AN ANATOMICAL-RADIOLOGICAL STUDY OF THE ARTERIES OF THE DISTAL EXTREMITY OF THE THORACIC AND PELVIC LIMBS OF THE HORSE, OX, AND DOG

by

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INTRODUCTION

The study of blood vascular arrangement has interested anatomists, zoologists, comparative morphologists, and surgeons alike. Dissection, as a method for studying blood supply and to know the anatomical makeup, has been followed ever since the first cadaver was opened. This early knowledge stimulated research workers in the field, to study the intricate patterns of arrangement, and correlate the findings in the field of comparative anatomy.

History has recorded that Hippocrates, who wrote about human anatomy, relied more on the anatomy of domestic animals, and found analogies which he described. Thus, the study of the anatomy of the domestic animals had a long record. Later studies which delved into greater details, necessitated embalming of cadavers. The advent of colored starch mass and latex as injectable materials facilitated dissection and added means of visualizing minute vessels. Adoption of vinyl acetate injection procedures and obtaining casts of blood vessels by corrosion, were techniques that aided detailed study.

The introduction of X-rays opened a new vista in the study of anatomy, by making visible the various anatomical structures in their insitu position and made possible the observation of structures while they were functioning. This also helped to make observations on physiological deviations, pathological processes, etc. while insitu.

The review of the available literature showed a lack of roentgenological study of blood vessels of the limbs of domestic animals, though description of arteries and veins based on dissections were available in textbooks and other reference material. X-ray studies of many parts of the body were made, necessitated by more frequent difficulties in clinical practice, for study of the physiology of organs, and also the increasing demand for technical advancement in the field of surgery, such as X-ray studies of the spleen, kidneys, uterus, ovaries, etc. Works on ontogenic phases were available for reference.

This phase of study was undertaken because the limbs of domestic animals were very important parts and prone to injuries and pathological processes. This study included the details of arterial distribution, the relationship of vessels to bony structures, and provided more information for the study of physiological deviations and the regeneration of vessels following injury. The horse, ox, and dog, which were the domestic animals of greatest economic importance and were most commonly visited by the veterinarian, were selected for study. In addition, these animals also represented a perissodactylar herbivore, an artiodactylar ruminant, and a pentadactylar carnivorous type, thus offering an interesting study of basic arterial pattern and its modifications in representative types.

MATERIALS AND METHODS

Subjects

The distal extremities of the thoracic and pelvic limbs of the horse, ox, and dog were procured from the necropsy laboratory of the Department of Pathology, Kansas State University, for use in this study. Eight thoracic and pelvic limbs of the horse; six of each of the ox; and eight of each of the dog were studied. Additional observations were made on ten ox and six dog specimens in the dissection laboratory of the Anatomy Department.

This study included dissection study in addition to recording arteriograms, and all specimens were embalmed with the embalming fluid made as given below.

Formalin	480 cc
Acetic acid	20 cc
Glycerine	150 cc
Water	q.s. ad 1 gallon

Radiopaque Materials

The choice of radiopaque material for injecting into the arteries was made on the following basis: 1. ready availability; 2. impermeability into venous channels; 3. stability and ease of handling under field conditions; 4. adaptability for use after embalming of specimens; 5. quick setting and hardening, giving color and contour to the arteries to facilitate dissection; and 6. the cost of the material--an important consideration. A commercial preparation called "Vultex," red latex (Batson, 1939)

was selected as it fulfilled, to a large measure, all the requirements mentioned above. This product was put up by General Latex & Chemical Corporation, 666 Main Street, Cambridge, Massachusetts.

Although other commercial preparations, commonly used in medical practice for angiography were tried, they were given up for the reasons mentioned below.

Urokon Sodium. This material gave very good contrast, but permeated into the venous channels quickly and could not be used in this study. It had to be injected in fresh specimens for the best results. The cost was prohibitive for large-scale use in the study of large animals. This medium had to be mixed with a dyd for making the arteries more obvious in later dissections, or following radiography latex had to be injected, making this an involved and prolonged procedure.

Lipiodol. This contrast medium also afforded good contrast in arteriograms. Since it had an oily base, the injecting had to be done when the material was hot, to overcome viscosity. It also had to be mixed with a dye for giving color to the arteries. The greatest disadvantage in its use, however, was the oozing out of the oil from cutaneous and other vessels during dissection. The cost was also considerable.

Gastrogaffin. Although this medium gave a good contrast, it had to be mixed with a suitable dye, and was not very convenient to handle. The cost was higher than that of Vultex.

Barium Sulphate "Veri-O-Pake." This product was tried in an emulsion form. There was considerable difficulty in the injecting procedure due to the clogging of the needle and the piston of the syringe. A mucilagenous preparation of this material with a suitable dye such as sudan red, gave good results although the injecting difficulties remained. These injections were made after the embalming of the specimens.

The use of "Vultex" was very satisfactory in most all respects, although in some instances the contrast in the arteriograms was not quite dense enough. It was also found that 1 to 2 per cent glacial acetic acid in the embalming fluid was not enough to harden the latex by counteracting the high alkalinity of the material. A higher percentage, up to 4 per cent acetic acid or carbolic acid, had to be used for satisfactory setting of the latex.

The use of 95 per cent alcohol for embalming was not practicable and hence was not attempted.

Constants in Arteriography

Par speed screens were used in this study for taking arteriograms. A tube length of 36 inches at 100 M.A. was maintained in all procedures.

Description Procedure

In the description of the dissection, capillaries and cutaneous vessels were omitted. Similarly, relationships of

nerves or tendons, etc. were not given since these points have been fully described in the textbooks, and also because they could not be visualized in the arteriograms made in this study.

REVIEW OF LITERATURE

Radiopaque Materials

Radiopaque materials were used for angiography as early as 1896 (Gough, 1920). Use of calcium sulphate with water as radiopaque material was accredited to an Italian, U. Dutto. The earliest report in English literature, to roentgenology of blood vessels is that of Sydney Rowland who reported in 1897 "Dr. Hedley. . . .a stereoscope, showing amongst other objects an injected human brain" (Gough, 1920).

Later, salts of heavy metals such as mercury, lead, bismuth, and barium, with various vehicles, were used by several workers. Metallic mercury was first used for injecting in England by H. E. Glew in 1899 (Gough, 1920). Parker (1917) recorded the use of

Bismuth subnitras	25 gms
Gelatin, dry	2.5 gms
Water	100 cc

Bismuth subnitras was to be dissolved in warm gelatin, strained, and injected warm.

Bismuth subnitras	20 gms
Vaseline	130 gms
Lead chromate	20 gms
Vaseline	100 gms

Both of the other materials were prepared and used in the same manner as the first formula. Hill (1924) recommended the use of

barium oxychloride with gum acacia as a base, for arterial injection, using the following formula.

Barium oxychloride	17 gms
Gum acacia	10 gms
Distilled water	100 cc

Gough (1920) recorded the use of barium sulphate with phenol and glycerine, in 96 per cent alcohol for injecting blood vessels for roentgenological studies and simultaneous embalming. Delahanty (1952) used barium sulphate with gum acacia as a base, made in a heavy cream consistency. Injection was made slowly and forcibly. The injected specimen was suspended for 48 hours before angiography. Reuber and Emerson (1959) used the following procedure in arteriography of the internal genitalia of the cow.

Injection mass:	Gelatin powder	45 gms)	Heated in a water
	Distilled water	300 ml)	bath at 180° F.
To this was added:	Potassium iodide	15 gms	
	Glycerol	100 ml	
	Formaldehyde solution	1.5 ml	
	Bismuth subnitras	32 gms	

This mass was injected warm, at 300 m.m. Hg. pressure and transferred to a cooler. A pre-injection rinse of 1 per cent sodium citrate solution was advised. Lum, Jr. (1946) used an injection mass with potassium iodide and red lead as radiopaque factors in a base of gelatin, glycerine, and distilled water. This was used after rinsing the arteries with 1 per cent sodium citrate solution in quantities of one-half to one-third of injection mass. Injection was made under 15 pounds per square inch pressure, and injected specimens cooled for a day before the radiograph was made.

Tobin (1944) tried mixing red liquid latex (pH 9.9) with Skiodan, crystalline potassium iodide, barium sulphate, and Tetradol emulsion and injected it into rats. Each material was found to coagulate latex and when used in lesser quantity, the diffusibility was poor. However, he preferred mixing Pantopaque 50 per cent, although it had the disadvantage of viscosity, because of its oily nature. He brought the pH of the material to 10.78, with the addition of ammonia water. The arteries were injected with this material in the fresh specimens and then embalmed with a formalin, acetic acid mixture. Batson (1939) used "Vultex" successfully. He used a pre-injection rinse of ammonia water. The specimens then were embalmed intra-arterially with a 5 to 8 per cent formalin and 1 to 2 per cent acetic acid mixture or 95 per cent alcohol. "Vultex" was injected intra-arterially 12 to 24 hours after completion of the embalming, using a rubber piston syringe. This method was found to be the most suitable, and hence was used in this study.

Arteriographical Studies

The only references in published literature available were the work of S. Tohara, A. Miyakawa, and B. Wagai who published anatomical and stereo-radiographical studies of the arteries of cattle hoof (bovine foot) (1954) and similar studies on the distribution of arteries in the foot of the horse (1955). They described the regions from the fetlock to the foot.

A description of arteries and their relative position in the horse, the ox, and the dog, based on dissections were found in Chauveau (1891) and Sisson and Grossman (1955). McLeod (1958), Habel (1950), and Way (1954) described these vessels in the bovine. M'Faedyean (1909) described the arteries in the horse. Bradley (1959) and Miller (1958) described the disposition of the arteries in the dog.

OBSERVATIONS

The following observations were made from arteriograms. They were combined with studies of dissections, to obtain a more comprehensive and detailed study of the arteries since stereoradiography was not used in this work. The dissection procedure also helped to show smaller vessels that had not been penetrated by the particular radiopaque material and therefore were not visible in radiographs.

Thoracic Limb - Horse*
(Plates I, II, III, IV, and VII)

Volar Surface. On this surface, five main arteries were observed in the region of the metacarpus, namely, (1) the medial deep volar metacarpal artery, (2) the medial superficial volar metacarpal artery, (3) the lateral deep volar metacarpal artery, (4) the lateral superficial volar metacarpal artery, and (5)

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* Plates I, II, III, IV, and VII are shown in the Appendix.

the great metacarpal artery. Two arterial arches, namely, the subcarpal arch and the distal volar arch, were formed by the union of the medial and the lateral deep arteries with the great metacarpal artery near the proximal and distal extremities, respectively.

(1) Medial Deep Volar Metacarpal Artery. This artery branched out from the median artery at the distal third of the antibrachium and descended on the volar surface of the carpus and metacarpus, along the medial border. The vessel lay in the interosseous groove which was formed by the metacarpal II and metacarpal III. This vessel received a communicating branch from the rete carpii volare in two specimens studied. This vessel was referred to as the posterior deep interosseous artery by M'Faedyean (1909). Just distal to the proximal end of the metacarpal II, a branch traveled toward the dorsal surface of the interosseous space, as the dorsal metacarpal artery. Two transverse branches were seen about three-fourths inch ventral to one another and joined the lateral deep arteries to form the subcarpal arch. The nutrient artery of the third metacarpal bone was derived from the medial deep volar metacarpal artery, and entered the nutrient foramen at the junction of the upper and middle third of the bone. The medial deep volar metacarpal artery descended in a flexuous manner and joined the medial superficial volar metacarpal artery in two of the specimens studied. It joined the great metacarpal artery in the formation of the distal volar arch and supplied a vessel which coursed over

to the dorsum of the fetlock.

(2) Medial Superficial Volar Metacarpal Artery. This artery arose from the medial deep volar metacarpal artery at about the level of the origin of the transverse branch referred to above. It was slender and descended along the medial border of the flexor tendons and joined the parent vessel a little proximal to the distal volar arch. It gave small twigs along its course, which anastomosed with the great metacarpal artery and the lateral superficial volar metacarpal artery, forming rings around the flexor tendons. In one specimen, the medial superficial volar metacarpal artery arose from the great metacarpal artery.

(3) Lateral Deep Volar Metacarpal Artery. This artery branched off the median artery and joined the ulnar artery, thus forming the supracarpal arch. It descended in the metacarpal region along the medial surface of the accessory carpal bone and lodged in the groove between the third and fourth metacarpal bones. In two of the specimens studied it received a communicating branch from the rete carpii volare. The collateral branches and the termination of this artery were the same as for the medial deep volar artery except for the nutrient artery of the third metacarpal bone which originated only from the medial deep volar metacarpal artery.

(4) The lateral superficial volar metacarpal artery was similar to the corresponding medial artery, and was referred to as the lateral branch accompanying the lateral volar nerve by Sisson and Grossman (1955).

(5) Great Metacarpal Artery. This was the largest of the arteries in the region and was the continuation of the median artery. It lay on the volar surface nearer to the medial border. About two inches proximal to the fetlock it bifurcated to form the medial and lateral digital arteries. At the fetlock, about one-half inch proximal to the bifurcation, anastomosis of the medial and lateral superficial arteries, the deep volar metacarpal arteries, and the great metacarpal artery formed the distal volar arch. The collateral branches of the great metacarpal artery were twigs along the course of the flexor tendons, to the medial and lateral superficial volar metacarpal arteries. These collateral branches surrounded the flexor tendons, forming rings around them, arranged like the rungs of a ladder.

The Dorsal Surface. The two dorsal metacarpal arteries, called the anterior interosseous arteries (M'Faedyean, 1909), were the main arteries on the dorsal surface of the metacarpal region. They emerged from the medial and lateral deep volar metacarpal arteries, passed through the groove between the second and the third, and the third and the fourth metacarpal bones, to the dorsal surface and divided into an ascending and a descending branch. The ascending branch joined proximally with branches from the rete carpii dorsale. The descending branch lay in the interosseous groove and at about one inch proximal to the distal extremities of the second and fourth metacarpal bones, turned inward, and anastomosed with the corresponding deep volar metacarpal arteries. Inconstantly, one or two branches, after

arising from the parent vessels, turned over the shafts of the second and the fourth metacarpal bones, near their proximal extremity and joined the dorsal descending branches. The dorsal surface of the third metacarpal bone also received, as seen in four of the specimens, a vessel descending from the rete carpii dorsale, which reached the junction of the middle and distal third of its shaft. The distal extremity of this bone received two or three vessels from the volar surface which formed a network on the dorsum around the fetlock. These vessels came generally from the deep volar metacarpal arteries at the level of their union to form the distal volar arch or form the arch itself.

The Digital Arteries. The two digital arteries, the medial and the lateral volar digitals, came out from the bifurcation of the common digital trunk as a continuation of the great metacarpal artery, distal to the distal volar arch. These passed around the abaxial surface of the proximal sesamoid bones and descended along the lateral borders of the phalanges. They terminated by anastomosing with each other in the semilunar canal of the os pedis and formed the terminal arch.

The collateral branches were: 1. the artery to the fetlock joint; 2. the artery to the ergot; 3. the artery of the first phalanx, 4. the artery of the digital cushion; 5. the arteries of the second phalanx; 6. the dorsal artery of the third phalanx; and 7. the arteries to the lateral cartilages.

1. The artery to the fetlock joint. A medial and a lateral artery arose near the sesamoid bones and spread out on both surfaces of the fetlock joint.

2. The artery to the ergot. Two vessels arose, one from each of the digital arteries in the region of the fetlock and then passed backward and outward and slightly distally to arborize on the ergot.

3. The artery of the first phalanx. This vessel, also called the perpendicular artery (M'Faedyean, 1909), arose near the middle on each side of the first phalanx and divided into two vessels, seen as a dorsal and a volar branch. The dorsal vessels proceeded to the dorsum of the bone and formed a network by anastomoses. The volar branches were smaller and formed a similar anastomosis on the volar aspect of the bone.

Accessory artery of the first phalanx. In four of the specimens studied, a small accessory artery which contributed branches to both the fetlock and the ergot, was found near the proximal extremity of the first phalanx.

4. Artery of the digital cushion. This vessel was larger than the other collateral vessels and was given off at the level of the articulation of the first and second phalanges. The artery ran downward and backward in the direction of the digital cushion, branches extensively and anastomosed with the volar artery of the second phalanx in the region of the frog, and with the ascending branch of the dorsal artery of the third phalanx, in the area of the lateral cartilages.

