

Chapter 2: Thoracic Limb

1. The Skeleton of the Thoracic Limb

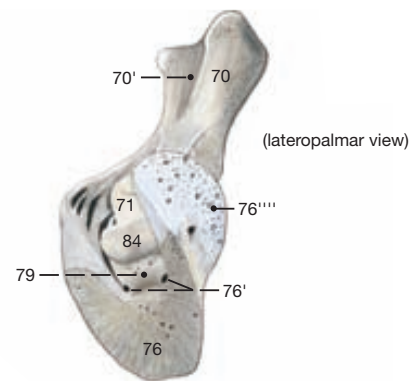
- 1 The limbs of the horse are adapted for the well-developed ability to run fast. Compared to the plantigrade stance (newborn dog) and the digitigrade stance (adult dog), the overextended angulation at the canine carpus has been lost in the horse. The horse is an unguigrade animal and as a result of the straightening and lengthening of its limbs is capable of a long stride. The loss of rays 1 and 5, the reduction of 2 and 4, and the very well-developed digit 3 as the only one that supports the body are part of the same adaptation. The thoracic limbs in the standing horse carry about 55–60 % of the body weight. The rider, by using the reins to flex the atlanto-occipital and nearby cervical joints, “shortens” the neck and thus causes the center of gravity to move toward the hindlimbs. In horses of good conformation, the forelimbs appear straight and parallel to one another when viewed from the front. In lateral view, they should appear straight and vertical. A plumb line from the palpable **tuber (5')** on the scapular spine passes through the center of the fetlock joint and touches the caudal aspect of the hoof.
- The shoulder girdle (scapula, coracoid, clavicle of other animals) is greatly reduced; the clavicle has disappeared and only a fibrous strip (clavicular intersection) is left in the brachiocephalicus.
- 2 a) The equine **SCAPULA** is characterized by the wide, semilunar **scapular cartilage (14)** that enlarges its dorsal border. The spine presents a palpable tuber and subsides distally opposite the neck of the bone without forming an acromion. An **infraglenoid tubercle (20)** is sometimes present.
- 3 b) **HUMERUS**. The **greater (25)** and **lesser (29)** tubercles on the lateral and medial sides, respectively, of the proximal extremity are nearly equally well developed. Both tubercles are separated by a sagittal **intertubercular groove (28)** which is wide and carries an **intermediate tubercle (28')**. The latter fits into a depression on the deep surface of the wide biceps tendon and seems to impede movement of the tendon relative to the humerus in the standing horse. The body of the bone presents the **teres major tuberosity (32')** on its medial surface about opposite the much more salient **deltoid tuberosity (32)** on the lateral surface. The distal end forms a cylindrical **condyle (35)** that transfers the weight onto the radius. The condyle presents laterally a slight sagittal ridge flanked by grooves that fit into corresponding features on radius and ulna. The **epicondyles, lateral (38)** and **medial (39)**, as well as the **lateral supracondylar crest (38')** are palpable. The shallow **radial fossa (41)** is just proximal to the condyle on the cranial surface of the bone. The very much deeper **olecranon fossa (40)** between the two epicondyles lies opposite the radial fossa on the caudal surface. (There is no perforation in the form of a supratrochlear foramen between the two fossae.)
- 4; 6 c) Of the two bones, **RADIUS** and **ULNA**, that form the antrebrachial skeleton, only the radius supports the humerus in the elbow joint. The **radius** on its proximomedial aspect presents the large **radial tuberosity (46)** that serves as the insertion of the biceps tendon. At the distal end of the bone, unobtrusive **medial (50)** and **lateral (61)** styloid processes form the ends of the articular surface; the lateral process contains a distal remnant of the ulna.
- The **ulna** is fused to the radius and with its olecranon limits extension of the elbow joint. Its proximal extremity (**olecranon tuber, 52**) reaches to the fifth rib. The shaft of the bone is greatly reduced and tapers to end in midforearm. The fusion of the two bones is interrupted at an **interosseous space (62)** that is situated in the proximal third of the forearm.
- 5 d) **CARPAL BONES**. The bones of the proximal row from medial to lateral are the **radial (63)**, the **intermediate (63')**, the **ulnar (64)**, and the **accessory (65)** carpal bones. The bones of the distal row are

numbered, **first to fourth carpal bones (66)**, of which the first is small and inconstant.

e) **METACARPAL BONES**. Only Mc2, 3, and 4 are present. Mc1 and 5 have disappeared and Mc2 and 4 are greatly reduced in accordance with the streamlining and lengthening of the limb for speed. Mc3, also known as **canon bone**, is well developed and carries the entire weight assigned to the limb; it is a very robust bone with a lateromedially oriented oval cross section. The caput at the distal end of the bone presents a sagittal ridge that engages a groove in the proximal phalanx. Mc2 and 4, known also as **splint bones**, are slender and about a third shorter than the canon bone. The **proximal bases (67)** of the metacarpal bones articulate with the carpal bones (Mc2 with C2; Mc3 with C2 and 3; and Mc4 with C4). The splint bones are connected to Mc3 by fibrous tissue, their rounded distal end is an important palpable landmark.

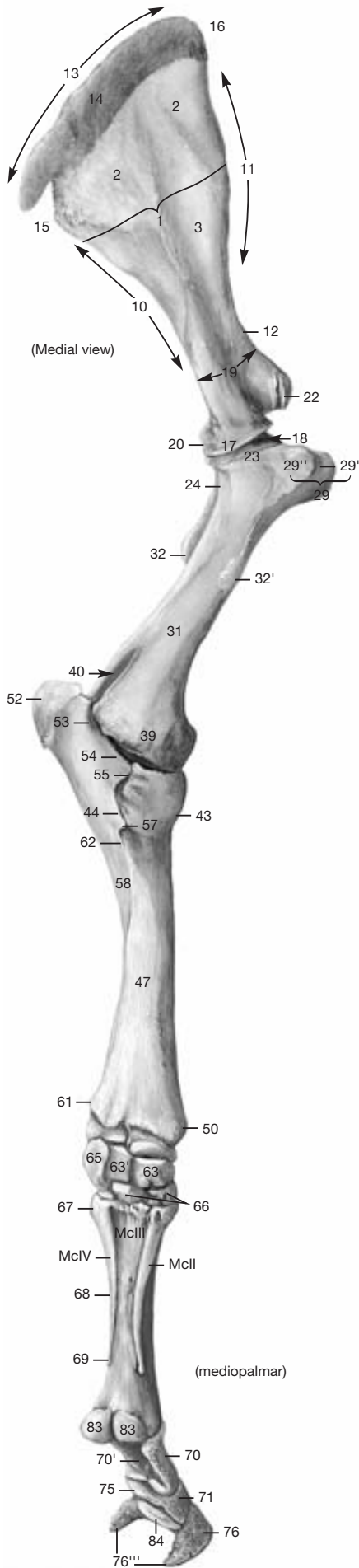
f) The proximal, middle, and distal **PHALANXES (70, 71, 76)** form the supporting skeleton of the single third digit. The **proximal phalanx**, also known as Phalanx I (PI), is the longest of the three; it presents a **triangular rough area (70')** on its palmar surface. The **middle phalanx (PII)** is half as long as the preceding bone and presents a **flexor tuberosity (75)** on its proximopalmar aspect that, in the fresh state, is enlarged proximally by a stout **complementary fibrocartilage** for the attachment of ligaments and the tendon of the supf. digital flexor. The **distal phalanx (PIII)** is also known as the coffin bone. It consists of spongy bone throughout and presents **sole foramina (76')** and **parietal grooves (76'')** as conduits for blood vessels. The medial and lateral **hoof cartilages (76''')** surmount respective **palmar processes (76''')** of the bone; they are slightly curved to conform to the curvature of the hoof. Their proximal border projects above the hoof where they can be palpated. The **articular surface (77)** of the distal phalanx makes contact principally with the middle phalanx, but has a small facet for articulation with the distal sesamoid bone. The **flexor surface (79)** of the coffin bone provides insertion for the deep flexor tendon.

Phalanges, Navicular Bone, and Hoof Cartilages with some of their Ligaments



g) The proximal and distal **SESAMOID BONES** are of considerable clinical importance in the horse. The (paired) **proximal bones (83)** articulate with Mc3, while the single distal bone, known as the **navicular bone (84)**, lies within the hoof and contacts both middle and distal phalanges.

