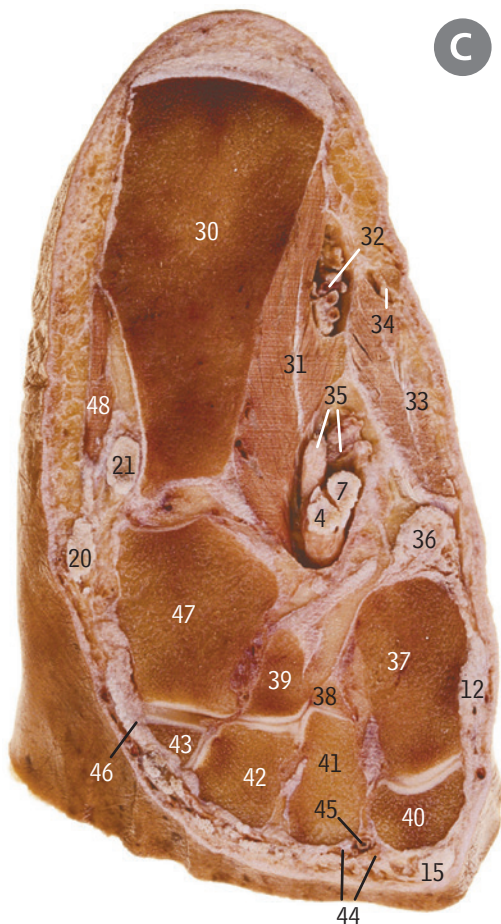
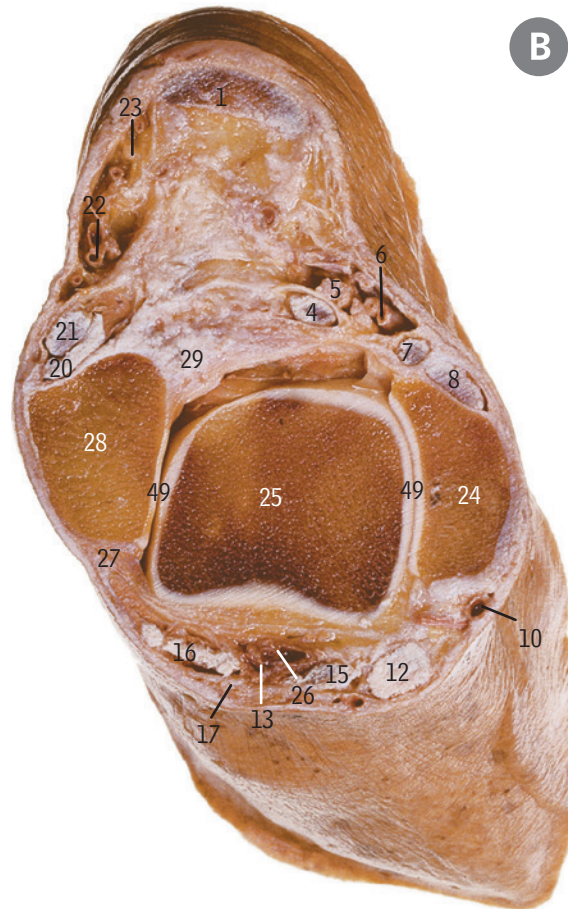
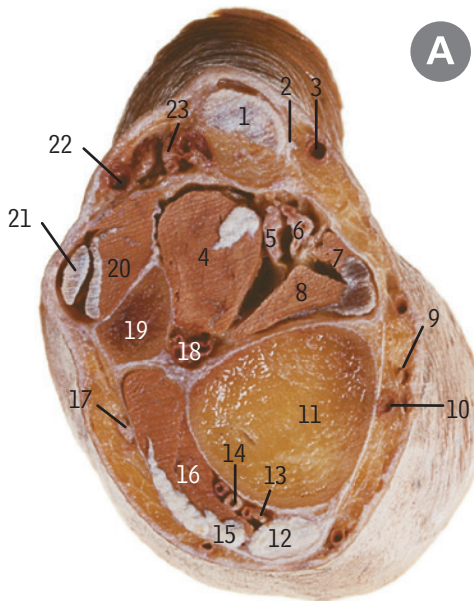


B Through the fifth toe, from the medial side



Sections of the foot

Axial sections and images of the right lower leg and foot



- A** Axial section 6 cm above the ankle joint
- B** Axial section through the ankle joint
- C** Oblique section 5 cm below the ankle joint

Above the ankle in A, fibularis (*peroneus*) brevis (20) is behind the fibula (19) with the tendon of fibularis (*peroneus*) longus (21) lying laterally, but at the lower levels in B and C the tendon of fibularis (*peroneus*) longus (21) is behind that of fibularis (*peroneus*) brevis (20). The lowest part of flexor hallucis longus (4) is seen arising from the fibula (19).

At the level of the medial malleolus (24) in B, the tendon of tibialis posterior (8) lies adjacent to the bone, with the tendon of flexor digitorum longus (7) immediately behind it. The posterior tibial vessels (6) and the tibial nerve (5) intervene between the flexor digitorum tendon (7) and the tendon of flexor hallucis longus (4). At the front of the medial malleolus (24) in B, note the great saphenous vein (10), and in front of

the talus (25) the dorsalis pedis artery (26) and deep fibular (*peroneal*) nerve (13) lie between the tendons of extensor hallucis longus (15) and extensor digitorum longus (16).

In the oblique section in C, the cuboid (47) lies in front of the calcaneus (30), and at a lower level the tendon of fibularis (*peroneus*) longus (21) will pass underneath the cuboid. On the medial side behind the medial cuneiform (37), the very tip of the tuberosity of the navicular (36) receives the main attachment of tibialis posterior. The tendons of flexor hallucis longus (4) and flexor digitorum longus (7) are more laterally placed.

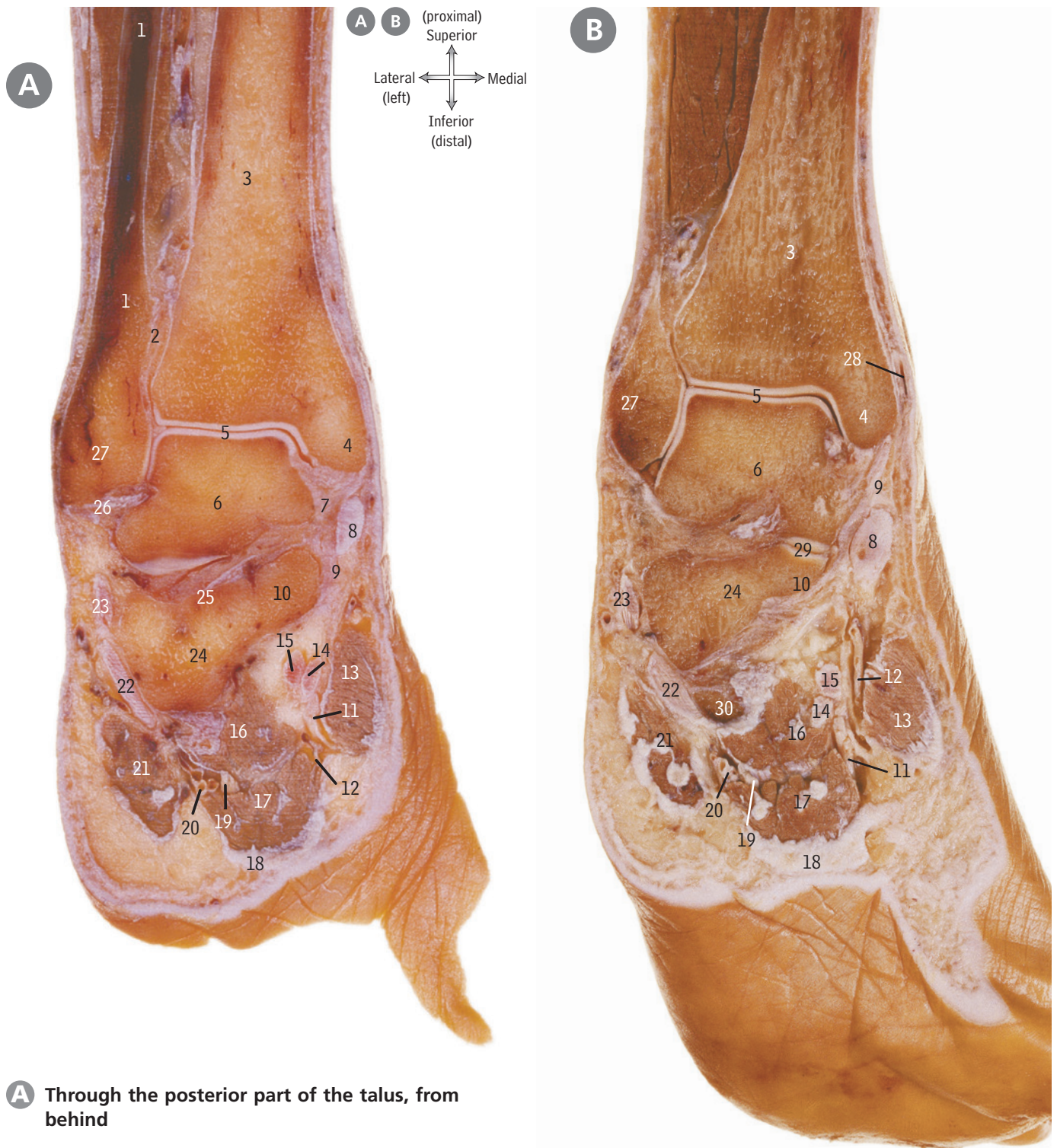
The sections A, B and C are viewed from above, looking from the knee toward the ankle.

- 1 Tendo calcaneus
- 2 Plantaris
- 3 A tributary of great saphenous vein
- 4 Flexor hallucis longus
- 5 Tibial nerve
- 6 Posterior tibial vessels
- 7 Flexor digitorum longus
- 8 Tibialis posterior
- 9 Saphenous nerve
- 10 Great saphenous vein
- 11 Tibia
- 12 Tibialis anterior
- 13 Deep fibular (*peroneal*) nerve
- 14 Anterior tibial vessels
- 15 Extensor hallucis longus
- 16 Extensor digitorum longus
- 17 Superficial fibular (*peroneal*) nerve
- 18 Fibular (*peroneal*) vessels
- 19 Fibula
- 20 Fibularis (*peroneus*) brevis
- 21 Fibularis (*peroneus*) longus
- 22 Small saphenous vein
- 23 Sural nerve
- 24 Medial malleolus
- 25 Talus

- 26 Dorsalis pedis artery
- 27 Anterior talofibular ligament
- 28 Lateral malleolus
- 29 Posterior talofibular ligament
- 30 Calcaneus
- 31 Quadratus plantae
- 32 Lateral plantar nerve and vessels
- 33 Abductor hallucis
- 34 Medial calcaneal nerve
- 35 Medial plantar nerve and vessels
- 36 Tip of tuberosity of navicular and tibialis posterior
- 37 Medial
- 38 Intermediate } cuneiform
- 39 Lateral
- 40 First
- 41 Second } metatarsal base
- 42 Third
- 43 Fourth
- 44 First dorsal interosseus
- 45 Deep plantar artery
- 46 Extensor digitorum brevis
- 47 Cuboid
- 48 Abductor digiti minimi
- 49 Ankle joint

Sections of the foot

Coronal sections of the left ankle joint and foot (in plantarflexion)



A Through the posterior part of the talus, from behind

B About 1 cm in front of A, through the talocalcaneonavicular part of the talocalcaneonavicular joint, from behind

These coronal sections through the ankle joint (5) emphasize how the talus (6) is gripped between the two malleoli (27 and 4). In A the interosseous talocalcaneal ligament (25) lies between the talus (6) and calcaneus (24), while in B the section has passed through the part of the sustentaculum tali (10), which forms the talocalcaneal part of the talocalcaneonavicular joint (29). In the center of the

sole in both sections, flexor digitorum brevis (17) overlies quadratus plantae (16); the fusion of plantae with the tendon of flexor digitorum longus (14) is shown in B, where the tendon of flexor hallucis longus (15) has come to lie deep to the digitorum tendon (compare with the dissection B on p. 93 and the section B on p. 110).

- **Joints, muscles and movements:**

- At the ankle joint

- Dorsiflexion:** tibialis anterior, extensor hallucis longus, extensor digitorum longus and fibularis (*peroneus*) tertius

- Plantarflexion:** gastrocnemius, soleus, plantaris, tibialis posterior, flexor hallucis longus and flexor digitorum longus

- At the talocalcaneal and talocalcaneonavicular joints

- Inversion:** tibialis anterior and tibialis posterior

- Eversion:** fibularis (*peroneus*) longus, fibularis (*peroneus*) brevis and fibularis (*peroneus*) tertius

- At the other small joints of the foot there are minor degrees of gliding or rotatory movements. At the transverse tarsal joint (p. 57) a small amount of inversion and eversion occurs, but by far the greater part of these important movements takes place at the two joints beneath the talus. To visualize inversion and eversion, imagine the talus held firmly between the tibia and fibula, and the whole of the rest of the foot swivelling inwards or outwards underneath the talus. These movements do not take place at the ankle joint, which essentially only allows dorsiflexion and plantarflexion.
- The actions of muscles on the toes are indicated by their names, but the part played by the interossei and lumbricals requires some explanation (apart from the abduction and adduction produced by the interossei and referred to on p. 95). Briefly the interossei and lumbricals work together to flex the metatarsophalangeal joints and extend the interphalangeal joints; these apparently contradictory actions on different joints by the same muscles can be explained as follows.
- The interossei (both plantar and dorsal) are attached mainly to the sides of the proximal phalanges but also into the dorsal digital expansions; the lumbricals are usually attached entirely to the expansions. Because of the position of these attachments in relation to the axis of movement of the metatarsophalangeal joints, the interossei and lumbricals plantarflex these joints.
- Because the lumbrical attachments and parts of the interosseous attachments are to the basal angles of the expansions, the line of pull is transmitted to the dorsal surfaces of the toes distal to the metatarsophalangeal joints, and so the interphalangeal joints are extended.
- In most feet the interosseous attachment to the expansion is minimal, and it is the lumbricals that are mainly responsible for assisting the long and short extensor tendons in extending the toes, keeping them straight and stabilized against the pull of the flexors, which tend to make them buckle, especially during the push-off phase of walking when flexor hallucis longus and flexor digitorum longus are contracting strongly.

- 1 Fibula
- 2 Interosseous tibiofibular ligament
- 3 Tibia
- 4 Medial malleolus
- 5 Ankle joint
- 6 Talus
- 7 Deep part of medial (deltoid) ligament
- 8 Tibialis posterior
- 9 Medial ligament
- 10 Sustentaculum tali
- 11 Medial plantar nerve
- 12 Medial plantar artery
- 13 Abductor hallucis
- 14 Flexor digitorum longus
- 15 Flexor hallucis longus
- 16 Quadratus plantae
- 17 Flexor digitorum brevis
- 18 Plantar aponeurosis
- 19 Lateral plantar nerve
- 20 Lateral plantar vessels
- 21 Abductor digiti minimi
- 22 Fibularis (*peroneus*) longus
- 23 Fibularis (*peroneus*) brevis
- 24 Calcaneus
- 25 Interosseous talocalcaneal ligament
- 26 Posterior talofibular ligament
- 27 Lateral malleolus
- 28 Great saphenous vein
- 29 Talocalcaneal part of talocalcaneonavicular joint
- 30 Cuboid



Sections of the foot *Oblique axial sections of the left foot*

The plane of section is shown in the small illustration. The surfaces A and B have been separated and are viewed like two pages in an open book.

Between the tarsal bones in A, the various joint cavities, outlined in black and numbered with Roman figures, are explained in the notes below.

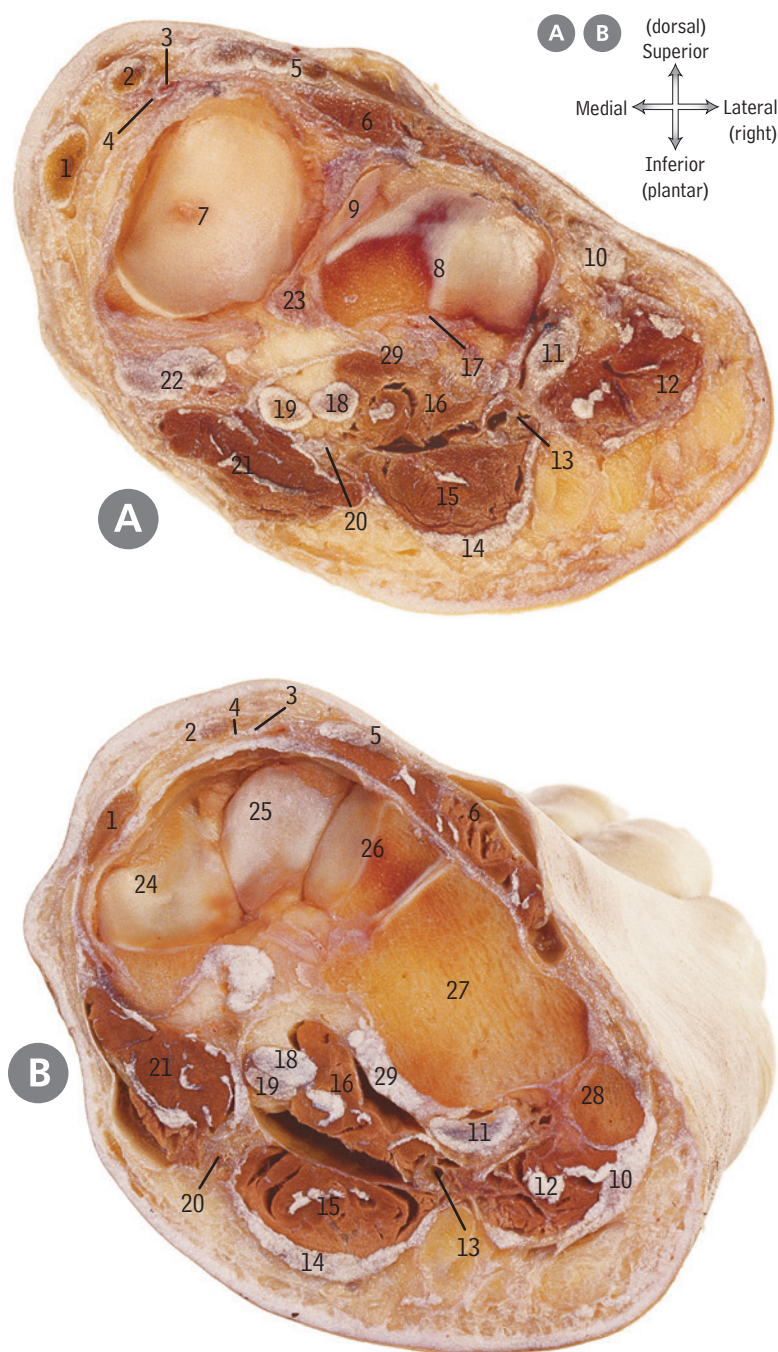
In B the navicular (9) is seen between the talus (2) and the three cuneiforms (10–12). Note how the base of

the second metatarsal (15) projects more proximally than the bases of the first and third metatarsals (14 and 16). On the lateral side the cuboid (13) articulates at the back with the very small part of the calcaneus (8) seen in this section, and at the front with the bases of the fourth and fifth metatarsals (17 and 18). Parts of all the interosseus muscles (four dorsal and three plantar, 20–26) are identified in the forefoot.

- 1 Ankle joint
 - 2 Talus
 - 3 Fibularis (*peroneus*) brevis
 - 4 Fibularis (*peroneus*) longus
 - 5 Interosseous talocalcaneal ligament
 - 6 Extensor digitorum brevis
 - 7 Cervical ligament
 - 8 Calcaneus
 - 9 Navicular
 - 10 Medial
 - 11 Intermediate
 - 12 Lateral
 - 13 Cuboid
 - 14 First
 - 15 Second
 - 16 Third
 - 17 Fourth
 - 18 Fifth
 - 19 Deep plantar branch of first dorsal metatarsal artery
 - 20 First dorsal
 - 21 Second dorsal
 - 22 First plantar
 - 23 Third dorsal
 - 24 Second plantar
 - 25 Fourth dorsal
 - 26 Third plantar
 - 27 Flexor digiti minimi brevis
 - 28 Abductor digiti minimi
 - 29 Head of second metatarsal
 - 30 Head of third metatarsal
 - 31 Inferior extensor retinaculum
- } cuneiform
 } metatarsal base
 } interosseus

- The cavities of a number of synovial joints in the foot are continuous with one another to the extent that there are normally six synovial cavities associated with the tarsal bones:
 - I The talocalcaneal joint cavity
 - II The talocalcaneonavicular joint cavity
 - III The calcaneocuboid joint cavity
 - IV The cuboideometatarsal joint cavity (between the cuboid and the bases of the fourth and fifth metatarsals)
 - V The cuneonavicular and cuneometatarsal joint cavity (between the navicular, the three cuneiforms and the bases of the second, third and fourth metatarsals)
 - VI The medial cuneometatarsal joint cavity (between the medial cuneiform and the base of the first metatarsal)
- Parts of all the above cavities can be seen in the foot sectioned here; they are indicated by the black lines in A and numbered as above. (The cuboideonavicular joint is usually a fibrous union, but in this specimen it is synovial and continuous with the cuneonavicular joint cavity.)

Sections of the foot *Coronal sections of the tarsus of the right foot*



Both sections are viewed from behind, looking from the heel toward the toes.

In A the section has passed through the talonavicular joint, so displaying the posterior (proximal) surface of the navicular (7). A small part of the cuboid (8) has been sliced off, leaving cartilage on the more lateral part of its posterior (calcanean) surface. The plantar aponeurosis (14) overlies flexor digitorum brevis (15), with abductor hallucis (21) on the medial side and abductor digiti minimi (12) laterally. Quadratus plantae (16) lies centrally, with the tendons of flexor hallucis longus (18) and flexor digitorum longus (19) more medially placed at this level.

In B at the level of the posterior (navicular) surfaces of the cuneiform bones, the tendon of flexor hallucis longus (18) is now passing deep to the digitorum tendon (19). The tendon of fibularis (*peroneus*) longus (11) is turning laterally under the cuboid (27), where a little more distally it will become covered by the long plantar ligament (29) (compare with the dissection on p. 99).

- 1 Tibialis anterior
- 2 Extensor hallucis longus
- 3 Dorsalis pedis artery
- 4 Deep fibular (*peroneal*) nerve
- 5 Extensor digitorum longus
- 6 Extensor digitorum brevis
- 7 Posterior articular surface of navicular (for talus)
- 8 Posterior articular surface of cuboid (for calcaneus)
- 9 Anterior tip of calcaneus
- 10 Fibularis (*peroneus*) brevis
- 11 Fibularis (*peroneus*) longus
- 12 Abductor digiti minimi
- 13 Lateral plantar nerve and vessels
- 14 Plantar aponeurosis
- 15 Flexor digitorum brevis
- 16 Quadratus plantae
- 17 Plantar calcaneocuboid (short plantar) ligament
- 18 Flexor hallucis longus
- 19 Flexor digitorum longus
- 20 Medial plantar nerve and vessels
- 21 Abductor hallucis
- 22 Tibialis posterior
- 23 Plantar calcaneonavicular (spring) ligament
- 24 Medial
- 25 Intermediate } cuneiform
- 26 Lateral
- 27 Cuboid
- 28 Tuberosity of fifth metatarsal
- 29 Long plantar ligament

A Through the transverse tarsal joint, proximal to the navicular

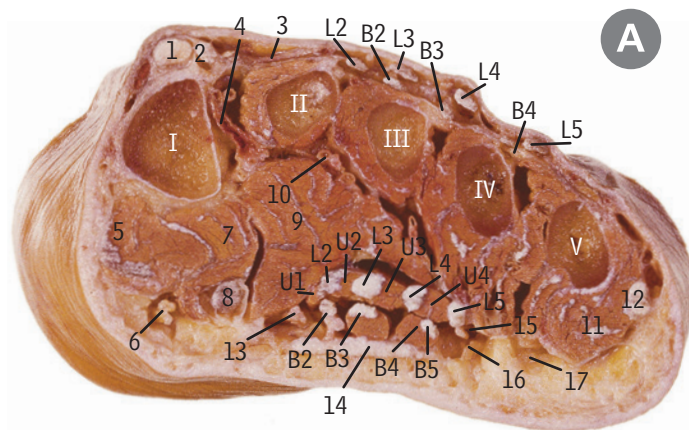
B Through the cuneonavicular joint, distal to the navicular

Coronal sections of the right metatarsus

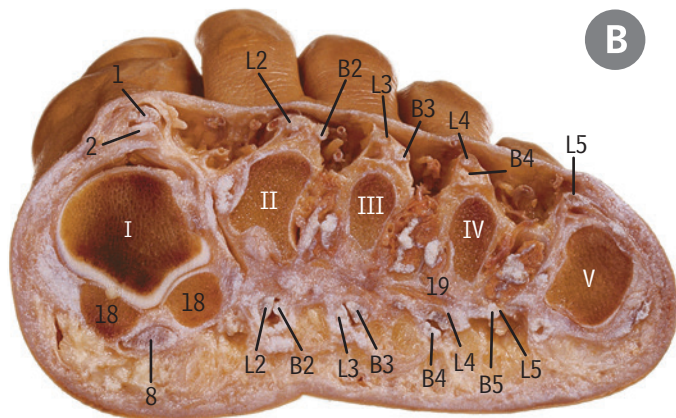
Both sections are viewed from behind, looking toward the toes. The metatarsals are numbered in Roman figures. On the dorsum the tendons of extensor digitorum longus to the appropriate toes are numbered L2–L5, and those of extensor digitorum brevis B2–B4 (recall that the brevis tendon to the great toe is named extensor hallucis brevis, 2). Similarly in the sole the flexor digitorum longus tendons are numbered L2–L5,

with the lumbrical muscles that arise from those tendons numbered U1–U4. The various interosseus muscles between and below the metatarsals have not been labeled.

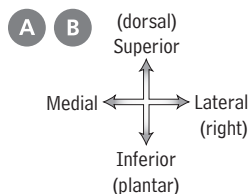
In B note the sesamoid bones (18) under the head of the first metatarsal (I), with the tendon of flexor hallucis longus (8) between them.



A Through the middle of the metatarsal shafts

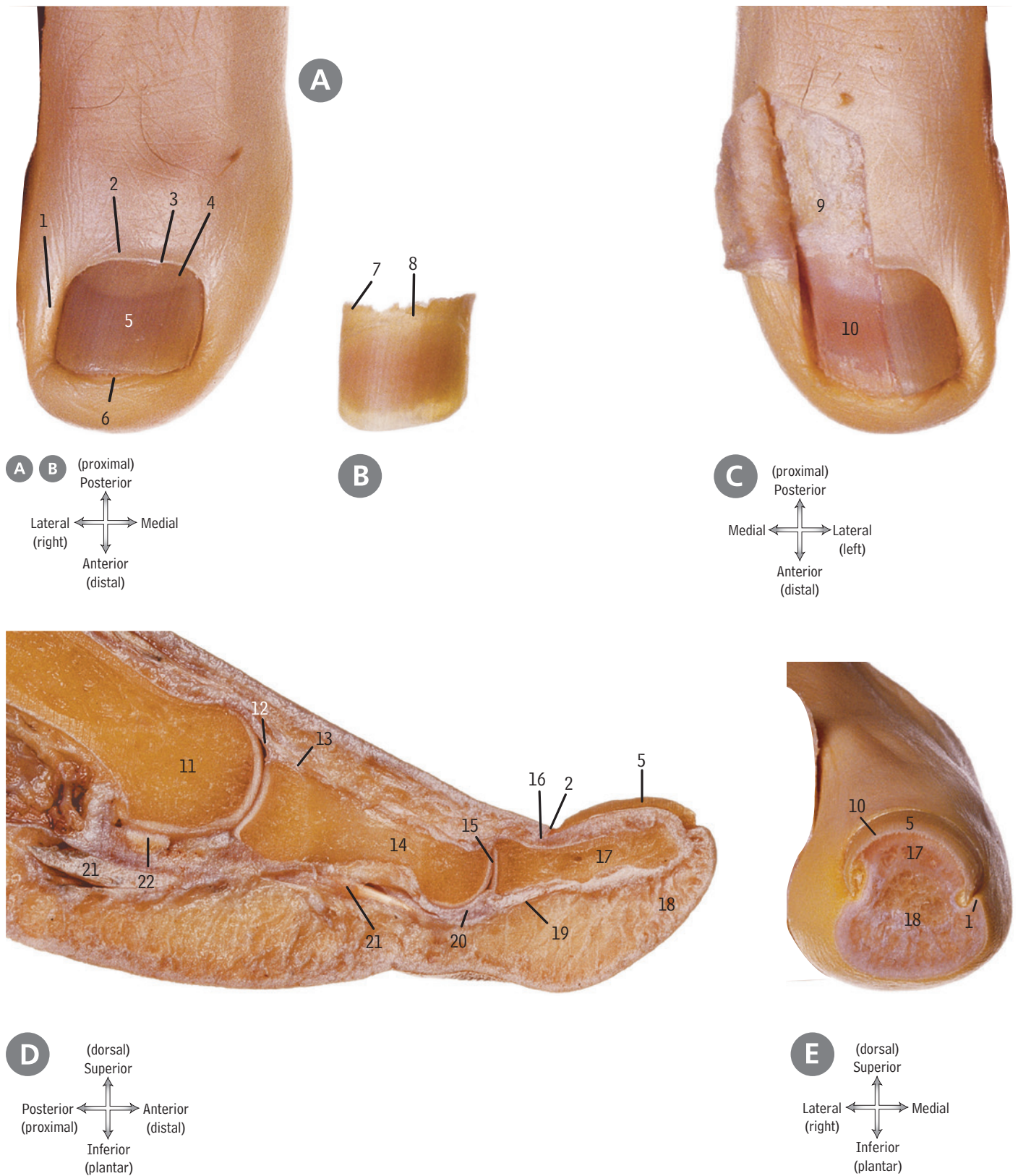


B Through the heads of the first and fifth metatarsals



- 1 Extensor hallucis longus
- 2 Extensor hallucis brevis
- 3 Arcuate artery
- 4 Deep plantar artery
- 5 Abductor hallucis
- 6 Proper plantar digital nerve of great toe
- 7 Flexor hallucis brevis
- 8 Flexor hallucis longus
- 9 Oblique head of adductor hallucis
- 10 Second plantar metatarsal artery
- 11 Flexor digiti minimi brevis
- 12 Abductor digiti minimi
- 13 Common plantar digital branches of medial plantar nerve
- 14 Plantar aponeurosis
- 15 Deep branch of lateral plantar nerve
- 16 Fourth common plantar digital nerve
- 17 Proper plantar digital nerve of fifth toe
- 18 Sesamoid bone
- 19 Transverse head of adductor hallucis

Great toe *The dorsum, nail and sections of the great toe*



- A** Dorsum of the right great toe
- B** Nail
- C** Nail bed of the left great toe
- D** Sagittal section of the right great toe, from the lateral side
- E** Coronal section of the distal phalanx of the right great toe

- 1 Nail wall
- 2 Nail fold
- 3 Eponychium
- 4 Lunule
- 5 Body
- 6 Free border
- 7 Occult border
- 8 Root
- 9 Germinal matrix
- 10 Sterile matrix
- 11 Head of first metatarsal
- 12 Capsule of metatarsophalangeal joint
- 13 Attachment of extensor hallucis brevis
- 14 Proximal phalanx
- 15 Capsule of interphalangeal joint
- 16 Attachment of extensor hallucis longus
- 17 Distal phalanx
- 18 Septa of pulp space
- 19 Attachment of flexor hallucis longus
- 20 Plantar ligament of interphalangeal joint
- 21 Flexor hallucis longus
- 22 Sesamoid bone

