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CHAPTER

Functional Anatomy of the Equine Musculoskeletal System

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ANATOMIC NOMENCLATURE AND USAGE

Veterinary medical anatomists have been using the Nomina Anatomica Veterinaria, created by the International Committee on Veterinary Gross Anatomical Nomenclature since 1968 to standardize the names of anatomical structures.[46] This chapter endeavors to use the most current, correct terms as outlined in that publication. Nonetheless, equine practitioners need to be equally fluent in older terminology, which is likely to be in wide usage among horse owners and equine professionals. This chapter will provide useful and common synonyms for many structures, along with their more technically correct terms.

Figure 1.1 provides the directional terms for veterinary anatomy that will be used in this chapter. With the exception of the ocular and oral cavity structures, the terms anterior, posterior, superior, and inferior are not applicable to quadrupeds.

THORACIC LIMB

Digit and Fetlock

The digit is composed of distal (third), middle (second), and proximal (first) phalanges and associated structures (Figure 1.2). The fetlock consists of the metacarpophalangeal (fetlock) joint and the structures surrounding it. Because the digits and fetlocks of the thoracic limb and the pelvic limb are similar in most respects, the following descriptions pertain to both limbs unless otherwise indicated. When referring to structures of the forelimb, the term "palmar" is used; this will obviously be replaced with "plantar" when referring to the hindlimb. Likewise, such terms as metacarpophalangeal and metatarsophalangeal are counterparts in fore- and hindlimbs, respectively.

Foot

The foot consists of the hoof and all it encloses: the connective tissue corium (dermis), digital cushion, distal phalanx (coffin bone), most of the cartilages of the distal phalanx, distal interphalangeal (coffin) joint, distal part of the middle phalanx (short pastern bone), distal sesamoid (navicular) bone, podotrochlear bursa (navicular bursa), several ligaments, tendons of insertion of the common digital extensor and deep digital flexor muscles, blood vessels, and nerves. Skin between the heels is also part of the foot.

Hoof Wall, Sole, and Frog

The hoof is continuous with the epidermis at the coronet, and the underlying corium of the hoof is likewise continuous with the dermis of the skin. The ground surface of the hoof comprises the sole, frog, heels, bars, and ground surface of the wall (Figure 1.3). The ground surface of the forefoot is normally larger and rounder than that of the hindfoot, reflecting the corresponding shape of the distal surface of the distal phalanx (coffin bone).

The hoof wall extends from the coronary band (also called the coronet), the transition between skin and hoof, distad to the ground. The surface of the wall is divided into the toe, medial and lateral quarters, and heels (Figures 1.3 and 1.4). From the toe, where it is thickest, the wall becomes progressively thinner and more elastic toward the heels, where it thickens again when it reflects to become the bars. Ranges for the angle of the toe between the dorsal surface of the hoof wall and the ground surface of the hoof vary widely.[1,16] In the ideal digit, the dorsal surface of the hoof wall and the dorsal surface of the pastern should be parallel, reflecting the axial alignment of the phalanges.

The vascular and densely innervated collagenous connective tissue deep to the hoof is the corium. The corium

Adams and Stashak's Lameness in Horses, Seventh Edition. Edited by Gary M. Baxter.

Companion website: www.wiley.com/go/baxter/lameness

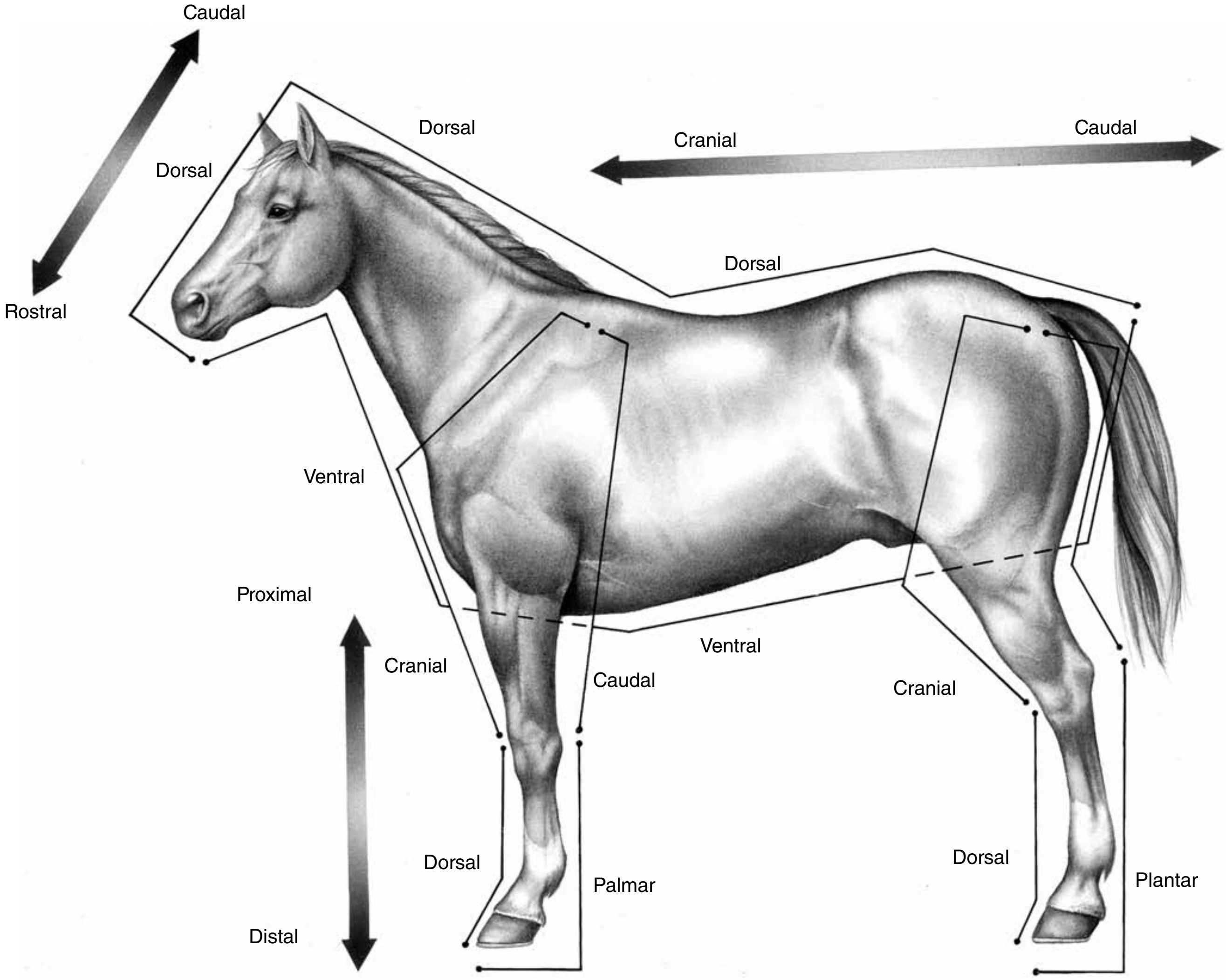

Figure 1.1. Positional and directional terms.

provides sensation, vascular supply, and attachment for the overlying stratified squamous epithelium that constitutes the hoof or ungual epidermis (*L. ungula*, hoof). Regions of the corium are named according to the parts of the hoof under which they are located: perioplic corium, coronary corium, laminar corium, corium of the frog (cuneate corium), and solar corium. Histologically, coronary corium gives rise to elongated, distally directed papillae. Laminar corium forms a series of sheets that interdigitate with epidermal laminae of the stratum internum of the hoof wall. Shorter papillae extend from the perioplic, solar, and cuneate coria.

In the coronary region, the deepest layer (the stratum basale) of the ungual epidermis is a single layer of proliferating keratinocytes lying upon and between long dermal papillae. Cellular division here pushes cells distad into the stratum medium of the hoof wall, forming the epidermis that undergoes cornification.[2] Nearly the entire hoof is composed of a thick layer of anucleate squamous keratinocytes.

For the most part, the keratinaceous tissues of the hoof are devoid of nerve endings; as a consequence it is the "insensitive" part of the foot. However, a few sensory nerve endings from nerves in the corium penetrate between cells of the deepest layer of the epidermis.

Three histological layers comprise the hoof wall: the stratum externum, stratum medium, and stratum internum (Figure 1.5). The superficial stratum externum, commonly called the periople, is a thin layer of horn extending distad from the coronet a variable distance; this thin, soft layer wears from the surface of the hoof wall so that it is present only on the bulbs of the heels and the proximal parts of the hoof wall. The bulk of the wall is the stratum medium consisting of cornified horn.[2] The stratum internum comprises the epidermal laminae.

Distal to the coronary sulcus (Figure 1.4), about 600 primary epidermal laminae of the stratum internum interleave with the primary dermal laminae of the laminar corium (Figures 1.6 and 1.7). Approximately 100 microscopic secondary laminae branch at an angle from each primary lamina, further binding the hoof and corium together (Figures 1.3–1.6). The epidermal laminae are routinely referred to as "insensitive," whereas the dermal laminae are called "sensitive." In the strictest sense, though, only the *keratinized* parts of the primary epidermal laminae are insensitive; the deepest layer of

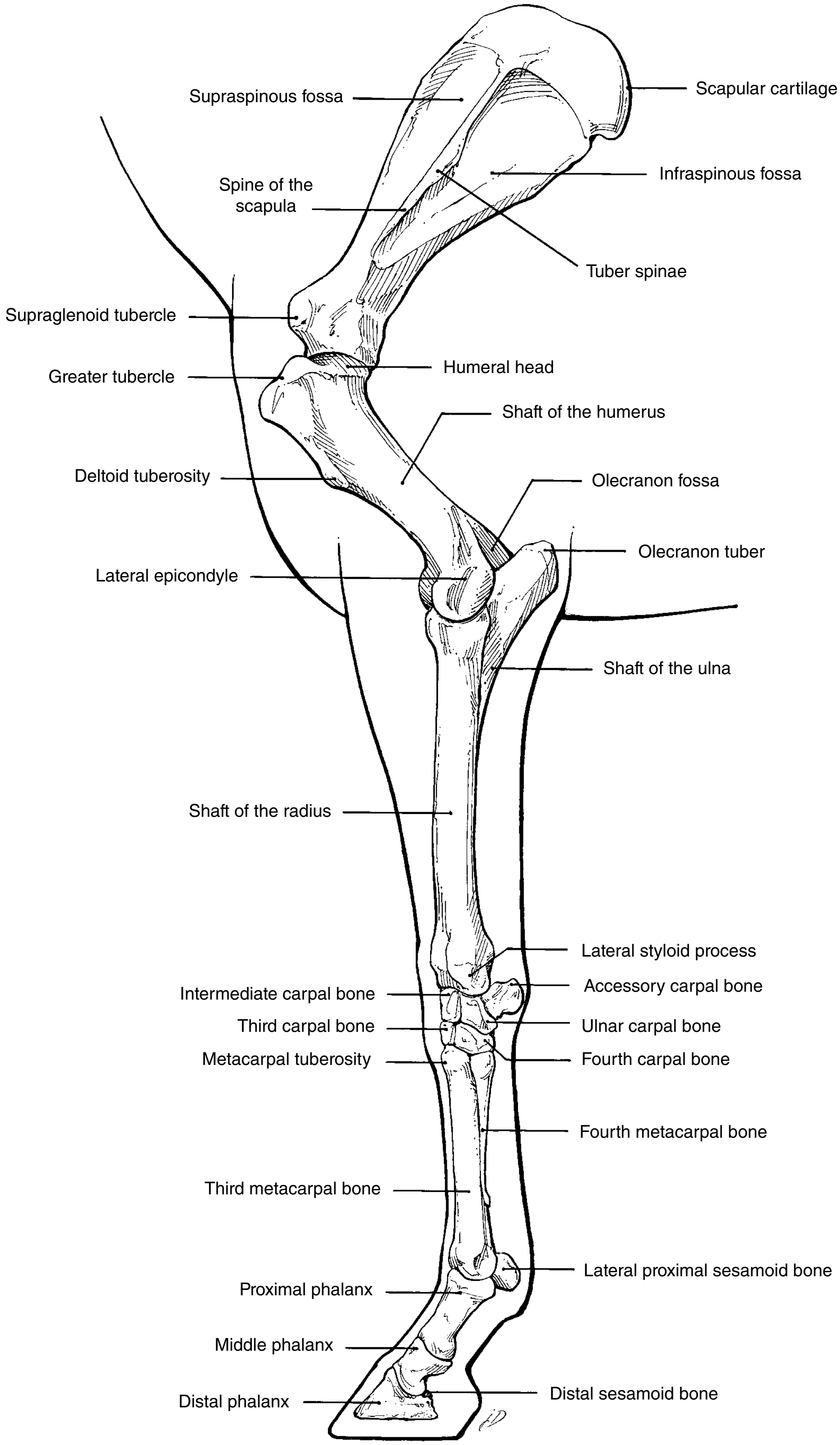

Figure 1.2. Bones of the left equine thoracic limb. Lateral view.

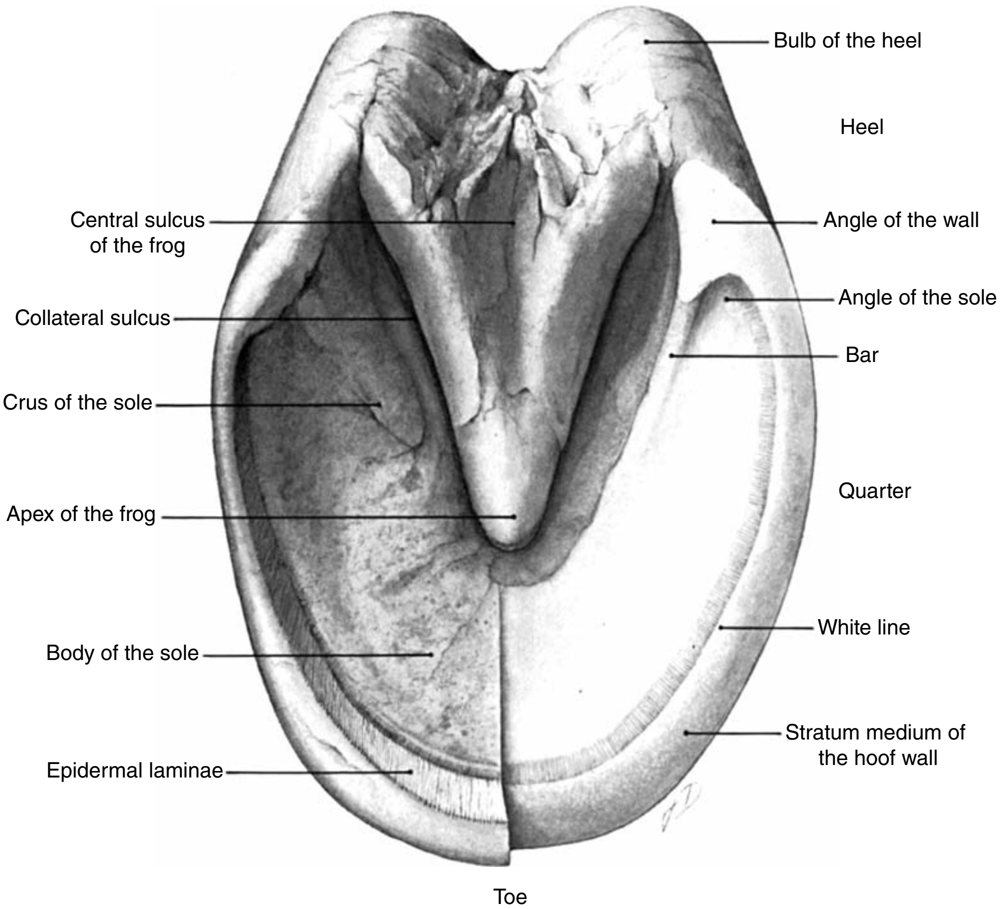

Figure 1.3. Topography of the solar surface of the hoof. The right half has been trimmed to emphasize the region of the white line.

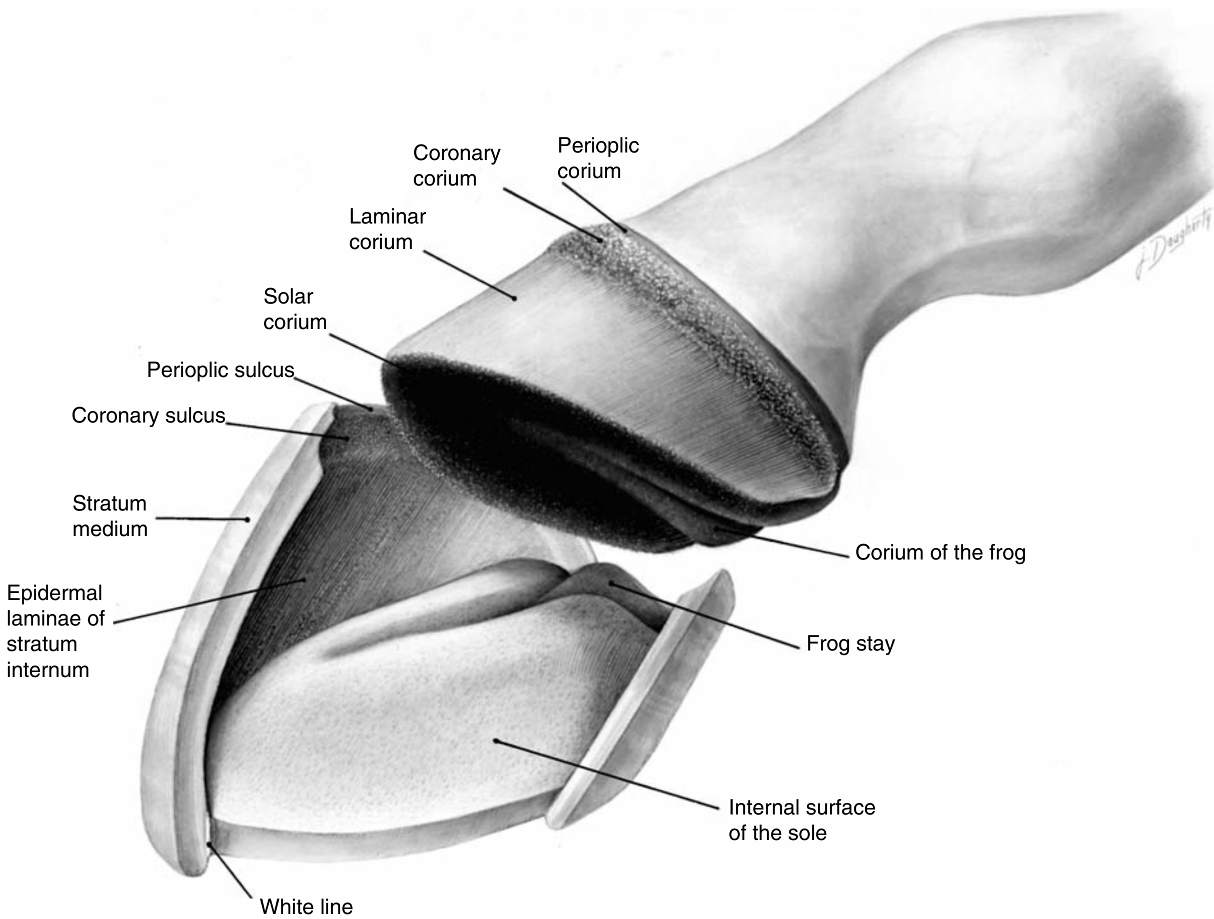

Figure 1.4. Dissected view of relationships of the hoof to underlying regions of the corium (dermis).

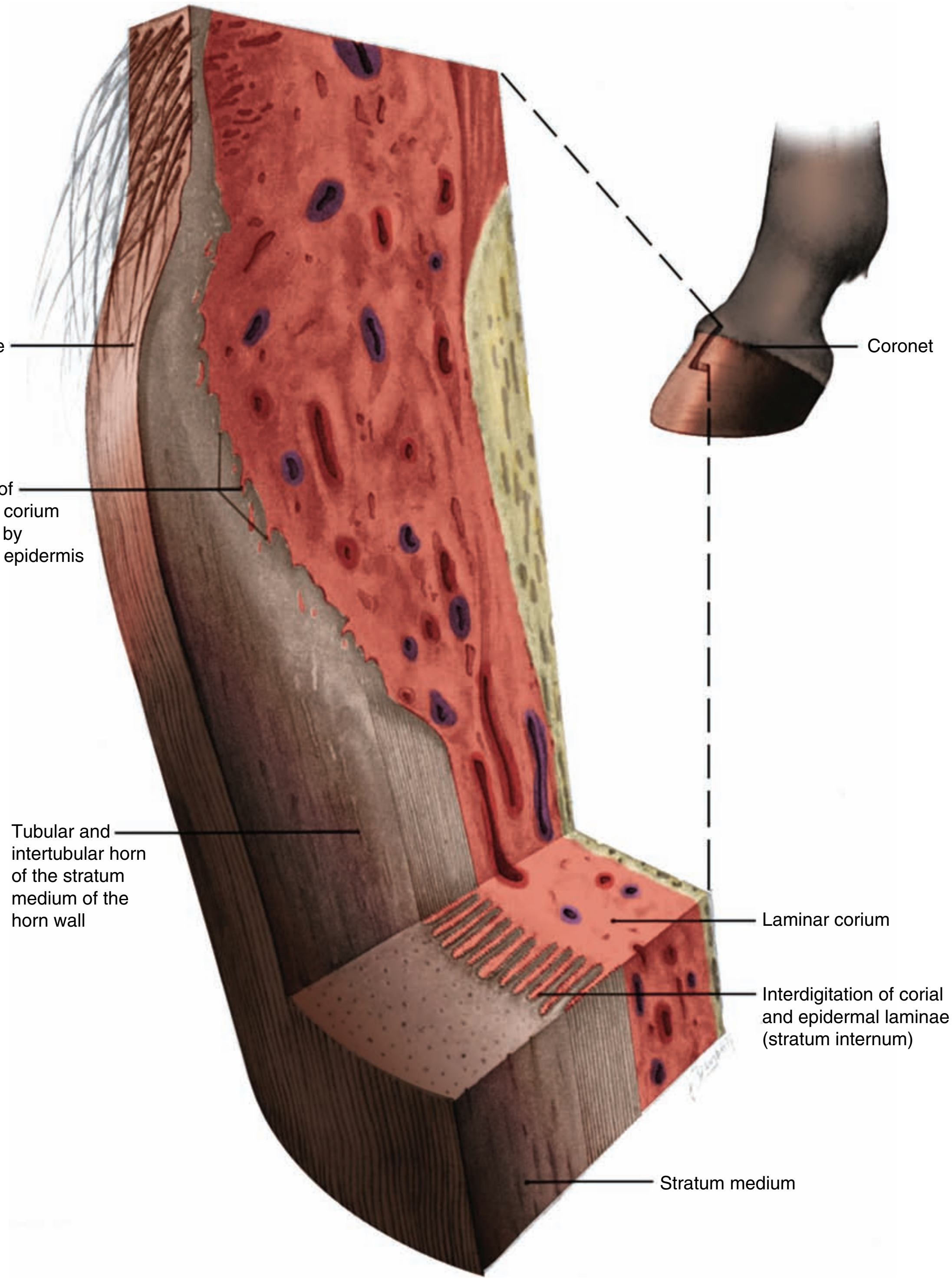

Figure 1.5. Three-dimensional dissection of coronary region of the hoof wall.

the epidermis, the stratum basale, including all of the secondary epidermal laminae, and the laminar corium are both innervated and therefore "sensitive."[42]

Growth of the hoof wall is primarily from the coronary epidermis toward the ground. Trauma or inflammation stimulates greater production of horn. Ultrastructural studies indicate that during growth of the hoof, primary epidermal laminae move past the secondary epidermal laminae by breaking and then reforming desmosomes between the two cell populations.[23] The relationship between the epidermal and dermal laminae plus the blending of the laminar corium with the periosteum of the distal phalanx suspend and support the bone, aiding in the dissipation of concussion and the movement of blood.

The growth of the wall progresses at the rate of approximately 6 mm per month, taking from 9 to

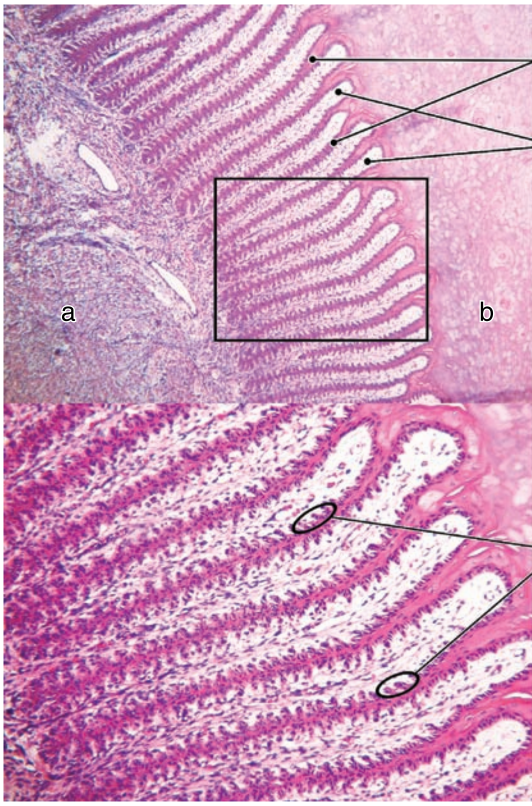

Figure 1.6. Photomicrograph of laminae of the equine hoof. In the top image, a indicates corium; b is the epidermis (hoof wall). Laminae extending from the corium (primary dermal laminae) are the so-called "sensitive laminae." Laminae extending from the epidermal portions of the hoof (primary epidermal laminae) are the "insensitive laminae." The box indicates the region enlarged in the lower image. Here, smaller interdigitating projections, the secondary laminae, can be seen arising perpendicular to the primary laminae.

12 months for hoof generated at the coronary band to reach the ground. The wall grows more slowly in cold and/or dry environments. The hoof wall grows evenly distal to the coronary epidermis so that the youngest portion of the wall in contact with the ground is at the heel (where it is shortest). Because this is the youngest part of the wall, it is also the most elastic, which allows it to accommodate heel expansion during concussion.

Stratum medium may be pigmented or nonpigmented. Contrary to popular belief, there is no difference in the stress–strain behavior or strength properties of pigmented versus nonpigmented equine hooves.[21] It has also been demonstrated that pigmentation has no effect on fracture toughness of hoof keratin.[3] On the other hand, water content of the hoof significantly affects its mechanical properties. In the natural hydration gradient in the hoof wall, the moisture content decreases from deep to superficial.[21] Very dry or extremely hydrated hoof wall is more likely to crack than normally hydrated hoof wall. A normally hydrated hoof is better able to absorb energy without mechanical failure.[4]

The slightly concave sole does not normally bear weight on its ground surface except near its junction with the white line, but it bears internal weight transmitted from the distal phalanx through the solar corium. In the unworn, untrimmed hoof wall, insensitive laminae can be seen on the internal surface of the wall where it makes contact with the ground (Figure 1.3). When the hoof is trimmed, the white line where the wall meets the sole is more clearly discerned. The sensitive corium is immediately internal to the white line that serves as a landmark for determining the proper position and angle for driving horseshoe nails.[14]

The frog (cuneus ungulae) is a wedge-shaped mass of keratinized stratified squamous epithelium made softer than other parts of the hoof by its greater water content.[21] Apocrine glands, spherical masses of tubules in the corium of the frog, deliver secretions to the surface of the frog.[25] The ground surface of the frog presents a pointed apex and central sulcus bordered by two crura. Paracuneal (collateral) sulci separate the crura of the frog from the bars and the sole. The palmar aspect of the frog blends into the bulbs of the heels. Compression of the frog during weight-bearing is transferred to the fibrofatty digital cushion deep to the heels; this force assists with movement of venous blood from the interior of the hoof capsule to the veins of the distal limb.

The corium blends with the periosteum of the distal phalanx, serving (particularly in the laminar region) to connect the hoof to the bone. The corium, the hoof's homolog to the dermis of skin, is composed of dense white fibrous connective tissue that is rich in elastic fibers, highly vascular, and well supplied with nerves. Corial arterial supply derives from numerous branches radiating outward from the terminal arch in small canals extending from the solar canal in the distal phalanx and from the dorsal and palmar branches of the distal phalanx, themselves branches of the digital arteries (Figure 1.8).

The coronary and perioplic coria and the stratum basale of the coronary and perioplic epidermis constitute

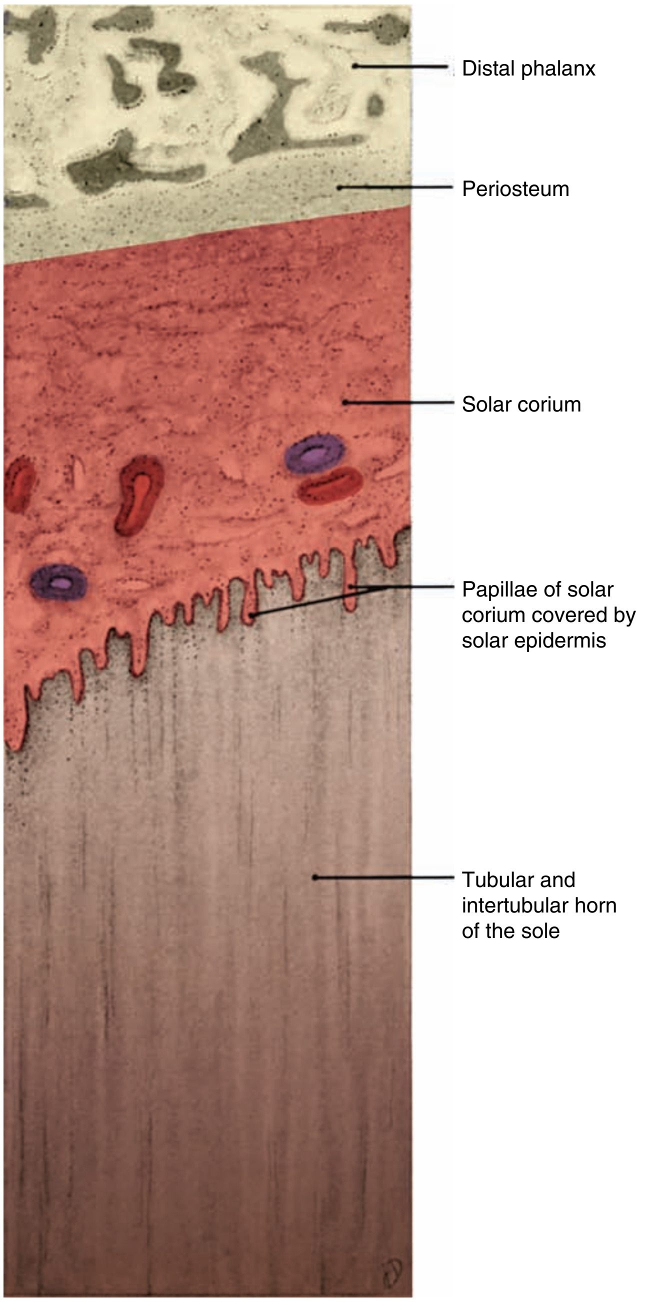

Figure 1.7. Histological relationships of periosteum, corium, and horn of the sole.

the coronary band (Figure 1.5). Deep to the coronary band, the subcutis is modified into the highly elastic coronary cushion. The coronary band and cushion form the bulging mass that fits into the coronary sulcus of the hoof (Figure 1.4). Part of the coronary venous plexus is within the coronary cushion. The plexus receives blood from the dorsal venous plexus in the laminar corium.

Internal Structures of the Foot

The "collateral" cartilages of the distal phalanx (often "lateral cartilages"; most correctly ungual cartilages) lie deep to the hoof and the skin, covered on their abaxial surfaces by the coronary venous plexus. They extend from each palmar process of the bone and project proximad to the coronary band of the hoof where they may be palpated (Figure 1.9). The cartilages are concave on their axial surfaces, convex on their abaxial surfaces, and thicker distally where they attach to the bone. Each cartilage is perforated in its palmar half by several foramina for the passage of veins connecting the palmar venous plexus with the coronary venous plexus.

Five ligaments stabilize each ungual cartilage (Figure 1.9):

1. A short, prominent ligament extends from the dorsal surface of the middle phalanx to the dorsal part of the cartilage.
2. A poorly defined elastic band extends from the side of the proximal phalanx to the proximal border of the cartilage and also detaches a branch to the digital cushion.
3. Several short fibers attach the distal part of the cartilage to the distal phalanx.
4. A ligament extends from the dorsal aspect of the cartilage to the termination of the tendon of insertion of the common digital extensor muscle. The dorsal part of each cartilage also serves as part of the distal attachment for the respective collateral ligament of the coffin joint.
5. An extension of the collateral sesamoidean ligament (CSL) attaches the end of the navicular bone to the cartilage of the distal phalanx.

Between the cartilages on the palmar side of the foot is the digital cushion, a highly modified subcutis consisting of a meshwork of collagen, elastic fibers, adipose tissue, and small masses of fibrocartilage (Figure 1.10). Only a few blood vessels ramify in the digital cushion. Dorsoproximally the digital cushion connects with the distal digital annular ligament. The apex of the wedge-shaped digital cushion is attached to the deep digital flexor tendon (DDFT) as the latter inserts on the solar surface of the distal phalanx. The base of the digital cushion bulges into the bulbs of the heels. The digital cushion serves an anticoncussive function.

As the DDFT courses to its insertion on the distal phalanx, it is bound down by the distal digital annular ligament, a sheet of deep fascia supporting the terminal part of the tendon and sweeping proximad to attach on each side of the proximal phalanx (Figure 1.11). The tendon passes over a complementary fibrocartilaginous plate on the proximal extremity of the palmar surface of the middle phalanx; this is the middle scutum (*L. shield*), which provides a smooth gliding surface for the tendon. Then the tendon gives off two small secondary attachments to the distopalmar surface of the second phalanx; these are part of the so-called T ligament (Figures 1.10 and 1.12).

Continuing toward its primary attachment on the flexor surface of the distal phalanx, the DDFT passes over the navicular (podotrochlear) bursa, interposed between the tendon and the fibrocartilaginous distal scutum covering the flexor surface of the navicular bone. From the exterior of the foot, the navicular bursa lies deep to the approximate middle third of the frog on a plane parallel to the coronet over the quarters of the hoof wall.

The proximal border of the navicular bone (distal sesamoid bone) possesses a groove containing foramina for the passage of small vessels and nerves. The distal border of the bone has a small, elongated facet that

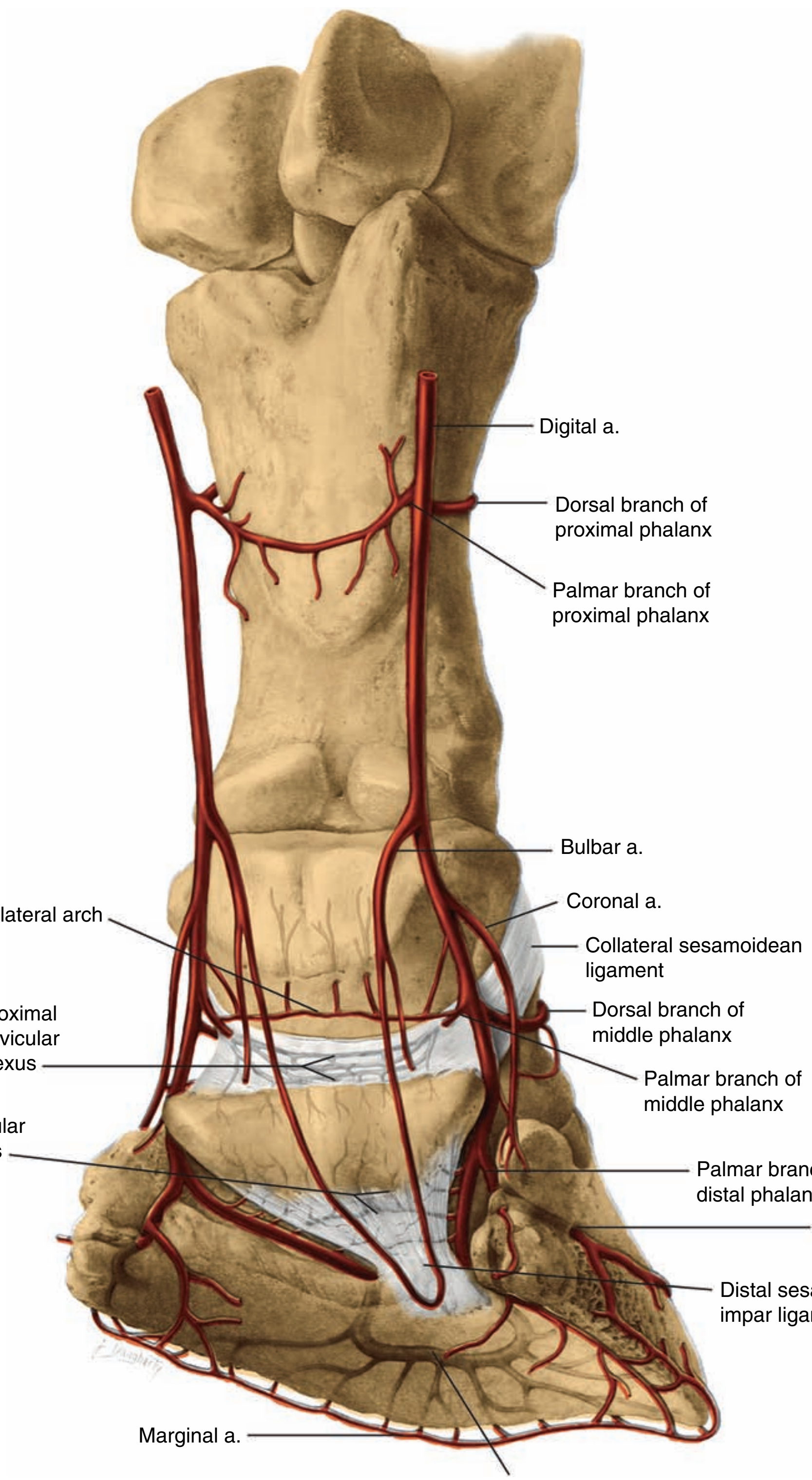

Figure 1.8. Arterial supply to the digit of the forelimb.

articulates with the distal phalanx. Several large, irregular fossae lie in an elongated depression palmar to that facet (Figure 1.13). The main articular surface of the navicular bone contacts the middle phalanx.

