

CONSIDERATIONS REGARDING THE VENOUS SYSTEM OF THE AUTOPODIUM AND ZEUGOPODIUM PELVIC IN HORSES

CONSIDERAȚII PRIVIND SISTEMUL VENOS AL AUTOPODIULUI ȘI ZEUGOPODIULUI PELVIN LA CABALINE

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ABSTRACT | REZUMAT

The evolutionary process of mammals has led to important phenotypic changes as a result of their adaptation to the living environment. The most remarkable were due to the specialization of the limbs and consisted of the numerical reduction of the digits. The simplification of the free limb extremity also resulted in the remodeling of vascular and nervous structures. In our paper we approached the study of the venous system of the distal region of the pelvic limb in equines, a species in which digital reduction was maximal. Following the study carried out on pelvic limbs from ten adult animals, used in the Anatomy Laboratory of the Faculty of Veterinary Medicine in Bucharest, we followed in detail the anatomy of the venous system, in particular the description of individual variants. The results confirmed that there are also unusual aspects such as individual variations in the way the plantar veins detach from the deep metatarsal arch or the way some superficial veins (medial saphenous vein) discharge. We have taken into account the use of the N.A.V - 2017 recommended terminology in writing the descriptions.

Keywords: horse, vascularisation, pelvic limbs, veins

Procesul de evoluție al mamiferelor a dus la modificări fenotipice importante, urmare a adaptării acestora la mediul de viață. Cele mai remarcabile s-au datorat specializării membrilor și au constat în reducția numerică a degetelor. Simplificarea extremității libere a membrilor a determinat și o remodelare a structurilor vasculare și nervoase. În lucrarea noastră am abordat studiul sistemului venos al regiunii distale a membrului pelvin la ecvine, specie la care reducția digitală a fost maximă. În urma studiului realizat pe membrele pelvine provenite de la zece exemplare, utilizate în cadrul laboratorului de Anatomie a Facultății de Medicină Veterinară București, am urmărit în detaliu anatomia sistemului venos în special descrierea variantelor individuale. Rezultatele au confirmat că există și aspecte inedite precum variații individuale în modul de desprindere al venelor plantare din arcul profund metatarsian sau al modului de descărcare a unor vene superficiale (vena safenă medială). Am ținut cont de folosire terminologiei recomandate de N.A.V – 2017 în redactarea descrierilor.

Cuvinte cheie: cal, vascularizație, membre pelvine, vene

The numerical reduction of digits is an important feature in mammalian evolution. In contrast to species belonging to the order *Squamata*, where reduction to the total disappearance of the entire limb is common, the degree of reduction in mammals is smaller, and this phenomenon mainly affects the fingers (8, 9). Horses show the most advanced reduction of the toes, species of the genus *Equus* being monodactyl. Finger reduction has been associated with limb lengthening but at the same time with mechanical stabilisation by reducing the number of joints (1, 4). In addition to osteological and arthrological studies, research on the distribution of vessels and nerves in extant and extinct species of the genus *Equus* has attempted to demonstrate the identification of vestiges of missing digits as evidence of this invo-

lution with beneficial results in adaptation (5,6). There is undeniable interest among anatomists in deciphering the anatomy of appendicular segments in equines, with angiology being a priority area and knowledge of vessel topography and structure directly benefiting clinicians (2, 3, 7). A number of seemingly insignificant morphological details, such as the various individual variants, are useful to other fields, namely biology and palaeontology, in deciphering the complex processes that directed evolution. With this in mind, our research has aimed to bring to the fore individual details or variants to enrich the database that can be consulted by those interested.

MATERIALS AND METHODS

The biological material researched was represented by the pelvic limbs from 10 horses used in the Anatomy Laboratory of the Faculty of Veterinary Medicine, for organ harvesting, preparation and dissection.

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Vessel research was performed after the introduction of a contrast agent (AGO in which a dye was introduced).

The identification, description and homologation of the formations were done in correlation with *Nomina Anatomica Veterinaria* – 2017 (10).