Thoracic Limb



Scapula

- Costal surface (1)
- Serrated surface (2)
- Subscapular fossa (3)
- Lateral surface (4)
- Scapular spine (5)
- Tuber of scapular spine (5')
- Supraspinous fossa (6)
- Infraspinous fossa (7)
- Caudal border (10)
- Cranial border (11)
- Scapular notch (12)
- Dorsal border (13)
- Scapular cartilage (14)
- Caudal angle (15)
- Cranial angle (16)
- Ventral [articular] angle (17)
- Glenoid cavity (18)
- Neck of scapula (19)
- Infraglenoid tubercle (20)
- Supraglenoid tubercle (21)
- Coracoid process (22)

Humerus

- Head of humerus (23)
- Neck of humerus (24)
- Greater tubercle (25)
- Cranial part (25')
- Caudal part (25'')
- Crest of greater tubercle (26)
- Triceps line (27)
- Intertubercular groove (28)
- Intermediate tubercle (28')
- Lesser tubercle (29)
- Cranial part (29')
- Caudal part (29'')
- Body of humerus (31)
- Deltoid tuberosity (32)
- Teres tuberosity (32')
- Crest of humerus (33)
- Brachialis groove (34)
- Condyle of humerus (35)
- Lateral epicondyle (38)
- Lateral supracondylar crest (38')
- Medial epicondyle (39)
- Olecranon fossa (40)
- Radial fossa (41)

Radius

- Head of radius (43)
- Circumferential facet (44)
- Neck of radius (45)
- Radial tuberosity (46)
- Body of radius (47)
- Trochlea of radius (48)
- Medial styloid process (50)

Ulna

- Olecranon (51)
- Olecranon tuber (52)
- Anconeal process (53)
- Trochlear [semilunar] notch (54)
- Medial coronoid process (55)
- Lateral coronoid process (56)
- Radial notch (57)
- Body of ulna (58)
- Lateral styloid process (61)
- Interosseus space (62)

Carpal bones

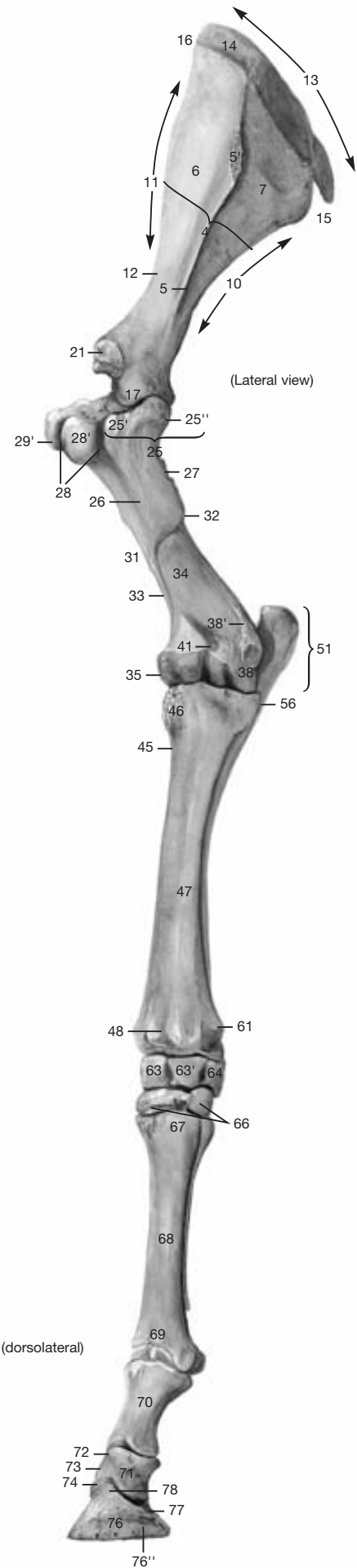
- Radial carpal bone (63)
- Intermediate carpal bone (63')
- Ulnar carpal bone (64)
- Accessory carpal bone (65)
- First, second, third, fourth carpal bones (66)

Metacarpal bones II-IV

- Base (67)
- Body (68)
- Head (69)

Digital bones

- Proximal phalanx (70)
- Triangular rough area (70')
- Middle phalanx (71)
- Base (72)
- Body (73)
- Caput (74)
- Flexor tuberosity (75)
- Distal phalanx (76)
- Sole foramen (76')
- Parietal groove (76'')
- Palmar process (76''')
- Hoof cartilage (76''')
- Articular surface (77)
- Extensor process (78)
- Flexor tuberosity (79)
- Proximal sesamoid bone (83)
- Distal (navicular) sesamoid bone (84)



2. Topography of the Thoracic Limb (Nerves and Muscles) Clinical and Functional Anatomy p. 118

The two Figures on the opposite page show the structures mentioned in the account below to best advantage. The following steps would reproduce the dissection upon which the two Figures were based:

Skin the limb to the hoof (note the chestnut, the homologue of the carpal pad, proximomedial to the carpus; the ergot, homologue of the metacarpal pad, caudal to the proximal phalanx is often hidden in long hair). Remove the **pectoral muscles** and the **subclavius** (innervated by the cranial and caudal pectoral nerves, respectively). Preserve the blood vessels throughout. Transect the **deltoideus** at the level of the shoulder joint. The tensor fasciae antebrachii and the lateral head of the triceps are transected at their middle. In mid-forearm, the flexor carpi radialis and flexor carpi ulnaris are transected.

In addition, transect the tendon of origin of the **biceps brachii** to expose the intertubercular bursa; the supf. and deep digital flexor tendons are lifted from the carpal canal after transection of the flexor retinaculum.

a) SHOULDER AND ARMS

1 A) The roots of the **brachial plexus** (4) arise from the ventral branches of C6 through T2.

2 B) The **axillary nerve** (14) innervates the **teres major** (1), the caudal segment of the **subscapularis** (3), and, on the lateral side, the **deltoideus** (6) and the relatively tendinous **teres minor** (13). The axillary nerve ends by furnishing the **cranial cutaneous antebrachial nerve** (26) which supplies the skin on the cranial aspect of the forearm. The **subscapular nerves** (3) innervate most of the subscapularis. The **suprascapular nerve** (9) crosses the cranial border of the scapula and ends in the **supra-** (5) and **infraspinatus** (10) muscles. The sharp scapular border and the absence of an acromion are thought to expose the nerve to mechanical trauma. The **thoracodorsal nerve** (2) passes caudally to innervate the **latissimus dorsi** (2). **Median** (8) and **musculocutaneous** (7) nerves join to form a loop (*ansa axillaris*) which supports the axillary artery as it passes into the limb. The musculocutaneous nerve, with its proximal and distal muscular branches, supplies the **coracobrachialis** (19) and **biceps** (25), and the **brachialis** (20), respectively. It ends as the **medial cutaneous antebrachial nerve** (30). The proximal muscular branch passes deep (lateral) to the coracobrachialis to reach the biceps. The **radial nerve** (11) releases a branch to the **tensor fasciae antebrachii** (21) before changing over to the lateral aspect of the arm. Proximal muscular branches are given off to the **anconeus** (24) and the **long** (15), **medial** (17), and **lateral** (16) heads of the triceps that lacks an accessory head in the horse. The nerve then crosses the lateral supracondylar crest of the humerus and splits into **supf.** (27) and **deep** (18) branches.

b) NERVES AND MUSCLES ON THE CRANIOLATERAL SURFACE OF THE FOREARM

The supf. branch of the radial nerve gives rise to the **lateral cutaneous antebrachial nerves** (29); none of these reach the carpus—the dorsum of metacarpus and digit is supplied by the median and ulnar nerves. The deep branch of the radial nerve goes to the craniolateral muscles of the forearm.

The carpal and digital extensors arise from the craniolateral aspect of the distal end of the humerus and from the nearby lateral collateral ligament of the elbow joint. The **common digital extensor**, in

addition to its large **humeral head** (33), has a small **radial head** (34) known formerly as Phillip's muscle, whose thin tendon joins that of the lateral digital extensor to end on the proximal phalanx. (A tiny deeply placed ulnar head, formerly Thierness' muscle, is also present.) The tendon of the common digital extensor, before ending on the extensor process of the distal phalanx, attaches also on the middle phalanx and receives the extensor branches of the largely tendinous interosseus (see p. 13).

The **lateral digital extensor** (36) presents a bursa at its insertion on the proximolateral surface of the proximal phalanx.

The **extensor carpi radialis** (31) receives the lacertus fibrosus (see p. 13) and terminates on the proximodorsal tuberosity of the large metacarpal bone.

The **ulnaris lateralis** (38; m. extensor carpi ulnaris) ends on the accessory carpal bone, and with a second, longer tendon on the lateral splint bone. Only the long tendon has a tendon sheath.