The navicular bone is supported in its position by three ligaments comprising the navicular suspensory apparatus. Medial and lateral collateral sesamoidean (suspensory navicular) ligaments arise from the distal end of the proximal phalanx (Figure 1.12). These sweep obliquely distad, each ligament crossing the pastern joint and attaching broadly along the proximal border of the navicular bone. Along this border, each ligament

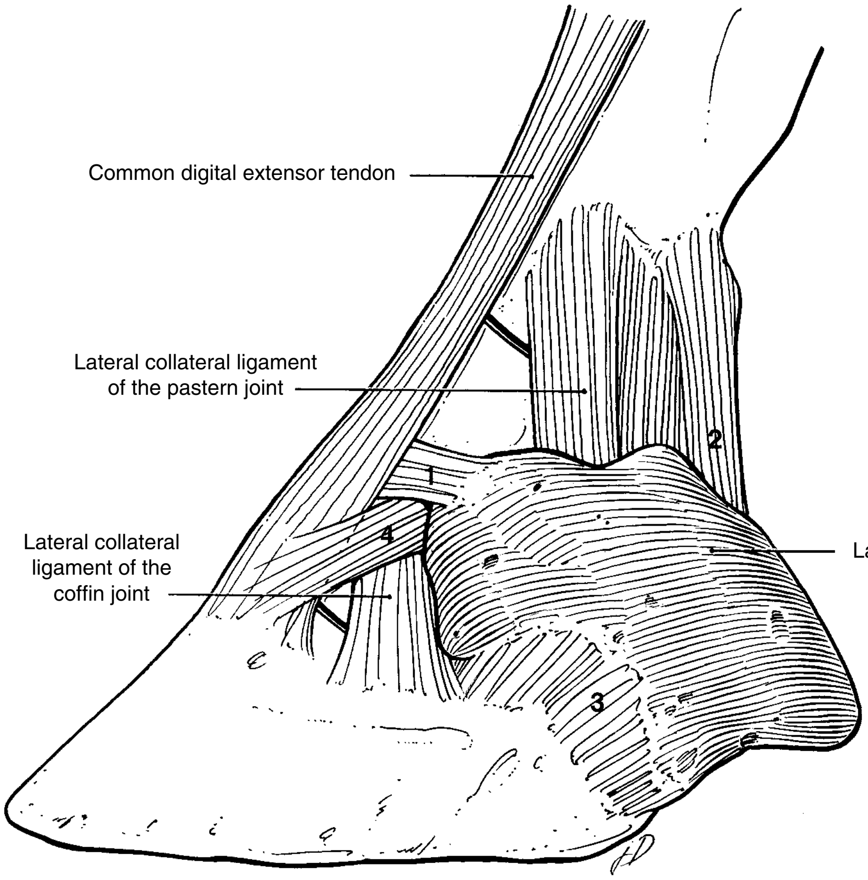

Figure 1.9. Four of the ligaments (1, 2, 3, and 4) that stabilize the cartilage of the distal phalanx. The fifth ligament listed in the text is not depicted as it attaches to the medial aspect of the cartilage.

meets and blends with its contralateral partner. This attachment on the proximal border is joined by branches from the deep digital flexor; together, these constitute the "T ligament" that attaches to the palmar surface of the middle phalanx. Fibers of the CSLs also attach the end of the navicular bone to the palmar process and cartilage of the distal phalanx.

Distally, the navicular bone is stabilized by the distal sesamoidean impar ligament, extending from the distal border of the bone to intersect with the insertion of the DDFT (arrow, Figure 1.10).[6]

The distal articular surface of the middle phalanx, the articular surface of the distal phalanx, and the two articular surfaces of the navicular bone form the coffin joint, a hinge joint of limited range of motion. Short collateral ligaments arise from the distal end of the middle phalanx, pass distad deep to the cartilages of the distal phalanx, and terminate on either side of the extensor process and the dorsal part of each cartilage.

The synovial membrane of the distal interphalangeal (coffin) joint has a dorsal pouch that extends proximad on the dorsal surface of the middle phalanx deep to the common digital extensor tendon nearly to the pastern joint. The synovium has a complex relationship on its palmar side to the ligaments and tendons that are found here. The proximal portions wrap around the distal ends of the CSLs. The distal pouch forms a thin extension between the articulation of the navicular bone and the distal phalanx. This pouch's synovial membrane surrounds the distal sesamoidean impar ligament on each side where the distal interphalangeal joint is closely associated with the neurovascular bundle that will enter the distal phalanx. Although a direct connection between the distal interphalangeal joint and the navicular bursa is rare, passive diffusion of injected dye and anesthetic occurs.[7]

The common digital extensor tendon terminates on the extensor process of the distal phalanx, receiving first branches from the suspensory ligament at the level of the pastern and then an additional ligament from each ungual cartilage as it inserts (Figure 1.9).

Pastern

Deep to the skin and superficial fascia on the palmar aspect of the pastern, the proximal digital annular ligament covers the superficial digital flexor as it bifurcates. In this location, it binds down both digital flexor tendons.

Two distinct ligaments of the ergot diverge from beneath the horny ergot on the palmar skin of the fetlock. Each ligament descends obliquely just deep to the skin. Distally it widens and blends into the dense connective tissue of the distal digital annular ligament.

The superficial digital flexor tendon (SDFT) terminates by bifurcating into two branches that insert on the

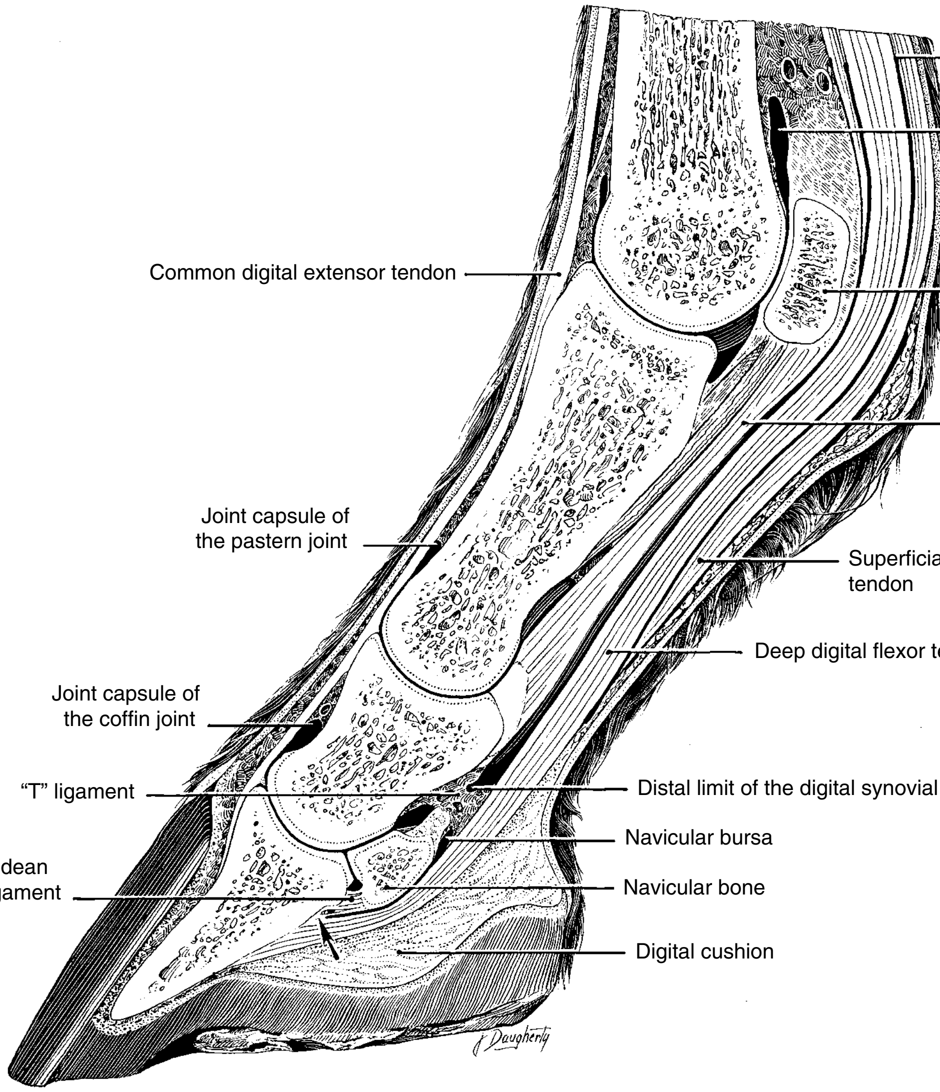

Figure 1.10. Sagittal section of equine fetlock and digit.

proximal extremity of the middle phalanx just palmar to the collateral ligaments of the proximal interphalangeal joint. Traditionally, the insertion of the SDFT has been described as also having additional attachments on the distal extremity of the proximal phalanx; radiographic studies have concluded that these attachments are not strictly part of the flexor tendon and instead represent associated palmar ligaments.[44] The DDFT descends between the two branches of the SDFT. A digital synovial sheath surrounds both tendons and continues in association with the DDFT as far as the "T ligament" (Figures 1.10 and 1.11).

Deep to the digital flexor tendons, a series of ligaments (often collectively referred to as the distal sesamoidean ligaments) extend distad from the bases of the two proximal sesamoid bones (Figure 1.11). These are the functional continuation of the suspensory apparatus into the digit. The most superficial of these is the straight sesamoidean ligament, which attaches primarily to the palmar aspect of the middle phalanx and less robustly to the palmar first phalanx. The wedge-shaped middle (oblique) sesamoidean ligament attaches distally to a rough area on the palmar surface of the proximal phalanx. Deep to these is the pair of cruciate ligaments that cross midline, each attaching distally to the contralateral eminence on the proximal end of the proximal phalanx. Deepest of the distal sesamoidean ligaments are a pair of short sesamoidean ligaments extending from the dorsal aspect of the base of each proximal sesamoid bone to the edge of the articular surface of the proximal phalanx (Figure 1.11).

An extensor branch of the suspensory ligament passes from the abaxial surface of the respective proximal sesamoid bone dorsodistad obliquely across the proximal phalanx to the dorsal surface where each branch blends with the common digital extensor tendon near the distal end of the proximal phalanx. An elongated bursa under each extensor branch is extensive enough to be considered a synovial sheath.[16]

In the dorsal aspect of the pastern, the common digital extensor tendon is attached to the proximal ends of the proximal and middle phalanges on its way to its definitive insertion on the extensor process of the distal phalanx. A bursa often occurs under this tendon near its union with the extensor branches of the suspensory ligament. The tendon of the lateral digital extensor muscle

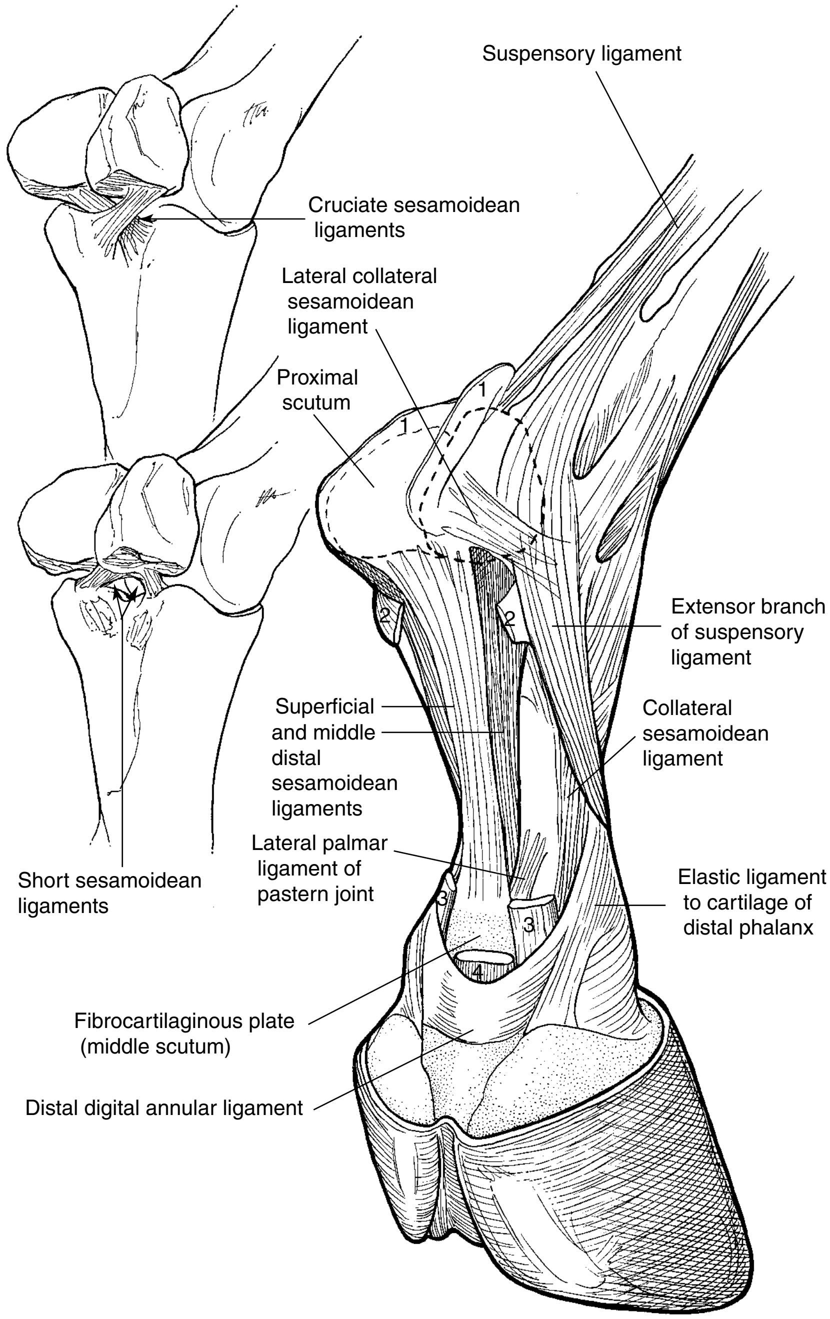

Figure 1.11. Sesamoidean ligaments. Dashed lines indicate positions of the proximal sesamoid bones embedded in the metacarpointersesamoidean ligament. Numbers indicate cut stumps of (1) palmar annular ligament, (2) proximal digital annular ligament, (3) superficial digital flexor, and (4) deep digital flexor tendon.

inserts lateral to the common digital extensor tendon on the proximal dorsal surface of the proximal phalanx.

The proximal interphalangeal (pastern) joint is formed by the condyle on the distal end of the proximal phalanx and two corresponding concave articular foveae on the proximal end of the middle phalanx. Two short collateral ligaments and four palmar ligaments stabilize these bones. The collateral ligaments are oriented vertically between the eminences on the bones rather than parallel to the axis of the digit. The axial pair of palmar ligaments extends from the ridges on the palmar side of the proximal phalanx to the region on each side of the straight sesamoidean ligaments' attachment on the middle phalanx. The abaxial palmar ligaments pass from the lateral aspects of the proximal phalanx to the palmar surface of the middle phalanx. The axial ligaments blend somewhat with the branches of the SDFT and the straight sesamoidean ligament, and they may be difficult to discern as individual entities.

The joint capsule of the pastern joint blends with the deep surface of the common digital extensor tendon dorsally where it is accessible for arthrocentesis (Figure 1.10). It also blends with the collateral ligaments of the joint. The palmar aspect of the capsule extends slightly proximad, compressed between the middle phalanx and the terminal branches of the SDFT and the

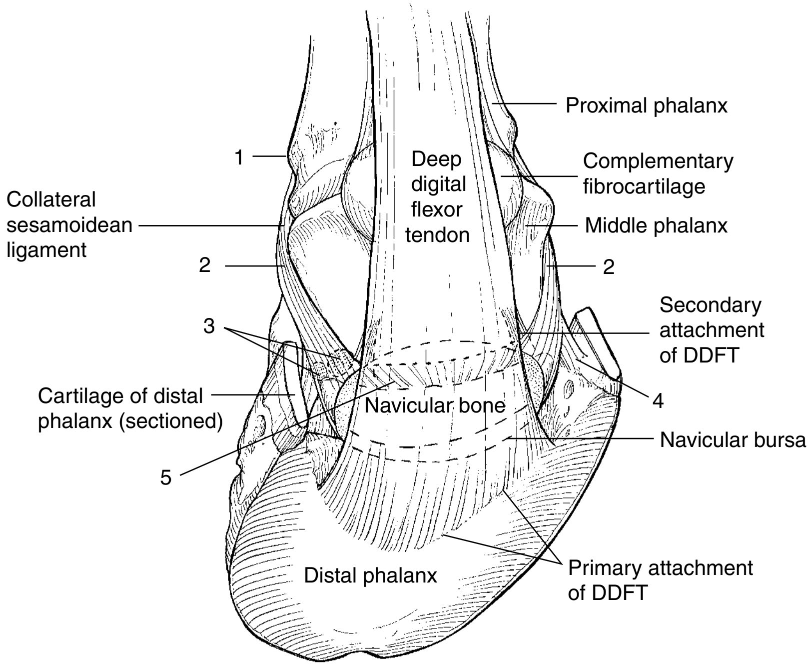

Figure 1.12. Attachments of deep digital flexor tendon and collateral sesamoidean ligaments (CSLs). (1) Attachment of CSL to proximal phalanx, (2) attachment of CSL to middle phalanx, (3) abaxial outpocketings of palmar pouch of the synovial cavity of the distal interphalangeal joint, (4) attachment of CSL to cartilage of the distal phalanx, and (5) attachment of medial and lateral CSLs to navicular bone.

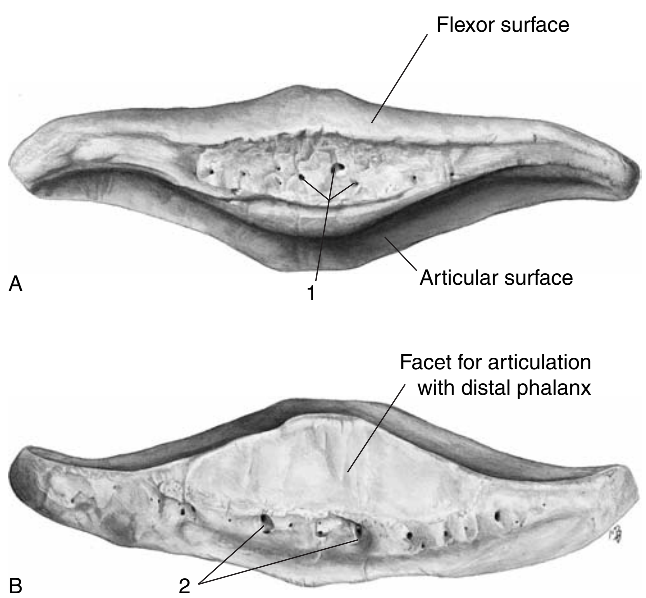

Figure 1.13. Distal sesamoid (navicular) bone. (A) Proximal view. (B) Distal view. (1) Foramina and (2) fossae.

straight sesamoidean ligament. These taut overlying structures subdivide the capsule into medial and lateral pouches that are accessible for arthrocentesis.

Fetlock

The fetlock of the thoracic limb is the region around the metacarpophalangeal (fetlock) joint. On the palmar aspect of the fetlock, the ergot is a prominent cutaneous feature. Its dermal base gives origin to the two distally diverging ligaments of the ergot. Deep to the skin and superficial fascia, the palmar annular ligament of the fetlock encircles the digital flexor tendons and their digital synovial sheath, binding them in the groove between the proximal sesamoid bones. Distally, the palmar annular ligament of the fetlock blends with the proximal digital annular ligament.

The fetlock joint is formed by the distal end of the third metacarpal bone (the cannon bone), the proximal end of the proximal phalanx, the two proximal sesamoid bones, and the extensive fibrocartilaginous palmar ligament that the proximal sesamoids are embedded. The articular surface on the third metacarpal bone, its trochlea, is sharply divided by a sagittal ridge, and this ridge fits into a complementary sagittal groove in the articular surface of the proximal phalanx.

Collateral ligaments of the fetlock joint extend distad from the eminence and depression on each side of the distal cannon bone. The superficial part of each ligament attaches to the edge of the articular surface of the proximal phalanx; the shorter, stouter deep part of the ligament attaches to the abaxial surface of the adjacent proximal sesamoid and the proximal phalanx.

The smooth depression between the proximal sesamoid bones through which the digital flexor tendons pass is formed by the fibrocartilage of the palmar ligament that covers the flexor surfaces of the proximal sesamoid bones. Immediately distal to the canal formed by the encircling annular ligament and the groove between the proximal sesamoids, the DDFT perforates through a ringlike opening in the SDFT, the manica flexoria.

The common and lateral digital extensor tendons pass over the dorsal aspect of the fetlock joint where a bursa lies deep to each tendon. Small but common subcutaneous bursae may occur on the palmar surface of the fetlock joint and on the lateral aspect of the joint just proximal to the extensor branch of the suspensory ligament.[30]

The palmar part of the fetlock joint capsule is thicker and more voluminous than the dorsal part. A consistent bursa deep to the digital flexor tendons at the distal end of the cannon bone lies against the thickened capsule and may communicate with the joint cavity.[16] The palmar recess (pouch) of the fetlock joint capsule extends proximad between the cannon bone and the suspensory ligament. This pouch is palpable and even visible in the presence of joint effusion.

Support for the fetlock and stabilization during weight-bearing and locomotion is rendered by the suspensory apparatus, a part of the stay apparatus. The suspensory apparatus of the fetlock comprises the suspensory ligament (interosseus medius muscle) and its extensor branches to the common digital extensor tendon, the proximal sesamoids embedded in the palmar ligament, and the distal sesamoidean ligaments extending from the bases of the proximal sesamoid bones to the proximal and middle phalanges.

Blood Vessels of the Digit and Fetlock

Arterial Supply

The arterial supply to the digit and fetlock of the thoracic limb is derived principally from the medial palmar artery. This substantial vessel divides in the distal fourth of the metacarpus between the digital flexor tendons and the suspensory ligament into the medial and lateral digital arteries. An anastomotic branch from the distal deep palmar arch unites with the lateral digital artery to form the superficial palmar arch. Branches from this arch directly supply the fetlock joint (Figure 1.8).

Each digital artery becomes superficial on the fetlock. The artery lies palmar to its satellite vein, running between the palmar digital nerve and its dorsal branch (Figures 1.14 and 1.15). As each digital artery courses distad over the fetlock, it gives off branches to the fetlock joint, digital extensor and flexor tendons, digital synovial sheath, ligaments, fascia, and skin.

Distal to the fetlock, the digital arteries run parallel with the borders of the DDFT, giving off branches that create encircling anastomoses around the proximal and middle phalanges. The anastomosis associated with the proximal phalanx is created from dorsal and palmar branches of the proximal phalanx that encircle the digit (Figure 1.8). The palmar branch joins the contralateral vessel between the straight and oblique sesamoidean ligaments. The dorsal branch anastomoses with the contralateral vessel deep to the common digital extensor tendon.

At the level of the middle phalanx, dorsal and palmar branches again arise. The dorsal branch of the middle phalanx anastomoses with the contralateral branch deep to the common digital extensor tendon to form a coronary arterial circle. This vascular complex supplies branches to the distal interphalangeal joint, common digital extensor tendon, perioplic and coronary coria, fascia, and skin. The palmar branches of the middle phalanx run parallel to the proximal border of the distal sesamoid bone, uniting to complete the arterial circle around the middle phalanx. Branches from the palmar portion of the arterial circle supply an anastomotic proximal navicular plexus; this gives rise to several small arteries that enter the foramina along the proximal border of the navicular bone.[9,18] The bone receives approximately one-third of its blood supply from this plexus.

Immediately distal to the distal sesamoid bone, each digital artery gives off one to three small arteries that supply the distolateral border of the navicular bone. The digital arteries further give rise to branches that form a distal navicular plexus within the distal sesamoid impar ligament. Six to nine distal navicular arteries from the plexus enter the distal sesamoid bone through the distal border. These supply the distal two-thirds of the distal sesamoid bone.[18]

Near the level of the pastern joint, a prominent bulbar artery (artery of the digital cushion) arises from each digital artery (Figure 1.8). Their branches supply the frog, the digital cushion, palmar part of the cuneate corium, laminar corium of the heel and bar, and palmar parts of the perioplic and coronary coria. A small coronal artery arises from either the digital artery or the bulbar artery, and its branches supply the heel and perioplic corium.

Within the foot opposite each end of the navicular bone, an artery to the dermal laminae of the heel arising from the digital artery has been noted on radiographic angiograms.[10,18] At the level of the palmar process of the distal phalanx, the digital artery gives off the dorsal branch of the distal phalanx and then continues distad to form the terminal arch within the distal phalanx. The dorsal branch of the distal phalanx gives off a small artery supplying the digital cushion and corium of the frog and then passes through a notch or foramen in the palmar process. Emerging onto the dorsal side of the distal phalanx, the dorsal branch of the distal phalanx bifurcates. One branch supplies the corium of the heels and quarters; the other courses dorsad in a bony sulcus to supply the corium of the toe and to form anastomoses with other arteries on the distal phalanx (Figure 1.8).

The continuation of the digital artery enters a solar foramen and anastomoses with the contralateral artery to form the terminal arch within the solar canal (Figure 1.8). Branches from the terminal arch course through the bone, 4 or 5 of them emerging through foramina on the parietal surface to supply the proximal part of the laminar corium; another 8–10 vessels emerge through foramina near the solar border of the bone and anastomose to form the prominent marginal artery of the sole. This artery supplies the solar and cuneate coria.

The arterial network of the corium can be divided into three regions with independent blood supplies: (1) the dorsal coronary corium, (2) the palmar part of the coronary corium and laminar corium, and (3) the dorsal laminar corium and solar corium.[32] Other regions are supplied by multiple other small arteries. Angiographic studies indicate that blood flow within dermal laminae is from distal to proximal.[10,32]

Branches of the digital arteries in the hindfoot are essentially the same as in the forefoot except for the blood supply to the distal sesamoid bone. In 50% of hindfeet examined in a definitive study, the collateral arch from the plantar branches of the middle phalanx supplied the primary arteries to the proximal navicular network.[18]

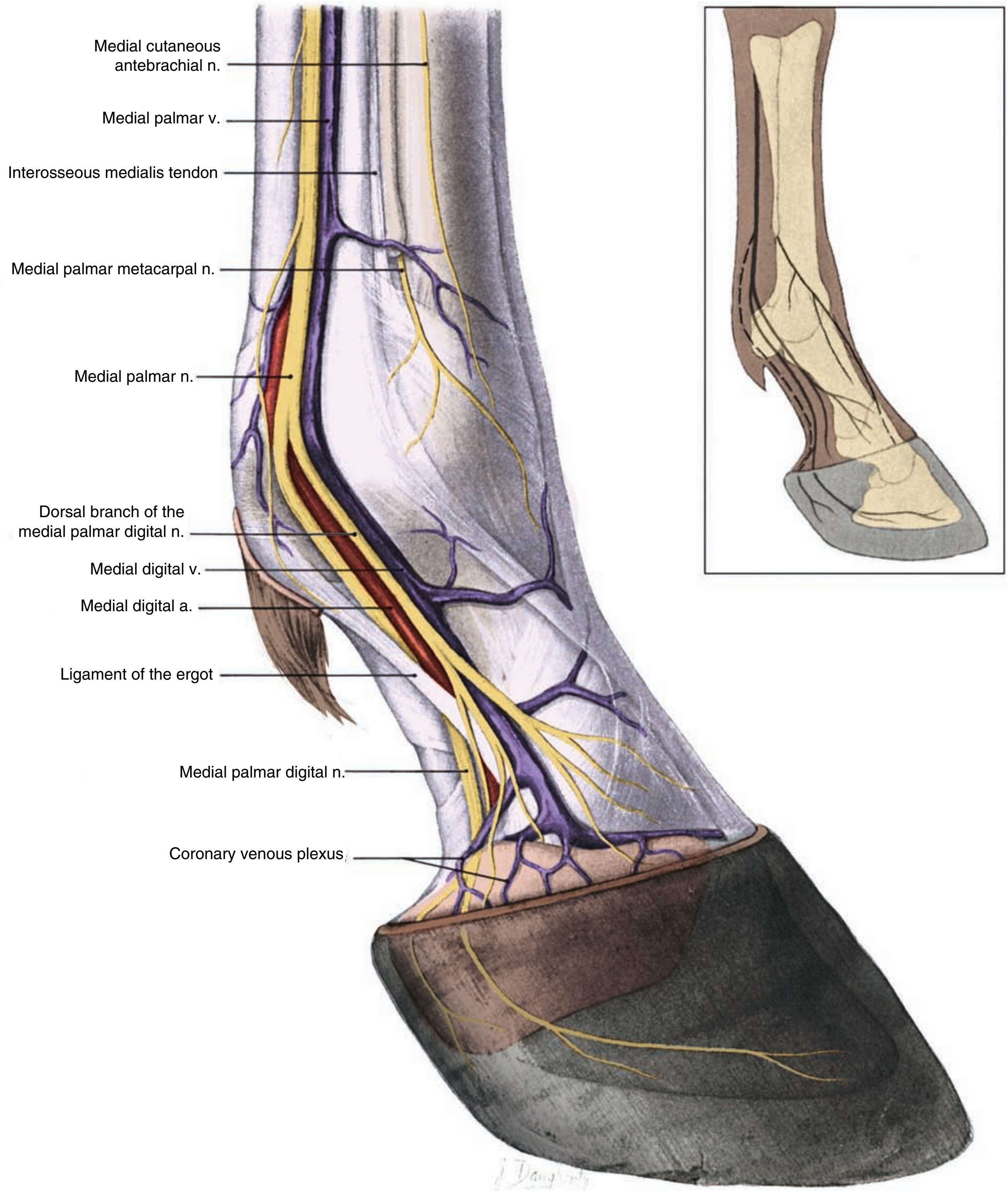

Figure 1.14. Medial aspect of distal metacarpus, fetlock, and digit with skin and superficial fascia removed. Inset: Schematic of the distribution of major nerves; dashed lines indicate variant branches.

Venous Drainage

Venous drainage from the laminar corium begins with veins from the laminar circulation continuing into the parietal (associated with the hoof wall) venous plexus and the coronary venous plexus (Figure 1.16). Veins from the perioplic and coronary coria drain toward the coronary venous plexus, and those from the solar and cuneate coria drain into the solar venous plexus.[26]

Veins in the solar canal come together at the level of the distal sesamoid bone to form the medial and lateral

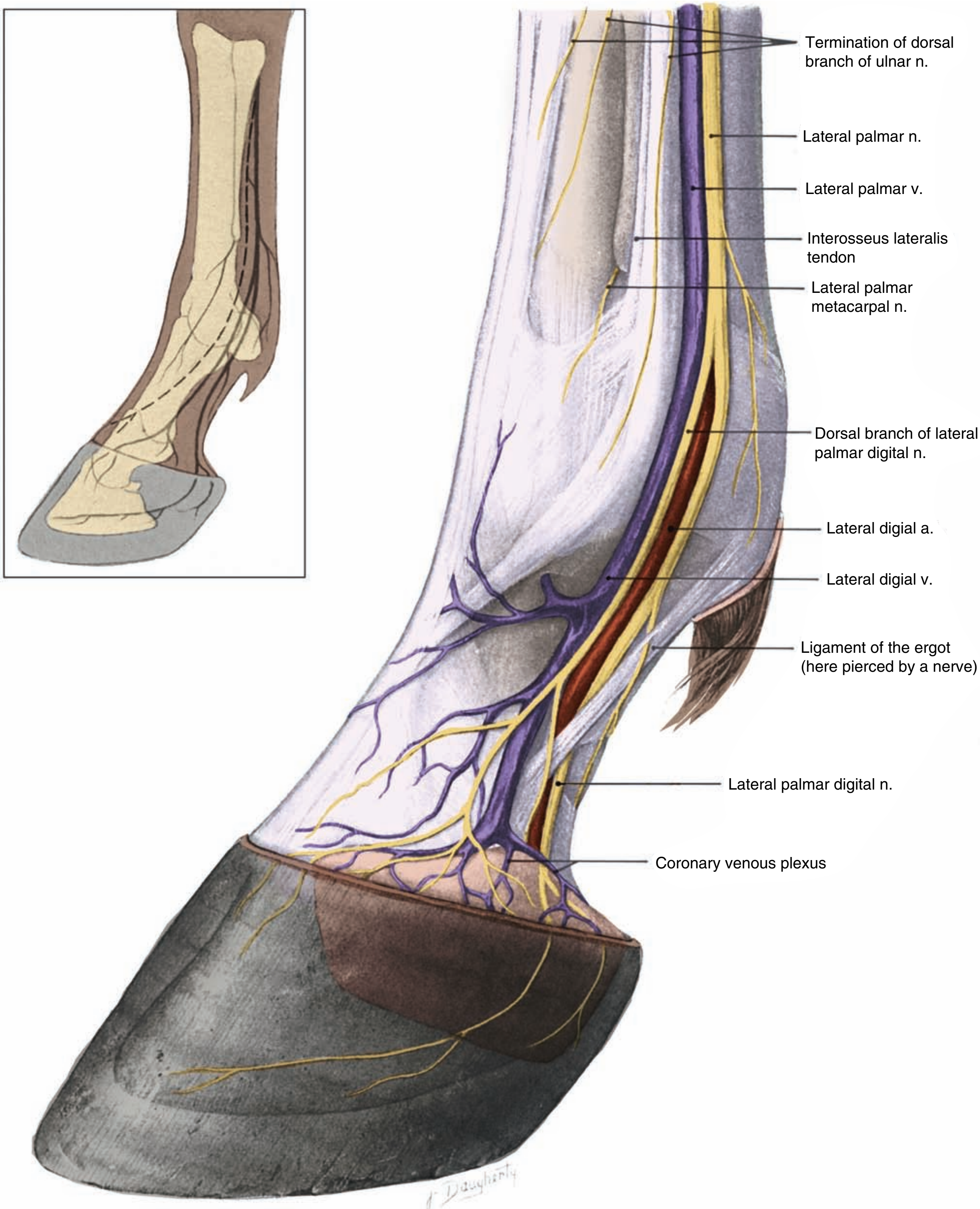

Figure 1.15. Lateral aspect of distal metacarpus, fetlock, and digit with skin and superficial fascia removed. Inset: Schematic of the distribution of major nerves; dashed lines indicate variant branches.

terminal veins. Each terminal vein joins with branches of an inner venous plexus to form a digital vein. The digital vein receives branches from the distal sesamoid bone, coronary vein, inner venous plexus, and large bulbar vein carrying blood from the heel. Most venous blood in the foot is drained by the veins located in the palmar aspect which are largely valveless. Some valves are present in the tributaries of the coronary and subcoronary

Figure 1.16. Venogram of equine foot. *Source*: Photo courtesy of Dr. Andrew Lewis.

veins and in the bulbar veins and their branches. Thus, the flow of blood may take different routes with the weight-bearing force essential to its proximal flow.[26]

Nerves of the Digit and Fetlock

As they descend to the fetlock, the medial and lateral palmar nerves supply small branches to the fetlock and flexor tendons. Each then gives off a dorsal branch at this level, continuing over the widest part of the joint as the medial and lateral palmar digital nerves (Figures 1.14 and 1.15). The corresponding digital artery lies between this dorsal branch and the palmar digital nerve. The dorsal branch courses distad between the digital vein and artery, branching midway down the pastern. In approximately one-third of the cases, an intermediate branch also arises from the dorsal aspect of the palmar digital nerve.[29] The dorsal (and intermediate, when present) branches supply sensory and vasomotor innervation to the dorsal part of the fetlock joint, dorsal parts of the interphalangeal joints, coronary corium and dorsal parts of the laminar and solar coria, and dorsal part of the cartilage of the distal phalanx.[5,12]

The main continuation of the palmar digital nerve descends palmar and parallel to the digital artery. The nerve and artery are deep to the ligament of the ergot as the latter descends obliquely across the lateral aspect of the pastern. A branch may arise from the lateral palmar digital nerve and perforate the lateral ligament of the ergot (Figure 1.15).

The palmar digital nerves supply the palmar parts of the fetlock joint capsule and of the digit: skin, pastern joint capsule, digital synovial sheath and flexor tendons, distal sesamoidean ligaments, coffin joint capsule, navicular bone and its ligaments, navicular bursa, palmar part of the cartilage of the distal phalanx, part of the laminar corium, coria of the sole and frog, and digital cushion.

A fine terminal branch of each palmar digital nerve and an accompanying small artery constitute a neurovascular bundle that descends adjacent to the synovial membrane of the distal interphalangeal joint to enter the distal phalanx.[5]

Additional cutaneous innervation of the fetlock is supplied by terminal branches of the medial cutaneous antebrachial nerve dorsomedially and the dorsal branch of the ulnar nerve dorsolaterally. Medial and lateral palmar metacarpal nerves emerge immediately distal to the distal end of the respective small metacarpal (splint) bone, supplying branches to the fetlock joint capsule and ramifying in the superficial fascia of the pastern. It has been reported that in some instances, a terminal branch from the medial palmar metacarpal nerve descends to the coronary band (Figure 1.14).[19,31] An occasional variant, a palmarly directed branch from the medial palmar nerve in the distal metacarpus, courses palmar to the medial palmar digital nerve, reaching the digital cushion (Figure 1.14). Another variant branch may arise from the lateral palmar nerve in the proximal metacarpus, cross over the fetlock, and extend obliquely to the coronary band (Figure 1.15).

Electrophysiologic studies confirm that stimuli on the medial half of the digit and fetlock of the forelimb are mediated by the median nerve and stimuli on the lateral half are mediated by the median and ulnar nerves.[5]

Although direct communication between the distal interphalangeal joint and the navicular bursa is very rare, indirect communication via diffusion of molecules has been demonstrated.[8] Dye injected experimentally into the distal interphalangeal joint diffused into the navicular bursa and also stained the synovial coverings of the CSLs and the distal sesamoidean impar ligament and the medullary cavity of the navicular bone.

Basic Functions of the Digit and Fetlock

In the standing position, the fetlock and digit are prevented from nonphysiologic hyperextension by the suspensory apparatus of the fetlock (interosseus muscle [suspensory ligament], palmar ligament and proximal sesamoids, and distal sesamoidean ligaments), digital flexor tendons, and collateral ligaments of the joints.

During flexion and extension of the digit, most of the movement comes from the fetlock joint. The least amount of movement is in the pastern joint, and movement in the coffin joint is intermediate. Although the pastern joint is a hinge joint, normally providing only limited flexion and extension, manipulation can produce transverse movement and some rotation when the joint is flexed.

When the unshod hoof contacts the ground, the heels usually strike first, followed in sequence by the ground surfaces of the quarters and toe. Expansion of the heels is facilitated by the elasticity of the hoof wall. Most of the impact is sustained by the hoof wall, and compression of the wall creates tension on the interlocking epidermal and dermal laminae and, hence, to the periosteum of the distal phalanx. The concave sole does not absorb much force although it is depressed somewhat by the downward force of the distal phalanx, causing expansion of the quarters. Descent of the coffin joint occurs as the navicular bone moves in a distopalmar direction, stretching its collateral (suspensory) and impar ligaments and pushing against the navicular bursa and tendon of the deep digital flexor muscle. Forces acting on the distal phalanx are indicated in Figure 1.17. Magnitude and direction of the forces may change with limb position and loading state.[22] Concussion is further dissipated by pressure from the frog being transmitted to the digital cushion and the cartilages of the distal phalanx.