RESULTS AND DISCUSSION

The veins of the pelvic autopodium generally have the same topography as those of the forelimb. The dorsal digital proper veins are missing, being replaced by the medial and lateral plantar digital proper veins. The latter two form a deep plantar arch, located between the plantar side of the main metatarsal bone and the median interosseous muscle. The lateral and medial plantar digital veins are placed on the lateral, and medial sides of the flexor tendons respectively, anterior to the arteries. On the dorsal aspect of the metapodial region there are two veins: one well represented, the common dorsal digital vein II, and a much smaller one, the dorsal metatarsal vein II. The origin of the dorsal common digital vein II is in the distal deep plantar arch. Very strong, it has a relatively short trajet in common with the plantar homologous, namely the common plantar digital vein II, which is much smaller. The dorsal common digital vein II is a continuation of the medial proper digital vein (Fig. 1).

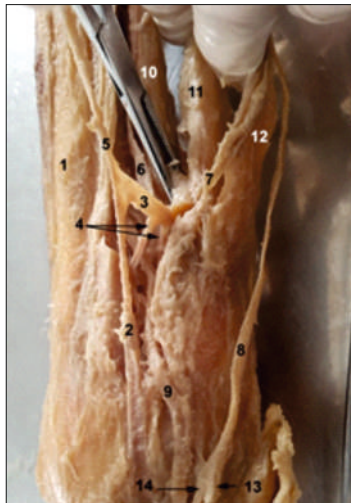


Fig. 1. Distal venous arch in horse, left pelvic limb - medial view (original)

1-the main metatarsal bone III; 2- medial proper digital vein (II); 3- distal venous arch; 4- articular branches; 5- dorsal common digital vein II; 6- medial deep plantar metatarsal vein; 7- common digital vein II; 8- medial plantar nerve; 9- medial digital proper artery; 10- interosseous muscle; 11- tendon of deep digital flexor muscle; 12- tendon of superficial digital flexor muscle; 13- posterior digital nerve; 14- the common trunk of anterior and middle digital nerves

Initially ascends on the medial border of the interosseous muscle, then it separates from the common trunk and, in the middle third of the metatarsal bone, it runs towards the dorsal part of the tarsal region, where it will form the

cranial root of the medial saphenous vein (Fig. 2). On the dorsal side of the tarsus is placed the dorsal vein of the foot, which continues the perforating tarsal vein, emerging from the cubo-scapho-cuneal duct. The origin of the latter is in the proximal deep plantar arch. The dorsal vein of the foot, continues proximally from the tibio-astragal joint with the cranial tibial vein. A complex anastomotic network can be isolated between the origin of common dorsal digital vein II, and the origins of the dorsal leg and cranial tibial veins. Dorsal metatarsal vein II is formed from two thin, isolated roots in the middle of the dorsal metatarsal region. It reaches the cranial side of the tarsus, discharging into an anastomosis, established between the cranial root of the saphenous vein and the distal part of the dorsal vein of the foot (Fig. 3).

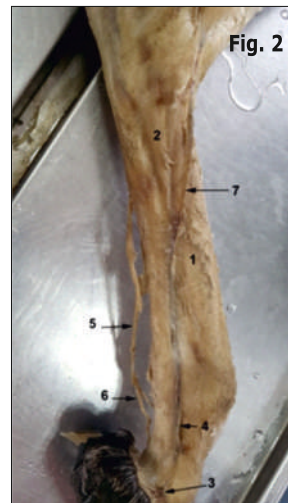


Fig. 2. The trajet of the common dorsal digital vein II in the horse - left limb - medial view (original)

1- main metatarsal bone III; 2- medial rudimentary metatarsal bone (II); 3- coronal veins; 4- medial proper digital vein; 5- medial plantar nerve; 6- posterior digital nerve; 7- common dorsal digital vein II

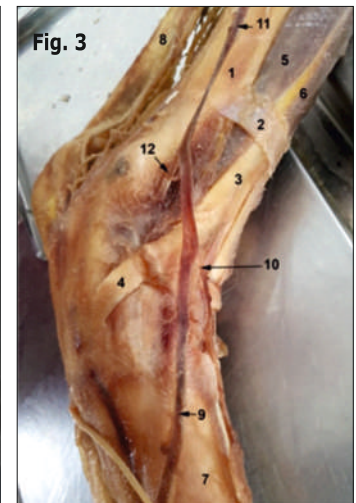


Fig. 3. Dorsal common digital vein II course in the tarso-metatarsal region of the horse - left limb - medial view (original). 1- tibia; 2- tibial ring; 3- fibular muscle III; 4- cuneal bridle of cranial tibial muscle; 5- cranial tibial muscle; 6- long digital extensor muscle; 7- main metatarsal bone III; 8- common calcaneal tendon; 9- common dorsal digital vein II; 10- dorsal metatarsal vein II; 11- the cranial root of great saphenous vein; 12- articular branch