The **extensor carpi obliquus** (42; m. abductor pollicis longus) ends on the proximal end of the medial splint bone; its tendon is protected by a synovial sheath and a subtendinous bursa.

c) NERVES AND MUSCLES ON THE CAUDOMEDIAL SURFACE OF THE FOREARM

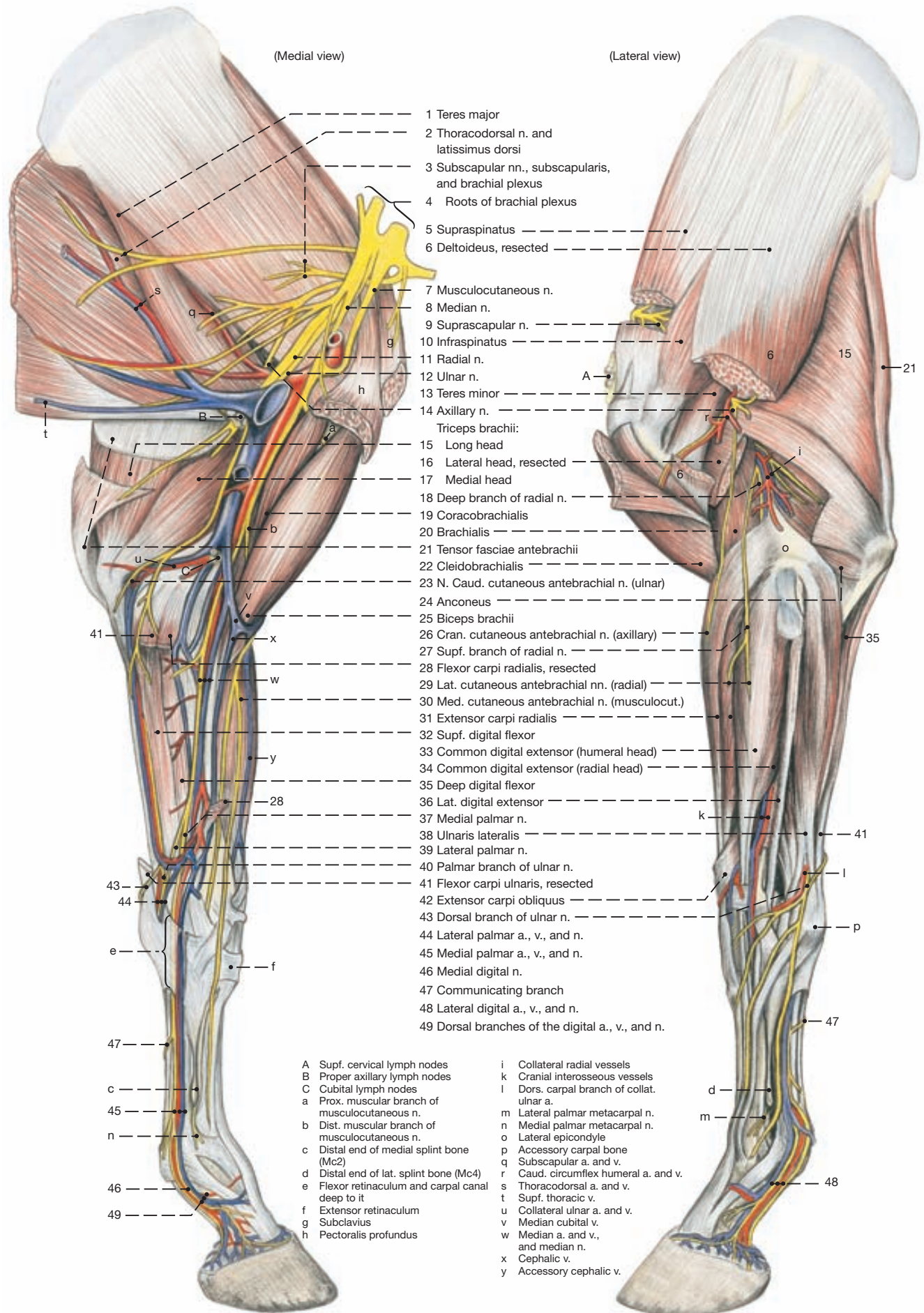
The median nerve accompanies the brachial artery and vein over the elbow joint where it releases muscular branches to the **flexor carpi radialis** (28) and to the radial and humeral heads of the **deep digital flexor** (35; see p. 13). (The pronator teres of other species has become the long part of the medial collateral ligament of the elbow joint; the pronator quadratus is absent.)

The median nerve ends in the distal half of the forearm by dividing into **medial** (37) and **lateral** (39) **palmar nerves**. The medial palmar nerve passes through the carpal canal along the medial border of the deep flexor tendon. The lateral palmar nerve crosses the musculotendinous junction of the supf. digital flexor, receives the palmar branch of the ulnar nerve, and follows the lateral border of the deep flexor tendon through the carpal canal. (The two nerves, after passing the carpal canal, may also be termed the common digital nerves II and III.)

The **ulnar nerve** (12) lies caudal to the brachial vessels and, in the distal third of the arm, releases the **caudal cutaneous antebrachial nerve** (23). After crossing the elbow joint the ulnar nerve releases muscular branches to the **flexor carpi ulnaris** (41), the **supf. digital flexor** (32), and to the ulnar head (see p. 13) and the humeral head of the deep digital flexor. The nerve then passes distally in the caudal border of the forearm. A few cm proximal to the accessory carpal it divides into dorsal and palmar branches. The **dorsal branch** (43), palpable as it becomes subcutaneous at this location, passes around the lateral aspect of the carpus to innervate the skin on the dorsolateral surface of the cannon. The **palmar branch** (40) as already mentioned joins the lateral palmar nerve of the median in the carpal canal.

The bellies of the supf. and deep flexors form a partially fused muscle mass on the caudal surface of the radius. Their tendons distal to the carpus are described on p. 13.

Thoracic Limb



3. Cutaneous Innervation, Blood Vessels, and Lymphatic Structures of the Thoracic Limb

a) CUTANEOUS INNERVATION

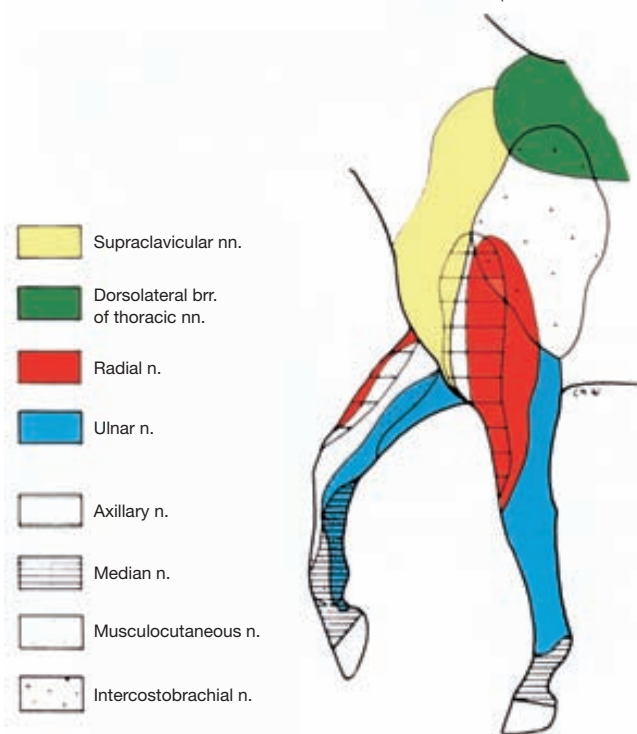
The skin of the forelimb is innervated in the region of the scapular cartilage by the dorsal branches of the thoracic nerves. The small area over the cranial border of the scapula is supplied by the ventral branch of the 6th cervical nerve (n. supraclavicularis). The large region over scapula and triceps receives its innervation from the **intercostobrachial nerve** (1; from brachial plexus and the ventral branches of T2 and T3) which carries also motor fibers for the m. cutaneus omobrachialis.

The cranial region of distal arm and forearm receives skin sensation from the **cranial cutaneous antebrachial nerve** (axillary; 24). The lateral skin region of distal arm and forearm is supplied by the **lateral cutaneous antebrachial nerve** (radial; 27). The **caudal cutaneous antebrachial nerve** (ulnar; 9) innervates the caudal, and the **medial cutaneous antebrachial nerve** (musculocutaneous; 29) the medial surface of the forearm.

Carpus and metacarpus receive skin innervation from the **medial cutaneous antebrachial nerve** (29) for the dorsomedial surface, from the **dorsal branch of the ulnar nerve** (14) for the dorsolateral surface, and from the **medial** (16) and **lateral** (15) **palmar nerves** for the palmar surface.

The medial surface of the digit is innervated by the **medial digital nerve** (median n.; 17), while the lateral surface receives a mixed innervation (median and ulnar nn.) from the **lateral digital nerve** (see pp. 7 and 11).