Lateral expansion of the hoof and cartilages of the distal phalanx compresses the venous plexuses of the foot, forcing blood proximad into the digital veins. The hydraulic shock absorption afforded by the blood within the vessels augments the direct cushioning by the frog and digital cushion and the elasticity of the hoof wall.

During concussion, the palmar ligaments of the pastern joint, the straight sesamoidean ligament, and the tendon of the deep digital flexor provide the tension necessary to prevent overextension of the pastern joint. Contraction of the superficial digital flexor muscle tightens its insertions on the middle phalanx, preventing the pastern joint from buckling.

The suspensory apparatus of the fetlock and the digital flexor tendons ensure that overextension of the fetlock joint is minimized when the hoof strikes the ground. Under extreme loading conditions (e.g. at a gallop or when landing a jump), the palmar aspect of the fetlock comes very close to the ground. During this descent of the fetlock, the coffin joint is flexed by the increased tension on the DDFT.

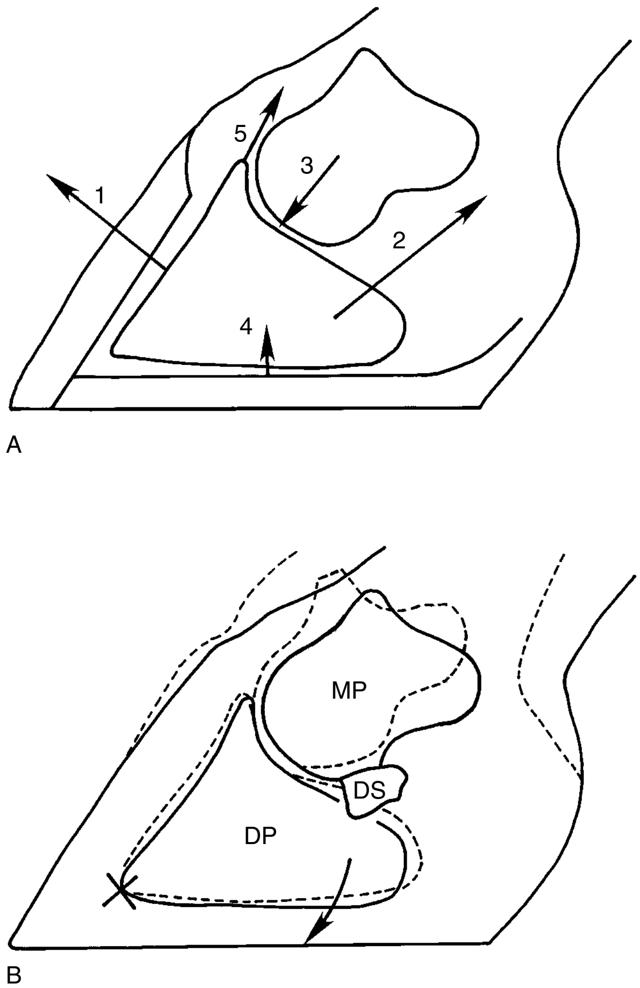

Figure 1.17. (A) Diagram of forces acting on distal phalanx. (1) Forces from laminae of wall, (2) tensile force from deep digital flexor tendon, (3) compressive force from middle phalanx, (4) compressive force from sole, and (5) tensile forces from extensor branches of suspensory ligament and common (long, in pelvic limb) digital extensor tendon. (B) Position changes in middle phalanx (MP), distal phalanx (DP), distal sesamoid (DS), and hoof wall resulting from weight-bearing. X = axis about which the distal phalanx rotates; arrow indicates rotation from unloaded (dotted line) to loaded (solid line) state. *Source*: Redrawn from Leach.[22]

Metacarpus

The equine metacarpus consists of the large third metacarpal (cannon) bone, the second (medial) and fourth (lateral) metacarpal bones (splint bones), and the structures associated with them. The shaft of each splint bone is united to the cannon bone by an interosseous ligament. Length and curvature of the shafts and the prominence of the free distal ends ("buttons") of the splint bones are variable. The proximal ends of the metacarpal bones articulate with the distal row of carpal bones. The second metacarpal articulates with the second and third carpals; the third metacarpal articulates with the second, third, and fourth carpals; and the fourth metacarpal articulates with the fourth carpal bone.

Dorsal Aspect

The structures of the dorsal aspect of the metacarpus receive their blood supply from small medial and lateral dorsal metacarpal arteries. These originate from the network of small arteries on the dorsum of the carpus (dorsal carpal rete) and descend between the cannon bone and the respective medial or lateral splint bone. The medial cutaneous antebrachial nerve (Figures 1.14 and 1.20) and the dorsal branch of the ulnar nerve (Figures 1.18 and 1.21) provide innervation to this region.

Deep to the skin, the common digital extensor tendon inclines laterad as it ascends from its central position at the fetlock across the dorsum of the cannon bone. Just distal to the carpus, the main tendon and the tendon of the much smaller radial head of the muscle run lateral to the extensor carpi radialis tendon on the prominent metacarpal tuberosity of the third metacarpal bone (Figure 1.20). The tendon of the lateral digital extensor muscle is lateral to the common extensor tendon, and the small radial tendon of the latter usually joins the lateral digital extensor tendon (Figure 1.21). Occasionally the radial tendon pursues an independent course to the fetlock. A strong fibrous band from the accessory carpal bone blends with the lateral digital extensor tendon as it angles dorsad in its descent from the carpus.

Medial and Lateral Aspects

The medial palmar vein is the direct continuation of the medial digital vein at the fetlock. In the distal half of the metacarpus, the vein is related palmarly to the medial

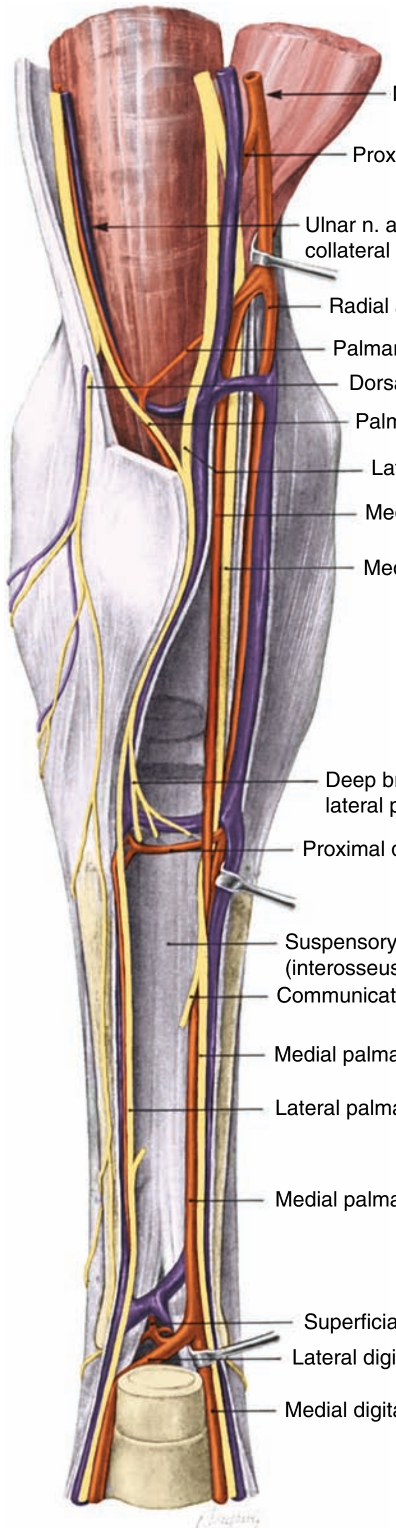

Figure 1.18. Caudal view of left carpus and metacarpus; most of the digital flexor tendons are removed.

palmar nerve (Figure 1.14); in the proximal half, the large medial palmar artery can be seen palmar to the vein (Figure 1.18). A similar relationship exists on the lateral side except that the corresponding lateral palmar artery is generally quite small. The palmar nerves run in the groove between DDFT and suspensory ligament, supplying the digital flexor tendons and the skin superficial to them. At the middle of the metacarpus, the medial palmar nerve detaches a communicating branch that angles distolaterad in the subcutaneous fascia superficial to the flexor tendons to join the lateral palmar nerve. Branches from the dorsal branch of the ulnar nerve ramify in the fascia and skin of the lateral aspect of the metacarpus. Branches from the medial cutaneous antebrachial nerve (itself a branch of the musculocutaneous nerve) supply the medial and dorsal skin of the metacarpus with the large dorsal branch reaching the skin over the dorsomedial aspect of the fetlock.

Palmar Aspect

The SDFT is deep to the skin and subcutaneous fascia throughout the length of the metacarpus. Dorsally, it is intimately related to the DDFT. The latter, in turn, lies against the palmar surface of the suspensory ligament (a.k.a. m. interosseus medius; middle or third interosseous muscle). The carpal synovial sheath, enclosing both digital flexor tendons, extends distad as far as the middle of the metacarpus. At this level, the DDFT is joined by its accessory ligament (carpal check ligament or "inferior" check ligament), a distal continuation of the palmar carpal ligament (Figure 1.32). The medial and lateral lumbricales muscles, fleshy in other species, are reduced in the horse to fibrous slips that originate from either side of the DDFT and insert in the fibrous tissue deep to the ergot. The lumbricales in the pelvic limb tend to be better developed. The digital synovial sheath around the digital flexor tendons is present through the distal fourth of the metacarpus (Figure 1.11).

The metacarpal groove, formed by the palmar surface of the third metacarpal bone and the axial surfaces of the second and fourth metacarpal bones, is occupied by the suspensory ligament. The suspensory ligament arises from the distal row of carpal bones and the proximal end of the third metacarpal bone (Figures 1.18 and 1.19). It is broad, relatively flat, and shorter than the suspensory ligament of the hindlimb. Variable amounts of muscle fibers are seen within the mainly collagenous suspensory ligament primarily in foals, in which these are gradually replaced by collagen with musculoskeletal maturation.[45] In the distal fourth of the metacarpus, the suspensory ligament bifurcates to become associated with the two proximal sesamoid bones. Each branch makes a broad attachment across the abaxial surface of proximal sesamoid bone and blends with the origin of the ipsilateral CSL (Figure 1.12). Two (medial and lateral) vestigial interosseous muscles originate on the heads of the respective splint bones; their slender tendons pass distad alongside the splint bones and end near the buttons by blending into the fascia of the fetlock.

A deep branch of the lateral palmar nerve supplies branches to and then perforates the suspensory ligament, whereupon it divides into the medial and lateral palmar metacarpal nerves. These nerves and their satellite vessels lie in the grooves formed by the cannon bone and the respective splint bones (Figure 1.19). After sending branches to the fetlock joint capsule, each palmar metacarpal nerve emerges distal to the distal extremity

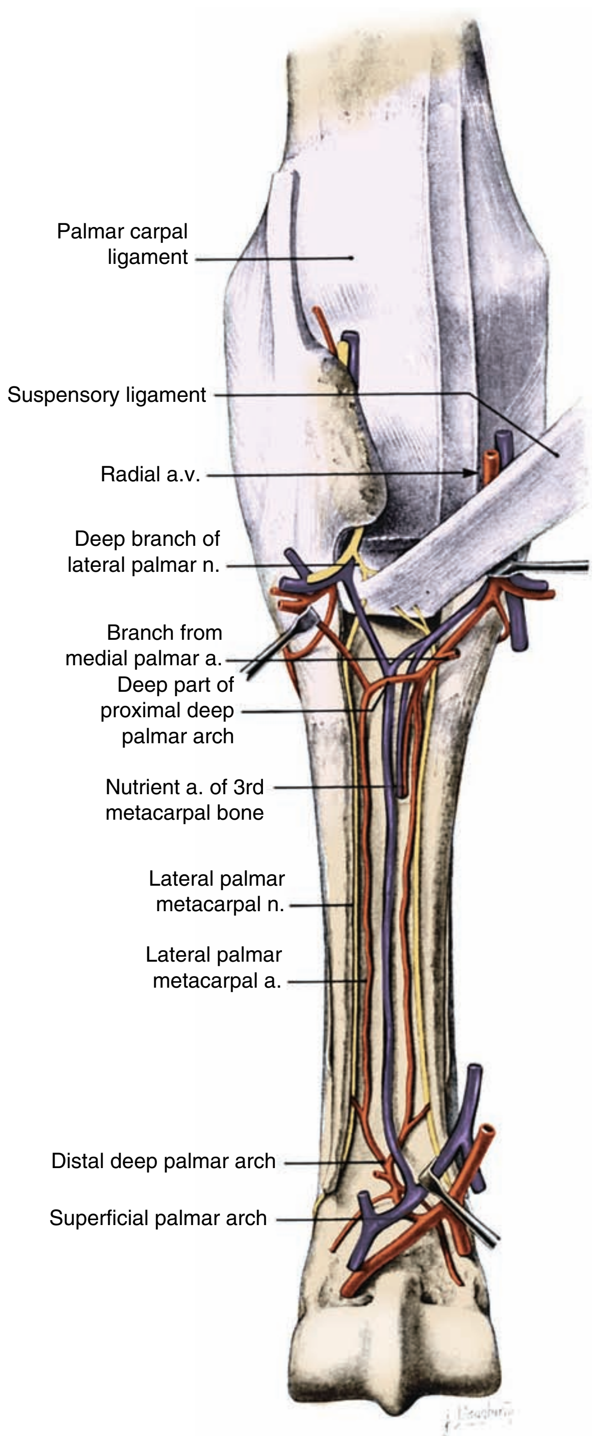

Figure 1.19. Deep dissection of caudal aspects of left carpus and metacarpus with medial palmar artery removed.

(the "button") of the respective splint bone to ramify in skin of the pastern.

The palmar metacarpal arteries originate from the proximal deep palmar arch, an anastomotic complex formed by the termination of the radial artery where it joins the smaller palmar branch of the median artery (Figure 1.19). Part of the arch lies between the carpal check ligament and the suspensory ligament. The medial palmar metacarpal artery supplies a nutrient artery to the third metacarpal bone. Small branches from the palmar metacarpal arteries extend through the interosseous spaces between cannon and splint bones to join the dorsal metacarpal arteries. In the distal fourth of the metacarpus, the palmar metacarpal arteries anastomose to form the distal deep palmar arch. A branch from this arch to the lateral digital artery is termed the superficial palmar arch.

A single, large palmar metacarpal vein courses proximad to join the venous deep palmar arch.

The vascular patterns described above are subject to considerable variations, but the variations are of no clinical significance.

Carpus

The carpal region includes the carpal bones (radial, intermediate, ulnar, and accessory in the proximal row; first, second, third, and fourth in the distal row), the distal end of the radius, the proximal ends of the three metacarpal bones, and the soft tissue structures adjacent to these osseous components.

Dorsal Aspect

A vascular network in the skin on the dorsal carpus, the rete carpi dorsale, is formed by branches from the cranial interosseus, transverse cubital, and proximal radial arteries. Medial and lateral cutaneous antebrachial nerves supply branches to the medial and dorsal aspects of the carpus. The dorsal branch of the ulnar nerve emerges between the tendon of the flexor carpi ulnaris muscle and the short tendon of the extensor carpi ulnaris or between the short and long tendons of the latter muscle (Figure 1.21). The nerve supplies branches to the fascia and skin of the dorsal and lateral aspects of the carpus.

The tendons of each of the antebrachial muscles that cross the carpus are invested with synovial sheaths, excepting the extensor carpi ulnaris (formerly ulnaris lateralis) and flexor carpi ulnaris mm. (Figures 1.20 and 1.21). The tendon sheath of the extensor carpi radialis muscle terminates at the middle of the carpus, and then the tendon becomes adherent to the retinaculum as it reaches its insertion on the metacarpal tuberosity (Figure 1.20). A distal bursa near the insertion often communicates with the carpometacarpal joint.

A subtendinous bursa lies between the tendon of the extensor carpi obliquus and the medial collateral ligament of the carpus (Figure 1.20). In most foals younger than 2 years, the bursa is a separate synovial structure; in older horses it communicates with the adjacent tendon sheath.[36]

The extensor retinaculum serves as the dorsal part of the common fibrous joint capsule of the carpal joints. It attaches to the radius, the dorsal intercarpal and dorsal carpometacarpal ligaments, the carpal bones, and the third metacarpal bone. Laterally and medially it blends with the collateral ligaments of the carpus.

Lateral Aspect

The lateral collateral carpal ligament originates from the styloid process of the radius (Figure 1.22). The

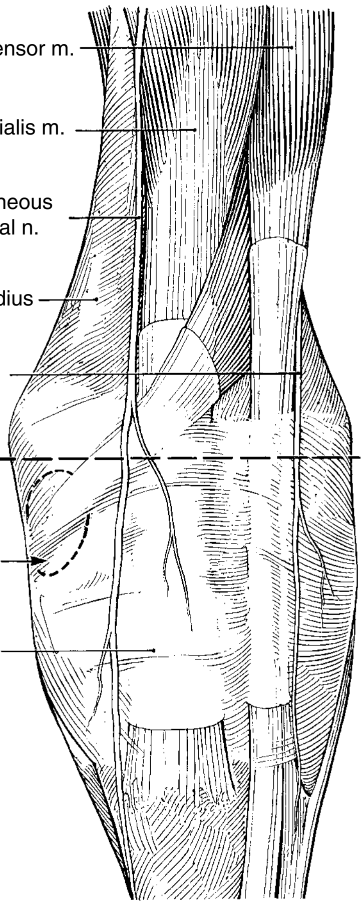

Figure 1.20. Dorsal view of left carpus.

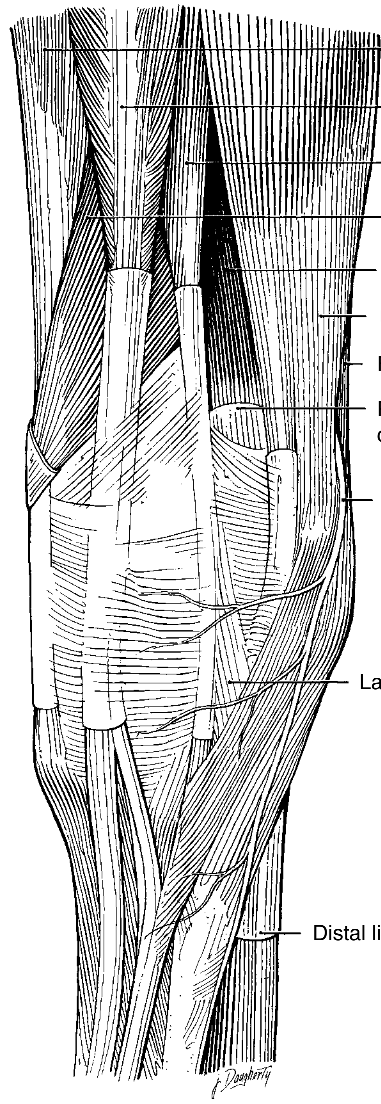

Figure 1.21. Lateral view of left distal forearm, carpus, and proximal metacarpus. Note that the ulnaris lateralis is now called extensor carpi ulnaris.

superficial part of the ligament attaches distally on the fourth metacarpal bone and partly on the third metacarpal bone. A canal between the superficial part and the deep part of the ligament provides passage for the tendon of the lateral digital extensor muscle and its synovial sheath. The deep part of the ligament attaches on the ulnar carpal bone.

Palmar to the lateral collateral carpal ligament, four ligaments attach to the accessory carpal bone, attaching it to adjacent bones (Figure 1.22). Two muscles have insertions on the accessory carpal bone. The short tendon of the extensor carpi ulnaris muscle (formerly ulnaris lateralis m.) attaches to the proximal border and lateral surface of the bone; the muscle's long tendon, enclosed in a synovial sheath, passes through a groove on the bone's lateral surface and then continues distad to insert on base of the lateral splint bone (Figure 1.21). Proximally, a pouch of the antebrachiocarpal joint capsule lies between the long tendon of the extensor carpi ulnaris and the lateral styloid process of the radius. The single tendon of the flexor carpi ulnaris muscle attaches to the proximal border of the accessory carpal bone. A strong fibrous band from the accessory carpal bone attaches to the lateral digital extensor tendon.

Medial Aspect

On the medial side of the carpus, the skin and fascia receive blood from branches of the radial artery. The medial cutaneous antebrachial nerve provides the innervation.

The medial collateral carpal ligament extends from the medial styloid process of the radius and widens distally to attach to the second and third metacarpal bones. Bundles of fibers also attach to the radial, second, and third carpal bones (Figure 1.23). The ligament also joins the flexor retinaculum on the palmar aspect of the joint. At this juncture a canal is formed that accommodates the passage of the tendon of the flexor carpi radialis and its synovial sheath as the tendon descends to the base of the medial splint bone. An inconstant first carpal bone may be embedded in the palmar part of the medial collateral carpal ligament adjacent to the second carpal bone.

Palmar Aspect

The flexor retinaculum is a fibrous band extending from the medial collateral ligament, distal end of the radius, radial and second carpal bones, and proximal

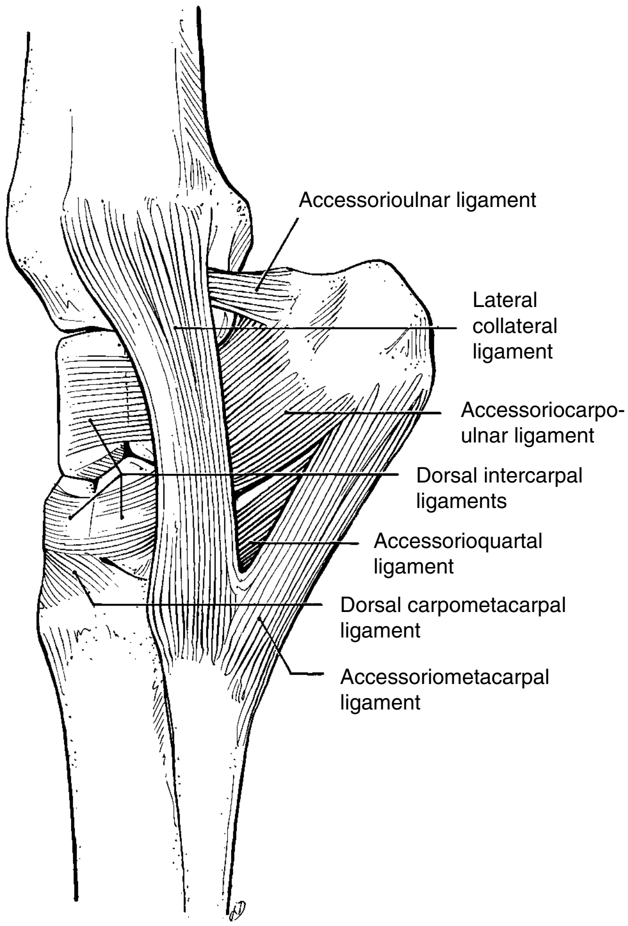

Figure 1.22. Carpal ligaments, lateral view.

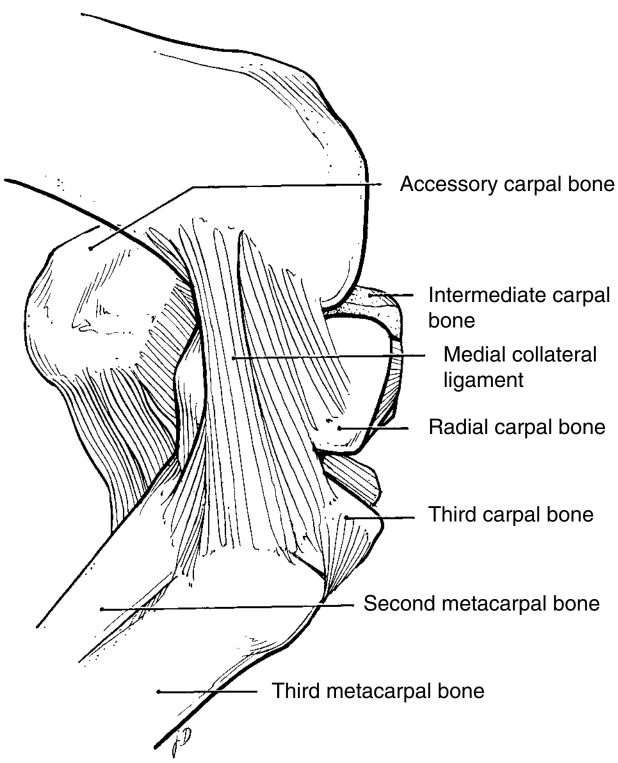

Figure 1.23. Carpal ligaments, medial view.

end of the second metacarpal bone laterad to the accessory carpal bone. By bridging the carpal groove, the flexor retinaculum forms the mediopalmar wall of the carpal canal. It blends both proximally and distally with the fascia of the limb. Proximally, the fan-shaped accessory ligament of the SDFT (radial check ligament) completes the medial wall of the carpal canal. The accessory carpal bone and its two distal ligaments form the lateral wall of the carpal canal. The palmar carpal ligament forms the smooth wall interposed between flexor tendons and the carpal bones; it serves as part of the common fibrous capsule on the palmar side of the carpus. Distally, the palmar carpal ligament gives origin to the carpal check ligament of the DDFT.

The carpal canal (Figures 1.24 and 1.25) contains the following structures: the SDFT and DDFT enclosed in the carpal synovial sheath, the medial palmar nerve and artery, and the lateral palmar nerve, artery, and vein. Medial to the carpal canal, just outside the flexor retinaculum, the tendon of the flexor carpi radialis descends to its attachment on the head of the medial splint bone. The radial artery and vein lie palmar to this tendon embedded in the flexor retinaculum.

The carpal synovial sheath enclosing the digital flexor tendons extends from 8 to 10 cm proximal to the antebrachiocarpal joint to near the middle of the metacarpus (Figure 1.25). Fibers from the carpal check ligament of the SDFT blend into the medial aspect of the proximal end of the sheath. Between the flexor tendons, an intertendinous membrane attaches to the palmaromedial surface of the DDFT and the dorsomedial surface of the SDFT, dividing the carpal synovial sheath into lateral and medial compartments.[40]

In the forearm proximal to the carpus, the palmar branches of the median and collateral ulnar arteries anastomose deep to the flexor carpi ulnaris muscle (Figure 1.18). Small branches from the palmar branch of the median and proximal radial arteries supply the vascular network of the deep palmar carpal region, the rete carpi palmare. The small lateral palmar artery continues distad to near the proximal end of the fourth metacarpal bone where it participates with the radial artery in forming the proximal deep palmar arch. Branches from the radial artery (also a terminal branch of the median artery) extend around the medial aspect of the carpus to contribute to the dorsal carpal rete.

Carpal Joints

The bones of the carpus abut one another at a number of intercarpal joints, but these are capable only of minimal gliding movements. The overall movement of the carpus comes from the horizontally oriented joints: antebrachiocarpal (radiocarpal) between the radius and proximal row of carpal bones, middle carpal between proximal and distal rows of carpal bones, and carpometacarpal between the distal row of carpal bones and the metacarpals. Nearly all of the flexion and extension of the carpus come from the antebrachiocarpal and middle carpal joints; the carpometacarpal joint is a plane joint with minimal movement. The extensive antebrachiocarpal synovial sac extends between the carpal bones of the proximal row, including the accessory carpal bone. It typically does not communicate with the

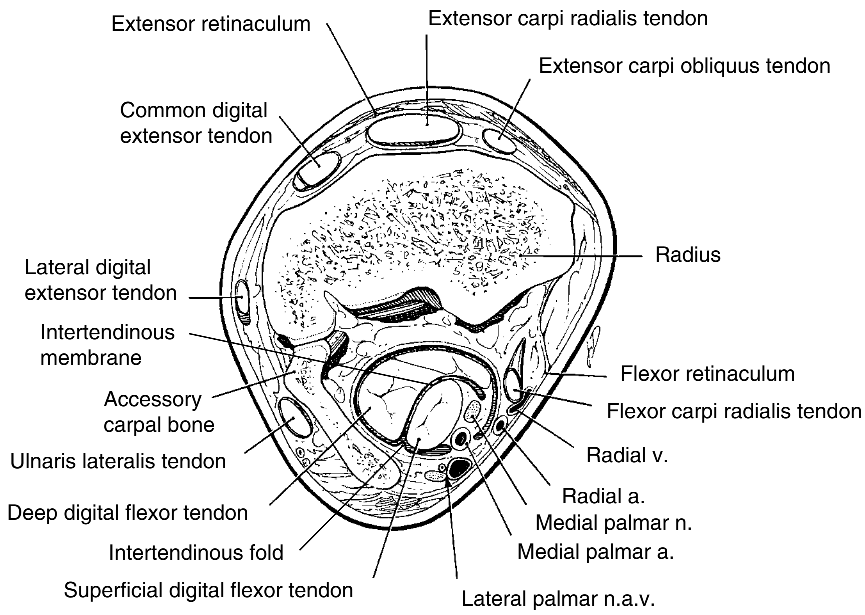

Figure 1.24. Cross section just proximal to the left antebrachiocarpal joint. Note that the ulnaris lateralis (tendon labeled here) is now called extensor carpi ulnaris.

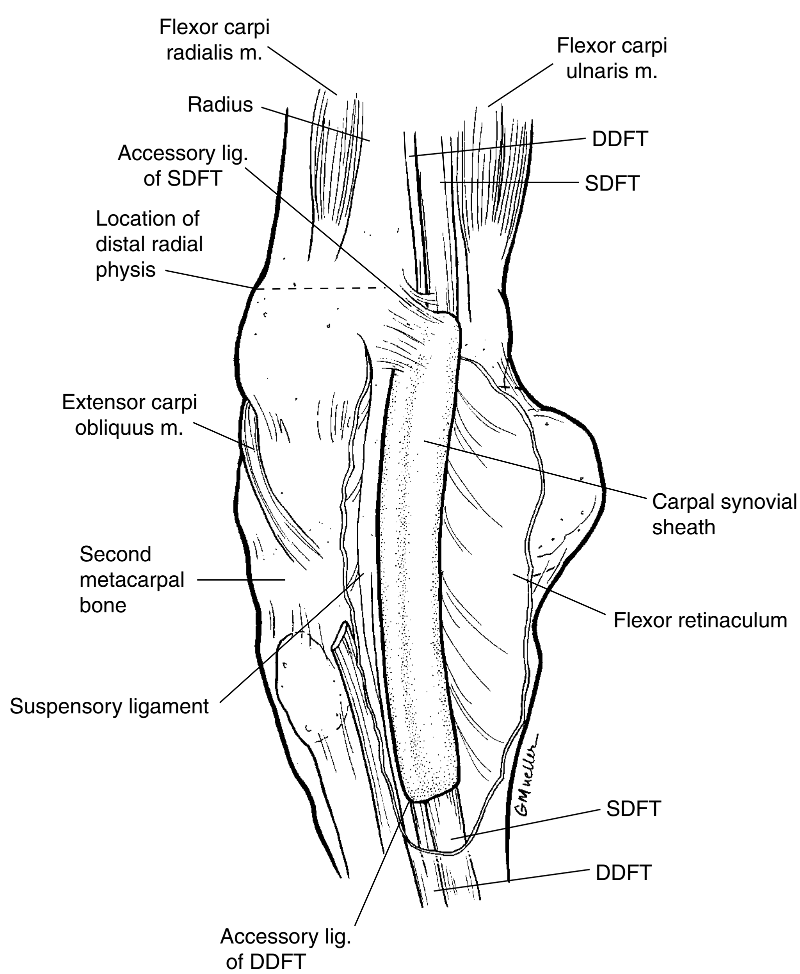

Figure 1.25. Palmaromedial view of carpus with flexor retinaculum cut and reflected. SDFT = superficial digital flexor tendon; DDFT = deep digital flexor tendon.

synovial spaces of the more distal carpal joints. The middle carpal synovial sac communicates with the small carpometacarpal sac between the third and fourth carpal bones.

The carpus is flexed by the combined action of the flexor carpi radialis, flexor carpi ulnaris, and probably the oddly named extensor carpi ulnaris. It is extended by the extensor carpi radialis and extensor carpi obliquus (a.k.a. abductor digiti I longus) muscles and also by the digital extensors. The thick palmar carpal ligament uniting the palmar aspect of the carpal bones serves to prevent overextension of the antebrachiocarpal and middle carpal joints.

Antebrachium

The antebrachium (forearm) includes the radius and ulna and the muscles, vessels, nerves, and skin surrounding the bones. The prominent muscle belly of the extensor carpi radialis muscle creates the distinctive bulging contour on the cranial antebrachium. A horny cutaneous structure, the chestnut, is present on the medial skin of the distal one-third of the forearm. The chestnut is considered to be a vestige of a carpal pad.[28]

There is extensive overlapping among adjacent sensory cutaneous branches of the axillary, radial, musculocutaneous, and ulnar nerves in the forearm.[5] The axillary nerve gives rise to cutaneous branches to the lateral aspect of the brachium and terminates as the cranial cutaneous antebrachial nerve, which courses distad over the extensor carpi radialis muscle (Figure 1.30).

The lateral cutaneous antebrachial nerve arises from the superficial branch of the radial nerve as the latter runs between the extensor carpi radialis and the lateral head of the triceps brachii (Figure 1.30). In its course the lateral cutaneous antebrachial nerve descends to supply the skin on the craniolateral part of the distal forearm. Terminal branches often course as far as the carpus and proximal metacarpus (Figure 1.20).

The medial cutaneous antebrachial nerve continues distad from the musculocutaneous nerve, coursing over the biceps brachii muscle and then along the deep face of the lacertus fibrosus, and continues into the tendon of the extensor carpi radialis muscle. The nerve is readily palpable through the skin as it crosses the cranial edge and then the medial surface of the lacertus fibrosus, dividing here into two main branches (Figure 1.26). The larger branch accompanies the accessory cephalic vein. The nerve continues on the dorsomedial aspect of the carpus and metacarpus to the fetlock. The smaller branch runs briefly with the cephalic vein and then courses obliquely across the medial surface of the radius where the bone is subcutaneous. This branch of the nerve is sensory to the skin as far as the medial carpus.

Ascending over the transverse pectoral muscle, the cephalic vein runs in the groove between the descending pectoral and cleidobrachialis muscles. A small artery accompanies the cephalic vein in the groove. Under cover of the cutaneous colli muscle, the cephalic vein empties into the external jugular vein or occasionally into the subclavian vein. The more cranial accessory cephalic vein joins the cephalic vein close to the point at which the latter gives rise to the median cubital vein (Figure 1.26). The median cubital courses proximocaudad over the insertion of the biceps brachii and then passes over the median nerve and brachial artery to join the brachial vein in the distal part of the brachium. Midway in its course the median cubital vein may receive a large branch emerging from between the radius and the flexor carpi radialis muscle.

The caudal cutaneous antebrachial nerve (from the ulnar nerve) emerges through the pectoralis transversus to innervate the skin on the caudal aspect of the forearm.

Fascia

The deep antebrachial fascia is especially thick. It invests all of the muscles of the forearm and provides for attachment of the tensor fasciae antebrachii muscle medially, the cleidobrachialis muscle laterally, and the biceps brachii muscle cranially (the latter by means of the lacertus fibrosus). The deep fascia blends with the periosteum on the medial radius and with the collateral ligaments and bony prominences at the elbow. Intermuscular septa from the deep fascia extend between the bellies of the antebrachial muscles.

Extensor Muscles

The extensor carpi radialis is the largest of the extensor muscles of the antebrachium. It arises proximally on the lateral epicondyle and radial fossa of the humerus (in common with the tendon of origin of the common digital extensor) and is attached to the elbow joint capsule and the deep fascia in this region. The tendon of the extensor carpi radialis runs nearly the length of the muscle, becoming visible on its cranial surface about halfway on the antebrachium and completely replacing the fleshy muscle bellow at the junction of the middle and distal thirds.

The extensor carpi obliquus muscle originates broadly on the lateral side of the distal radius. Its muscle belly is at first deep to the common digital extensor; then its tendon crosses that of the extensor carpi radialis superficially as it angles distad over the carpus toward its insertion on the base of the medial splint bone. On the medial aspect of the carpus, a bursa underlies the tendon; it usually communicates with the tendon's synovial sheath in older horses (Figure 1.20).[30]

The common digital extensor muscle takes origin along with the extensor carpi radialis on the lateral epicondyle and radial fossa of the humerus, with additional attachments to the ulna, deep fascia, lateral aspect of the radius, and the lateral collateral ligament of the elbow. Its tendon of insertion, enclosed in its tendon sheath, occupies its respective groove on the distal extremity of the radius. A slender tendon from the very small radial head of the muscle accompanies the main tendon as the two tendons enter the synovial sheath proximal to the carpus. Distal to the carpus, it diverges laterad to unite with the tendon of the lateral digital extensor.

The lateral digital extensor originates from the radius, ulna, and lateral collateral ligament of the elbow joint, and the intermuscular septum from the deep fascia. It is a relatively weak muscle whose muscle belly lies adjacent to the radius and ulna between the extensor carpi ulnaris caudally and the larger common digital extensor muscle belly cranially (Figure 1.26). The muscle's tendon crosses

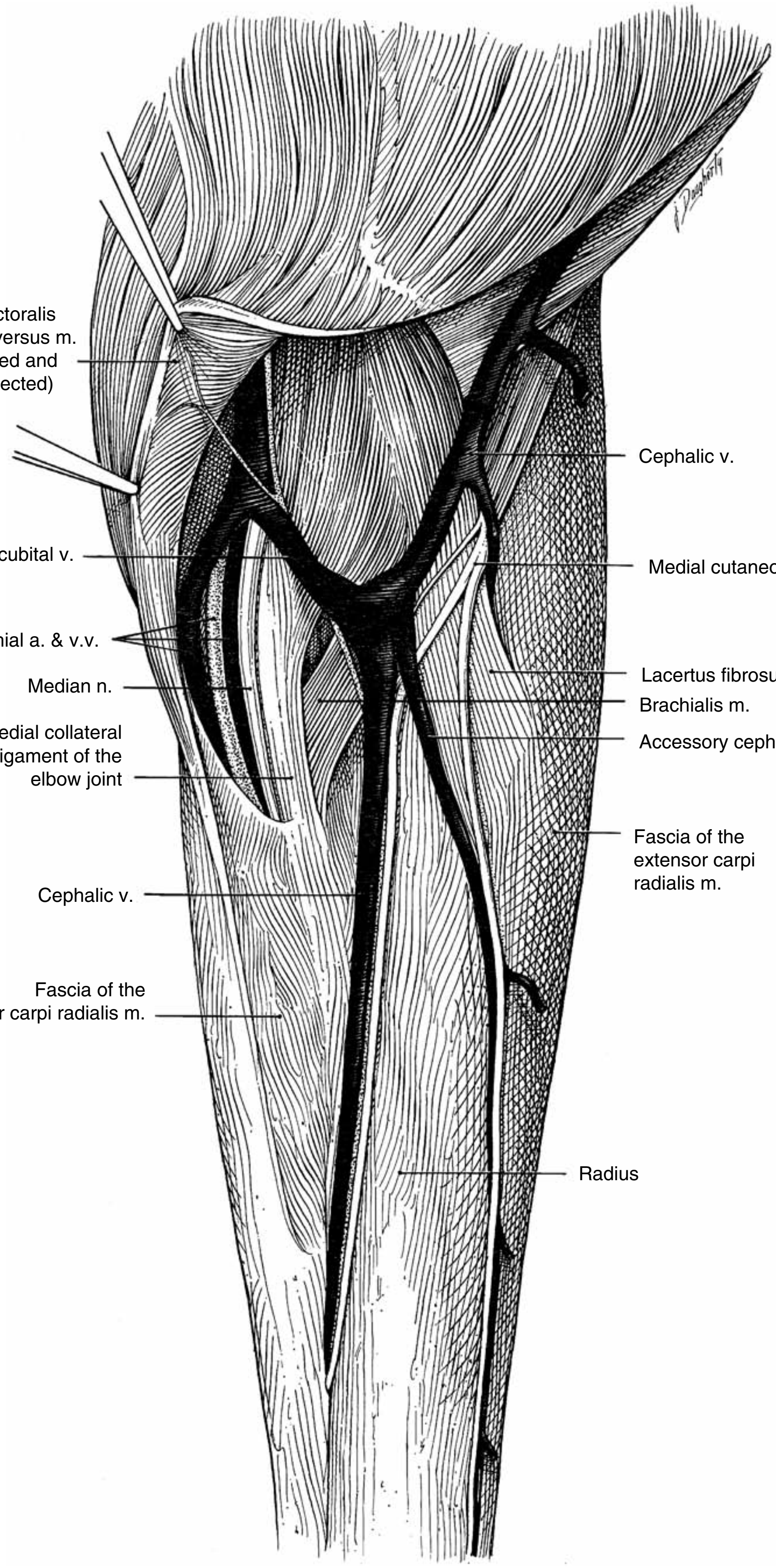

Figure 1.26. Craniomedial view of a superficial dissection of left elbow and forearm.

the carpus surrounded by a tendon sheath within a fascial canal on its way to the proximal phalanx where it inserts.