The veins from the plantar side are represented by the digital proper veins, the common digital veins and the plantar metatarsal veins. Plantar metatarsal veins II and III originate in the deep distal plantar arch, in the common trunk or separated in 30% of cases but very close to each other. Plantar metatarsal vein III is very thin and sometimes (20% of cases) even missing. The plantar metatarsal veins participate in the formation of the proximal deep plantar arch. At this arch originates the perforating tarsal vein, a vein which is practically a continuation of the plantar metatarsal vein II. There are two common plantar digital veins:

one medial, II, and one lateral, III. The common plantar digital vein II originates, as mentioned, together with the dorsal homologous vein, under a very acute angle, placing itself dorsal to the artery at the medial edge of the digital flexor tendons (Fig. 4). Distal to the tarsus, it makes an anastomosis to the proximal deep plantar arch, continuing from this level as the medial plantar vein. Regarding the topography of the common plantar digital vein III is similar to the medial homologous vein (II). Below the tarsus, it anastomoses with the common plantar digital vein II but also with the plantar metatarsal veins, forming an arch similar to the distal deep plantar arch. From this arch, the common plantar digital vein III continues as the lateral plantar vein. In the zeugopodium area, the superficial veins are very unequal. The medial saphenous vein is voluminous and provided with two roots (Fig. 5).

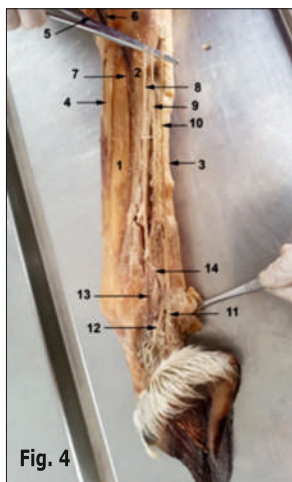


Fig. 4. Topography of vascular and nervous formations in the region of the pelvic autopodium in horse, left limb - lateral view (original). 1- main metatarsal bone III; 2- lateral rudimentary metatarsal bone (IV); 3- superficial digital flexor muscle tendon; 4- tendon of long digital extensor muscle; 5- the dorsal artery of the foot; 6- perforating tarsal artery; 7- dorsal metatarsal artery III; 8- common digital vein III; 9- common digital artery III; 10- lateral plantar nerve; 11- posterior digital nerve; 12- common trunk of anterior and middle digital nerves; 13- lateral digital proper vein; 14- lateral digital proper artery

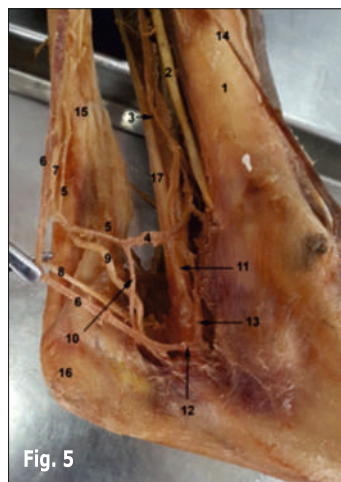


Fig. 5. Topography of vascular and nervous formations in the hock region of the horse, left limb - medial view (original). 1- tibia; 2- tendon of the flexor *digitalis pedis longus*; 3- caudal tibial artery and vein; 4- tibial "S" of caudal tibial artery; 5- descending branch of caudal femoral artery; 6- caudal root of great saphenous vein; 7- tibial nerve; 8- lateral plantar nerve; 9- medial plantar nerve; 10- lateral plantar artery; 11- medial plantar artery; 12- supratarsal venous arch; 13- root of caudal tibial veins; 14- cranial root of great saphenous vein; 15- common calcaneal tendon; 16- tuberosity of calcaneus; 17- tendon of deep digital flexor muscle