Cutaneous Nerves of the Thoracic Limb (craniolateral view)



b) BLOOD VESSELS

The **subclavian artery** (19), before becoming the **axillary artery** (20), gives off the **supf. cervical artery**. The deltoid branch of the latter accompanies the **cephalic vein** (23) through the groove between brachiocephalicus and pectoralis descendens. (The cephalic vein arises from the external jugular vein.) The axillary vessels (a. and v.) give rise, either directly or indirectly, to the **external thoracic vessels** (21) to the pectoral muscles, the **suprascapular vessels** (18) to the lateral scapular muscles, the **subscapular vessels** (2) to the caudal border of the like-named muscle, the **thoracodorsal vessels** (4) to

the latissimus dorsi, and the **caudal circumflex humeral vessels** (3) which anastomose with the cranial circumflex humeral vessels, the last branches of the axillary vessels before the stem artery becomes the brachial artery. (The thoracodorsal and caudal circumflex humeral arteries are branches of the large subscapular artery and therefore indirect branches of the axillary.) The **cranial circumflex humeral artery** (22) accompanies the proximal muscular branch of the musculocutaneous nerve deep to the coracobrachialis to the biceps, while the often double satellite vein can cross the coracobrachialis on either surface. The **supf. thoracic (spur) vein** (5) arises from the initial segment of the thoracodorsal vein, passes caudally, and drains the ventral part of the trunk.

The **brachial vessels** (7) in midarm give off the **deep brachial vessels** (6) to the triceps, and more distally the **bicipital vessels** (25) to the biceps. The **transverse cubital vessels** (26), the next branches, pass deep to the biceps. From the caudal surface of the brachial vessels arise the **collateral ulnar vessels** (8) which follow the ulnar nerve. The last branches are the **common interosseous vessels** (28) which pass to and through the interosseous space. They often are continued by the cranial interosseous vessels.

At the level of the elbow, the brachial vein gives off the **median cubital vein** (10) which provides an anastomosis to the cephalic vein. After leaving the groove between brachiocephalicus and pectoralis descendens, the **cephalic vein** (23) descends on the medial surface of the forearm. Already at the elbow joint it releases the **accessory cephalic vein** (30) which parallels the cephalic vein, but inclines more cranially to end on the dorsal surface of the carpus.

The **median artery and vein** (11) continue the brachial vessels in the forearm in close mediocaudal proximity to the radius. The vein is often double. The median vessels give off one or two **deep antebrachial vessels** (12) which supply the caudomedial antebrachial musculature. Proximal to the carpus they give rise to the proximal radial artery and the **radial vessels** (31). The radial vein receives the cephalic vein and as the **medial palmar vein** (16) passes subfascially over the mediopalmar aspect of the carpus. The **palmar branch** (13) of the median vein receives the collateral ulnar vein and as the **lateral palmar vein** (15) continues over the lateropalmar surface of the carpus.

The median artery after giving off its palmar branch passes through the carpal canal. After that it is joined by a branch from the radial artery, and as the **medial palmar artery** (16) (the largest artery in this area) passes toward the digit.

The small **lateral palmar artery** (15) originates from the union of the palmar branch of the median artery with the collateral ulnar artery proximal to the carpus.

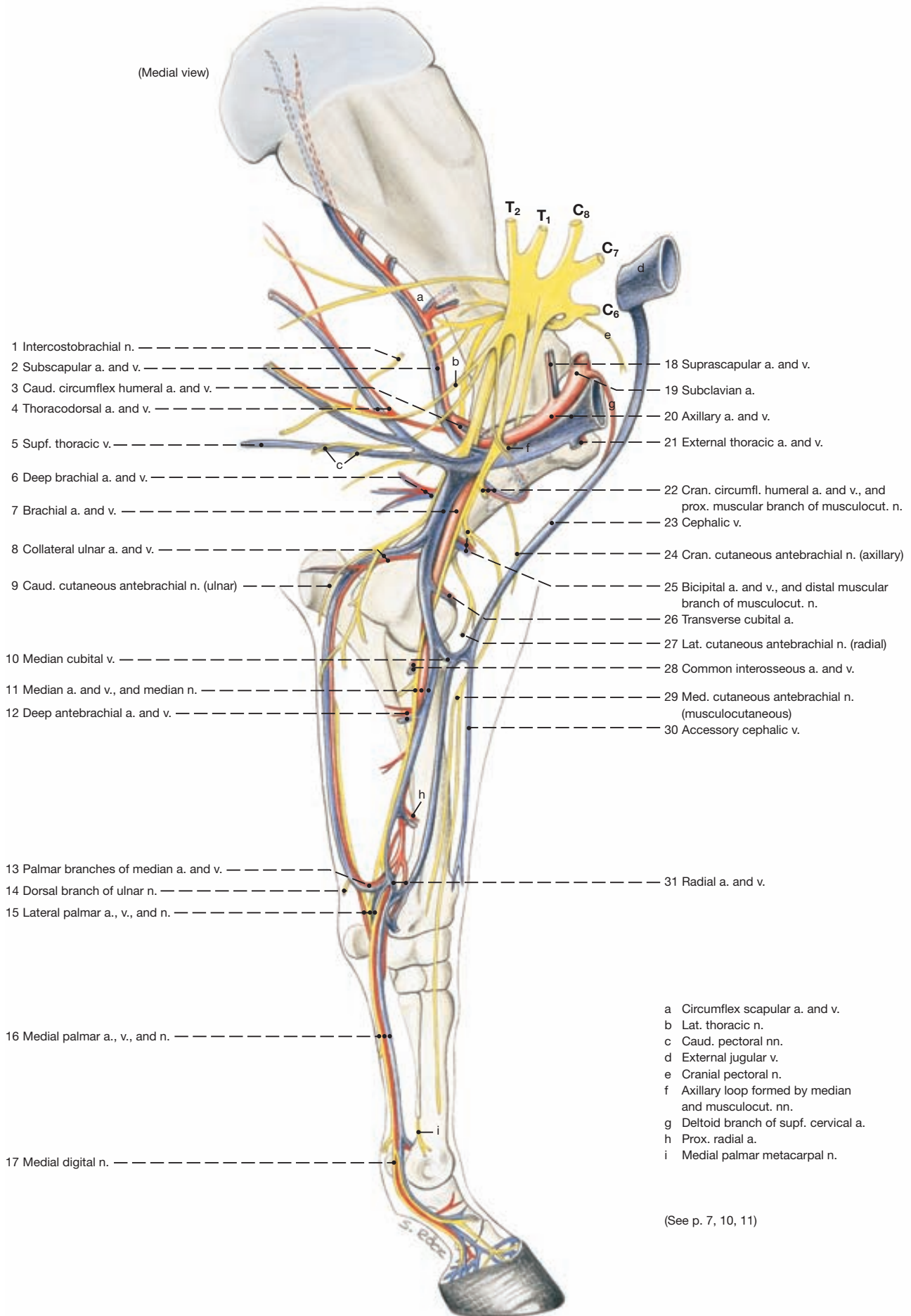
The median and lateral palmar metacarpal arteries descend on the axial surface of the splint bones. They arise distal to the carpus from the deep palmar arch that is formed by branches of the median and radial arteries.

c) LYMPHATIC STRUCTURES

Lymph from the hoof is collected in several vessels that become dissectable proximal to the coronet. At first evenly spaced around the digit, they converge on each side to form one to three vessels. Those on the lateral side change over to the medial side a few cm proximal to the proximal sesamoid bones. They do so either deeply between the interosseus and the deep flexor tendon or subcutaneously. The lymphatics then accompany the medial palmar vessels and nerve and ascend (predominantly through the carpal canal) to the medial aspect of the forearm and thence to the **cubital lymph nodes** (see p. 7.C) that lie just proximal to the elbow joint. From here the lymph passes to the **axillary nodes** (see p. 7.B) on the distal end of the teres major.

From the axillary nodes the lymph passes via the caudal deep cervical nodes to the veins at the thoracic inlet. Lymph, especially from the proximal and lateral areas of the forelimb, is channeled to the **supf. cervical nodes** (see p. 7.A), not to the axillary ones.

Arteries, Veins and Nerves of the Thoracic Limb



4. Vessels, Nerves, and Deep Fascia of Carpus, Metacarpus, and Digit

1 a) Just distal to the carpus the **MEDIAL PALMAR ARTERY, VEIN AND NERVE (2)** lie next to each other in this dorsopalmar sequence (VAN). Artery and nerve have just passed through the carpal canal; the vein crossed the carpus supf. to the flexor retinaculum. In the metacarpus, the three structures, retaining this sequence, lie medial to the interosseus and deep flexor tendon. (There are no corresponding dorsal vessels and nerves.)

At the fetlock joint the medial palmar vessels and nerve become the **medial digital vessels and nerve (7)**. These release several **dorsal branches (9)** that serve the dorsal surface of the digit. Opposite the pastern joint they give off a branch to the **digital cushion (10)**.

The **lateral palmar artery, vein, and nerve (3)** pass the carpus near the tip of the accessory carpal. They are markedly thinner than their medial counterparts, especially the artery. Vein and nerve lie next to each other, and deep to them lies the small artery. They are succeeded at the fetlock by the **lateral digital vessels and nerve (8)**. There are no real differences in distribution from the same structures on the medial side. The prominent **communicating branch (4)** connecting the medial and lateral palmar nerves must be taken into account when nerve blocks are performed.