Flexor Muscles

The flexor carpi radialis muscle is related to the mediocaudal surface of the radius (Figure 1.26), extending from the medial epicondyle of the humerus to the base of the medial splint bone. Caudal to the flexor carpi radialis, the flexor carpi ulnaris muscle consists of an ulnar head from the olecranon and a humeral head from the medial epicondyle; it inserts on to the accessory carpal bone.

Between flexor carpi ulnaris caudally and the lateral digital extensor laterally is the extensor carpi ulnaris muscle (formerly ulnaris lateralis) that originates on the lateral epicondyle of the humerus caudal to the lateral collateral ligament of elbow joint. A bursa lies deep to the muscle at this location; it often communicates with the elbow synovial joint.[30] The muscle extends distad to insert on the accessory carpal bone and, by means of a somewhat longer, sheathed tendon, to the proximal end of the fourth metacarpal bone.

The preceding three muscles flex the carpal joint and, through their humeral origins, extend the elbow joint. Although the extensor carpi ulnaris is morphologically in the extensor group and is supplied by the radial nerve, its attachments make it a flexor of the carpus.

The superficial digital flexor muscle has a single humeral head, which originates from the medial epicondyle of the humerus and then lies deep to the flexor carpi ulnaris and ulnar head of the deep digital flexor (which is quite superficial as it originates from the medial surface of the olecranon). The muscle belly of the superficial digital flexor lies flat against the deep digital flexor muscle. Under the proximal part of the flexor retinaculum, the tendon of the humeral head of the superficial digital flexor is joined by a flat, wide fibrous band, its accessory ligament (really a radial head of the muscle), which arises on a ridge on the mediocaudal surface of the distal half of the radius (Figure 1.32, later in text).

The deep digital flexor muscle has one large humeral head and two small heads originating from the ulna (olecranon) and radius. The long slender tendon of the ulnar head joins the main tendon of the humeral head proximal to the carpus just before the combined tendon becomes enclosed within the carpal synovial sheath alongside the SDFT. The tendon of the radial head also joins the main tendon near this level. The radial head is inconsistently identifiable; when present, it takes origin from the middle third of the caudal radius. A synovial pouch from the elbow joint capsule protrudes distad beneath the humeral head's origin on the medial epicondyle of the humerus.

Nerves and Deep Vessels

The deep branch of the radial nerve descends over the flexor surface of the elbow and supplies motor branches to the extensor muscles of the forearm and the extensor carpi ulnaris.

The ulnar nerve crosses the medial epicondyle of the humerus accompanied by the collateral ulnar artery and vein, descends obliquely across the medial head of the triceps brachii and the elbow, and then runs between the ulnar heads of the flexor carpi ulnaris and deep digital flexor. It supplies these two muscles and the superficial digital flexor. From here the nerve runs under the deep antebrachial fascia, passing between the superficial digital flexor and the extensor carpi ulnaris and finally between the latter and flexor carpi ulnaris muscles as they near their insertions. A few centimeters proximal to the accessory carpal bone, the ulnar nerve divides into palmar and dorsal branches.

Distal to the elbow the median nerve runs along the caudal border of the medial collateral ligament of the elbow joint, cranial to brachial veins and artery (Figure 1.26). In the proximal part of the forearm, the median nerve supplies branches to the flexor carpi radialis muscle, the humeral and radial heads of the deep digital flexor muscle, and the periosteum of the radius and ulna. At about the middle of the forearm, the median nerve divides into the medial and lateral palmar nerves that remain together in a common sheath before separating close to the carpus. The medial palmar nerve descends in the carpal canal; the lateral palmar nerve is joined by the palmar branch of the ulnar nerve and descends within the dense connective tissue of the flexor retinaculum (Figure 1.18).

Just distal to the elbow joint, the common interosseous artery, a branch of the brachial artery, gives off a small caudal interosseous artery and then, continuing as the cranial interosseous, passes through the interosseous space, supplying nutrient arteries to the radius and ulna. Together with the transverse cubital artery (arising proximal to the elbow joint), the cranial interosseous provides branches to the cranial and medial aspects of the forearm.

After giving off the common interosseous artery, the brachial artery continues as the median artery between the flexor carpi radialis and the radius. In the distal part of the forearm, the median artery angles caudad and gives rise to the proximal radial artery, a small vessel that courses to the palmar aspect of the carpus. The median artery terminates at the distal end of the forearm by trifurcating into the large medial palmar artery, the much smaller lateral palmar artery, and, medially, the radial artery (Figure 1.18).

Two median veins accompany the median artery and nerve: a proximal continuation of the lateral palmar vein, which ascends caudal to the artery, and a vein formed by branches from the caudal antebrachial muscles, which ascends cranial to the artery.

Elbow Joint

The two principle flexors of the equine elbow (cubital) joint are the biceps brachii and the brachialis, with lesser contributions made by the extensor carpi radialis and common digital extensor muscles. The principal extensors are the tensor fasciae antebrachii, triceps brachii, and the anconeus; these are assisted by the flexors of the carpus and digit.

The terminal part of the biceps brachii muscle crosses the joint cranially and inserts on the radial tuberosity and medial collateral ligament. This tendon of insertion also gives rise to the lacertus fibrosus, which blends into the deep fascia of the extensor carpi radialis (Figure 1.27).

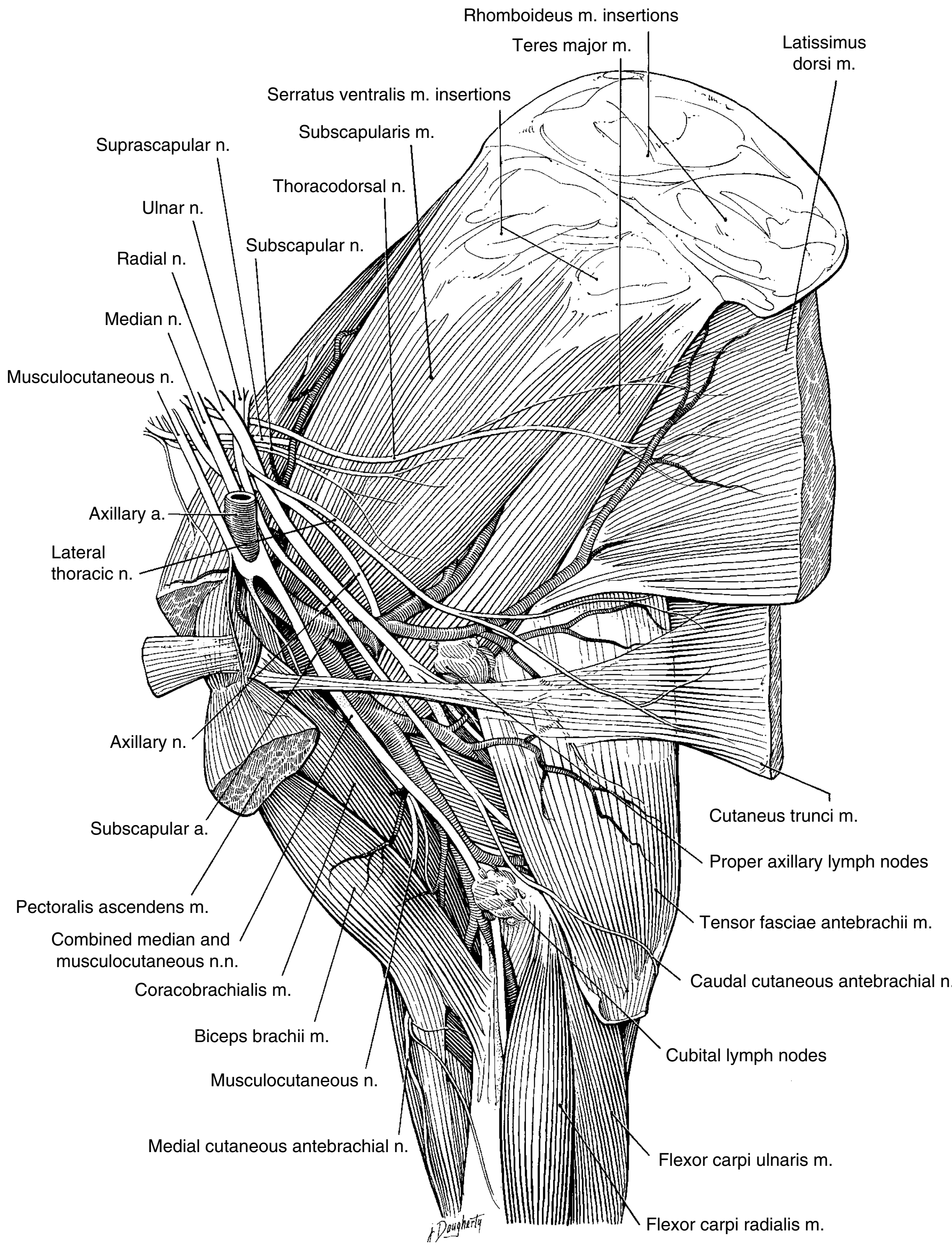

Figure 1.27. Medial view of left shoulder, arm, and proximal forearm. Veins are not depicted.

The terminal part of the brachialis muscle, curving around from its location in the musculospiral groove of the humerus, passes between the biceps brachii and extensor carpi radialis muscles to attach to the medial border of the radius deep to the medial collateral ligament (Figure 1.26). A bursa lies between the tendon and the collateral ligament.[30]

The median nerve, brachial artery, and the two brachial veins lie caudal to the medial collateral ligament of the elbow joint deep to the cranial part of the transverse pectoral muscle (Figure 1.26). Proximocaudal to the joint the collateral ulnar artery and vein and the ulnar nerve with its cutaneous branch (caudal cutaneous antebrachial nerve) cross obliquely between the medial head of the triceps brachii and tensor fasciae antebrachii.

All three principal extensors of the elbow insert on the olecranon tuberosity. A subcutaneous bursa may cover the caudal aspect of the olecranon tuberosity; a subtendinous bursa lies deep to the tendon of insertion of the long head of the triceps brachii muscle[30] (Figure 1.28). The medially located tensor fasciae antebrachii also inserts on and acts to tense the deep antebrachial fascia. The small anconeus muscle originates from the lateral edge of the olecranon fossa, inserts on the olecranon, and is attached on its deep surface to the elbow joint capsule, acting to elevate it when the joint is extended.

Laterally the elbow is covered by the distal part of the cutaneous omobrachialis muscle. A short, stout lateral collateral ligament extends from the lateral epicondyle of the humerus to the lateral tuberosity of the radius. The cranial part of the joint capsule is robust, but caudally it becomes thinner as it extends into the olecranon fossa deep to the anconeus muscle. The joint capsule is adherent to the anconeus muscle, the collateral ligaments, and tendons of surrounding muscles. Extensions

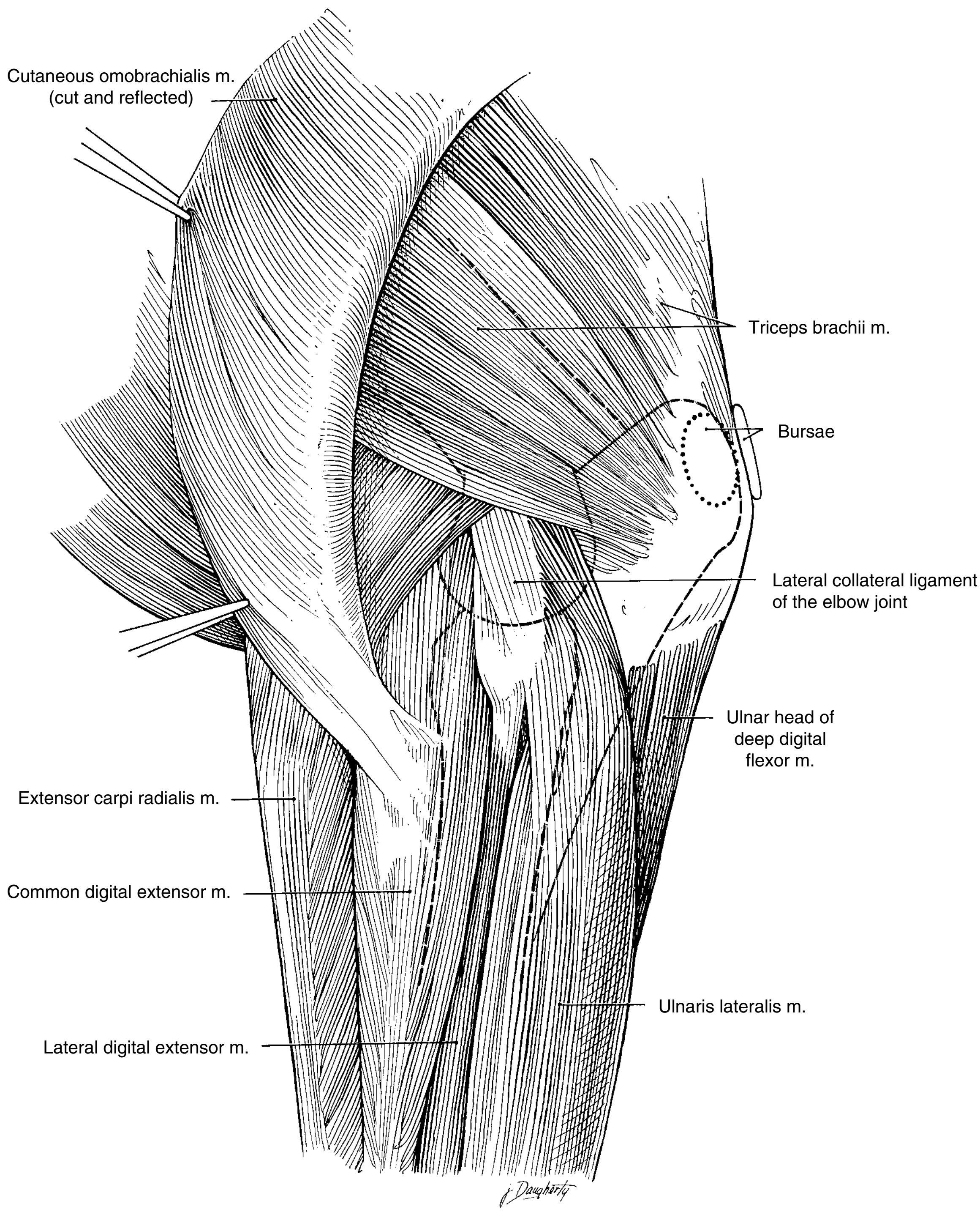

Figure 1.28. Lateral view of left elbow. Dashed lines represent the locations of bony elements. Note that the ulnaris lateralis is now called extensor carpi ulnaris.

of the synovial lining of the joint project under the origins of the extensor carpi ulnaris and the digital flexor muscles and into the radioulnar articulation. The elbow joint is supplied by branches from the transverse cubital artery cranially and a branch from the collateral ulnar artery caudally.

The articular surface of the radius features a concave fovea, partially subdivided by two sagittal ridges. This surface plus the trochlear notch of the ulna articulates with the humerus, forming a hinge joint. The articular angle can range from approximately 60° to 150°.[16]

Arm and Shoulder

The "arm" (*L. brachium*) is the region of the limb between the elbow and shoulder (scapulohumeral) joints. Within the superficial fascia over the lateral aspect of the shoulder and arm, the cutaneous omobrachialis muscle arises in the region lateral to the scapula and extends as far distal as the elbow joint (Figure 1.28). The cutaneous muscle is innervated by the intercostobrachial nerve (a branch of the lateral thoracic nerve). The intercostobrachial nerve and branches of the axillary, radial, and spinal nerves provide cutaneous sensation to this region. Superficial blood vessels are branches of the caudal circumflex humeral vessels.

The cleidobrachialis muscle (distal part of the brachiocephalicus) covers the craniolateral aspect of the shoulder joint on the way to its insertion on the deltoid tuberosity, humeral crest, and the fascia of the arm (Figure 1.29). When the head and neck are fixed and the limb is free to swing, this muscle acts as an extensor of the shoulder joint, drawing the forelimb forward. With the limb fixed on the ground, its contraction draws the head and neck into lateral flexion.

Muscles Substituting for Shoulder Joint Ligaments

Cranially, the dense, partly cartilaginous tendon of the biceps brachii muscle originates on the supraglenoid tubercle of the scapula and occupies the intertubercular groove of the humerus. A connective tissue band extends from the lesser tubercle to the greater tubercle, serving as a retinaculum for the biceps tendon. A bursa lies under the tendon, partially extending around its sides. A tendinous band (an "internal tendon") is continuous from the tendon of origin distad through the muscle. In addition to the muscle's primary function of elbow flexion, the internal tendon of the biceps brachii passively fixes the elbow and shoulder in the standing position. The musculocutaneous nerve supplies the biceps brachii.

The supraspinatus muscle arises in the supraspinous fossa, the spine, and cartilage of the scapula. It divides distally to attach to the greater and lesser tubercles of the humerus, serving with the bicipital tendon to stabilize the shoulder joint cranially and to a smaller degree laterally (Figure 1.30). The supraspinatus is a shoulder extensor; it is innervated by the suprascapular nerve, which reaches the supraspinous fossa by coursing between the subscapularis and supraspinatus muscles and then wrapping around the distal fourth of the cranial border of the scapula.

The infraspinatus muscle extends from the scapular cartilage and infraspinous fossa to insert on the caudal and distal parts of the greater tubercle, distal to the insertion of the supraspinatus (Figure 1.30). The partly cartilaginous tendon is protected from the underlying caudal eminence by adipose tissue and a synovial bursa that may communicate with the shoulder joint cavity. The tendon is the main lateral support of the shoulder joint. It is assisted by the teres minor, a smaller muscle deep to the infraspinatus and arising from the infraspinous fossa, the caudal border, and a small tubercle on the distal end of the scapula. It inserts proximal to and on the deltoid tuberosity. The teres minor muscle flexes the joint and, together with the infraspinatus, abducts the arm. The infraspinatus also rotates the arm laterad. The infraspinatus muscle is supplied by the suprascapular nerve, and the teres minor by the axillary nerve.

The subscapularis muscle stabilizes the shoulder joint medially. This adductor of the arm originates in the subscapular fossa of the scapula and inserts on the lesser tubercle of the humerus. Caudal support to the joint is rendered by the long head of the triceps brachii, the only head of this muscle originating from the scapula.

Flexor Muscles of the Shoulder Joint

In addition to the long head of the triceps brachii muscle, four muscles flex the shoulder joint: laterally, the deltoideus and teres minor; medially, the teres major and coracobrachialis; and the latissimus dorsi. The first three muscles are innervated by branches from the axillary nerve; the coracobrachialis, by the musculocutaneous nerve; and the latissimus dorsi, by the thoracodorsal nerve.

The deltoideus lies on the lateral surface of the triceps brachii and partly on the infraspinatus and teres minor muscles. It originates from the caudal border of the scapula and the scapular spine via the aponeurosis covering the infraspinatus and inserts on the deltoid tuberosity of the humerus and the brachial fascia (Figure 1.30).

The teres major muscle extends from the caudal border of the scapula and crosses the medial surface of the triceps brachii to the teres major tuberosity of the humerus, where it inserts in common with the latissimus dorsi muscle (Figure 1.27).

The coracoid process of the scapula gives origin to the coracobrachialis muscle that crosses the medial aspect of the shoulder joint to attach to the humerus just proximal to the teres major tuberosity and on the middle of the cranial surface of the bone. A bursa lies between the tendon of origin of the coracobrachialis and the tendon of insertion of the subscapularis muscle.[30]

Shoulder Joint

The fibrous joint capsule of the shoulder joint attaches up to 2 cm from the margins of the articular surfaces. Two elastic glenohumeral ligaments reinforce the joint capsule on its cranial side as they diverge from the supraglenoid tubercle to the humeral tuberosities. A very small articularis humeri muscle lies on the flexion surface of the joint capsule, extending from the caudal part of the scapula to the caudal surface of the humerus just distal to the head. Innervated by the axillary nerve, the articularis humeri muscle tenses the joint capsule during flexion of the shoulder joint.

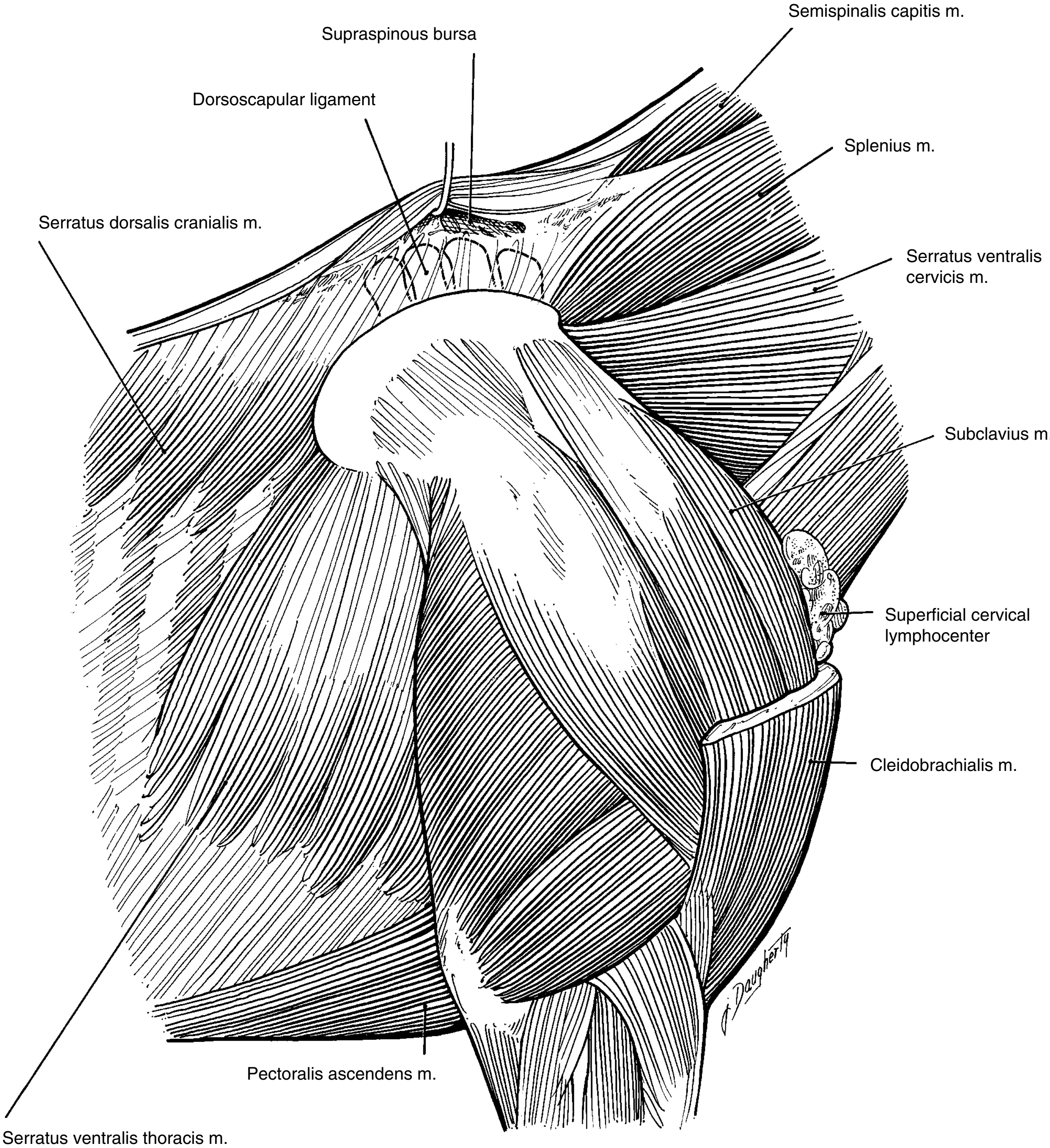

Figure 1.29. Right shoulder and dorsoscapular ligament. Spines of thoracic vertebrae 2–5 are outlined by dashed lines.

Within the shoulder joint the articular surface of the humeral head has approximately twice the area of the glenoid cavity of the scapula even with the small extension afforded by the glenoid lip around the rim. The great stability of this joint is largely owed to the support of the surrounding muscles. In spite of its classification as a ball-and-socket joint, major movements are limited to flexion and extension; muscles around the joint restrict abduction and adduction, and rotation is very limited. While standing, the caudal angle of the shoulder joint is 120°–130°. The angle can increase to approximately 145° in extension and decrease to 80° in flexion.[16]

Muscles of the Scapula

In the scapular region the flat, triangular trapezius muscle covers parts of eight underlying muscles. The cervical part of the trapezius arises by a thin aponeurosis from most of the funicular part of the nuchal ligament and inserts on the scapular spine and fascia of the shoulder and arm. The thoracic part of the trapezius takes an

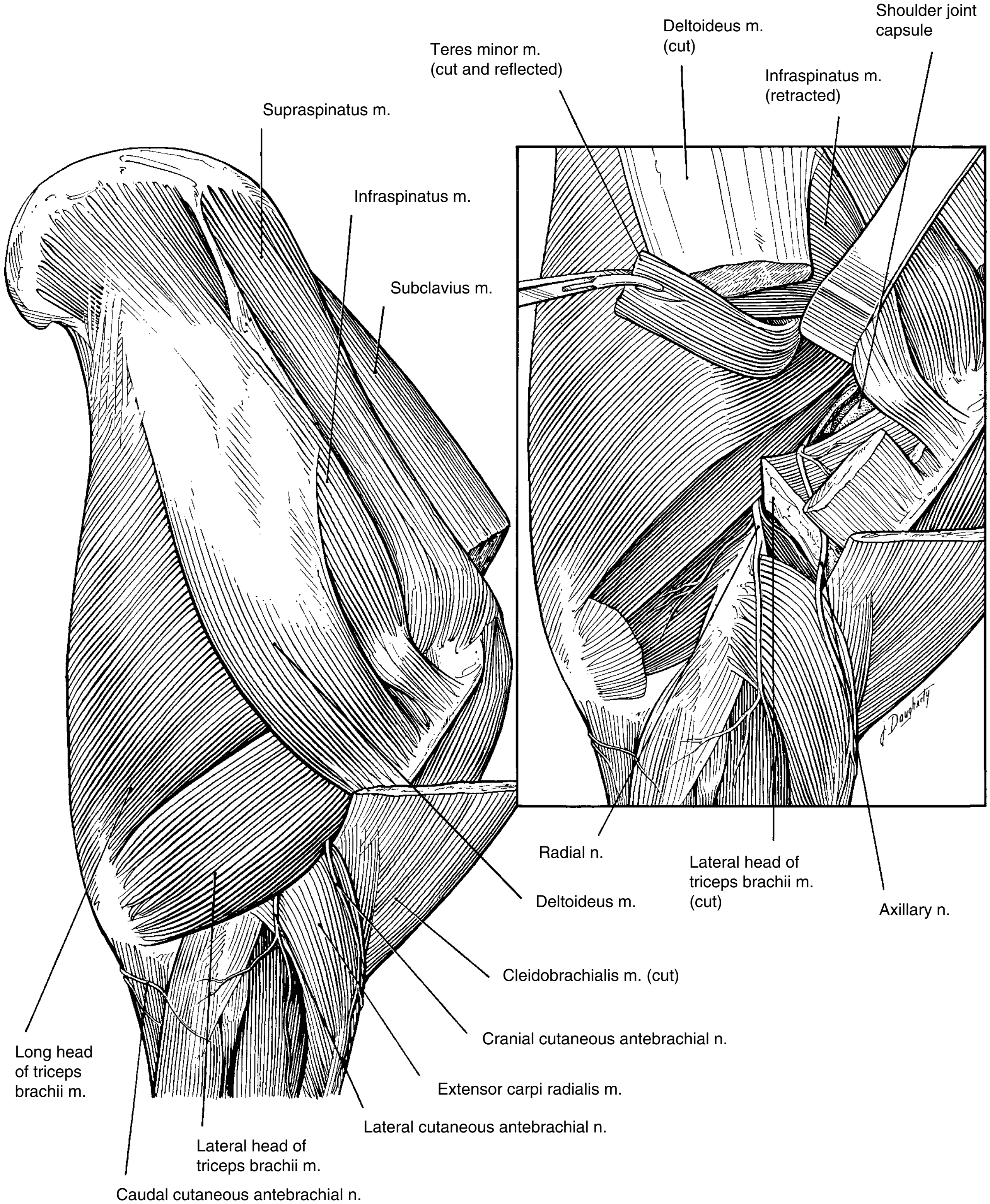

Figure 1.30. Lateral aspect of right shoulder. Inset: Deeper dissection exposing shoulder joint.

aponeurotic origin from the supraspinous ligament from the third to the tenth thoracic vertebrae and inserts on the tuber of the spine of the scapula. An aponeurosis joins the two parts of the trapezius. Innervated by the accessory nerve and dorsal branches of adjacent thoracic nerves, the trapezius muscle elevates the shoulder and draws it either craniad or caudad, depending on the activity of the cervical or thoracic parts, respectively.

Like the trapezius, the rhomboideus possesses cervical and thoracic parts. Lying deep to the trapezius, the rhomboideus cervicis originates from the funicular part of ligamentum nuchae; the rhomboideus thoracis originates from the superficial surface of the dorsal part of the dorsoscapular ligament. Both parts of the rhomboideus muscle insert on the medial side of the scapular cartilage (Figure 1.27). This muscle is innervated by the sixth and seventh cervical nerves and dorsal branches of nerves adjacent to the rhomboideus thoracis. The rhomboideus draws the scapula dorsocraniad, and, when the limb is stationary, the cervical part helps to raise the neck.

The latissimus dorsi muscle has a triangular shape with the origin arising through a broad aponeurosis from the thoracolumbar fascia. Thin near its aponeurotic origin, the muscle becomes thicker as it approaches its insertion, passing medial to the long head of the triceps brachii to converge on a flat, common tendon of insertion with the teres major muscle on the teres major tuberosity of the humerus (Figure 1.27).

From deep to superficial, the muscles contributing most substantially to the attachment of the thoracic limb to the trunk and neck are the serratus ventralis, pectoral muscles (including subclavius), brachiocephalicus, and omotransversarius. The cervical part of serratus ventralis extends from the transverse processes of the cervical vertebrae C4–C7 to the serrated face of the medial scapula and scapular cartilage; the thoracic part of serratus ventralis converges from the lateral surfaces of the first eight or nine ribs to the serrated face of the scapula and the scapular cartilage. Elastic sheets from the ventral part of the dorsoscapular ligament (Figure 1.31) are interspersed through the attachments of the serratus ventralis on the scapula. The right and left serratus ventralis muscles form a muscular sling suspending the thorax between the thoracic limbs. When both muscles contract, they elevate the thorax; acting independently, each serratus ventralis shifts the trunk's weight to the ipsilateral limb. During locomotion the cervical part of the muscle draws the dorsal border of the scapula craniad; the thoracic part draws the scapula caudad. When the limb is fixed, the cervical portion lifts the neck dorsad and/or pulls it laterad. The long thoracic nerve and branches from the fifth to the eighth cervical nerves supply this muscle.

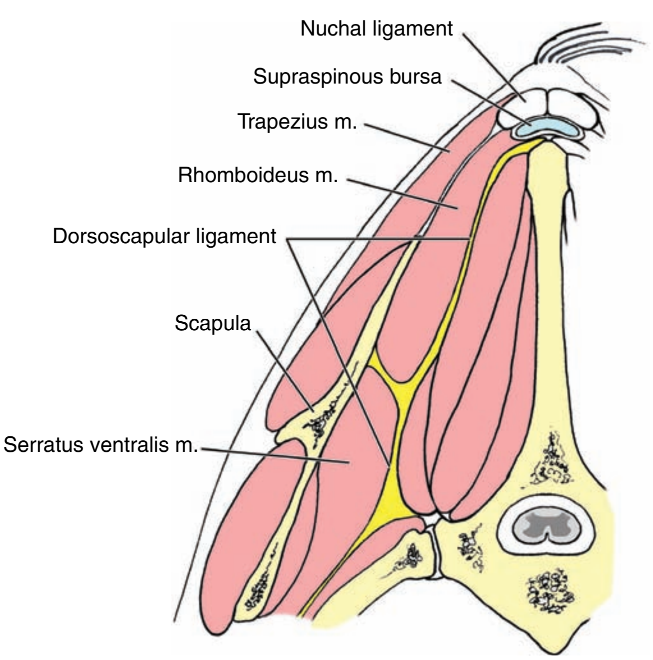

Figure 1.31. Cross section of right dorsoscapular ligament. The ligament covers the medial and ventral aspects of the rhomboideus and gives rise to sheets of elastic tissue that interdigitate with the fascicles of the serratus ventralis.

Pectoral muscles attach to the sternum. There are two superficial pectoral muscles: (1) the descending pectoral muscle passing from the cartilage of the manubrium of the sternum to the deltoid tuberosity and the crest of the humerus and brachial fascia and (2) the transverse pectoral muscle extending from the ventral part of the sternum to the superficial fascia on the medial aspect of the antebrachium and to the humeral crest. The largest pectoral muscle, the deep pectoral (ascending pectoral) muscle (Figure 1.29), passes from its attachments on the xiphoid cartilage, the ventral part of the sternum, the fourth to ninth costal cartilages, and the abdominal tunic to the cranial parts of the lesser and greater humeral tubercles. The subclavius has been traditionally grouped with the pectorals. It arises from the first four costal cartilages and the cranial half of the sternum and ends in an aponeurosis over the dorsal part of the supraspinatus muscle and the scapular fascia (Figure 1.29).

The superficial pectoral muscles adduct the limb. The deep pectoral and subclavius are also adductors, and, if the limb is fixed in the advanced position, they pull the trunk craniad. Cranial and caudal pectoral nerves (with musculocutaneous and intercostal nerves contributing to the cranial pectoral nerves) supply these muscles.

The brachiocephalicus is traditionally divided into two parts based on the embryological location (not apparent in the fully formed muscle) of the clavicular intersection. The cleidobrachialis part of the brachiocephalicus muscle extends from the clavicular intersection to the arm and is innervated by the axillary nerve. The mastoid part of the muscle (a.k.a. cleidomastoideus) lies between the intersection and its attachments to the mastoid process and nuchal crest of the skull, partly overlapping the omotransversarius muscle dorsally. The omotransversarius originates from the wing of the atlas and the transverse processes of the second, third, and fourth cervical vertebrae and inserts on the humeral crest and fascia of the shoulder and arm. The cleidobrachialis is innervated by the accessory nerve (cranial nerve XI), and the omotransversarius is innervated segmentally by cervical spinal nerves.

Dorsoscapular Ligament

Further attachment of the limb to the trunk is afforded by a thickened specialization of the thoracolumbar fascia, the dorsoscapular ligament (Figure 1.31). Its collagenous portion attaches to the third, fourth, and fifth thoracic spines under the nuchal ligament close to the supraspinous bursa.[15] This part of the dorsoscapular ligament passes ventrad, attaching to the medial surface of the rhomboideus thoracis muscle. As it curves ventral to the muscle, the collagenous part transitions to elastic tissue. A horizontal lamina of this elastic part forms the ventral sheath of the rhomboideus thoracis muscle. Vertical laminae project from the ventral aspect of the horizontal lamina, investing bundles of the serratus ventralis muscle that insert on the scapula (Figure 1.31).

Nerves and Vessels

The ventral branches of spinal nerves C6 through T2 create the brachial plexus, which perforates the scalenus muscle and passes into the forelimb craniomedial to the shoulder joint (Figure 1.27). Vessels supplying the thoracic limb accompany the nerves in this location.

Suprascapular vessels accompany the suprascapular nerve, passing laterad between the subscapular and suprascapular muscles. The median nerve descends with the axillary artery, forming a loop medial to the artery by uniting with a large branch from the musculocutaneous nerve. Proximal branches from the musculocutaneous nerve supply the coracobrachialis and biceps brachii muscles. Distal to the axillary loop, the median and musculocutaneous nerves are contained in a common sheath, coursing distad along with the brachial artery. In the middle of the arm, the musculocutaneous nerve terminates by dividing into a distal branch supplying the brachialis muscle and the medial cutaneous antebrachial nerve that spirals around the biceps brachii to the lacertus fibrosus.

The axillary nerve crosses the medial surface of the subscapularis muscle, and, together with the large subscapular vessels (from the axillary vessels), the nerve passes laterad between the subscapularis and teres major muscles. Innervating these muscles and others of the caudal shoulder, the axillary nerve is accompanied by the caudal circumflex humeral artery, a branch of the subscapular artery. It ultimately gives rise to the cranial cutaneous antebrachial nerve.

The large radial nerve and smaller ulnar nerve descend close to each other medial to the subscapular artery and then caudal to the brachial vein. After supplying a branch to the tensor fasciae antebrachii muscle, the radial nerve plunges laterad between the teres major and the triceps to run along the musculospiral groove of the humerus. Here it gives off lateral cutaneous branches to the caudodistal aspect of the arm and supplies branches to the triceps brachii and anconeus muscles. Just proximal to the elbow joint, the radial nerve divides into deep and superficial branches. The deep branch supplies the craniolateral muscles of the antebrachium. The superficial branch winds laterad between the lateral head of the triceps brachii and the extensor carpi radialis muscles accompanied by the transverse cubital artery. It gives rise to the lateral cutaneous antebrachial nerve, which supplies sensory innervation to the fascia and skin of the lateral aspect of the forearm (Figure 1.30).

