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CONTRIBUTIONS TO THE MORPHOLOGY OF THE THORACIC AUTOPODIAL NERVES IN HORSE

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Abstract

As it is known, taxonomy is one of the most dynamic aspects of biology. Ever since Antiquity, throughout the linnaen and post-linnaen period and until the new cladistics era, all branches of the phylogenetic tree were subject to plenty of modifications. The Equus genus was no exception, one of the most important evolutionary transformations being the reduction of the number of fingers in this genus, criterion considered crucial for correctly placing a species. Numerical reduction is also accompanied by a reorganisation of vascular and nervous trajectories. Based on autopodial parts of 10 individuals, this study aims to identify details and potentially individual variants which may complete existing literature data and which will represent additional arguments to the taxonomic classification of the species. The main objectives of this study were represented by the description of individual variants and clarifying of data regarding anatomical terminology, hoping that once achieved the results will aid veterinary research and practice.

Key words*: horse, autopodium, nerves, forelimb.*

INTRODUCTION

Out of all domesticated mammals, only in carnivores are the nerves of the limbs almost completely developed.

Seeing as in the evolutionary process the locomotor way has changed, from the plantigrade stance to the digitigrade and finally the unguligrade one, there has been a concomitant numerical reduction of fingers, a remodelling of both the active and the passive locomotor apparatus as well as an associated reorganisation of the vasculo-nervous formations (Barone & Simoens, 2010).

However, in spite of the strict specialisation of the free extremity of the limbs, as is the case for example in equines, the organisation of the trajectories of vascular and nervous formations still maintains some similar elements to the ones observed in penta-dactyl limbs (Robu et al., 2018; Schummer et al., 2013).

The nerves of the autopodium originate in the zeugopodial segment, through fascicles disposed on the cranial and caudal side of the latter. These nerves' participation in the horse is special due to their necessity to adapt to the phylogenetic differentiation of the passive and active locomotor apparatus, an example being the almost total lack of dorsal autopodial nerves both in the case of the thoracic and the pelvic segment.

In time, anatomists have paid great attention to the study of the autopodial segment in equines and the interest for this area is known: any problem, no matter how apparently insignificant, can remove an animal (oftentimes a valuable one) from the competitive or economic cycle (Ganță & Pentea, 2006; Spătaru, 2013).

Morphological research of great detail appears as far back as two thousand years ago, studies of more recent artistic anatomy as well as studies for the simulation of models which respect the biomechanics of equines prove how wide the interest sphere really is (Coțofan, 1969; Gheție et al., 1955; Gudea et al., 2009).

Even though at first sight it may appear an exhausted subject, we consider that there are always individual variations waiting to be discovered and interpreted especially in order to understand the evolutionary process mentioned at the beginning of this work.

MATERIALS AND METHODS

The study material was represented by limbs originating from ten horse bodies. After skinning, the thoracic limbs were detached by sectioning the connecting muscles between the scapula and the trunk.
The dissection was performed by classical methods, on successive planes, carefully following the topography of the nervous formations in the autopodial region.
The most suggestive images on the studied material were photographed, and then edited in the Adobe Photoshop C3 program. The identification, description and homologation of the formations was done in correlation with the Nomina Anatomica Veterinaria - 2017

RESULTS AND DISCUSSIONS

The nerves of the autopodium are characterised through the reduction of those on the dorsal side, which is largely served by nerves on the palmar side that are very well represented in contrast. On the dorsal side, dorsal digital nerves are absent. They are replaced in the dorso-medial half of the carpus and metacarpus with the last ramifications of the medial cutaneous nerve of the forearm (from the musculo-cutaneous nerve), and in the dorso-lateral half of the same regions with the caudal cutaneous nerve of the forearm (from the ulnar nerve) and inconstantly (in 40% of cases) with the lateral cutaneous nerve of the forearm (from the radial nerve). Out of the dorsal metacarpal nerves, the only present one, albeit very thin, is the lateral one which originates in the dorsal branch of the ulnar nerve. This branch has a descendent trajectory on the lateral side of the carpus and obliquely crosses the proximal extremity of the lateral metacarpal bone. It continues as a dorsal metacarpal nerve, descending near this bone until the metacarpo-phalangeal joint to which it provides fibres. The palmar branch of the ulnar nerve contributes to the formation of the nerves of the palmar side through two fascicles. On the medio-palmar margin of the pisiform bone, it joins the lateral branch of the median nerve (which basically constitutes the lateral palmar nerve). At the level of the second row of carpal bones its fibres distribute into two terminal branches: the superficial branch remain definitively interwoven with the lateral palmar nerve; the others form the profound branch (known in the past as "profound palmar branch") which curves between the origin of the III interosseous muscle and the accessory ligament (the carpal bridle) of the tendon of the profound flexor muscle of the fingers in order to provide the palmar metacarpal nerves after sending a branch to the III interosseous muscle (Fig. 1). The palmar metacarpal nerves, one medial and one lateral, each descend between this bone and the corresponding accessory metacarpus. It sends fibres to the II and IV interosseous muscles and the lumbrical muscles, as well as to the periosteum of the metacarpus. A bunch of final fibres reach the palmar side of the metacarpo-phalangeal joint.
The common digital palmar nerves are strong.