5. Arteries of the second phalanx. Two vessels, a dorsal and a volar artery, originated in this region, from the digital arteries. The dorsal artery arose at the level of the upper border of the distal sesamoid bone, passed on to the dorsal surface of the second phalanx, and formed a circle in the region of the coronary groove. It received anastomosing vessels from the descending branch of the dorsal artery of the first phalanx. The volar artery was smaller than the dorsal and was located slightly distally. This vessel anastomosed extensively with its fellow vessel from the opposite side, received communicating branches from the artery of the digital cushion, and sent anastomotic branches to the ascending branch of the dorsal artery of the third phalanx in the region of the lateral cartilages. The two arteries thus formed a circle around the coronet. This circle has been named the coronary circle by Chauveau (1891).

6, 7. The dorsal artery of the third phalanx, and arteries to the lateral cartilages. This vessel came off the digital artery at the volar angle of the third phalanx. It soon divided, with one branch entering a groove through the notch on the dorsal or wall surface and the main branch entering the volar groove on the sole surface. The dorsal branch branched extensively, entered the foramina on the wall surface of the os pedis, and then anastomosed dorsally and proximally with the coronary circle and distally with the basilar artery or the circumflex artery of the third phalanx, which lay along the free distal border of the third phalanx. A branch was detached from the dorsal artery of

the third phalanx before it entered the groove. This branch ran backward and slightly downward and medially to anastomose with the network of the artery of the digital cushion. The volar branch entered the volar groove and united with the opposite artery, forming an arch in the semilunar canal which is named the terminal arch. Branches emerged from the vessel through the foramena of the wall of the third phalanx to unite dorsally with the dorsal branch. The descending branches emerged along the distal free border of the third phalanx, anastomosed in arciform fashion, forming the circumflex artery of the third phalanx (Chauveau, 1891). The other collateral branches of the dorsal artery of the third phalanx, given out before it entered the volar groove, entered the region of the lateral cartilages of the third phalanx.

Pelvic Limb - Horse*
(Plates V, VI, and VII)

Volar Surface. The basic pattern of arterial distribution remained the same as in the thoracic limb. There was, however, a difference in the position and the location of the great metatarsal artery, as compared to the corresponding vessel, namely, the great metacarpal artery. These two were each the largest vessels in their particular limbs and both terminated by forming the common digital trunk. The great metacarpal artery continued

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* Plates V, VI, and VII are shown in the Appendix.

from the median artery, was located on the medial surface of the forearm, and descended along the mediovolar surface of the metacarpal region. The great metatarsal artery, on the other hand, was continued from the anterior tibial artery in the anterior surface of the leg, and descended obliquely across the anterolateral border of the tarsus, to the lateral border on the plantar surface of the metatarsal region. The vessel was located in a more plantar position towards the distal third of the fourth metatarsal bone. The other difference was in the formation of the proximal plantar arch corresponding to the subcarpal arch of the thoracic limb. The proximal plantar arch was formed by the union of the medial and lateral deep plantar metatarsal arteries with their transverse branches going along the distal border of the tarsometarsal articulation from the perforating tarsal artery, which was a branch of the anterior tibial artery. The general arrangement of the five metatarsal arteries on the plantar surface, namely, the medial and lateral superficial and deep metatarsal arteries and the great metatarsal artery, corresponded with the similar vessels of the thoracic limb.

The Medial Deep Plantar Metatarsal Artery. This artery arose from the bifurcation of the medial plantar artery, which in its turn, emanated from the medial tarsal artery. It proceeded along the volar interosseous groove, formed by the second and the third metatarsal bones, and united at or slightly proximal to the groove's distal extremity with the corresponding dorsal metatarsal artery. It also united with the great

metatarsal artery about one and one-half to two inches proximal to the fetlock.

The Medial Superficial Plantar Metatarsal Artery. This artery branched out from the medial deep metatarsal artery at the level of the proximal interosseous space between the second and the third metatarsal bones. This vessel was superficial and was accompanied by the flexor tendons. It united distally with the corresponding digital artery.

The Lateral Deep Plantar Metatarsal Artery. This artery arose from the lateral plantar artery, which in its turn, emanated from the bifurcation of the medial tarsal artery. The artery ran a course similar to the corresponding medial vessel, but along the plantar interosseous groove formed by the third and the fourth metatarsal bones. Its division to form the lateral superficial plantar metatarsal artery and its termination in the great metatarsal artery remained the same as in the corresponding vessel. It was, however, related to a greater extent to the great metatarsal artery which descended along its superficial surface up to the distal third of the fourth metatarsal bone. At this level it communicated by a small branch, with the great metatarsal artery. Another artery arose from the parent trunk at this level, and curved along to the dorsal surface of the third and the fourth metatarsal bones and then ramified on the bones.

The Lateral Superficial Plantar Metatarsal Artery. This artery branched from the lateral deep metatarsal artery, at the

same level as the corresponding medial branch, and terminated similarly by joining the lateral digital artery.

The Proximal Plantar Arch. This arterial arch was formed by the union of the medial and lateral plantar arteries, by their transverse branches, with the perforating tarsal artery. These vessels descended obliquely along the tarsometatarsal articulation.

The Distal Plantar Arch. This arch was formed by the anastomosis of the medial and the lateral deep metatarsal arteries with the great metatarsal artery, about one and one-half inches proximal to the fetlock joint. From the deep face of the arch emerged two vessels which diverged toward the proximal sesamoid bones, passed over to the dorsum of the fetlock, and detached small vessels to the fetlock. These vessels formed an arterial network on the dorsum of the fetlock.

The Digital Arteries. The common digital artery, the proper-digital arteries and their collateral branches were similar to those noted in the thoracic limb.

The Dorsal Surface. The two dorsal arteries occupied this surface, and their origin and course were similar to the corresponding arteries noted in the thoracic limb.

Thoracic Limb - Ox*
(Plates VIII and IX)

Volar Surface. The volar surface presented the following main arteries and arterial arches, namely, (1) the medial volar

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* Plates VIII and IX are shown in the Appendix.

metacarpal artery, (2) the lateral volar metacarpal artery, (3) the great metacarpal artery; and (a) the subcarpal arch, (b) the distal superficial volar arch (proximal), (c) the distal superficial volar arch (distal), and (d) the deep volar arch (distal).

(1) The Medial Volar Metacarpal Artery. This artery was the continuation of the smaller, medial terminal branch of the median artery, in the middle of the antibrachium, and is called the radial artery (Sisson and Grossman, 1955). Descending on the medio-volar aspect of the carpus, it detached two large and one small arteries, proximal to the dorsal surface of the carpus. Of these three branches, one large and one small artery ramified on the dorsal surface of the carpus to form the rete carpii dorsale, and the other large vessel descended on the dorsomedial aspect of the carpus to anastomose with the dorsal metacarpal artery. About one and one-half inches distally, the radial artery detached two branches which ramified on the volar surface of the carpus to form the rete carpii volare. In addition to the above, smaller twigs emerged on both surfaces of the carpus to enter the joint. The continuation of the radial artery, now called the medial volar metacarpal artery, divided, at the level of the proximal extremity of the large metacarpal bone into: the medial superficial volar metacarpal artery; the medial deep volar metacarpal artery and; detached the middle deep volar metacarpal artery.

The Medial Superficial Volar Metacarpal Artery. At its point of origin, it detached a transverse branch extending

proximally to the middle vascular groove of the metacarpal bone, and entered the proximal metacarpal foramen, as the proximal perforating metacarpal artery. The main branch descended from the proximal metacarpal foramen distally, as the middle deep volar metacarpal artery. A large vessel, which was subcutaneous, arose from the medial superficial volar metacarpal artery one-fourth inch distal to its origin. The main medial superficial volar metacarpal artery descended along the mediovolar border of the large metacarpal bone. At about level of the distal third of the region, it detached an oblique branch which descended laterad and joined the great metacarpal artery, forming the distal superficial volar arch (proximal). The parent vessel continued distally one and one-half inches proximal to the fetlock, and divided into three main vessels. The first vessel coursed the abaxial surface of the proximal sesamoid bones and continued on the medial chief digit as the medial abaxial digital artery. The second vessel joined the great metacarpal artery. The third branch, after joining the middle deep volar metacarpal artery, continued laterad and united with the lateral deep volar metacarpal artery to form the distal (deep) volar arch. In its course, it gave a variable number of smaller branches which joined the great metacarpal artery and the lateral superficial volar metacarpal artery to form rings around the flexor tendons.

The Medial Deep Volar Metacarpal Artery. In the arteriograms, because of its smaller size and deeper position, this vessel remained covered by the medial superficial volar metacarpal

artery, except near its origin and termination. In two of the specimens studied, it descended halfway down the metacarpal bone, close to the medial border, where it became very small. It was substituted in the distal portion by a recurrent branch from the deep volar arch (Habel, 1950), which after joining the medial superficial volar metacarpal artery, coursed to the middle of the large metacarpal bone, and then faded out near its middle. In the remaining specimens it remained a continuous vessel and descended to about two to two and one-half inches proximal to the fetlock. The medial deep volar metacarpal artery, about one-half inch distal to its origin, detached an oblique branch which joined the middle deep volar metacarpal artery. About one and one-half inches proximal to the fetlock, it gave origin to a vessel which crossed to the dorsum of the fetlock and formed a network at the region. The artery terminated by joining the middle deep volar metacarpal artery, about one-half to one inch proximal to the deep (distal) volar arch.

The Middle Deep Volar Metacarpal Artery. This artery arose as a continuation of the proximal perforating metacarpal artery, and descended distally in the vascular groove. Near the middle of the metacarpal bone it received one branch each from the medial and lateral deep volar metacarpal arteries, and terminated about one inch proximal to the fetlock by joining the great metacarpal artery and the medial and lateral deep volar metacarpal arteries to form the deep volar arch. Its union with vessels mentioned above, presented a diamond-shaped pattern . . .

At the distal metacarpal foramen it detached the distal perforating metacarpal artery. Both the proximal and the distal perforating metacarpal arteries joined the dorsal metacarpal artery.

(2) The Lateral Volar Metacarpal Artery. This artery descended on the laterovolar border of the metacarpal bone as the continuation of the dorsal interosseous artery. After emerging through the distal interosseous space of the radius and ulna, it descended along the volar surface of the carpus. In two of the specimens studied, it bifurcated on its emergence from the distal interosseous space and united about two inches further distad, and again bifurcated, giving the appearance of two radicles for the origin of the superficial and the deep lateral volar metacarpal arteries. In the remaining specimens it remained as one vessel. It gave collateral vessels similar to the medial volar metacarpal artery until it reached the proximal extremity of the large metacarpal bone. Distally, it divided into two terminal vessels: the lateral superficial volar metacarpal artery, and the lateral deep volar metacarpal artery.

The Lateral Superficial Volar Metacarpal Artery. This artery joined the great metacarpal artery and formed the superficial (distal) volar arch about one-half inch distal to the deep (distal) volar arch. The termination was similar to the corresponding medial vessel but its branch, going along the abaxial sesamoid bones to the lateral chief digit, was called the lateral abaxial digital artery.

The Lateral Deep Volar Metacarpal Artery. This artery remained covered in the arteriograms by the superficial vessel, except at its origin and termination, largely because of its deeper location and smaller size. It detached, near its origin, a transverse branch which joined the middle deep volar metacarpal artery to form the subcarpal arch.

The termination of both of the lateral vessels was similar to the corresponding medial vessels. The lateral superficial volar metacarpal artery, however, did not take part in the origin of the proximal perforating metacarpal artery.

(3) The Great Metacarpal Artery (McLeod, 1958). This vessel was named the volar common digital artery by Sisson and Grossman (1955). This was the largest artery in the region and arose as the lateral terminal branch of the median artery and descended along the volar surface of the large metacarpal bone, a little closer to the medial border than its middle. It ended at the distal extremity of the bone, where it detached a communicating branch to the deep distal volar arch and continued as the common digital trunk. In its course, in the middle third of the large metacarpal bone, it was superficial to the medial superficial volar metacarpal artery and covered it from view in the arteriograms. In its course by its anastomoses with the medial and lateral superficial metacarpal arteries, it formed the proximal and distal superficial volar arches and also the ring-like anastomoses around flexor tendons.

(a) Subcarpal Arch. Two parts of the arch were observed in this region. They were a proximal and a distal part. The proximal part of the subcarpal arch was formed by the transverse branch of the medial superficial volar metacarpal artery which united with a similar vessel from the lateral deep volar metacarpal artery. This union occurred close to the proximal extremity of the large metacarpal bone, and at the origin of the middle deep volar metacarpal artery. The distal part was formed by the anastomosing branches from the medial and lateral deep volar metacarpal arteries as they joined the middle deep volar metacarpal artery.

(b) Distal Superficial Volar Arch (proximal). This arch was formed about one and one-half inches proximal to the distal extremity of the large metacarpal bone, by the union of the medial superficial volar metacarpal artery and the great metacarpal artery.

(c) The Distal Superficial Volar Arch (distal). This arch was formed about one-half inch distal to the superficial volar arch, described above, by the union of the lateral superficial volar metacarpal artery and the great metacarpal artery.

(d) The Deep Volar Arch (distal). This extensive network was formed by anastomoses of the medial and lateral superficial and deep volar metacarpal arteries, the middle deep volar metacarpal artery, and the great metacarpal artery. From this arch an artery descended into the groove separating the trochlea and joined the dorsal metacarpal artery and the common digital artery

of the first phalanx. Another vessel descended to the medial abaxial sesamoid bones and entered the fetlock. A similar, but lateral vessel, descended on the lateral aspect, joined the lateral deep volar metacarpal artery, and continued on to the lateral axial sesamoid bones of the fetlock joint.

The Digital Arteries. The volar common digital artery, which was the distal continuation of the great metacarpal artery distal to the deep (distal) volar arch and the medial and lateral abaxial digital arteries, constituted the main arterial supply to the fetlock, the digits, and the adjacent structures.

The Volar Common Digital Artery. This was the largest vessel in the region and descended to the interdigital space at the level of the second phalanx, where it divided into three main branches named: (a) the anterior branch, (b) the distal branch, and (c) the posterior branch. In the fetlock region the volar common digital artery detached two branches to the proximal and axial surfaces of the dewclaws. One of the branches continued outward and joined the corresponding abaxial digital artery. At the level of the base of the sesamoid bones, the trunk detached branches, which ramified on the basal surface (distal area) of the dewclaws. The volar common digital artery entered the interdigital space of the first phalanges and detached an ascending vessel which divided into two branches. These branches supplied the proximal extremity of both the first phalanges and the basal surface of the sesamoid bones (Sisson and Grossman, 1955). A little distally the volar artery of the first phalanx

emanated from the main trunk, traveled on the volar surface of the corresponding phalanx, and divided into a superficial and a deeper branch. The larger of the two vessels was superficial, and it coursed over the tendons to meet the corresponding abaxial digital artery. The deeper vessel was smaller, entered the deeper face of the tendons, and variably met the corresponding abaxial digital artery.

(a) The Anterior (main) Branch. This vessel arose from the volar common digital artery at the level of the second phalanx, passed craniad and distad in the interdigital space, and united with the dorsal common digital artery to form the interdigital arch. Additional smaller vessels were given out to the adjacent structures.

(b) The Distal (main) Branch. This vessel divided into two axial (proper) digital arteries and descended along the axial surface of the digits. In its course, each artery gave rise to a volar artery of the second phalanx, which divided similar to the volar artery of the first phalanx. Each artery also gave rise to an artery of the distal sesamoid bone at the level of its proximal border. These vessels ramified on the superficial surface of the distal sesamoid bone and joined the bulbar arteries of the corresponding digit. The proper digital arteries divided at the distal interphalangeal articulation into two branches; one branch entered the proximal foramen on the third phalanx and the other circled around the proximal border of the phalanx. The artery entering the third phalanx detached smaller vessels

which entered the foramina on the wall surface and the sole surface of the phalanx, and formed a semicircular pattern of arterial arch similar to that of the horse. In addition, smaller vessels were given off to the adjacent structures.

(c) The Posterior (main) Branch. This was the terminal branch of the volar common digital artery, and arose a little proximal to the distal branch. This artery divided into the two bulbar arteries of the corresponding digits. These vessels ramified extensively in the region of the heel, and anastomosed with the corresponding abaxial digital arteries and also with the collateral vessels from the distal main branch of the volar common digital artery.

The Dorsal Surface. The slender dorsal metacarpal artery was the main artery on this surface. There variably were two to three small vessels on either side of the main vessel, which came from the antibrachium. In the arteriograms, the dorsal metacarpal artery did not appear prominent because of its deeper position in the dorsal metacarpal groove, and its being superimposed by the larger middle deep volar metacarpal artery. It was more distinct in the interdigital space where it emerged as the dorsal common digital artery, before its union with the volar common digital artery at the interdigital arch.