The ulnar nerve angles caudodistad to the middle of the arm. It gives rise to the caudal cutaneous antebrachial nerve that courses across the medial surface of the tensor fasciae antebrachii (Figure 1.27). The continuation of the ulnar nerve passes between that muscle and the medial head of the triceps brachii, accompanied here by the collateral ulnar vessels as they cross the medial humeral epicondyle.

After giving off the cranial circumflex humeral vessels in the proximal part of the brachium, the axillary vessels continue as the brachial artery and vein. As they descend the arm they give rise to the deep brachial vessels supplying the triceps muscle and then the collateral ulnar vessels caudally and the bicipital vessels cranially. The transverse cubital vessels are given off cranially and pass distolaterad deep to the biceps brachii and brachialis muscles to the cranial aspect of the cubital joint. The nutrient artery of the humerus may come from the first part of the collateral ulnar artery, or it may arise from the brachial artery.

Lymphatic Drainage

Lymphatic vessels from structures distal to the elbow are afferent to the cubital lymph nodes, a group of 5–20 small nodes found just proximal to the medial side of the elbow (Figure 1.27). Efferent vessels from the cubital lymph nodes end in the proper axillary lymph nodes on the medial surface of the teres major muscle (Figure 1.27). These also receive lymph from the muscles of the arm and shoulder and from the adjacent skin and the ventrolateral trunk. Vessels from the proper axillary lymph nodes carry lymph to the caudal deep cervical lymph nodes. Some efferents of the deep cervical nodes drain directly into the venous system; others pass to other regional nodes and therefore drain indirectly through these to the venous system.[28]

Lymphatic vessels from the skin of the entire thoracic limb, neck, and dorsolateral trunk and more proximal parts of the limb are afferent to the superficial cervical lymphocenter on the cranial border of the subclavius muscle, deep to the brachiocephalicus. Efferent lymphatic vessels from the superficial cervical lymph nodes terminate in the caudal deep cervical lymph nodes or by entering the common jugular vein.[16,28]

Stay Apparatus of the Thoracic Limb

Muscles, tendons, and ligaments constituting the stay apparatus of the thoracic limb fix the carpus, elbow, and shoulder joints in the standing position (Figure 1.32). This complex of structures functions almost entirely as a passive, force-resisting system.[35] It permits the horse to stand (and sleep) with a minimum of muscular activity. The elasticity of the tissues in the stay apparatus also stores energy during weight-bearing and redeliver that energy back to the limb during the swing phase of gait, markedly improving the efficiency of movement, especially when working at speed.

In the manus, elements of the stay apparatus resist nonphysiologic hyperextension of the fetlock and interphalangeal joints.

The DDFT forms a continuous ligamentous band from its accessory (carpal check) ligament to the solar surface of the distal phalanx. This is the only element that resists hyperextension of the distal interphalangeal joint; as a consequence, disruption of this part of the suspensory apparatus can produce a characteristic hyperextension of the coffin joint, identifiable as the foot is rotated back onto the heels and the toe lifts from the ground.

The four palmar ligaments stretched tightly across the pastern joint, the straight distal sesamoidean ligament, and the digital flexor tendons (with their accessory ligaments) prevent hyperextension of the pastern joint.

The suspensory apparatus is a ligamentous continuum extending from the proximal end of the third metacarpal bone to the proximal and middle phalanges. It consists of the suspensory ligament, palmar ligament with its embedded proximal sesamoid bones, and the distal sesamoidean ligaments. The SDFTs and DDFTs

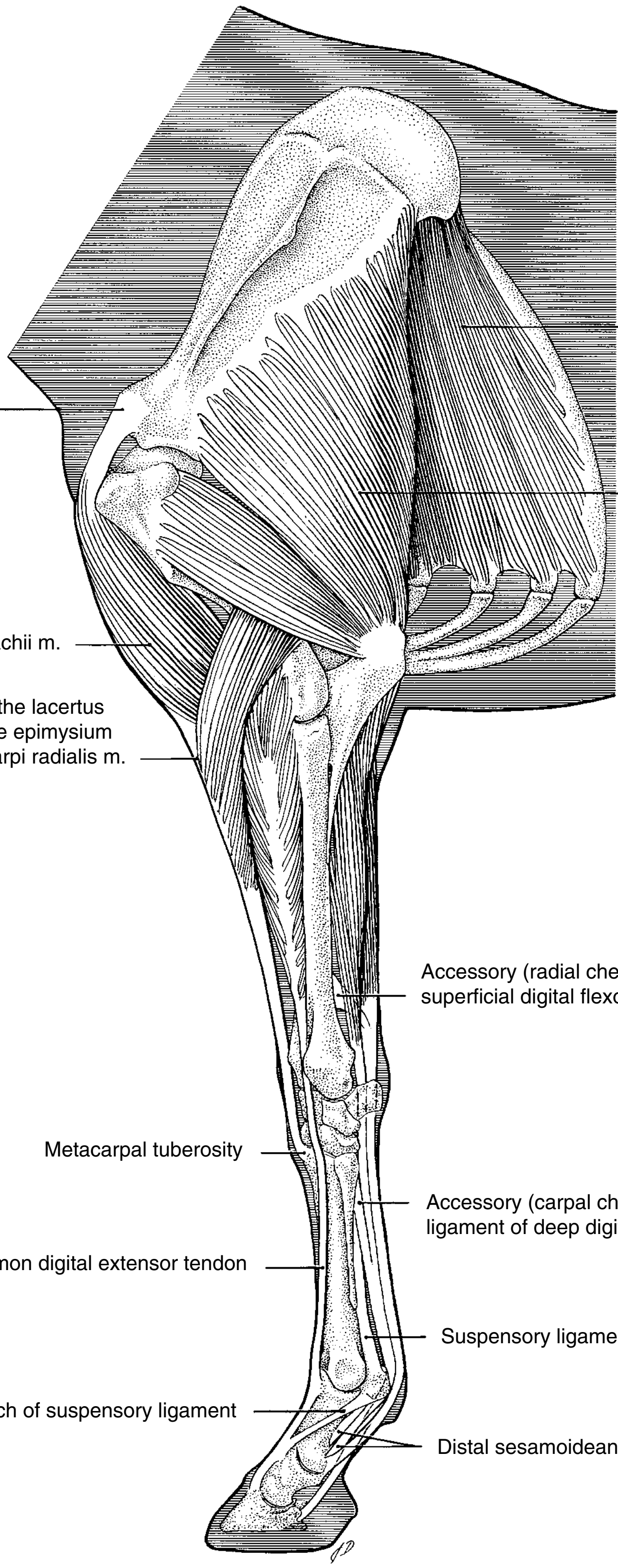

Figure 1.32. The passive stay apparatus of the left thoracic limb with assisting active elements.

and their accessory (check) ligaments assist the suspensory apparatus of the fetlock in suspending the fetlock and preventing excessive overextension of the metacarpophalangeal joint and collapse of the fetlock during loading.[11] Disruption of the suspensory apparatus alters its support of the fetlock, resulting in "sinking" or hyperextension of the fetlock.[35]

The skeletal elements of the carpus exhibit some stability in extension. Soft tissue stabilization is provided by the palmar carpal ligament and the collateral ligaments.

Palmarly, the digital flexor tendons bridging the carpus in the carpal canal between their respective accessory ligaments, and dorsally the extensor tendons, principally the extensor carpi radialis tendon, lend further stability to the carpus.

A certain amount of muscle tone prevails in all "resting" muscles of the limb, even during most stages of sleep. Tension exerted by the long head of the triceps brachii muscle is essential to prevent flexion of the elbow joint.[33] The elbow's eccentrically placed collateral ligaments afford it surprising stability in the extended position, a stability enhanced by the triceps' tone. Flexion of the joint is further limited by the superficial digital flexor muscle descending from its attachment of the medial epicondyle of the humerus.[11]

A tendinous continuum extending from the supraglenoid tubercle of the scapula to the metacarpal tuberosity is formed by the main tendon of the biceps brachii muscle and its fibrous "internal tendon" and superficial connection to the fascia of extensor carpi radialis muscle via the lacertus fibrosis. Through the tendon of insertion of the extensor carpi radialis, a continuous band is therefore created from the scapula to the metacarpus. This complex prevents flexion of the loaded shoulder joint caused by the weight of the trunk being transferred to the appendicular skeleton via the scapular attachments of the serratus ventralis muscle and the dorsoscapular ligament.

HINDLIMB

Digit and Fetlock

The hindfoot is somewhat smaller and more elongate than the forefoot. Compared with the forefoot, the angle of the toe of the hindfoot is slightly greater (i.e. it is steeper).[1] The middle phalanx is narrower and longer, and the proximal phalanx somewhat shorter than their counterparts in the thoracic limb (Figure 1.33).

The long digital extensor muscle's tendon attaches to the dorsal surfaces of the proximal and middle phalanges and the extensor process of the distal phalanx, but the tendon of the lateral digital extensor usually does not reach the digit as it does in the thoracic limb. Digital flexor tendons, tendon sheaths, and bursae of the hind digit are not remarkably different. The suspensory apparatus of the fetlock and the configuration of the fetlock (metatarsophalangeal) joint are much the same as in the thoracic limb except that the dorsal articular angle of the fetlock is approximately 5° greater (i.e. is slightly more "upright").

Blood Vessels and Nerves of the Hind Digit and Fetlock

The principal blood supply to the fetlock and digit of the pelvic limb is derived from the continuation of dorsal metatarsal artery III, the distal perforating branch, which bifurcates into medial and lateral digital arteries in the distoplantar region of the metatarsus. A small secondary supply is contributed by medial and lateral plantar arteries that join the digital arteries to form the superficial plantar arch just proximal to the widening of the fetlock (Figure 1.34). Branches of the digital arteries form a pattern similar to that in the thoracic limb except for the blood supply to the navicular bone. In contrast to all arteries originating from palmar arterial branches of the middle phalanx, in the pelvic limb, half of the primary arteries originate from the plantar arterial branches of the middle phalanx, and half from the collateral arch (cf. Figure 1.8). More significantly, a greater number of vessels enter the distal border of the navicular bone from the distal anastomotic network in the hindfoot than the same region in the forefoot.[18]

Venous drainage of the digit of the pelvic limb is similar to that of the forelimb. The digital veins carry blood to the plantar common digital veins at the level of the fetlock.

The pattern of distribution of the plantar digital and plantar metatarsal nerves in the fetlock and digit of the pelvic limb is similar to the pattern of the counterpart nerves in the thoracic limb. Some differences exist, however. The dorsal branch of each plantar digital nerve is given off more distally than the corresponding branch of the forelimb. Medial and lateral dorsal metatarsal nerves (from the deep fibular—formerly peroneal—nerve) course distad subcutaneously parallel and dorsal to the medial and lateral plantar metatarsal nerves (Figures 1.34 and 1.35). The lateral plantar metatarsal nerve extends distad over the fetlock to the lateral aspect of the pastern, while the medial plantar metatarsal nerve may reach as far as the coronet; both dorsal metatarsal nerves continue into the laminar corium.[20] Terminal branches of the saphenous nerve medially, the superficial fibular nerve dorsally and laterally, and the caudal cutaneous sural nerve dorsolaterally complete the sensory innervation to the skin of the fetlock.

Metatarsus

The equine metatarsus is about 16% longer than the corresponding metacarpus, and the third metatarsal bone is more round in cross section than the third metacarpal bone.[16] The lateral splint bone, particularly its proximal extremity, is much larger than the medial splint bone.

Dorsal Aspect

Three superficial nerves supply sensory innervation to the skin of the dorsal, lateral, and medial aspects of the metatarsus. Dorsally and laterally the two terminal branches of the superficial fibular nerve descend as far as the fetlock. The terminal branch of the caudal cutaneous sural nerve descends obliquely from the lateral aspect of the hock to course over the dorsolateral part of the third metatarsal bone, terminating in the skin of the fetlock, and the terminal branch of the saphenous nerve supplies medial skin of the metatarsus down to the fetlock.

The dorsal common digital vein II (great metatarsal vein) ascends from a venous arch proximal to the proximal sesamoids as the primary continuation of the venous drainage on the medial side of the digit and fetlock. At first, the great metatarsal vein lies along the medial border of the suspensory ligament, and then it angles dorsad in a groove on the third metatarsal bone to the hock where it becomes the cranial branch of the medial saphenous vein (Figure 1.35).

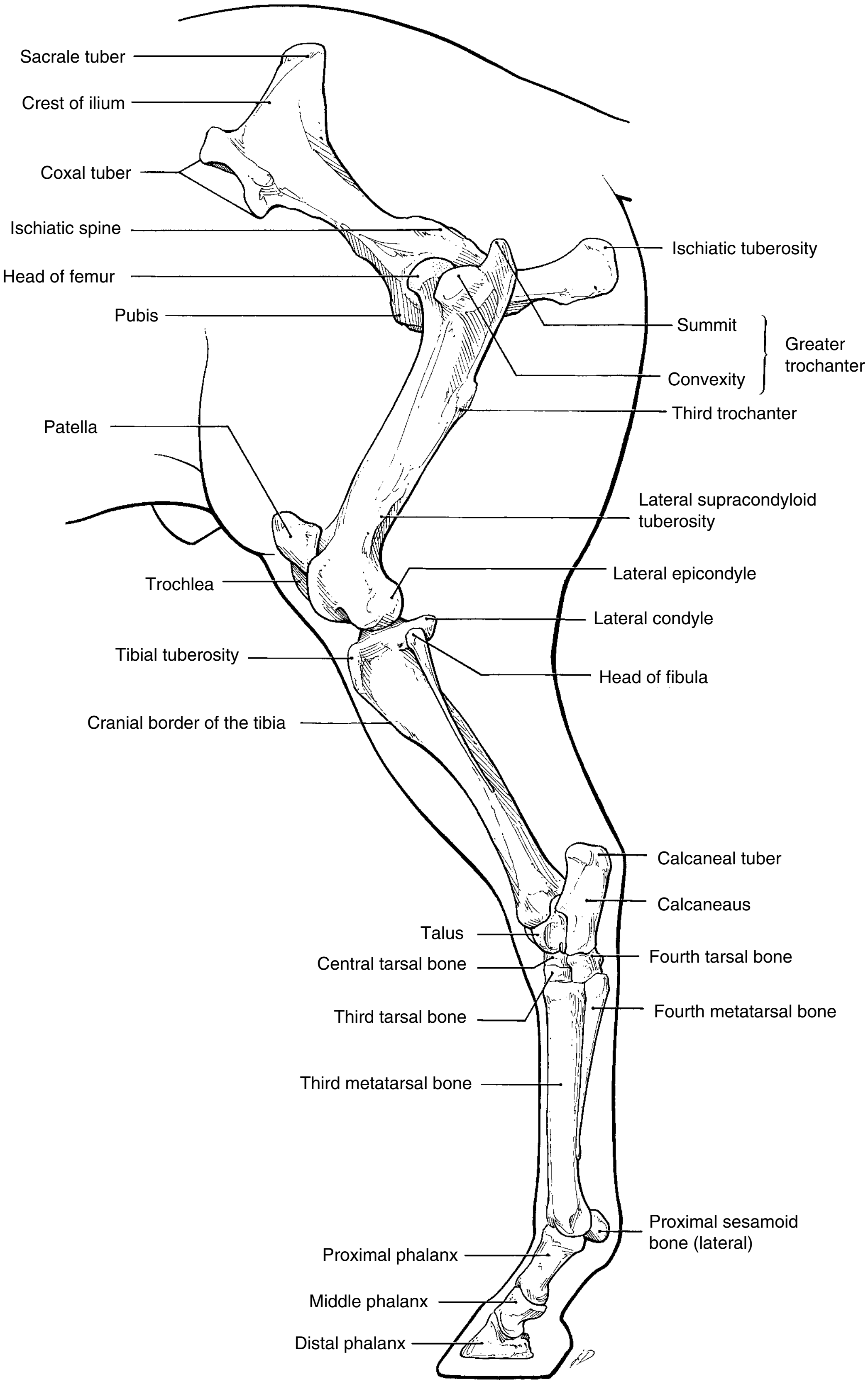

Figure 1.33. Bones of the left pelvic limb. Lateral view.

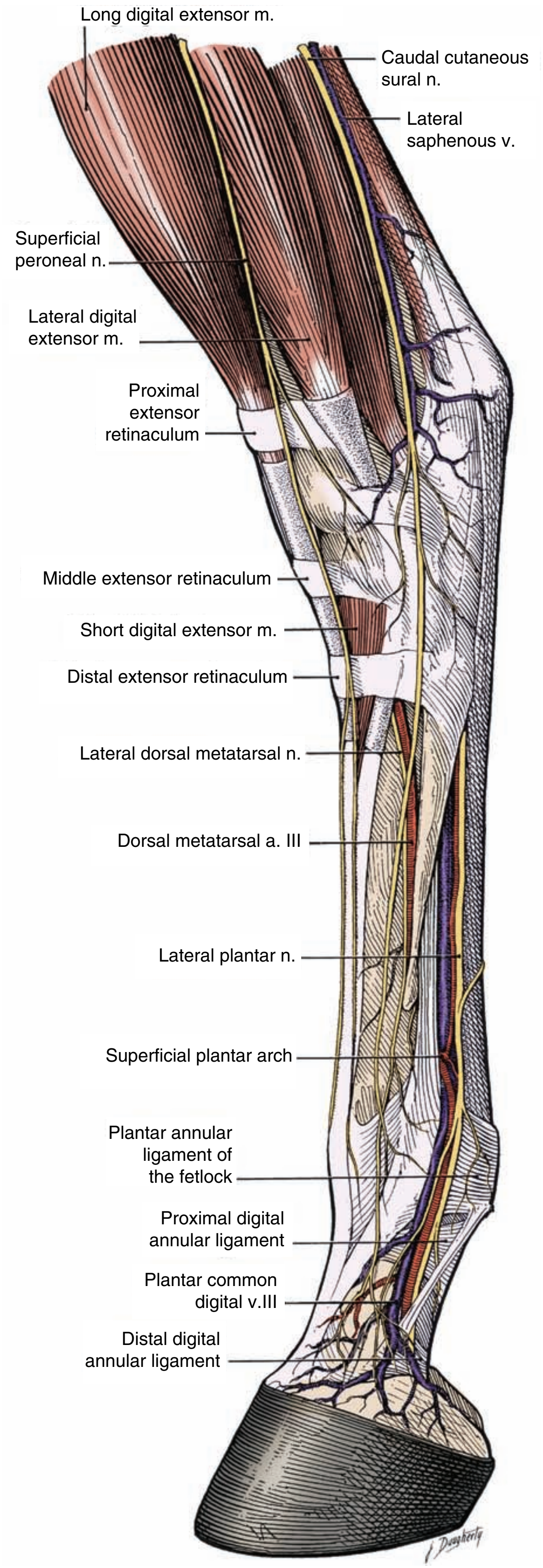

Figure 1.34. Lateral view of left distal crus and pes. Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal) although both are widely used.

The tendon of the long digital extensor muscle extends the length of the metatarsus on the dorsal surface of the cannon bone. At the proximal third of the metatarsus, the tendon of the lateral digital extensor muscle joins the long digital extensor tendon. Rarely, the tendon of the lateral digital extensor courses separately to the proximal phalanx. The angle formed by the conjoined long and lateral digital extensor tendons is occupied by the thin, triangular short digital extensor muscle. This vestigial muscle originates on the lateral collateral ligament of the hock, the lateral tendon of the fibularis tertius, and the middle extensor retinaculum. It inserts on the long digital extensor tendon. All digital extensor muscles are bound down by the distal extensor retinaculum in the proximal third of the metatarsus (Figure 1.34).

Emerging under the distal edge of the distal extensor retinaculum, the large dorsal metatarsal artery III ("great metatarsal artery") runs obliquely to the groove between the third and fourth metatarsal bones. A very small satellite vein and the lateral dorsal metatarsal nerve run with the artery. The terminal branch of the caudal cutaneous sural nerve crosses superficial to the dorsal metatarsal artery III (Figure 1.34). Distally the artery passes between the cannon and lateral splint bones near the button of the splint. Here it continues as the distal perforating branch, sending branches to the distal deep plantar arch and then dividing into medial and lateral digital arteries. These continue along the plantar aspect of the third metatarsal bone in the distal fourth of the metatarsus.

The lateral dorsal metatarsal nerve remains superficial, courses to the fetlock, and descends on the dorsal pastern to terminate in the laminar corium. The medial dorsal metatarsal nerve supplies sensory fibers to the hock joint capsule and a motor branch to the short digital extensor muscle. The nerve courses between the long digital extensor tendon and the second metatarsal bone to be distributed distally to the pastern and laminar corium (Figure 1.35).

Lateral and Medial Aspects

The lateral and medial plantar nerves lie plantar to their satellite vessels along the dorsal borders of the digital flexor tendons (Figures 1.34 and 1.35). These nerves supply the lateral, medial, and plantar structures of the metatarsus. The lateral plantar nerve gives rise to a deep branch close to the tarsus; this is the parent trunk of the deeply located lateral and medial plantar metatarsal nerves that pursue courses homologous to the palmar metacarpal nerves in the forelimb. It likewise gives off a sensory branch to the suspensory ligament at this level.

At about the mid-metatarsus, the medial plantar nerve gives off the communicating branch that angles laterodistad superficial to the digital flexor tendons to join the lateral plantar nerve in the distal fourth of the metatarsus. The communicating branch is generally smaller than its counterpart in the metacarpus, and it may be absent.

On each side the very small medial and lateral plantar arteries arise from the deep plantar arch in the proximal metatarsus, itself supplied mainly by the proximal perforating branch from the dorsal pedal artery. The plantar arteries course down to the distal end of the

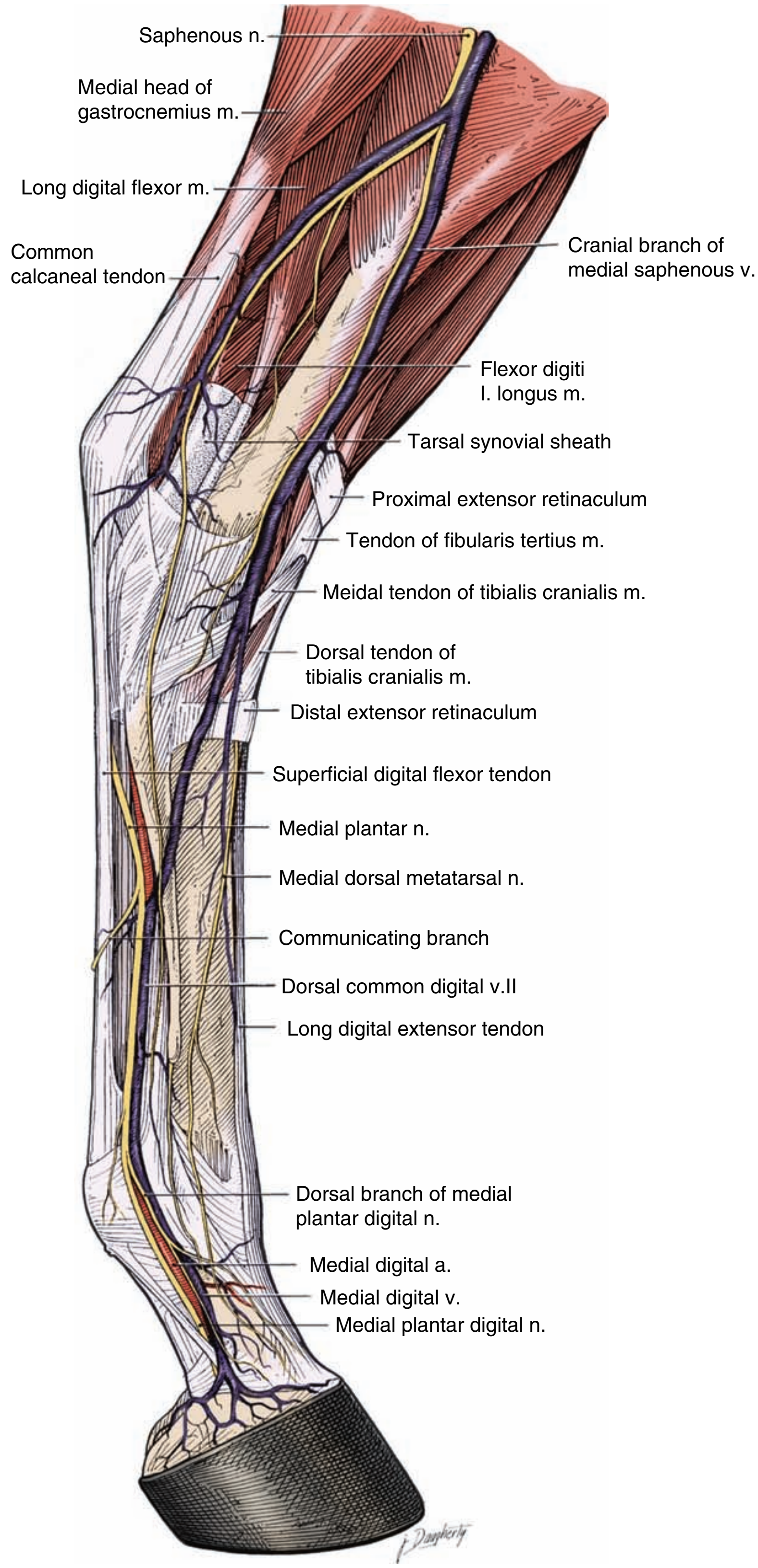

Figure 1.35. Medial view of left distal crus and pes. Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal), although both are widely used.

metatarsus where they send branches to the respective digital arteries, forming the superficial plantar arch.

Plantar Aspect

The SDFT is similar to the corresponding tendon in the metacarpus.[11] The deep digital flexor muscle's principal tendon is intimately related to the SDFT. In the proximal third of the metatarsus, the tendon of the medial digital flexor muscle (a.k.a. the medial head of the deep digital flexor muscle) joins the main part of the DDFT. A poorly developed, slender accessory ligament (tarsal or "inferior" check ligament) arises from the plantar aspect of the fibrous joint capsule of the hock. Longer and more slender than its counterpart in the forelimb, it joins the DDFT near the middle of the metatarsus. The tarsal check ligament may be absent in some horses, and it is usually absent in mules and ponies.[16]

The suspensory ligament takes origin from a large area on the proximal aspect of the third metatarsal bone, with a smaller attachment on the distal row of tarsal bones. Lying within the plantar groove created by the metatarsal bones, the suspensory ligament of the hindlimb is relatively thinner, more rounded, and longer than the ligament of the forelimb. In some horses (e.g. Standardbreds), the suspensory ligament of the hindlimb contains more muscle than the suspensory ligament of the forelimb.[45] The two extensor branches course in a similar manner to those in the forelimb. Vestigial medial and lateral interossei and lumbricales muscles are present in the metatarsus as in the metacarpus.

Distribution of the medial and lateral plantar metatarsal arteries coursing distad under the suspensory ligament to the distal deep plantar arch is similar to the distribution of the palmar metacarpal arteries. Satellite veins accompany the arteries.

Tarsus (Hock)

The bones of the tarsus include the talus, calcaneus, and central, fused first and second, third, and fourth tarsal bones (Figure 1.33). Proximally, the trochlea of the talus articulates with the tibia in the tarsocrural (a.k.a. tibiotarsal) joint; the distal row of tarsal bones and the three metatarsal bones articulate in the tarsometatarsal joint. Extensive collateral ligaments span these and the intertarsal joints. In the horse, nearly all the movement of the hock arises from the tarsocrural joint.

Dorsal Aspect

The large cranial branch of the medial saphenous vein continues proximad and crosses the mediodorsal aspect of the tarsus, lying upon the dorsomedial pouch of the tarsocrural joint capsule (Figure 1.36). The dorsal pedal vein is continued proximad by the cranial tibial vein, which lies under the cover of the cranial tibial muscle. The superficial fibular (peroneal) nerve lies lateral and parallel to the tendon of the long digital extensor muscle. The middle extensor retinaculum leaves the lateral tendon of insertion of the fibularis (peroneus) tertius muscle, wraps superficial to the long digital extensor tendon and its sheath, and attaches to the calcaneus.

The long digital extensor tendon is located just lateral to the palpable medial ridge of the trochlea of the talus. Its synovial sheath extends from the level of the lateral malleolus distad nearly to the junction of the tendon with the tendon of the lateral digital extensor muscle (Figure 1.34). The short digital extensor muscle covers the tarsal joint capsule, the dorsal pedal artery, and the termination of the deep fibular nerve as it bifurcates into the two dorsal metatarsal nerves (Figure 1.34).

As it crosses the dorsal surface of the tarsocrural joint, the tendon of the fibularis tertius muscle is superficial to the tendon of the cranial tibial muscle (Figures 1.35 and 1.36). After passing deep to the proximal extensor retinaculum, it splits to create a sleevelike cleft through which the tendon of the cranial tibial and its synovial sheath pass. Having allowed passage of the cranial tibial tendon, the fibularis tertius divides into a dorsal and a lateral tendon of insertion. The dorsal tendon inserts on the third tarsal and third metatarsal bone (Figure 1.36). The lateral tendon extends distad deep to the long digital extensor tendon. It then bifurcates and inserts on the calcaneus and the fourth tarsal bone.

The tendon of the cranial tibial muscle, having emerged through the fibularis tertius, itself bifurcates into a dorsal tendon, which inserts on the cannon bone, and a medial ("cunean") tendon, which angles mediad to insert on the first tarsal bone after passing superficial to the medial tendon of insertion of the fibularis tertius. A large bursa (cunean bursa) is interposed between the cunean tendon and the long medial collateral ligament (Figure 1.37).

The cranial tibial artery is the main blood supply to the pes (tarsus, metatarsus, and digit). At the level of the tarsocrural joint, it is continued as the dorsal pedal artery (Figure 1.36). Branches from the dorsal pedal artery form the dorsal tarsal rete in the tarsal fascia. Small medial and lateral tarsal arteries arise from the dorsal pedal artery and supply respective sides of the tarsus. Before continuing as the dorsal metatarsal artery III, the dorsal pedal artery gives off the proximal perforating branch that traverses the vascular canal formed by the central, third, and fourth tarsal bones. This branch joins the proximal deep plantar arch. Satellite veins accompany the arteries.

Lateral Aspect

The caudal cutaneous sural nerve innervates the lateral aspect of the tarsus as it courses superficial to the calcaneus and from the more dorsally located superficial fibular nerve (Figure 1.34).

The tendon of the lateral digital extensor muscle is bound by a fibrous band in a groove in the lateral malleolus of the tibia and then passes through the long lateral collateral ligament of the tarsus as it angles dorsodistad (Figure 1.38). A synovial sheath enfolds the tendon from just proximal to the lateral malleolus to a point just proximal to the tendon's junction with the long digital extensor tendon. Plantar to the lateral extensor tendon, the lateroplantar pouch of the tarsocrural joint capsule protrudes between the lateral malleolus and the calcaneus.

Medial Aspect

The chestnut, the keratinaceous vestige of a tarsal pad, is located in the skin on the distomedial aspect of

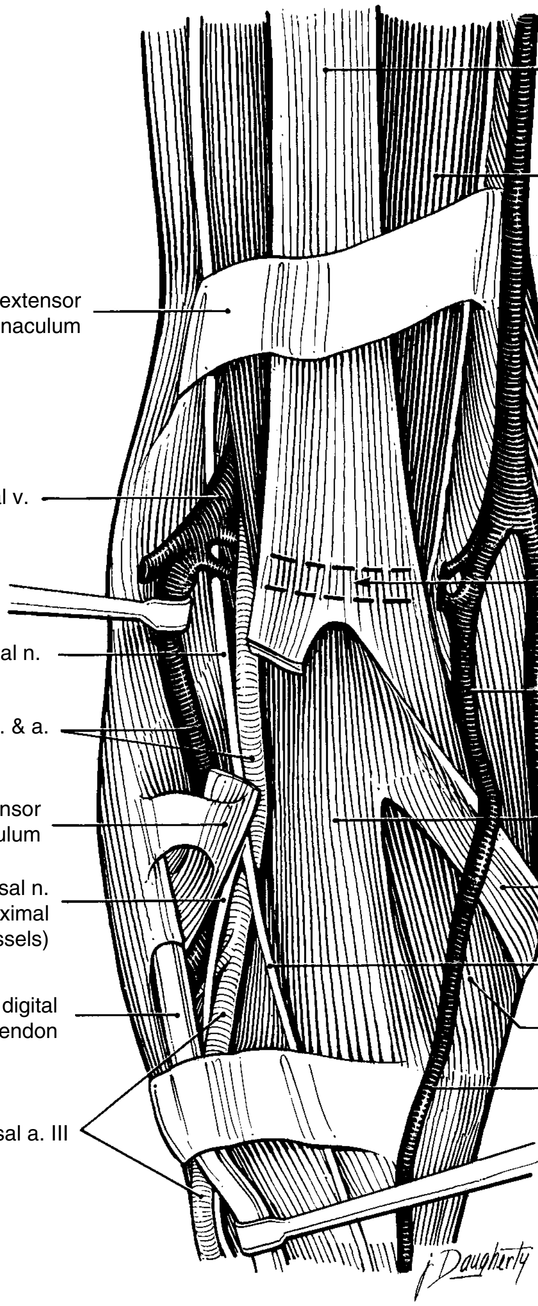

Figure 1.36. Dorsal dissection of right tarsus. The long digital extensor and short digital extensor muscles have been removed. The lateral tendon of the fibularis tertius is sectioned. Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal), although both are widely used.

the tarsus. Branches from the saphenous and tibial nerves supply sensory innervation to the medial aspect of the tarsus. The large cranial branch of the medial saphenous vein courses subcutaneously, superficial to the dorsomedial pouch of the tarsocrural joint capsule. At the level of the medial malleolus of the tibia, it sends a small anastomotic branch to the cranial tibial vein. The caudal branch of the medial saphenous vein receives blood from branches in the medial and plantar regions of the hock.

A palpable feature of the medial aspect of the hock is the medial (cunean) tendon of the cranial tibial muscle as it inserts on the fused first and second tarsal bone. The bursa between the cunean tendon and the distal part of the long medial collateral ligament of the tarsus is not normally palpable (Figure 1.37). The tendon of the medial digital flexor (a.k.a. medial head of the deep digital flexor muscle or long digital flexor muscle) passes through a fascial tunnel plantar to the medial collateral ligament. A synovial sheath surrounds this tendon from the distal fourth of the tibia to the tendon's junction with the main tendon of the deep digital flexor (Figure 1.39). A compartment of the tarsocrural joint capsule, the medioplantar pouch, is located a short distance plantar to the medial digital flexor tendon and proximal to the sustentaculum tali of the calcaneus at the level of the medial malleolus.

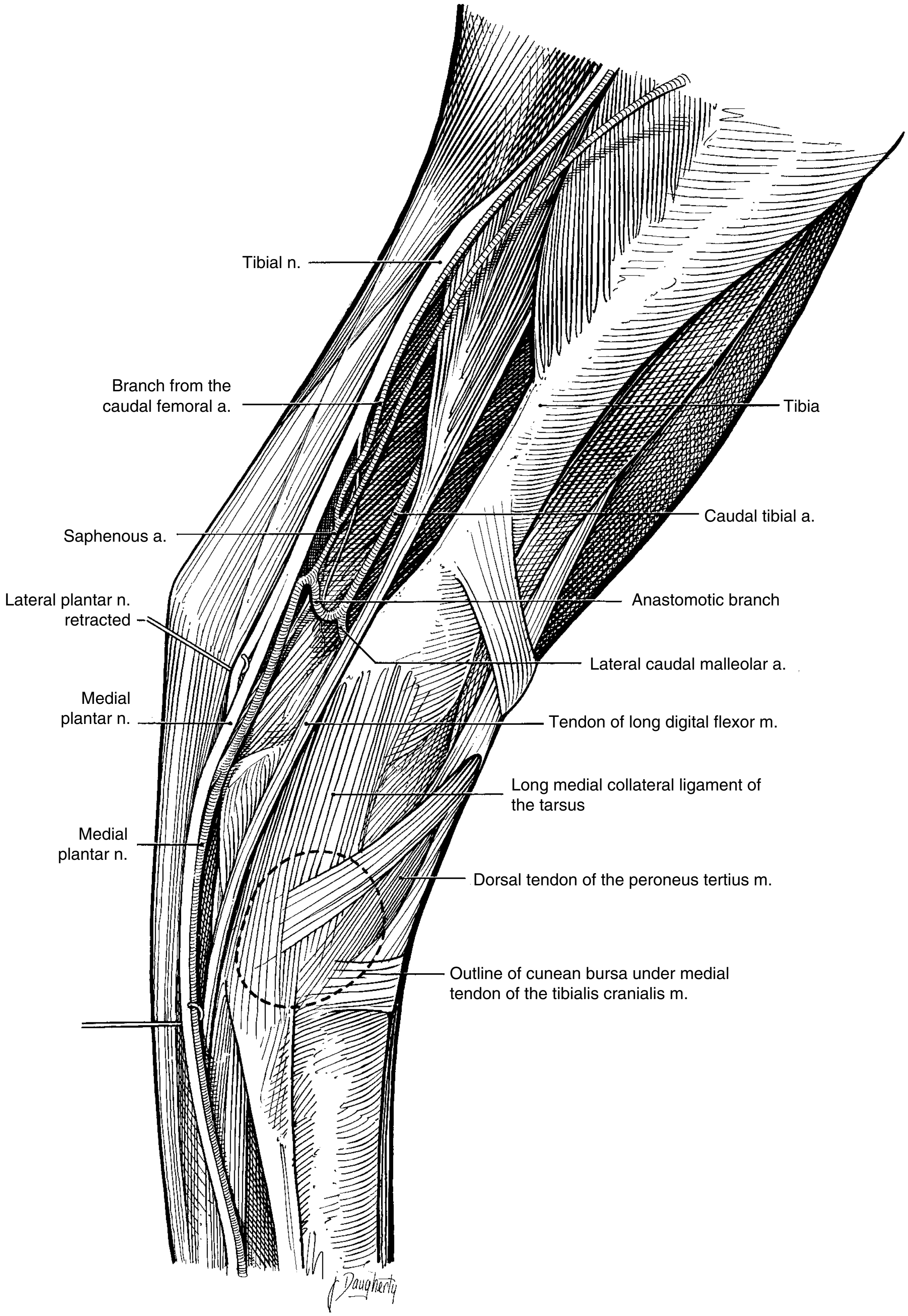

Figure 1.37. Medial dissection of left distal crus, tarsus, and metatarsus. Medial view. Please note that the term “fibularis” has superceded “peroneus” (fibular rather than peroneal), although both are widely used.