2

For the deeper-lying palmar metacarpal nerves we need to return to the carpal level. Here the median nerve (g) splits into medial and lateral palmar nerves (c and b; or 2 and 3 that were followed into the

digit just now). The ulnar nerve (a) also splits: its **dorsal branch (1)** supplies the skin over the dorsolateral aspect of carpus and metacarpus, while its **palmar branch (d)** joins the lateral palmar nerve. Soon after receiving the branch of the ulnar, the lateral palmar nerve gives off a deep branch that innervates the interosseus and is continued by the **medial and lateral palmar metacarpal nerves (5; 6)**. These are deeply placed and run along the axial surfaces of the two splint bones where they are accompanied by equally thin arteries.

3 b) The **DEEP FASCIA** on the dorsal surface of the carpus forms the **extensor retinaculum** (see p. 7.f) that guides the extensor tendons over the joint. On the palmar surface it furnishes the **flexor retinaculum** (see p. 7.e) that extends from carpal bones on the medial side to the accessory carpal forming the carpal canal with these bones. At the level of the fetlock joint the deep fascia is again thickened to form the **annular ligament of the fetlock joint (A** in Figure below) that is most prominent at the palmar aspect where it connects the abaxial borders of the proximal sesamoid bones and holds the flexor tendons in place. Distal to this the deep fascia forms the **proximal digital annular ligament (B)**. This resembles the letter X and holds the flexor tendons against the ligaments on the palmar surface of the proximal phalanx. Its four corners insert on the medial and lateral borders of the bone, the distal two attachments being weaker than the proximal, as the ligament here blends also with the two branches of the supf. flexor tendon. The **distal digital annular ligament (C)** arises from the medial and lateral borders of the proximal phalanx and descends to the distal phalanx between the deep flexor tendon and the digital cushion. It is crossed medially and laterally by the ligament of the ergot (not shown), subcutaneously, connects the ergot with the hoof cartilage.

3

4

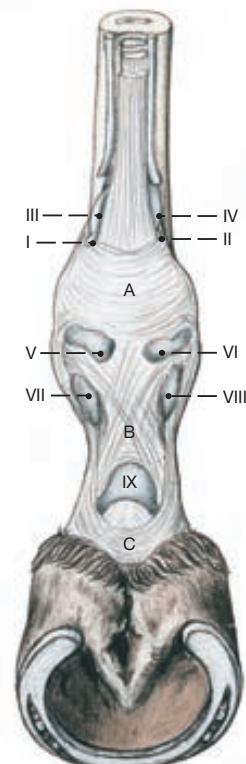
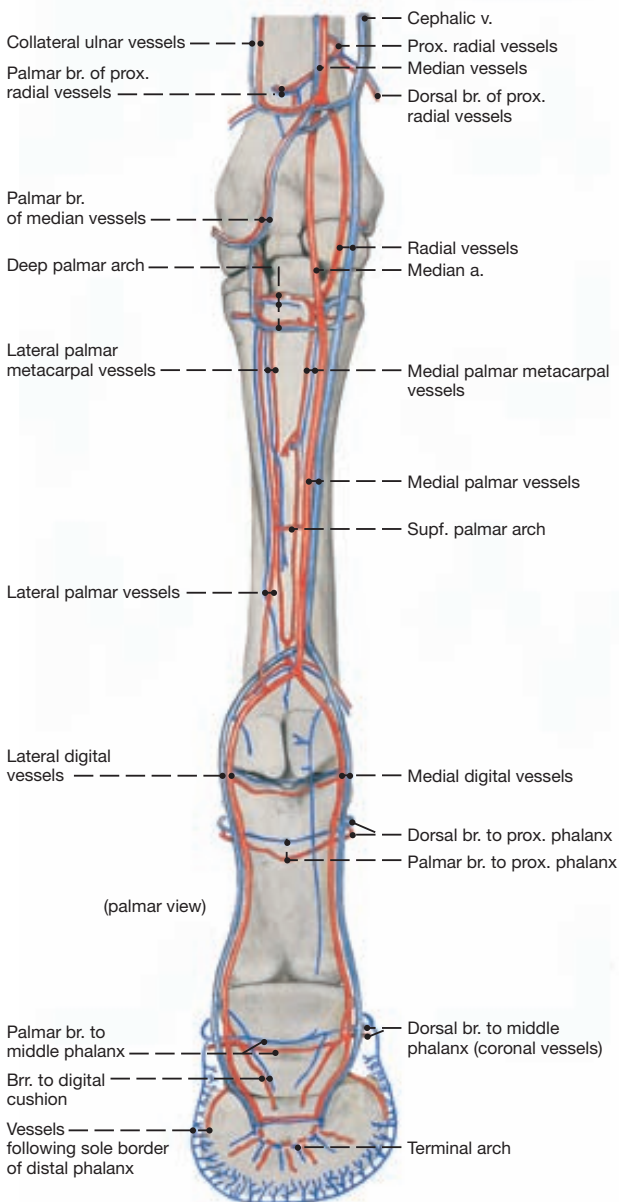
The **digital synovial sheath** surrounds the flexor tendons and facilitates their movements against each other and over the three bearing surfaces on the palmar surface of the digit.

Inflammation may cause the sheath to swell and to pouch out in any of the nine places where it is not bound down by the annular ligaments just described: Four pouches occur proximal to the annular ligament of the fetlock joint; two (I and II) medial and lateral to the supf. flexor tendon and two (III and IV) medial and lateral to the interosseus. The remaining more discrete single pouches are as shown in the next figure below.

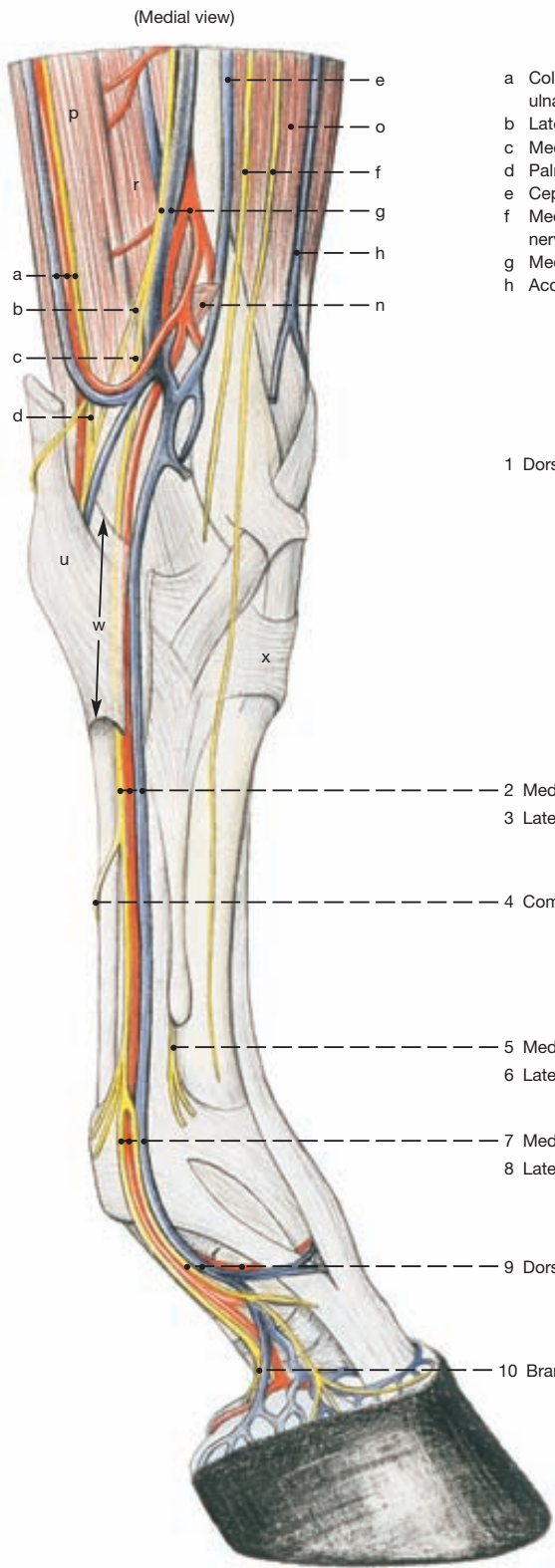
Palmar View of Fetlock and Digit

(For explanation see text above.)