Dorsal Metacarpal Artery. This artery emerged from the rete carpii dorsale, and descended in the dorsal metacarpal groove. It received an anastomotic branch, the proximal perforating metacarpal artery, from the volar surface, at the

proximal metacarpal foramen, about one inch distal to the proximal extremity of the large metacarpal bone. At the same level it anastomosed with a dorsal branch of the radial artery, which descended from the antibrachium, along the dorsomedial border of the carpus. At the distal metacarpal foramen, it communicated through the distal perforating metacarpal artery with the middle deep volar metacarpal artery. About one-half inch distally, it detached small branches which ramified on the dorsum of the fetlock joint and anastomosed with branches of medial and lateral deep volar metacarpal arteries coming on to the dorsal surface of the fetlock. In its course distal to this level, the vessel was named the dorsal common digital artery. In the groove separating the trochlea at the distal extremity of the large metacarpal bone, it detached a branch which anastomosed with a corresponding vessel from the deep (distal) volar arch or the volar common digital artery. At the interdigital space of the first phalanx, it detached the dorsal artery of the first phalanx to each digit. At the level of the second phalanx, it divided into two main branches, namely, (a) the posterior main branch, and (b) the distal main branch.

(a) The Posterior Main Branch. This was the larger of the two terminal branches of the dorsal common digital artery. This branch descended obliquely in the interdigital space of the second phalanx where it united with the anterior branch of the volar common digital artery to form the interdigital arch. Before uniting, it detached smaller vessels to the axial part of

the dorsal surface of the interdigital space and the digits.

(b) The Distal Main Branch. This vessel divided into the two dorsal axial digital arteries, and descended along the dorsal surface of the two digits. Each digital artery detached an artery to the second phalanx and the third phalanx, which ramified on the dorsum of the phalanges and abaxial surface of the third phalanx and anastomosed with the volar abaxial digital arteries. The dorsal axial digital arteries became very small as they reached the third phalanx.

Pelvic Limb - Ox*
(Plates X and XI)

Plantar Surface. This surface presented primarily two arteries, namely, (1) the larger, medial plantar metatarsal artery, and (2) the slender, lateral plantar metatarsal artery. Both of the arteries emerged about one to one and one-half inches medial and distal to the os calcis by the bifurcation of the medial tarsal artery, which was the larger of the two terminal branches of the saphenous artery. Diverging from their origin, the vessels descended on either border of the metatarsal bone. There was no corresponding vessel to represent the great metacarpal artery of the thoracic limb. The main arteries, namely, the medial and the lateral plantar metatarsal arteries, ran a similar course and bifurcated, as the corresponding vessels,

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* Plates X and XI are shown in the Appendix.

in the thoracic limb. The arterial arches represented in the pelvic limb were: (a) the proximal plantar arch, (b) the superficial distal plantar arch, and (c) the deep distal plantar arch. The plantar common digital artery was formed by the bifurcation of the medial superficial plantar metatarsal artery. The medial and lateral plantar metatarsal arteries, before detaching the deep branches, received somewhat large communicating branches from the rete tarsii dorsale. The lateral deep plantar metatarsal artery was not always continuous and was represented by a recurrent branch from the deep (distal) plantar arch that reached the middle of the metatarsal bone. The perforating tarsal artery entered the proximal metatarsal foramen and joined the anterior tibial artery on the dorsal face of the tarsus by passing through the tarsal joint.

(a) The Proximal Plantar Arch. This arterial arch was formed by the anastomosis of the transverse branch from the medial superficial plantar metatarsal artery and a similar branch from the lateral deep plantar metatarsal artery. The arch was not represented in two parts as in the thoracic limb.

(b) The Superficial Distal Plantar Arch. This arch was formed by a transverse branch from the medial superficial plantar metatarsal artery, which joined the lateral superficial plantar metatarsal artery about two inches proximal to the fetlock joint. This also was not represented in two parts, as in the thoracic limb, because of the lack of the vessel representing the great metacarpal artery.

(c) The Deep Distal Plantar Arch. This arch was formed by the concurrence of the medial and the lateral superficial and deep plantar metatarsal arteries and the middle deep plantar metatarsal artery. It was very nearly similar in formation and position to the corresponding arch in the thoracic limb.

The Dorsal Surface. The dorsal metatarsal artery, the distal continuation of the anterior tibial artery, represented the arterial supply on this surface. This artery was the largest in the metatarsal region, as compared with the corresponding slender dorsal metacarpal artery in the thoracic limb. Its course, branching, and anastomosis with other vessels were similar to the corresponding vessel of the thoracic limb. The dorsal common digital artery, the continuing trunk of the dorsal metatarsal artery, initially coursed caudally in the interphalangeal space of the first phalanges, and upon reaching the level of the second phalanx, formed the interdigital arch and the axial digital arteries. It ran a wavy course, more cranial than in the thoracic limb. In the thoracic limb the volar common digital artery, which was the larger vessel, received the dorsal common digital artery at the level of the second phalanx, with the axial digital arteries. The axial digital arteries coursed more medially than cranially.

Thoracic Limb - Dog*
(Plates XII and XIII)

Volar Surface. The arteries presented on this surface were: (1) the volar interosseous artery, (2) the ulnar artery, and (3) the radial artery (volar branch). The ulnar artery was the largest and appeared to be the primary continuation of the median artery, although the smaller radial artery was the other branch derived from the median artery. This surface also presented two arterial arches, named: (a) the superficial volar arch, and (b) the deep volar arch and a smaller arterial network, the rete carpii volare.

(1) The Volar Interosseous Artery. This large artery emerged from the distal interosseous space and inclined medially from the lateral border. At the level of the accessory carpal bone, it detached the superficial volar branch and continued deeply along the mediovolar border of the fifth metacarpal bone. A little proximal to the superficial volar branch, it detached a contributory artery to the rete carpii dorsale. The superficial volar branch extended distally to about the middle third of the fourth metacarpal bone and joined the superficial volar metacarpal artery IV, to form the superficial volar arch. The parent vessel, the volar interosseous artery, detached a branch at the distal border of the carpus which ramified on the deeper surface of the superficial digital flexor tendons, and supplied

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* Plates XII and XIII are shown in the Appendix.

an artery to the carpal pad, as well as the lateral artery of the fifth metacarpal bone. The continuation of the volar interosseous artery detached the superficial volar artery of the fifth metacarpal bone. It then inclined medially, joined the volar branch of the radial artery to form the deep volar arch deep on the volar surface of the proximal third of the intermetacarpal spaces II and III.

(2) The Ulnar Artery. This artery descended from the medial surface of the antibrachium and inclined medially to the middle of the carpus. It then continued on the deep surface of the superficial volar branch of the volar interosseous artery. It detached smaller branches on the dorsal surface of the proximal end of the carpus to the rete carpii dorsale, and on the volar surface to the rete carpii volare. It also contributed a branch to the deep volar arch. At the level of the metacarpophalangeal articulation, it detached the superficial volar metacarpal artery I. It divided a little distally into three large superficial volar metacarpal arteries II, III, and IV, which continued on the volar surface of the paw, along the intermetacarpal spaces.

(3) The Radial Artery (Volar Branch). This artery emerged on the volar surface, through the proximal part of the intermetacarpal space II, and inclined laterally. It then joined the volar interosseous artery to form the extensive deep volar arch which was a little proximal to the superficial volar arch. From the deep volar arch arose the deep volar metacarpal arteries II, III, and IV. Smaller vessels from the deep volar arch were

detached to the volar surface of the carpus.

Superficial Volar Metacarpal Arteries. These five arteries descended on the volar surface of the paw. Superficial volar metacarpal arteries I and V were derived from the ulnar and the interosseous arteries, respectively, while arteries II, III, and IV were from the superficial volar arch and were larger. They descended in the intermetacarpal spaces. At the metacarpophalangeal articulation they detached four arteries to the metacarpal pads in which they arborized extensively. They also detached branches to the sesamoid bones and adjacent structures. At about the same level, they anastomosed on their deeper surface with the corresponding deep volar metacarpal arteries. The superficial volar metacarpal artery III, divided a little distal to the metacarpophalangeal articulation, into volar common digital arteries of the third and fourth digits, and descended along the axial surface of the digits. Superficial volar metacarpal arteries II and IV descended along the corresponding digits as volar common digital arteries. They then divided to detach a smaller branch which coursed the abaxial surface of the digit, as the lateral volar digital artery. The large main vessel descended on the axial surface as the medial volar digital artery. Superficial volar metacarpal artery I entered the intermetacarpal space of the first and second metacarpal bones and at the metacarpophalangeal articulation. At this place it anastomosed with the dorsal deep metacarpal artery I to form the common digital artery I.

Deep Volar Metacarpal Arteries. The deep volar metacarpal arteries II, III, and IV emanated from the deep volar arch. These deep arteries detached muscular branches to the region and a little proximal to metacarpophalangeal articulation, anastomosed with the corresponding superficial volar metacarpal arteries.

Digital Arteries. The common digital arteries, derived from the union of the superficial and deep volar metacarpal arteries, were the main vessels supplying the digits and the attendant structures. These arteries divided into medial volar digital and lateral volar digital arteries and descended along the interdigital spaces to their termination in the third phalanges. The common digital artery I was formed by the anastomosis of the superficial volar metacarpal artery I and the dorsal branch of the medial branch of the proximal collateral radial artery. The volar common digital III was the largest, and divided into branches which descended along the axial surface of the third and fourth digits. At about the level of their division into the medial and lateral volar proper digital arteries, the volar common digital arteries received one or two anastomotic branches from the corresponding dorsal arteries. These arteries detached a variable number of branches to the metacarpal and digital pads. In addition they detached collateral branches to the volar surface of the phalanges, the volar artery of the first phalanx, and the volar artery of the second phalanx. Each of these was derived from the medial volar proper digital

arteries, at the level of the upper third of the respective digit. They crossed the volar surface of the phalanges and anastomosed with the lateral volar digital arteries. At the proximal extremity of the third phalanx, an arterial circular network was formed by the volar and dorsal digital arteries from which two vessels emerged. These two vessels reached the termination of the third phalanx, and ramified in the corium of the claw.

The Dorsal Surface. There were four primary arteries present on this surface. They were: (1) the dorsal branch of the radial artery medially, (2) the medial branch of the proximal collateral radial artery, lateral to the first artery, (3) the lateral branch of the proximal collateral radial artery, at the middle of the region, and (4) the dorsal branch of the volar interosseous artery. In addition, an arterial network, the rete carpii dorsale, was featured on this surface. The lateral branch of the proximal collateral radial artery was the largest vessel on this surface.

(1) The Dorsal Branch of the Radial Artery. This was a small vessel which descended along the dorsomedial border of the carpus. It anastomosed with the medial branch of the proximal collateral radial artery, and assisted in the formation of the rete carpii dorsale.

(2) The Medial Branch of the Proximal Collateral Radial Artery. This was a smaller vessel located near the middle of the carpus on its dorsomedial aspect. It joined the dorsal branch of the radial artery, assisting in forming the rete carpii dorsale,

and descended across the second metacarpal bone to the dorsal surface of the first metacarpal, forming the superficial dorsal metacarpal artery I. This artery joined the similar volar artery to form the proper digital artery I.

(3) The Lateral Branch of the Proximal Collateral Radial Artery. Although it was a comparatively small vessel, it was the largest vessel of the dorsal surface. It detached a branch to the rete carpii dorsale in the carpal region. At the upper third of the third and fourth metacarpals, it divided into superficial dorsal metacarpal arteries II, III, and IV.

(4) The Dorsal Branch of the Volar Interosseous Artery. This small artery anastomosed with the medial branch of the proximal collateral radial artery and made up the rete carpii dorsale.

The superficial dorsal metacarpal arteries. The superficial dorsal metacarpal artery II arose a little more proximally than the others. The superficial dorsal metacarpal artery III was larger. These arteries descended in the intermetacarpal spaces II, III, and IV along the border of the metacarpal bones. At the distal third of the metacarpal bones, the vessels anastomosed by small communicating branches with the corresponding deep dorsal metacarpal arteries. The union of the superficial and deep dorsal metacarpal arteries was not prominent. From this anastomosis, descended the dorsal common digital arteries II, III, and IV.

Rete carpii dorsale and the deep dorsal metacarpal arteries. The rete was an arterial network on the dorsum of the carpus, formed by the anastomosis of branches from the radial, ulnar,

proximal collateral radial, and the dorsal branch of the volar interosseous arteries.

The deep dorsal metacarpal arteries. From the rete carpii dorsale emerged three very small arteries called the deep dorsal metacarpal arteries II, III, and IV. These arteries descended in the deep intermetacarpal spaces and anastomosed with the corresponding superficial dorsal arteries near the distal third of the metacarpals.

The digital arteries. The dorsal common digital arteries descended distal to the metacarpophalangeal articulation, as a continuation from the anastomosis of the superficial and dorsal metacarpal arteries. At the level of the upper third of the first phalanx they anastomosed by one or two branches with the corresponding volar common digital arteries. The remainder of their distribution was similar to the corresponding volar digital arteries. The corresponding collateral branches such as the dorsal artery of the first phalanx and the second phalanx, were very small.

In the arteriograms, the dorsal superficial or deep vessels were not clearly shown since they were of very small size and were overlapped by the corresponding larger superficial volar branches. They could, however, be recognized at the interdigital spaces.

Pelvic Limb - Dog*
(Plate XIV)

Plantar Surface. This surface presented two main arteries, (1) the plantar branch of the saphenous artery, and (2) the perforating metatarsal artery. The perforating metatarsal artery was the plantar continuation of the anterior tibial artery, the arteria dorsalis pedis. An arterial arch, named the proximal plantar arch, was present. The perforating metatarsal artery was the largest vessel in the area.

(1) The Plantar Branch of the Saphenous Artery. This artery was the larger of the two terminal branches of the saphenous artery and descended on the medioplantar surface of the tarsus. At the level of the distal third of the fibular tarsal bone, it detached the lateral planter artery and continuing distally, at the level of the tarsometatarsal articulation, detached the medial plantar artery. It then descended and inclined outward in the intermetatarsal space between the third and fourth metatarsal bones, and divided at the distal third of the space into the superficial plantar metatarsal arteries II, III, and IV. These were comparatively small vessels and descended in the space between the second and third, the third and the fourth, and the fourth and the fifth metatarsal bones. At the level of the upper third of the third metatarsal, the plantar branch of the saphenous artery detached the superficial plantar metatarsal artery V,

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* Plate XIV is shown in the Appendix.

which descended along the lateral border of the fifth metatarsal bone. The superficial plantar metatarsal arteries II, III, and IV anastomosed with the corresponding deep metatarsal arteries at the distal third of the metatarsal bones.

The lateral plantar artery. This vessel was a branch of the plantar branch of the saphenous artery. It descended approximately parallel to the parent vessel. At the proximal third of the third metatarsal bone, it attained the deep surface and anastomosed with the perforating metatarsal artery. The vessel then united with the medial plantar artery to form a common trunk at the anastomosis.

The medial plantar artery. This was the larger of the two branches of the saphenous in this region, and was detached distal to the lateral plantar artery. It coursed into the space between the second and the third metatarsals and joined the lateral plantar artery, to form a common trunk that joined the perforating metatarsal artery described above. In two of the specimens, the lateral plantar artery was very small, and remained in the space between the fourth and the fifth metatarsal bones to the middle of the space and disappeared there. It did not join the medial plantar artery nor the perforating metatarsal artery. In two other specimens the lateral plantar artery joined the medial plantar by means of a transverse branch, while the continuation of the main vessel joined the origin of the deep plantar metatarsal artery IV. In the same specimens, the medial plantar artery terminated by joining the origin of the deep plantar

metatarsal artery II.

(2) The Perforating Metatarsal Artery. This was the large vessel that emerged from the dorsal surface to the plantar surface, between the second and the third metatarsal bones at their upper third. It joined the common trunk of the medial and lateral plantar arteries. Three deep plantar metatarsal arteries descended from this union into the intermetatarsal spaces II, III, and IV. In addition, three smaller muscular branches were given at the level of the emergence of the deep arteries. The muscular branches also descended to the distal end of the metatarsus. The deep plantar metatarsal arteries were large and appeared to be the main arterial supply to the region of the pes. They anastomosed with the corresponding superficial plantar metatarsal arteries at the level of the proximal end of the metatarsophalangeal articulation. The continuations from the union, named the common plantar metatarsal arteries until they formed the common digitals, appeared to be the continuations of the deep arteries since the superficial ones were very small.

The Plantar Arch. This arterial arch located near the proximal third of the metatarsals was formed by the anastomosis of the medial and the lateral plantar arteries.