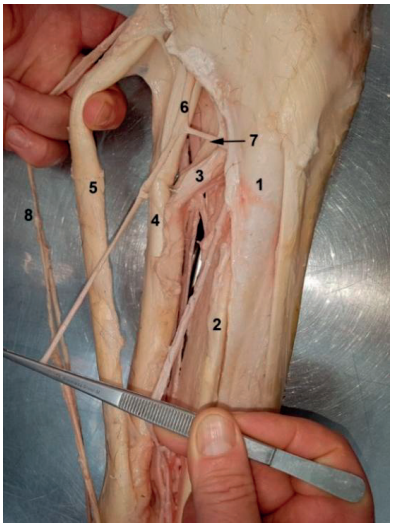

Fig. 1. Topography of the profound palmar nerve in the horse, right thoracic limb - lateral view (original): 1 - lateral rudimentary metacarpal IV; 2 - the median interosseous muscle; 3 - carpal bridle for the tendon of the deep digital flexor muscle; 4 - deep digital flexor muscle tendon; 5 - tendon of the superficial digital flexor muscle; 6 - lateral palmar nerve; 7 - deep palmar nerve (for the median interosseous muscle); 8 - medial palmar nerve

The medial palmar nerve is the medial branch through which the median nerve ends. It accompanies the palmar margin of the median artery on its trajectory, then the common digital artery II, descending on the medial side of the tendon of the deep flexor of the finger muscle, in

the palmar sheath of the carpus (the greater postcarpal sheath), then under the palmar metacarpal fascia (where it can be anaesthetised). Above the metacarpo-phalangeal joint it ends in the proper digital nerve which it continues, the latter giving a dorsal branch on its origin. On its trajectory it emits multiple fibres to the skin and the tendons of the digital flexor muscles. A remarkable communicant branch detaches in a very sharp angle from the palmar side, in the middle third of the metacarpus, crossing the tendons of the flexors superficially in order to unite with the lateral palmar nerve.

The lateral palmar nerve is formed through the joining of the lateral branch of the median nerve with the superficial palmar branch of the ulnar nerve. It joins the palmar margin of the III common digital palmar vein, thus descending on the lateral margin of the tendon of the profound digital flexor, relatively similar to its medial homologous. Halfway to the metacarpus it receives a communicant branch from the medial palmar nerve. It ends at the same level as the medial palmar nerve through the lateral proper digital nerve.

The two proper digital nerves, lateral and medial, have exactly the same distribution. Each proper digital nerve is located on the palmar side and supplements the absence of the dorsal digital nerves by emitting a strong dorsal branch which constitutes the first collateral branch (Fig. 2). This occurs above the metacarpo-phalangeal joint, the detachment place of the branch representing the limit between the palmar nerves and the proper digital nerves.

Alongside the proper digital artery and vein, the nerve will form a vasculo-nervous fascicle located under the thick skin of the metacarpo-phalangeal region, and then the pastern region. The nerve occupies the palmar margin of this fascicle, the digital vein is located dorsally and the artery intermediary (Fig. 2). Fine nervous threads originating from the dorsal branch accompany the vessels; one is located on the dorsal side of the vein and another between the artery and vein. The aforementioned vasculo-nervous fascicle obliquely crosses the ergot ligament which orients from the III finger to the ergot, crossing the profound side of the vein and then the surface of the artery and nerve.

At the level of the proximal margin of the ungular cartilage the fascicle dissociates and only the artery and the proper digital nerve pass on its profound side to distribute to deep portions of the ungular region.