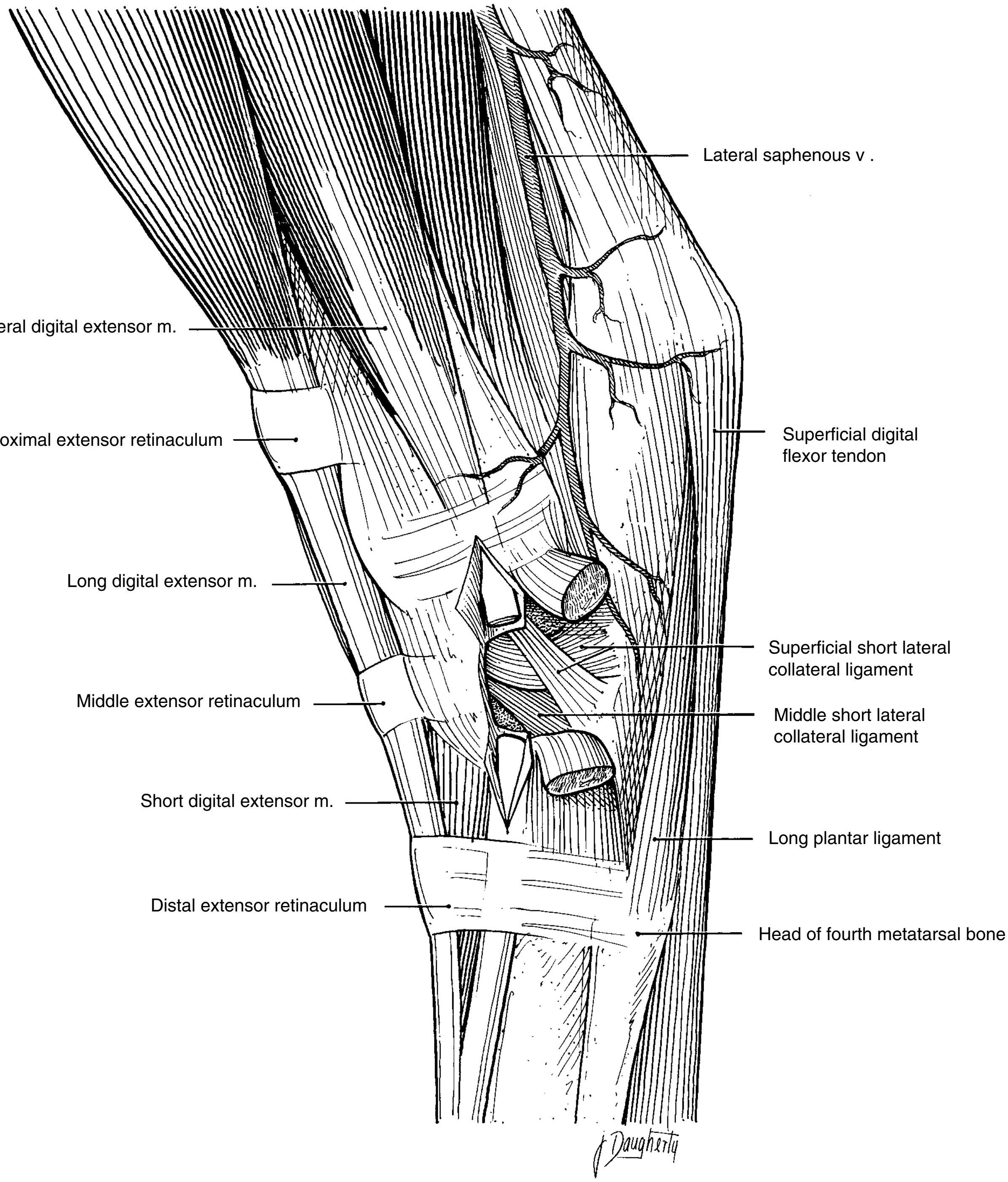

Figure 1.38. Lateral view of left tarsus. The long lateral collateral ligament has been cut and reflected. A section of the lateral digital extensor tendon has been removed.

The tarsal fascia thickens into a flexor retinaculum, bridging the groove on the calcaneus to form the tarsal canal containing the principal tendon of the deep digital flexor muscle. The tendon's synovial sheath, the tarsal sheath, extends from a level proximal to the medial malleolus to the proximal fourth of the metatarsus (Figure 1.35). After joining the anastomotic branch of the caudal tibial artery just proximal to the tarsus, the saphenous artery continues distad with the tendon (Figure 1.37). It bifurcates at the level of the sustentaculum tali of the calcaneus into small medial and lateral plantar arteries. Medial and lateral plantar nerves from the tibial nerve in the distal crural region also accompany the principal DDFT (Figure 1.37). At the level of the tarsometatarsal joint, the medial plantar nerve and artery cross obliquely over the plantar surface of the DDFT to the medial side of the tendon.

Plantar Aspect

In the distal third of the crus, the tendon of the superficial digital flexor muscle arcs around the medial side of

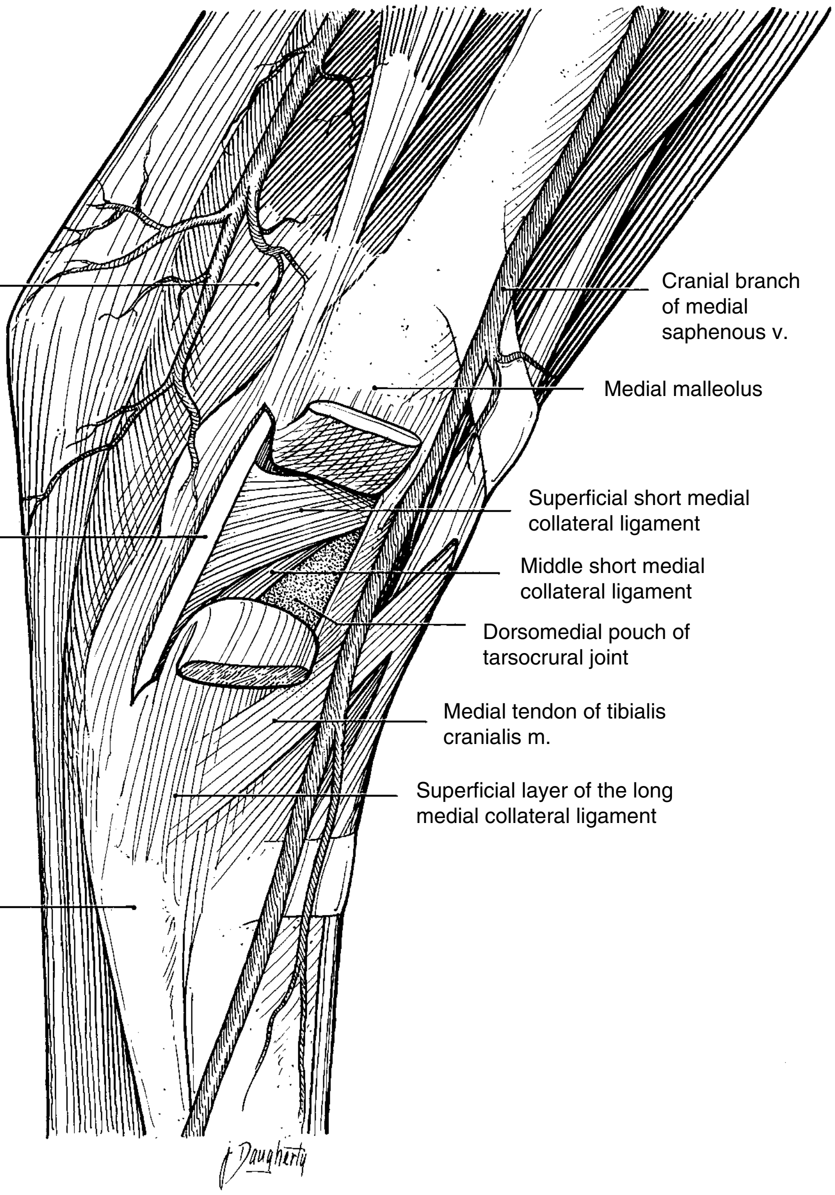

Figure 1.39. Medial view of left tarsus. The long medial collateral ligament has been cut and reflected. The tendon sheath of the long digital flexor tendon has been opened. Please note that "long digital flexor" is an alternative term for the medial head of the deep digital flexor muscle.

the tendon of the gastrocnemius muscle to become superficial as the tendons approach the calcaneal tuber. The SDFT flattens and is joined by aponeurotic connections of the biceps femoris and semitendinosus muscles. This tendinous complex attaches to the point and sides of the calcaneal tuber. The continuation of the tendon then narrows and continues distad superficial to the long plantar ligament. The tendon of the gastrocnemius, deep to the superficial digital flexor at the hock, inserts on the plantar surface of the calcaneal tuber. An elongated bursa is interposed between the two tendons just above the tarsus. A smaller bursa is present between the SDFT and the calcaneal tuber. These two bursae usually communicate across the lateral surface of the gastrocnemius tendon.[30] An inconstant subcutaneous bursa may develop over the superficial digital flexor at the level of the calcaneal tuber.

Deep to the superficial digital flexor, the long plantar ligament is attached to the plantar surface of the calcaneus. It terminates distally on the fourth tarsal bone and the proximal extremity of the fourth metatarsal bone (Figure 1.38).

Tarsal Joint (Hock Joint)

The distal end of the tibia features deep grooves that constitute the cochlear articular surface. In the standing position, the dorsal articular angle of the hock is around 150°.[16] The joint can be flexed to the extent that the metatarsus contacts the cranial crus. During flexion of the tarsocrural joint, the pes is directed slightly laterad due to the configuration of the joint. Joints between the tarsal bones of the same row, the intertarsal joints, and the tarsometatarsal joint are capable of only a small amount of gliding movement, so that nearly all of the hock's range of motion arises from the tarsocrural joint.

A long collateral ligament and three short collateral ligaments bind each side of the hock (Figures 1.38–1.40).[43] The long lateral collateral ligament extends from the lateral malleolus and attaches distally to the calcaneus, talus, fourth tarsal, lateral splint, and cannon bones. The three short lateral collateral ligaments are fused proximally where they attach to the lateral malleolus. The superficial component attaches distoplantarly to both the talus and calcaneus, whereas the middle and deep short lateral collateral ligaments attach solely on the lateral surface of the talus.

The long medial collateral ligament of the hock has less well-defined borders than its lateral counterpart. From its proximal attachment on the medial malleolus, the long medial collateral ligament extends distad and divides into two layers along its dorsal border. The superficial layer passes over the cunean tendon of the cranial tibial muscle and attaches to the fused first and second tarsal bones and the second and third metatarsal bones just distal to the cunean bursa. The deep layer attaches distally to the talus and the central and third tarsal bones. The plantar edge of the ligament attaches to the deep fascia over the sustentaculum tali and the ligament between the second and third metatarsal bones.

The superficial short medial collateral ligament extends from the medial malleolus to the tuberosities of the talus and the ridge between them (Figure 1.39). The middle short medial collateral ligament extends obliquely from the medial tibial malleolus to the sustentaculum tali and central tarsal bone. It lies on the medial surface of the talus between the two tuberosities, varying in position during movement of the joints. The smallest component, the deep short medial collateral ligament, courses from the distal edge of the medial tibial malleolus obliquely to the ridge between the two tuberosities of the talus.

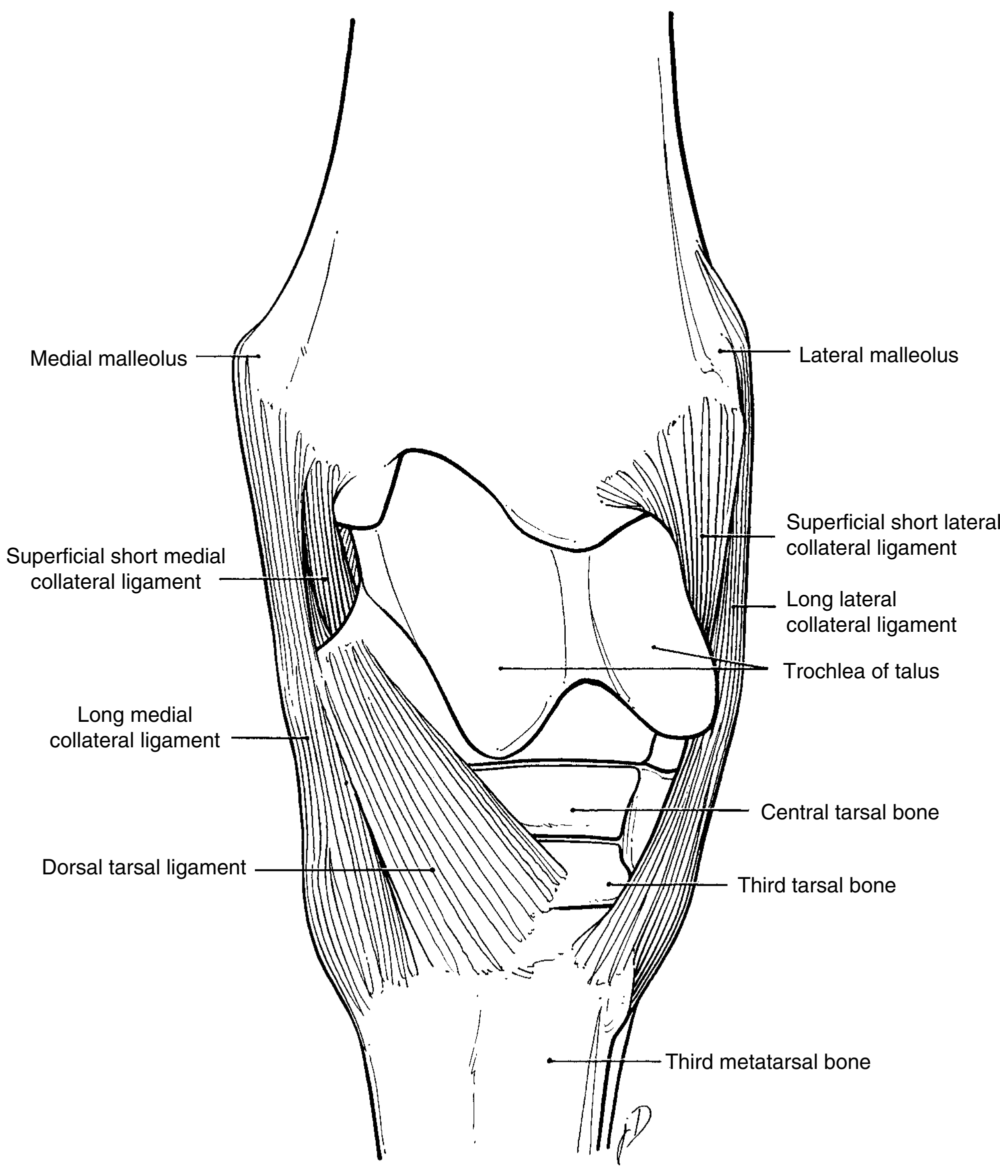

Figure 1.40. Dorsal view of right tarsus.

A dorsal tarsal ligament fans out distad from the distal tuberosity of the talus, attaching to the central and third tarsal bones and the proximal extremities of the second and third metatarsal bones (Figure 1.40). A plantar tarsal ligament attaches to the plantar surface of the calcaneus and fourth tarsal bone and the fourth metatarsal bone. Smaller, less distinct ligaments join contiguous tarsal bones.

The tarsal joint capsule is thinnest dorsally and thickest in its plantar and distal parts. Cartilage in the capsule covering the flexor groove of the sustentaculum tali provides a smooth surface for the DDFT. Distally the tarsal check ligament of the DDFT takes origin from the fibrous joint capsule.

Three pouches can protrude (most notably with joint effusion) from the large tarsocrural synovial sac where it is not bound down by ligaments: the dorsomedial (largest), medioplantar, and lateroplantar pouches. The tarsocrural sac consistently communicates with the synovial sac associated with the proximal intertarsal joint formed by the talus and calcaneus proximally and the central and fourth tarsal bones distally. The distal intertarsal sac, between the central tarsal and contiguous bones and the distal tarsal row, typically does not communicate with the proximal intertarsal sac, but may communicate with the synovial sac of the tarsometatarsal joint. Communications have been demonstrated in 8.3%–23.8% of cases studied.[38]

Movements of the Tarsocrural Joint

The tarsocrural joint is flexed by contraction of the cranial tibial muscle and the passive pull of the tendinous fibularis (peroneus) tertius. Contraction of the gastrocnemius, biceps femoris, and semitendinosus muscles and the passive pull of the tendinous superficial digital flexor muscle extend the joint. By virtue of its attachments in the extensor fossa of the femur proximally, and on the lateral aspect of the tarsus and dorsal surface of the third metatarsal bone distally, the fibularis tertius passively flexes the tarsocrural joint when the stifle joint is flexed. The superficial digital flexor originates in the supracondyloid fossa of the femur and attaches to the calcaneal tuber. This part of the superficial digital flexor serves to passively extend the tarsocrural joint when the femorotibial joint is extended. The two tendinous, passively functioning elements constitute the reciprocal apparatus (Figure 1.41).

Crus (Leg or Gaskin)

The crus is the region of the hindlimb containing the tibia and fibula, extending from the tarsocrural joint to the femorotibial joint. The proximal end of the fibula articulates with the lateral condyle of the tibia. Distally the fibula narrows to a free end, terminating in the distal one-half to two-thirds of the crus as a thin ligament. An interosseous ligament occupies the space between the two bones. The cranial tibial vessels pass through the proximal part of the ligament. The current preference among anatomists is to replace the Greek word “peroneus” with its Latin equivalent “fibularis” in the naming of crural structures.

Beneath the skin and superficial fascia, a dense crural fascia invests the entire region. The deep crural fascia is continuous with the femoral fascia and with tendons descending from the thigh. It blends with the medial and lateral patellar ligaments and attaches to the medial tibia in the middle of the leg. Caudally, the crural fascia forms the combined aponeuroses of the biceps femoris and semitendinosus muscles that attach with the SDFT to the calcaneal tuber. Deeper layers of the crural fascia invest the muscles of the leg.

Cranial Aspect

The belly of the long digital extensor muscle is prominent beneath the skin on the craniolateral aspect of the crus. It originates in common with the fibularis tertius from the extensor fossa of the femur, the common tendon descending through the extensor sulcus of the tibia (Figure 1.42). The long digital extensor muscle is related on its deep side to the tendinous fibularis tertius and the fleshy cranial tibial muscles. Caudally, it contacts the lateral digital extensor muscle from which it is separated by a distinct intermuscular septum. The superficial fibular nerve courses distad in the groove between the digital extensor muscles and angles craniad toward the hock. The deep fibular nerve courses distad between the two muscles on the cranial surface of the intermuscular septum. At its origin this nerve sends branches to the digital extensor muscles, fibularis tertius, and cranial tibial muscles (Figures 1.42 and 1.43).

Deep to and intimately associated with the fibularis tertius, the cranial tibial muscle covers the craniolateral surface of the tibia, originating from the tibial tuberosity, lateral condyle, and lateral border of the bone and from the crural fascia (Figure 1.42). After it passes through the interosseous space (between the tibia and fibula), the cranial tibial artery courses distad on the tibia deep to the cranial tibial muscle, accompanied by two satellite veins.

Lateral Aspect

The caudal cutaneous sural nerve arises from the tibial nerve (Figure 1.43). Along with the lateral saphenous vein, the caudal cutaneous sural nerve courses laterad across the gastrocnemius muscle. The nerve and vein then descend under the crural fascia and tarsal attachment of the biceps femoris muscle to the distal third of the crus where the nerve penetrates the crural fascia and divides into several branches, one of which courses distad over the hock to the metatarsus (Figures 1.34 and 1.43).

The tibial attachment of the biceps femoris muscle is a broad aponeurosis. It sweeps across the proximal third of the lateral crus to attach to the cranial tibial border. Deep to the belly of the biceps femoris, the common fibular nerve crosses the lateral surface of the lateral head of the gastrocnemius muscle and divides into superficial and deep fibular nerves (Figure 1.43). Caudal to these, the lateral digital extensor muscle originates on the fibula, interosseus ligament, lateral surface of the tibia, and the lateral collateral ligament of the femorotibial joint. The lateral head of the deep digital flexor muscle lies caudal to the belly of the lateral digital extensor.

The lateral head of the gastrocnemius originates on the lateral supracondyloid tuberosity of the femur.

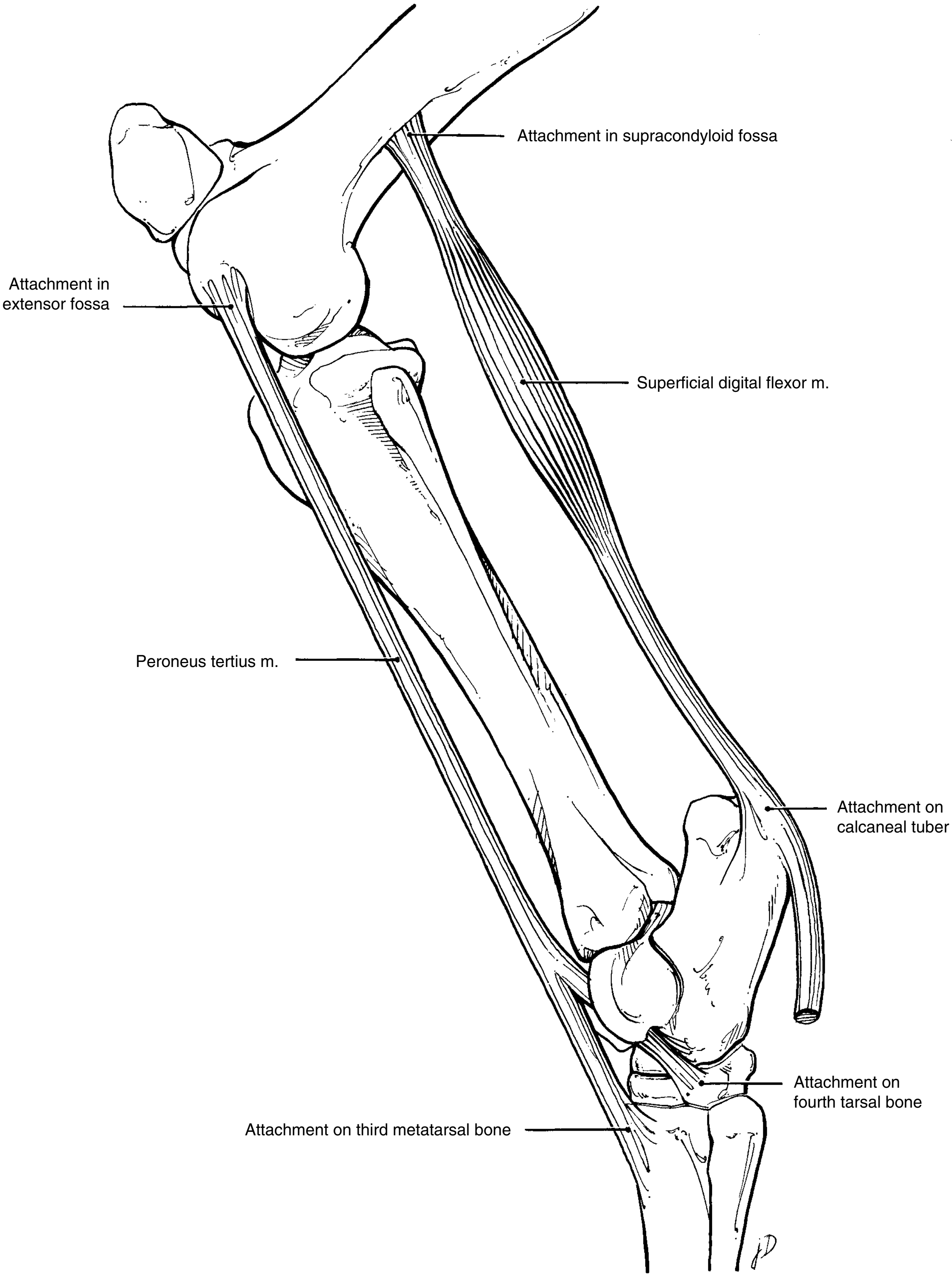

Figure 1.41. Reciprocal apparatus, lateral view of left hindlimb. Please note that the term “fibularis” has superseded “peroneus” (fibular rather than peroneal), although both are widely used.

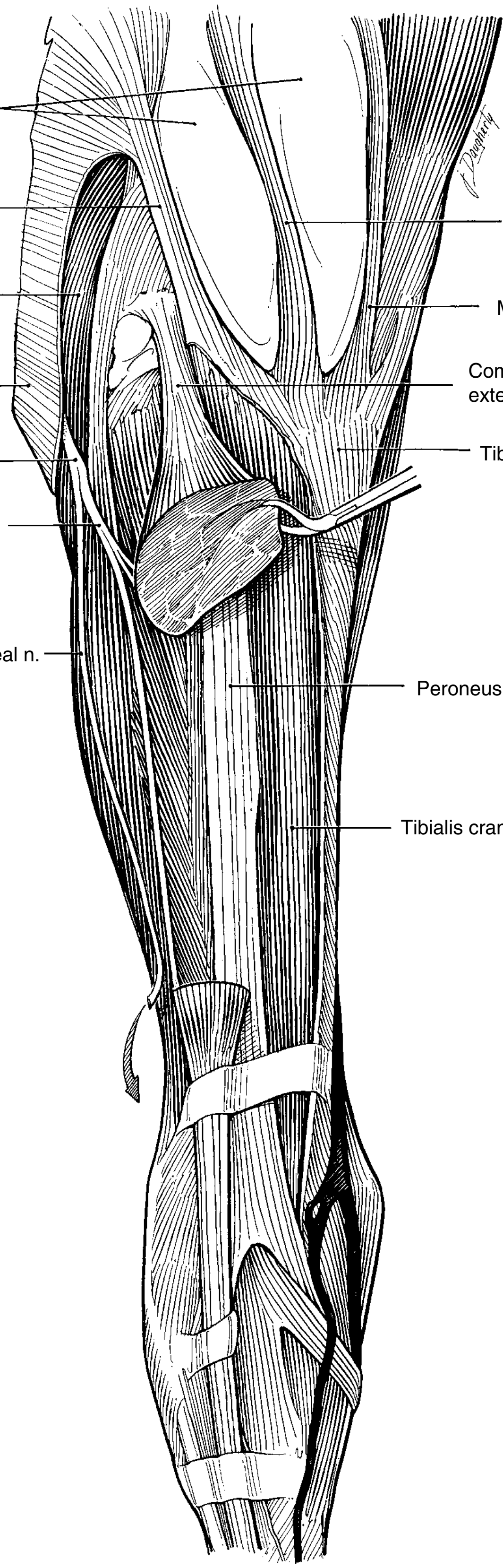

Figure 1.42. Dorsal view of right stifle, crus, and tarsus. The long digital extensor muscle belly has been removed, along with the terminal parts of the superficial fibular (peroneal) nerve (shown by arrow). Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal), although both are widely used.

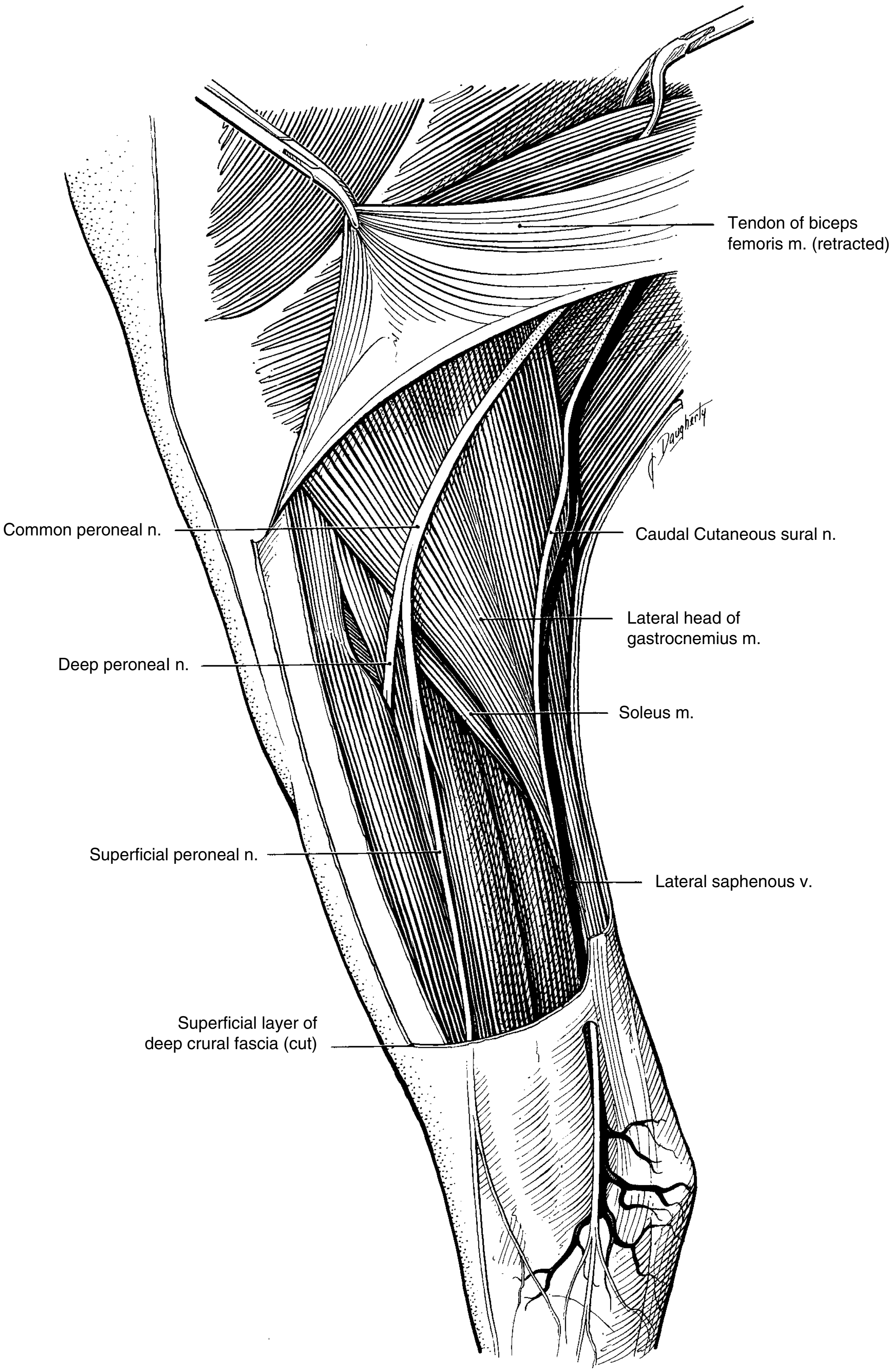

Figure 1.43. Superficial dissection of lateral aspect of left stifle, crus, and tarsus. Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal), although both are widely used.

Under the crural fascia in the proximal half of the crus, the small soleus muscle extends from its origin on the fibula along the lateral aspect of the gastrocnemius muscle to join the gastrocnemius tendon (Figure 1.43).

Medial Aspect

Throughout most of its length, the medial surface of the tibia is subcutaneous (Figure 1.35). Sensation is provided to the medial and cranial aspects of the crus by branches of the saphenous nerve. The distal continuation of the nerve follows the prominent cranial branch of the medial saphenous vein that angles across the medial surface of the tibia. Accompanied by the saphenous artery, the smaller caudal branch of the medial saphenous vein crosses medial to the medial head of the deep digital flexor muscle and joins the cranial branch of the vein superficial to the tibial attachment of the semitendinosus muscle.

Deep to the crural fascia and caudal to the caudal branch of the medial saphenous vein, the tibial nerve descends along with branches of the caudal femoral vessels. The tibial nerve bifurcates into the medial and lateral plantar nerves about 8–10 cm proximal to the point of the calcaneal tuber. These nerves continue distad to the tarsus where they diverge to pursue their independent courses.

The caudal tibial vessels lie deep to the tendon of the medial head of the deep digital flexor as it passes distad. The anastomosis between the caudal tibial and saphenous vessels is located medial to the main tendon of the deep digital flexor (Figure 1.37).

Caudal Aspect

Descending from their origins on the supracondylar tuberosities of the femur, the two heads of the gastrocnemius surround the round, mostly tendinous superficial digital flexor. The latter wraps medially from deep to superficial around the gastrocnemius tendon in the distal third of the crus.

The deep digital flexor muscle possesses three heads with a bewildering variety of names that appear in anatomical texts (Figure 1.45). In the distal third of the crus, the flat tendon of the caudal tibial (the superficial head) joins the larger tendon of the lateral head, whereas the tendon of the medial head (medial digital flexor, long digital flexor) passes over the medial aspect of the hock to join the principal tendon in the proximal metatarsus.

Stifle (Genu)

The stifle is the region that includes the stifle joint (femorotibial joints and femoropatellar joint) and surrounding structures.

Cranial Aspect

Cutaneous innervation of the cranial aspect of the stifle is provided by terminal branches of the lateral cutaneous femoral nerve and lateral branch of the iliohypogastric nerve.

Three patellar ligaments descend from the patella, converging to their attachments on the tibial tuberosity. Between the ligaments and the joint capsule of the femoropatellar joint is an extensive fat pad that wraps around the sides of the ligaments (Figure 1.42). The space between the medial and middle patellar ligaments is greater than the space between the middle and lateral ligaments, reflecting the more widely spaced origin of the medial patellar ligament as it arises from the parapatellar fibrocartilage. The fibrocartilage extends mediad from the patella, giving attachment to the medial patellar ligament. This arcs and descends medial to the medial ridge of the femoral trochlea, attaching distally on the medial side of the tibial tuberosity.

Two bursae lie under the middle patellar ligament. The proximal infrapatellar bursa lies between the proximal part of the ligament and the pointed distal end (apex) of the patella. The distal infrapatellar bursa lies between the ligament and the groove of the tibial tuberosity. Inclining mediad from the lateral aspect of the patella, the lateral patellar ligament serves as an attachment for the biceps femoris muscle and for the fascia lata just before the ligament attaches to the lateral aspect of the tibial tuberosity. The tendon from the biceps femoris continues on to the cranial surface of the patella.

The base, cranial surface, and medial border of the patella, and the parapatellar fibrocartilage and femoropatellar joint capsule all serve as attachments for the insertions of the quadriceps femoris muscle.

Lateral Aspect

The insertional parts of the biceps femoris and the semitendinosus muscles dominate the lateral aspect of the stifle region. The tendon from the cranial part of the biceps femoris inserts on the lateral patellar ligament and the patella; the tendon from the middle division of the muscle sweeps craniodistad to insert on the cranial border of the tibia.

Cutaneous innervation is supplied to this region by branches from several nerves: lateral branches of the iliohypogastric and ilioinguinal nerves, the lateral cutaneous sural nerve originating from the common fibular nerve and passing out between the middle and caudal divisions of the biceps femoris, the caudal cutaneous sural nerve (from the tibial nerve), and terminal branches of the caudal cutaneous femoral nerve (from the caudal gluteal nerve).

Deep to the distal part of the biceps femoris muscle, the lateral femoropatellar ligament extends obliquely from the lateral epicondyle of the femur to the lateral border of the patella (Figure 1.44). The lateral head of the gastrocnemius muscle is crossed by the common fibular nerve and, further caudal, by the caudal cutaneous sural nerve and the lateral saphenous vein (Figure 1.43). As it extends from the lateral epicondyle of the femur to the head of the fibula, the thick lateral collateral ligament passes superficial to the tendon of origin of the popliteus muscle that originates from the lateral epicondyle cranial to the collateral ligament. A pouch from the lateral femorotibial joint capsule lies deep to the tendon. The common tendon of the long digital extensor and fibularis tertius takes origin from the extensor fossa in the craniodistal surface of the lateral epicondyle of the femur. The tendon is cushioned as it extends distad by an elongated pouch from the lateral femorotibial joint capsule.

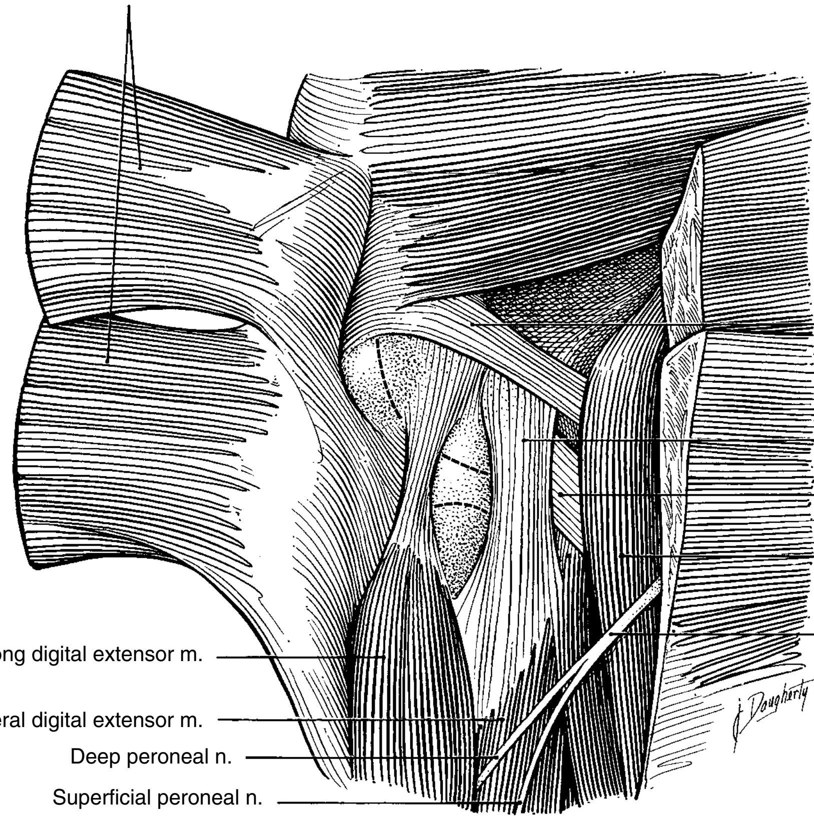

Figure 1.44. Deep dissection of lateral aspect of left stifle with femoral and tibial condylar surfaces indicated by dashed lines. Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal), although both are widely used.

Caudal Aspect

The caudal femoral nerve supplies the skin of the caudal aspect of the stifle. The caudal part of the biceps femoris muscle covers the lateral head of the gastrocnemius; a division of the biceps femoris inserts on the cranial border of the tibia, while another continues distad to attach to crural fascia and the calcaneal tuber. The semitendinosus muscle sweeps to its insertion on the cranial border of the tibia and distad toward its tarsal insertion, covering the medial head of the gastrocnemius. The tendons of the two heads of the gastrocnemius combine, and in the proximal part of the crus, the tendon is superficial to the tendon of the superficial digital flexor muscle. Separation of the two heads of the gastrocnemius muscle reveals the tendinous superficial digital flexor muscle that arises in the supracondylar fossa of the femur between the two heads, its initial part embedded in the lateral head (Figure 1.45).