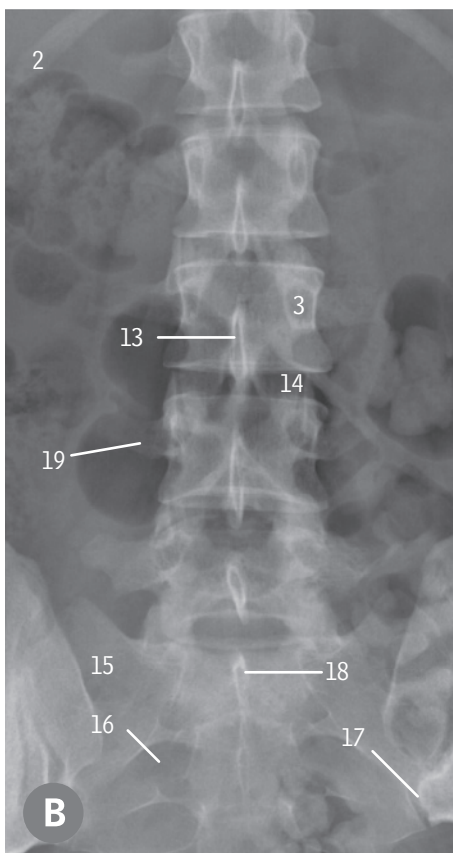
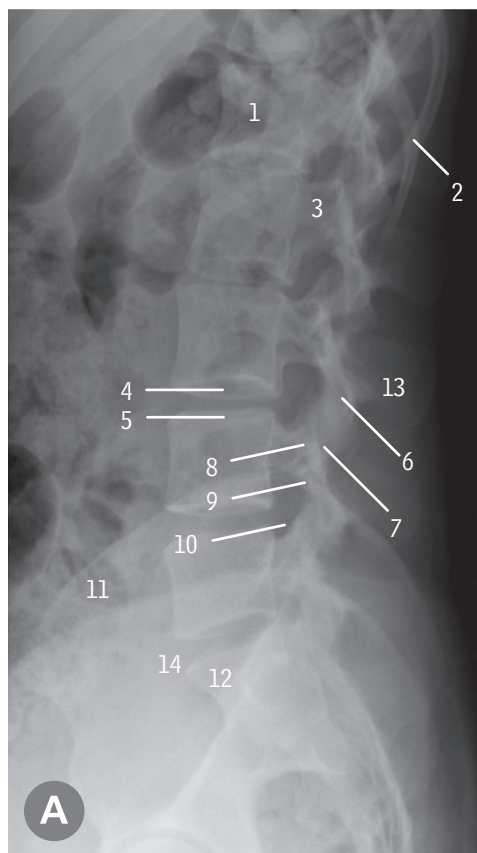
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Imaging of the lower limb

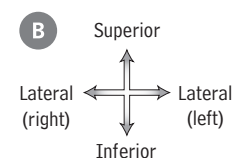
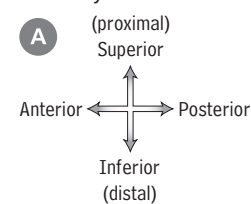
4

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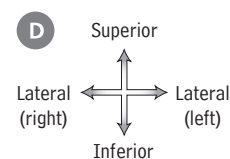
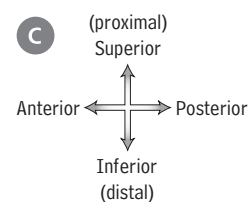
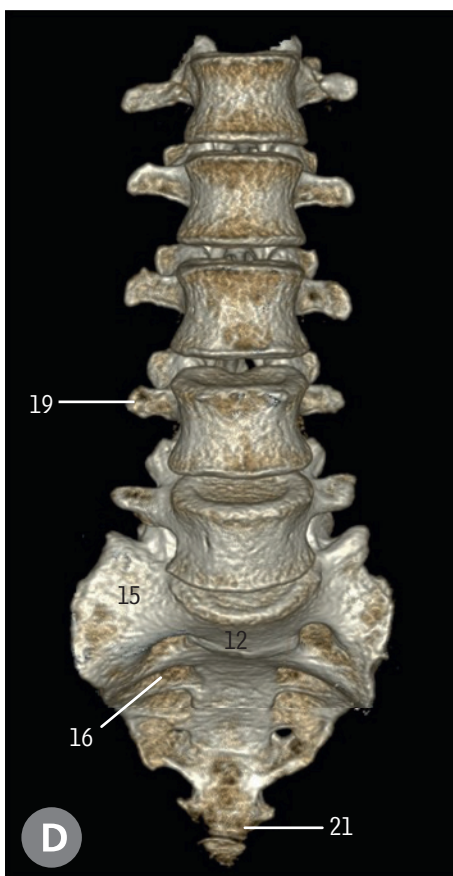
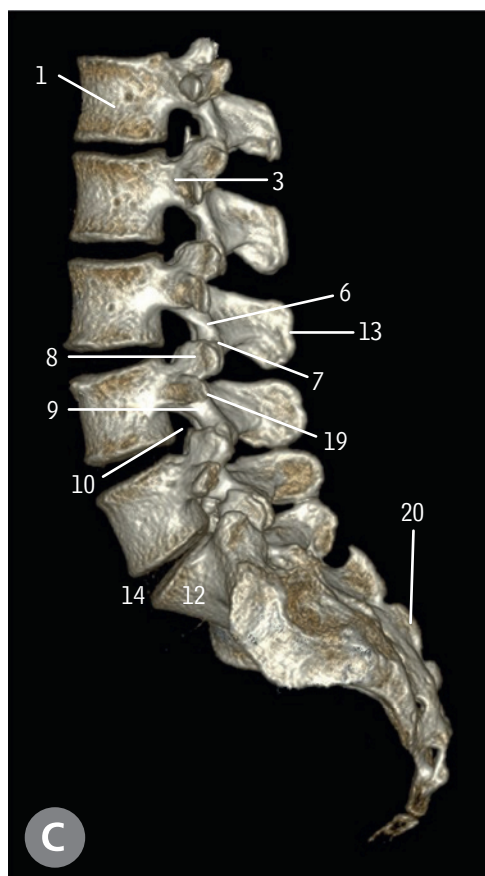
Lumbar spine Plain radiographic and CT anatomy



- 1 Body of L1 vertebra
- 2 12th rib
- 3 Pedicle of L2 vertebra
- 4 Inferior endplate of L3 vertebra
- 5 Superior endplate of L4 vertebra
- 6 Inferior articular process of L3 vertebra
- 7 Facet joint between L3 and L4 vertebrae
- 8 Superior articular process of L4 vertebra
- 9 Pars interarticularis
- 10 Neural foramen between L4 and L5 vertebrae
- 11 Wing of ilium
- 12 Body of S1 vertebra
- 13 Spinous process of L3 vertebra
- 14 Intervertebral disc space
- 15 Sacral ala
- 16 Second sacral neural foramen
- 17 Sacroiliac joint
- 18 Spinous process of S1
- 19 Transverse process of L4 vertebra
- 20 Sacral crest
- 21 Coccyx

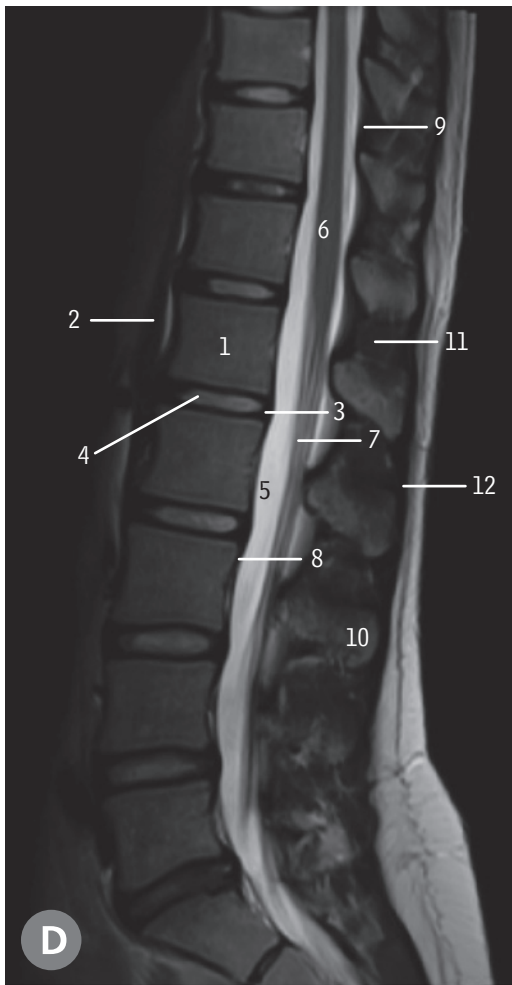


Lateral (A) and anteroposterior (B) plain radiographs



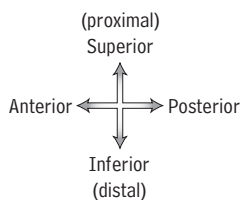
Lateral (C) and anteroposterior (D) volume-rendered CT images

Lumbar spine MRI anatomy—sagittal



D E

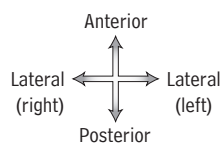
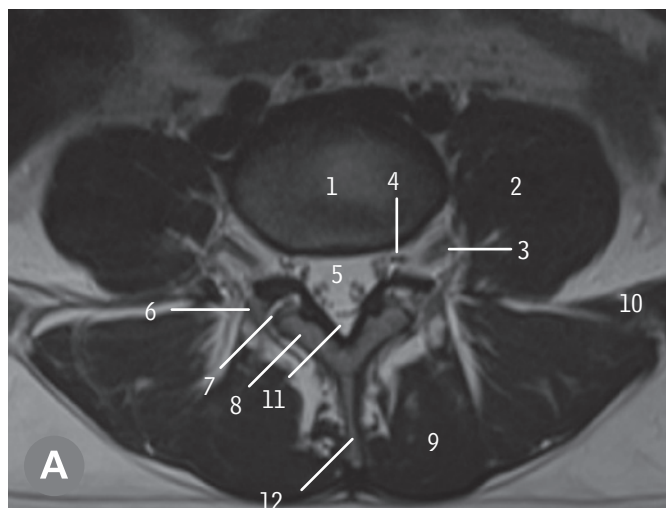
Sagittal T2-weighted (D) and T1-weighted (E) MR images



- | | |
|---|-----------------------------------|
| 1 Body of L1 vertebra | 10 Spinous process of L3 vertebra |
| 2 Anterior longitudinal ligament | 11 Interspinous ligament |
| 3 Annulus fibrosus of intervertebral disc | 12 Supraspinous ligament |
| 4 Nucleus pulposus | 13 Epidural fat |
| 5 Cerebrospinal fluid within dural sac | |
| 6 Conus medullaris of spinal cord | |
| 7 Cauda equina | |
| 8 Posterior longitudinal ligament | |
| 9 Ligamentum flavum | |

- The typical appearances of normal plain radiographic anatomy result from the superimposition of structures in both the lateral (A) and frontal (B) projections. The characteristic “owl’s face” appearance of vertebrae on the frontal view (B) is accounted for by the “eyes” being formed by the pedicles (B3), and “beak” by the spinous process (B13); disruption of this normal appearance may be seen in disease, such as following tumour metastasis to the spine and in cases of trauma.
- (C) and (D) represent VRT (“Volume Rendered Technique”) images acquired following computer-aided post-processing of Computed Tomographic (CT) data, a technique using X-rays. VRT images enable the selective visualization of bones and soft tissues which may subsequently be manipulated in three dimensions, an invaluable tool to the radiologist and surgeon. Virtual dissection, in which selected parts of anatomy are removed from images and which was used to obtain the images shown, can also be used to facilitate examination of inaccessible structures in three dimensions.
- Magnetic resonance imaging (MRI) provides detailed information on the soft tissues and bone marrow via the use of radio waves and strong magnetic fields, which may be manipulated in a variety of ways to selectively examine different tissue types. (D) demonstrates a “T2 weighted” image in which fluid, such as cerebrospinal fluid and that within the nucleus pulposus of intervertebral discs, appears bright (“high signal”). In “T1 weighted” images such as (E) fluid appears dark, while fat—such as that in the epidural space—is bright. Normal fat conversion of bone marrow occurs during ageing and is seen to manifest as relatively high signal within the vertebral bodies.

Lumbar spine MRI anatomy—axial

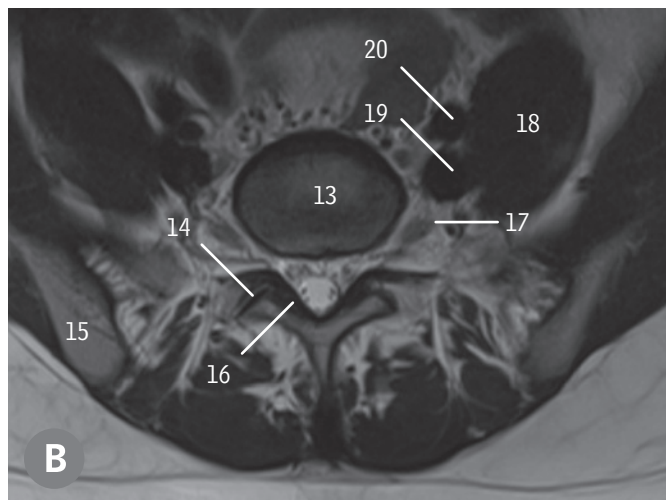


A B C

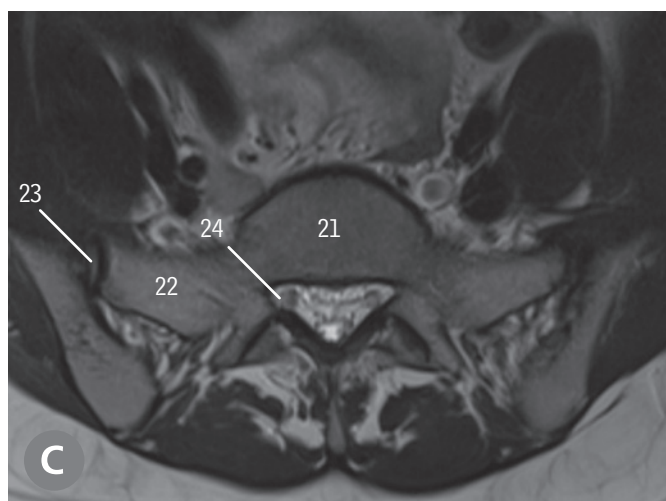
Axial T2-weighted MR images



Axial sections

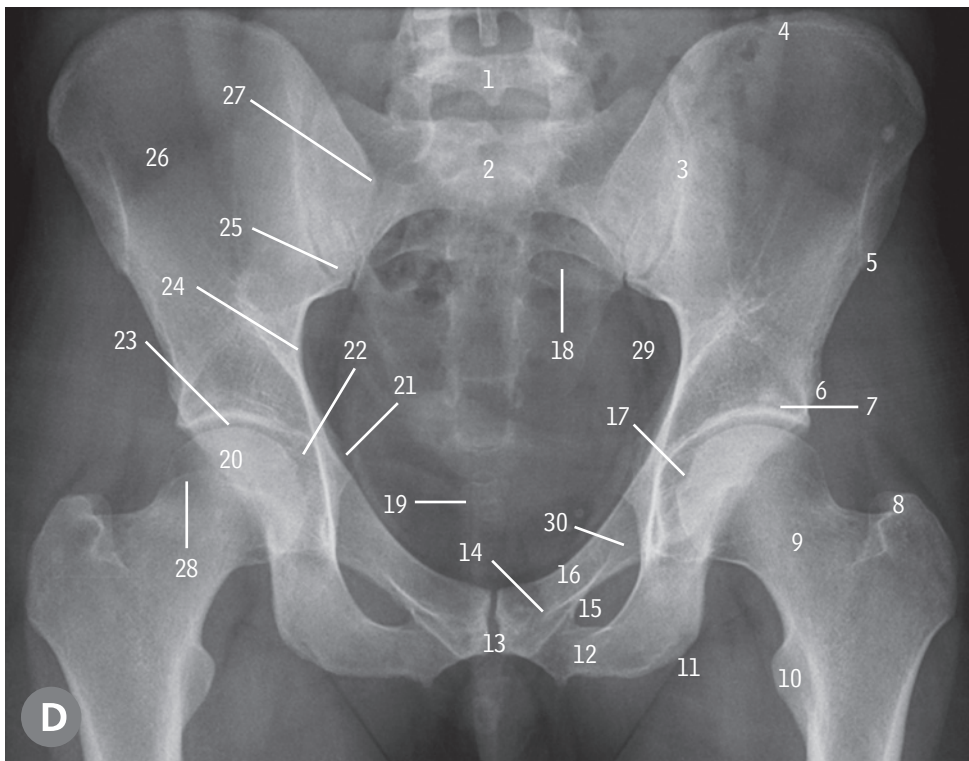


- 1 Intervertebral disc between L4/L5
- 2 Psoas major
- 3 Exiting L4 nerve root
- 4 L5 nerve root within lateral recess
- 5 Thecal sac
- 6 Superior facet of L5 vertebra
- 7 Facet (zygapophyseal) joint of L4/L5
- 8 Inferior facet of L4 vertebra
- 9 Erector spinae
- 10 Quadratus lumborum
- 11 Epidural fat
- 12 Spinous process of L4 vertebra
- 13 Intervertebral disc between L5/S1
- 14 Facet (zygapophyseal) joint of L5/S1
- 15 Right wing of ilium
- 16 Ligamentum flavum
- 17 Exiting L5 nerve root
- 18 Psoas major
- 19 Left common iliac vein
- 20 Left common iliac artery
- 21 S1 vertebral body
- 22 Right sacral ala
- 23 Right sacroiliac joint
- 24 S1 nerve root



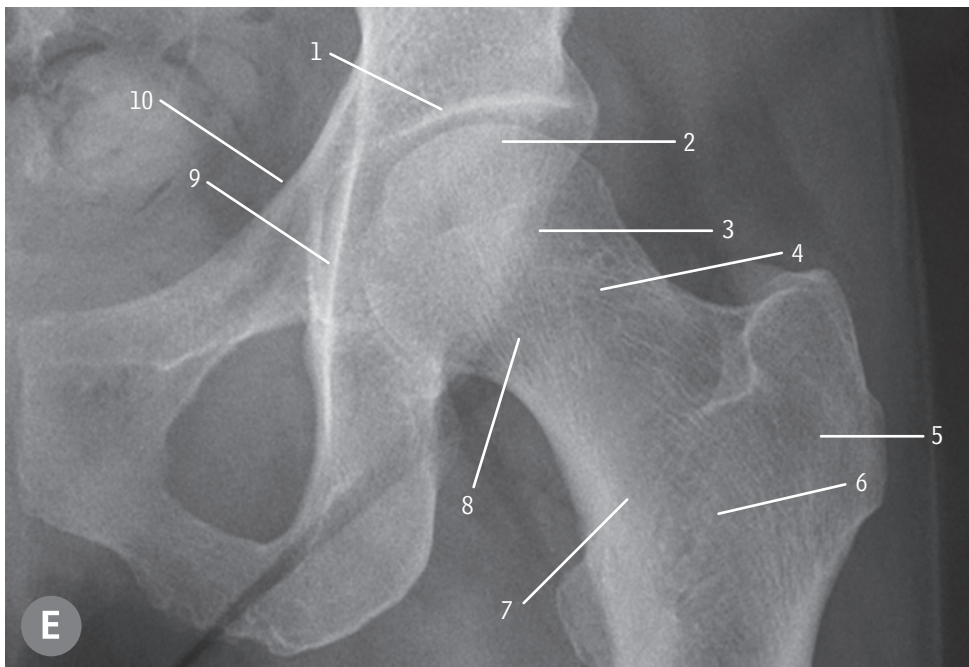
- Axial MR imaging of the spine, such as shown in images A–C, is invaluable in the assessment of intervertebral disc disease; herniation of disc material from the nucleus pulposus through the annulus fibrosus may compress the spinal cord (if occurring above the level of the cauda equina) or nerve roots either within the spinal canal or neural exit foramina.

Pelvis Plain radiographic anatomy

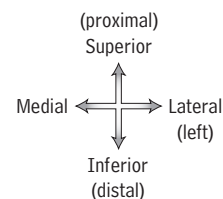


- 1 L5 vertebra
- 2 Sacrum
- 3 Sacroiliac joint
- 4 Iliac crest
- 5 Anterior superior iliac spine
- 6 Anterior inferior iliac spine
- 7 Roof of acetabulum
- 8 Greater trochanter of femur
- 9 Neck of femur
- 10 Lesser trochanter of femur
- 11 Ischial tuberosity
- 12 Inferior pubic ramus
- 13 Pubic symphysis
- 14 Pubic tubercle
- 15 Obturator foramen
- 16 Superior pubic ramus
- 17 Fovea capitis
- 18 Second sacral foramen
- 19 Coccyx
- 20 Head of femur
- 21 Ischial spine
- 22 Acetabular fossa
- 23 Hip joint space
- 24 Arcuate line
- 25 Posterior inferior iliac spine
- 26 Iliac wing
- 27 Posterior superior iliac spine
- 28 Epiphyseal line
- 29 Greater sciatic notch
- 30 Lesser sciatic notch (en face)

D Anteroposterior radiograph



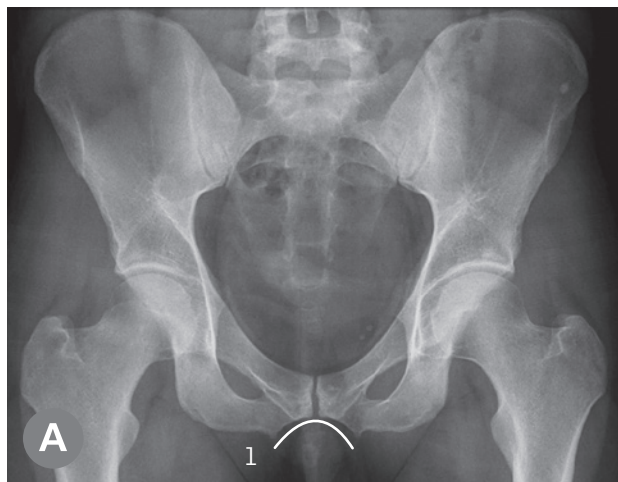
- 1 Roof of acetabulum
- 2 Anterior wall of acetabulum
- 3 Posterior wall of acetabulum (en face)
- 4 Principle tensile group
- 5 Greater trochanter group
- 6 Secondary tensile group
- 7 Secondary compressive group
- 8 Principle compressive group
- 9 Ilioischial line
- 10 Iliopectineal line



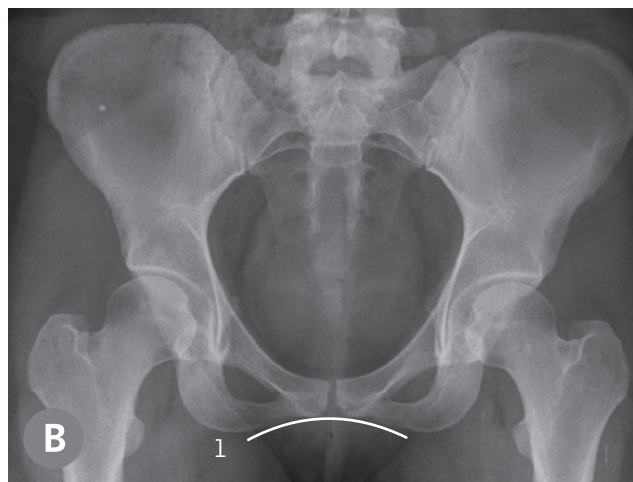
E Left hip (magnified view)

- Among others, Julius Wolff (1836–1902), a German surgeon and anatomist, described the process by which organization of bone occurs in response to the stresses placed upon it as a result of gravity and dynamic forces—subsequently known as “Wolff’s Law”. This may be clearly seen in the organization and distribution of trabeculae (cancellous bone), a relatively lightweight form of bone that has a high surface area to mass ratio and that plays a key role in bone strength.
- Trabeculae can be seen to organize themselves in distinct patterns, which are well illustrated in the proximal femur (E). Classically, five groups of trabeculae (E4–8) can be reliably identified as a result of the compressive and tensile forces placed upon them. Long periods of inactivity (e.g. bed rest, spaceflight), in addition to age-related loss of bone mass (osteopaenia, osteoporosis), may result in weakening of trabeculae with resultant “insufficiency fractures”. The femoral neck, as well as sacrum, pelvic bones and vertebral bodies, are commonly involved and such fractures are a major source of morbidity.

Pelvis *Male and female pelvis, sacrum*

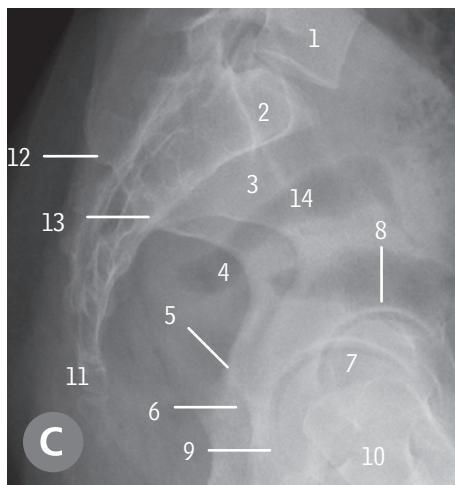


A Adult male pelvis radiograph

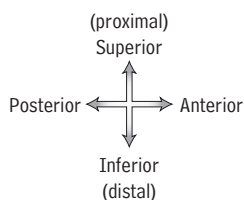


B Adult female pelvis radiograph

- Sex differences in the anatomy of the male and pelvis can be readily identified, although due to variation in the female pelvis (of which at least four types can be described—gynaecoid (50%), anthropoid (25%), android (20%) and platypelloid (5%)—not all may be seen in every individual.
- Classically, the following features may be seen:
 - Wider infrapubic angle (A1), >90 degrees in females, <90 degrees in males
 - Circular/oval pelvic inlet (females), heart-shaped (males)
 - Oval obturator foramen (females), rounded (males)
 - Wider sciatic notch (females)
 - Shorter, more triangular sacrum (females)
 - More anteriorly facing acetabulum (females)

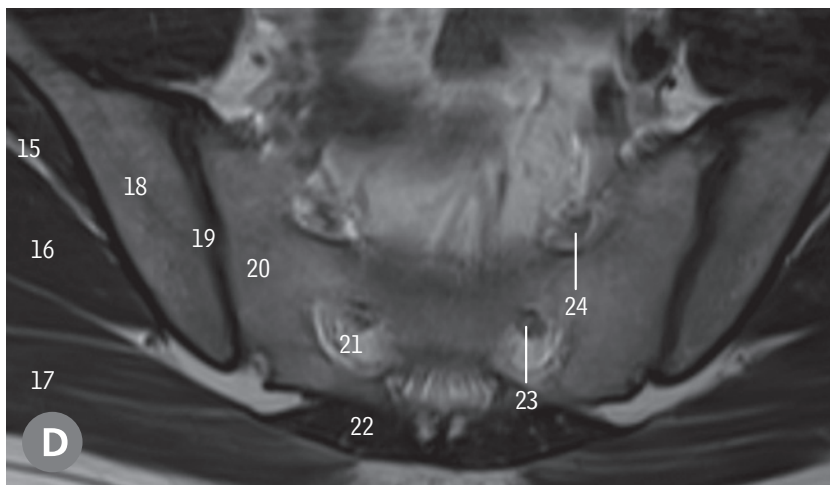


C Lateral radiograph of sacrum

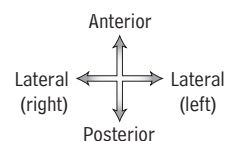


- 1 Body of L5 vertebra
- 2 Sacrum
- 3 Wing of ilium
- 4 Greater sciatic notch
- 5 Ischial spine
- 6 Lesser sciatic notch
- 7 Head of femur
- 8 Roof of acetabulum

- 9 Ramus of ischium
- 10 Obturator foramen (en face)
- 11 Coccyx
- 12 Posterior superior
- 13 Posterior inferior } iliac spine
- 14 Gas within rectum
- 15 Gluteus minimus
- 16 Gluteus medius

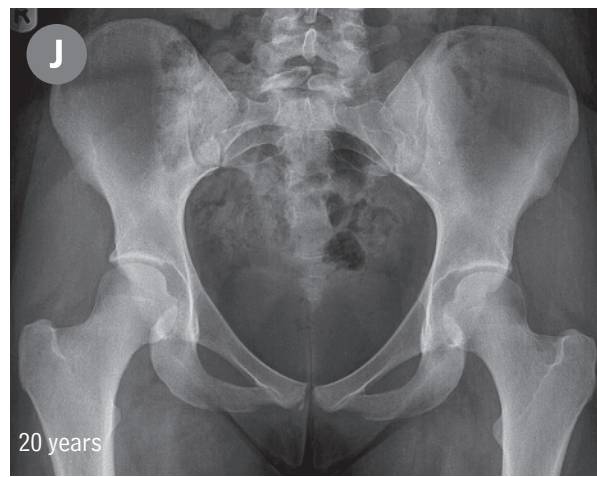
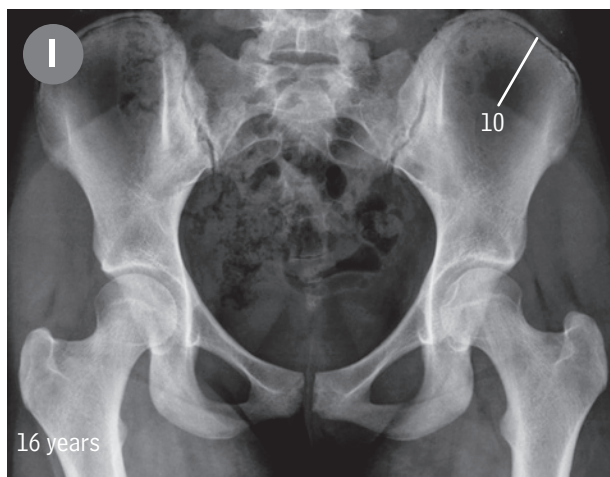
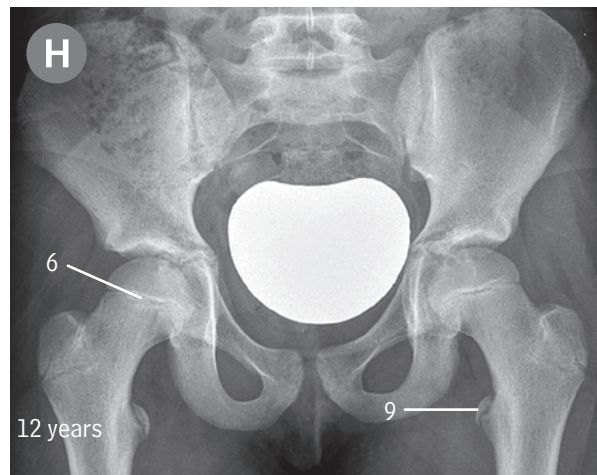
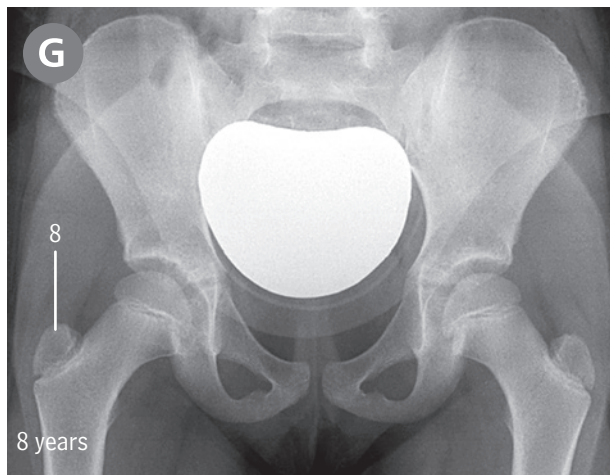
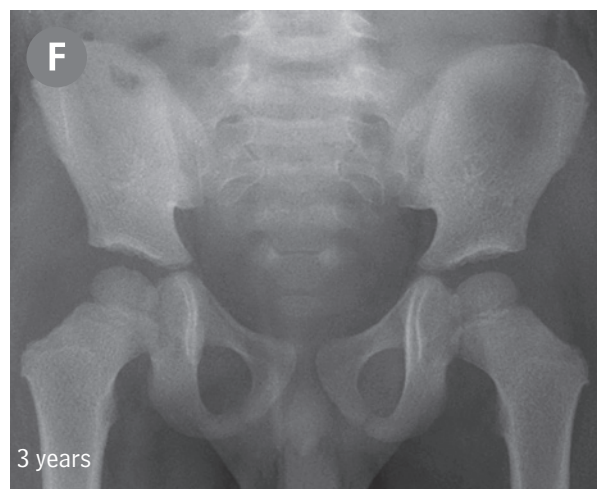
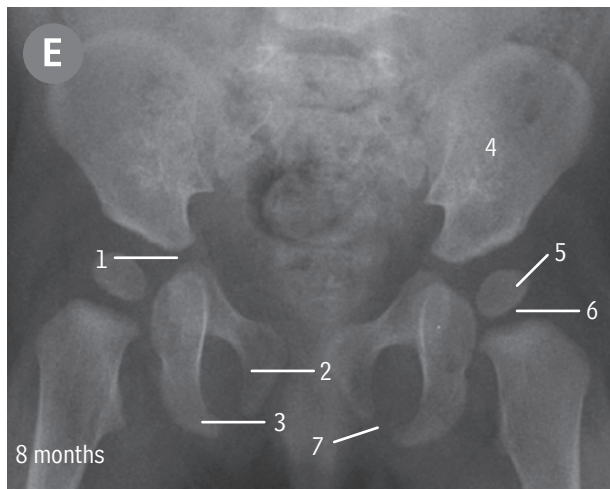


D Axial T1-weighted MR image of sacrum (S1/S2 level)



- 17 Gluteus maximus
- 18 Right wing of ilium
- 19 Sacroiliac joint
- 20 Sacral ala
- 21 Second sacral foramen
- 22 Multifidus/iliocostalis lumborum
- 23 S2 nerve root
- 24 S1 nerve root

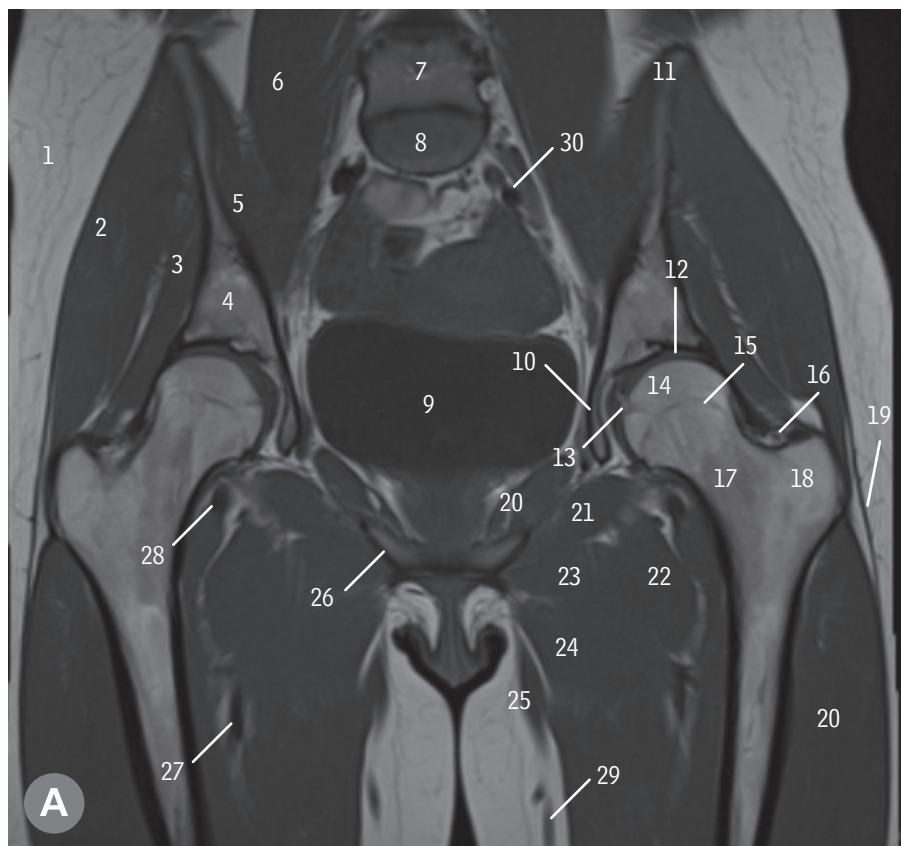
Pelvis *Developmental changes within the pelvis*



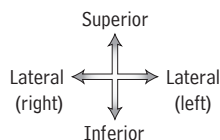
- Ossification of the pelvic bones progresses throughout infancy and childhood, with fusion not typically completing until 20–25 years of age. The pattern of ossification is predictable, depending on age, and may therefore be used to assess for delayed skeletal development.
- The triradiate cartilage (E1) represents the synchondrosis of the ilium, ischium and pubic bones and is an important landmark in the ultrasound assessment of infants for the presence of developmental dysplasia of the hip; in this condition, abnormal development of a shallow acetabulum occurs and predisposes the individual to subsequent subluxation and dislocation of the hip joint. If undetected, mobility may be affected in addition to the development of early-onset degenerative joint disease.
- Fusion of the iliac crest apophysis (*apophysis* = separate centre of ossification attached to a tendon or muscle, not forming part of a joint) is amongst the last to occur (I10), and can be seen to progress in a predictable pattern from laterally to medially.

