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Normal Vascular and Nerve Distribution of the Pes Region in Dogs: An Anatomical and Diagnostic Imaging

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ABSTRACT

To investigate the normal anatomical distribution of the arterial blood supply, venous drainage and innervation on both the dorsal and plantar aspects of pes region including the level of tarsal joint due to its clinical importance with a little data available. Methods: Ten hind paws of five adult apparently healthy domestic dogs of both sexes; six paws injected, through blood vessels with colored latex neoprene for anatomical dissection and the other four paws injected a contrast mixture of red lead oxide and turpentine oil for the radiographic investigation of blood vessels. In addition to five live dogs used to apply the distal limb local anesthesia with the aid of Needle-Guided Ultrasonography. Results: This investigation revealed that the dorsal and plantar aspects of dog pes region supplied by superficial and deep sets of arteries, veins and nerves. The three dorsal metatarsal arteries originated from the arcuate artery. The medial tarsal vein forming characteristic venous arcades. The 3rd plantar metatarsal artery divided into two axial arteries while the 2nd and 4th continued axially without division. The plantar common digital and metatarsal nerves II, III, IV communicated to give origins of the axial and abaxial plantar proper digital nerves except the abaxials of the 2nd and 5th digits which supplied by a branch from medial plantar nerve and lateral plantar nerve respectively. Conclusion: There were little differences between dogs and other carnivores in vascularization of hind paw with the recommendation of using Needle-Guided Ultrasonography in the distal limb local anesthesia to avoid vascular puncture or damage.

Key words: Anatomy, Dog, Diagnostic Imaging, Nerve, Pes, Vascular

INTRODUCTION

The current study illustrating the morphological anatomy of the pes region in native domestic dogs (*Canis familiaris*) through different dissection techniques in addition to diagnostic imaging techniques such as x-ray and ultrasonography. The domestic dogs considered as the most geographically widespread species and most abundant carnivore in Egypt. They classified as mammalian carnivores of the Canidae family with a scientific name of Canis species (Wang and Tedford, 2008).

Compared to other animal models, the dogs were long been used in medical and developmental researches and as a model in drug discovery, especially for cancer drugs (Khanna *et al*., 2006). In addition to other peculiarities specified for nervous, urogenital and skeletal systems due to the close physio-anatomical characters with a human. In dogs, the most commonly described affections in pes region were accidental traumatic peroneal nerve injury with tarsus hyperextension and digit knuckling (Harasen, 2002 and Dayer *et al*., 2017), Achilles tendon rupture with plantigrade position and swelling (Spinella *et al*., 2010) and joint instability with sprains, luxation or fracture in hind paw (Yayla *et al*., 2016).

Introducing a diagnostic catheter and taking blood samples from blood vessels were critical techniques at the clinic for accurate screening of small animal vascular affections such as distal arterial thrombosis which of clinical and surgical importance due to its complication causing vascular necrosis of metatarsal and pedal soft tissues (Rezk and Shaker, 2014). This study aimed to support the surgeons and clinicians with detailed anatomical and diagnostic data on the vascularization and innervation of the dog pes region due to a few data reported in the previous literature that might be helpful and clinically useful for treatment of the upper known affections.

MATERIALS AND METHODS

The present investigation was performed on ten distal paws of dog's hind limb (5 right and 5 left) obtained from five condemned adult healthy dogs of both sexes from the of dog's hind limb (5 right and 5 left) obtained from five condemned adult healthy dogs of both sexes from the Anatomy Department, Faculty of Veterinary Medicine, Cairo University. The specimens divided according to the performed technique:

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A) Anatomical Dissection

Six paws were used to illustrate the anatomical distribution of arteries (2), veins (2) and nerves (2) through injecting one dog with red-colored latex through the abdominal aorta, injecting another dog with blue colored latex through the caudal vena cava and the third dog was injected with buffered formalin 10 % through the common carotid artery then injected through the arteries and veins together. All specimens preserved in formalin for successive three days for solidification of latex before dissection.