The Digital Arteries. Except for a few minor variations, the basic pattern of these vessels remained similar to that of the thoracic limb. The metatarsal artery I was rudimentary and the corresponding digital arteries were absent. The common digital arteries of digits III and IV were prominent branches of

the plantar metatarsal artery III. On the rest of the digits, the lateral branch was variable and whenever present, was a very small vessel. The common digital arteries were not observed to divide to form a medial and a lateral plantar digital artery.

The Dorsal Surface. Three arteries derived from two main vessels formed the arterial distribution on this surface. These arteries were: 1. The lateral branch of the anterior tibial artery, 2. The anterior tibial artery, continuing in the tarsal region as the arteria dorsalis pedis, and 3. The dorsal branch of the saphenous artery.

(1) The Lateral Branch of the Anterior Tibial Artery. This small vessel branched off the anterior tibial artery at the proximal third of the tibia. It then descended along the lateral border, inclined medially on the tarsus, and joined the dorsal branch of the saphenous artery. It detached one or two branches to the tarsus. In three specimens, it detached the superficial dorsal metatarsal artery V, which descended on the dorsolateral aspect of the fifth metatarsal. The parent vessel did not form an anastomosis with the dorsal branch of the saphenous artery.

(2) The Anterior Tibial Artery. This was the largest vessel in the region. It descended on the dorsum of the tarsus as the arteria dorsalis pedis. It detached one or two branches which extensively ramified on the tarsus, and then continued to the upper third of the spaces between the second and the third metatarsals where it pierced as the perforating metatarsal artery and emerged on the plantar surface. At the proximal extremity of

the second and the third metatarsal bones, it detached laterally a transverse branch which divided into dorsal deep metatarsal arteries III and IV. In four specimens, the dorsal deep metatarsal artery II came from the arteria dorsalis pedis before its entry to the plantar surface. In two other specimens, the deep dorsal metatarsal artery II was derived from artery III.

(3) The Dorsal Branch of the Saphenous Artery. This artery was the smaller of the two terminal branches of the saphenous artery. It descended on the dorsomedial aspect of the tarsus where it detached a variable number of twigs. The twigs ramified on the tarsus. The dorsal branch anastomosed with the lateral branch of the anterior tibial artery in three specimens. In three specimens the superficial dorsal metatarsal artery V came from this vessel, where the lateral branch of the anterior tibial artery joined the anterior branch of the saphenous artery. At the level of the proximal extremity of the second metatarsal, it detached the dorsal metatarsal artery I, which descended on the dorsomedial aspect of the second metatarsal, and anastomosed with the corresponding vessel on the plantar surface. The vessel from the plantar area arose from the medial plantar artery. A little distally, the main dorsal branch of the saphenous artery divided into three branches called the superficial dorsal metatarsal arteries II, III, and IV. Of these, artery II was seen to arise more proximally than the others. These superficial dorsal metatarsal arteries anastomosed with the corresponding deep arteries a little proximal to the metacarpophalangeal articulation.

The common superficial digital arteries were formed similar to those of the thoracic limb.

The Digital Arteries. The dorsal digital arteries were similar in their position and distribution to those in the thoracic limb.

DISCUSSION

The arterial pattern of the pectoral and pelvic limbs of the horse, observed in arteriograms and dissections, conformed to a great extent, to the observations of Cheaveau (1891), M'Faedyean (1919), and Sisson and Grossman (1955). All these authors described the larger arteries in detail, but gave only general indications of the blood supply to the adjacent structures, and no details of the origins of the smaller arteries, their course, or the number of vessels supplying the various regions. They did not describe collateral vessels in detail, and omitted reference to smaller vessels not regarded as being of surgical importance.

The nomenclature adopted by authors in the field of veterinary anatomy varied to a great extent, and so some difficulty was encountered in the recording of the observations in this study. Since the procedure adopted in naming the artery included considerations of the region of the location of the artery, and its position and relation to other vessels and adjacent structures, a similar system was followed for recording observations in this study. This resulted in some names of arteries differing from the accepted names found in the references listed above.

The variations from the aforementioned references were as follows:

Horse - Thoracic Limb

The Dorsal Metacarpal Arteries. Cheaveau (1891) and M'Faedyean (1919) mentioned these vessels as arising from the subcarpal arch, while Sisson and Grossman (1955) gave the origin of these vessels as from the rete carpii dorsale. It was observed that these vessels were larger at their union on the volar surface, giving an appearance that their origin was from the subcarpal arch; however, their connection with the rete carpii dorsale, not mentioned by Cheaveau (1891) and M'Faedyean (1919), was corroborated in this study.

Volar Metacarpal Arteries. The medial and lateral volar metacarpal arteries (Sisson and Grossman, 1955) were named by Cheaveau (1891) and M'Faedyean (1919) as posterior interosseous arteries. These vessels were deeply located as stated by all authors. It was observed in this study, however, that both of these arteries detached a small superficial artery, similar to the lateral branch accompanying the lateral volar nerve, described by Sisson and Grossman (1955). It was noted that the medial superficial branch was smaller and of variable length, originating in one specimen, from the great metacarpal artery. While no name was given to the lateral branch, the medial branch was not recorded by these authors. Since these vessels arose from the volar metacarpal arteries, and were superficial in relation

to the parent vessels, they were identified in this study as the medial and the lateral superficial volar metacarpal arteries, and the parent vessels as medial and lateral deep volar metacarpal arteries.

The Subcarpal Arch. Cheaveau (1891) and M'Faedyean (1919) did not mention a second transverse branch constituting the arch. This was described by Sisson and Grossman (1955) and was also observed in this study.

Articular Branches to the Fetlock. All authors mentioned arteries supplying the region of the fetlock without giving the details of the number of branches or their location, although in the illustrations some vessels were shown. Tohara et al. (1954) described a branch arising on either side from the volar common digital artery. This vessel was observed in this study, and additional vessels illustrated by other authors, were described in some detail.

Digital Arteries. It was observed that in addition to the perpendicular artery, another vessel arose from the digital arteries on each side, and was distributed to the fetlock and adjacent structures. This vessel was not described by any authors referred to before. The distribution and location of other arteries in this region were collaborated with the description given by all the authors cited before.

Pelvic Limb

The observations recorded in this study conformed to those made by Cheaveau (1891) and M'Faedyean (1919), Sisson and Grossman (1955), and Tohara et al. (1954).

Ox - Thoracic Limb

The Volar Metacarpal Arteries. Sisson and Grossman (1955) and Habel (1950) listed the arteries on the volar surface as: (1) the medial deep volar metacarpal artery, which was the continuation of the radial artery; (2) the lateral deep volar metacarpal artery, which was the continuation of the dorsal interosseous artery; (3) the volar common digital artery, which was the continuation of the ulnar artery; and (4) the middle deep volar metacarpal artery, which arose from the medial artery. These vessels were named as deep arteries, apparently on their location, although no superficial arteries were mentioned. McLeod (1958), however, named these vessels the medial and lateral volar metacarpal arteries and the great metacarpal artery, respectively, but did not describe the middle deep volar metacarpal artery. He mentioned, however, that this vessel might be functional as the nutrient artery of the large metacarpal bone and if incompletely developed, it may not be seen on the volar groove. It was observed in this study that, in addition to the above, there was a smaller artery on either side, deeper to the medial and lateral volar metacarpal arteries. These deeper arteries, in

addition to anastomosing with each other, the middle deep volar metacarpal artery and the medial and lateral volar metacarpal arteries, also entered into the formation of the subcarpal and the deep distal volar arches. On this basis they were identified in these observations, as the medial and lateral deep volar metacarpal arteries. The superficial volar metacarpal arteries described in these observations corresponded to the deep arteries of the above-mentioned authors. The details of anastomosis in the region of the deep distal volar arch, described in this study, were not available in the literature for comparison.

On the deep surface of the fetlock, an unnamed vessel was described as passing through the groove separating the trochlea. This collaborated the observations of Tohara et al. (1955). It was noted in this study that the vessel passed on to the dorsum of the fetlock and anastomosed with the dorsal common digital artery. The ascending first phalangeal artery described by Tohara et al. (1955) was confirmed. A similar vessel was described by Sisson and Grossman (1955). The observations on the distribution of the arteries below the fetlock region conformed to the stereoradiographical observations of Tohara et al. (1955) and to a great extent, the description of the vessels made by the other authors quoted. The different origins of the arteries of the bulb or the heel artery, described by Tohara et al. (1955), were not found. In this study the origin of these vessels was from the volar common digital artery, in all specimens.

The distribution of the dorsal arteries conformed, in general, to the description given by Sisson and Grossman (1955) and McLeod (1958), except for smaller vessels and their details.

Pelvic Limb

The nomenclature and distribution of the superficial and deep medial and lateral plantar metatarsal arteries remained similar to the thoracic limb, with the exception that the arteries referred to as medial and lateral superficial metatarsal arteries in this study, corresponded to the medial and lateral plantar metatarsal arteries referred to in the literature of Sisson and Grossman (1955), McLeod (1958), and Habel (1950). References describing the deeper arteries, described in this study, were not available in the literature. The distribution of the arteries below the fetlock conformed to the observations of the stereoradiographical studies of Tohara et al. (1955).

Dog - Thoracic Limb

The arteries on the volar surface were much larger than those on the dorsal surface. The superficial volar metacarpal artery V, was given off by the volar interosseous artery, as described by Bradley (1959) and Sisson and Grossman (1955). Miller (1952) did not mention this vessel. The superficial volar branch of the volar interosseous artery which joined the superficial volar metacarpal artery IV, and described by Miller (1952) and Sisson and Grossman (1955) was observed in this study.

This arterial arch, however, was not described by Bradley (1959). It was observed that a branch not mentioned in references, emerged from the rete carpii volare and joined the deep volar arch. The anastomosis, on the carpus, of the ulnar artery and the superficial branch of the volar ramus of the radial artery, referred to by Miller (1952), was not observed in this study. The detailed description of the emergence of the arteries to the carpal, metacarpal and digital pads, and the digital arteries and their collateral branches, given in this study, was not available in the literature cited.

Pelvic Limb

The plantar branch of the saphenous artery which was observed to detach the superficial lateral plantar metatarsal artery V, was not cited in the literature. It was also observed in three specimens that the lateral plantar artery descended to the middle of the intermetatarsal space of the fourth and fifth metatarsal bones, and faded out. It did not join either the medial plantar artery or the deep plantar arch. The medial plantar artery joined the lateral plantar artery which, in turn, anastomosed with the deep plantar arch. The medial plantar artery was seen in some specimens to join the origin of the deep plantar metatarsal artery IV, which was not mentioned in the literature.

On the dorsal surface, the lateral branch of the anterior tibial artery joined the dorsal branch of the saphenous artery

(Miller, 1952) and terminated there, as observed in this study. In the same specimens it was observed that the dorsal metatarsal artery V was detached from the saphenous artery. The dorsal deep metatarsal artery II was given off in three specimens, from the deep dorsal metatarsal artery III, instead of by the perforating metatarsal artery. This also was not cited in the references.

SUMMARY

The arterial pattern in the distal extremities of the thoracic and pelvic limbs of the horse, ox, and dog was studied, using radiography and corroborating the observations by dissection. Eight thoracic and six pelvic limbs of the horse, six of each of the limbs of the ox, and eight of each of the limbs of the dog were procured from the necropsy laboratory and used for this study. In addition, observations were made on dissection specimens in the anatomy laboratory of the Kansas State University. The limbs were embalmed and injected with "Vultex," a commercial radiopaque material. This material had the advantage of the combination of latex and the contrast material which facilitated both radiographic and dissection procedures. In general, the observations in this study conformed to the descriptions of arteries found in standard veterinary anatomy textbooks. They also conformed to the stereoradiographical observations of Tohara et al. who studied the arteries of the foot of the horse and the ox.

The following features, not listed in the references, were observed in this study.

Horse

In the thoracic limb, the dorsal metacarpal arteries extended from the subcarpal arch to the rete carpii dorsale. The medial and lateral volar metacarpal arteries each detached a superficial branch which joined the corresponding digital arteries. Larger vessels were detached from the volar metacarpal arteries and/or the deep distal volar arch, which traversed and ramified on the dorsum of the fetlock. Another collateral vessel arose from the digital arteries, proximal to the perpendicular artery which supplied the fetlock region.

The arterial distribution in the pelvic limb conformed to the standard pattern described in the references, except for small variations and details in the pelvic limb as well.

Ox

Small arteries, one on each side, deeper to the medial and lateral volar metacarpal arteries, were observed as a constant feature. These small deep arteries anastomosed with each other and with the larger metacarpal arteries and detached communicating vessels to the subcarpal and the deep distal volar arches. The middle deep volar metacarpal artery was found to be present in all specimens. A deeper vessel arose from the distal volar arch, passed through the groove separating the trochlea, and

joined the dorsal common digital artery. The ascending first phalangeal artery was observed in all specimens. Small vessels observed in the region of the carpus and the fetlock were described in detail.

In the pelvic limb the arterial pattern remained basically the same as in the thoracic limb, with the characteristic absence of the artery corresponding to the great metacarpal artery.

Dog

In the thoracic limb, a branch was observed to descend from the rete carpii volare and join the deep volar arch. The anastomosis of the ulnar artery and the superficial branch of the volar ramus of the radial artery on the carpus was not found. Details were added to the description of the arteries to the carpal, metacarpal, and digital pads and also to the digital arteries and their collateral branches.

In the pelvic limb, the plantar branch of the saphenous artery was observed to detach the superficial plantar metatarsal artery V. In some specimens the lateral plantar artery, instead of joining the deep plantar arch, descended to the middle of the intermetatarsal space of the fourth and the fifth metatarsals and faded. The medial plantar artery was seen in some specimens to join the origin of the deep plantar metatarsal artery IV, and subsequently, the lateral plantar artery, to complete the deep plantar arch. In some specimens, on the dorsal surface, the lateral branch of the anterior tibial artery terminated by

joining the dorsal ramus of the saphenous artery. In these specimens it was observed that the dorsal metatarsal artery V was detached from the saphenous artery. In some specimens the dorsal deep metatarsal artery II was derived from the dorsal deep metatarsal artery III instead of from the perforating metatarsal artery.

The arteriograms did not show up clearly, the dorsal metacarpal arteries and the deep vessels on the volar surface in the thoracic limbs of the ox, as these vessels were overlapped by the larger superficial vessels except at their extremities. Similarly, in the thoracic limbs of the dog, the volar vessels which were considerably larger, dominated the area and obstructed the view of the smaller dorsal vessels. In the pelvic limbs of the dog, the deep plantar vessels which were the largest, showed up most prominently.