- 1 Triradiate cartilage (synchondrosis)
- 2 Pubis
- 3 Ischium
- 4 Ilium
- 5 Femoral epiphysis
- 6 Proximal femoral physis (growth plate)
- 7 Ischiopubic synchondrosis
- 8 Greater } trochanter apophysis
- 9 Lesser }
- 10 Iliac crest apophysis

Pelvis *MRI anatomy of the pelvis*



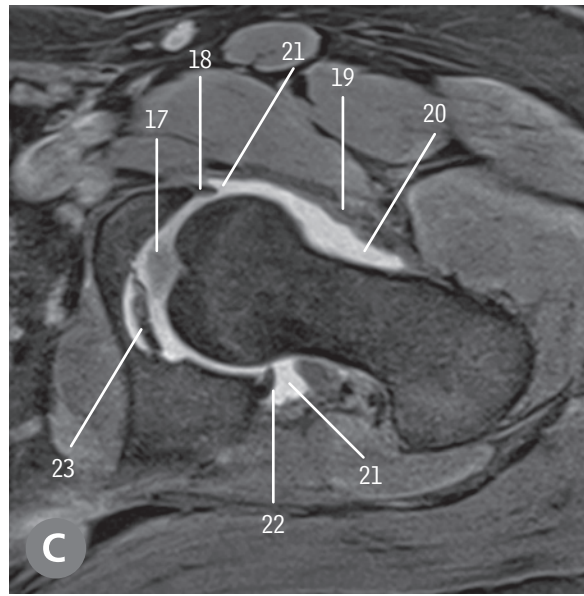
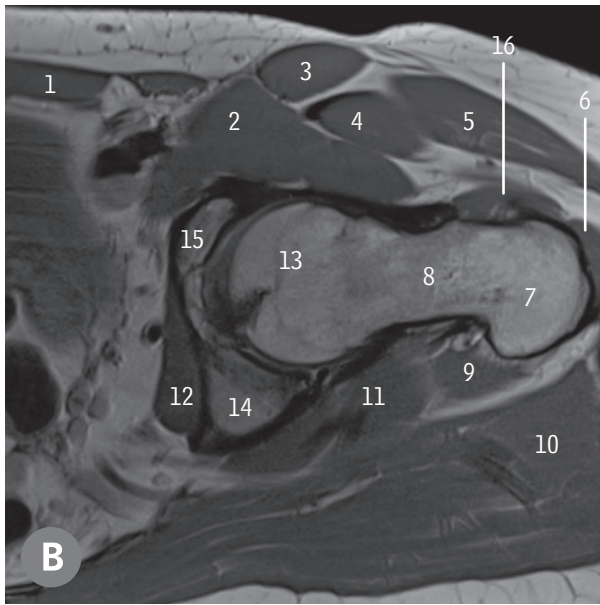
A Coronal T1-weighted MR image of the pelvis



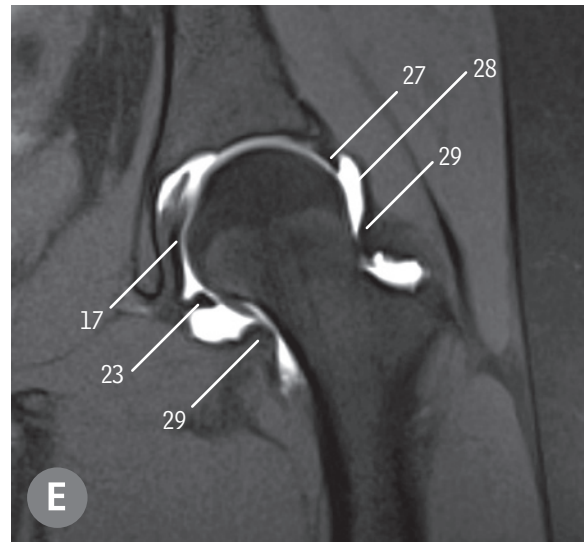
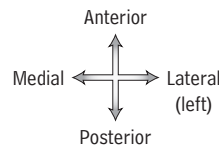
- | | | | |
|--------------------|--------------------------------|-------------------------------|-----------------------------------|
| 1 Subcutaneous fat | 10 Medial wall of acetabulum | 19 Iliotibial band | 28 Iliopsoas tendon |
| 2 Gluteus medius | 11 Iliac crest | 20 Vastus lateralis | 29 Great saphenous vein |
| 3 Gluteus minimus | 12 Articular cartilage | 21 Obturator externus | 30 External iliac artery and vein |
| 4 Acetabulum | 13 Fovea capitis | 22 Pectineus | |
| 5 Iliacus | 14 Femoral epiphysis | 23 Adductor minimus | |
| 6 Psoas major | 15 Epiphyseal line | 24 Adductor brevis | |
| 7 L5 vertebra | 16 Circumflex femoral vessels | 25 Gracilis | |
| 8 S1 vertebra | 17 Neck of femur | 26 Pubic tubercle | |
| 9 Urinary bladder | 18 Greater trochanter of femur | 27 Superficial femoral artery | |

- Given the prevalence of chronic hip pain and the relative insensitivity of plain radiographs in the detection of pathology, MR imaging plays a critical role in assessment of the articular cartilage, periarticular bone and associated soft tissues.
- Fluoroscopically-guided injection of gadolinium-based contrast media into the hip joint space enables further evaluation, in particular of the articular cartilage and acetabular labrum. This is demonstrated in figures B-E, in which additional information on the structure of the various cartilaginous and ligamentous structures may be clearly seen.

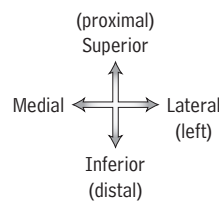
Pelvis *MRI anatomy of the hip*



B C Axial T1 (C) and arthrogram (D) MR images of the left hip



D E Coronal T1 (E) and arthrogram (F) MR images of the left hip



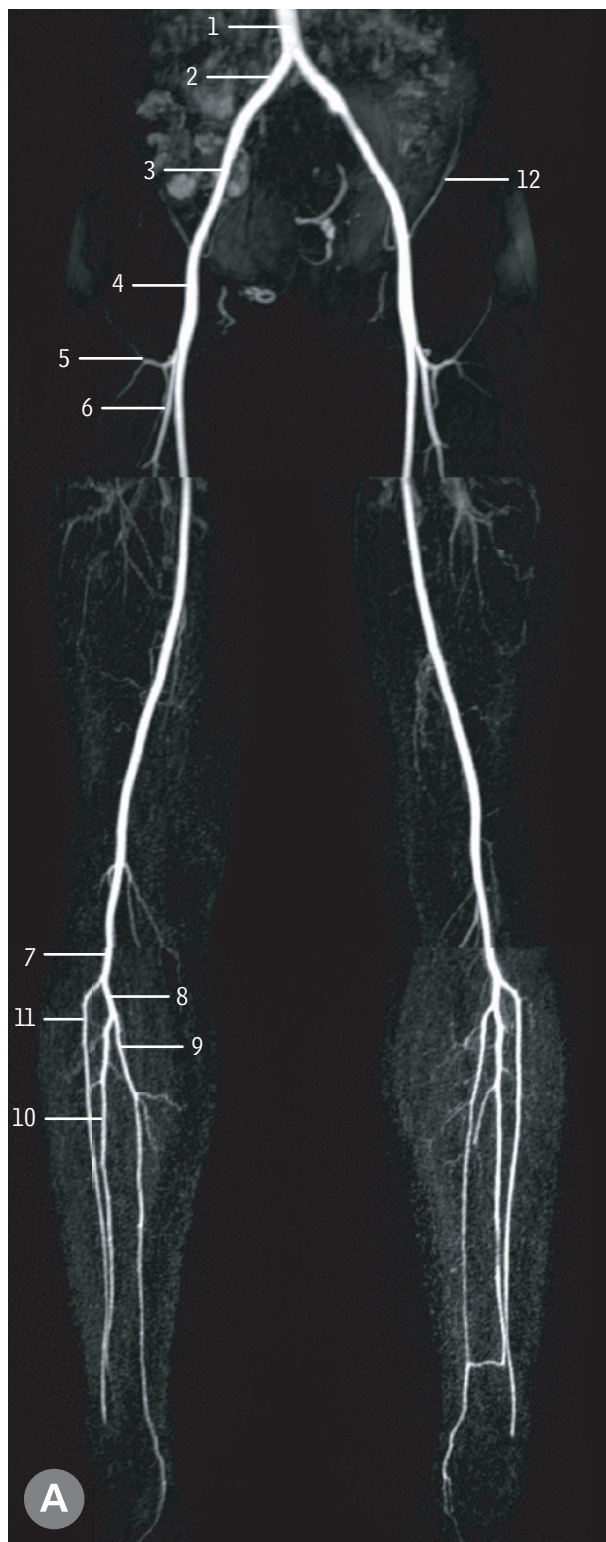
- 1 Rectus abdominis
- 2 Iliopsoas
- 3 Sartorius
- 4 Rectus femoris
- 5 Tensor fascia lata
- 6 Gluteus medius
- 7 Greater trochanter of femur
- 8 Neck of femur

- 9 Quadratus femoris
- 10 Gluteus maximus
- 11 Obturator externus
- 12 Obturator internus
- 13 Head of femur
- 14 Ischium
- 15 Pubis
- 16 Vastus lateralis

- 17 Ligamentum teres (round ligament)
- 18 Anterior labrum
- 19 Joint capsule
- 20 Joint space (distended by contrast medium)
- 21 Perilabral sulcus
- 22 Posterior labrum

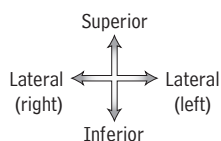
- 23 Transverse acetabular ligament
- 24 Acetabulum
- 25 Gluteus minimus
- 26 Gluteus medius
- 27 Superior labrum
- 28 Superior perilabral recess
- 29 Zona orbicularis

Arterial anatomy *MRA angiographic anatomy of the pelvis and leg*



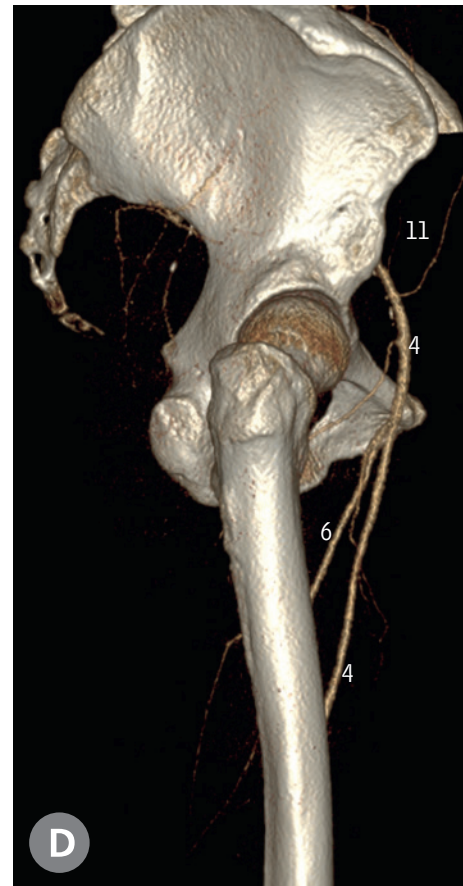
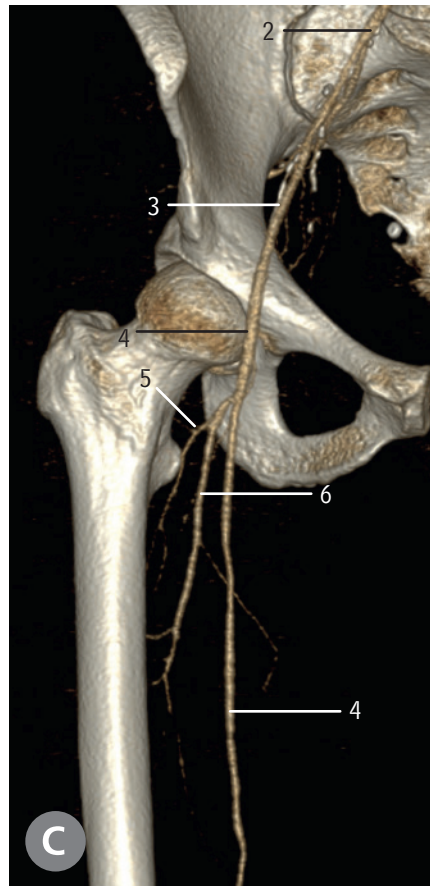
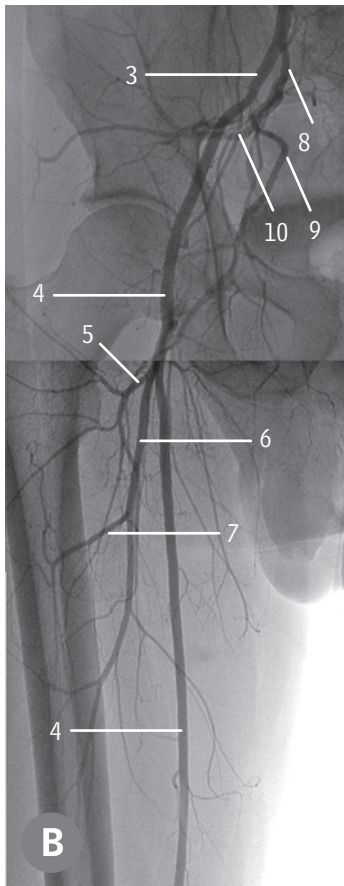
A Coronal T1-weighted Maximum Intensity Projection (MIP) MR angiogram of the legs

- Recent years have seen a paradigm shift in techniques used in the assessment of the vasculature. Previously, digital subtraction angiography (DSA) was widely used in a diagnostic role, requiring puncture of a vessel, placement of an indwelling catheter, and injection of radiopaque contrast media (B).
- Notwithstanding the radiation burden to the patient, the use of such a technique also involved the attendant risks and potential complications of vascular puncture as well as adverse reactions to relatively high doses of iodine-based contrast media.
- Although still used in a therapeutic role (e.g. angioplasty), DSA has essentially been replaced by noninvasive techniques in the investigation of patients for potential vascular disease.
- Computed tomographic angiography (CTA) is a minimally invasive technique involving the use of CT imaging in conjunction with iodine-based contrast media, injected via a small cannula typically sited within a peripheral vein. This is in contrast to DSA, in which a specialized catheter requires placement either close to or within the vessel of interest itself and which uses significantly higher volumes of contrast media.
- Evaluation of the data acquired allows assessment for the development of significant atherosclerotic disease, in particular the presence of stenoses (narrowings) of vessels that may require subsequent treatment, as well as assessment for vascular integrity in the context of trauma and haemorrhage.
- Volume rendered technique (VRT) images may also be produced from datasets, thereby providing three dimensional information not available using DSA (C, D). Figure (C) clearly shows the relationship of the femoral artery to the femoral head posteriorly; this is of clinical use in the context of the acute management of major trauma to the leg, in which direct compression of the artery against the femoral head posteriorly may be employed to temporarily reduce or stop haemorrhage prior to definitive management.
- Magnetic resonance angiography (MRA) is a further technique which employs gadolinium-based contrast media and avoids the use of ionizing radiation (A). In certain circumstances, using special techniques, the use of contrast media may be avoided entirely via the evaluation of the physical properties of flowing blood in a strong magnetic field. This is less commonly used in the evaluation of the vasculature of the lower limb, however, and is more prone to image artefact, which may make interpretation challenging.
- Maximum intensity projection (MIP) images, such as in (A), are employed in both CTA and MRA. In this technique, only the points of highest signal (MR) or radiodensity (CT) are displayed, thereby allowing the rapid evaluation of a large body area but without the three dimensional information provided by VRT images.



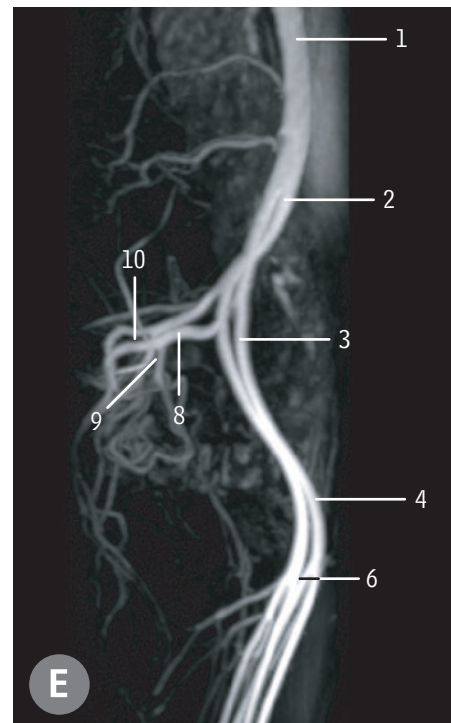
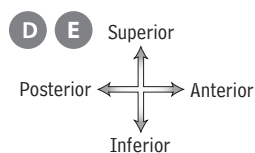
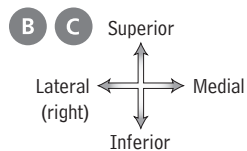
- 1 Abdominal aorta
- 2 Common iliac artery
- 3 External iliac artery
- 4 Femoral artery
- 5 Lateral circumflex femoral artery
- 6 Profunda femoris
- 7 Popliteal artery
- 8 Tibiofibular (tibio-peroneal) trunk
- 9 Posterior tibial artery
- 10 Anterior tibial artery
- 11 Fibular (peroneal) artery
- 12 Superficial circumflex iliac artery

Arterial anatomy *Arterial anatomy of the hip*

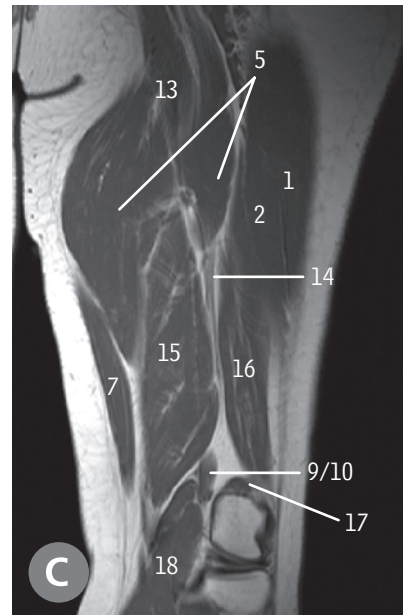
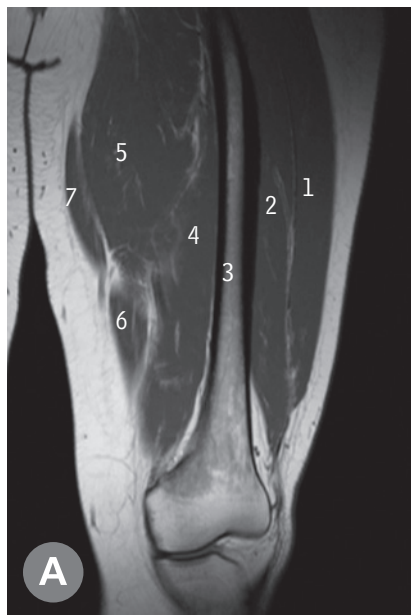


- B** Anteroposterior digital subtraction angiogram of the right hip
- C** Anteroposterior (C) and lateral (D) volume-rendered CT angiogram images of the right hip
- D**
- E** Lateral T1-weighted Maximum Intensity Projection (MIP) MR angiogram of the pelvis

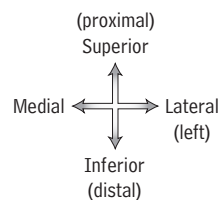
- 1 Abdominal aorta
- 2 Common iliac artery
- 3 External iliac artery
- 4 Femoral artery
- 5 Lateral circumflex femoral artery
- 6 Profunda femoris
- 7 Perforating artery
- 8 Internal iliac artery
- 9 Anterior division of internal iliac artery
- 10 Posterior division of internal iliac artery
- 11 Superficial epigastric artery



Thigh MRI anatomy of the thigh—coronal



A B C Coronal T1-weighted MR images of the left thigh

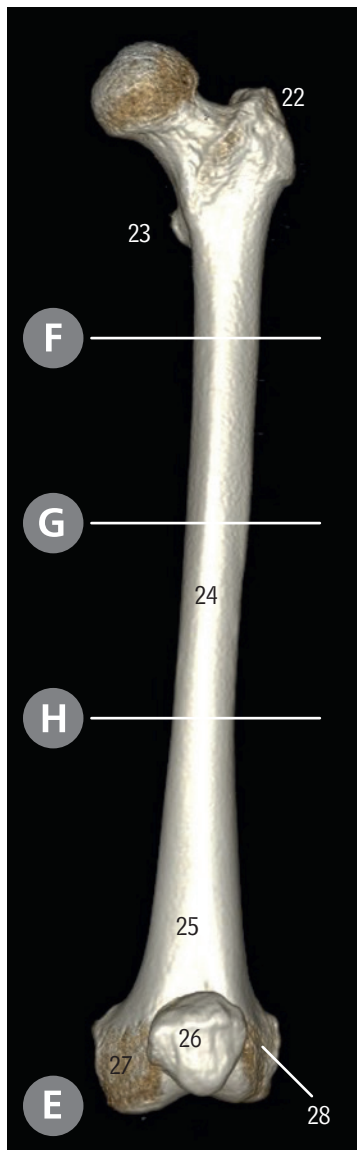


- 1 Vastus lateralis
- 2 Vastus intermedius
- 3 Shaft of femur
- 4 Vastus medialis
- 5 Adductor magnus
- 6 Sartorius
- 7 Gracilis
- 8 Great saphenous vein
- 9 Femoral artery
- 10 Femoral vein
- 11 Lateral condyle of femur

- 12 Medial condyle of femur
- 13 Semitendinosus
- 14 Sciatic nerve
- 15 Semimembranosus
- 16 Biceps femoris
- 17 Lateral } head of gastrocnemius
- 18 Medial }
- 19 Head of femur
- 20 Neck of femur
- 21 Lesser trochanter of femur
- 22 Patella

D Volume-rendered CT image of the left leg, medial view

Thigh MRI anatomy of the thigh—axial

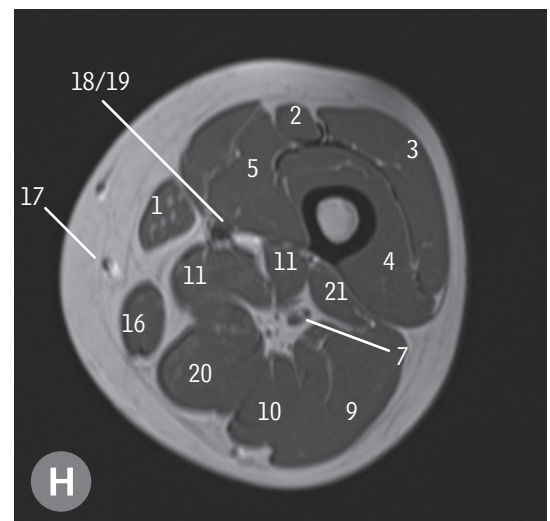
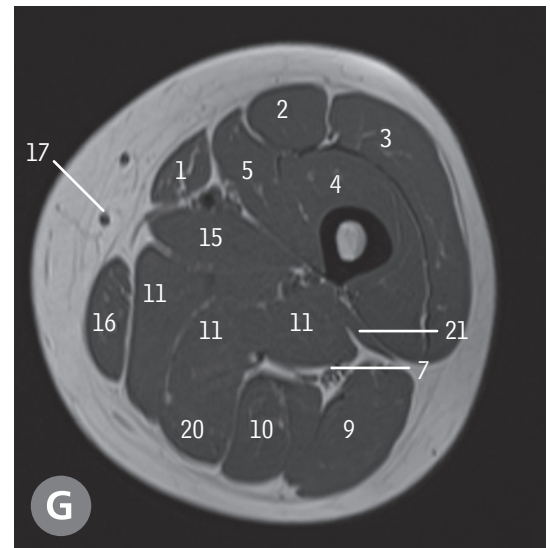
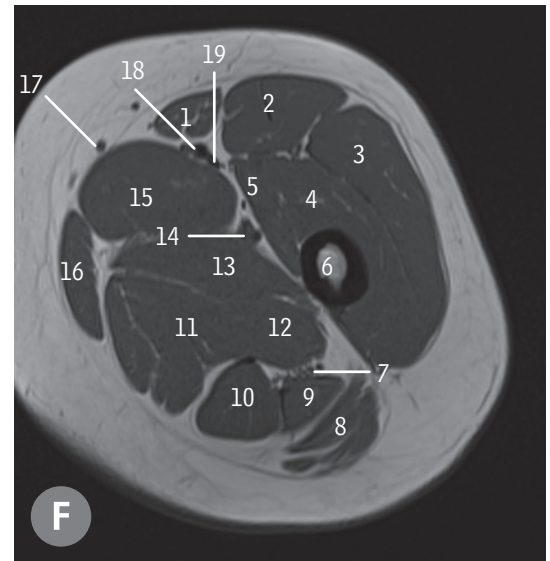
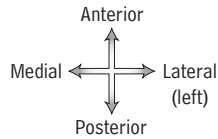


E Volume-rendered CT image of the left femur, anterior view

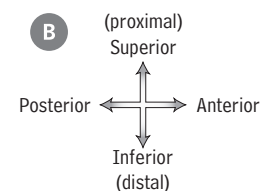
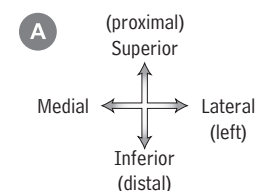
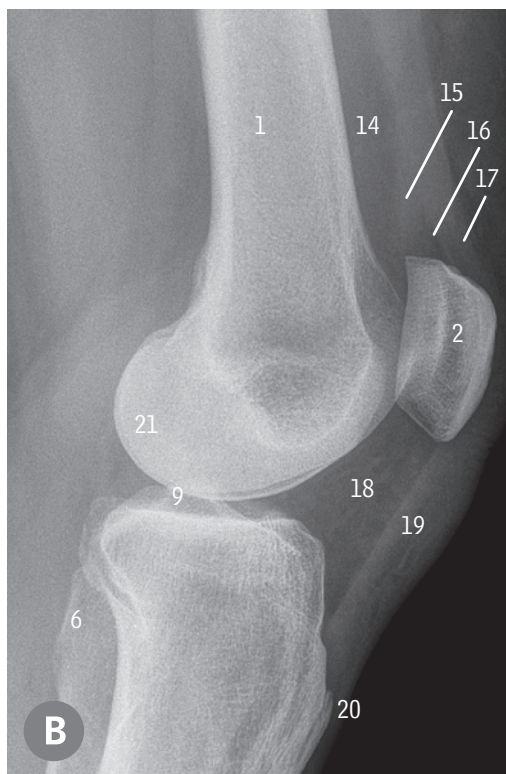
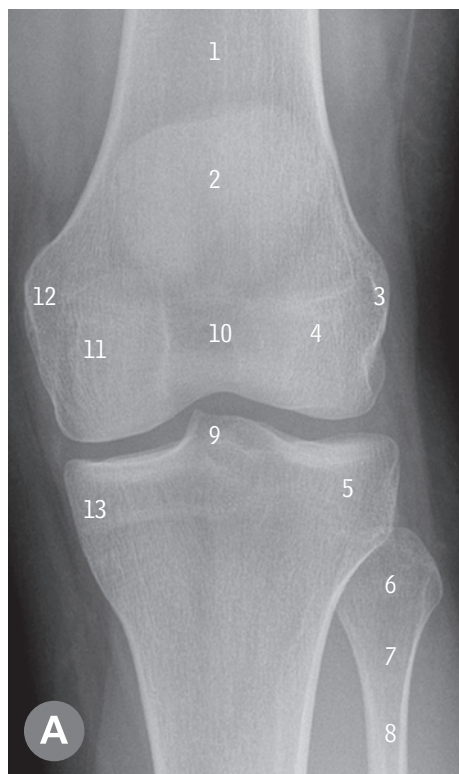
- | | |
|---|----------------------------------|
| 1 Sartorius | 15 Adductor longus |
| 2 Rectus femoris | 16 Gracilis |
| 3 Vastus lateralis | 17 Great saphenous vein |
| 4 Vastus intermedius | 18 Femoral artery |
| 5 Vastus medialis | 19 Femoral vein |
| 6 Femur | 20 Semimembranosus |
| 7 Sciatic nerve | 21 Biceps femoris (short head) |
| 8 Gluteus maximus | 22 Greater } trochanter of femur |
| 9 Biceps femoris (long head) | 23 Lesser } |
| 10 Semitendinosus | 24 Femoral shaft (diaphysis) |
| 11 Adductor magnus | 25 Distal metaphysis |
| 12 Adductor minimus | 26 Patella |
| 13 Adductor brevis | 27 Medial } condyle of femur |
| 14 Profunda femoris and deep femoral vein | 28 Lateral } |

F G H

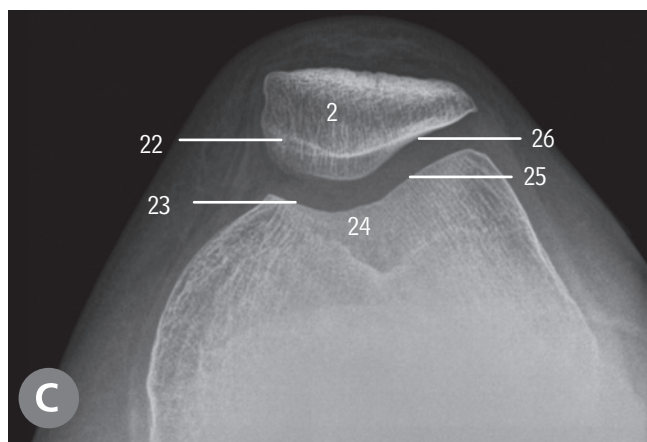
Axial T1-weighted MR images of the left thigh