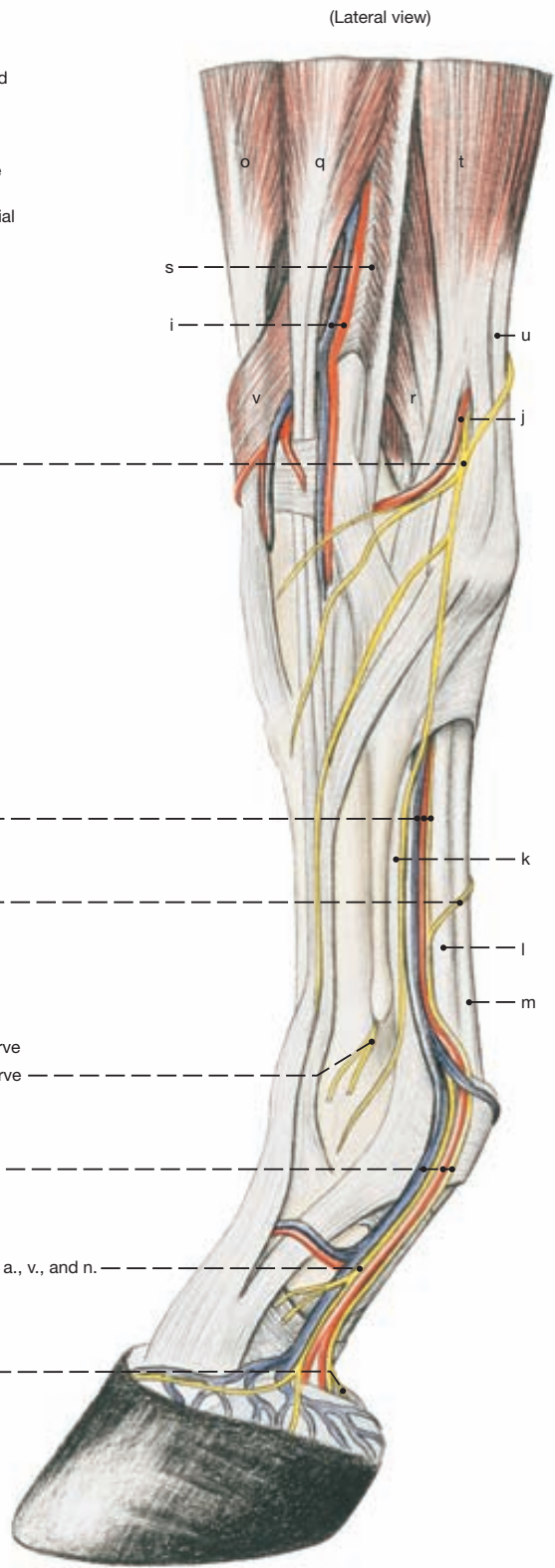
Arteries and Veins of the Left Distal Forelimb



Arteries, Veins, and Nerves of the Distal Forelimb



- a Collateral ulnar a., and v., and ulnar nerve
- b Lateral palmar nerve
- c Medial palmar nerve
- d Palmar branch of ulnar nerve
- e Cephalic vein
- f Medial cutaneous antebrachial nerve (musculocutaneous)
- g Median a., v., and n.
- h Accessory cephalic vein



- 1 Dorsal branch of ulnar nerve

- 2 Medial palmar a., v., and n.
- 3 Lateral palmar a., v., and n.
- 4 Communicating branch
- 5 Medial palmar metacarpal nerve
- 6 Lateral palmar metacarpal nerve
- 7 Medial digital a., v., and n.
- 8 Lateral digital a., v., and n.
- 9 Dorsal branches of the digital a., v., and n.
- 10 Branches to digital cushion

(See p. 7, 9, 10)

- | | | | |
|----------------------------------------------|------------------------------------------|----------------------------------|--------------------------------------------------|
| i Cranial interosseous a. and v. | m Supf. digital flexor tendon | r Deep digital flexor | w Flexor retinaculum and carpal canal deep to it |
| j Dorsal carpal branch of coll. ulnar artery | n Flexor carpi radialis, resected | s Lat. digital extensor | x Extensor retinaculum |
| k Interosseus | o Extensor carpi radialis | t Ulnaris lateralis | |
| l Deep digital flexor tendon | p Supf. digital flexor | u Flexor carpi ulnaris, resected | |
| | q Common digital extensor (humeral head) | v Extensor carpi obliquus | |

The structures making up the **PASSIVE STAY-APPARATUS** are shown on the opposite page schematically and on two dissections. The latter show the actual structures to best advantage and were made by the following steps. The limb is skinned to the hoof, and the pectoral muscles, subclavius, and rests of the trapezius and brachiocephalicus are removed. Blood vessels and nerves can be discarded (and removed) throughout. The extensor carpi radialis is resected at the level of the elbow, preserving the lacertus fibrosus as shown. Then the brachialis is resected. At the level of the fetlock and digit, the palmar annular ligament and the prox. digital annular ligament are transected axially, and the sleeve formed by the supf. digital flexor around the deep digital flexor tendon is opened by a similar but deeper cut. The deep flexor tendon is transected in midmetacarpus and lifted out of the sleeve so it can be reflected distally.

The **PASSIVE STAY-APPARATUS** of both fore- and hindlimbs enables the horse to be on its feet for long periods with a minimum of muscular effort. Older subjects actually doze (perhaps sleep) while standing, although for a refreshing sleep horses lie down, usually at night when they are unobserved. By being on its feet most of the time, the horse, a rather nervous and excitable animal that uses flight as its principal means of defense, appears to be in perpetual readiness to run away from danger.

The four limbs that carry the body of a quadruped are angulated bony columns that would collapse were they not prevented from doing so by the activity of the intrinsic limb muscles. Active muscles soon tire and become painful, which signals the animal to lie down. The effort of the intrinsic limb muscles of horses is greatly reduced by the non-tiring tendons and ligaments of the stay-apparatus, which stabilizes the joints in a position suitable for the support of the body. In most joints stabilization means preventing them from flexing. Pastern and fetlock joints in the standing horse, however, are extended and overextended, respectively; their stabilization requires them not to overextend further so as to prevent the fetlock from sinking to the ground.

1. The fleshy attachment (**synsarcosis**) of the forelimb to the trunk is not part of the stay-apparatus, though the serratus ventralis that serves as the principal **weight-bearing** connection is heavily interlaced with non-tiring tendinous tissue.

2. Though no collateral ligaments are present, the movements in the **shoulder joint** are restricted largely to flexion and extension in the sagittal plane by the subscapularis medially and the infraspinatus and (to a lesser degree) the supraspinatus laterally.

The principal stabilizer of the shoulder joint in the standing horse is the biceps tendon pressing against the cranial (extensor) surface of the joint. The way the tendon caps the intermediate tubercle of the intertubercular groove suggests a partial locking of the joint. The shoulder joint is further prevented from collapsing (flexing) by the internal tendon of the biceps that anchors the muscle to the most proximal part of the radius and, via the lacertus fibrosus and extensor carpi radialis, to a similar point on the large metacarpal bone. Thus the weight of the trunk acting on the proximal end of the scapula, tenses the biceps-lacertus-extensor carpi “rigging” just mentioned. This causes a cranial “pull” on the elbow joint (i. e., an extension of the joint) and “pressure” on the extensor surface of the carpal joint that tends to prevent flexion in that joint.

3. The **elbow joint** is stabilized (i. e., prevented from flexing) principally by tension in a group of carpal and digital flexors that arise on the medial and lateral epicondyles of the humerus and contain much fibrous tissue. Eccentrically placed collateral ligaments inhibit flexion to a lesser degree. The principal extensor of the joint, the triceps, seems inactive by its flabbiness in the quietly standing horse, although some workers believe that its tonus alone would prevent collapse of this key joint. The “pull” on the flexor surface by the

biceps insertion that would tend to keep the joint extended has already been mentioned.

4. The **carpal joint** is stabilized (prevented from flexing) by the (dorsal) “pressure” of the extensor carpi radialis tendon already alluded to. The flexor carpi ulnaris and ulnaris lateralis ending on the accessory carpal and being tensed by the weight of the trunk via scapula, fixed shoulder joint, and humerus, “pulls” on the flexor surface of the carpal joint in an attempt to keep the joint extended. The accessory ligaments of the supf. and deep digital flexors attaching on the palmar surface of radius and large metacarpal bone above and below the carpus tend to supply a similar “pull”, again by the weight of the animal, but in the opposite direction—distally. Some workers ascribe a similar potential to the interosseus.

5. The **fetlock joint** needs to be stabilized by being prevented from further overextending, i. e., sinking toward the ground. This is accomplished by three elements: the suspensory apparatus associated with the interosseus, and the supf. and deep digital flexor tendons. These attach to the palmar surface of the limb skeleton proximal and distal to the joint and are tensed when the weight of the horse overextends the joint. Their elastic properties “carry” the joint in a yielding, anticoncussive manner that is best observed in slow-motion films of a horse at speed.

The **suspensory apparatus** consists again of three parts: interosseus, proximal sesamoid bones, and sesamoidean ligaments. The interosseus arises from the carpus and proximal end of the large metacarpal bone and ends on the two sesamoid bones. (Before doing so it sends extensor branches around the proximal phalanx to the common extensor tendon.) The proximal sesamoid bones articulate with the distal end of the large metacarpal bone to reduce friction between the suspensory apparatus and the palmar surface of the fetlock joint. Collateral ligaments tie the sesamoid bones to the cannon bone and proximal phalanx, while a thick palmar ligament unites the sesamoid bones and forms a smooth bearing surface for the digital flexor tendons. The tension in the interosseus is continued distal to the joint by four sesamoidean ligaments (short, cruciate, oblique, and straight) of which the first three end on the proximal, and the last on the middle phalanx.