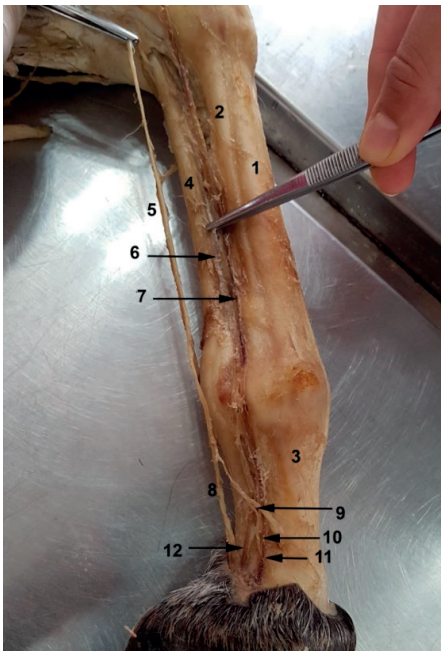

Fig. 2. Topography of vascular-nervous formations in the thoracic autopodium region in horses, left limb - medial view (original):
1 - main metacarpal bone III; 2 - rudimentary metacarpal bone II; 3 - phalanx I; 4 - flexor tendons; 5 - medial palmar nerve; 6 - palmar artery; 7 - common digital vein II; 8 - posterior digital nerve; 9 - anterior digital nerve (dorsal branch); 10 - middle digital nerve; 11 - proper digital medial vein; 12 - proper digital medial artery

The dorsal branch crosses the surface of the proper digital artery and vein, dorsal to which it ramifies dorso-distally. These nervous fibres distribute to the skin on the dorsal side of the finger until the dermis of limbus of the burelet, as well as in the sub-ungular dermis of the lateral regions of the hoof capsule. A remarkable and constant branch is the intermediary one, disposed between the artery and vein. Almost as thick as the dorsal branch, it detaches usually from its initial portion, but it can directly originate from the proper digital nerve, with which it exchanges dermis of the palmar portion of the hoof capsule.

Other branches of the proper digital nerve distribute as such: 1) near the proximal sesamoids are branches for the tendons of the digital flexors and a small nerve for the ergot (metacarpal torus); 2) the branch for the digital torus which accompanies the homonymous artery to distribute to the digital cushion; 3) deep branches for the tendons of the flexors; 4) coronary branches which emerge under the ungual cartilage to distribute together with branches of the dorsal artery of the middle phalanx to the interphalangeal joints and to the deep side of the ungual cartilage; 5) opposite to the latter, a thread is emitted which crosses the palmar process of the distal phalanx and traverses the ungual cartilage to participate in innervating the lamellar dermis, alongside branches of the coronary artery; 6) branches destined to the velutous tissue of the digital torus; 7) a thread which crosses the notch of the palmar process of the distal phalanx to accompany the dorsal artery of this phalanx to participate in the innervation of the lamellar dermis and the bone; 8) terminal branches are the ones which interweave with the arterial branches in the solar canal before distributing threads to the distal sesamoid and the adjacent recesses of the distal interphalangeal joint.

It is worth mentioning that the dorsal branch also innervates, aside from the skin of the pastern and the coronal regions, most of the lamellar dermis and velutous tissue. The proper digital nerve innervates mostly the deep organs of the hoof. At this level sensitivity is heightened, maintaining the functional activity of the keratogenic tissue, especially the lamellar dermis which ensures the fixation of the hoof wall to the distal phalanx.

CONCLUSIONS

The dorsal side of the autopodium in horses lacks nerves with the exception of a metacarpal nerve, represented in older terminology by the so- called dorsal nerve of the hand, a superficial branch of the ulnar nerve.

There are individual variations regarding the innervation of the dorso-lateral side of the carpus and metacarpus in 40% of cases the lateral cutaneous nerve of the forearm overlaps its territory with the caudal cutaneous nerve of the forearm.

The lateral and medial palmar nerves are terminal branches of the median nerve. In this sense the indications of the Nomina Anatomica Veterinaria must be respected, namely the participation of the ulnar nerve with superficial terminal threads in the consolidation of the lateral palmar nerve.

Deep terminal branches of the ulnar nerve will form a fascicle, known previously under the improper term of deep palmar nerve, which will serve the median interosseous muscle and will represent the origin of the palmar metacarpal nerves.

The two palmar nerves, lateral and medial, are symmetrical both as topography and as distribution of the proper digital nerves and their terminal branches.

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