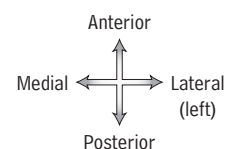
Knee Plain radiographic anatomy



A B Anteroposterior (A) and lateral (B) radiographs of the left knee



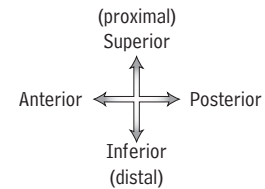
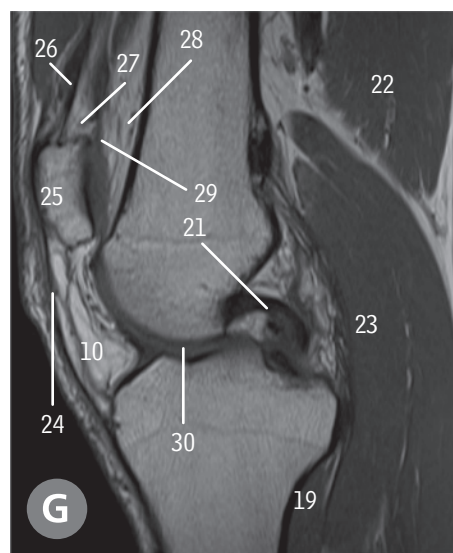
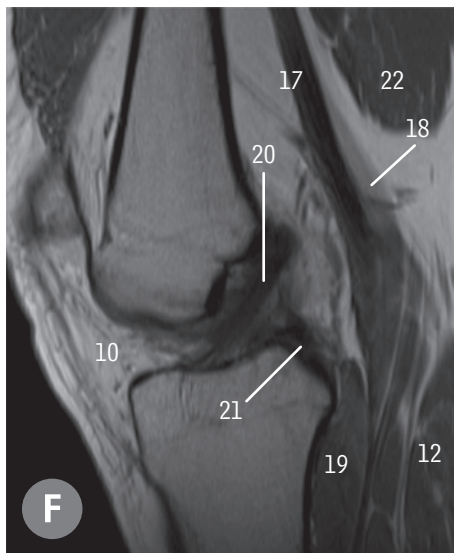
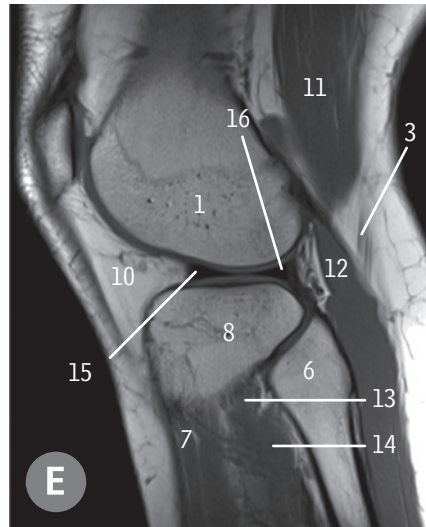
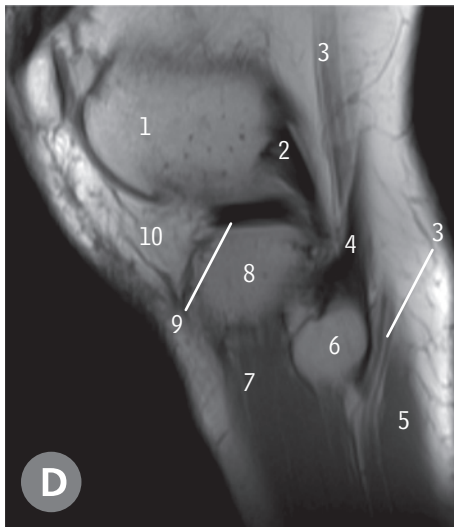
C “Skyline” or “sunrise” view of the left patellofemoral joint



- | | |
|-------------------------------------|--|
| 1 Femur | 19 Patellar tendon |
| 2 Patella | 20 Tibial tuberosity |
| 3 Lateral epicondyle of femur | 21 Femoral condyles (<i>en face</i>) |
| 4 Lateral condyle of femur | 22 Medial patellar facet |
| 5 Lateral condyle of tibia | 23 Medial trochlear facet |
| 6 Head of fibula | 24 Trochlea |
| 7 Neck of fibula | 25 Lateral trochlear facet |
| 8 Proximal shaft of fibula | 26 Lateral patellar facet |
| 9 Intercondylar eminence | |
| 10 Intercondylar fossa | |
| 11 Medial condyle of femur | |
| 12 Medial epicondyle of femur | |
| 13 Medial condyle of tibia | |
| 14 Prefemoral fat pad | |
| 15 Suprapatellar bursa | |
| 16 Quadriceps fat pad | |
| 17 Quadriceps tendon | |
| 18 Infrapatellar fat pad (of Hoffa) | |

- The “skyline” or “sunrise” view of the patellofemoral joint as shown in (C) is used most often to evaluate for the development of degenerative joint disease, assessment for possible fractures and for the evaluation of femoral trochlear dysplasia in which an abnormally shallow or flattened trochlear surface predisposes individuals to dislocation of the patella.
- As seen in (C), the normal lateral trochlear facet is steeper and longer than that on the medial side; despite this, lateral dislocation of the patella is far more common than medial dislocation, in part due to the biomechanical forces at the time of injury. Disruption of the medial patellofemoral ligaments frequently occurs, resulting in subsequent instability that may necessitate surgical intervention.
- As demonstrated in (D3), traumatic injury to the knee, in particular the head and neck of the fibula, may also result in injury to the common fibular nerve as it passes lateral to the bone where it is vulnerable to crushing forces. As a result, disabling weakness to the muscles of the calf may occur, resulting in foot drop and paraesthesia (skin sensory changes).

Knee MRI anatomy of the knee—sagittal



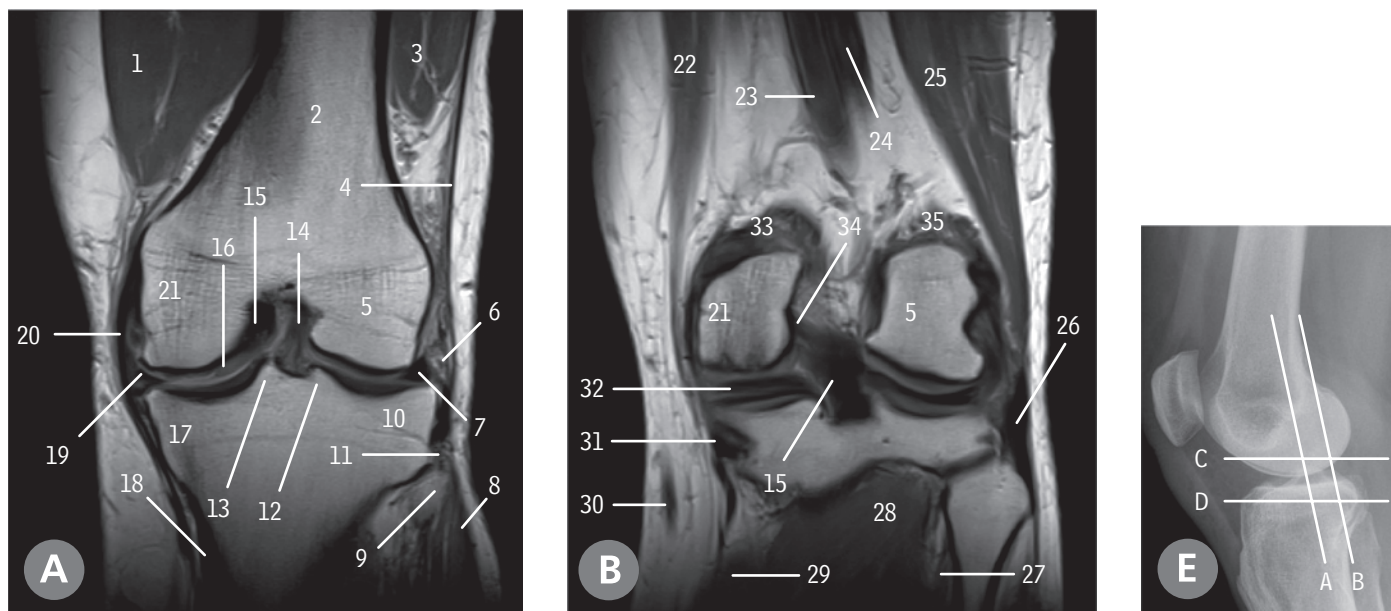
D-H

Sagittal T1-weighted MR images of the left knee

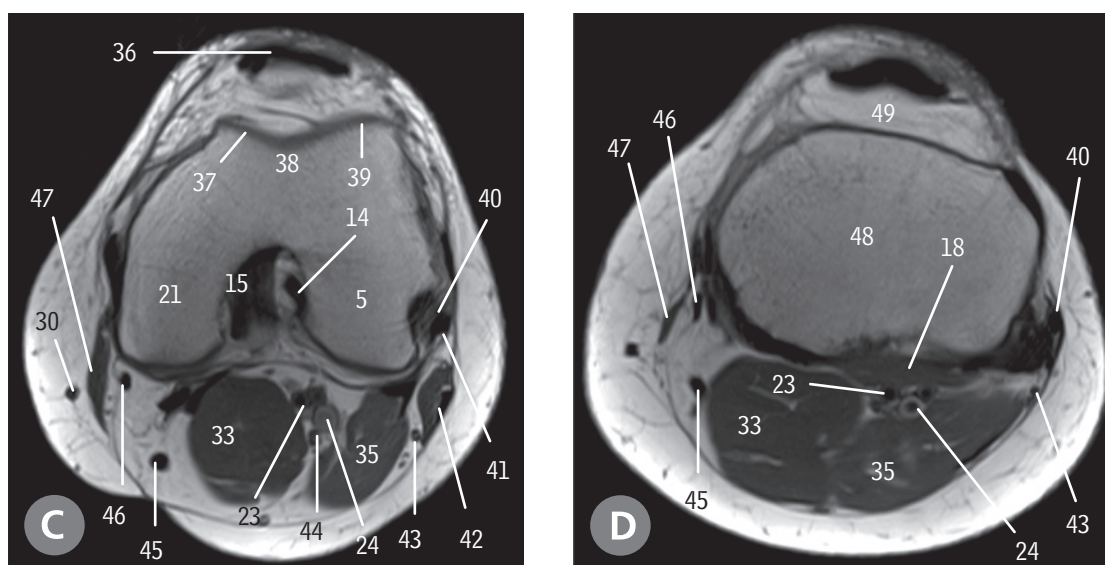
- 1 Lateral condyle of femur
- 2 Fibular collateral ligament
- 3 Common fibular (peroneal) nerve
- 4 Biceps femoris tendon
- 5 Soleus
- 6 Head of fibula
- 7 Tibialis anterior
- 8 Lateral condyle of tibia
- 9 Lateral meniscus
- 10 Infrapatellar fat pad (of Hoffa)
- 11 Biceps femoris
- 12 Lateral head of gastrocnemius
- 13 Extensor digitorum longus
- 14 Tibialis posterior
- 15 Anterior } head of lateral meniscus
- 16 Posterior }
- 17 Popliteal artery and vein
- 18 Tibial nerve

- 19 Popliteus
- 20 Anterior cruciate ligament
- 21 Posterior cruciate ligament
- 22 Semimembranosus
- 23 Medial head of gastrocnemius
- 24 Patella tendon
- 25 Patella
- 26 Quadriceps tendon
- 27 Quadriceps fat pad
- 28 Prefemoral fat pad
- 29 Suprapatellar bursa
- 30 Femoral articular cartilage
- 31 Vastus medialis
- 32 Medial condyle of femur
- 33 Oblique popliteal ligament/joint capsule
- 34 Posterior horn of medial meniscus
- 35 Medial condyle of tibia
- 36 Anterior horn of medial meniscus

Knee MRI anatomy of the knee—coronal and axial

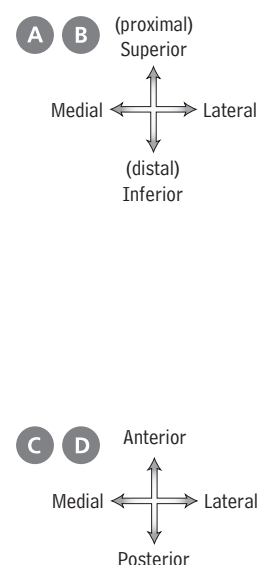


A B Coronal T1-weighted MR images of the left knee

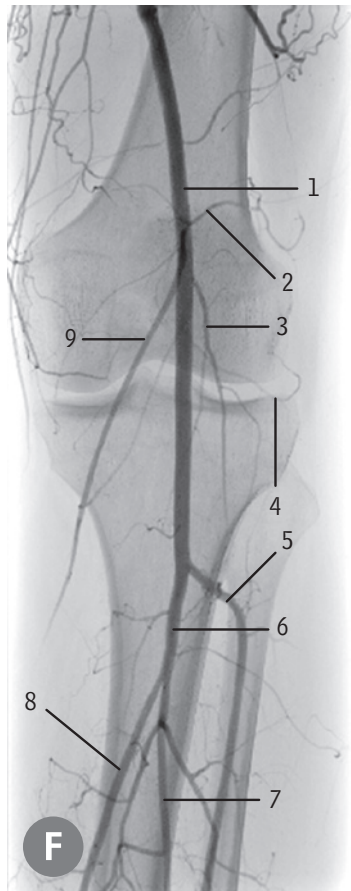


C D Axial T1-weighted MR images of the left knee

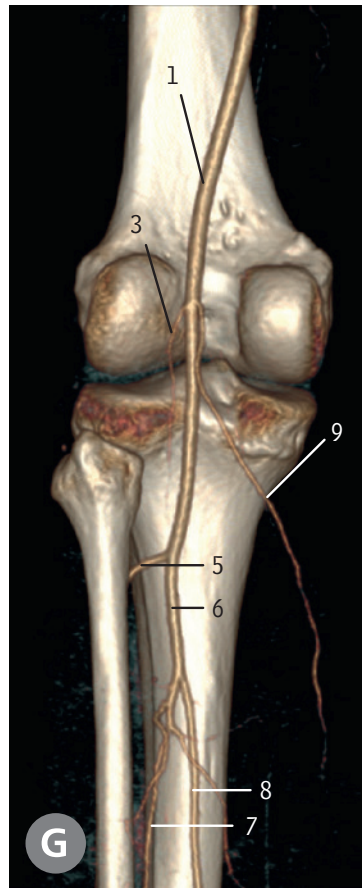
- | | | | |
|--|--------------------------------|---|--|
| 1 Vastus medialis | 14 Anterior cruciate ligament | 29 Medial head of gastrocnemius | 39 Lateral trochlear facet |
| 2 Femur | 15 Posterior cruciate ligament | 30 Great saphenous vein | 40 Fibular (lateral) collateral ligament |
| 3 Vastus lateralis | 16 Articular cartilage | 31 Semimembranosus tendon | 41 Joint capsule |
| 4 Iliotibial tract | 17 Medial condyle of tibia | 32 Posterior horn of medial meniscus | 42 Biceps muscle and tendon |
| 5 Lateral condyle of femur | 18 Popliteus | 33 Medial head of gastrocnemius | 43 Common fibular (peroneal) nerve |
| 6 Lateral inferior genicular artery | 19 Medial meniscus | 34 Posterior meniscomfemoral ligament (of Wrisberg) | 44 Tibial nerve |
| 7 Lateral meniscus | 20 Medial collateral ligament | 35 Lateral head of gastrocnemius | 45 Semitendinosus tendon |
| 8 Fibularis (peroneus) longus | 21 Medial condyle of femur | 36 Patellar ligament | 46 Gracilis tendon |
| 9 Head of fibula | 22 Sartorius | 37 Medial trochlear facet | 47 Sartorius |
| 10 Lateral condyle of tibia | 23 Popliteal vein | 38 Trochlea | 48 Tibia |
| 11 Anterior ligament of the fibular head | 24 Popliteal artery | | 49 Infrapatellar fat pad (of Hoffa) |
| 12 Lateral } intercondylar tubercle | 25 Biceps femoris, short head | | |
| 13 Medial } | 26 Biceps femoris tendon | | |
| | 27 Soleus | | |
| | 28 Popliteus | | |



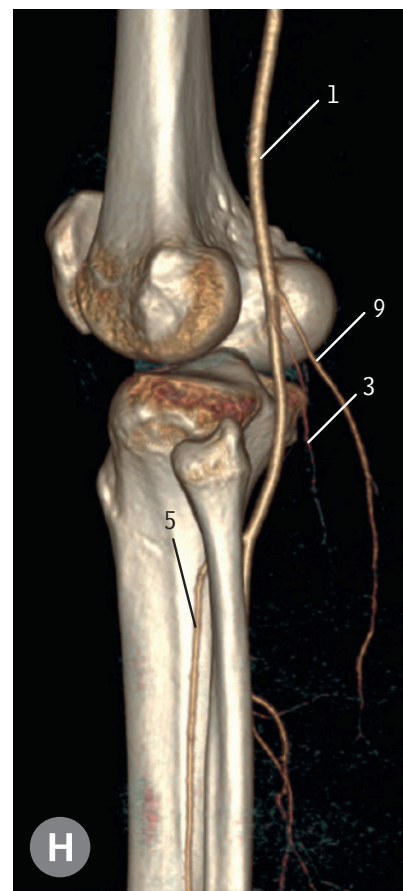
Knee Arterial anatomy of the knee—DSA, CT



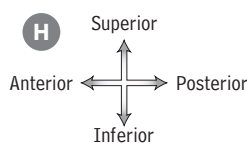
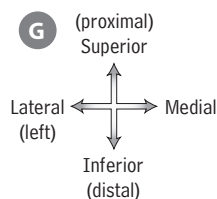
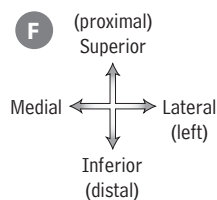
F Anteroposterior digital subtraction angiogram of the left knee



G H Volume-rendered CT image of the left knee, posterior view (G), lateral view (H)

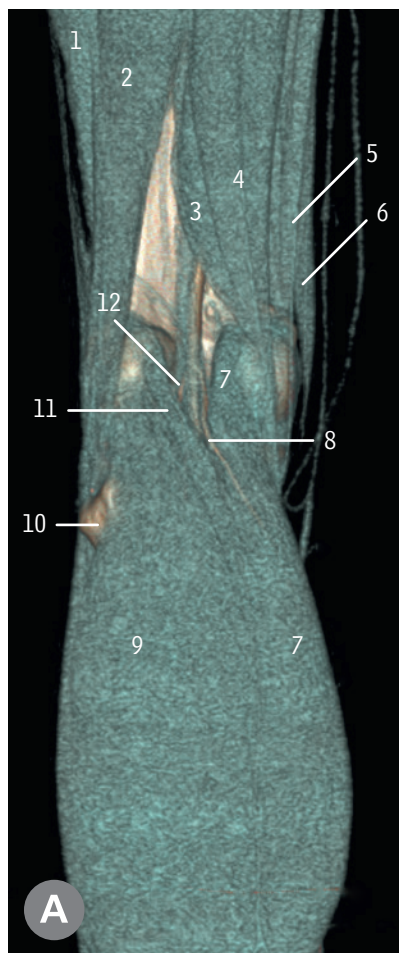


- 1 Popliteal artery
- 2 Lateral superior genicular artery
- 3 Lateral sural artery
- 4 Lateral inferior genicular artery
- 5 Anterior tibial artery
- 6 Tibiofibular (tibioperoneal) trunk
- 7 Fibular (peroneal) artery
- 8 Posterior tibial artery
- 9 Medial sural artery

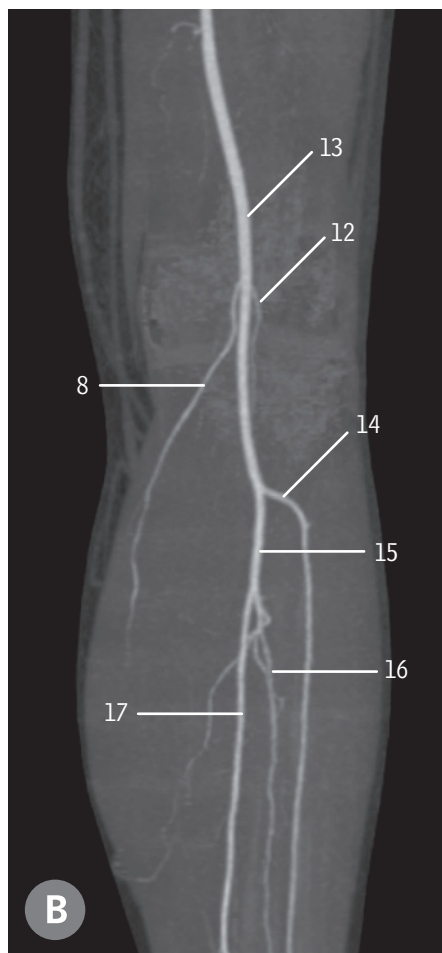


- In general, in clinical practice the term *peroneal* (Greek origin) is favoured over the term *fibular* (Latin orig.) as preferred by anatomists, when describing the muscles, nerves and vessels of the lower limb. Throughout this chapter, both may be considered synonymously but with the latter favoured.
- Furthermore, although not routinely recognized by anatomists, in clinical practice—and in particular in the context of interventional radiology and vascular surgery—the term **tibioperoneal** (tibiofibular) **trunk** (F, G 6) is used to describe the short section of artery between the origin of the anterior tibial and posterior tibial/fibular (peroneal) arteries, frequently affected by atherosclerotic disease along with its neighbouring vessels.
- Although there is relatively little variation in iliac or femoral arterial anatomy, considerable variation exists in the anatomy of the distal popliteal artery, in particular, the level and pattern of origins of the fibular (peroneal), anterior tibial and posterior tibial arteries.
- Figures F, G and H demonstrate the commonest pattern, seen in up to 90% of individuals, in which the popliteal artery divides at the inferior border of the popliteal muscle, continuing as the **tibioperoneal** trunk which subsequently gives rise to the anterior tibial and fibular (peroneal) arteries.
- In the remaining 10%, at least nine variant patterns are recognized, of varying frequency; although the anterior tibial artery invariably represents the first division, this, in addition to the origin of the posterior tibial artery, may occur above the level of the knee joint. The tibial artery may also be hypoplastic (poorly developed) or absent completely, the blood supply to the foot being provided exclusively by the anterior tibial and fibular (peroneal) arteries and their branches.
- Such variation is not simply of academic interest: failure to recognize variant anatomy may have significant consequences when surgical or interventional procedures are planned that in extreme cases may impact on limb salvage.

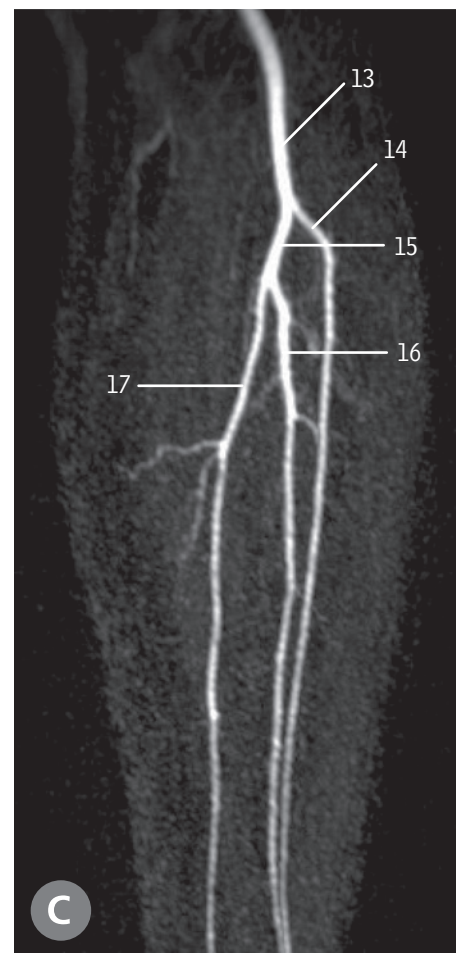
Knee Arterial anatomy of the knee—CT, MRI



A Volume-rendered CT image of the left knee, posterior view of popliteal fossa

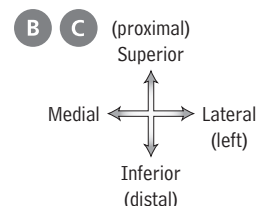
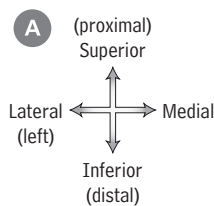


B Coronal Maximum Intensity Projection (MIP) CT angiogram of the left knee, viewed from anteriorly



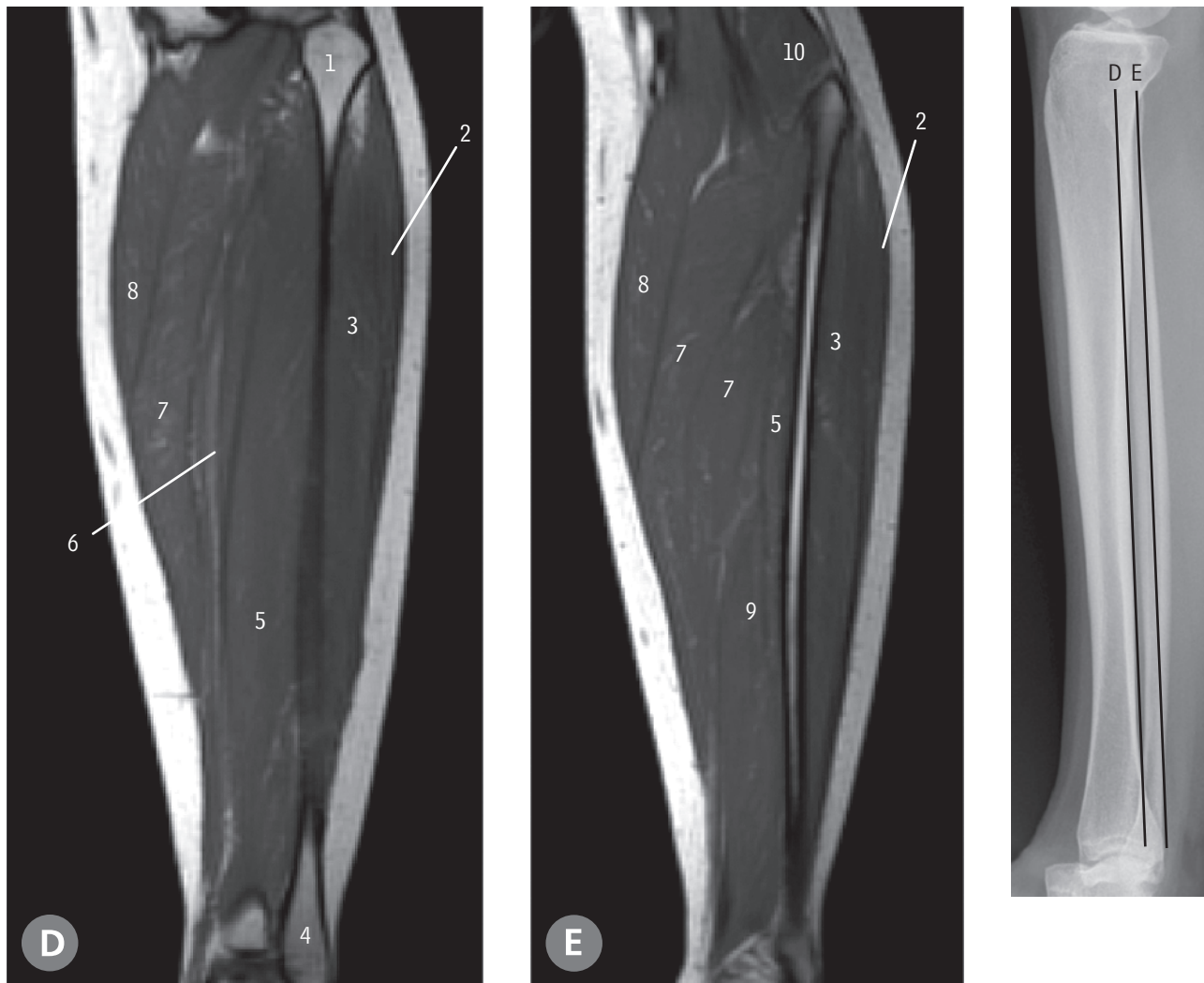
C Coronal Maximum Intensity Projection (MIP) MR angiogram of the left knee, viewed from anteriorly

- 1 Vastus lateralis
- 2 Biceps femoris
- 3 Semimembranosus
- 4 Semitendinosus
- 5 Gracilis
- 6 Sartorius
- 7 Medial head of gastrocnemius
- 8 Medial sural artery
- 9 Lateral head of gastrocnemius
- 10 Head of fibula
- 11 Plantaris
- 12 Lateral sural artery
- 13 Popliteal artery
- 14 Anterior tibial artery
- 15 Tibiofibular (tibioperoneal) trunk
- 16 Fibular (peroneal) artery
- 17 Posterior tibial artery



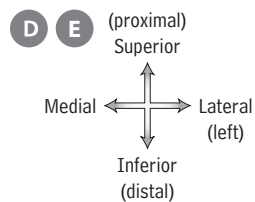
- Figure A, in addition to figures G and H on page 17, elegantly show the vulnerability of the popliteal artery to injury, in particular following traumatic posterior dislocation in which the artery may be compressed between the dislocated distal femur and posterior soft tissues; this may result in an acute and complete interruption to the lower leg blood supply requiring emergency intervention. A CT scan performed as part of trauma imaging protocols allows the rapid assessment of the lower limb vasculature in such cases.
- Certain individuals, due to variant anatomy, experience intermittent compression of the popliteal artery by the adjacent musculotendinous structures (most often the medial head of gastrocnemius) against the medial condyle of the femur. Magnetic resonance angiography (C) of the lower limbs allows the evaluation of the vasculature in such cases and enables the radiologist to determine the precise relationships of the popliteal vasculature and adjacent muscles due to much greater soft tissue contrast when compared with CT.