After giving rise to the caudal cutaneous sural nerve, the tibial nerve descends between the two heads of the gastrocnemius along the medial side of the superficial digital flexor. The tibial nerve supplies the gastrocnemius, soleus, superficial digital flexor, deep digital flexor, and popliteus muscles. The femoral artery gives off the distal caudal femoral vessels and continues as the popliteal artery, descending between the two heads of the gastrocnemius (Figure 1.46). Distal to the stifle joint, the popliteal vessels divide into cranial and caudal tibial vessels. The larger cranial artery, the main blood supply to the pes, deviates laterad into the interosseous space between the tibia and fibula; the smaller caudal tibial artery continues distad between the tibia and the popliteus muscle. Satellite veins of the same name accompany these vessels.

The triangular popliteus muscle extends mediodistad from its origin on the lateral epicondyle of the femur (Figure 1.44). The tendon of origin passes deep to the lateral collateral ligament of the stifle joint, partly enveloped in its course by an extension of the femorotibial joint capsule. The popliteus broadens and inserts on the medial part of the caudal tibia, lying alongside the medial head of the deep digital flexor (Figure 1.45).

Medial Aspect

Skin and fascia on the medial aspect of the stifle are supplied by the saphenous and lateral cutaneous femoral nerves. The region is traversed by the medial saphenous vein and the saphenous artery and nerve. Cranially, the vastus medialis of the quadriceps femoris muscle attaches to the parapatellar fibrocartilage, medial border of the patella, and medial patellar ligament. The strap-like sartorius muscle attaches to the medial patellar ligament and the tibial tuberosity. Caudal to the sartorius, the gracilis muscle also attaches to the medial patellar ligament and to the medial collateral ligament

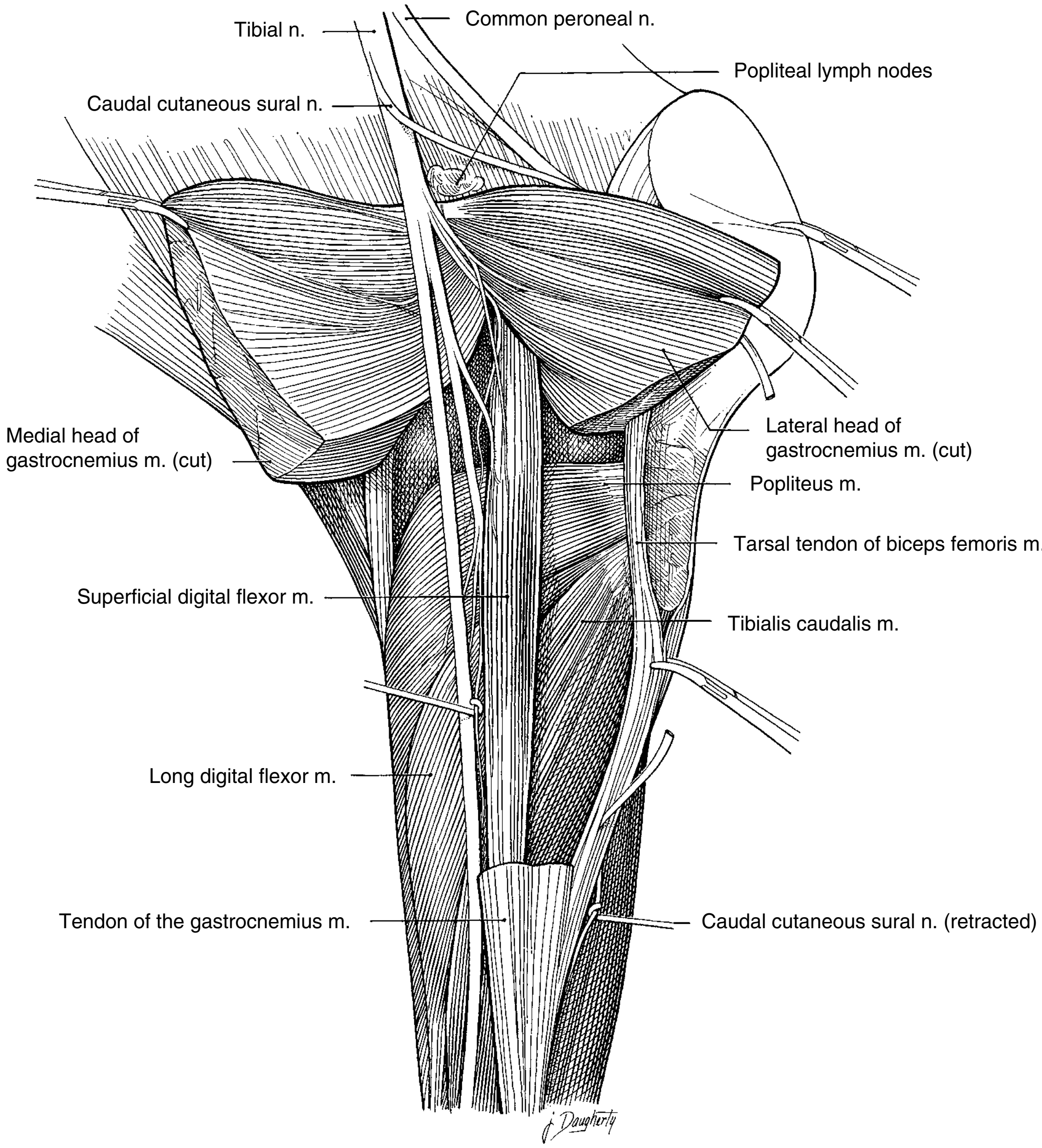

Figure 1.45. Dissection of caudal aspect of right stifle and crus. Please note that the term "fibularis" has superseded "peroneus" (fibular rather than peroneal), although both are widely used.

of the femorotibial joint and the crural fascia (Figure 1.47).

The medial collateral ligament of the femorotibial joint extends from the medial epicondyle of the femur to just distal to the margin of the medial tibial condyle (Figure 1.47). In its course, it detaches fibers to the medial meniscus. The adductor muscle inserts on the ligament and the medial epicondyle. The medial femoropatellar ligament is thinner than its lateral counterpart. It extends from proximal to the medial epicondyle of the femur to the parapatellar fibrocartilage, blending with the femoropatellar joint capsule in its course.

Stifle Joint

The stifle is the "true knee." It comprises two joints, the femoropatellar and femorotibial joints, which together form a hinge joint. The synovial space of the stifle is partitioned into three distinct sacs: the femoropatellar sac and right and left femorotibial joint sacs.[34]

Femoropatellar Joint

The patella is a sesamoid bone between the termination of the quadriceps femoris muscle and the three patellar ligaments constituting the tendon of insertion. The articular surface of the patella is much smaller than the trochlear surface of the femur; the larger gliding surface of the trochlea accommodates the proximal–distal movements of the patella. Contact between the patella and trochlea changes as the patella moves on its gliding surface. During full extension and "locking" of the stifle, the patella is rolled onto to its narrow distal articular surface (resting surface). The narrow craniodorsal surface of the proximal part of the trochlea offers a complimentary resting surface for the patella in this position.[37]

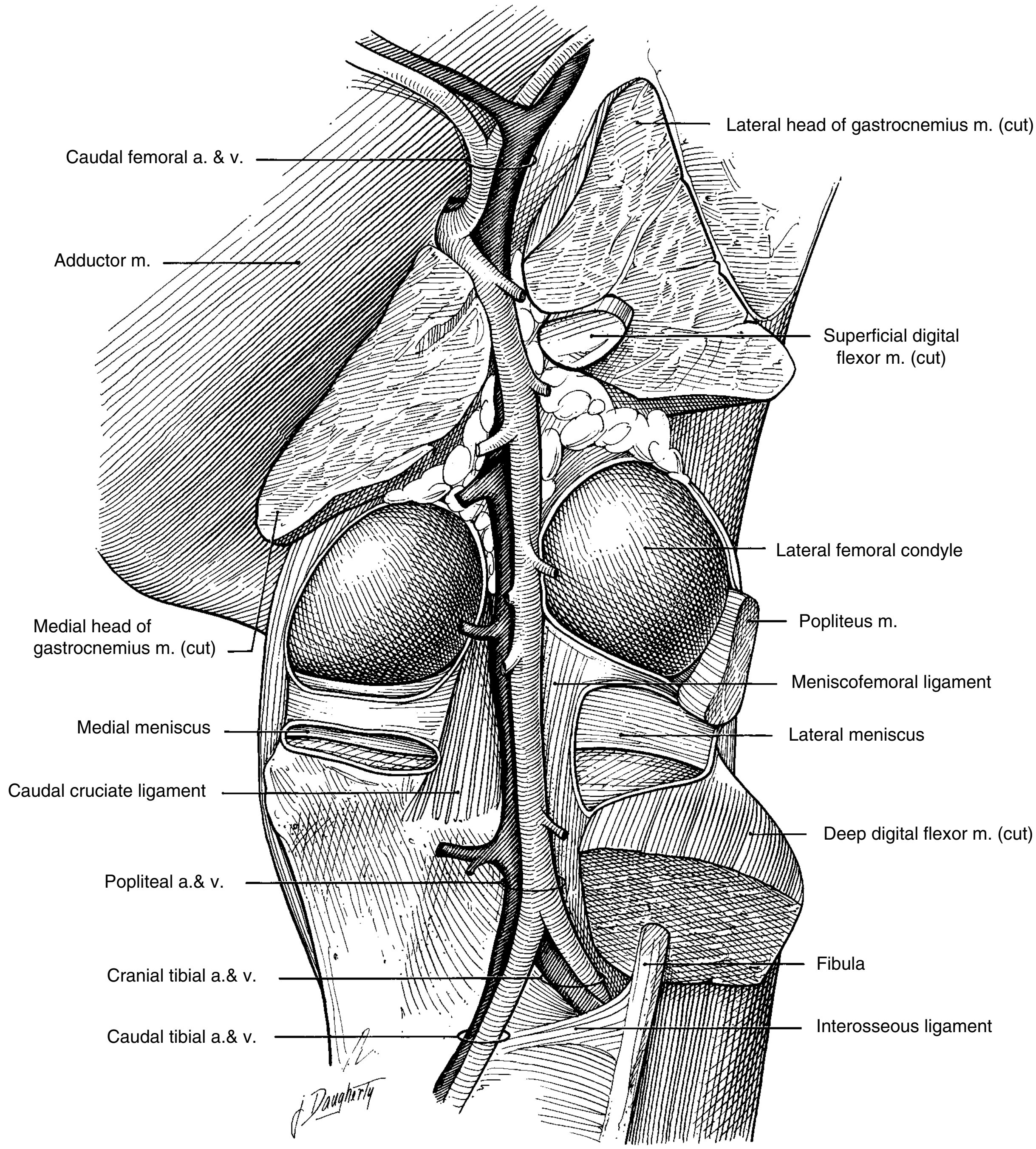

Figure 1.46. Deep dissection of caudal aspect of right stifle. The joint capsule of the femorotibial joint has been opened.

A voluminous joint capsule attaches to the edges of the femoral trochlea, and its patellar attachment lies close to the edge of the patellar articular surface. A large pouch from the joint capsule protrudes proximad under a fat pad and the distal part of the quadriceps femoris muscle. The vastus intermedius of the quadriceps femoris attaches, in part, to the femoropatellar joint capsule, acting to tense the capsule during extension of the femoropatellar joint.

Femorotibial Joint

The fibrous part of the joint capsule is thick caudally, thin cranially. The cruciate ligaments of the femorotibial joint lie between the joint capsule's medial and lateral synovial sacs. These two sacs rarely communicate with one another, although the medial sac communicates with the femoropatellar joint sac in a majority (65%) of horses.[34] Two fibrocartilaginous menisci intervene between the femoral and tibial articular surfaces. An extension of the lateral synovial sac encloses the tendon of origin of the popliteus muscle, and another protrudes distad under the common tendon of origin of the long digital extensor and fibularis tertius muscles.

The two fibrocartilaginous menisci are crescent shaped, thicker peripherally and thinner along the concave edge. Their proximal surfaces are concave to accommodate the convex femoral condyles. Distally they conform to the articular surfaces of the tibial condyles.

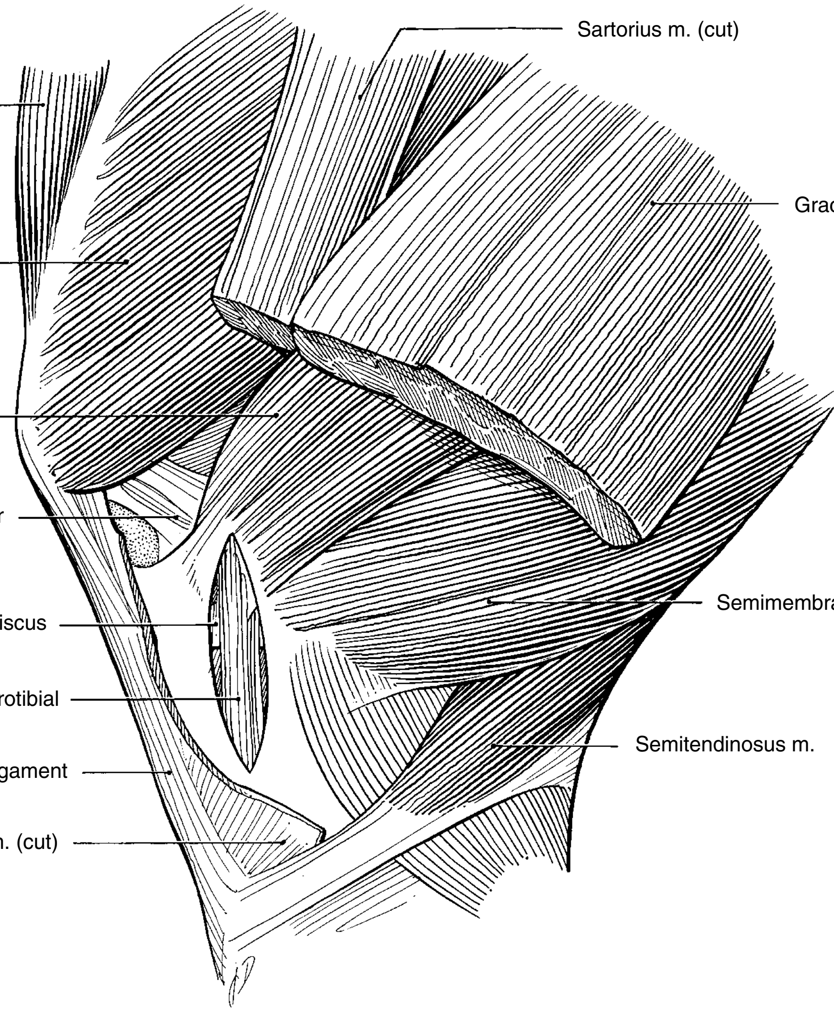

Figure 1.47. Deep dissection of medial aspect of left stifle. Tendon of adductor muscle is incised to reveal medial collateral ligament of the stifle.

Cranial and caudal ligaments anchor each meniscus to the tibia, and a meniscofemoral ligament attaches the caudal aspect of the lateral meniscus to the caudal surface of the intercondyloid fossa of the femur.

In addition to the support rendered by medial and lateral collateral ligaments, the femur and tibia are joined by the two cruciate ligaments that cross one another in the intercondyloid space between the two synovial sacs of the femorotibial joint. The caudal cruciate ligament, the more substantial of the two, extends from the cranial part of the intercondyloid fossa of the femur to the popliteal notch of the tibia, crossing the medial aspect of the cranial cruciate ligament. From its attachment on the caudolateral side of the intercondyloid fossa, the cranial cruciate ligament attaches to a central fossa between the articular surfaces of the condyles.

The stifle is supplied principally by the descending genicular artery that originates from the femoral artery and descends toward the medial aspect of the stifle joint deep to the sartorius and vastus medialis muscles.

Movements of the Stifle Joint

In the standing position, the caudal angle of the stifle joint is around 150°.[16] Extension of the stifle joint through action of the quadriceps femoris, tensor fasciae lata, and cranial division of the biceps femoris muscles is limited by tension from the collateral and cruciate ligaments. Flexion of the joint by the semitendinosus, middle division of the biceps femoris, popliteus, and gastrocnemius muscles is limited only by the caudal muscle masses. During flexion the crus is rotated slightly mediad, and the femoral condyles and menisci move slightly caudad on the tibial condyles.

When a horse shifts its weight to rest on one hindlimb, the supporting limb flexes slightly as the contralateral relaxed limb is brought to rest on the toe. The pelvis is tilted so that the hip of the supporting limb is higher. The stifle on the supporting limb is locked in position as the medial patellar ligament and parapatellar cartilage are pulled proximad and mediad to engage the medial ridge of the femoral trochlea. The locked position achieved by this configuration together with the support rendered by the other components of the stay apparatus minimizes muscular activity in the supporting limb while the relaxed contralateral hindlimb is resting. A very small amount of muscle tone in the vastus medialis is necessary to stabilize the stifle in the locked position.[38]

Thigh and Hip

Lateral Aspect

Cutaneous innervation is supplied to the lateral aspect of the thigh and hip by the lateral branches of the iliohypogastric and ilioinguinal nerves, the caudal cutaneous femoral nerve, and the dorsal branches of the lumbar and sacral nerves.[17]

From caudal to cranial the superficial muscles of the lateral thigh and hip are the semitendinosus, biceps femoris, gluteus superficialis, gluteus medius, and tensor fasciae lata. Both the semitendinosus and biceps femoris have ischiatic (pelvic) and vertebral origins. The semitendinosus attaches to the first and second caudal vertebrae and fascia of the tail, and the biceps femoris attaches to the dorsal sacroiliac ligament and the gluteal and tail fasciae. A prominent longitudinal groove marks the site of the intermuscular septum between the semitendinosus and the biceps femoris muscles.

The strong gluteal fascia gives origin to the long caudal head and the cranial head of the superficial gluteal (gluteus superficialis) muscle. The two heads of the superficial gluteal muscle come together in a flat tendon that attaches to the trochanter tertius of the femur.

The large middle gluteal (gluteus medius) muscle forms most of the mass of the rump. The middle gluteal muscle is massive, giving the rump its rounded shape. It takes origin from the aponeurosis of the longissimus lumborum muscle, the gluteal surface of the ilium, the tuber coxae and tuber sacrale, the sacrotuberal and dorsal sacroiliac ligaments, and the gluteal fascia. Distally the muscle attaches to greater trochanter and the intertrochanteric crest. A smaller deep part of the middle gluteal, the gluteus accessorius, arises entirely from the ilium. Its tendon passes over greater trochanter on its way to attach on the crest distal to the trochanter. The large trochanteric bursa lies between the tendon and the cartilage covering the convexity (Figure 1.48).

The small deep gluteal (gluteus profundus) muscle is deep to the caudal part of the gluteus medius, arising from the ischiatic spine and body of the ilium and attaching on the medial edge of the convexity of the greater trochanter (Figure 1.50). This muscle covers the hip joint and parts of the articularis coxae, a small fusiform muscle that occasionally has two heads. A bursa is commonly present under the tendon of insertion of the deep gluteal.[30]

The tensor fasciae latae muscle arises from the tuber coxae and fans out distally to insert into the fascia lata. An intermuscular septum attaches the caudal part of the muscle to the cranial head of the superficial gluteal. The fascia lata attaches to the patella and the lateral and middle patellar ligaments (Figures 1.48 and 1.49).

On the caudal side of the proximal part of the femur lie three short muscles that arise from their origins on the ischium, pubis, ilium, and wing of the sacrum to insert in the trochanteric fossa. These are the gemelli, external obturator, and internal obturator muscles, which are rotators of the hip joint. The nearby quadratus femoris muscle extends from the ventral aspect of the ischium to a line on the femur near the distal part of the lesser trochanter where it produces hip extension.

A broad sheet of dense white fibrous connective tissue, the sacrotuberous (sacrotuberal) ligament (a.k.a. broad pelvic ligament), forms most of the lateral wall of the pelvic canal, attaching dorsally to the sacrum and first two caudal vertebrae and ventrally to the ischiatic spine and ischiatic tuber (Figure 1.50). The ventral edge of the sacrotuberous ligament creates two openings along the dorsal edge of the ischium: the lesser and greater ischiatic foramina that allow passage of neurovascular bundles to the soft tissues of the rump.

Branches of the cranial gluteal vessels and nerve pass through the greater ischiatic foremen to supply the gluteal muscles, tensor fasciae latae, and articularis coxae. The caudal gluteal vessels and nerve perforate the sacrotuberal ligament dorsal to the sciatic nerve. The caudal gluteal nerve divides into two trunks. The dorsal trunk supplies the biceps femoris, middle gluteal, and long head of the superficial gluteal; after supplying a branch to the semitendinosus, the ventral trunk continues as the caudal cutaneous femoral nerve. The latter passes outward between the biceps femoris and semitendinosus to branch subcutaneously over the lateral and caudal surfaces of the thigh and hip. Muscles in this region are supplied by the caudal gluteal vessels.

In this region the internal pudendal artery courses on the deep face of the sacrotuberous ligament. It will terminate in branches that supply the urogenital organs and the perineal region. Iliolumbar vessels (from the cranial gluteal vessels) course laterad between the iliacus muscle and the ilium, supplying branches to the iliopsoas and longissimus lumborum. The vessels then go around the lateral border of the ilium and supply branches to the middle gluteal and tensor fasciae latae.

The large, flat sciatic nerve passes through the greater ischiatic foramen and courses ventrocaudad on the sacrotuberale ligament (Figure 1.50). Turning distad, the nerve passes over the gemelli, the tendon of the internal obturator, and the quadratus femoris, supplying branches to these muscles. A large branch is detached that supplies the semimembranosus, the biceps femoris and semitendinosus, and adductor medially and the biceps femoris laterally. The sciatic nerve terminates by dividing into common fibular and tibial nerves.

Medial Aspect

The medial aspect of the thigh receives cutaneous innervation from a mosaic of sensory nerves, including lateral cutaneous femoral nerve (craniomedial thigh); medial branches of the iliohypogastric, ilioinguinal, and genitofemoral nerves (medial thigh); and branches from the caudal cutaneous femoral nerve (caudomedial thigh).[17]

Accompanied by the small saphenous artery and the saphenous nerve, the large medial saphenous vein pursues a subcutaneous course proximad on the cranial part of the gracilis muscle and then between the gracilis and sartorius muscles to join the femoral vein. The broad gracilis muscle covers most of the medial aspect of the thigh, attaching proximally to the prepubic tendon, adjacent surface of the pubis, accessory femoral ligament, and middle of the pelvic symphysis. The narrow sartorius muscle takes origin from the tendon of the psoas minor and ilial fascia and descends toward its insertion in the stifle that blends with the aponeurosis of the gracilis.

The pectineus muscle lies deep to the gracilis. It originates on the cranial border of the pubis, the prepubic tendon, and accessory femoral ligament and inserts on

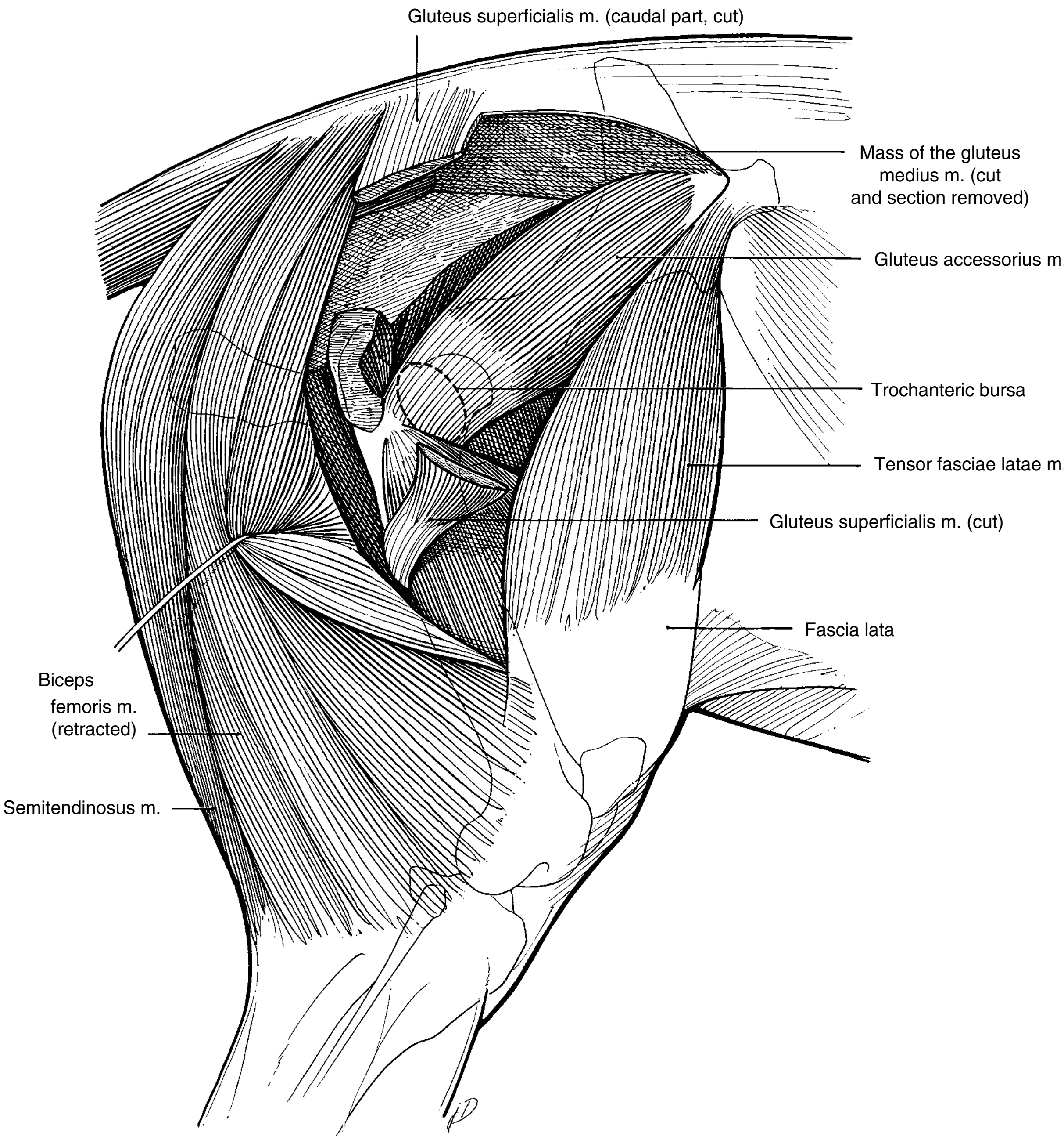

Figure 1.48. Lateral dissection of right thigh and hip. Most of the superficial and middle gluteal muscles have been removed.

the medial femur. The femoral canal, containing the neurovascular bundle supplying the pelvic limb, is bordered caudally by the pectineus, cranially by the sartorius, laterally by the vastus medialis and iliopsoas, and medially by the femoral fascia and cranial edge of the gracilis. The canal contains the femoral artery and vein, the saphenous nerve, and an elongated group of lymph nodes of the deep inguinal lymphocenter. Within the canal the saphenous nerve detaches a motor branch to the sartorius muscle (Figure 1.51).

Caudal to the pectineus and vastus medialis, the thick adductor muscle extends from the ventral surface of the ischium and pubis to the caudal surface of the femur, the medial femoral epicondyle, and the medial collateral ligament of the femorotibial joint. The obturator nerve passes through the cranial part of the obturator foramen and external obturator muscle and branches to supply the external obturator, adductor, pectineus, and gracilis muscles (Figure 1.51). Branches from the obturator artery (from the cranial gluteal artery) supply the muscles in this region.

Cranial Aspect

The quadriceps femoris, articularis coxae, and sartorius muscles lie in the cranial part of the thigh and hip. In addition, the iliacus muscle crosses the cranial aspect of the hip where the muscle is joined by the psoas major, creating the conjoined iliopsoas muscle. Their common tendon inserts on the lesser trochanter. The psoas major

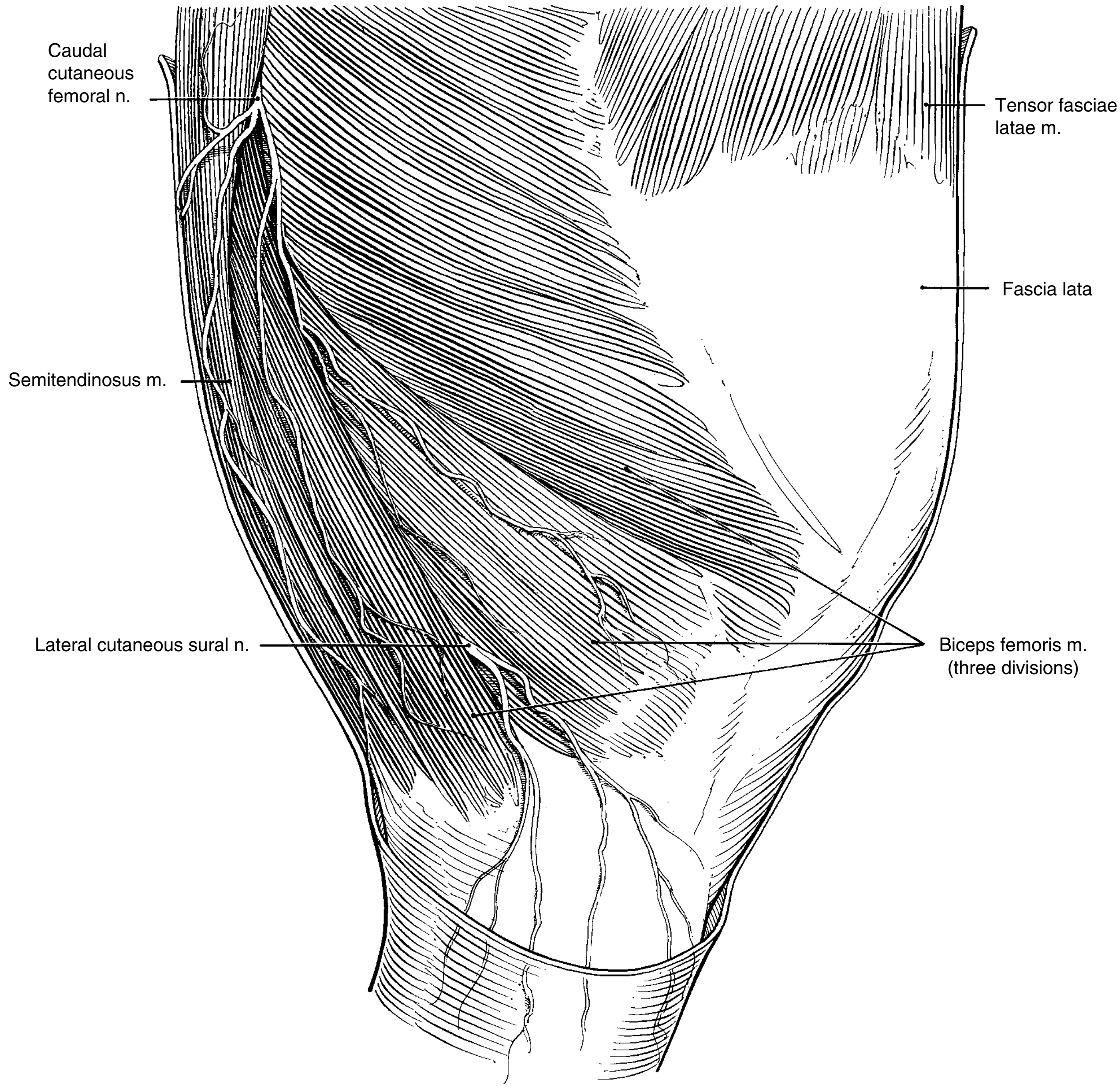

Figure 1.49. Lateral view of right stifle and thigh.

arises from the last two ribs and the lumbar transverse processes; the iliacus comes from the wing of the sacrum, ventral sacroiliac ligaments, ilium, and tendon of the psoas minor muscle.

Three heads of the quadriceps femoris muscles (vastus lateralis, vastus intermedius, and vastus medialis) take origin from the shaft of the femur. The fourth head, the rectus femoris, originates via a pair (medial and lateral) of tendons from the ilium craniodorsal to the acetabulum (Figure 1.50). A bursa is located under the lateral tendon.[30] All four heads of the quadriceps femoris attach to the patella. Bursae occur commonly under the insertions of the rectus femoris, vastus lateralis, and vastus medialis.

The femoral nerve passes distad between the iliopsoas and sartorius muscles. It supplies branches to the iliopsoas (which also receives segmental innervation from lumbar nerves) and to all heads of the quadriceps femoris. Near the insertion of iliopsoas, the femoral nerve gives rise to the saphenous nerve.

Caudal Aspect

Innervation to the caudal skin of the thigh and hip is provided principally by the caudal cutaneous femoral nerve (Figure 1.49). The main muscle mass is that of the semitendinosus and the semimembranosus with the caudal division of the biceps femoris related to these laterally and the gracilis medially. The long head of the semimembranosus attaches to the caudal border of the sacrotuberous ligament. The thicker short head attaches to the ventral part of the ischiatic tuber. The thick, roughly three-sided belly of the semimembranosus ends on a flat tendon that attaches to the medial femoral epicondyle.

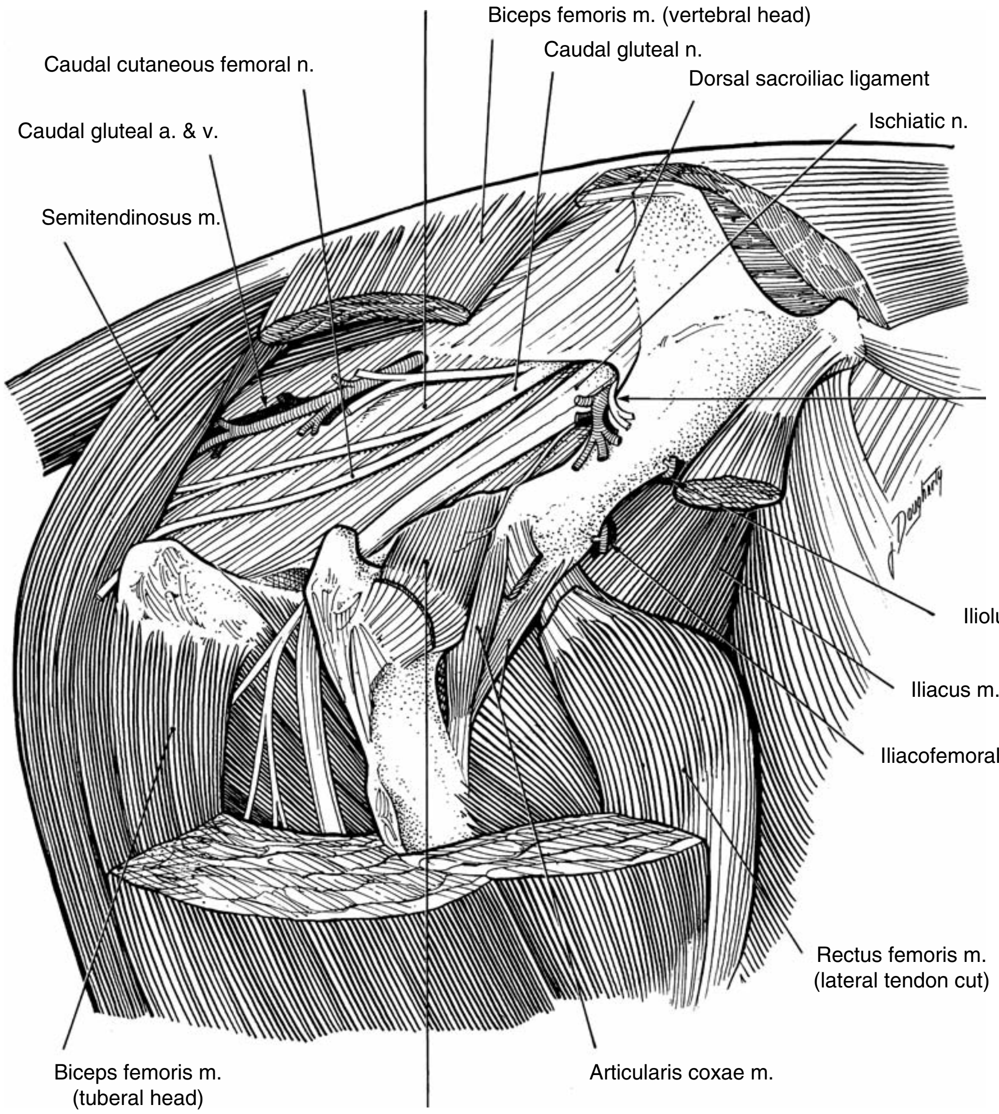

Figure 1.50. Deep dissection of right hip. Lateral view. Superficial and middle gluteal muscles and the vertebral head of biceps femoris removed.

Blood Supply to the Thigh

The external iliac artery gives off the deep femoral artery just prior to passing through the femoral ring to continue as the femoral artery. The deep femoral courses between the sartorius and iliopsoas muscles and then between the latter and the pectineus. After supplying branches to the deep inguinal lymphocenter, the deep femoral artery gives off the large pudendoepigastric trunk. This divides into the caudal epigastric artery and the external pudendal artery. The deep femoral artery continues ventral to the pubis as the medial circumflex femoral artery. This supplies the iliopsoas, pectineus, external obturator muscles, adductor, and semimembranosus. Satellite veins accompany the arteries.

The femoral artery continues distad through the femoral canal accompanied on its caudal side by the femoral vein and cranially by the saphenous nerve. Within the canal the femoral artery gives off the lateral circumflex femoral artery that enters the quadriceps femoris, passing between the vastus medialis and rectus femoris.

The femoral artery directly supplies branches to muscles in this region. At the distal end of the femoral canal, the saphenous artery leaves the femoral artery and passes to the subcutaneous tissues between the gracilis and sartorius muscles. It courses caudodistad, related caudally to the much larger medial saphenous vein. The saphenous nerve accompanies the vessels as they course over the tendon of the gracilis. At the level of the proximal crus, the saphenous artery and medial saphenous vein each divide into cranial and caudal branches. In its course, the saphenous artery supplies the sartorius, gracilis, and adductor muscles as well as fascia and skin.