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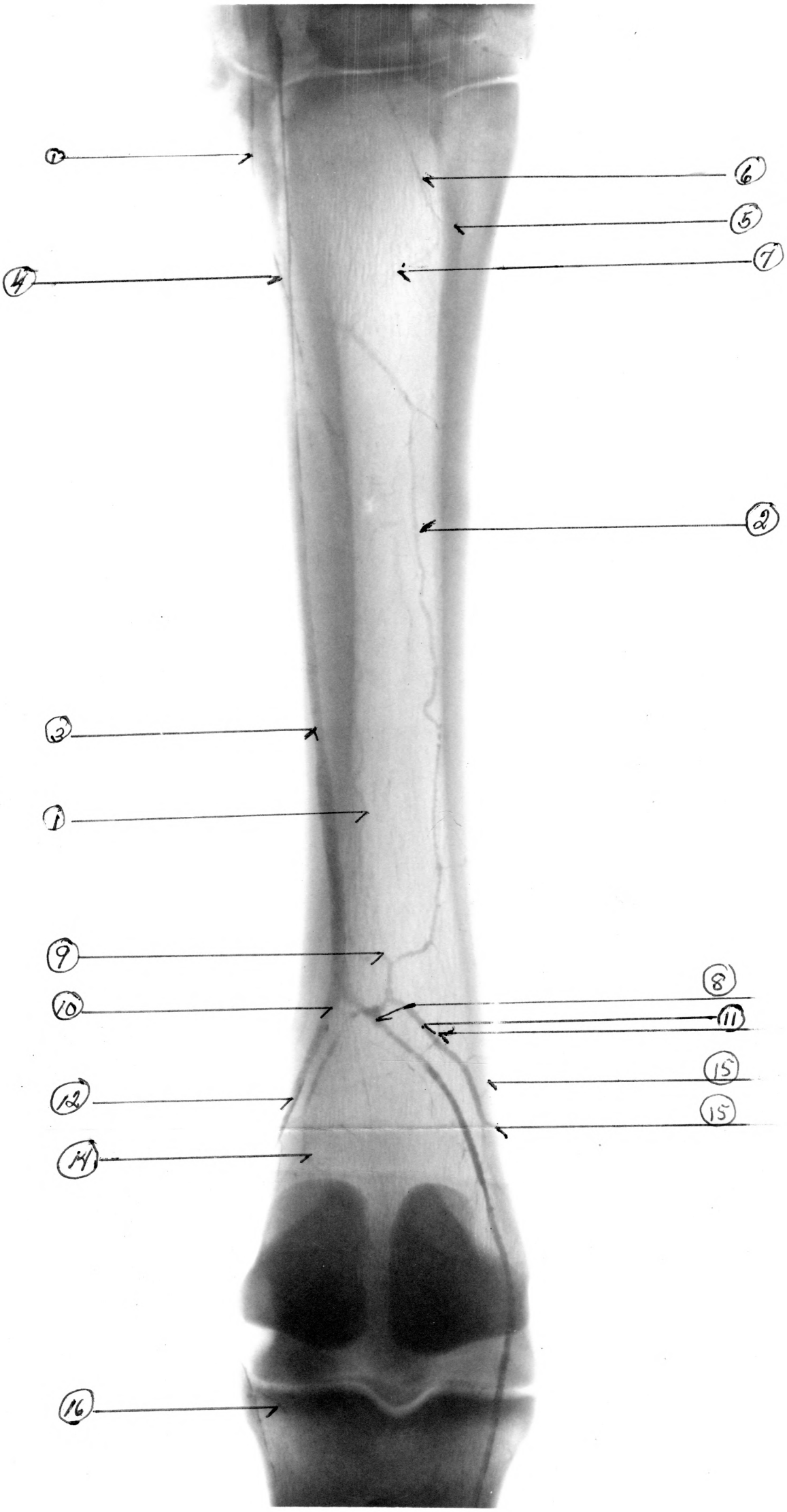
APPENDIX

EXPLANATION OF PLATE I

Volar View of the Thoracic Limb - Horse

1. Medial deep volar metacarpal artery.
2. Lateral deep volar metacarpal artery.
3. Great metacarpal artery.
4. Anastomosis of the dorsal metacarpal artery and the medial deep volar metacarpal artery.
5. Origin of the dorsal metacarpal artery.
6. Communicating branch from the rete carpii volare to the subcarpal arch.
7. Subcarpal arch.
8. Deep volar arch.
9. Superficial volar arch.
10. Volar common digital artery.
11. Artery from the deep volar arch to the fetlock joint.
12. Medial digital artery.
13. Lateral superficial volar metacarpal artery anastomosing with the lateral digital artery.
14. Branches to the sesamoid bones.
15. Branches from the deep volar arch proceeding to the dorsum of the fetlock.
16. Accessory artery of the first phalanx.

PLATE I

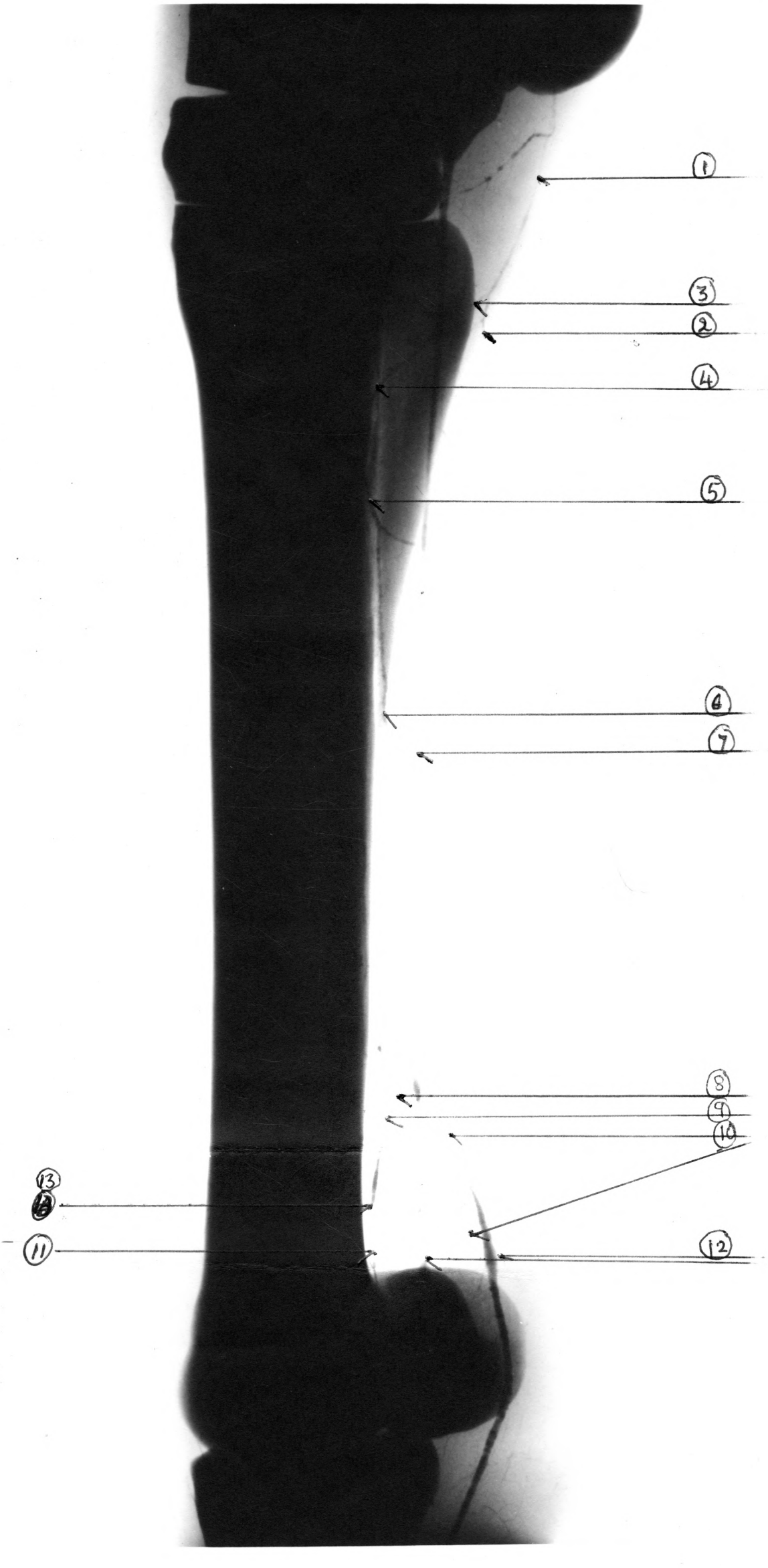


EXPLANATION OF PLATE II

Lateral View of the Thoracic Limb - Horse

1. Lateral volar metacarpal artery.
2. Lateral superficial volar metacarpal artery.
3. Lateral deep volar metacarpal artery.
4. Subcarpal arch.
5. Dorsal metacarpal artery - descending branch.
6. Lateral deep volar metacarpal artery.
7. Great metacarpal artery.
8. Superficial volar arch - distal.
9. Deep volar arch - distal.
10. Anastomosis of the superficial volar metacarpal arteries and the digital arteries.
11. Branch from the deep volar arch to the sesamoid bones (fetlock).
12. Medial and lateral digital arteries.
13. Branch from the deep volar arch to the dorsum of the fetlock.

PLATE II

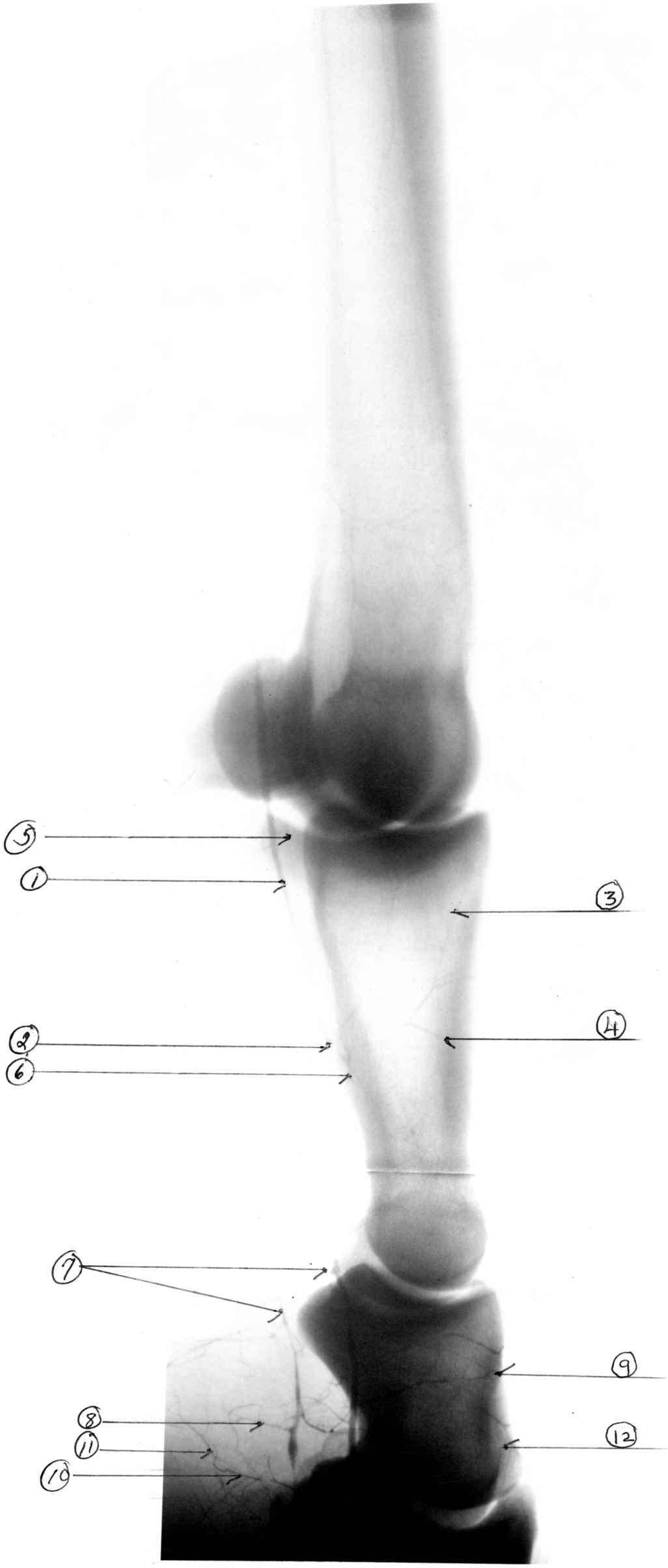


EXPLANATION OF PLATE III

Lateral View of the Foot - Horse

1. Digital artery.
2. Perpendicular artery.
3. Ascending branch of the perpendicular artery.
4. Descending branch of the perpendicular artery.
5. Accessory artery of the first phalanx.
6. Volar branch of the artery of the first phalanx.
7. Artery of the digital cushion.
8. Volar artery of the second phalanx.
9. Dorsal artery of the second phalanx.
10. Artery of the distal sesamoid bone.
11. Anastomosis of the artery of the digital cushion and volar artery of the second phalanx and the artery of the frog.
12. Coronary circle.

PLATE III

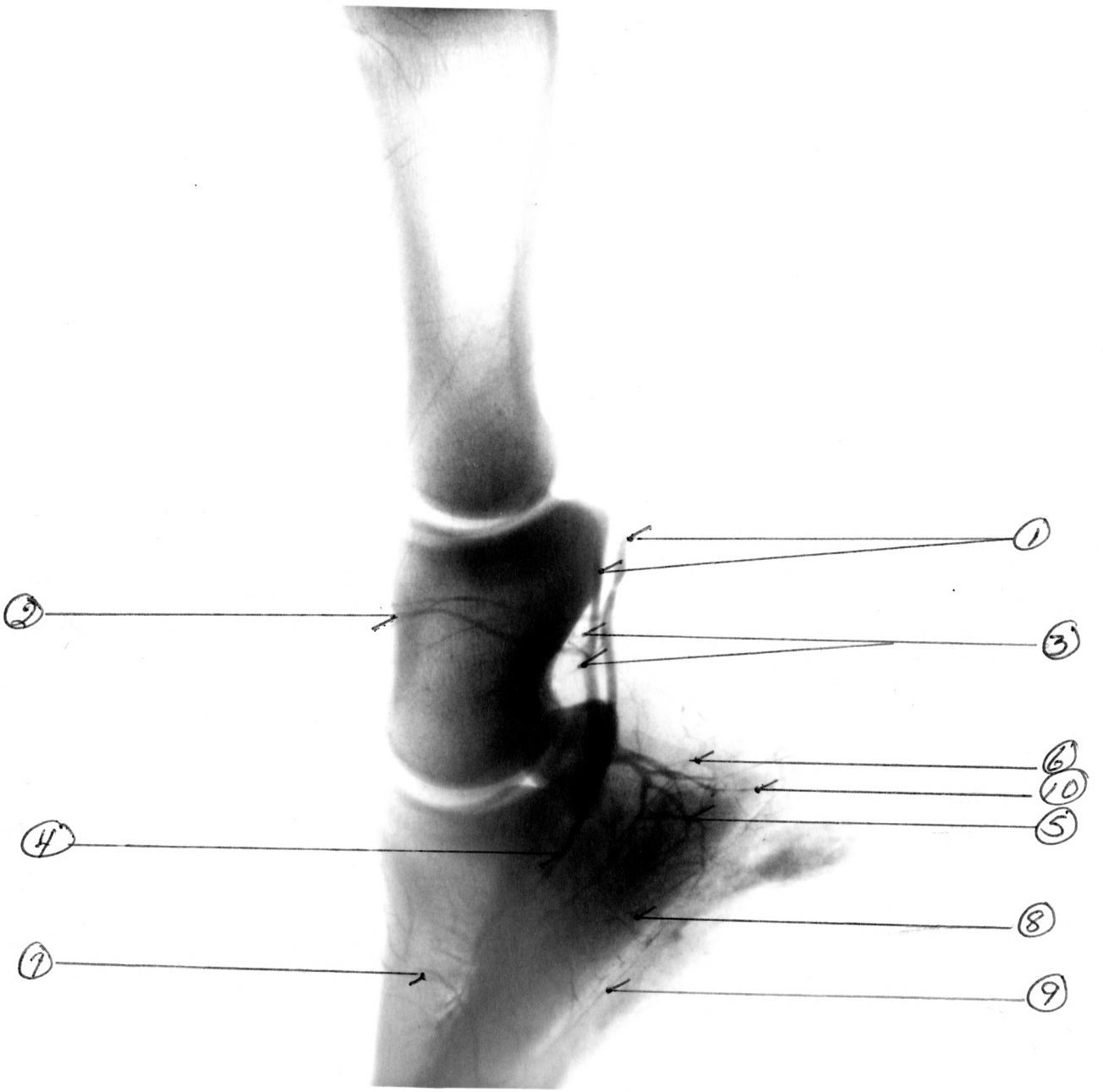


EXPLANATION OF PLATE IV

Lateral View of the Foot - Horse

1. Digital arteries.
2. Dorsal artery of the second phalanx, artery of the coronary circle.
3. Volar artery of the second phalanx.
4. Dorsal artery of the third phalanx.
5. Volar artery of the third phalanx.
6. Arteries to the lateral cartilages.
7. Dorsal branches passing through the foramena of the wall surface.
8. Ventral branches passing through the foramena of the sole surface.
9. Basal artery (ungual artery) along the distal border of the third phalanx.