Lower leg MRI anatomy of the lower leg—coronal

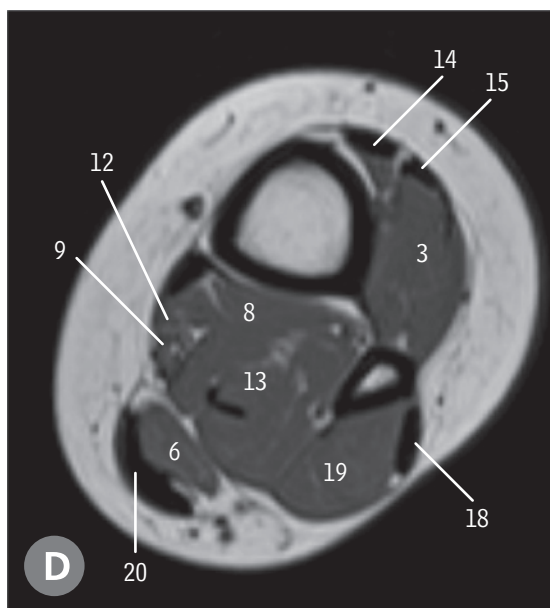
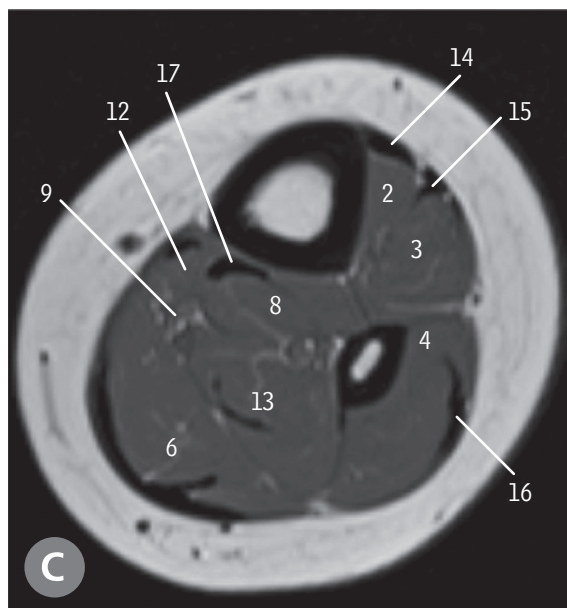
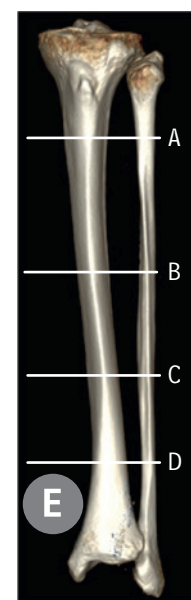
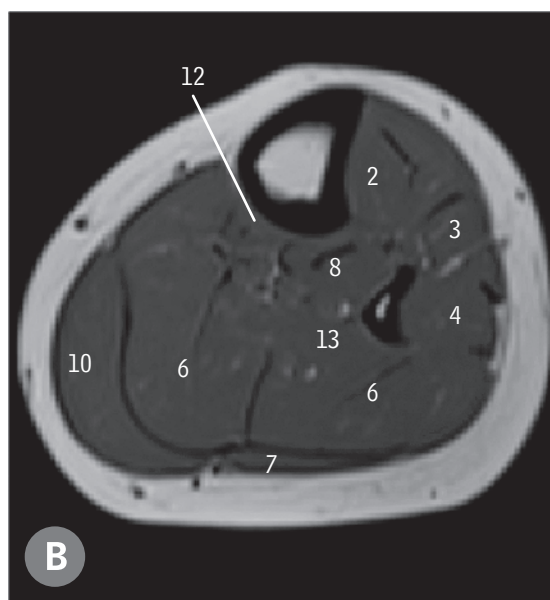
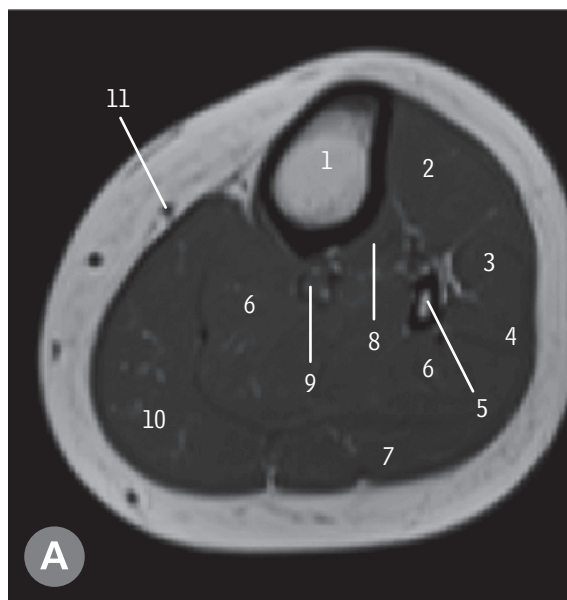


D E Coronal T1-weighted MR images of the left calf

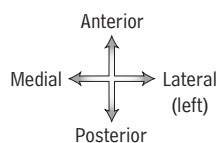
- 1** Head of fibula
- 2** Fibularis (peroneus) longus
- 3** Fibularis (peroneus) brevis
- 4** Lateral malleolus of fibula
- 5** Tibialis posterior
- 6** Tibial artery and nerve
- 7** Soleus
- 8** Medial head of gastrocnemius
- 9** Flexor hallucis longus
- 10** Lateral head of gastrocnemius



Lower leg MRI anatomy of the lower leg—axial



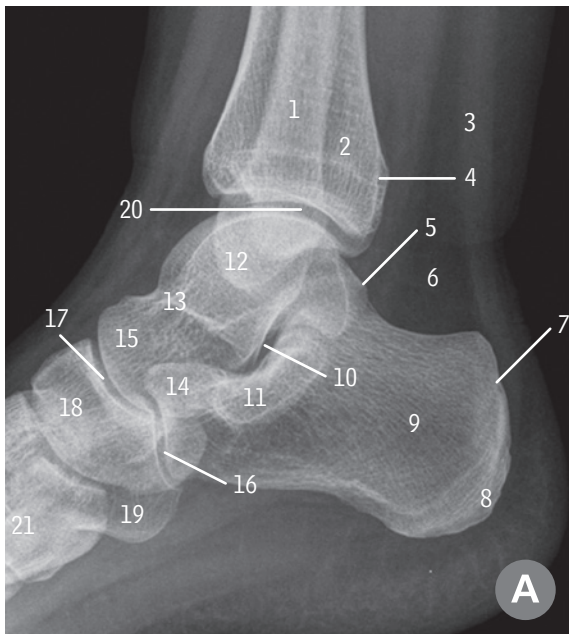
A-D Axial T1-weighted MR images of the left calf



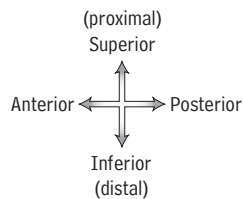
- 1 Tibia
- 2 Tibialis anterior
- 3 Extensor hallucis longus and extensor digitorum longus
- 4 Fibularis (peroneus) longus and brevis
- 5 Fibula
- 6 Soleus
- 7 Lateral head of gastrocnemius
- 8 Tibialis posterior
- 9 Posterior tibial artery and tibial nerve
- 10 Medial head of gastrocnemius

- 11 Great saphenous vein
- 12 Flexor digitorum longus
- 13 Flexor hallucis longus
- 14 Tibialis anterior tendon
- 15 Extensor digitorum longus tendon
- 16 Fibularis (peroneus) longus and brevis tendon
- 17 Tibialis posterior tendon
- 18 Fibularis (peroneus) longus tendon
- 19 Fibularis (peroneus) brevis
- 20 Tendo calcaneus (Achilles tendon)

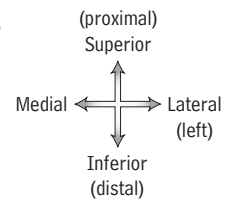
Ankle Plain radiographic anatomy



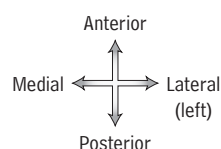
A Lateral radiograph of the left ankle



B Anteroposterior radiograph of the left ankle

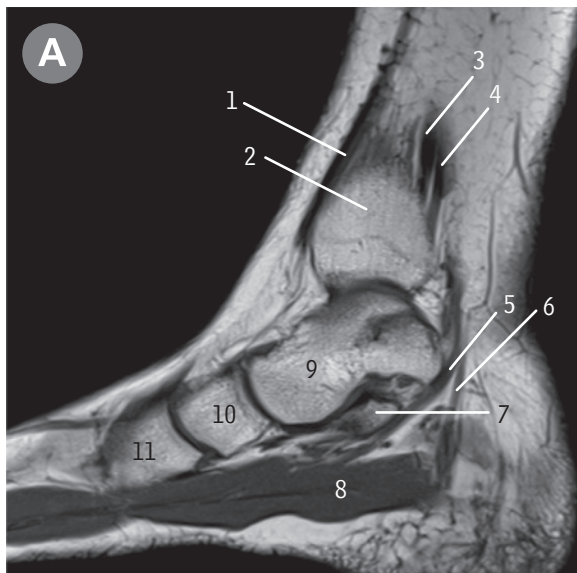


C Axial radiograph of the left calcaneus

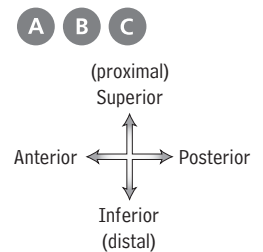
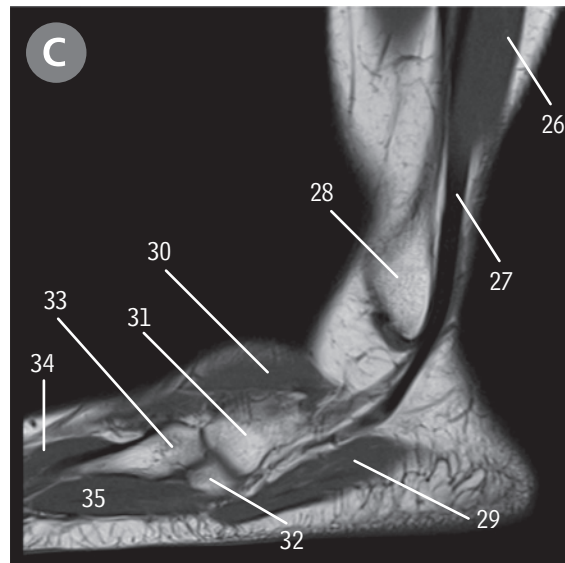
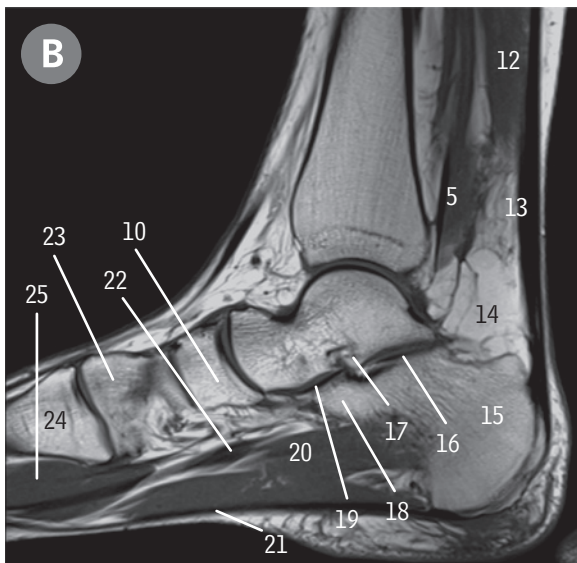


- 1 Fibula
- 2 Tibia
- 3 Tendo calcaneus (Achilles tendon)
- 4 Posterior process of tibia
- 5 Posterior process of talus
- 6 Pre-Achilles fat pad (of Kager)
- 7 Posterior surface of calcaneus
- 8 Calcaneal tuberosity
- 9 Calcaneus
- 10 Subtalar (talocalcaneal) joint
- 11 Sustentaculum tali
- 12 Body } of talus
- 13 Neck }
- 14 Anterior process of calcaneus
- 15 Head of talus
- 16 Calcaneocuboid joint
- 17 Talonavicular joint
- 18 Navicular
- 19 Cuboid
- 20 Tibiotalar joint
- 21 Cuneiform bones (en face)
- 22 Lateral malleolus of fibula
- 23 Talar dome
- 24 Medial malleolus of fibula
- 25 Medial cuneiform
- 26 Medial process of calcaneus
- 27 Base of fifth metatarsal
- 28 Groove for fibularis (peroneus) longus
- 29 Lateral process of calcaneus

Ankle MRI anatomy of the ankle—sagittal

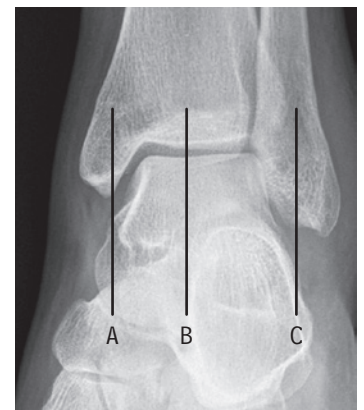


- The *subtalar joint* is a complex joint of the hindfoot comprised of the *talocalcaneal joint* posteriorly between the posterior talar and calcaneal facets (B16) and *talocalcaneonavicular joint* more anteriorly; the latter is formed by congruent articulations between the head of the talus, anterior and middle articular facets of the calcaneus and posterior articular facet of the navicular. Functionally, the subtalar joint plays a key role in imparting stability to the midfoot and hindfoot and allows pronation and supination, of importance when walking on uneven surfaces and during running.
- The *sinus tarsi* (B17) is a fat-filled space between the talus and calcaneus; its boundary is formed by the neck of the talus medially, calcaneus inferiorly and extensor retinaculum laterally. Contained within the sinus are the cervical and interosseous talocalcaneal ligaments, in addition to extensive nerve endings. Injury to the ligaments or haemorrhage within the sinus following trauma may result in instability, inflammation of synovium and the formation of scar tissue. The resultant symptoms of pain and persistent hindfoot instability are known as *sinus tarsi syndrome* and are particularly recognized in overweight individuals, those with 'flat feet' and in those with occupations predisposing them to repetitive injury.
- The *tarsal tunnel* (E18) lies medially within the ankle, has a boundary formed by the flexor retinaculum (lacinate ligament), talus and calcaneus and contains the posterior tibial neuromuscular bundle, tibialis posterior tendon and tendons of flexor digitorum longus and flexor hallucis longus. Swelling within the tunnel or compression from external sources—for example, due to the presence of accessory muscles (e.g. Flexor digitorum accessorius longus), tumours or scar tissue—may result in compression of the posterior tibial nerve or its branches. Those affected report pain and abnormal sensation along the medial foot and hallux, symptoms that are exacerbated by exercise. Surgical release by transecting the flexor retinaculum may be required to relieve symptoms.

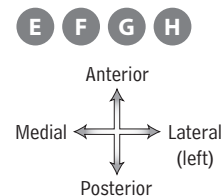
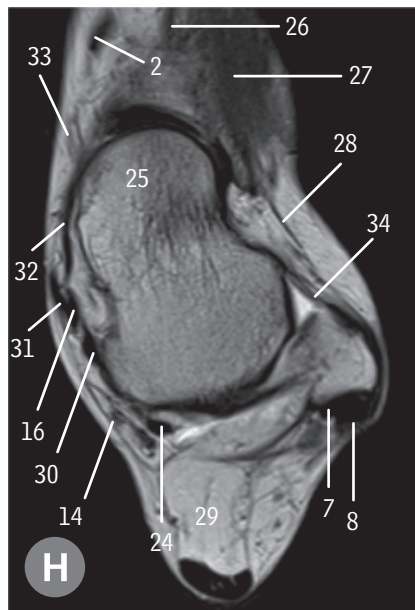
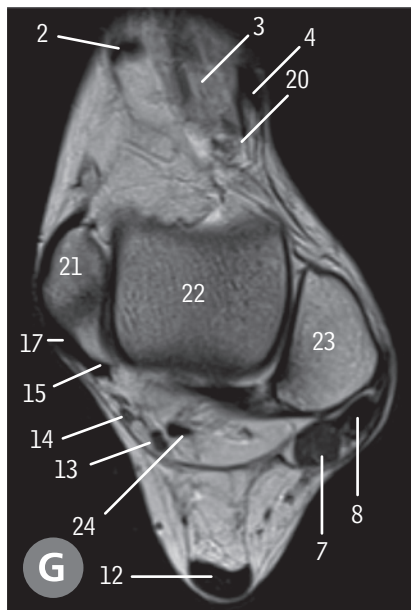
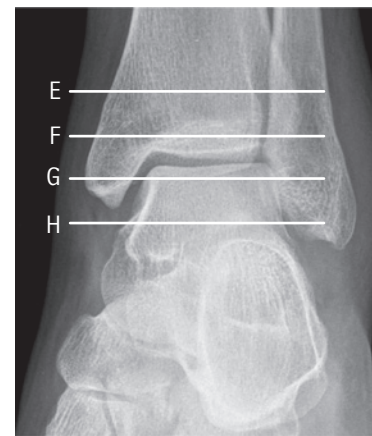
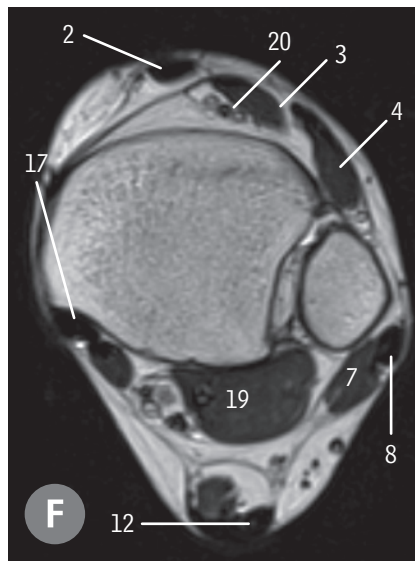
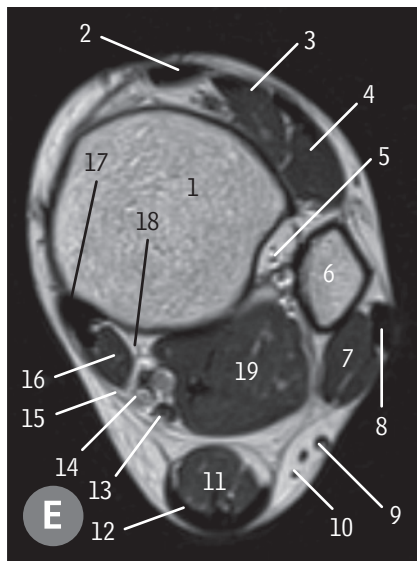


A B C Sagittal T1-weighted MR images of the left ankle

- | | | |
|--------------------------------------|---|---|
| 1 Great saphenous vein | 14 Pre-Achilles fat pad (of Kager) | 26 Fibularis (peroneus) brevis |
| 2 Tibia | 15 Calcaneus | 27 Fibularis (peroneus) longus tendon |
| 3 Tibialis posterior tendon | 16 Posterior talocalcaneal facet | 28 Lateral malleolus of fibula |
| 4 Flexor digitorum longus tendon | 17 Sinus tarsi | 29 Abductor digiti minimi |
| 5 Flexor hallucis longus tendon | 18 Anterior process of calcaneus | 30 Extensor digitorum brevis and extensor hallucis brevis |
| 6 Tibial nerve | 19 Middle talocalcaneal joint | 31 Cuboid |
| 7 Sustentaculum tali | 20 Quadratus plantae | 32 Base of fifth metatarsal |
| 8 Flexor digitorum brevis | 21 Plantar aponeurosis | 33 Fourth metatarsal |
| 9 Talus | 22 Flexor digitorum longus and flexor hallucis longus tendons | 34 Dorsal interosseous |
| 10 Navicular | 23 Intermediate cuneiform | 35 Flexor digiti minimi |
| 11 Medial cuneiform | 24 Second metatarsal | |
| 12 Soleus | 25 Adductor hallucis | |
| 13 Tendo calcaneus (Achilles tendon) | | |



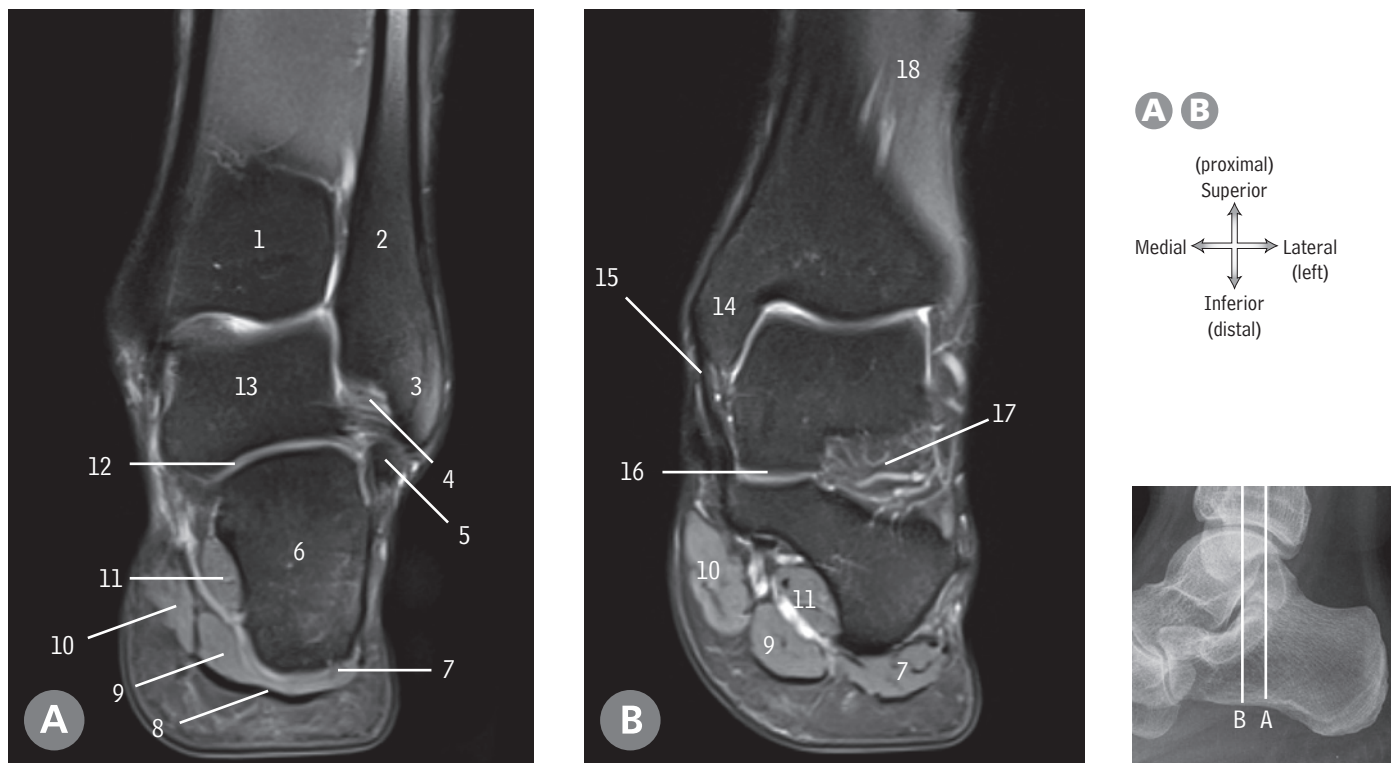
Ankle MRI anatomy of the ankle—axial



E-H Axial T1-weighted MR images of the left ankle

- | | |
|---|---|
| 1 Tibia | 18 Tarsal tunnel |
| 2 Tibialis anterior tendon | 19 Flexor hallucis longus muscle and tendon |
| 3 Extensor hallucis longus muscle and tendon | 20 Anterior tibial artery and deep fibular (peroneal) nerve |
| 4 Extensor digitorum longus muscle and tendon | 21 Medial malleolus of tibia |
| 5 Fibular (peroneal) artery and vein | 22 Talus |
| 6 Fibula | 23 Lateral malleolus of tibia |
| 7 Fibularis (peroneus) brevis | 24 Flexor hallucis longus tendon |
| 8 Fibularis (peroneus) longus tendon | 25 Head of talus |
| 9 Lesser (small) saphenous vein | 26 Extensor hallucis longus tendon |
| 10 Sural nerve | 27 Extensor digitorum brevis |
| 11 Soleus | 28 Extensor retinaculum |
| 12 Tendo calcaneus (Achilles tendon) | 29 Pre-Achilles fat pad (of Kager) |
| 13 Tibial nerve | 30 Flexor digitorum longus tendon |
| 14 Posterior tibial artery and vein | 31 Deltoid ligament (tibio calcaneal) |
| 15 Flexor retinaculum | 32 Deltoid ligament (tibionavicular) |
| 16 Flexor digitorum longus muscle and tendon | 33 Great saphenous vein |
| 17 Tibialis posterior tendon | 34 Anterior talofibular ligament |

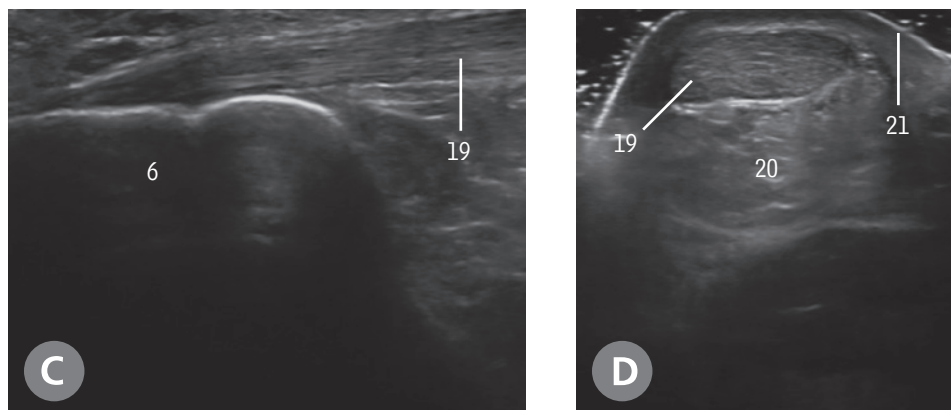
Ankle MRI anatomy of the ankle—coronal and ultrasound anatomy



A B Coronal proton-density fat saturated MR images of the left ankle

- | | |
|--|---|
| 1 Tibia | 13 Talus |
| 2 Fibula | 14 Medial malleolus of tibia |
| 3 Lateral malleolus of fibula | 15 Deltoid (medial collateral) ligament |
| 4 Posterior talofibular ligament | 16 Middle talar facet |
| 5 Fibularis (peroneus) longus and brevis tendons | 17 Sinus tarsi |
| 6 Calcaneus | 18 Extensor digitorum longus and fibularis (peroneus) tertius |
| 7 Abductor digiti minimi | 19 Tendo calcaneus (Achilles tendon) |
| 8 Plantar aponeurosis | 20 Pre-Achilles fat pad (of Kager) |
| 9 Flexor digitorum brevis | 21 Skin surface |
| 10 Abductor hallucis | |
| 11 Quadratus plantae | |
| 12 Posterior talocalcaneal facet | |

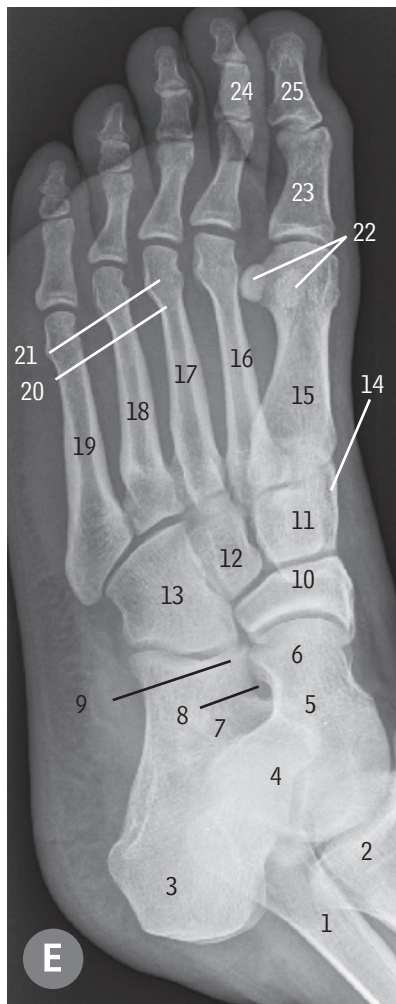
- Ultrasound evaluation of musculoskeletal structures is now standard in the evaluation of those with musculoskeletal disease, due to its ease of availability, lack of expense, high resolution and the ability to image tendons and ligaments during active and passive movement.
- Figures C and D demonstrate high resolution ultrasound images of the Achilles tendon (C19) in longitudinal and axial (transverse) orientations respectively. The ordered pattern of parallel collagen fibres are clearly seen as they course toward their insertion on the calcaneus (A6).



C Longitudinal ultrasound image of the left Achilles tendon and calcaneus

D Axial ultrasound image of the left Achilles tendon

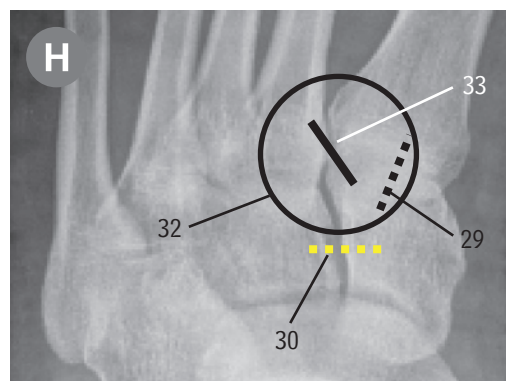
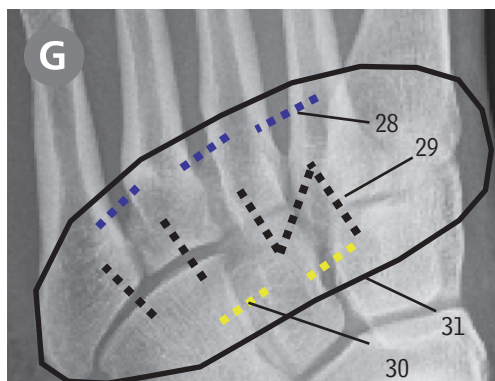
Foot Plain radiographic anatomy



- 1 Fibula
- 2 Tibia
- 3 Calcaneus
- 4 Body } of talus
- 5 Neck }
- 6 Head }
- 7 Neck of calcaneus
- 8 Sinus tarsi
- 9 Anterior process of calcaneus
- 10 Navicular
- 11 Intermediate cuneiform
- 12 Lateral cuneiform
- 13 Cuboid
- 14 Medial cuneiform
- 15 First } metatarsal
- 16 Second }
- 17 Third }
- 18 Fourth }
- 19 Fifth }
- 20 Neck } of third metatarsal
- 21 Head }
- 22 Sesamoid bones
- 23 Proximal } phalanx
- 24 Middle }
- 25 Distal }
- 26 Medial } malleolus of tibia
- 27 Lateral }
- 28 Intermetatarsal ligaments
- 29 Dorsal ligaments
- 30 Dorsal intertarsal ligaments
- 31 Lisfranc joint complex
- 32 Lisfranc joint
- 33 Dorsal Lisfranc ligament

E F

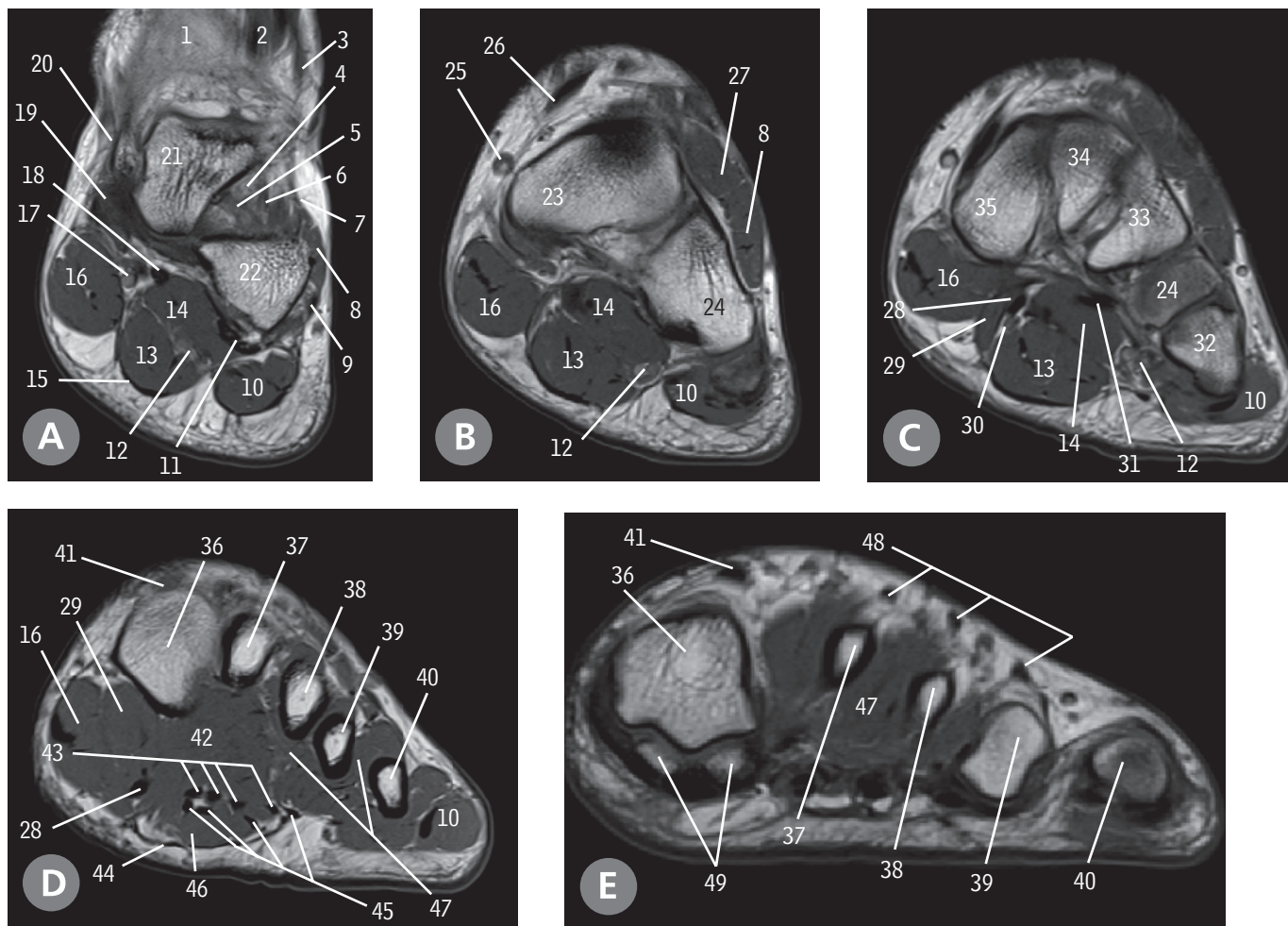
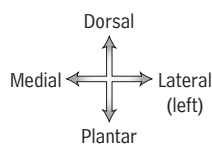
Oblique (E) and dorsoplantar (F) radiographs of the left foot



G H

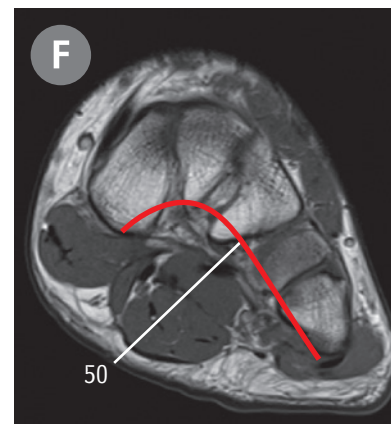
Magnified oblique (G) and dorsoplantar (H) radiographs of the left tarsometatarsal joints

- *Jacques Lisfranc de St. Martin* (1790–1847) was a French surgeon and gynaecologist who served as a field surgeon in Napoleon's army on the Russian front and whose name has been adopted in the description of the complex ligamentous structures of the forefoot. He became famous initially for his description of a novel and extremely rapid technique of forefoot amputation, involving disarticulation across the tarsometatarsal joints without the need for osteotomy. Such amputations became necessary (depending on one's source) as a result either of injuries sustained by riders falling from their horses with a foot caught in stirrups or due to frostbite and gangrene as a consequence of the harsh Russian winter. Despite his skill and reputation, however, he was apparently not a popular man due to his pompous and pugnacious demeanour.
- Although terminology has been confused, the term *Lisfranc joint complex* is now used in clinical practice to describe the intricate complex of ligaments and articulations at the level of the tarsometatarsal joints (illustrated as **G31**). The term *Lisfranc joint* collectively refers to those at the base of the first and second metatarsals (**H32**), and the *Lisfranc ligament* is that which bridges the base of the second metatarsal and medial cuneiform (**H33**). This ligament, as well as the "keystone" wedging of the second metatarsal within the cuneiforms, is of key importance since it provides the only ligamentous support between the first and second metatarsals. Its disruption, which may follow both high velocity and apparently innocent trauma, results in marked weakness of the forefoot articulations and may lead to severe functional instability and subluxation across the tarsometatarsal joints. Unfortunately, plain radiographic findings, especially when acquired non-weightbearing, may be very subtle and such a pattern of injury is frequently missed on initial imaging. The subsequent chronic pain and development of disabling premature degenerative joint disease are therefore a major source of litigation.