The next branch of the femoral artery is the nutrient artery of the femur, and then the large descending genicular

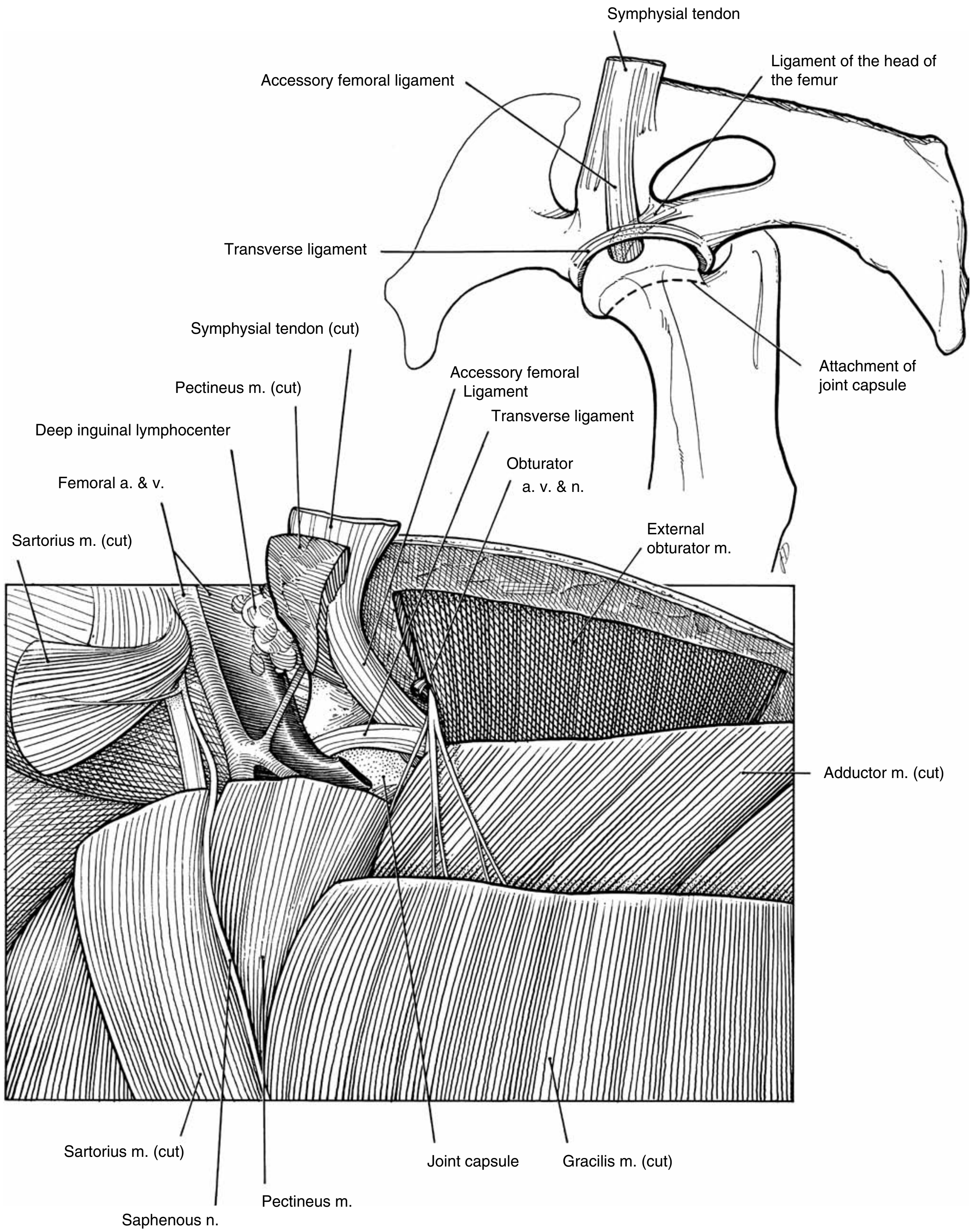

Figure 1.51. Deep dissection of right hip. Ventromedial view.

artery is detached from the cranial wall of the femoral artery. In the distal third of the thigh, the descending genicular artery courses distocraniad between the sartorius and the adductor, supplying these muscles and terminating in branches to the stifle.

The femoral artery gives off its last branch, the (distal) caudal femoral artery, and continues between the medial and lateral heads of the gastrocnemius as the popliteal artery (Figure 1.46). The caudal femoral artery pursues a short course caudad, giving off muscular branches to the superficial digital flexor and gastrocnemius. Ascending branches from this substantial artery supply thigh and calf muscles. A descending branch of the caudal femoral artery runs distocaudad over the lateral head of the gastrocnemius along with the lateral saphenous vein. The many branches of the caudal femoral artery make anastomotic connections between the obturator artery proximally and the saphenous artery distally.

Hip (Coxofemoral) Joint

The acetabulum of the os coxae is formed where the ilium, ischium, and pubis meet. The lunate surface of the acetabulum, a cup-shaped cavity arcing around a deep nonarticular fossa, articulates with the head of the femur. A fibrocartilaginous rim, the acetabular labrum, increases the articular surface of the acetabulum. The transverse acetabular ligament bridges the labrum across the medially located acetabular notch, binding two ligaments as they emerge from the fovea capitis of the femoral head (Figure 1.51). The ligament of the head of the femur comes from the fovea and attaches in the pubic groove on the ventral aspect of the pubis. The thick accessory femoral ligament passes out through the acetabular notch to blend into the prepubic tendon. It provides partial origin to the gracilis and pectineus muscles.

The capacious joint capsule of the hip attaches to the acetabular labrum and on the neck of the femur a few millimeters from the margin of the femoral head (Figure 1.51). The synovial membrane within the joint wraps around the intracapsular ligaments. An outpocketing of the synovium passes out through the acetabular notch to lie between the accessory femoral ligament and the pubic groove. The fibrous joint capsule is intimately attached to the fascia of the external obturator and deep gluteal muscles. Fat covers the capsule dorsally. The articularis coxae muscle is related to the lateral aspect of the hip joint, detaching some fibers to the joint capsule. During flexion of the hip joint, the articularis coxae tense the joint capsule.

Movements of the Hip Joint

While the hip joint is a ball-and-socket joint, it is capable only of very limited movement beyond flexion and extension. Abduction of the thigh is restricted by the ligament of the head of the femur and the accessory femoral ligament. Adduction is checked by the attachments of the gluteal muscles on the femur. In the normal standing position, the caudolateral part of the head of the femur lies outside the acetabulum. The hip joint is slightly flexed in this position. The range of motion between extreme flexion and extension is only 60°.[16]

Flexor muscles of the hip joint are the gluteus superficialis, tensor fasciae latae, rectus femoris, iliopsoas, sartorius, and pectineus. Extensor muscles of the hip joint are the gluteus medius, biceps femoris, semitendinosus, semimembranosus, adductor, and quadratus femoris. Muscles adducting the thigh include the gracilis, sartorius, adductor, pectineus, quadratus femoris, and obturatorius externus. Slight abduction is exerted on the thigh by all three gluteal muscles. The thigh is rotated laterad by the iliopsoas, external and internal obturators, and the gemelli. Medial rotation is accomplished through the combined action of the adductor and gluteus profundus muscles.

Pelvis

The equine pelvis, like that of other animals, comprises ilium, ischium, and pubis; these bones are individually identifiable in the young but have fused by 10–12 months of age.[16] The acetabulum is formed through contributions from all three bones of the pelvis.

The wing-shaped ilium presents two prominences, visible landmarks on the horse. The dorsally directed tuber sacrale inclines mediad toward its fellow, so that the two sacral tubers come within 2–3 cm over the first sacral spinous process. The ilial wing sweeps ventrolaterad as the tuber coxae, creating the point of the hip. Caudally, the ischial tuberosity presents as a laterally directed ridge to which muscles of the thigh attach.

The pubis and ischium from each side meet ventrally at the pelvic symphysis. In the young animal fibrocartilage joins the bones. Later in life, a synostosis is formed as the cartilage ossifies in a cranial to caudal sequence.

Lymphatic Drainage

Two lymphocenters are involved in the lymphatic drainage of the pelvic limb. The popliteal lymphocenter consists of 3–12 small popliteal lymph nodes embedded about 5 cm deep between the biceps femoris and semitendinosus muscles adjacent to the tibial nerve (Figure 1.44). They may be absent in some horses. The popliteal lymph nodes receive afferent lymphatics from the distal pelvic limb. Efferents drain to the deep inguinal lymphocenter.

The deep inguinal lymphocenter is a mass of lymph nodes 8–12 cm long within the femoral canal. It consists of 16–35 individual lymph nodes. In addition to receiving lymphatic vessels from the popliteal lymphocenter, the lymph nodes of the deep inguinal lymphocenter (Figure 1.50) receive vessels from the caudal abdominal wall and superficial inguinal lymph nodes. Efferent vessels from the deep inguinal lymphocenter are afferent to the medial iliac lymph nodes, located retroperitoneally near the origin of the external iliac arteries.[16]

Stay Apparatus of the Pelvic Limb

The quadriceps femoris muscle and the tensor fasciae latae act to pull the patella, parapatellar cartilage, and medial patellar ligament proximad to the locked position over the medial trochlear ridge of the femur when the limb is positioned to bear weight at rest (Figure 1.52). Through the components of the reciprocal apparatus (cranially,

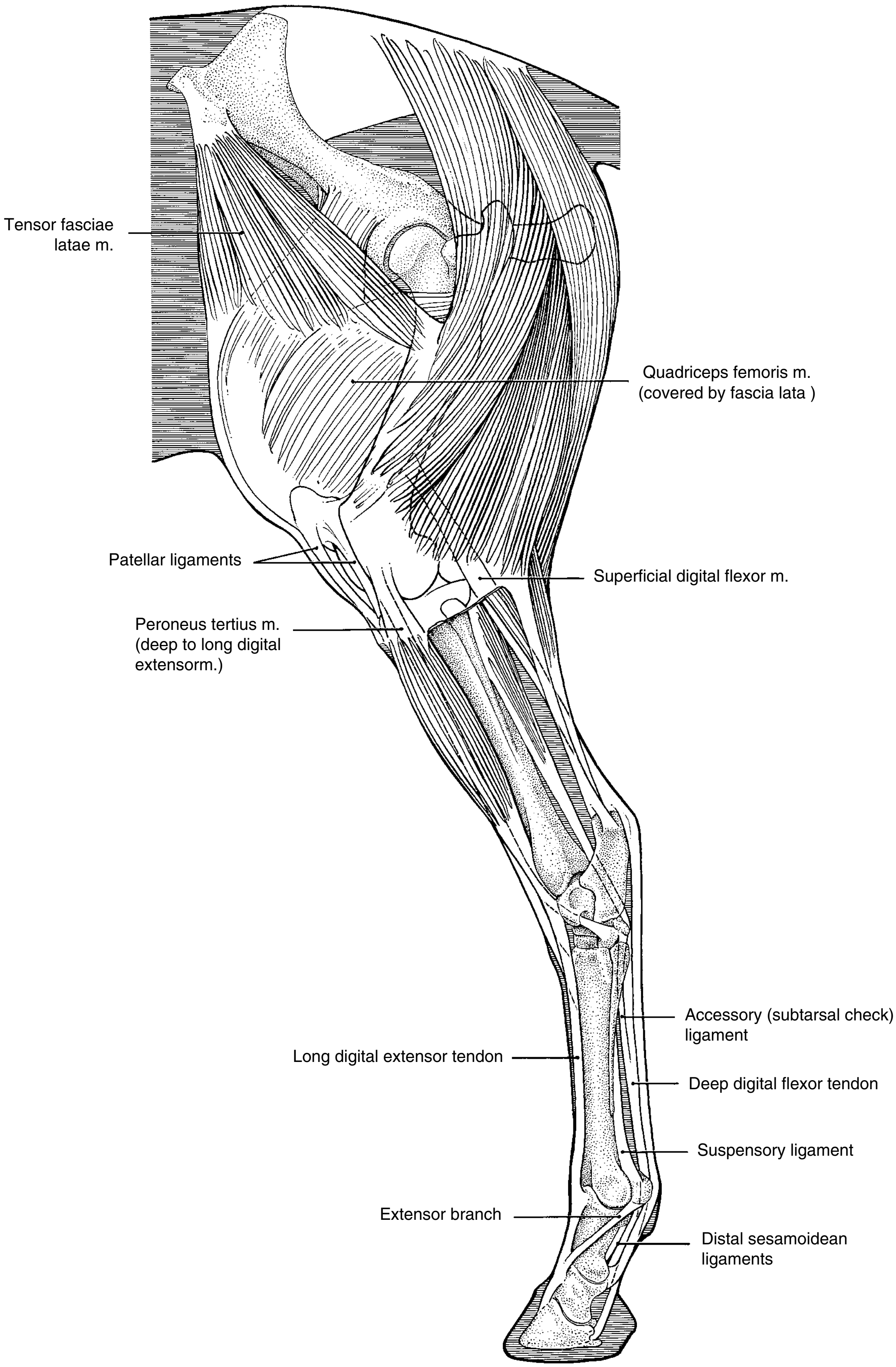

Figure 1.52. Stay apparatus of the pelvic limb.

fibularis tertius and, caudally, superficial digital flexor), the tarsus is correspondingly locked in extension. Even during sleep, small amount of muscular tone in the quadriceps muscle assures stability of this locked configuration, preventing flexion of the stifle and tarsocrural joints.[39]

Distal to the hock the elements of the stay apparatus are analogous to those of the thoracic limb. The superficial digital flexor is connected proximally to the calcaneal tuber (effectively, its "check ligament"), and the deep digital flexor is anchored via its accessory (tarsal check) ligament to the thick plantar part of the tarsal fibrous joint capsule. Prevention of overextension of the fetlock and interphalangeal joints during the fixed, resting position is accomplished through the support rendered by the digital flexor tendons and the suspensory apparatus (suspensory ligament, proximal sesamoid bones, and their ligaments).

AXIAL COMPONENTS

Vertebral Column

The vertebral formula of the horse is 7 cervical, 18 thoracic, 6 lumbar, 5 sacral, and an inconsistent number of caudal vertebrae (ranging from 15 to 21). There is some individual variation in numbers of other vertebrae, most commonly in the number of lumbar vertebrae where five or seven are sometimes seen (there is an increased incidence of five lumbar vertebrae in Arabian horses[41]). The typical vertebra possesses a ventrally placed, roughly cylindrical body whose cranial and caudal ends articulate with adjacent vertebrae at the intervertebral disc (Figure 1.53). A bony vertebral arch attaches to the body and surrounds the spinal cord. The aperture created within a given vertebrae by the dorsal

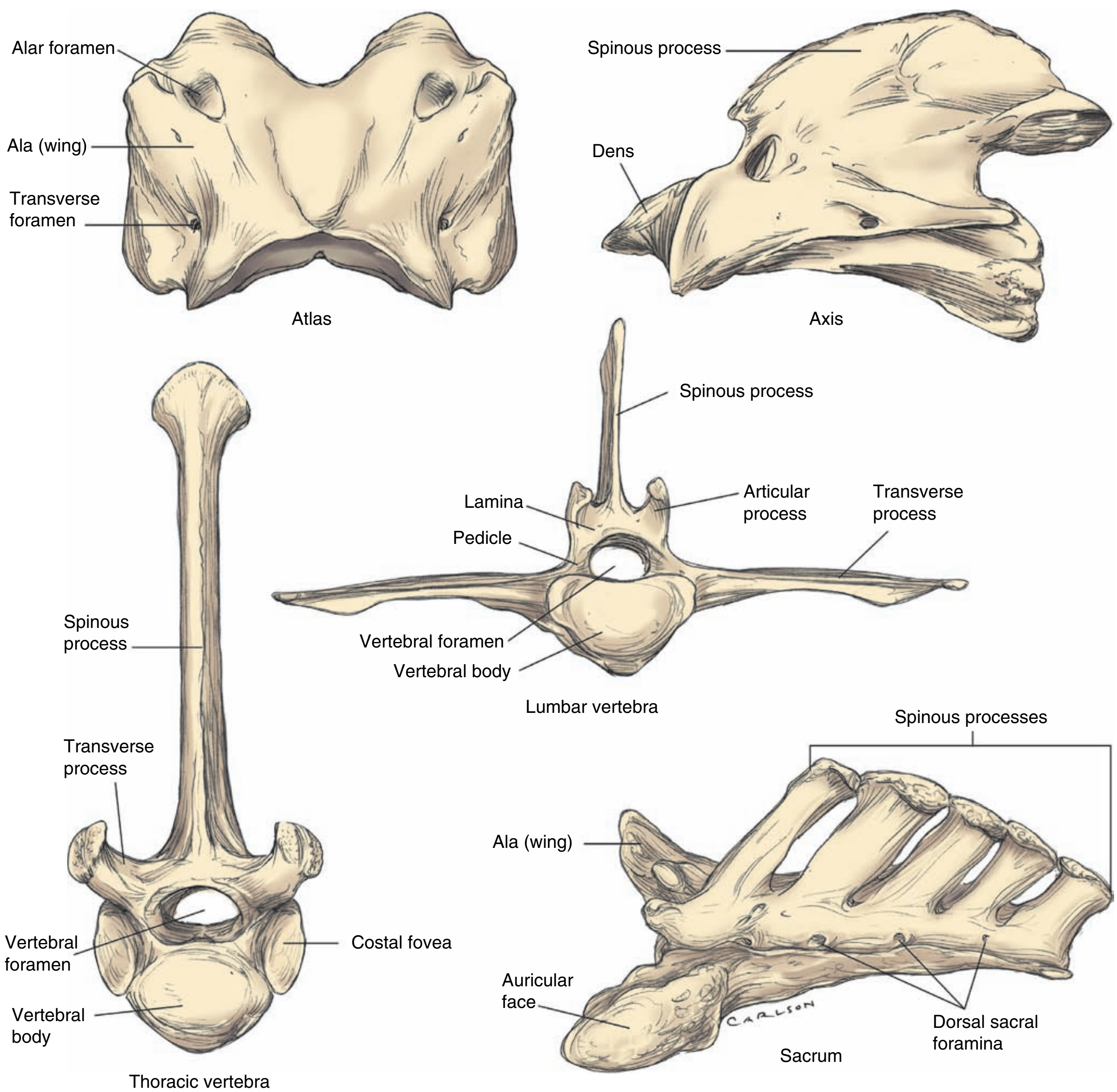

Figure 1.53. Vertebrae.

aspect of the body and the medial and ventral parts of the arch is the vertebral foramen; where vertebral foramina of adjacent vertebrae are aligned to admit the spinal cord, the resulting passageway is called the vertebral canal. The vertebral canal is widest in the caudal cervical–cranial thoracic region, where it accommodates the cervical enlargement of the spinal cord. A second dilation of the canal occurs in the lumbar region where the lumbosacral enlargement of the cord resides.

The vertebral arch comprises the pedicles and laminae, which together create the "roof" over the spinal cord. The pedicles are the vertical attachments to the vertebral body. The dorsal part of the arch is created by the right and left laminae. The arch is characterized by vertebral notches, indentations on the cranial and caudal aspects of the pedicle. When individual vertebrae are articulated, the cranial vertebral notch of one vertebra abuts the caudal vertebral notch of another, creating an intervertebral foramen through which the spinal nerve emerges from the vertebral canal.

The vertebral arch features other bony processes that bear synovial joints between adjacent vertebrae and that serve as sites of attachment for epaxial muscles. Each vertebra has a single dorsal midline spinous process and two transverse processes that arise near the point at which the pedicle attaches to the body. The dorsal contour of the equine thorax and loin is largely determined by the relative size and prominence of the spinous processes of thoracic and lumbar vertebrae. Arising adjacent to the spinous process are a pair of cranial articular processes and a pair of caudal articular processes.

Cervical Vertebrae

The first two cervical vertebrae are highly modified to meet their specialized function in permitting movement of the head. The first vertebra is the atlas. It lacks the cylindrical body characteristic of other vertebrae, instead taking the form of a bony ring comprising dorsal and ventral arches. The spinous process is likewise absent. The transverse processes are modified into the wings of the atlas. These are robust, bent in a ventrolateral direction, and strongly concave ventrally. Their craniolateral edges form a prominent palpable ridge caudal to the ramus of the mandible. The dorsal aspect of the wing of the atlas bears three foramina: the transverse foramen, the alar foramen, and the lateral vertebral foramen. The cranial aspect of the atlas possesses two deeply concave cranial articular foveae, which form a synovial joint (the atlanto-occipital joint) with the occipital condyles. The caudal articular foveae are also concave and participate in the synovial atlantoaxial joint.

The second cervical vertebra is the axis. The body of the axis is long, and its cranial extremity is modified into a scoop-like projection called the dens, which features a rounded ventral articular surface that articulates with the floor of the atlas. The caudal extremity of the axis' body is deeply concave where it articulates with the body of the third cervical vertebra. The spinous process of the axis is tall and long, modified into a thick midline plate. The transverse processes are small and caudally directed.

The third through seventh vertebrae are similar to one another and follow the basic pattern of most vertebrae. They are progressively shorter from cranial to caudal. Cervical vertebrae three, four, and five bear a distinct ventral crest on their bodies. This crest is diminished in size on the sixth and absent from the seventh cervical vertebra. Articular processes on these cervical vertebrae are large, with prominent oval fovea for articulation between vertebral arches. The cranial articular processes present their foveae in the dorsomedial direction; caudal articular processes have complementary foveae directed in the ventrolateral direction. Transverse processes are broad, each with two thick tubercles for muscular attachment. Transverse processes of the sixth cervical vertebra are especially robust, while those of the seventh are somewhat diminished relative to the other cervical vertebrae. The dorsocaudal aspect of the seventh cervical body features a costal fovea that participates in the synovial articulation of the head of the first rib with the seventh cervical and first thoracic vertebrae. The spinous process of the seventh cervical vertebra is tall compared with other cervical vertebrae.

Thoracic Vertebrae

There are usually 18 thoracic vertebrae in the horse, although on occasion there may be one more or one less than typical. The bodies of the thoracic vertebrae tend to be short with a small vertebral arch dorsally. The spinous processes are relatively tall, with the first four or five increasing in height and more caudal spinous processes gradually decreasing in height until at the level of the 12th thoracic vertebra, after which they are the same height as those of the lumbar vertebrae. The tall spinous processes of those first 12 vertebrae constitute the withers. The dorsal apex of the spines is somewhat expanded and in young horses surmounted by cartilage. The cartilage is replaced by bone as the horse ages, with the cartilages associated with the prominence of the withers persisting the longest at 10 years or more. The anticlinal vertebra is defined as the one whose spinous process is perpendicular to the long axis of the vertebral column. The spinous processes of more cranial vertebrae incline caudad, while those of more caudal vertebrae incline craniad. In the horse, the anticlinal vertebra is usually the 16th and occasionally the 14th.

The vertebral bodies possess cranial and caudal costal foveae for articulation with the heads of ribs, excepting the last thoracic vertebra, which features only cranial costal foveae. Transverse processes are irregular, largest in the cranial thoracic vertebrae and gradually decreasing in size toward the lumbar region. Mammillary processes appear in the caudal thoracic region. These are directed craniad and arise primarily from the transverse processes. In the most caudal of the thoracic vertebrae, they arise in common from the transverse and cranial articular processes and may for this reason be called mamilloarticular processes.

Lumbar Vertebrae

There are usually six lumbar vertebrae, although five and seven have also been reported. The cylindrical bodies of the lumbar vertebrae are somewhat flattened dorsoventrally, especially the last three. Except for the seventh and sometimes the sixth lumbar vertebrae, a ventral crest is prominent. The spinous processes project slightly craniad. The vertebral arches tend to overlap dorsally, except at the L5–L6 and L6–S1 interspaces where the larger interarcuate spaces are much larger and clinically accessible. The cranial and caudal articular processes articulate in an approximation of the sagittal plane, an orientation that allows for a very slight degree of flexion and extension of the vertebral column but prevents lateral flexion. The transverse processes of the lumbar vertebrae are large and blade-like. They project laterad. The caudal aspect of the fifth transverse process articulates with the cranial aspect of the sixth. The caudal aspect of the sixth transverse process features a large concave facet through which it articulates with the sacrum.

Sacrum

The equine sacrum is a single bone formed through fusion of embryologically distinct sacral vertebrae, generally five of these, with four, six, and seven sacral vertebrae also being reported.[41] Fusion is usually complete by 5 years of age. The sacrum is triangular and gently curving so as to present a slightly concave ventral aspect. Intervertebral foramina are transformed by the fusion of adjacent vertebrae into a row of four dorsal sacral foramina and four ventral sacral foramina, through which pass dorsal and ventral branches, respectively, of the sacral spinal nerves. The spinous processes remain individually distinct and incline slightly caudad. The second through fifth spinous processes end in slight enlargements that are not uncommonly bifid.

The first sacral vertebra gives rise to the wings of the sacrum. Their articular surfaces face dorsolateral to articulate with the auricular surface of the ilium. The ventral aspect of the first sacral vertebra is slightly rounded, forming the promontory of the sacrum, the point from which the conjugate diameter (the dorsal–ventral distance) of the pelvic canal is measured.

Caudal Vertebrae

Although there is considerable individual variation, the average horse has 18 caudal vertebrae. Only the first three or so have vertebral arches, the remaining being represented by cylindrical bodies only. The first caudal vertebra is not uncommonly fused with the sacrum, especially in old horses.

Vertebral Articulations

Excluding the atlantoaxial joint (a pivot joint), the joints of the vertebral column all permit small amounts of flexion, extension, lateral flexion, and limited rotation. These movements are especially limited through thoracic and lumbar regions, but the cervical vertebral column is capable of more extensive movement. Intervertebral discs of fibrocartilage are interposed between adjacent vertebral bodies. Further stabilization is provided to the vertebral column by (1) the continuous dorsal and ventral longitudinal ligaments on their respective surfaces of the vertebral bodies; (2) a supraspinous ligament that passes along the dorsal aspect of the spinous processes of thoracic, lumbar, and sacral vertebrae; and (3) interspinal ligaments that pass between adjacent spinous processes. In the thoracic region, intercapital ligaments pass transversely between the heads of contralateral ribs over the dorsal aspects of the intervertebral discs. Articulations between articular processes on vertebral arches are true synovial joints. In the cervical region, these constitute broad plates, oriented in a nearly horizontal plane to permit significant lateral bending. Articular facets on the cranial articular processes face dorsomediad, while the complementary facets on the caudal articular processes face ventrolaterad. Synovial joints also exist between the transverse processes of the fifth and sixth lumbar vertebrae and between the transverse processes of the sixth lumbar vertebra and the wings of the sacrum.

Sacroiliac Region

The axial skeleton and appendicular skeleton of the hindlimb are united at the sacroiliac joint (Figure 1.54). This planar joint is created by the auricular face of the wings of the sacrum, which are oriented dorsolaterad, and the auricular face of the wings of the ilia, which angle ventromediad. This joint is histologically synovial but is capable of only extremely limited gliding movement. Its principle purpose is most likely absorption of some of the concussive forces transmitted through the appendicular skeleton to the vertebral column. The joint capsule is close-fitting and is substantially reinforced by

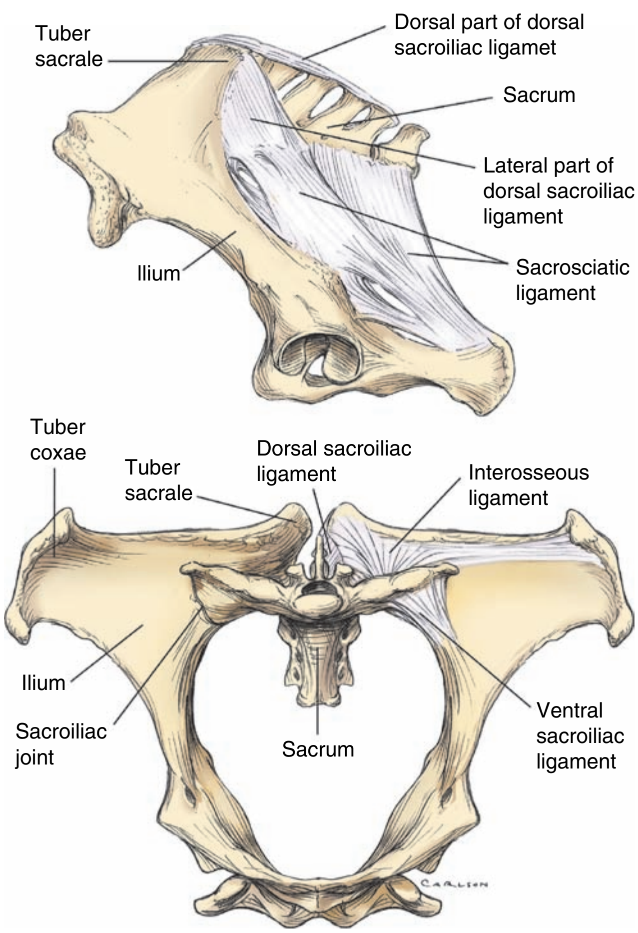

Figure 1.54. Sacroiliac joint. Lateral (top) and cranial (bottom) views.

a series of sacroiliac ligaments that contribute markedly to the overall stability of the joint and probably act to transfer most of the weight of the trunk to the pelvic limbs. These ligaments can be summarized as the ventral sacroiliac ligament, dorsal sacroiliac ligament, and interosseous ligament.

The ventral sacroiliac ligament surrounds the joint and fills the space between the ilium and the ventral aspect of the wing of the sacrum. The dorsal sacroiliac ligament presents two distinct portions. One (dorsal or short part) arises from tuber sacrale and inserts on the spinous processes of the sacral vertebrae. The other (lateral or long part) arises from tuber sacrale and the caudal edge of the ilial wing and inserts along the lateral aspect of the sacrum. From here it blends ventrad into the broad sacrosciatic ligament that fills the space between the pelvis and sacrum. The interosseous ligament (interosseous sacroiliac l.) consists of strong, vertically oriented fibers between the ventral part of the wing of the ilium and the dorsal aspect of the wing of the sacrum.

Ligamentum Nuchae

The topline of the neck is in part determined by the presence of the ligamentum nuchae (nuchal ligament), which in horses extends from its cranial attachments on the external occipital protuberance to the spinous process of the third or fourth thoracic vertebra. Both parts of the nuchal ligament (funicular and laminar) are paired. The rope-like funicular part is connected to sheets that compose the laminar portions. These midline elastic sheets arise from the second through fifth cervical vertebrae and insert on the spines of the second and third thoracic vertebrae.[24] Bursae are consistently found between the funicular part of the nuchal ligament and the atlas and between the nuchal ligament and the second thoracic spine. These are the bursa subligamentosa nuchalis cranialis and the bursa subligamentosa supraspinalis, respectively. A third bursa (bursa subligamentosa nuchalis caudalis) is inconsistently found between the nuchal ligament and the spine of the axis.[13,16]

Muscles of the Trunk and Neck

Muscles of the torso (neck, trunk, and tail) may be roughly divided into those dorsal to the transverse processes (epaxial muscles) and those ventral to the transverse processes (hypaxial muscles). The dorsal branches of the spinal nerves innervate the epaxial muscles while hypaxial muscles receive their innervation from the ventral branches.

The epaxial muscles are extensors of the vertebral column and are themselves divided into three parallel bundles of fascicles: from lateral to medial these are the iliocostalis system, the longissimus system, and the transversospinalis system (Figure 1.55). The iliocostalis system (named for its attachments to the ilium and ribs) does not extend into the neck. The others continue into the cervical region and are associated with additional distinct muscles. Of these, the splenius muscle is most superficial (Figure 1.56). The splenius possesses capital and cervical parts. Both arise from the third, fourth, and fifth thoracic spines and from the funicular part of the nuchal ligament, and they insert on the nuchal crest of the skull, the wing of the atlas, and the transverse processes of the third, fourth, and fifth cervical vertebrae. The splenius extends the neck and elevates the head, and it is largely the rhythmic contraction of this powerful muscle that creates the thrusting movements of the neck during the gallop.[27]

Deep to the splenius are a number of shorter muscles extending from the cervical vertebrae to the skull; these "specific activators of the head" are important in giving the head and neck its considerable range of motion.

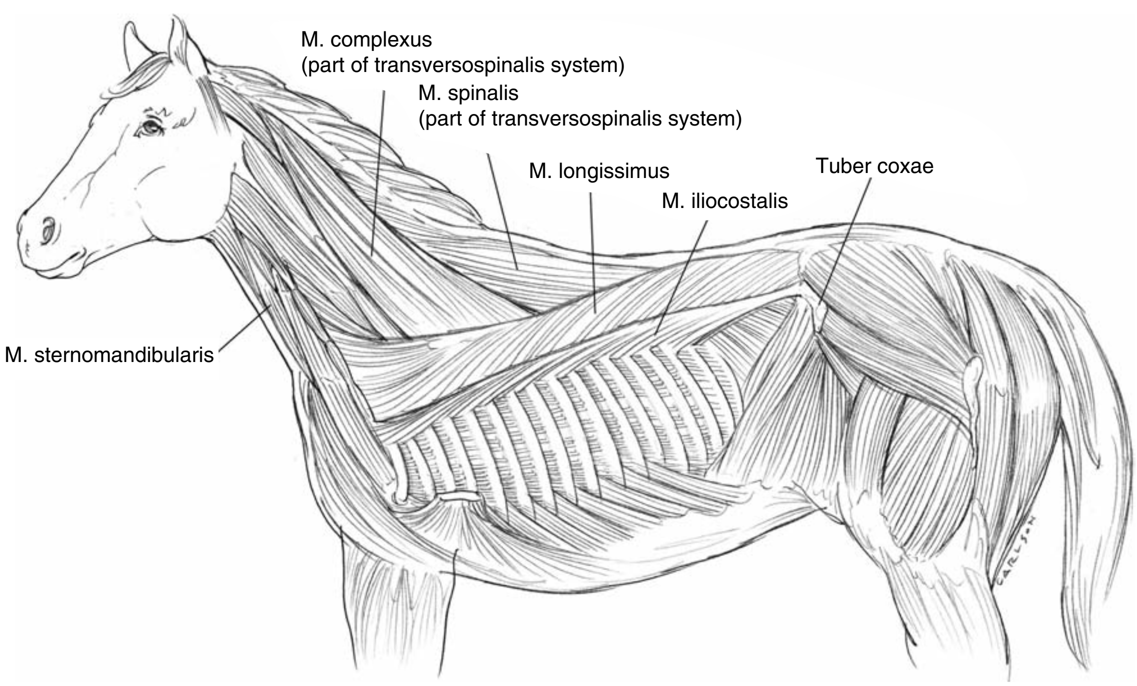

Figure 1.55. Deep muscles of trunk.

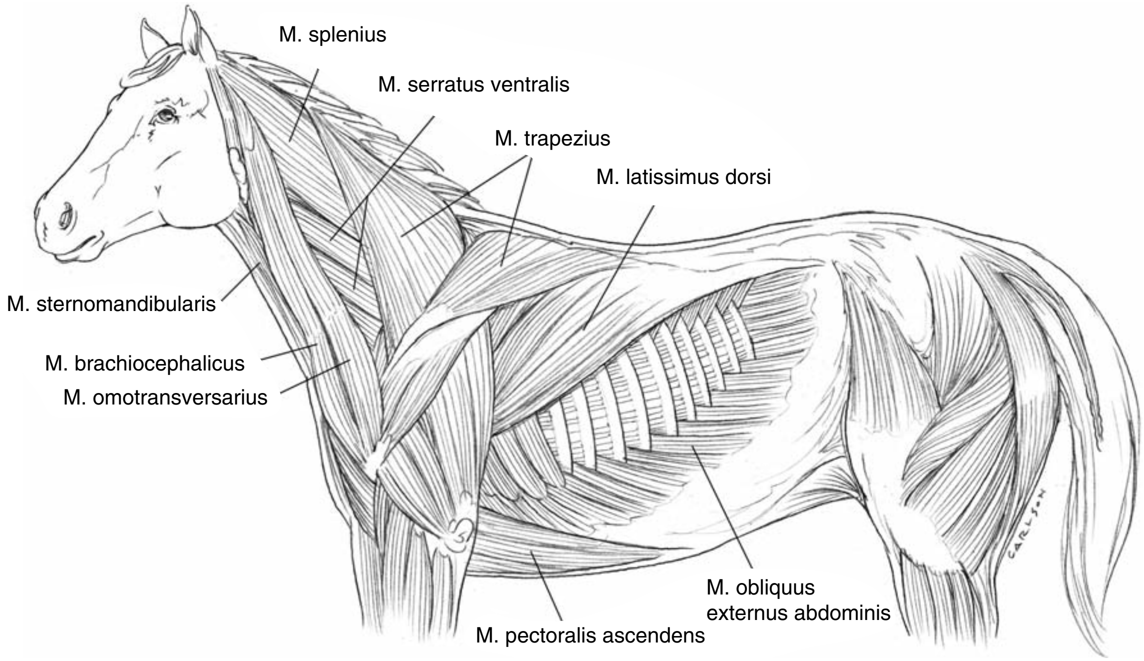

Figure 1.56. Superficial muscles of trunk. Cutaneous muscles have been removed.

Among those dorsal to the transverse processes are the cranial and caudal parts of the obliquus capitis muscle. The cranial part bridges between the nuchal crest and the cranial border of the wing of the atlas. The caudal part is a large, powerful rotator of the atlantoaxial joint. It attaches to the cranial border of the wing of the atlas and the vertebral arch of the axis.

Deep to the oblique muscles are a series of straight muscles that link the skull to the atlas and axis. The major part of rectus capitis dorsalis attaches on the caudal aspect of the occipital bone and the spinous process of the axis; its minor portion lies dorsal to the dorsal atlanto-occipital membrane, bridging between occipital bone and the wing of the atlas. Rectus capitis ventralis runs from the base of the skull to the ventral arch of the atlas. Rectus capitis lateralis attaches from the wing of the atlas to the paracondylar process. These last two muscles are relatively weak in the horse.

The longus capitis muscle bridges between the transverse processes of C2 through C4 or C5 and the ventral skull.

Activators of the head that are above the transverse processes will extend the atlanto-occipital and atlantoaxial joints; those ventral to the transverse processes flex those joints. When acting unilaterally, all of these muscles have the ability to turn the head laterally.

The longissimus group is described as having lumbar, thoracic, cervical, atlantal, and capital portions. It is most robust in the lumbar region, where it gives a well-conditioned horse's back its typical rounded appearance.

Hypaxial muscles of the trunk (the psoas minor, quadratus lumborum, and the four abdominal muscles on each side) act to flex the vertebral column during the gallop. Epaxial muscles extend the vertebral column. When they contract unilaterally, both hypaxial and epaxial muscles create lateral movement of the trunk and neck.

In the ventral neck, the equine m. longus colli is particularly well developed relative to other domestic species. The cervical portion of this muscle arises from the transverse processes and bodies of the third through sixth cervical vertebrae in paired bundles that converge to an insertion on the preceding vertebral bodies, sometimes bridging more than one intervertebral space. The most cranial attachment is on the ventral aspect of the atlas. The thoracic portion of the longus colli arises on the lateral vertebral bodies of thoracic vertebrae one through six, passing craniad to insert on the transverse processes of cervical vertebrae six and seven.

The omohyoideus muscle is well developed in the horse. It arises from an aponeurosis in the fascia near the shoulder joint. Its muscle belly is closely attached to the deep side of the brachiocephalicus until the neck's midpoint, where the omohyoideus becomes evident as a distinct muscle as it passes craniad deep to the sternocephalicus muscle. Near its insertion on the lingual process, it fuses with its partner from the contralateral side and with the sternohyoideus.

The right and left sternomandibularis muscles of the horse are fused on midline near their origin on the manubrium. Near mid-neck, the two halves separate, moving from their position ventral to the trachea to a more lateral location. As the muscle approaches its insertion on the sternomandibular tuberosity on the ramus of the mandible, it narrows to a distinct tendon that is visible in the cranial neck just caudal to the caudal border of the mandible. The tendon of insertion is classically considered one side of Viborg's triangle.

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