PLATE IV

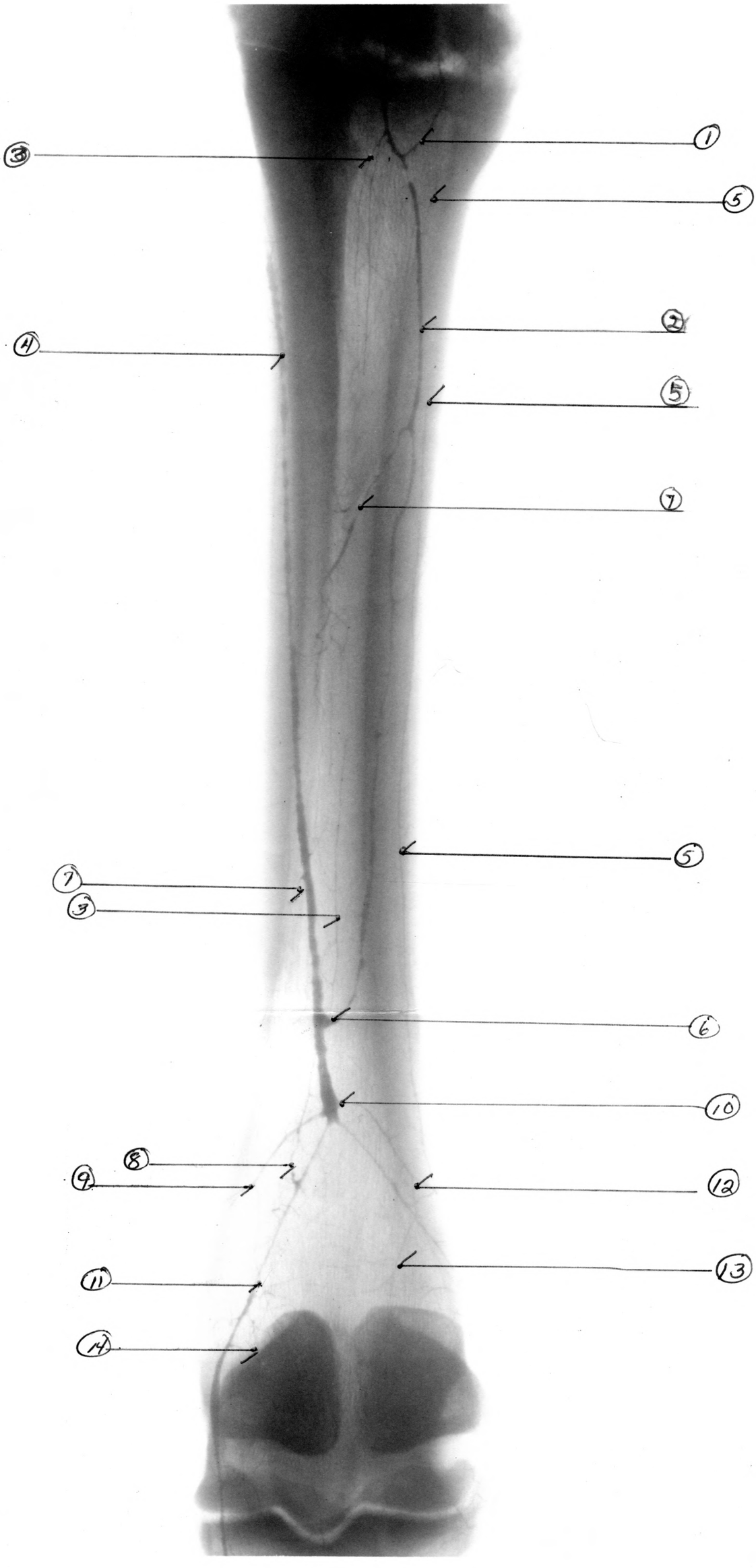


EXPLANATION OF PLATE V

Pelvic Limb of the Horse - Plantar View

1. Proximal plantar arch.
2. Medial deep plantar metatarsal artery.
3. Lateral deep plantar metatarsal artery.
4. Great metatarsal artery.
5. Medial superficial plantar metatarsal artery.
6. Superficial plantar arch.
7. Anastomosis of the dorsal metatarsal and the great metatarsal arteries.
8. Anastomosis of the lateral superficial plantar metatarsal and the lateral digital arteries.
9. Branch from the deep plantar arch to the dorsum of the fetlock.
10. Deep plantar arch.
11. Lateral digital artery.
12. Anastomosis of the medial superficial plantar metatarsal and the medial digital arteries.
13. Branch from the deep plantar arch to the sesamoid bones.
14. Artery to the ergot.

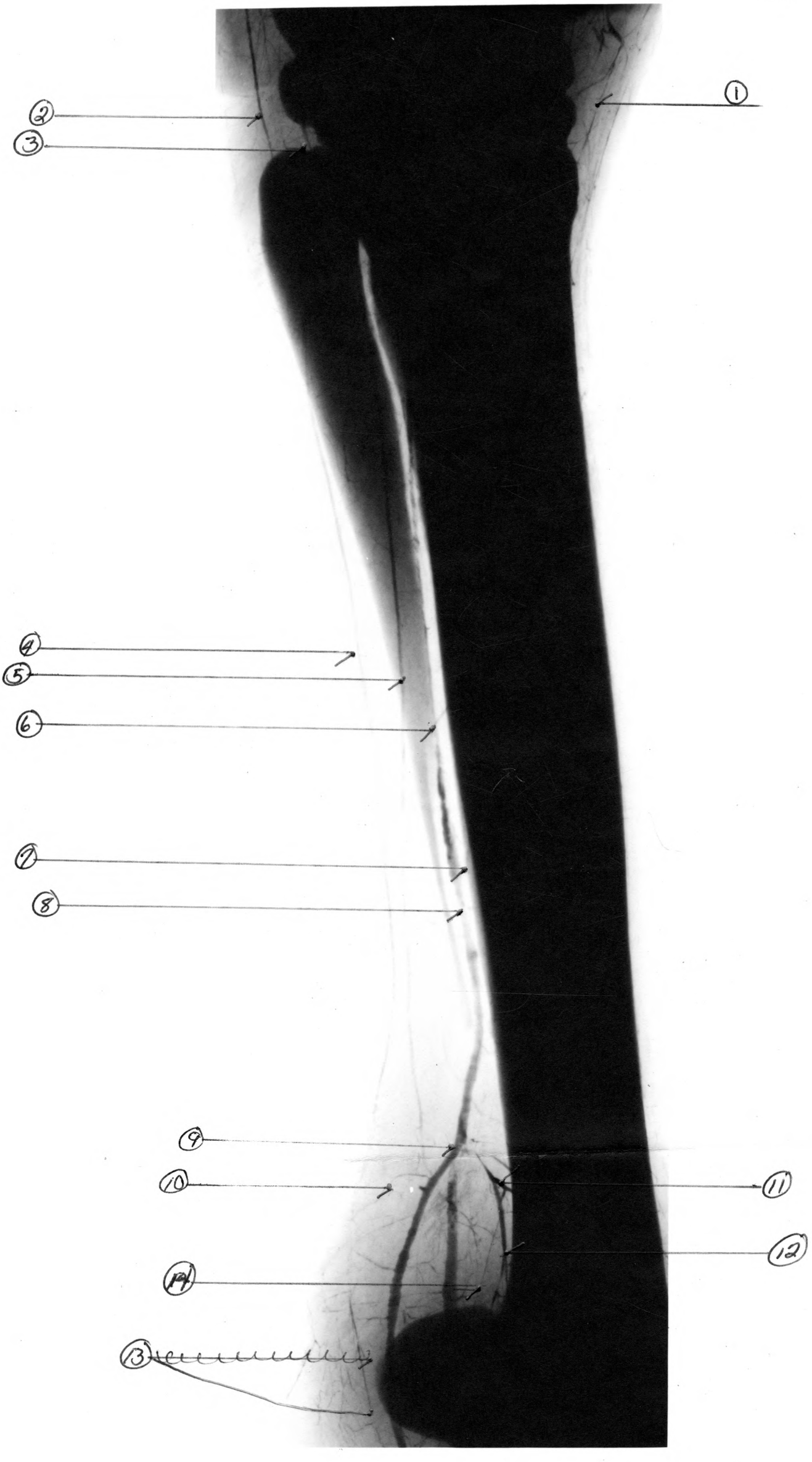
PLATE V



EXPLANATION OF PLATE VI

Lateral View of the Pelvic Limb - Horse

1. Perforating tarsal artery.
2. Medial plantar metatarsal artery.
3. Lateral plantar metatarsal artery.
4. Medial superficial plantar metatarsal artery.
5. Lateral superficial plantar metatarsal artery.
6. Anastomosis of the lateral deep plantar metatarsal and the great metatarsal artery.
7. Lateral deep plantar metatarsal artery.
8. Great metatarsal artery.
9. Deep plantar arch (distal).
10. Anastomosis of the medial and lateral superficial plantar metatarsal arteries and the digital arteries.
11. Branch from the deep plantar arch to the dorsum of the fetlock.
12. Artery to the fetlock from the deep volar arch.
13. Artery to the ergot.
14. Arborization of arteries at the fetlock.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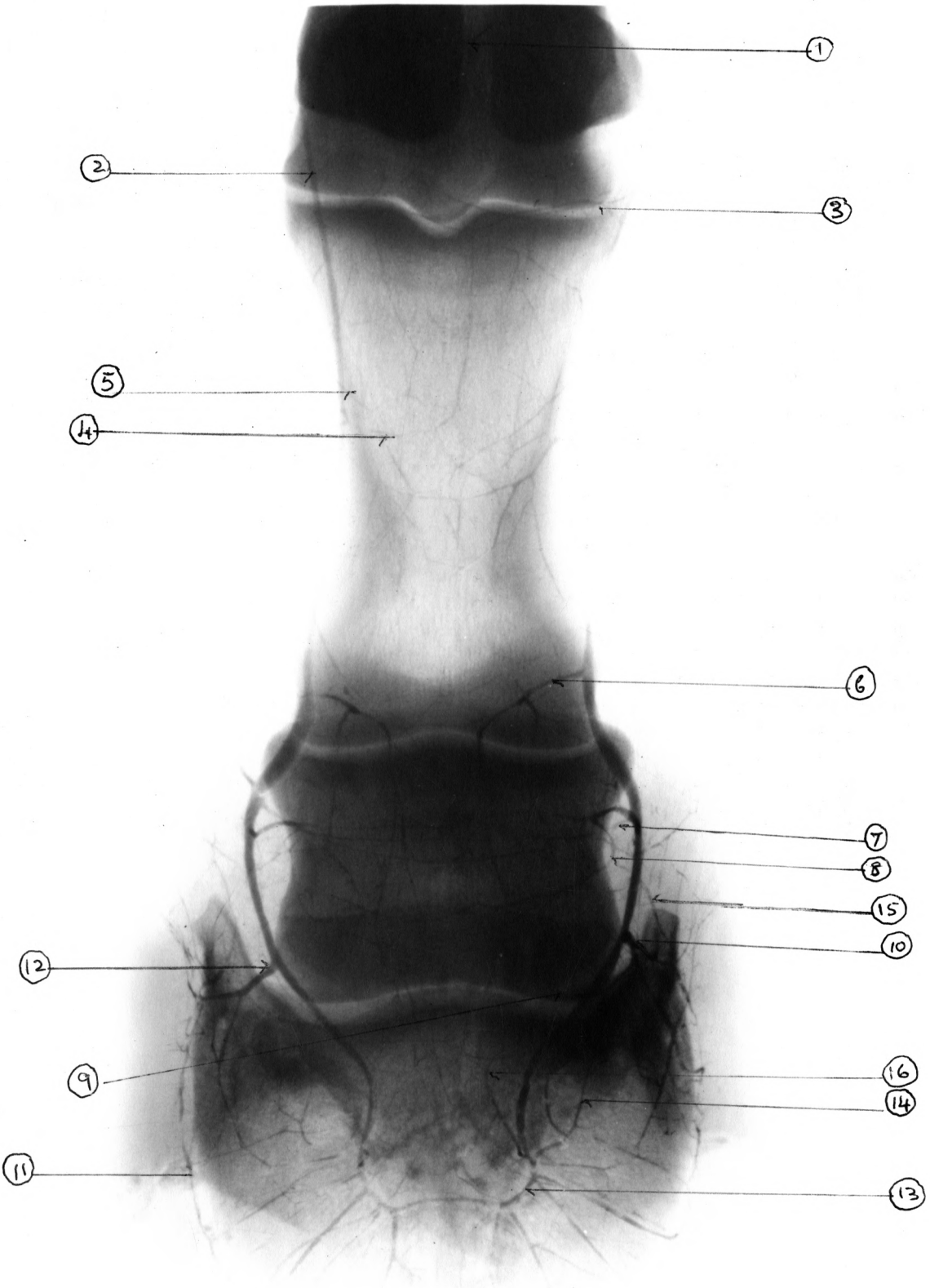
EXPLANATION OF PLATE VII

Foot of the Horse - Posterior View and Sole Surface

1. Articular branch to the sesamoid bones.
2. Digital artery.
3. Accessory artery of the first phalanx.
4. Volar branch of the artery of the first phalanx.
5. Dorsal branch of the artery of the first phalanx.
6. Artery of the digital cushion.
7. Dorsal artery of the second phalanx) Arteries of the
8. Volar artery of the second phalanx) coronary circle.
9. Artery of the distal sesamoid bone.
10. Dorsal branch of the artery of the third phalanx.
11. Basal artery.
12. Artery of the third phalanx.
13. Terminal arch.
14. Communicating branches through the foramena of the wall surface.
15. Artery to the lateral cartilages.
16. Anastomosis of the arteries of the digital cushion with branches in the frog region.

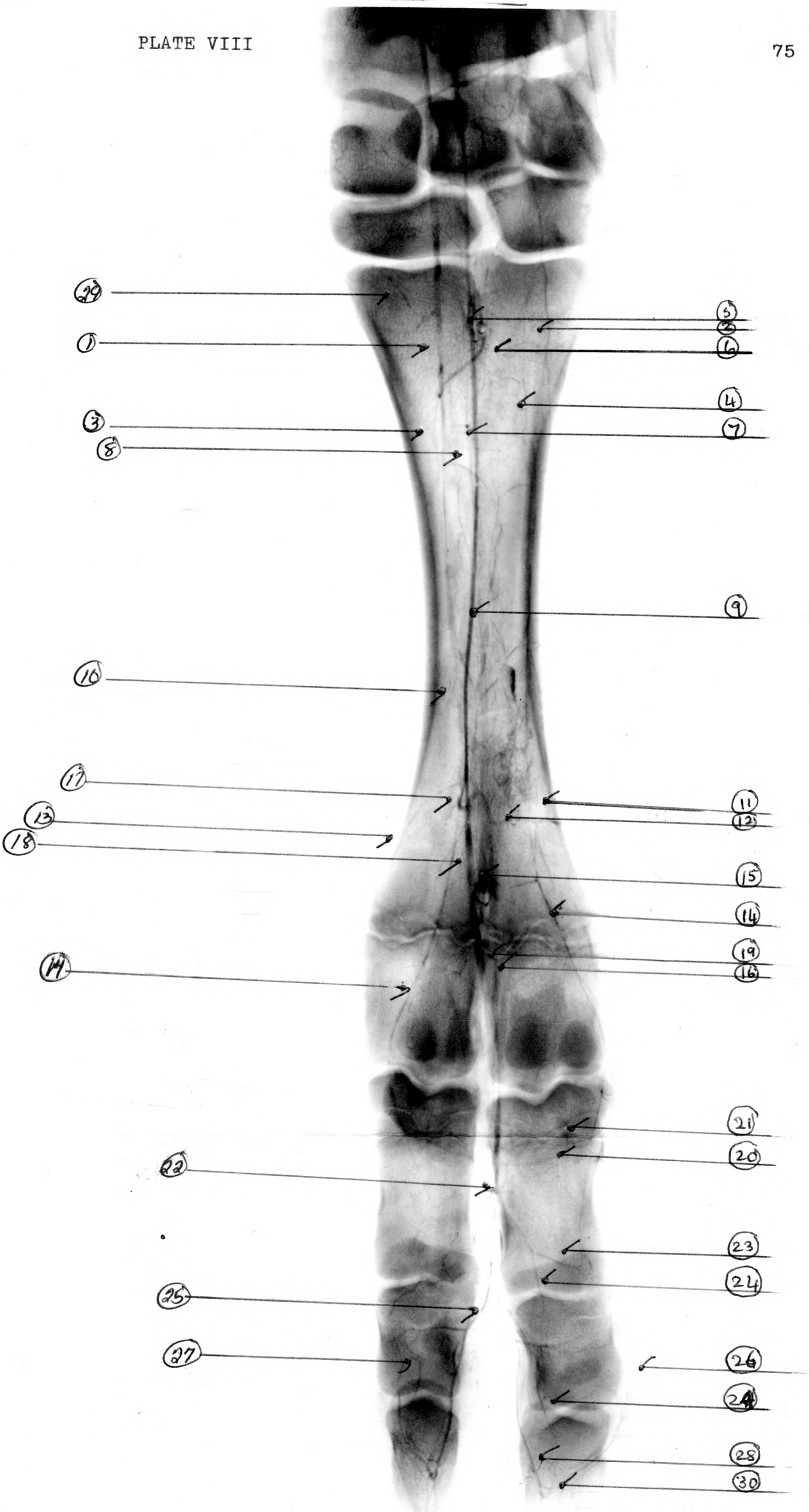
PLATE VII



EXPLANATION OF PLATE VIII

Thoracic Limb - Ox (volar surface)