B) Imaging Techniques

Radiography: Four specimens were injected through the femoral artery (for arterial distribution) and the femoral vein (for venous drainage of the hind paw) with a radiopaque mixture of red lead oxide well dissolved in turpentine oil which was prepared one day before injection for homogenization of the solution.

Ultrasonography: Random selection to five adult dogs at the faculty clinic then the region of interest shaved, cleaned and disinfected with alcohol. A pulsed-wave Doppler ultrasound scanner equipped with multifrequency 7.5-10 MHz linear-array trans-rectal transducer (EXAGO, Echo Control Medical, France) was used for the examination of tibial nerve trunk with the probe placed in a vertical plane parallel to Achilles tendon. All anatomical and imaging findings were photographed using a digital photo camera Nikon COOLPIX L310 14.1 Megapixels in 9 photographs.

RESULTS

Arterial supply

The major arterial blood supply for the dog pes region constituted through participation between two well-defined arteries, the saphenous and cranial tibial arteries. Each dorsal and plantar surfaces of the pes owing double-layered vascular ramification; the superficial layer formed of 2nd, 3rd, and 4th common digital arteries while, the deep layer formed of 2nd, 3rd and 4th metatarsal arteries which communicated with each other at the level of metatarsophalangeal articulation.

A. saphena: the saphenous artery originated from the femoral artery, proximal to stifle joint supplying skin of its medial aspect and accompanied by tibial nerve (Fig. 2/B/2) and medial saphenous vein (Fig. 3/B/40) then terminated as a short cranial and a long-continued caudal branch.

Ramus cranialis: of the saphenous artery (Fig. 1/B/1), at the tarsus proximity, participated in constitution of dorsal common digital arteries (II, III and IV) with the superficial branch of the cranial tibial artery (Fig. 1/B/7) forming the superficial arterial layer which supplied the dorsal aspect of the paw. These small fine arteries (Fig. 1/B/12,13,14) descend subcutaneously in the intervals between the metatarsal bones that divided at the level of the fetlock joint giving off axial and abaxial dorsal proper digital arteries (Fig. 7/A/19,20) II, III, IV.

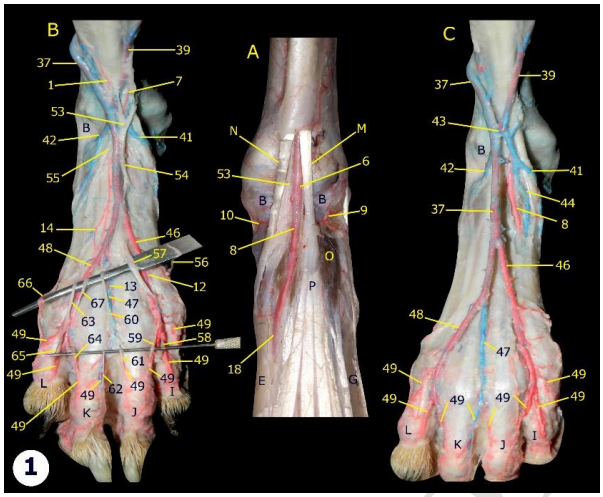

Fig. 1: A Photograph showing distribution of arteries, veins and nerves on dorsal aspect of Dog hind paw.