Foot *MRI anatomy of the foot—coronal***A–F** Coronal T1-weighted MR images of the left foot

- 1 Tibia
- 2 Extensor hallucis longus
- 3 Extensor digitorum longus
- 4 Sinus tarsi
- 5 Talocalcaneal interosseous ligament
- 6 Cervical ligament
- 7 Extensor retinaculum
- 8 Extensor digitorum brevis
- 9 Fibularis (peroneus) brevis
- 10 Abductor digiti minimi
- 11 Long plantar ligament (calcaneometatarsal)
- 12 Lateral plantar artery and nerve
- 13 Flexor digitorum brevis
- 14 Quadratus plantae
- 15 Plantar aponeurosis (medial part)
- 16 Abductor hallucis
- 17 Medial plantar artery and nerve
- 18 Tendon of flexor hallucis longus
- 19 Tendon of tibialis posterior
- 20 Deltoid ligament (tibio calcaneal part)
- 21 Talus
- 22 Calcaneus
- 23 Navicular
- 24 Cuboid
- 25 Great saphenous vein
- 26 Tendon of tibialis anterior

- 27 Extensor hallucis brevis
- 28 Flexor hallucis longus tendon
- 29 Flexor hallucis brevis
- 30 Deep branches of medial plantar artery and nerve
- 31 Fibularis (peroneus) longus tendon
- 32 Base of fifth metatarsal
- 33 Lateral
- 34 Intermediate } cuneiform
- 35 Medial
- 36 First
- 37 Second } metatarsal
- 38 Third
- 39 Fourth
- 40 Fifth
- 41 Extensor hallucis longus tendon
- 42 Adductor hallucis
- 43 Flexor digitorum longus tendons
- 44 Plantar aponeurosis
- 45 Flexor digitorum brevis tendons
- 46 Lumbricals
- 47 Interossei
- 48 Extensor digitorum longus tendons
- 49 Sesamoid bones
- 50 Transverse arch

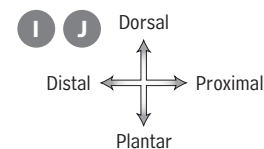
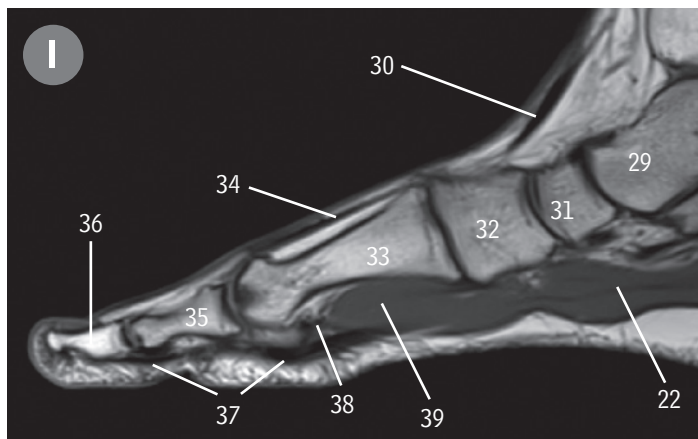
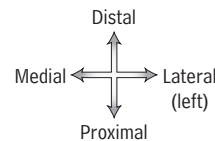


Foot MRI anatomy of the foot—axial and sagittal



- 1 First
- 2 Second } metatarsal
- 3 Third }
- 4 Extensor digitorum brevis
- 5 Fibularis (peroneus) brevis tendon
- 6 Fibularis (peroneus) longus tendon
- 7 Sural nerve
- 8 Calcaneus
- 9 Quadratus plantae
- 10 Posterior tibial artery and nerve
- 11 Medial and lateral plantar artery and nerve
- 12 Flexor digitorum longus tendon
- 13 Cuboid
- 14 Lateral } cuneiform
- 15 Intermediate }
- 16 Medial }
- 17 Tibialis posterior tendon
- 18 Tendo calcaneus (Achilles tendon)
- 19 Bifurcate ligament (calcaneonavicular and calcaneocuboid parts)
- 20 Sesamoid bones
- 21 Flexor hallucis longus tendon
- 22 Abductor hallucis
- 23 Flexor digitorum brevis
- 24 Flexor digitorum longus tendons
- 25 Base of fifth metatarsal
- 26 Lumbricals
- 27 Abductor digiti minimi
- 28 Head of fifth metatarsal
- 29 Talus
- 30 Tibialis anterior tendon
- 31 Navicular
- 32 Medial cuneiform
- 33 First metatarsal
- 34 Extensor hallucis longus tendon
- 35 Proximal } phalanx of great toe
- 36 Distal }
- 37 Flexor hallucis longus tendon
- 38 Flexor hallucis brevis tendon
- 39 Flexor hallucis brevis
- 40 Medial } longitudinal arch
- 41 Lateral }

G H Axial T1-weighted MR images of the left foot, axial view

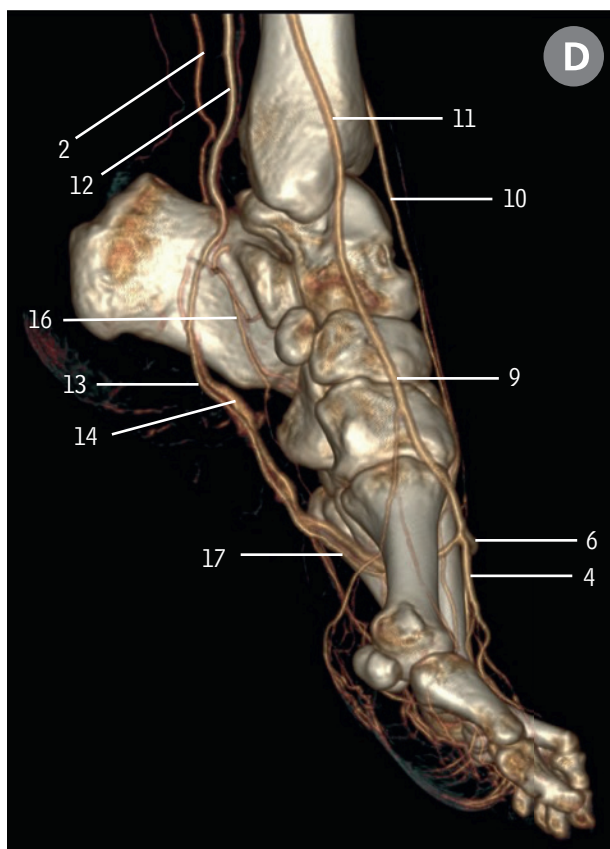
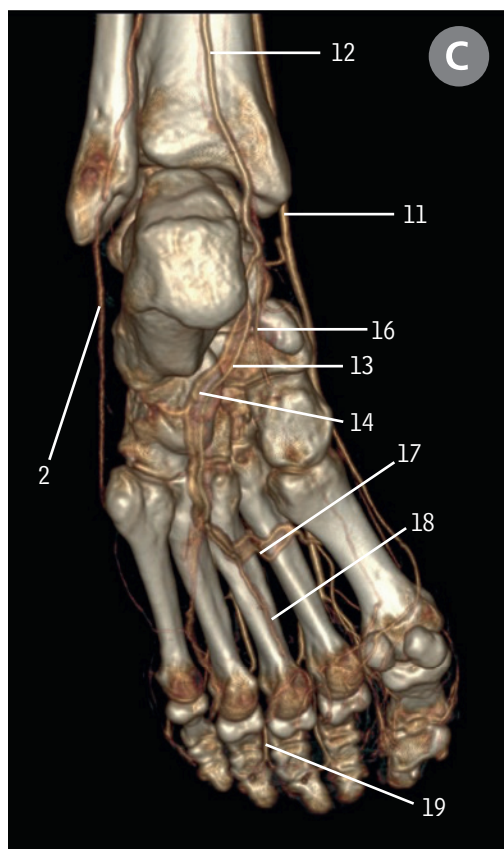
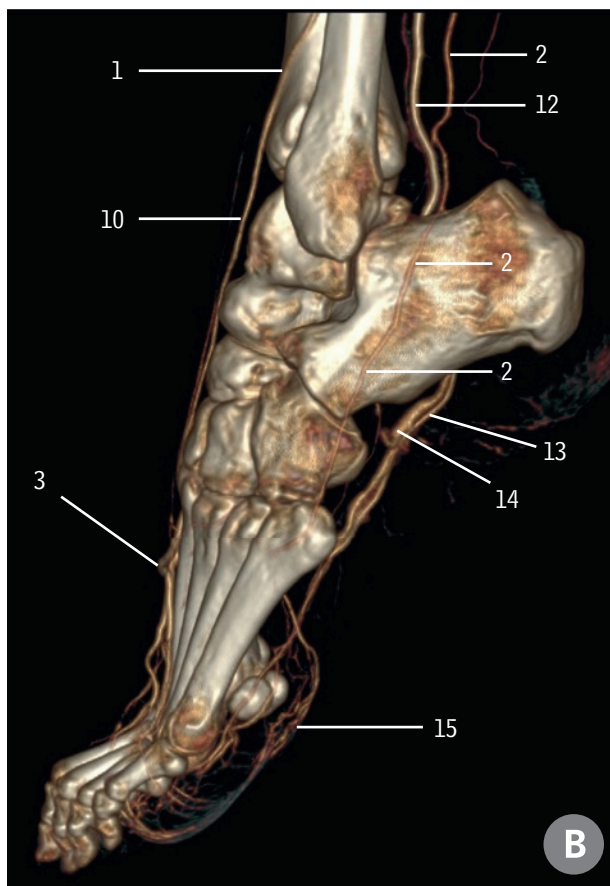
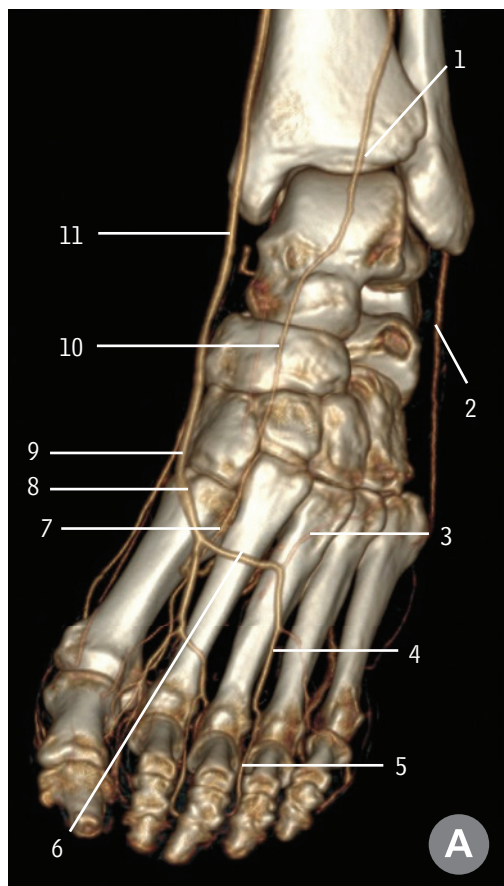


I Sagittal T1-weighted MR images of the left foot, through the level of the first metatarsal

J Lateral radiograph of the foot

- Figures F50 and J40 and J41 illustrate the *transverse* and *longitudinal arches* of the foot, which are formed by the configuration of the bones with support from the associated muscles, ligaments and tendons. The arches play a key role in supporting body weight, as well as aiding locomotion via their shock absorptive capacities and ability to provide leverage in a spring-like fashion.
- The transverse arch (F50) in reality forms a half-dome in the coronal plane, with a full arch seen when both feet are placed together. The medial longitudinal arch (J40) is the higher of the two longitudinal arches and is formed by the calcaneus, talus, navicular, cuneiforms and first three metatarsals. The lateral longitudinal arch is flatter—as evidenced by the mark left by wet feet on a floor—and is formed by the calcaneus, cuboid, fourth and fifth metatarsals.
- Loss of the medial longitudinal arch—which may be acquired or congenital in nature—results in *pes planus* ('flat feet'). In adults, loss of function of the posterior tibialis tendon or muscle, which may occur due to a variety of causes, is an important cause. If untreated, pain, swelling and the development of premature degenerative joint disease may occur.

Foot *Vascular anatomy of the foot and ankle*



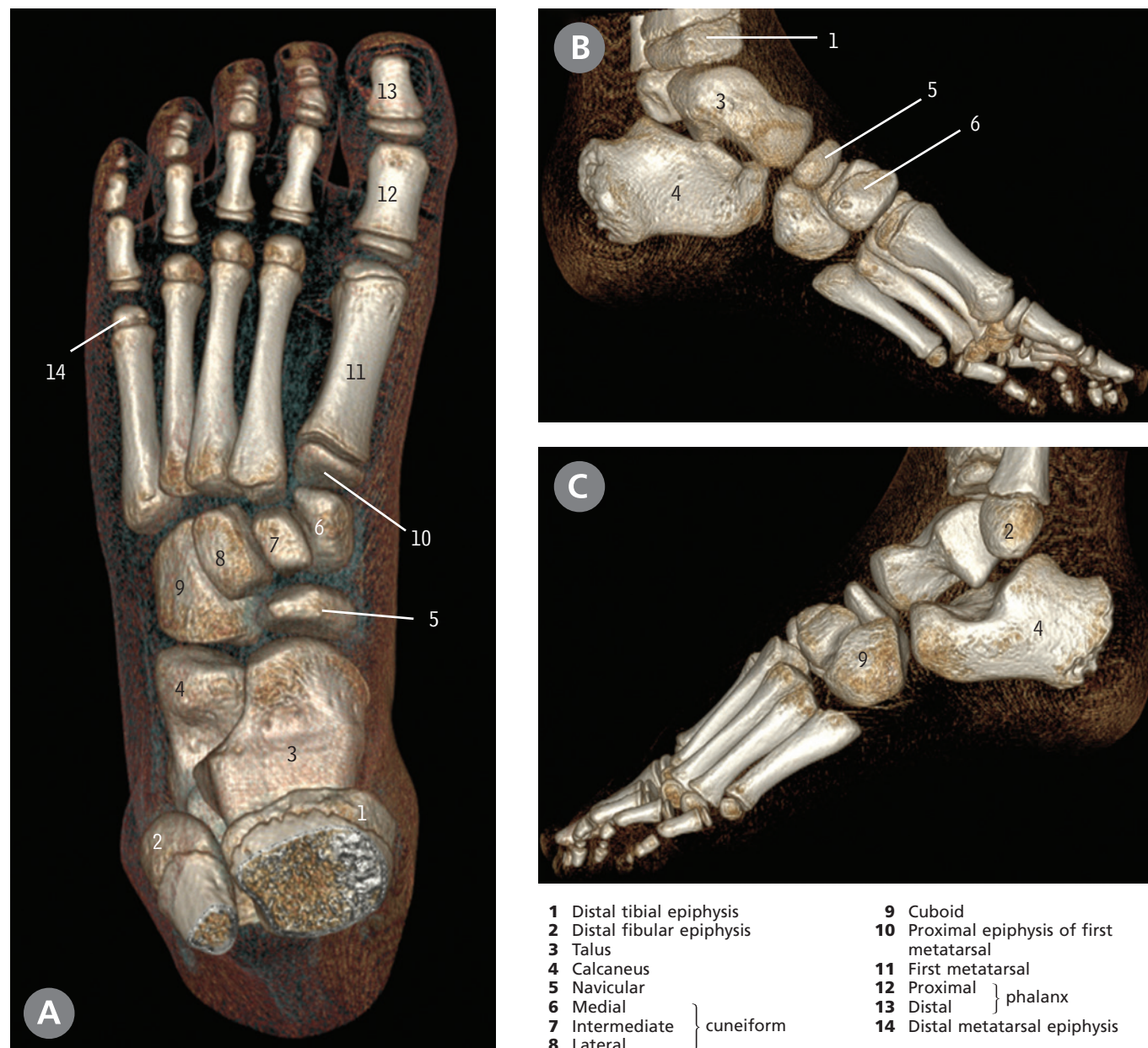
A-D Volume-rendered CT angiogram images of the left foot and ankle

- A** From above (dorsal surface) **B** From the lateral side
C From posteriorly and below (plantar surface) **D** From the medial side

- 1 Anterior tibial artery
- 2 Fibular (peroneal) artery
- 3 Lateral marginal vein
- 4 Metatarsal vein
- 5 Dorsal digital vein
- 6 Dorsal venous arch
- 7 First dorsal metatarsal artery
- 8 Valve within medial marginal vein
- 9 Medial marginal vein
- 10 Dorsalis pedis artery
- 11 Great saphenous vein
- 12 Posterior tibial artery
- 13 Lateral plantar artery
- 14 Lateral plantar vein
- 15 Venous plexus of sole
- 16 Medial plantar artery
- 17 Plantar arch
- 18 Metatarsal artery
- 19 Plantar digital vein

- Figures **A-D** represent CT angiographic images acquired following the injection of intravenous iodinated contrast medium. Because of the timing of image acquisition following injection, early filling of foot veins is also demonstrated (e.g. marginal, plantar and long saphenous veins, **8**, **9**, **11** and **14**). Certain smaller veins, such as the lateral plantar vein (**D14**), are subsequently seen to fade out above the ankle because of the timing of imaging resulting in a reduced density of contrast medium within the flowing blood. If required, additional imaging following a short delay may be performed to further evaluate the venous system; this is rarely performed, however, due to the lesser importance of venous disease of the foot when compared with that involving the arteries.
- As with the lower leg, considerable variation in arterial and venous anatomy may be observed; in some cases, the posterior tibial artery is hypoplastic or absent completely, with blood supply to the feet being from branches of the anterior tibial, dorsalis pedis and fibular (peroneal) arteries. This is of clinical importance in the management of patients with peripheral vascular disease (atherosclerosis), who may require surgical intervention.

Foot Paediatric anatomy



A-C Volume-rendered CT images of the left foot and ankle

A From above (dorsal surface)

B From the medial side

C From the lateral side

- Figures A-C demonstrate the developing foot in an 8-year-old paediatric patient. Due to the method of computerized reconstruction performed in this case, soft tissues and the foot outline are faintly visible overlying the bones. Numerous centres of ossification within the epiphyses of the longer bones are demonstrated (e.g. A10), which subsequently fuse with the adjacent metaphyses. The tarsal bones form from a single centre of ossification: the appearance of increased gaps between them arises from the radiolucency of cartilage from which the bones form rather than from widened joint spaces. In addition, irregularity of certain bones is a normal finding (e.g. calcaneus, C4) and should not be confused with pathology.

Appendix

Skin	146	Regional anaesthesia for foot and ankle	155
Muscles	146	The lymphatic system	165
Nerves	152	Arteries	170

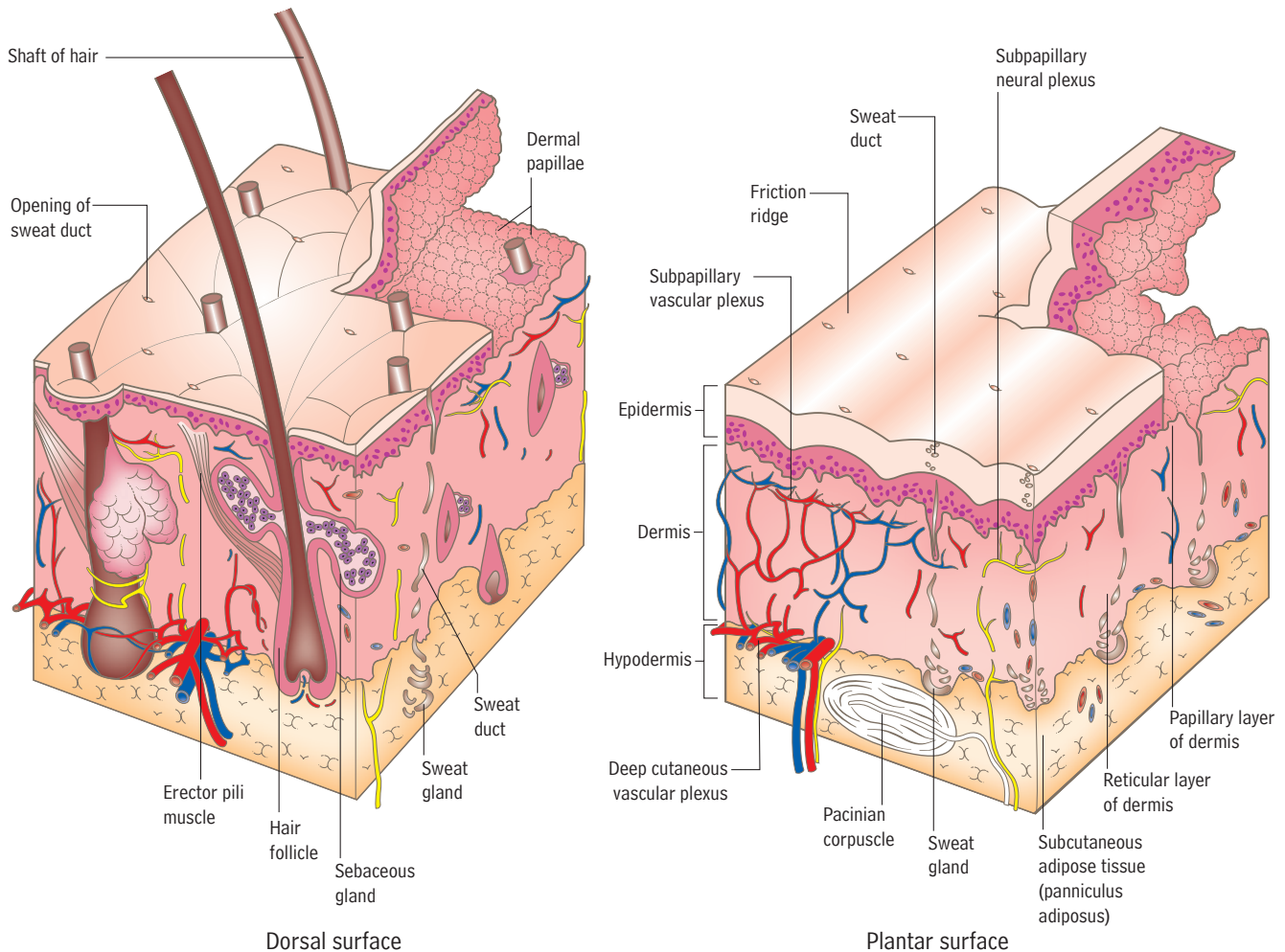


Fig. 1 Schematic diagram comparing the structures present in the thin and hairy dorsal skin and those in the thick, hairless plantar skin of the foot. The epidermis has been partially reflected to show epidermal and dermal papillae.

Skin

The skin of the dorsal and plantar surfaces of the foot differs in appearance and organization (Fig. 1).

Muscles

MUSCLES OF THE GLUTEAL REGION

Gluteus maximus

From the posterior gluteal line of the hip bone, the dorsal surface of the lower part of the sacrum and the side of the coccyx, the sacrotuberous ligament and the fascia over gluteus medius

To the iliotibial tract, with the deep fibres of the lower part attaching to the gluteal tuberosity of the femur

Inferior gluteal nerve, L5, S1, S2

Extension and lateral rotation of the hip joint

Gluteus medius

From the outer surface of the ilium between the posterior and anterior oblique lines

To the lateral surface of the greater trochanter of the femur

Superior gluteal nerve, L4, L5, S1

Abduction and medial rotation of the hip joint and prevention of adduction

Gluteus minimus

From the outer surface of the ilium between the anterior and inferior gluteal lines

To the anterior part of the lateral surface of the greater trochanter of the femur

Superior gluteal nerve, L4, 5, S1

Abduction and medial rotation of the hip joint, and prevention of adduction

Piriformis

*From the middle three pieces of the sacrum
To the upper border of the greater trochanter of the femur
Branches from L5, S1, S2
Abduction, lateral rotation and stabilization of the hip joint*

Quadratus femoris

*From the upper part of the outer border of the ischial tuberosity
To the quadrate tubercle of the intertrochanteric crest of the femur
Nerve to quadratus femoris, L4, L5, S1
Lateral rotation and stabilization of the hip joint*

Obturator internus

*From the inner surface of the obturator membrane and the adjacent anterolateral pelvic wall
To the greater trochanter of the femur, above and in front of the trochanteric fossa
Nerve to obturator internus, L5, S1, S2
Lateral rotation and stabilization of the hip joint*

Gemellus superior and inferior

*Superior from the dorsal surface of the ischial spine, inferior from the upper part of the ischial tuberosity
To the superior and inferior borders respectively of obturator internus
Nerves to obturator internus (superior) and quadratus femoris (inferior)
Assists obturator internus*

Obturator externus

*From the outer surface of the obturator membrane and the ischiopubic ramus
To the trochanteric fossa of the femur
Obturator nerve, L3, L4
Lateral rotator of the thigh*

MUSCLES OF THE FRONT OF THE THIGH**Iliacus**

*From the upper two-thirds of the iliac fossa in the lower abdomen
To the psoas tendon and the femur below and in front of the lesser trochanter
Femoral nerve, L2, L3
Flexor of the hip, assisting psoas major*

Psoas major

*From the sides of the lumbar vertebrae and intervertebral discs
To the lesser trochanter of the femur
Branches from L1, L2, L3
Flexor of the hip*

Tensor fasciae latae

*From the anterior 5 cm of the outer lip of the iliac crest
To the iliotibial tract
Superior gluteal nerve, L4, L5, S1
Extensor of the knee and lateral rotator of the leg*

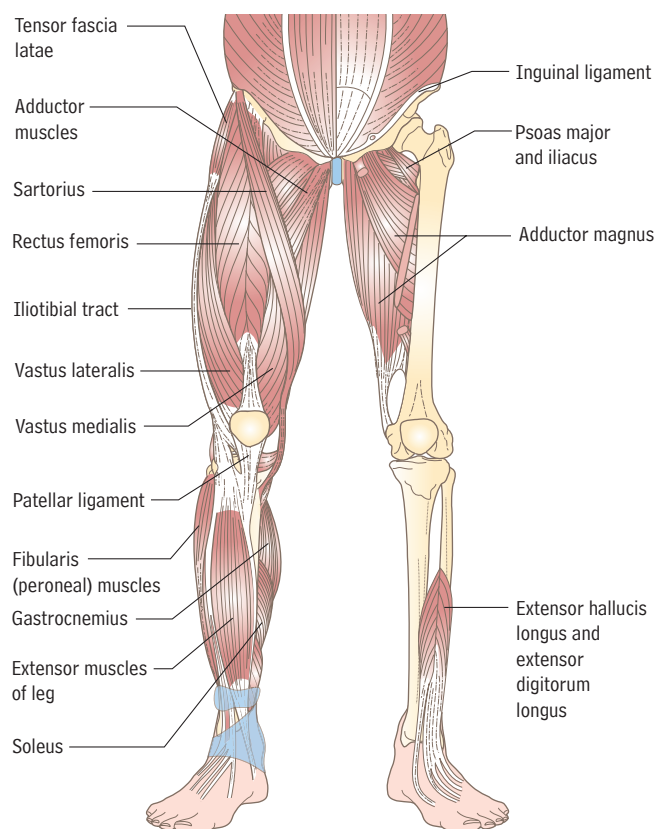


Fig. 2 Muscles: From the front. Superficial muscles on the right side of the body; deep muscles on the left side.

Sartorius

*From the anterior superior iliac spine
To the upper part of the medial surface of the shaft of the tibia in front of gracilis and semitendinosus
Femoral nerve, L2, L3
Flexor, adductor and lateral rotator of the hip*

Rectus femoris

*From the anterior inferior iliac spine (straight head) and the ilium above the rim of the acetabulum (reflected head)
To the base of the patella
Femoral nerve, L3, L4
Flexor of the hip and extensor of the knee*

Vastus lateralis

*From the upper part of the intertrochanteric line of the femur, anterior and inferior borders of the greater trochanter, lateral lip of the gluteal tuberosity and the upper part of the linea aspera
To the lateral border of the patella and the quadriceps tendon
Femoral nerve, L2, L3, L4
Extensor of the knee*

Vastus medialis

From the lower part of the intertrochanteric line of the femur, the spiral line, the linea aspera, the upper part of the medial supracondylar line and the tendon of adductor magnus

To the medial border of the patella and the quadriceps tendon

Femoral nerve, L2, L3, L4

Extensor of the knee

Vastus intermedius

From the anterior and lateral surfaces of the upper two-thirds of the shaft of the femur

To the deep part of the quadriceps tendon

Femoral nerve, L2, L3, L4

Extensor of the knee

Articularis genus

From the anterior surface of the femur below vastus intermedius

To the apex of the suprapatellar bursa

Femoral nerve, L3, L4

Retraction of the bursa as the knee extends

MUSCLES OF THE MEDIAL SIDE OF THE THIGH**Pectineus**

From the pectineal line of the pubis and bone in front of the line

To the femur on a line from the lesser trochanter to the linea aspera

Femoral nerve, L2, L3

Flexor, adductor and lateral rotator of the hip

Gracilis

From the body of the pubis and ischiopubic ramus

To the upper part of the medial surface of the shaft of the tibia, between sartorius and semitendinosus

Obturator nerve, L2, L3

Flexor, adductor and medial rotator of the thigh

Adductor brevis

From the body and inferior ramus of the pubis

To the shaft of the femur on a line from the lesser trochanter to the linea aspera and to the upper part of the linea

Obturator nerve, L2, L3, L4

Adductor of the thigh

Adductor longus

From the front of the pubis

To the middle part of the linea aspera

Obturator nerve, L2, L3, L4

Adductor of the thigh

Adductor magnus

From the lower lateral part of the ischial tuberosity and the ischiopubic ramus

To the shaft of the femur from the gluteal tuberosity along the linea aspera to the medial supracondylar line and to the adductor tubercle

Obturator nerve, L2, L3, L4 and sciatic nerve, L4, L5, S1

Adductor and lateral rotator of the thigh

MUSCLES OF THE BACK OF THE THIGH**Biceps femoris**

From the medial facet of the ischial tuberosity with semimembranosus (long head) and from the linea aspera and lateral supracondylar line of the femur (short head)

To the head of the fibula

Sciatic nerve (tibial part to long head, common fibular (peroneal) part to short head), L5, S1

Flexion and lateral rotation of the knee and extension of the hip

Semitendinosus

From the medial facet of the ischial tuberosity, with the long head of biceps

To the upper part of the subcutaneous surface of the tibia, behind gracilis

Sciatic nerve (tibial part), L5, S1

Flexion and medial rotation of the knee and extension of the hip

Semimembranosus

From the lateral facet of the ischial tuberosity

To the groove on the back of the medial condyle of the tibia, with expansions forming the oblique popliteal ligament and the fascia over popliteus

Sciatic nerve (tibial part), L5, S1

Flexion and medial rotation of the knee and extension of the hip

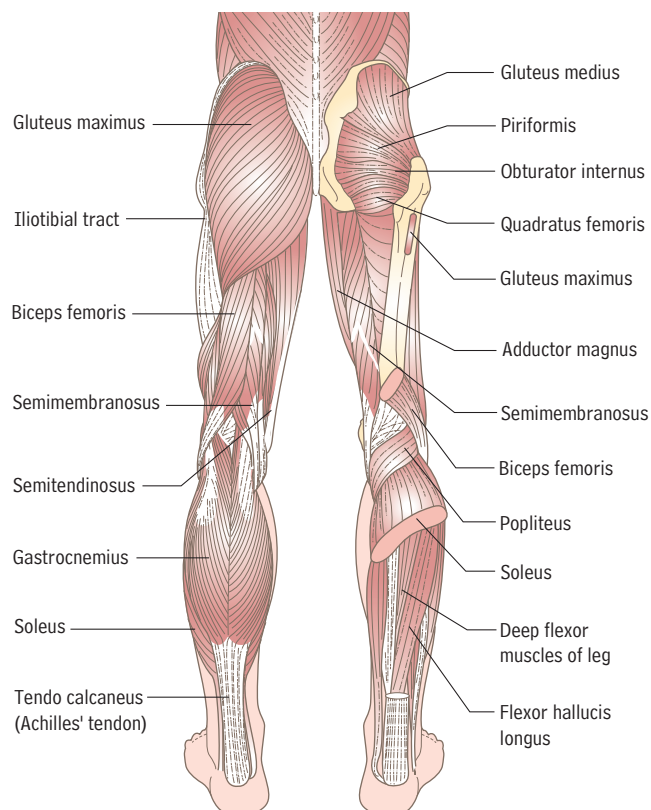


Fig. 3 Muscles: From the back. Superficial muscles on the left side of the body; deep muscles on the right side.