1. Medial superficial volar metacarpal artery.
2. Lateral superficial volar metacarpal artery.
3. Medial deep volar metacarpal artery.
4. Lateral deep volar metacarpal artery.
5. Proximal perforating metacarpal artery.
6. Subcarpal arch.
7. Great metacarpal artery.
8. Middle deep volar metacarpal artery.
9. Dorsal metacarpal artery.
10. Anastomosis of the medial superficial and deep volar metacarpal arteries.
11. Anastomosis of the lateral superficial and deep volar metacarpal arteries.
12. Deep volar arch (distal).
13. Branch from the deep volar arch to the dorsum of the fetlock.
14. Medial abaxial digital artery.
15. Distal perforating metacarpal artery.
16. Dorsal common digital artery.
17. Superficial volar arch (proximal).
18. Volar common digital artery.
19. Deep branch from the volar common digital artery joining the dorsal common digital artery.
20. Ascending first phalangeal artery.
21. Artery to the dew claw.
22. Interdigital arch.
23. Artery of the first phalanx.
24. Artery of the bulb.
25. Axial digital artery.
26. Abaxial digital artery.
27. Artery of the second phalanx.
28. Artery of the third phalanx.
29. Branches from the rete carpii volare to the medial volar metacarpal artery.
30. Terminal arch anastomosis of the axial and abaxial digital arteries.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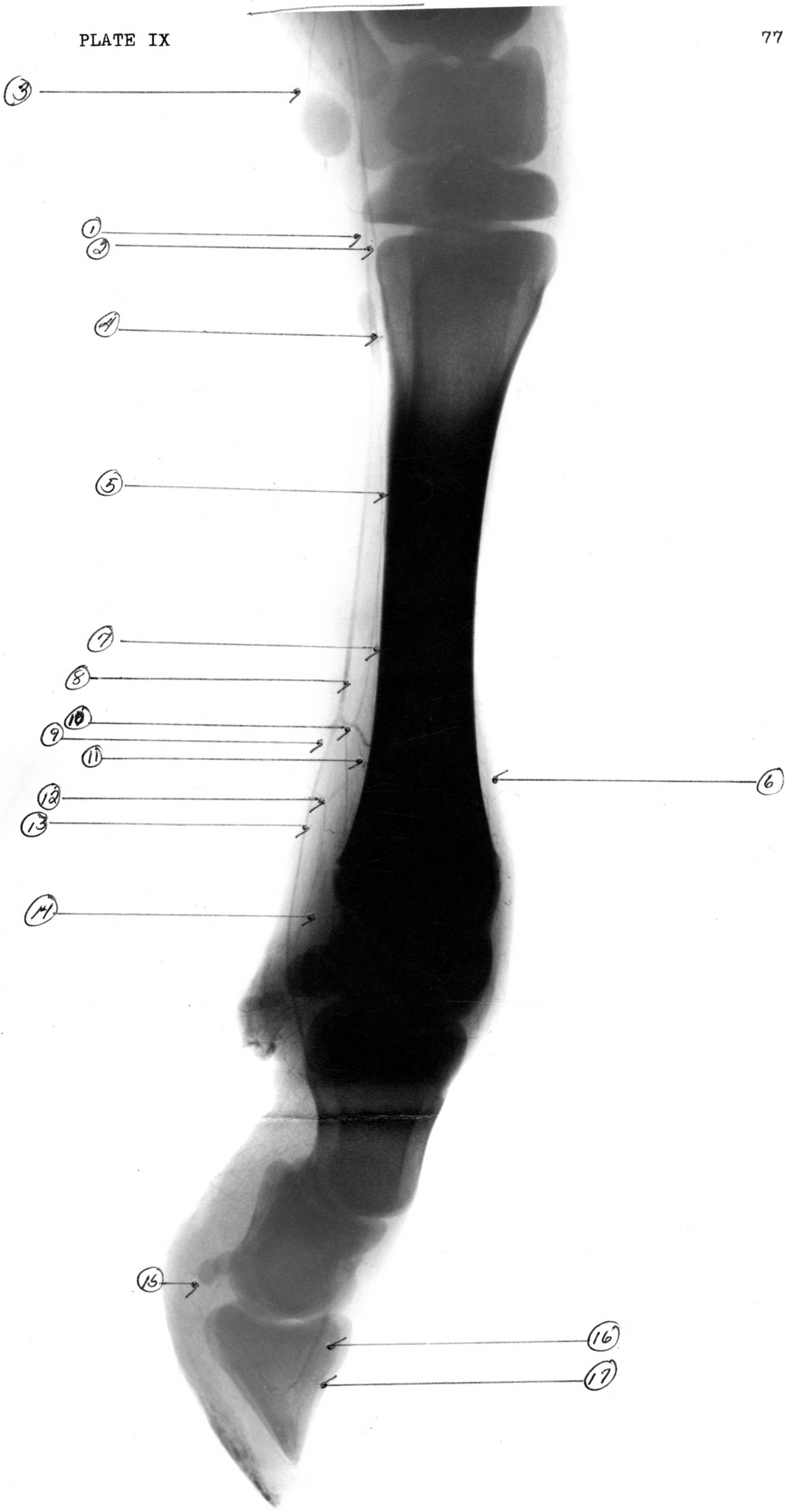
EXPLANATION OF PLATE IX

Lateral View of the Thoracic Limb - Ox

1. Great metacarpal artery.
2. Medial superficial volar metacarpal artery.
3. Lateral superficial volar metacarpal artery.
4. Subcarpal arch.
5. Continuation of #2.
6. Dorsal metacarpal artery.
7. Medial deep volar metacarpal artery.
8. Continuation of #1.
9. Superficial volar arch (distal).
10. Deep volar arch (distal).
11. Medial abaxial digital artery.
12. Anastomosis of the lateral volar metacarpal artery and the great metacarpal artery.
13. Volar common digital artery.
14. Artery to the fetlock joint.
15. Artery of the distal sesamoid bone.
16. Axial digital artery (proper digital).
17. Artery of the third phalanx.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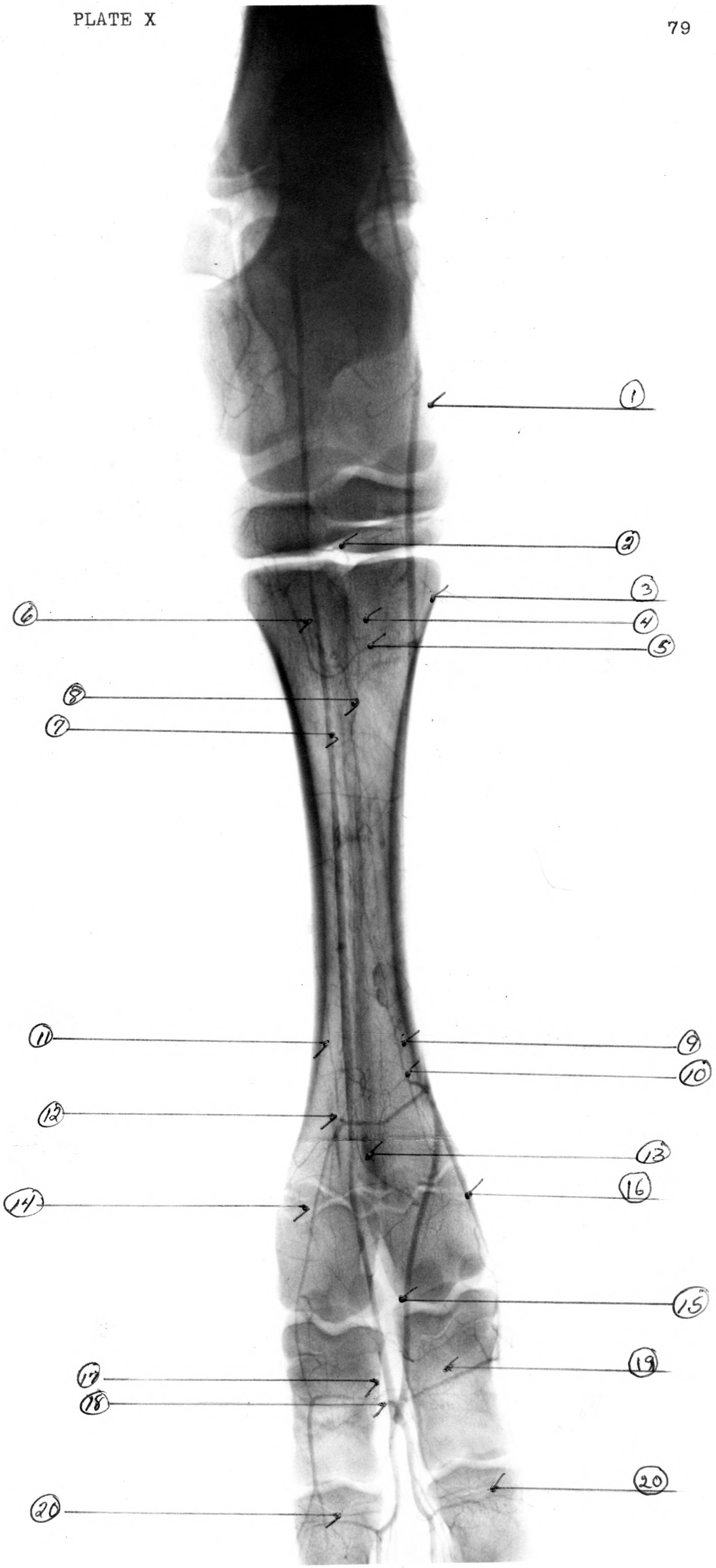
EXPLANATION OF PLATE X

Plantar Surface of the Pelvic Limb - Ox

1. Medial plantar superficial metatarsal artery.
2. Perforating tarsal artery.
3. Medial deep plantar metatarsal artery.
4. Middle deep plantar metatarsal artery.
5. Proximal plantar arch.
6. Lateral superficial plantar metatarsal artery.
7. Dorsal metatarsal artery.
8. Anastomosis of the medial deep plantar artery and middle deep plantar metatarsal artery.
9. Continuation of #3.
10. Superficial plantar arch.
11. Continuation of #6.
12. Deep plantar arch.
13. Deep branch from #12, anastomosing with dorsal metatarsal artery.
14. Lateral abaxial digital artery.
15. Plantar common digital artery.
16. Medial abaxial digital artery.
17. Dorsal common digital artery.
18. Interdigital arch.
19. Ascending artery of the first phalanx.
20. Artery of the third phalanx.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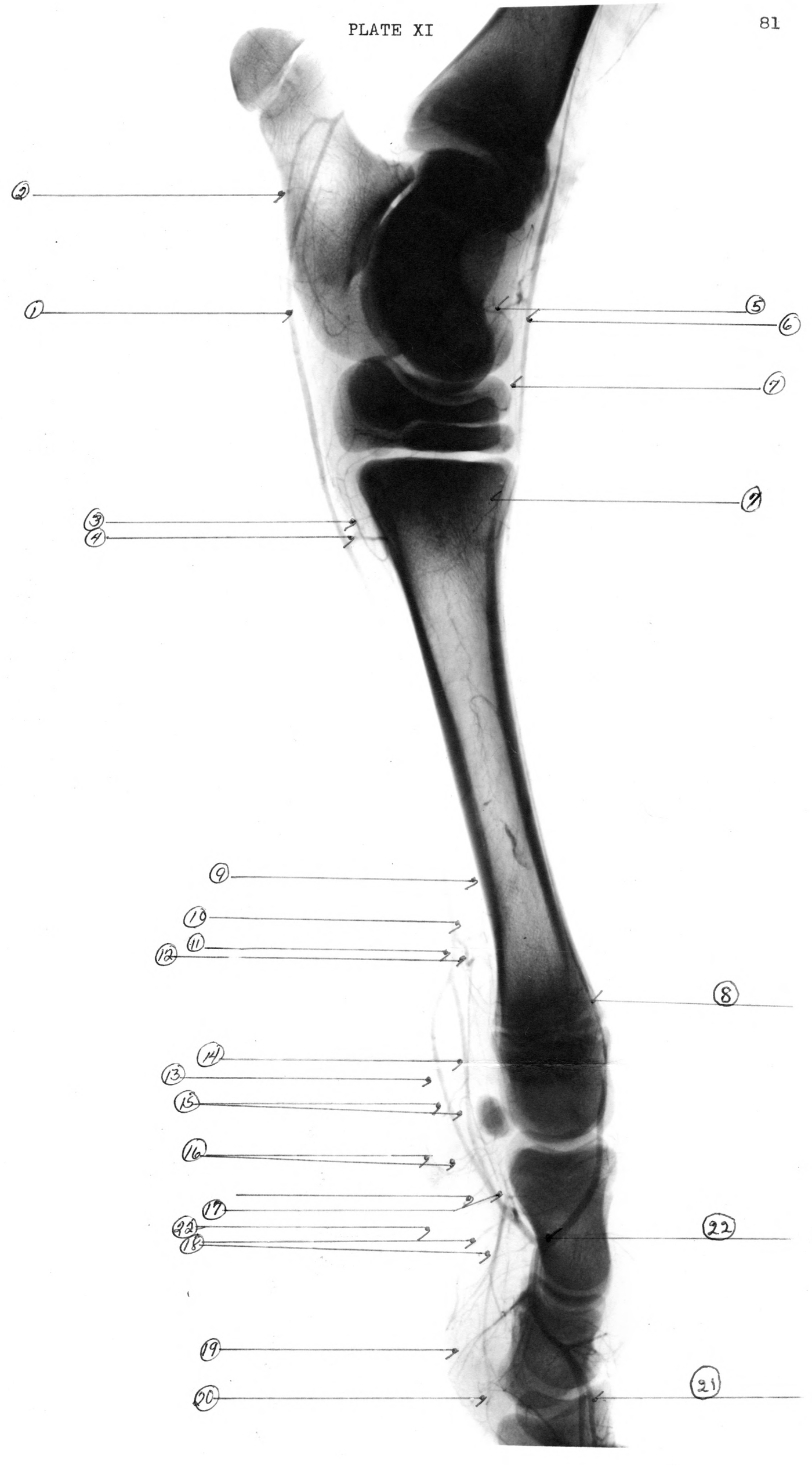
EXPLANATION OF PLATE XI

Medial View of the Pelvic Limb - Ox

1. Medial plantar metatarsal artery.
2. Lateral plantar metatarsal artery.
3. Perforating metatarsal artery.
4. Proximal plantar arch.
5. Rete tarsii dorsale.
6. Anterior tibial artery.
7. Medial branch from the rete tarsii dorsale communicating with the medial plantar artery.
8. Dorsal metatarsal artery.
9. Medial deep plantar metatarsal artery.
10. Lateral plantar metatarsal artery.
11. Plantar common digital artery.
12. Deep plantar arch.
13. Medial abaxial digital artery.
14. Continuation of #11.
15. Artery to the dewclaws.
16. Artery to the fetlock joint and anastomosis of arteries of the fetlock with the common digital arteries.
17. Artery of the first phalanx, volar branch.
18. Artery of the first phalanx, dorsal branch.
19. Arteries of the bulb.
20. Arteries of the second phalanx.
21. Anastomosis of the arteries of the bulb and the artery of the second phalanx.
22. Axial digital arteries.
23. Interdigital arch.