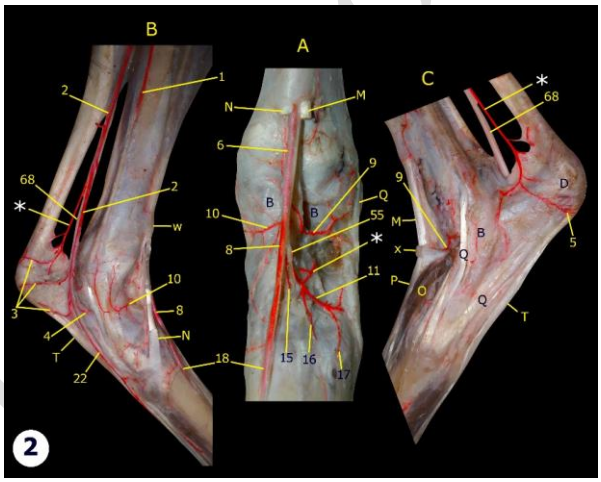

Fig. 2: A Photograph showing distribution of arteries and nerves at level of tarsal joint of Dog (A, Dorsal, B, Medial, C, Lateral Views).

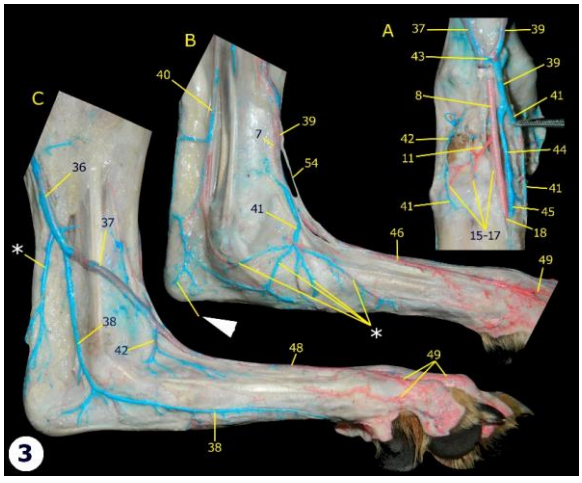

Fig. 3: A Photograph showing distribution of veins on dorsal (A), medial (B) and lateral (C) aspects of Dog hind paw.

A. tibialis cranialis: the cranial tibial artery (Fig. 2/A/6) supplied the extensor muscles of leg proximal to the tarsus then continued within their long tendons as the dorsal pedal artery (Fig. 1/A/8) opposite to the talocrural joint accompanied with the superficial and deep fibular nerves.

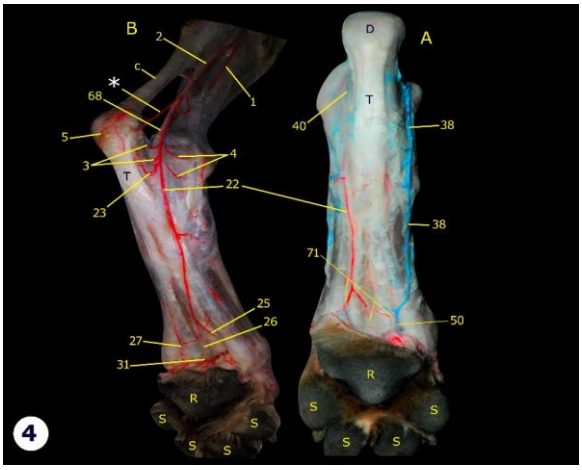

Fig. 4: A Photograph showing the superficial set of arteries, veins and nerves on Dog plantar surface (A, Right paw & B, Left paw).

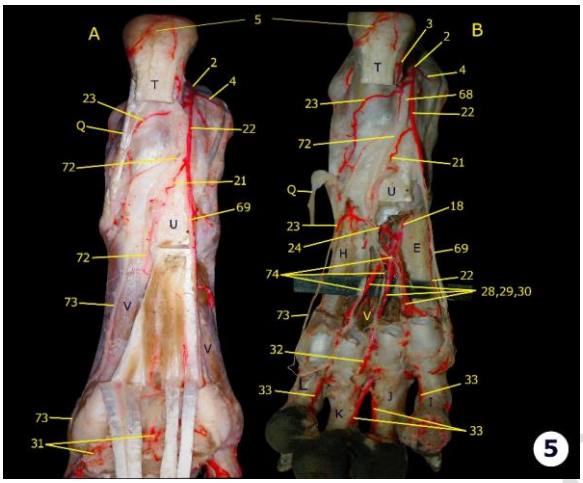

Fig. 5: A Photograph showing distribution of deep set of arteries on the plantar aspect of Dog hind paw (Right paws).