MUSCLES OF THE FRONT OF THE LEG

Tibialis anterior

From the upper two-thirds of the lateral surface of the tibia and adjoining part of the interosseous membrane
To the medial surfaces of the medial cuneiform and base of the first metatarsal
Deep fibular (peroneal) nerve, L4, L5
Dorsiflexion and inversion of the foot

Extensor hallucis longus

From the middle third of the medial surface of the fibula
To the base of the distal phalanx of the great toe
Deep fibular (peroneal) nerve, L4, L5
Extension of the great toe and dorsiflexion of the foot

Extensor digitorum longus

From the upper two-thirds of the medial surface of the fibula
To the four lateral toes by the dorsal digital expansions, attached to the middle and distal phalanges
Deep fibular (peroneal) nerve, L5, S1
Extension of the second to fifth toes and dorsiflexion of the foot

Fibularis (peroneus) tertius

From the lower third of the medial surface of the fibula, continuous with extensor digitorum longus
To the shaft of the fifth metatarsal
Deep fibular (peroneal) nerve, L5, S1
Dorsiflexion and eversion of the foot

MUSCLE OF THE DORSUM OF THE FOOT

Extensor digitorum brevis

From the upper surface of the calcaneus
To the base of the proximal phalanx of the great toe (as extensor hallucis brevis) and the dorsal digital expansions of the second to fourth toes
Deep fibular (peroneal) nerve, L5, S1
Extension of the first to fourth toes

MUSCLES OF THE LATERAL SIDE OF THE LEG

Fibularis (peroneus) longus

From the upper two-thirds of the lateral surface of the fibula
To the lateral sides of the medial cuneiform and base of the first metatarsal
Superficial fibular (peroneal) nerve, L5, S1, S2
Plantar flexion and eversion of the foot

Fibularis (peroneus) brevis

From the lower two-thirds of the lateral surface of the fibula
To the tuberosity of the base of the fifth metatarsal
Superficial fibular (peroneal) nerve, L5, S1, S2
Plantar flexion and eversion of the foot

MUSCLES OF THE BACK OF THE LEG

Gastrocnemius

Medial head from the upper posterior part of the medial condyle of the femur; lateral head from the lateral surface of the lateral condyle of the femur
To the middle of the posterior surface of the calcaneus by the tendo calcaneus (in association with soleus)
Tibial nerve, S1, S2
Plantar flexion of the foot and flexion of the knee

Soleus

From the soleal line and upper part of the medial border of the tibia, a tendinous arch over the popliteal vessels and tibial nerve and the upper part of the posterior surface of the fibula
To the tendo calcaneus with gastrocnemius (see above)
Tibial nerve, S1, S2
Plantar flexion of the foot

Plantaris

From the lateral supracondylar line of the femur
To the calcaneus on the medial side of the tendo calcaneus
Tibial nerve, S1, S2
Plantar flexion of the foot and weak flexion of the knee

Popliteus

From the back of the tibia above the soleal line
To the outer surface of the lateral epicondyle of the femur
Tibial nerve, L4, L5, S1
Lateral rotation of the femur on the fixed tibia (or medial rotation of the tibia on the fixed femur); pulls lateral meniscus backward during flexion of the knee

Tibialis posterior

From the posterior surface of the interosseous membrane and adjacent posterior surfaces of the tibia and fibula
To the tuberosity of the navicular, with slips to other tarsal bones (except the talus) and the middle three metatarsals
Tibial nerve, L4, L5
Plantar flexion and inversion of the foot

Flexor hallucis longus

From the lower two-thirds of the posterior surface of the fibula
To the plantar surface of the base of the distal phalanx of the great toe
Tibial nerve, S2, S3
Plantar flexion of the great toe and foot

Flexor digitorum longus

From the medial part of the posterior surface of the tibia below the soleal line
To the four lateral toes by a tendon to each, reaching the plantar surface of the base of the distal phalanx
Tibial nerve, S2, S3
Plantar flexion of the four lateral toes and foot

MUSCLES OF THE SOLE OF THE FOOT

FIRST LAYER (Fig. 4)

Abductor hallucis

From the medial process of the calcaneal tuberosity and the plantar aponeurosis

To the medial side of the proximal phalanx of the great toe

Medial plantar nerve, S2, S3

Abduction and plantar flexion of the great toe

Flexor digitorum brevis

From the medial process of the calcaneal tuberosity and the deep surface of the central part of the plantar aponeurosis

To the lateral four toes by a tendon to each; the tendon divides into two slips (to allow the flexor digitorum longus tendon to pass between them), which are attached to the sides of the middle phalanx

Medial plantar nerve, S2, S3

Plantar flexion of the four lateral toes

Abductor digiti minimi

From the lateral and medial processes of the calcaneal tuberosity and the plantar aponeurosis

To the lateral side of the base of the proximal phalanx of the fifth toe (with flexor digiti minimi brevis)

Lateral plantar nerve, S2, S3

Abduction and plantar flexion of the fifth toe

SECOND LAYER (Fig. 5)

Quadratus plantae (flexor accessorius)

From the (concave) medial surface of the calcaneus and from the plantar surface of the calcaneus in front of the lateral process of the tuberosity

To the lateral border of flexor digitorum longus before the division into four tendons

Lateral plantar nerve, S2, S3

Assistance with plantar flexion of the four lateral toes

Lumbricals

First lumbrical from the medial border of the first tendon of flexor digitorum longus

Second, third and fourth lumbricals from the four adjoining tendons of flexor digitorum longus

To the medial sides of the dorsal digital expansions of the tendons of extensor digitorum longus

First lumbrical—medial plantar nerve; second, third and fourth lumbricals by the lateral plantar nerve, S2, S3

Plantar flexion at the four lateral metatarsophalangeal joints and extension at interphalangeal joints

Tendons of flexor digitorum longus and flexor hallucis longus

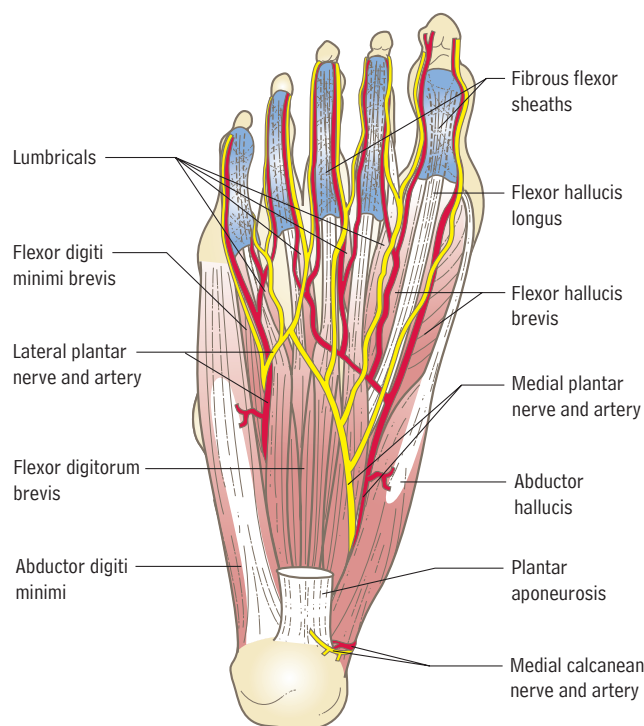


Fig. 4 Muscles of the sole of the right foot: first layer. For dissection see p. 92.

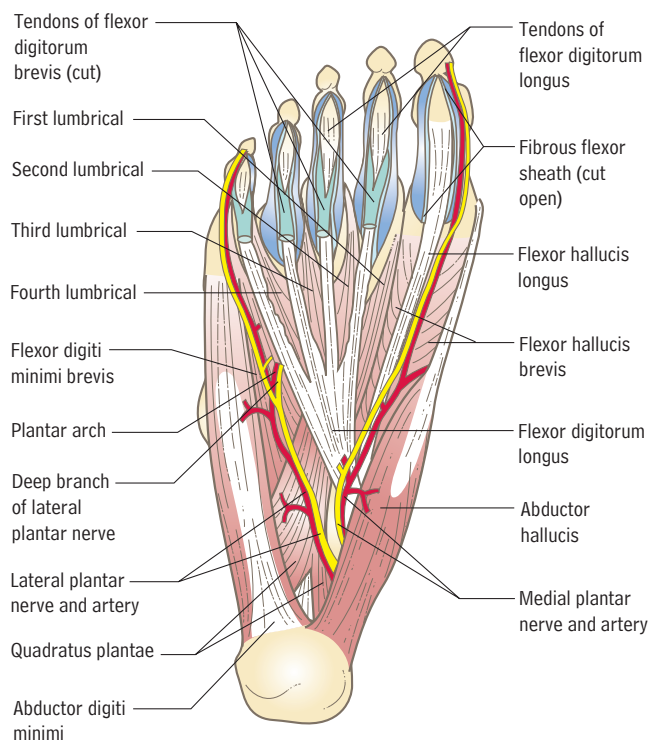


Fig. 5 Muscles of the sole of the right foot: second layer. For dissection see p. 93.

THIRD LAYER (Fig. 6)**Flexor hallucis brevis**

From the plantar surface of the cuboid and lateral cuneiform

By a tendon to each side of the base of the proximal phalanx of the great toe, the medial tendon joining with that of abductor hallucis and the lateral with adductor hallucis; there is a sesamoid bone in each tendon

Medial plantar nerve, S2, S3

Plantar flexion of the metatarsophalangeal joint of the great toe

Adductor hallucis

Oblique head from the bases of the second, third and fourth metatarsals

Transverse head from the plantar metatarsophalangeal ligaments of the third, fourth and fifth toes

To the lateral side of the base of the proximal phalanx of the great toe, with part of flexor hallucis brevis

Lateral plantar nerve, S2, S3

Adduction of the great toe

Flexor digiti minimi brevis

From the plantar surface of the base of the fifth metatarsal

To the lateral side of the base of proximal phalanx of the fifth toe, with abductor digiti minimi

Lateral plantar nerve, S2, S3

Plantar flexion of the metatarsophalangeal joint of the fifth toe

FOURTH LAYER (Fig. 7)**Dorsal interosseous (four)**

From adjacent sides of the bodies of the metatarsals

To the bases of proximal phalanges and the dorsal digital expansions; first and second to the medial and lateral sides of the second toe; third and fourth to the lateral sides of the third and fourth toes

Lateral plantar nerve, S2, S3

Plantar flexion of the metatarsophalangeal joints and extension (dorsiflexion) of the interphalangeal joints of the second, third and fourth toes; abduction of the same toes

Plantar interosseous (three)

From the bases and medial sides of the third, fourth and fifth metatarsals

To the medial sides of the bases of the proximal phalanges and dorsal digital expansions of the corresponding toes

Lateral plantar nerve, S2, S3

Plantar flexion of the metatarsophalangeal joints and extension (dorsiflexion) of the interphalangeal joints of the third, fourth and fifth toes; adduction of the same toes

Tendons of tibialis posterior and fibularis (peroneus) longus

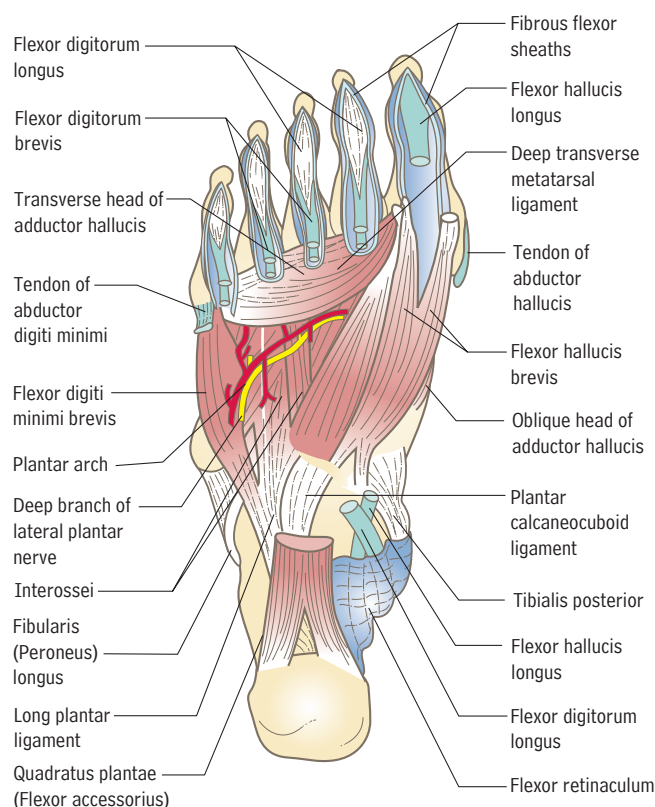


Fig. 6 Muscles of the sole of the right foot: third layer. For dissection see p. 94.

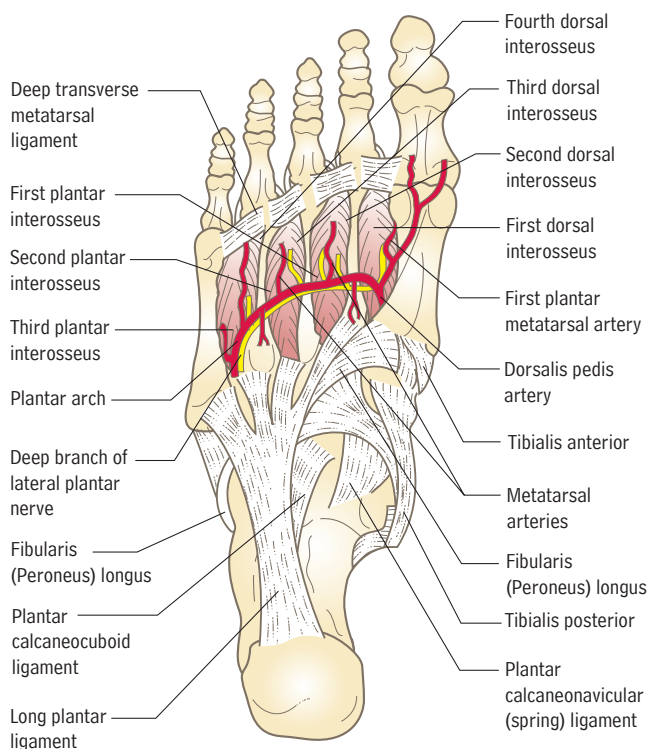


Fig. 7 Muscles of the sole of the right foot: fourth layer. For dissection see p. 95.

Nerves

BRANCHES OF THE LUMBAR PLEXUS (Fig. 8)

- Muscular T12, L1, L2, L3, L4 to psoas major and minor, quadratus lumborum and iliacus
- Iliohypogastric and ilioinguinal L1 to parts of internal oblique and transversus abdominis in anterior abdominal wall
- Genitofemoral L1, L2, giving off
 - Genital branch (to cremaster muscle of spermatic cord)
 - Femoral branch
- Lateral cutaneous of thigh L2, L3
- Femoral L2, L3, L4, giving off
 - Nerve to pectineus
 - Anterior division, giving off
 - Intermediate femoral cutaneous
 - Medial femoral cutaneous
 - Nerve to sartorius
 - Posterior division, giving off
 - Saphenous
 - Nerves to quadriceps femoris
- Obturator L2, L3, L4, giving off
 - Anterior branch
 - Muscular to adductor longus, adductor brevis and gracilis
 - Posterior branch
 - Muscular to obturator externus and adductor magnus
- Accessory obturator (occasional) L3, L4 to pectineus

BRANCHES OF THE SACRAL PLEXUS

- Superior gluteal* L4, L5, S1, to gluteus medius, gluteus minimus and tensor fasciae latae
- Inferior gluteal* L5, S1, S2, to gluteus maximus
- Nerve to piriformis* S1, S2
- Nerve to quadratus femoris* and gemellus inferior L4, L5, S1
- Nerve to obturator internus* and gemellus superior L5, S1, S2
- Posterior femoral cutaneous* S2, S3
- Sciatic nerve* L4, L5, S1, S2, S3 giving off
 - Muscular branches to biceps, semimembranosus, semitendinosus and part of adductor magnus
 - Tibial nerve—see below
 - Common fibular (*peroneal*) nerve—see below
- Perforating cutaneous, pudendal* and other pelvic and perineal branches

BRANCHES OF THE TIBIAL NERVE

L4, L5, S1, S2, S3 (Fig. 9)

- Muscular to gastrocnemius, plantaris, soleus, popliteus, tibialis posterior, flexor digitorum longus and flexor hallucis longus

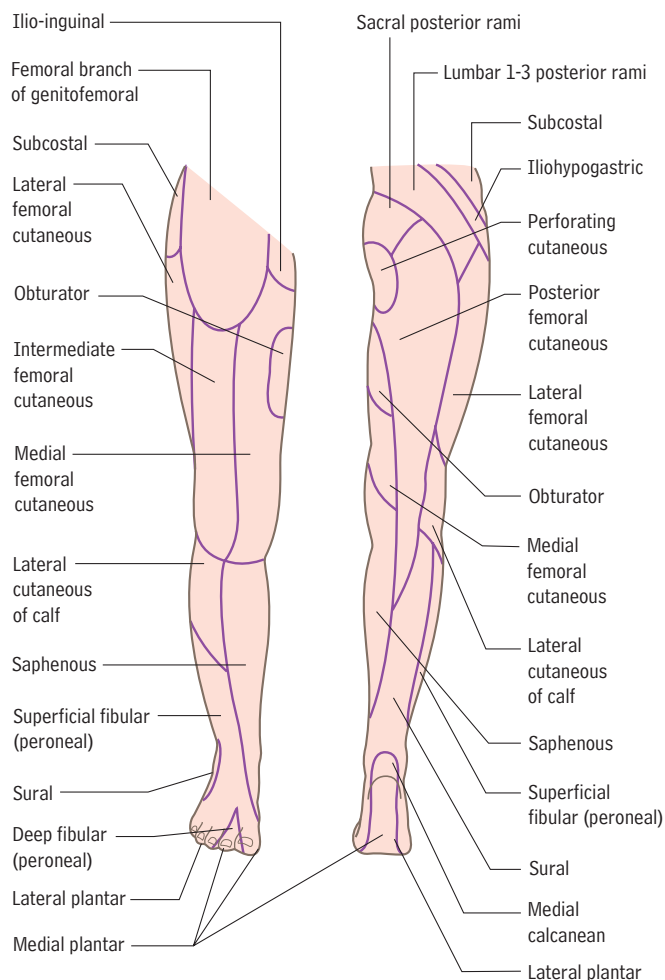


Fig. 8 Diagram of cutaneous nerves of the front and back of the right lower limb.

Sural (ending as lateral dorsal cutaneous and then dorsal digital to lateral side of fifth toe)

Medial calcaneal

Medial plantar—see below

Lateral plantar—see below

BRANCHES OF THE COMMON FIBULAR (*PERONEAL*) NERVE L4, L5, S1, S2

Recurrent

Lateral cutaneous of calf

Fibular (peroneal) communicating

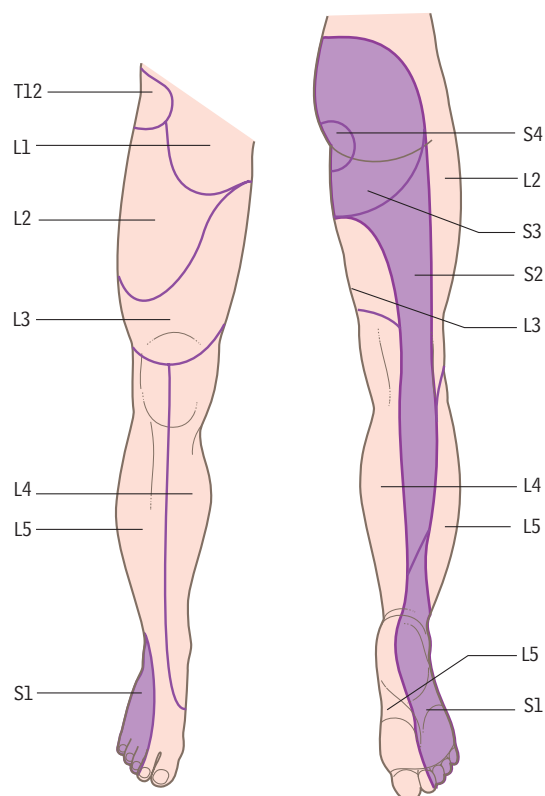


Fig. 9 Diagram of dermatomes of the front and back of the right lower limb. (A dermatome is the area of skin supplied by any one spinal nerve.) Note that both the dorsum and sole of the foot are supplied by L5 and S1 dermatomes.

Superficial fibular (peroneal), giving off
 Muscular to fibularis (*peroneus*) longus and fibularis (*peroneus*) brevis
 Medial branch (medial dorsal cutaneous), giving off
 Dorsal digital
 Lateral branch (intermediate dorsal cutaneous), giving off
 Dorsal digital
Deep fibular (peroneal), giving off
 Muscular to tibialis anterior, extensor hallucis longus, extensor digitorum longus and fibularis (*peroneus*) tertius
 Lateral terminal, to extensor digitorum brevis
 Medial terminal, giving off
 Dorsal digital (to first cleft)

BRANCHES OF THE MEDIAL PLANTAR NERVE L4, L5, S1

Trunk giving off
 Nerve to abductor hallucis
 Nerve to flexor digitorum brevis
Proper plantar digital nerve of great toe, giving off
 Nerve to flexor hallucis brevis
First common plantar digital nerve, giving off
 Nerve to first lumbrical
 Proper plantar digital nerves of first cleft
Second common plantar digital nerve, giving off
 Proper plantar digital nerves of second cleft
Third common plantar digital nerve, giving off
 Proper plantar digital nerves of third cleft

BRANCHES OF THE LATERAL PLANTAR NERVE S1, S2

Trunk, giving off
 Nerve to quadratus plantae
 Nerve to abductor digiti minimi
Superficial branch, giving off
 Fourth common plantar digital nerve, giving off
 Proper plantar digital nerves of fourth cleft
 Proper plantar digital nerve of fifth toe, giving off
 Nerve to flexor digiti minimi brevis
 Nerve to third plantar interosseous
 Nerve to fourth dorsal interosseous
Deep branch, giving off
 Nerve to adductor hallucis
 Nerves to second, third and fourth lumbricals
 Nerves to first, second and third dorsal interossei
 Nerves to first and second plantar interossei

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Regional anaesthesia for foot and ankle

- Popliteal Block
- Ankle Block
- Midfoot Field Block
- Common Digital Block

Advantages

- Most foot and ankle surgery can be performed in the day care setting.
- A combination of regional or field block with or without general anaesthesia allows faster patient recovery and better postoperative analgesia.

POPLITEAL BLOCK

A popliteal block essentially blocks two terminal branches of the sciatic nerve but has to be combined with a saphenous nerve block to ensure complete effectiveness of block technique. The nerves can be identified using the nerve stimulator (1) or, more easily, using the ultrasound (2) technique as described below.

Indications

For surgery on the ankle or foot, this block can be used as the sole anaesthetic or in conjunction with general or spinal anaesthesia for postoperative analgesia. If a tourniquet is required, a calf tourniquet should be used.

Contraindications

1. Patient refusal
2. Infection of the site of block
3. Coagulopathy

Precautions

As surgery on the forefoot can be easily performed under an ankle block; a popliteal block in these cases is not necessary. It will cause foot drop, which may delay patient mobilization or discharge.

Anatomy

The predominant nerve innervating the lower limb below the knee is the sciatic nerve and its branches. The saphenous nerve is the only sensory contribution below the knee.

The sciatic nerve divides at a variable distance proximal to the popliteal crease into the tibial and common fibular (peroneal) nerve branches.

The saphenous nerve is a branch of the femoral nerve from its posterior division. It leaves the femoral triangle at its lower angle and passes across the front of the femoral artery in the subsartorial canal to reach the medial side of the vessel. It leaves the canal by passing beneath the posterior border of sartorius and becomes superficial posterior and lateral to the knee joint, then travels the leg distally along with the great saphenous vein as far as the medial side of the foot).

(1) NERVE STIMULATOR-GUIDED TECHNIQUE

Although various approaches to the nerves situated in the popliteal fossa have been described, the preferable one is the posterior approach. This approach is less painful to the patient as the needle passes only through skin and adipose tissue on its way to the nerves.

Equipment and drugs

1. Nerve stimulator (e.g. B Braun Stimuplex)
2. Insulated 50 mm needle
3. Local anaesthetic: Use 0.5% levobupivacaine for anaesthesia and 0.25% if the block is done only for postoperative analgesia.

Procedure (Fig. 10)

After intravenous access is established and appropriate monitoring applied, the patient lies in a prone position

with a pillow placed underneath the leg so that the knee becomes slightly flexed.

A line is drawn on the skin along the popliteal crease and along this line the tendon of biceps is felt on the lateral side of the fossa and marked. Similarly, the tendon of semitendinosus is felt and marked on the medial side.

The line marking the popliteal crease between these tendons is divided and a perpendicular line drawn cephalad from this point.

A point on the perpendicular line is marked 7 cm from the popliteal crease line and the needle insertion point is 1 cm lateral to this point.

An intradermal wheal of local anaesthetic is injected at this point.

A 5 cm stimulating needle is then inserted perpendicular to the skin and initial stimulating current set at 1 mA, frequency 2 Hz.

Nerve stimulation should be elicited within 1.5–2.5 cm.

With this approach, the common fibular (*peroneal*) nerve is often first identified, causing dorsiflexion of the foot.

Once the needle is adjusted so that a twitch may be found at 0.3–0.5 mA, 10 ml of local anaesthetic is injected after excluding intravascular needle placement by careful aspiration, the twitch should disappear immediately.

The needle should then be redirected to stimulate the second nerve, by either moving it medially to locate the tibial nerve (if the common fibular (*peroneal*) nerve was found first) or laterally to locate the common fibular (*peroneal*) nerve (if the tibial nerve was found first).

When the other nerve is located, another 10 ml of local anaesthetic is injected.

Complications

1. Nerve damage
2. Intravascular injection leading to local anaesthetic toxicity

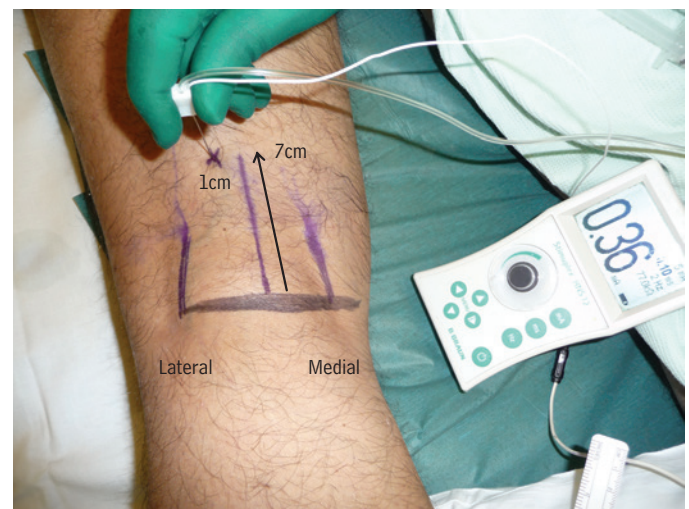


Fig. 10 Nerve stimulator-guided technique for popliteal block.



Fig. 11 Ultrasound technique for popliteal block

(2) ULTRASOUND TECHNIQUE

A popliteal block can be safely and easily done using ultrasound. Indications, contraindications and complications are similar to the nerve stimulator-guided technique.

Equipment and drugs

1. Ultrasound machine with high frequency linear probe
2. Probe cover and jelly
3. Nerve stimulator (e.g. B Braun Stimuplex)
4. Insulated 100 mm needle
5. Local anaesthetic. Use 0.5% levobupivacaine for anaesthesia and 0.25% if the block is done only for postoperative analgesia.

Procedure (Figs 11 and 12)

After intravenous access is established and appropriate monitoring applied, the patient lies supine with leg elevated and resting on a support.

The ultrasound probe is placed behind the knee just above the popliteal crease so that a transverse

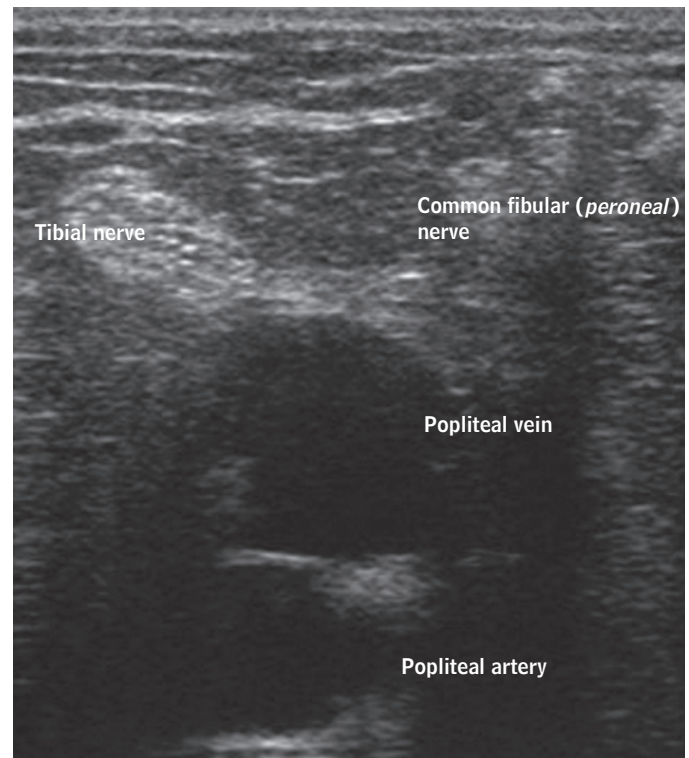


Fig. 12 Ultrasound image of popliteal fossa.

(cross-sectional) image of the popliteal artery and vein superior to it may be observed.

Nerves lay superficially to the blood vessels and the tibial nerve (largest) is identified first; then the common fibular (*peroneal*) nerve, which is seen to converge with the tibial nerve when the probe is moved cephalad, is identified.

Once the nerves have been clearly identified, a needle is inserted in the scanning plane so that the entire needle can be observed on the screen live, as it approaches the nerves; then, 20 ml of local anaesthetic is injected to surround the nerves.

Complications of this procedure are similar to nerve stimulator-guided procedure.

ANKLE BLOCK

The ankle block is a simple block to perform that targets the terminal branches of the sciatic and femoral nerves. Complete ankle block requires five injections; mild sedation, therefore, may improve patient comfort during block performance.

Indications

This block can be used as an anaesthetic technique for surgery on the forefoot. It can also be used for postoperative analgesia for surgery on the midfoot done under general anaesthesia, since most of these types of surgery need a thigh tourniquet.

Contraindications

1. Patient refusal
2. Infection at the site of block
3. Coagulopathy

Anatomy

The five nerves to block are:

The saphenous nerve, which arises from the femoral nerve.

The tibial, superficial and deep fibular (*peroneal*), and sural nerves, which are branches of the sciatic nerve.

(See p.152, Fig. 8 and p.163, Figs 22 and 23 for sensory innervation of the ankle).

Four of the five nerves lie very close to blood vessels:

1. The saphenous nerve lies close to the great saphenous vein in the subcutaneous tissue just in front of the medial malleolus.
2. The tibial nerve lies behind the posterior tibial artery, posterior to the medial malleolus, halfway between the malleolus and the tendo calcaneus (*Achilles tendon*).
3. The deep fibular (*peroneal*) nerve runs with the dorsalis pedis artery on the anterior aspect of the ankle.

4. The sural nerve lies on the lateral side of the tendo calcaneus in close proximity to the short saphenous vein.

The superficial fibular (*peroneal*) nerve begins on the lateral aspect of the neck of the fibula and descends to a point on the anterior border of the leg at which it pierces the deep fascia and divides into medial and lateral branches which diverge in the subcutaneous plane between the two malleoli.