PLATE XI

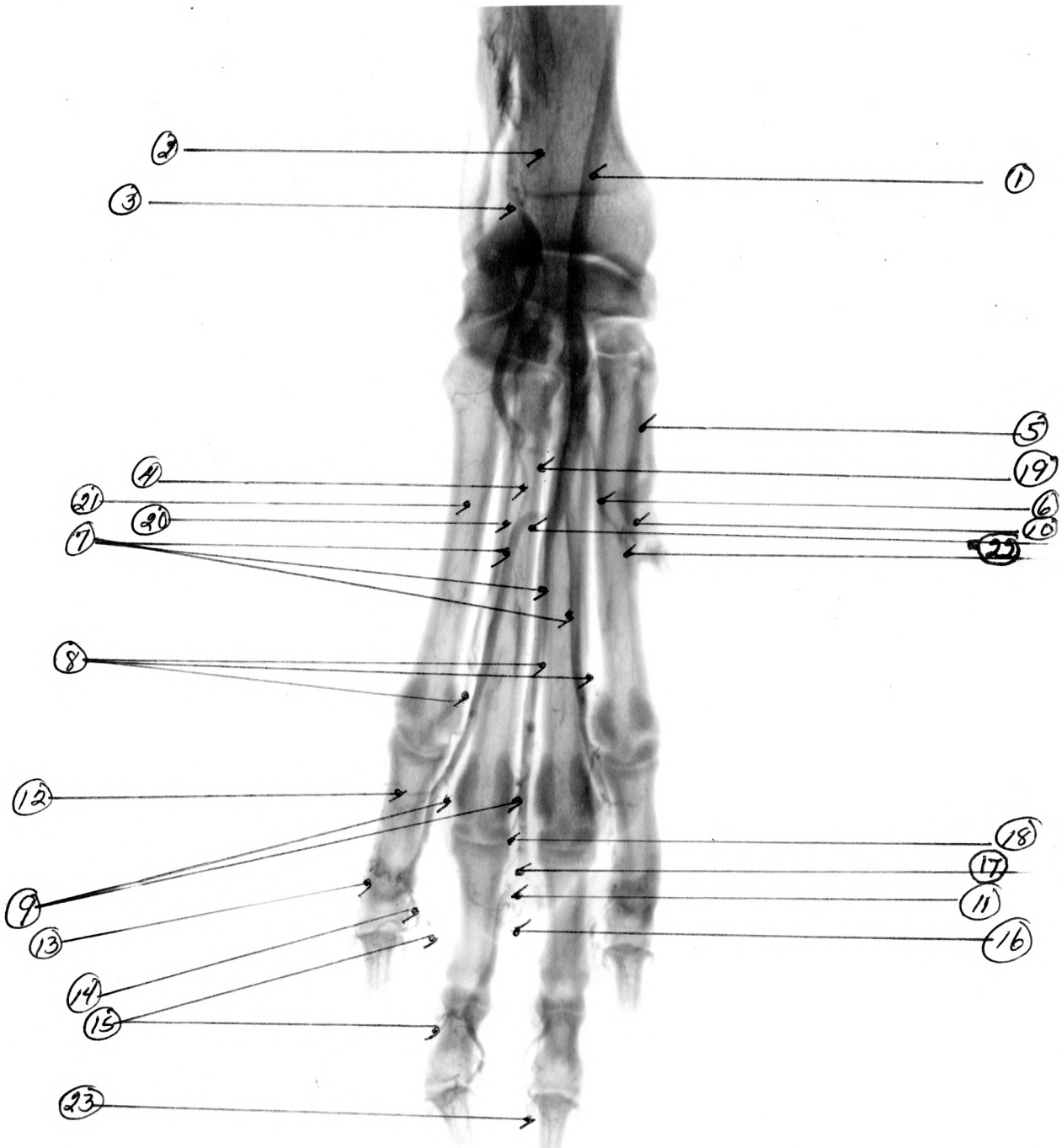


EXPLANATION OF PLATE XII

Volar View of the Thoracic Limb - Dog

1. Ulnar artery.
2. Radial artery - proximal collateral.
3. Volar interosseous artery.
4. Anastomosis of the branch from the volar interosseous and the origin of the superficial volar metacarpal artery IV.
5. Dorsal metacarpal artery I.
6. Volar metacarpal artery I.
7. Superficial volar metacarpal arteries II, III, and IV.
8. Deep volar metacarpal arteries II, III, and IV.
   Anastomosis of the superficial and deep volar metacarpal arteries II, III, and IV.
9. Superficial volar arch.
10. Volar common digital artery of the third and fourth digits.
11. Artery of the first phalanx.
12. Artery of the second phalanx.
13. Medial volar digital artery.
14. Lateral volar digital artery.
15. Branch to the metacarpal pad.
16. Branch to the metacarpal pad.
17. Anastomosis of the volar and dorsal metacarpal arteries.
18. Deep volar arch.
19. Dorsal deep metacarpal artery IV.
20. Dorsal superficial metacarpal artery V.
21. Common digital artery I.
22. Ungual artery to the third phalanx.

PLATE XII

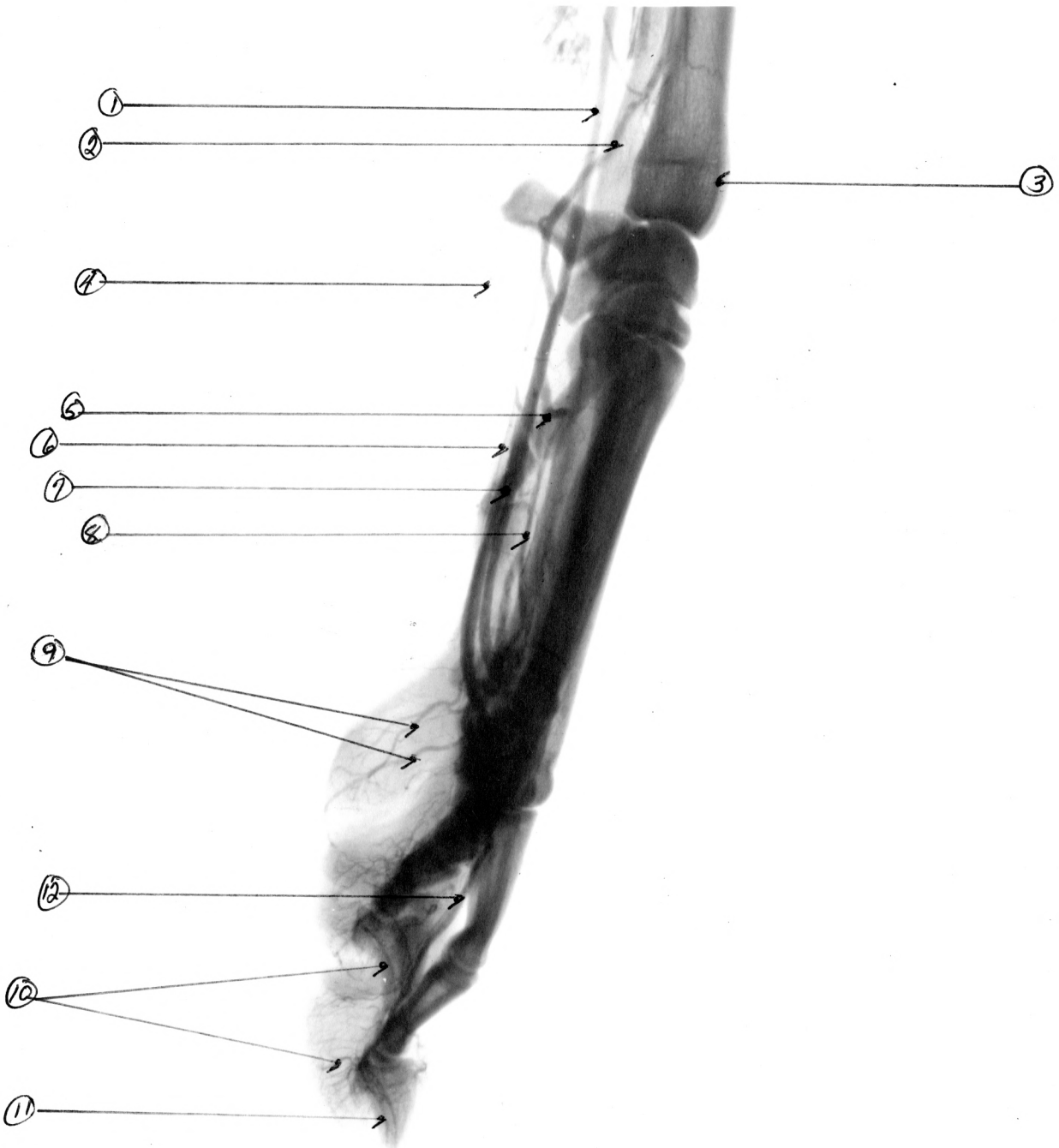


EXPLANATION OF PLATE XIII

Lateral View of the Thoracic Limb - Dog

1. Ulnar artery.
2. Volar interosseous artery.
3. Proximal collateral radial artery.
4. Artery to the carpal pad.
5. Deep volar arch.
6. Anastomotic branch of the volar interosseous to the superficial volar metacarpal artery IV.
7. Superficial volar arch.
8. Deep volar metacarpal arteries.
9. Arteries to the metacarpal pads.
10. Arteries to the digital pads.
11. Ungual artery (artery of the third phalanx).
12. Volar common digital artery.

PLATE XIII

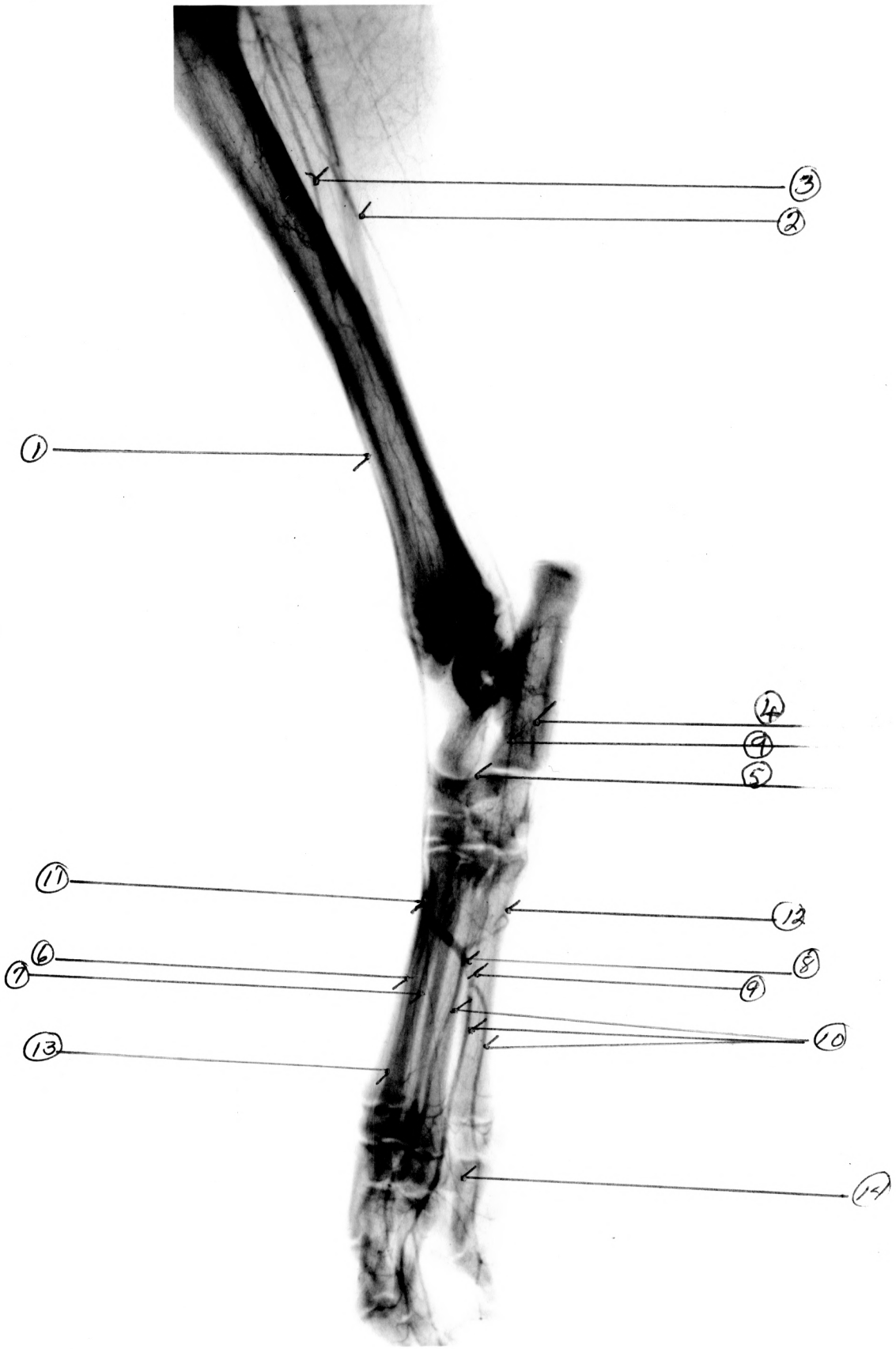


EXPLANATION OF PLATE XIV

Medio Plantar View of the Pelvic Limb - Dog

1. Anterior tibial artery.
2. Plantar ramus of the saphenous artery.
3. Dorsal ramus of the saphenous artery.
4. Lateral plantar artery.
5. Medial plantar artery.
6. Dorsal deep metatarsal arteries.
7. Muscular branches from the deep plantar arch.
8. Deep plantar arch.
9. Saphenous artery, plantar ramus.
10. Superficial plantar metatarsal arteries.
11. Perforating metatarsal artery.
12. Anastomosis of the superficial and deep plantar arteries.

PLATE XIV



AN ANATOMICAL-RADIOLOGICAL STUDY OF THE ARTERIES OF THE DISTAL EXTREMITY OF THE THORACIC AND PELVIC LIMBS OF THE HORSE, OX, AND DOG

by

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A review of the literature showed a lack of radiological studies of the arterial pattern of the limbs of the domestic animals. All descriptions available in the reference material and textbooks were based gross dissections. These descriptions omitted details of small and collateral arteries as being of no great surgical importance. This study was undertaken, therefore, to understand the insitu relations of the blood vessels to the bones, and make a more detailed observation of arterial pattern and physiological deviations.

The arterial distribution of the distal extremities of the thoracic and pelvic limbs of the horse, ox, and dog was studied, using the radiological techniques for this purpose. These observations were corroborated by dissection. Eight thoracic and six pelvic limbs of the horse; six of each of the limbs of the ox; and eight limbs of each of the dog were used for this study. In addition, observations were made on dissection specimens in the anatomy laboratory. The limbs were embalmed and then injected with Vultex, a commercial combined latex and radiopaque material. In general, the observations conformed to the descriptions of arteries found in standard veterinary anatomy textbooks. They also were similar to the stereoradiographical observations of Tohara et al. on the arteries of the foot of the horse and bovine or cattle hoof, which was the only reference work of this nature available in published literature.

The following observations made in this study were not cited as such in the available references.

Horse. In the thoracic limb, the dorsal metacarpal arteries extended from the subcarpal arch to the rete carpii dorsale. The medial and lateral volar metacarpal arteries each detached a superficial branch which joined the corresponding digital arteries. Larger vessels detached from the volar metacarpal arteries and/or the deep distal volar arch, coursed over to and ramified on the dorsum of the fetlock. An additional collateral vessel detached from the digital arteries, proximal to the perpendicular artery, supplied the fetlock region. In the pelvic limb, the observations conformed to the standard pattern except for minor variations and small details.

Ox. One artery on the deep surface of each of the medial and lateral volar metacarpal arteries was observed as a constant feature. These deep arteries anastomosed with each other and with the larger superficial metacarpal arteries and detached communicating branches to the subcarpal and deep distal volar arches. The middle deep volar artery was present in all specimens. A deeper vessel arose from the deep distal volar arch, passed through the groove separating the trochlea, and joined the dorsal common digital artery. The ascending first phalangeal artery was present in all specimens. Small vessels were observed in the region of the carpus and the fetlock and were described in detail.

In the pelvic limb, the arterial pattern resembled the basic pattern in the thoracic limb except for the characteristic absence of the artery corresponding to the great metacarpal artery.

Dog. In the thoracic limb, a vessel descended from the rete carpii volare and joined the deep volar arch. The anastomosis of the ulnar artery and the superficial branch of the volar ramus of the radial artery was not found. Details of the detachment and distribution of arteries to the carpal, metacarpal, and digital pads were given in this study. Similarly, the digital arteries and their collateral branches were studied in detail.

In the pelvic limb, the plantar branch of the saphenous artery was observed to detach the superficial plantar metatarsal artery V. In some specimens, the lateral plantar artery, instead of joining the deep plantar arch, descended to the middle of the intermetatarsal space of the fourth and fifth metatarsal bones, and faded. In some specimens, the medial plantar artery was observed to join the origin of the deep plantar metatarsal artery IV and subsequently, the lateral plantar artery, to complete the deep volar arch. In some specimens on the dorsal surface, the lateral branch of the anterior tibial artery terminated by joining the dorsal ramus of the saphenous artery. In those specimens, it was observed that the dorsal metatarsal artery V was detached from the saphenous artery. In some specimens, the dorsal deep metatarsal artery II was derived from the dorsal deep metatarsal artery III, instead of from the perforating metatarsal artery.

The arteriograms did not show up clearly the dorsal metacarpal arteries or the deep vessels on the volar surface in the thoracic limbs of the ox, as these vessels were overlapped by the

larger superficial vessels. Similarly, in the thoracic limbs of the dog, the volar vessels which were considerably larger, dominated the area and obstructed the view of the smaller dorsal vessels. In the pelvic limb of the dog, the deep plantar vessels which were the largest, showed up most prominently.