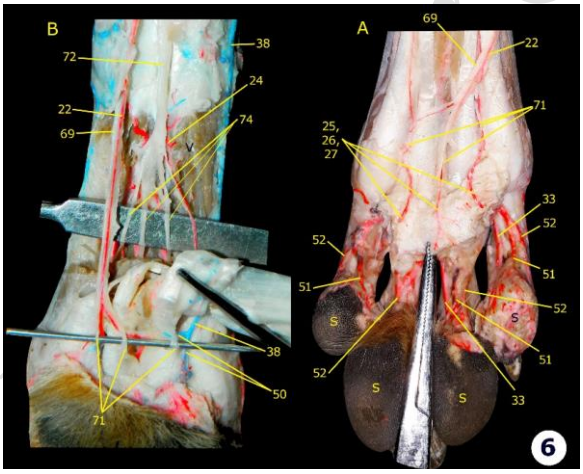

Fig. 6: A Photograph showing distribution of arteries, veins and nerves on the plantar aspect of Dog hind paw (A, Left & B, Right paws).

A. tarsea medialis et A. tarsea lateralis: the medial (Fig. 2/A/10) and lateral tarsal (Fig. 2/A/9) arteries originated from the sides of the dorsal pedal artery (Fig. 2/A/8) at the level of intertarsal joint directed medially and laterally toward the collateral ligaments with the lateral tarsal artery emerged proximal to the medial one.

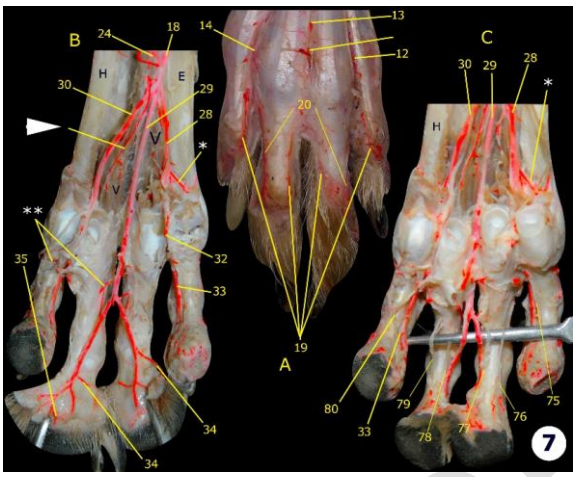

Fig. (7). A Photograph showing digital arterial and nerve distribution of dorsal (A) and plantar (B,C) aspects of Dog hind paw.

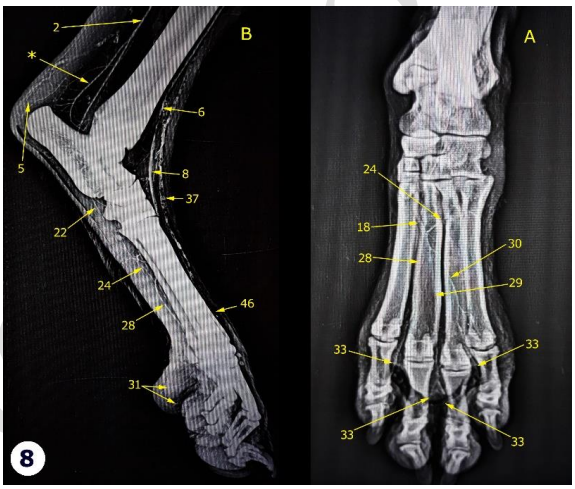

Fig. 8: A Radiograph showing main arterial and venous distribution of Dog hind paw (A, ventrodorsal view & B, mediolateral view).