The strongest cranial root is a continuation of the common dorsal vein II, from the level of the tarsus, the level

at which anastomoses are observed with the dorsal veins of the foot. It has an oblique trajectory, in the proximo-cranial direction, medial to the tibia, being a satellite of the medial saphenous artery. The caudal root is represented by the common trunk formed by the junction of the two plantar veins, lateral and medial, caudal to the tibio-astragalian joint. Initially, it will establish an anastomosis with the caudal tibial vein and then another connection with the lateral saphenous vein. It ascends to the cranio-medial side of the common calcaneal tendon together with the tibial nerve, separating from the latter and passing superficially, subcutaneously. After joining the two roots, the medial saphenous vein is satellite to the saphenous artery, up to the cranial border of the *gracilis* muscle. It then separates from the artery and runs to the inguinal region. It most commonly discharges into the femoral vein (80% of cases). Sometimes it opens into a thick vein draining the dorsal venous plexus of the penis or udder glands, and crosses a fibrous ring in the aponeurosis of origin of the *gracilis* muscle, eventually reaching the deep femoral vein, its name in the Nomina Anatomica is the accessory external pudendal vein.

The lateral saphenous vein is much thinner than the medial saphenous vein and has a single root, arising before the tuberosity of the calcaneus by the junction of two anastomoses, one originating from the lateral caudal malleolar vein (the root of the caudal tibial vein) and the other from the caudal root of the medial saphenous vein (Fig. 6). Accompanied by the caudal sural cutaneous nerve, it will pass on the cranio-lateral side of the common calcaneal tendon, ascend the caudal border of the opening into the caudal femoral vein in common with the distal root of this vein.

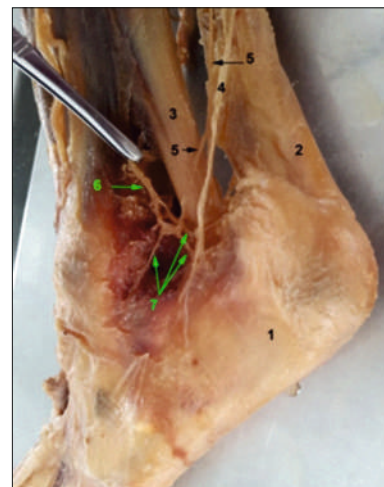


Fig. 6. Roots of the lateral saphenous vein in horse, left limb - lateral view (original). 1- calcaneus; 2- common calcaneal tendon; 3- tendon of lateral digital extensor muscle; 4- plantar sural cutaneous nerve; 5- lateral saphenous vein; 6- lateral tarsal artery; 7- roots of the lateral saphenous vein

The deep veins receive blood from the autopodium only from the cranial tibial vein. This continues the dorsal vein of the foot in the space between the distal end of the tibia and the tendons of the cranial tibial muscles.

Its origin is supplied by vessels arising from the cranial root of the medial saphenous vein in the form of anastomoses. The cranial tibial vein is always double, the one on the lateral side being much stronger than the one on the medial side. It receives multiple muscular tributaries and becomes simple in the vicinity of the proximal end of the interosseous space, which it crosses with the artery, after which it continues as the popliteal vein. The much reduced caudal tibial vein also appears double. It is formed by the union of two roots. One of the roots is the anastomosis arising cranio-medially from the tuberosity of the calcaneus on the caudal root of the medial saphenous vein, then flexing in the company of the distal portion of the caudal tibial artery. The other root is the lateral caudal malleolar vein, which arises at the lateral aspect of the tarsus, anastomoses to the lateral saphenous vein, then passes between the distal end of the tibia and the deep digital flexor muscles. The caudal tibial vein thus accompanies its homologous artery and tributaries correspond to its branch. Finally it enters between the proximal portion of the tibia and the popliteus muscle forming the second root of the popliteal vein. The latter is voluminous and follows the medial edge of the artery.

CONCLUSIONS

Unlike the thoracic autopodium, which lacks veins on the dorsal side, the metapodial region is characterised by the presence of two veins: the common dorsal digital vein II and the smaller dorsal metatarsal vein II, formed by two roots. On the palmar side, we note the individual variants identified in the morphology and topography of the plantar metatarsal veins. In all cases, the main venous blood-draining vessels are the common dorsal digital vein II and the perforating tarsal vein. Concerning the epifascial veins, two possibilities of discharge of the medial saphenous vein into the femoral vein were identified, most frequently (80% of cases) into the accessory external pudendal vein. The last aspect regarding the venous system of the studied segments was the rich anastomotic network, carried

out by veins in the area of the basipodium, both on the dorsal and palmar sides, some of these branches representing the roots of the main veins of the tibial region.

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