The **supf. digital flexor tendon** assists the suspensory apparatus by providing a tendinous support extending (via its accessory [check] ligament) from the radius above the fetlock joint to the proximal and middle phalanges below the joint.

The **deep flexor tendon** and its accessory (check) ligament provide added and similar support; the accessory ligament arises with the interosseus from the caudal aspect of carpus, the tendon itself ends on the distal phalanx.

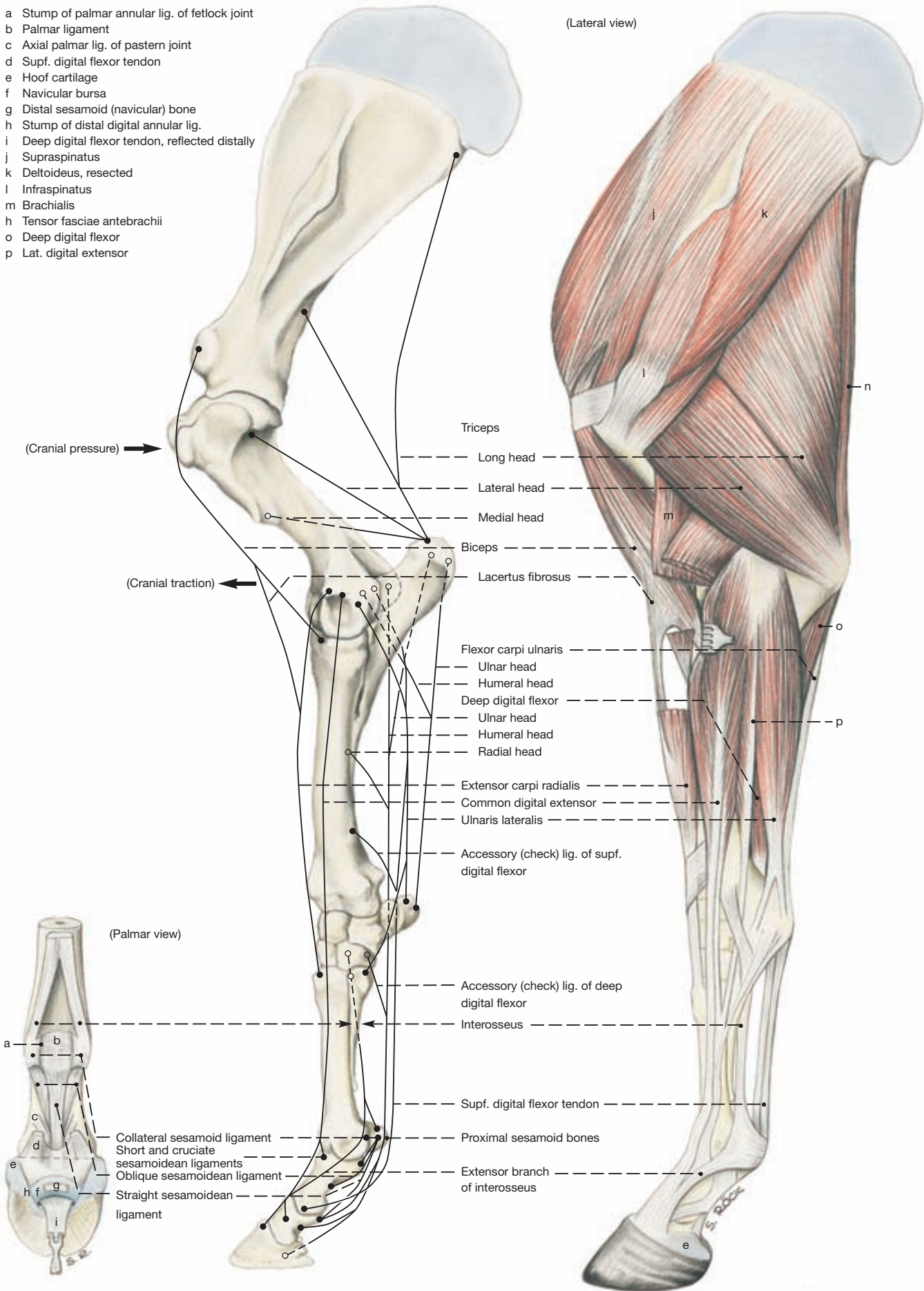
6. The **pastern joint** is prevented from overextension by four pastern ligament that connect the two bones that form the joint on the palmar surface. The straight sesamoidean ligament of the suspensory apparatus and the supf. and deep flexor tendons give additional support.

The proximopalmar border of the middle phalanx carries a complementary fibrocartilage into which the supf. flexor tendon and the ligaments reaching the bone from above insert. The cartilage and part of the bone form the second bearing surface over which the deep flexor tendon changes direction.

7. The **coffin joint** actually flexes when the fetlock sinks under weight and can be disregarded in the consideration of the stay-apparatus. On its palmar surface lies the distal (navicular) sesamoid bone suspended by proximal (collateral) and distal ligaments. It provides the third bearing surface for the deep flexor tendon which here is protected from wear by the navicular bursa.

Musculature of the Thoracic Limb

- a Stump of palmar annular lig. of fetlock joint
- b Palmar ligament
- c Axial palmar lig. of pastern joint
- d Supf. digital flexor tendon
- e Hoof cartilage
- f Navicular bursa
- g Distal sesamoid (navicular) bone
- h Stump of distal digital annular lig.
- i Deep digital flexor tendon, reflected distally
- j Supraspinatus
- k Deltoideus, resected
- l Infraspinatus
- m Brachialis
- n Tensor fasciae antebrachii
- o Deep digital flexor
- p Lat. digital extensor



1 a) JOINTS OF THE THORACIC LIMB

Name/Fig.	Bones involved	Type of joint	Function	Remarks
2 I. Shoulder Joint / 1–3	Glenoid cavity of scapula and head of humerus	Simple spheroidal joint	Restricted to flexion and extension by tendinous components of subscapularis and supra- and infraspinatus muscles	Site of injection Cranial border of palpable infraspinatus tendon, 2 cm proximal to greater tubercle, to a depth of about 5 cm
3 II. Elbow Joint / 4–6		Composite joint		
a) Humeroulnar articulation	a) Condyle of humerus and ulna	a) Simple hinge joint	a–b) Flexion and extension	Initial flexion of the joint is impeded by eccentrically placed collateral ligaments. The long part of the medial collateral ligament corresponds to the pronator teres of other animals
b) Humeroulnar articulation	b) Condyle of humerus and head of radius	b) Simple hinge joint		
c) Proximal radioulnar articulation	c) Articular circumference of radius and radial notch of ulna	c) Simple pivot joint	c) No movement	
III. Distal radioulnar joint (absent)				
CARPAL AND DIGITAL JOINTS				
4 IV. Carpal joint / 7, 8		Composite joint (in the wider sense)		
a) Radiocarpal joint	Trochlea of radius and carpal bones	Composite condylar joint	a) Flexion and extension up to 90°	a) Site of injection: Between lateral digital extensor and ulnaris lateralis into the proximal pouch when the carpus is flexed a–d) The fibrous layer of the joint capsule is common to all articulations in the carpus. The synovial layer is divided to enclose the three individual articulations separately. The midcarpal capsule communicates with that of the carpometacarpal articulation.
b) Midcarpal joint	Proximal and distal rows of carpal bones	Composite condylar joint	b) Flexion and extension up to 45°	
c) Carpometacarpal joint	Carpal bones II–IV and metacarpal bones II–IV	Composite plane joint	c) Little movement	
d) Intercarpal joints	Carpal bones of the same row	Composite plane joint	d) Little movement	
5 V. Fetlock (metacarpophalangeal) joint / 9, 10	Metacarpal 3, prox. phalanx, and prox. sesamoid bones	Composite hinge joint	Flexion and extension	Site of injection: Into the prox. palmar pouch between large metacarpal bone and interosseus
6 VI. Pastern (prox. interphalangeal) joint / 9, 10	Proximal and middle phalanx	Simple saddle joint	Flexion and extension, also slight side-to-side and rotational movements	Site of injection: Into the prox. dorsal pouch under the lateral border of the common extensor tendon
7 VII. Coffin (dist. interphalangeal) joint / 10	Middle phalanx, distal phalanx, with hoof cartilage, and navicular bone	Composite saddle joint	Flexion and extension, also slight side-to-side and rotational movements	Site of injection: Into the prox. dorsal pouch under the lateral border of the common extensor tendon

The three **digital joints** are the fetlock, pastern, and coffin joints. The proximal sesamoid bones and their ligaments are part of the fetlock joint, and the navicular bone and its ligaments are part of the coffin joint (page 12 and 13, and the Figure on page 4, respectively). The sesamoids receive part of the body weight when the limb is bearing weight. The capsules of the three digital joints present dorsal and palmar pouches which extend proximally; some of them are the sites for puncturing the joints.

b) IMPORTANT SYNOVIAL BURSAE

The **infraspinatus bursa** (1) lies between the tendon of the infraspinatus and the caudal part of the greater tubercle of the humerus.