Equipment and drugs

1. 23G hypodermic needle
2. 2% chlorhexidine
3. 20 ml of 0.5% levobupivacaine

Procedure

1. The saphenous nerve (Fig. 13)—subcutaneous infiltration above and slightly anterior to the medial malleolus
2. The tibial nerve (Fig. 14)—behind medial malleolus, posterior to the posterior tibial artery under the sustentaculum tali
3. The sural nerve (Fig. 15)—four-finger breadths above the lateral malleolus in the subcutaneous plane toward the tendo calcaneus
4. The superficial fibular (*peroneal*) nerve (Fig. 16)—subcutaneous infiltration between the two malleoli. Start in the midline and inject on either side.
5. The deep fibular (*peroneal*) nerve (Fig. 17)—on the anterior aspect of the ankle, inject either side of the dorsalis pedis artery.

Complications

1. Intravascular injection
2. May effect mobilization if proprioception is affected



Fig. 13 Saphenous nerve block.



Fig. 14 Tibial nerve block.



Fig. 15 Sural nerve block.



Fig. 16 Superficial fibular (*peroneal*) nerve block.



Fig. 17 Deep fibular (*peroneal*) nerve block.

MIDFOOT FIELD BLOCK

The midfoot field block is a simple block to perform. There is no requirement for a nerve stimulator or ultrasound guidance. This technique has proven to be very reliable for surgery on up to three rays of the forefoot. Limbers and associates reported a 100% success rate in 42 patients in a day care environment undergoing forefoot surgery. There were no conversions to a general anaesthetic, and the patients were sedated at the time of block insertion. The surgery was undertaken under an ankle tourniquet. Previous studies have shown similar results with 98% to 100% success rates.

Other midfoot blocks have been described and are known eponymously as the *Sharrock* and *Mayo* blocks. The midtarsal block described by *Sharrock* involves a block of the deep fibular (*peroneal*) nerve and posterior tibial nerve.

The deep fibular (*peroneal*) nerve lies lateral to the dorsalis pedis artery that is located by palpation.

The posterior tibial nerve is anaesthetised by palpating the posterior tibial artery and injecting posterior to it.

These two nerve blocks are supplemented by a subcutaneous field block, anaesthetising the superficial fibular (*peroneal*) and saphenous nerves.

The *Mayo* block involves infiltration of a local anaesthetic ring block in the tissues proximal to the surgical site. A wheal is raised proximal to the first digital interspace after which the needle is advanced in a plantar direction and additional anaesthetic injected. The needle is then withdrawn and directed medially from the dorsal surface to raise a wheal.

These blocks are intermediate procedures between anatomical nerve blocks at the ankle, as previously described, and local infiltration. The block described here, is a modification of the midfoot block as described by *Ptaszek and associates*, it is easy to perform and can be combined with controlled intravenous sedation if required.

Indications

1. Bunion surgery
2. First metatarsophalangeal joint fusion
3. Forefoot surgery (maximum three toes)

Contraindications

1. Patient refusal
2. Infection at the site of block
3. Coagulopathy
4. Allergy to anaesthetic agents

Anatomy

The Great Toe of the foot is supplied by branches of four main nerves, three dorsal and one plantar: dorsally—the superficial fibular (*peroneal*) nerve, saphenous nerve and deep fibular (*peroneal*) nerve; plantar—the medial plantar nerve.

The superficial fibular (*peroneal*) nerve divides at the level of the ankle into medial and lateral branches. The medial branch divides into two dorsal digital nerves: one branch supplies the medial side of the great toe and the other the adjacent sides of the second and third toes. It communicates with the saphenous nerve and deep fibular (*peroneal*) nerve, the terminal branch of which supplies sensation to the dorsum of the first web space (p.163, Fig. 22, A, B).

The medial plantar nerve is a branch of the tibial nerve and supplies the medial–plantar aspect of the great toe (p.163, Fig. 23 A, B). The common plantar digital nerves, which divide to supply the remaining plantar aspect of the medial three and a half toes, are also branches of the medial plantar nerve.

Equipment and drugs

1. 23G hypodermic needle
2. 2% chlorhexidine
3. 5–20 ml of 2% lignocaine without adrenaline (maximum dose of 4.5 mg/kg)

Procedure

Prior to block insertion, the patient may be sedated with monitored intravenous sedation.

The first injection site (Fig. 18) is at the level of the tarsometatarsal joint medially.

The needle is advanced in the subcutaneous plane from dorsal to plantar until the plantar skin is tented. Anaesthetic is injected as the needle is withdrawn.

The saphenous and medial plantar nerves are blocked at this point.

A small amount of anaesthetic is also injected subperiosteally into the first metatarsal.

The second injection site (Fig. 19) is into the first web space to block the medial terminal branch of the deep fibular (*peroneal*) nerve.

Along with infiltration of the web space, subperiosteal infiltration of the lateral first metatarsal is also undertaken.

The third injection site (Fig. 20) is on the plantar surface, just proximal to the metatarsophalangeal joint and blocks the plantar digital nerves.

If surgery to other toes is planned, the lesser rays are blocked with supplementary common digital blocks. Practically however, it is difficult to extend this block beyond three-toe surgery since the volume of anaesthetic required exceeds the toxic dose.

Complications

1. Intravascular injection
2. Failure of the block
3. Neuropraxia



Fig. 18 First injection site for midfoot field block.



Fig. 19 Second injection site for midfoot field block.



Fig. 20 Third injection site for midfoot field block.

THE COMMON DIGITAL BLOCK

The nerve supply to the lesser toes, 2, 3, 4, 5, is identical to that of the fingers. In the foot, four nerves supply each digit, two dorsal (dorsal digital nerves) and two plantar (proper plantar digital nerves). The dorsal nerves are branches of the superficial fibular (*peroneal*) nerve and the plantar nerves are from divisions of the medial and lateral plantar nerves (p.163, [Figs A,B](#)).

The common digital block is preferred to using a ring block because it causes less soft tissue swelling and tension, and it does not compromise surgical dissection. An ankle or toe tourniquet can be used with this block.

Indications

1. Nail surgery
2. Interphalangeal joint fusion
3. Flexor tenotomy

Contraindications

1. Infection at site of block
2. Coagulopathy
3. Patient refusal
4. Allergy to anaesthetic

Equipment and drugs

1. 23G hypodermic needle
2. 2% chlorhexidine
3. 2.5 ml of 1% lignocaine without adrenaline at each injection site (maximum dose of 4.5 ml /kg)

Procedure ([Fig. 21](#))

The needle is inserted in the web space at the level of the metatarsophalangeal joint and advanced vertically until it tents the plantar skin.

The needle is then slowly withdrawn and approximately 2.5 ml of local anaesthetic injected.

This procedure is then repeated on the opposite side of the same toe.

As with digital block in the fingers, co-administration of epinephrine must be avoided since this can cause spasm of

the end arteries that supply the digits, resulting in ischaemia and even necrosis.

Complications

1. Intravascular injection
2. Failure to block



Fig. 21 Common digital block.

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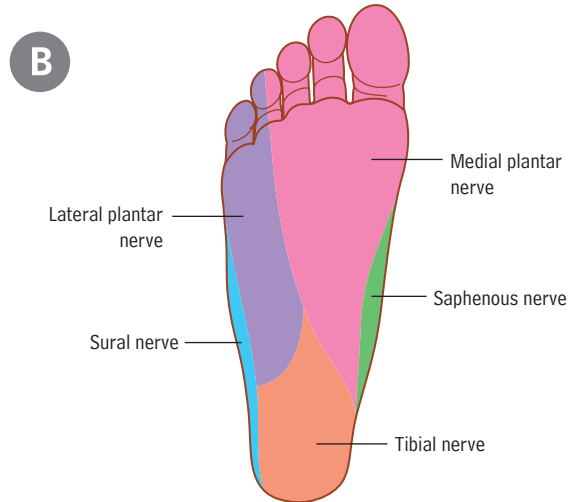
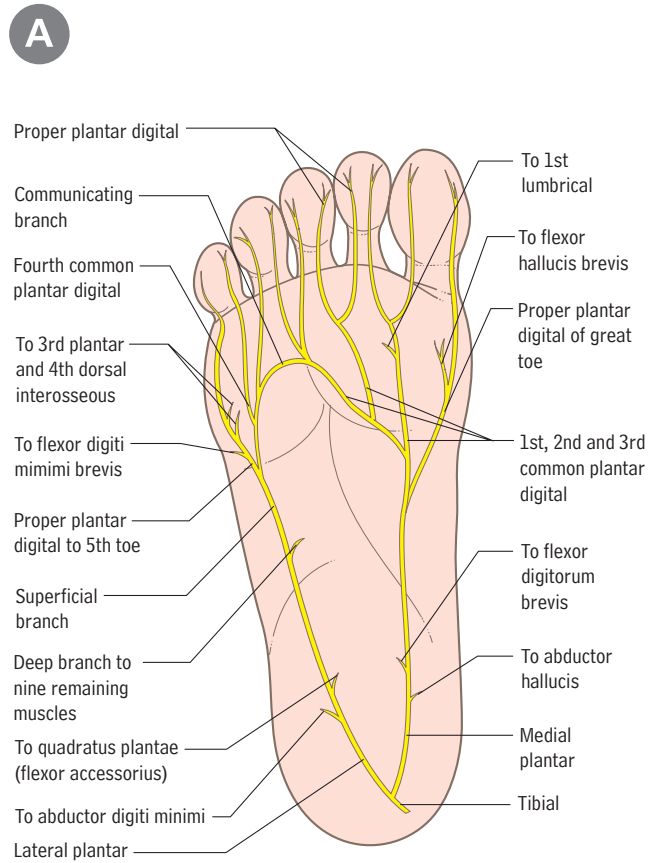
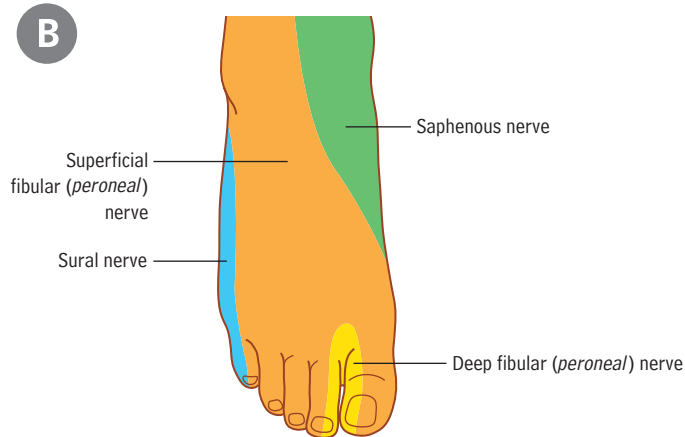
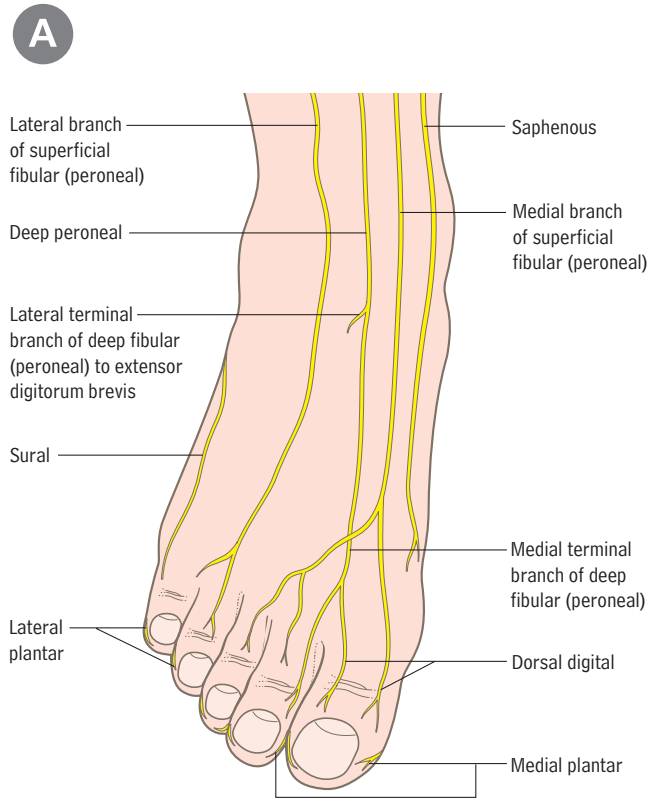


Fig. 22 A B
Fig. 23 A B

Sensory innervation of the ankle

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The lymphatic system

GENERAL KEY POINTS

The lymphatic system has four major functions:

1. **Produce, store and recirculate lymphocytes**, cells mainly responsible for immune response in the body.
2. **Store macrophages** (phagocytes).
3. **Drain surplus tissue fluid** to the bloodstream.
4. **Transport absorbed fat** from the intestine to the bloodstream.

The **combined fluid product** is known as **lymph**.

- **Lymph is drained** from areas of tissue **via very fine** threadlike lymphatic vessels (**lymphatics**), that are thin walled, **similar to veins**, and **have valves** to ensure **one-way flow**.
- **Lymph flow** is chiefly **maintained by external pressure** on the delicate-walled lymphatic vessels by surrounding tissue structures.
- **Lymphatics connect to main trunks** and are **interrupted** en route **by lymphoid organs and nodes**, which act as filters.
- **Afferent lymphatic vessels** carry unfiltered lymph **into a node**.
- **Efferent lymphatic vessels** carry filtered lymph **out of a node**.
- **Several main lymphatic trunks** converge towards their venous junction (cervical lymphovenous portals), returning lymph to the venous bloodstream.

There are normally **three trunks** on the **right** side of the body and **four** on the **left**.

Right-sided trunks	Left-sided trunks
Right jugular trunk	Left jugular trunk
Right subclavian trunk	Left subclavian trunk
Right bronchomediastinal trunk	Left bronchomediastinal trunk
	Thoracic duct

- The **main lymphoid organs of the body** are the **tonsils, spleen, thymus** and **lymph nodes**, of which some 400–450 are present in the normal adult.
- **Lymph nodes** are **sited regionally** and may be found as **singleton, pairs** or in distinct multiple **cluster groups** (Fig. 24).
- **Nodes** are usually **small, ovoid** or **kidney (reniform)** in **shape** and vary between 0.1 and 2.5 cm in length.
- **Some nodes, but not all, may be palpable** in their **normal state**, but particularly so when diseased.



Fig. 24 A cluster (group) of adult upper limb left axillary (lateral) lymph nodes with associated vessels. They are shown actual size as presented at dissection and are typical of normal lymph node appearance in the human body.

LOWER LIMB LYMPHATICS—KEY POINTS

- **Not many lymph nodes** are located in the limbs.
- The leg and superficial gluteal region, infra-umbilical abdominal wall and perineum have only about **20 recognized lymph nodes**. This does not include the intra-pelvic and intra-abdominal, iliac, lateral caval and aortic groups of nodes, into which the limb lymphatics drain.
- The **lymphatic drainage** of the **lower limb** is via a network of **superficial and deep** efferent lymphatic vessels, some of which may directly interconnect, or unite by an afferent vessel to a particular lymph node or group (cluster of nodes).
- Essentially, **superficial** lymphatics of the lower limb accompany **superficial veins**, whereas **deep** lymphatics accompany **arteries**.
- Both **superficial and deep** lymphatic networks of the lower limb **drain in a distal (foot) to proximal (thigh/groin)** limb direction.
- The intra-abdominal **right-side superior lateral caval group of lymph nodes** and opposite **left-side superior lateral aortic group of lymph nodes** are stated to be the **terminal groups of nodes for the lower limbs**.
- From the **lateral caval and aortic** groups of nodes, **lymph flows** through the **bilateral lumbar trunks**, their **confluence (cisterna chyli)** and then into the **thoracic duct**.
- **Lymph finally returns to the venous bloodstream** via a **lymphovenous portal** situated on the **left-side root of neck**, where the thoracic duct drains into the **junction of the internal jugular and subclavian vein**.
- The **inguinal nodes** are of **key importance for lower limb**. They may become enlarged due to infection of the foot (e.g. infected ingrowing toenail) or through involvement by tumour (e.g. leg melanoma).

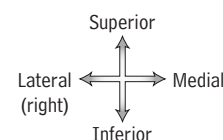


Fig. 25 Superficial dissection of the right upper thigh femoral (triangle) region, displaying lymph nodes and associated lymphatic vessels in situ, from the front

- | | |
|---|---|
| 1 Superficial inguinal lymph nodes | 7 Femoral artery |
| 2 Lymphatic vessels | 8 Femoral vein |
| 3 Fascia overlying adductor longus | 9 Superficial epigastric vein |
| 4 Great saphenous vein | 10 Saphenous nerve |
| 5 Sartorius | 11 Superficial external pudendal artery and vein |
| 6 Iliotibial tract | 12 Position of inguinal ligament |

Lymph nodes draining the lower limbs

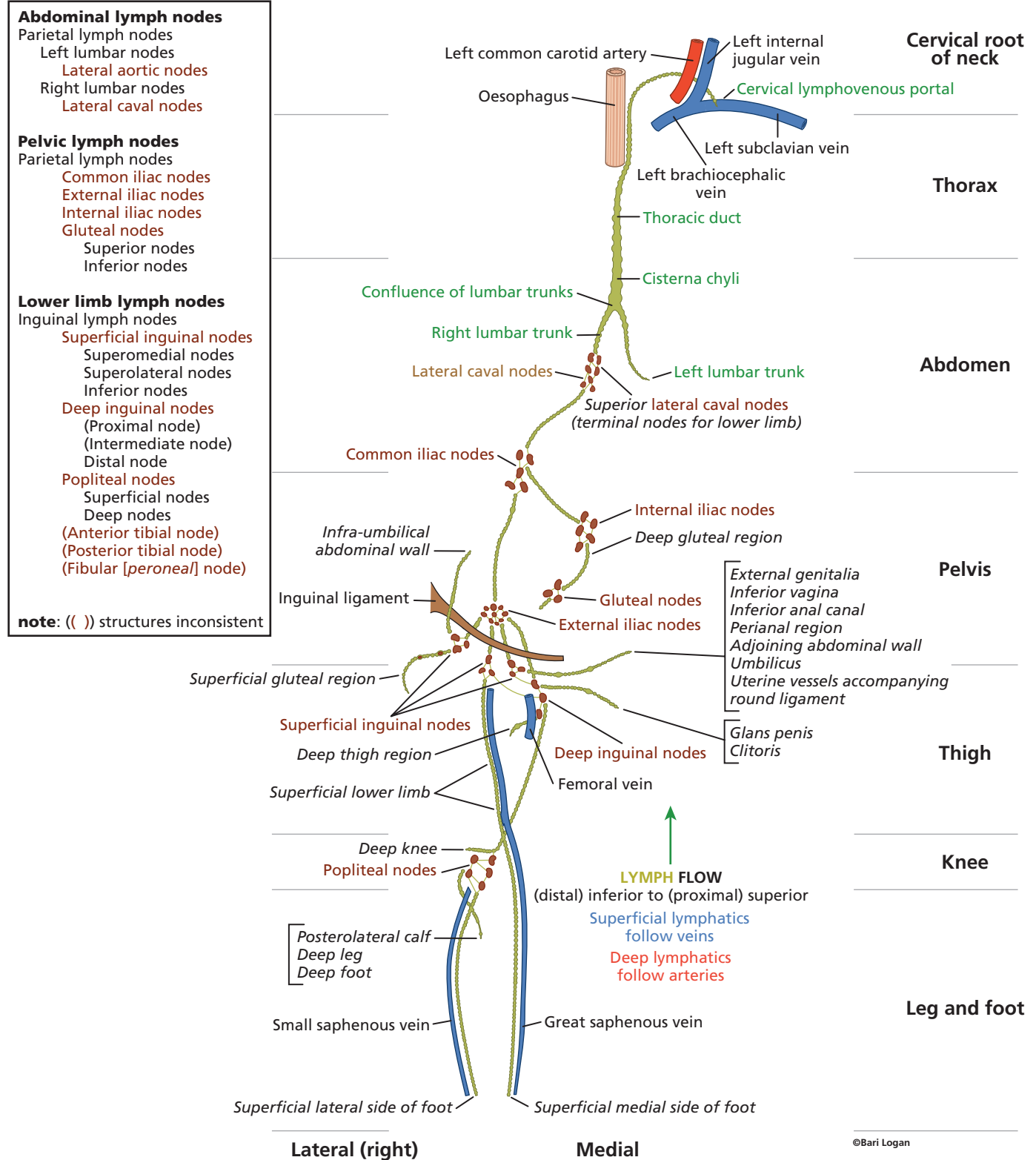


Fig. 26 Schematic drawing (not to scale) of the lymphatic drainage of the right lower limb.

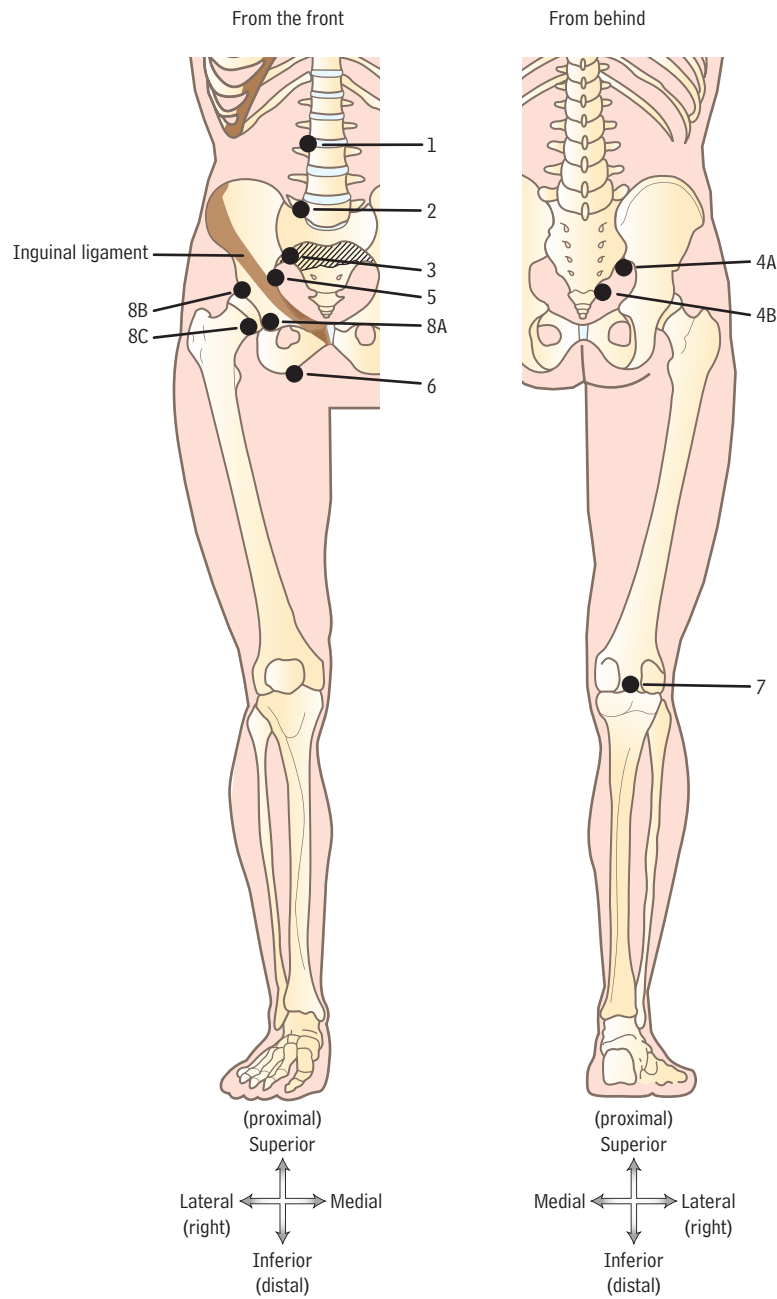


Fig. 27 Position of the main lymph node clusters (groups) responsible for draining the right lower limb.

1 Lateral caval nodes

Located within the retroperitoneum on the posterior abdominal wall, the **lateral caval nodes** occur on the **right side** of the body **flanking the vena cava**, hence (caval). Their counterparts, the **lateral aortic nodes**, occur on the **left side** of the body **flanking the aorta**, hence (aortic). Both groups of nodes, anterior to the medial margins of the psoas major muscles, diaphragmatic crura and sympathetic trunks, receive efferents from the common iliac nodes. There is moderate left-to-right crossover to nodes between the inferior vena cava and the aorta.

2 Common iliac nodes

Located within the pelvis, a cluster of normally **four to six nodes** scattered **around the common iliac artery**. Some nodes of this group occur inferior to the bifurcation of the aorta and anterior to the fifth lumbar vertebra or promontory of the sacrum. They receive efferents from the internal iliac nodes and external iliac nodes.

3 Internal iliac nodes

Located deep within the pelvis level with the lumbosacral intervertebral disc and anterior to the sacroiliac joint. These **nodes surround the internal iliac artery and vein** scattered between the commencement of the artery, at the common iliac bifurcation, and the superior margin of the greater sciatic notch. They receive efferents from the gluteal nodes.

4 Gluteal nodes

Located deep within the pelvis the gluteal nodes are a subgroup of the internal iliac nodes and form two small clusters:

- 4A. Superior node**—normally a single node that occurs close to the intrapelvic part of the superior gluteal artery near to the border of the greater sciatic notch of the hip bone.
- 4B. Inferior nodes**—normally two nodes that occur close to the inferior gluteal artery just inferior to the piriformis muscle. They drain the deep gluteal region.

5 External iliac nodes

Located within the pelvis posterior to the inguinal ligament midway between the anterior superior iliac spine of the hip bone and pubic symphysis. These nodes, normally **8–10 in number**, **form three clusters around the external iliac artery and vein** in a **lateral, medial and anterior*** position. They receive efferents from the superficial inguinal nodes and deep inguinal nodes.

6 Deep inguinal nodes

Located deep in the anterior upper thigh embedded in the fat of the femoral triangle. Normally **one to three nodes** in number, but may vary, lying **just medial to the femoral vein**. **Proximal node***—situated lateral in the femoral ring. **Intermediate node***—situated in the femoral canal. **Distal node**—situated just distal to the **saphenofemoral** junction. These nodes drain the glans penis, clitoris and deep thigh and receive efferents from the popliteal nodes and a few from the superficial inguinal nodes.

7 Popliteal nodes

Located at the back of the knee embedded in the fat of the popliteal fossa. Normally **six small nodes** laying close to the **popliteal vessels**. Some **superficial nodes** of the group occur near the termination of the small saphenous vein and some **deep nodes** lay between the popliteal artery and posterior aspect of the knee joint. This group of nodes drains the deep knee, posterolateral calf, deep leg and deep foot and receives efferents that accompany the small saphenous vein from the superficial lateral side of the leg and foot.

8 Superficial inguinal nodes

Located superficially in the anterior upper thigh embedded in the subcutaneous fat of the femoral triangle, these nodes form three distinct cluster groups. The **superomedial** and **superolateral** nodes, normally **five to six in number** situated just **distal and below the medial and lateral parts of the inguinal ligament**, and the **inferior nodes**, normally **four to five in number**, just lateral to and along the termination of the great saphenous vein.

- 8A.** The **superomedial nodes** drain superficial lymphatics from the external genitalia, inferior vagina, inferior anal canal, perianal region, adjoining abdominal wall, umbilicus and the uterine vessels that accompany the round ligament.
- 8B.** The **superolateral nodes** drain superficial lymphatics from the infraumbilical anterior abdominal wall and gluteal region.
- 8C.** The **inferior nodes** receive efferents accompanying the great saphenous vein from the superficial lateral side of the leg and foot, except for the posterolateral calf.

Note: * denotes inconsistent structures.

Arteries

BRANCHES OF THE FEMORAL ARTERY

Giving off the following before becoming the popliteal artery

Superficial epigastric
 Superficial circumflex iliac
 Superficial external pudendal
 Deep external pudendal
 Profunda femoris, giving off
 Lateral circumflex femoral
 Medial circumflex femoral
 Perforating
 Descending genicular

BRANCHES OF THE POPLITEAL ARTERY

Sural
 Superior, middle and inferior genicular
 Anterior tibial, giving off the following before becoming the dorsalis pedis artery (see below)
 Posterior and anterior tibial recurrent
 Anterior medial and anterior lateral malleolar
 Posterior tibial, giving off
 Circumflex fibularis
 Fibular (peroneal), giving off
 Nutrient to the fibula
 Perforating
 Communicating
 Lateral malleolar
 Calcaneal
 Nutrient to the tibia
 Communicating
 Medial malleolar
 Calcaneal
 Medial plantar (see below)
 Lateral plantar (see below)

BRANCHES OF THE DORSALIS PEDIS ARTERY (Fig. 28)

Lateral dorsal
 Medial dorsal
 First dorsal metatarsal, giving off
 Deep plantar (perforating) branch, to complete plantar arch
 Dorsal digital branch to medial side of great toe
 Dorsal digital branches of first cleft

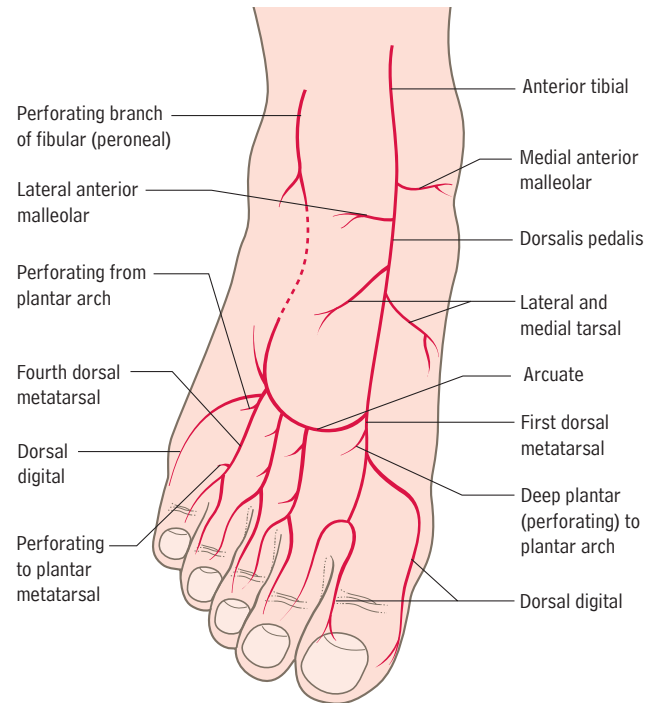


Fig. 28 Diagram of branches of the right dorsalis pedis artery, excluding muscular and most anastomotic branches; note that anastomoses from the perforating branch of the fibular (*peroneal*) artery may link up with the arcuate artery and enlarge to replace an absent dorsalis pedis artery.

Arcuate, giving off
 Second dorsal metatarsal, giving off
 Perforating branches
 Dorsal digital branches to second cleft
 Third dorsal metatarsal, giving off
 Perforating branches
 Dorsal digital branches to third cleft
 Fourth dorsal metatarsal, giving off
 Perforating branches
 Dorsal digital branches to fourth cleft
 Dorsal digital branch to lateral side of fifth toe

BRANCHES OF THE MEDIAL PLANTAR ARTERY

Anastomotic branch to plantar digital artery of medial side of the great toe
Superficial digital branches to anastomose with first, second and third plantar metatarsal arteries

BRANCHES OF THE LATERAL PLANTAR ARTERY (Fig. 29)

Plantar arch, giving off
First plantar metatarsal, giving off
Plantar digital artery to medial side of great toe
Plantar digital arteries to first cleft
Second, third and fourth plantar metatarsal arteries, each giving off
Plantar digital arteries to second, third and fourth clefts, respectively
Perforating branches
Plantar digital artery to lateral side of fifth toe

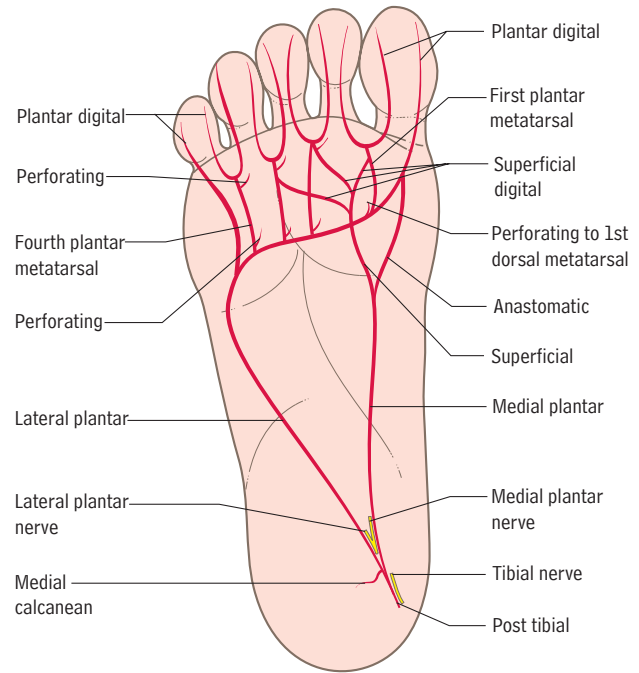


Fig. 29 Diagram of branches of the right medial and lateral plantar arteries (excluding muscular and most anastomotic branches). The proximal parts of the medial and lateral plantar nerves are shown in green to indicate that the nerves lie on the internal sides of their corresponding arteries.

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