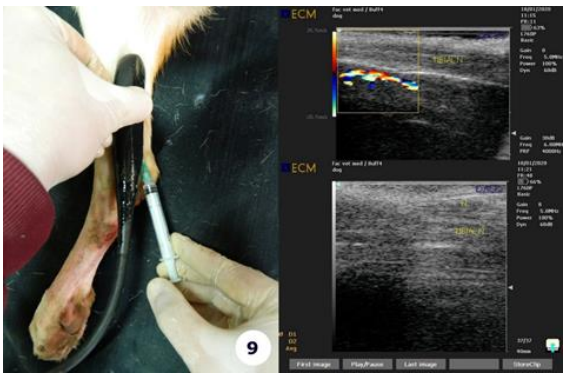

Fig. 9: A Needle-Guided Ultrasonographic Technique showing the accurate safe approach for tibial nerve local anesthesia.

A. arcuata: the arcuate artery (Fig. 2/A/11) arose from the lateral side of the dorsal pedal artery at the level of tarsometatarsal articulation then run transversely laterally and deeper through the ligamentous tissue. It gave off dorsal metatarsal arteries (II, III and IV) that run distally to supply the paw dorsally in addition to an artery that arose from its upper side (Fig. 2/A/star) and run deeper to the joint capsule.

Legends of Figures

1. A. Saphena (R. cranialis).
2. A. Saphena (R. caudalis).
3. Rami calcanei.
4. Rami tarsici
5. Rete calcaneum.
6. A. tibialis cranialis.
7. A. tibialis cranialis (R. superficialis).
8. A. dorsalis pedis.
9. A. tarsea lateralis.
10. A. tarsea medialis.
11. A. arcuata.
12. A. digitalis dorsalis communis II.
13. A. digitalis dorsalis communis III.
14. A. digitalis dorsalis communis IV.
15. A. metatarsea dorsalis II.
16. A. metatarsea dorsalis III.
17. A. metatarsea dorsalis IV.
18. Ramus perforans proximalis II.
19. Aa. digitales dorsales II, III, IV, V axiales.
20. Aa. digitales dorsales III, IV abaxiales.
21. A. plantaris medialis (R. profundus).
22. A. plantaris medialis (R. superficialis).
23. A. plantaris lateralis.
24. Arcus plantaris profundus.
25. A. digitalis plantaris communis II.
26. A. digitalis plantaris communis III.
27. A. digitalis plantaris communis IV.
28. A. metatarsea plantaris II.
29. A. metatarsea plantaris III.
30. A. metatarsea plantaris IV.
31. Ramus tori metatarsei.
32. A. interdigitalis.
33. Aa. digitales plantares propriae II,III,IV, V.
34. Ramus tori digitalis.
35. Arcus terminalis.
36. V. Saphena lateralis.
37. V. saphena lateralis (R. cranialis).
38. V. saphena lateralis (R. caudalis).
39. V. Saphena medialis (R. cranialis).
40. V. saphena medialis (R. caudalis).
41. V. tarsea medialis.
42. V. tarsea lateralis.
43. Ramus anastomoticus cum v. saphena mediali.
44. V. dorsalis pedis.
45. Ramus perforans proximalis II.
46. V. digitalis dorsalis communis II.
47. V. digitalis dorsalis communis III.
48. V. digitalis dorsalis communis IV.
49. Vv. Digitales dorsales propriae.
50. V. digitalis plantaris communis II-IV.
51. Vv. digitales plantares propriae II, III, IV, V axiales.
52. Vv. digitales plantares propriae II, V abaxiales.
53. N. fibularis (peroneus) communis.
54. N. fibularis superficialis.
55. N. fibularis profundus.
56. N. digitalis II abaxialis.
57. N. digitalis dorsalis communis II.
58. N. digitalis dorsalis proprius II axialis.
59. N. digitalis dorsalis proprius III abaxialis.
60. N. digitalis dorsalis communis III.
61. N. digitalis dorsalis proprius III axialis.
62. N. digitalis dorsalis proprius IV axialis.
63. N. digitalis dorsalis communis IV.
64. N. digitalis dorsalis proprius IV abaxialis.
65. N. digitalis dorsalis proprius V axialis.
66. N. digitalis dorsalis V abaxialis.
67. N. metatarsea dorsalis IV.
68. N. tibialis.
69. N. plantaris medialis.
70. N. digitalis plantaris II abaxialis.
71. Nn. Digitales plantares communis II-IV.
72. N. plantaris lateralis.
73. N. digitalis plantaris V abaxialis.
74. Nn. Metatarsei plantares II-IV.
75. N. digitalis plantaris proprius II axialis.
76. N. digitalis plantaris proprius III abaxialis.
77. N. digitalis plantaris proprius III axialis.
78. N. digitalis plantaris proprius IV axialis.
79. N. digitalis plantaris proprius IV abaxialis.
80. N. digitalis plantaris proprius V axialis.