8 The **intertubercular bursa** (4) underlies the biceps tendon between the greater and lesser tubercles of the humerus. It corresponds to the recess (of the shoulder joint capsule) that surrounds the biceps tendon in most other domestic mammals. Its inflammation can produce shoulder lameness.

9 The **subcutaneous olecranon bursa** (4) over the olecranon tuber is inconstant. Its hygromatous enlargement is known as capped elbow.

10 A **subcutaneous (precarpal) bursa** (7) on the dorsal surface of the carpus can develop after repeated injury in small box or trailer stalls.

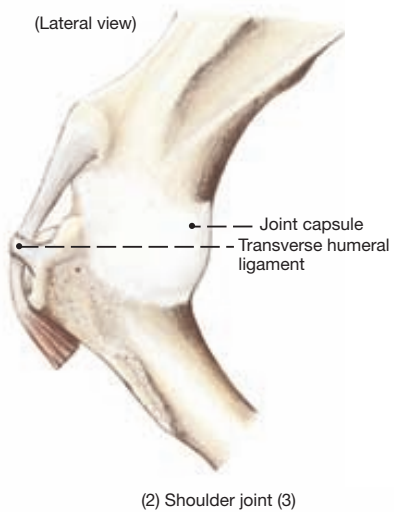
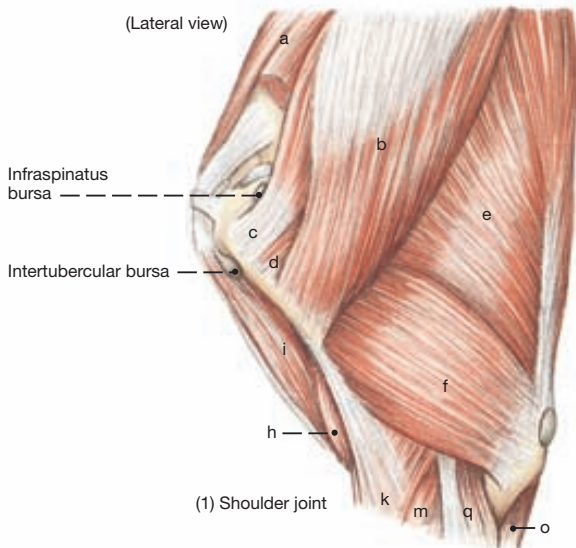
The subtendinous bursa of the common and lateral digital extensors (9) lies between the cannon bone and the tendons of these muscles.

The **navicular bursa** (10) provides frictionless movement of the deep flexor tendon over the navicular bone.

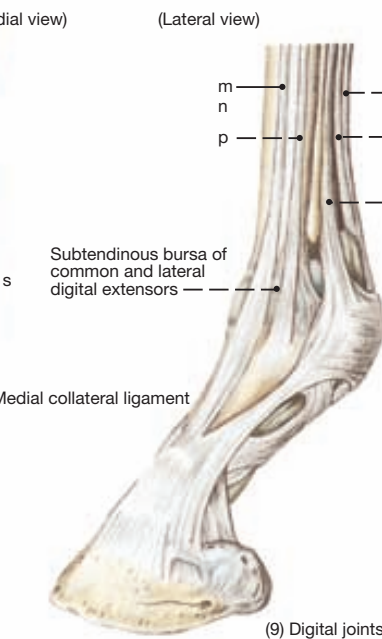
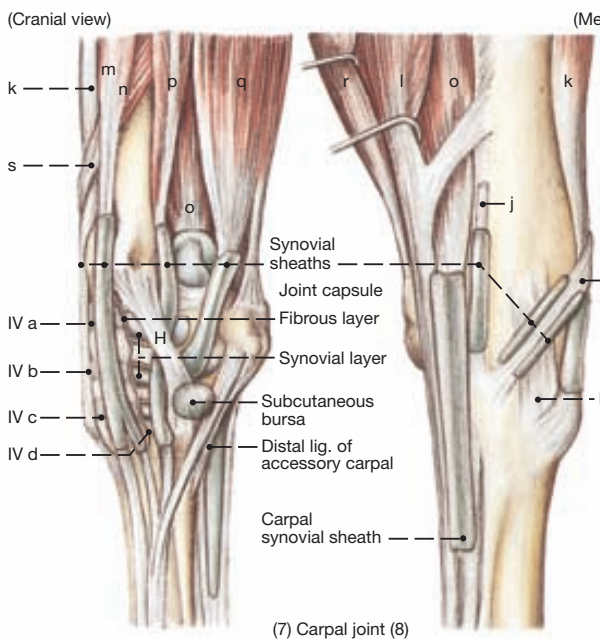
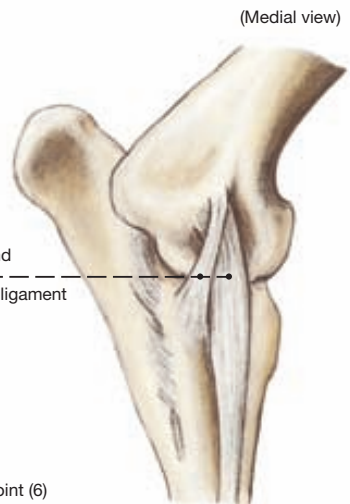
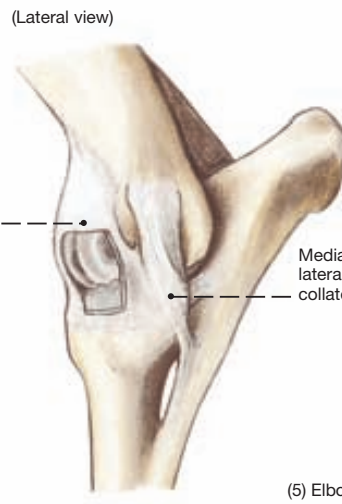
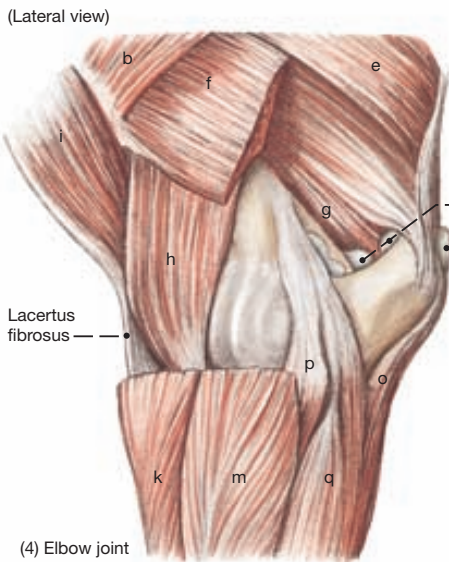
c) TENDON SHEATHS

Synovial tendon sheaths are thin walled, but double-layered, fluid-filled tubes surrounding stretches of tendons; they protect the tendons where they are exposed to wear. Synovial sheaths surround the **tendons passing over the carpus** (7), except for the short tendon of the ulnaris lateralis and that of the flexor carpi ulnaris. One of these is known as the **carpal sheath** (8); it serves both supf. and deep flexor tendons as they pass the carpus in the carpal canal. A similar sheath for both these tendons is the digital sheath which extends from above the fetlock joint to the middle of the middle phalanx. In both sheaths, the deep flexor tendon is wholly, but the supf. flexor is only partly surrounded. Only at the proximal extremity of the digital sheath is the supf. flexor tendon nearly completely enclosed. Except for the nine outpouchings illustrated on page 10, the palmar surface of the digital sheath is covered by the annular ligament of the fetlock joint and by the proximal and distal digital annular ligaments.

Joints, Bursae, and Synovial Sheaths



- a Supraspinatus
- b Deltoideus, resected
- c Infraspinatus
- d Teres minor
- Triceps brachii:
- e Long head
- f Lateral head, resected
- g Medial head
- h Brachialis
- i Biceps brachii
- j Flexor carpi radialis, resected
- k Extensor carpi radialis
- l Supf. digital flexor
- m Common digital extensor (humeral head)
- n Common digital extensor (radial head)
- o Deep digital flexor
- p Lat. digital flexor
- q Ulnaris lateralis
- r Flexor carpi ulnaris, resected
- s Extensor carpi obliquus



- A Lateral collateral lig. of coffin joint
- B Collateral lig. of navicular bone
- C Lateral collateral lig. of fetlock joint
- D Lateral collateral lig. of prox. sesamoid bones
- E Oblique sesamoidean ligament
- F Straight sesamoidean ligament
- G Navicular bone
- H Lateral collateral lig. of carpal joint