A. Tibia.
B. Tarsal joint.
C. Common calcaneal tendon.
D. Calcaneus.
E. 2nd metacarpal bone.
F. 3rd metacarpal bone.
G. 4th metacarpal bone.
H. 5th metacarpal bone.
I. 2nd digit.
J. 3rd digit.
K. 4th digit.
L. 5th digit.
M. Long digital extensor tendon.
N. Cranial tibial tendon.
O. Short digital extensor muscle.
P. Common digital extensor tendon.
Q. Collateral ligament.
R. Metatarsal torus.
S. Digital torus.
T. Superficial digital flexor tendon.
U. Deep digital flexor tendon.
V. Interosseous muscle.
W. Proximal extensor retinaculum.
X. Distal extensor retinaculum.

Aa. metatarseae dorsales: the dorsal metatarsal arteries (Fig. 2/A/15,16,17) were three in number (II, III and IV) that constituted the deep arterial layer that supply the dorsal aspect of the paw. All three arteries originated separately from the arcuate artery but number II coursed in close contact with the dorsal pedal artery and descended parallel to each other in the metatarsal grooves.

The dorsal pedal artery, after detaching the arcuate artery with its dorsal metatarsal arteries, sinking deeper in the inter-metatarsal groove between proximal halves of the 2nd and 3rd metatarsal bones to become the proximal perforating artery II (Fig. 3/A/18) passing from dorsal to plantar surface to join the proximal deep plantar arch.

Ramus caudalis: of the saphenous artery (Fig. 2/B/2) considered as the continuation of saphenous artery after detaching a descending caudo-distal branch (Fig. 2/B, C/star) at the middle and parallel to common calcaneal tendon which ended by branching into few medial (Fig. 2/C/5) and lateral (Fig. 2/B/3) smaller twigs supplying the calcaneus and skin at this region. The caudal branch of saphenous artery then coursed medially at the level of tarsus through the tarsal tunnel, associated with the digital flexors and tibial nerve to detach several tarsal branches (rami tarsici) (Fig. 2/B/4) for the cutaneous supply of the tarsal medial aspect and Achilles tendon.

At a level disto-medial to the calcaneal tuber, the caudal branch of saphenous artery detached early the lateral plantar artery (Fig. 5/B/23) which accompanied the lateral plantar nerve then continued distally for 3 cm as a medial plantar artery which divided into two branches, the superficial branch (Fig. 5/B/22) accompanied the medial plantar nerve coursing parallel to the medial border of digital flexor tendon and the deep branch (Fig. 5/B/21) coursing under cover of the deep flexor tendon directed to and fused with the lateral plantar artery constituting a short arterial trunk on the lateral side which participating in the formation of the deep plantar arch (arcus plantaris profundus) (Fig. 5/B/24) through anastomosis with the proximal perforating artery II (Fig. 5/B/18) on the medial side.

Aa. digitales plantares communes: the common plantar digital arteries (II, III and IV) (Fig. 4/B/25,26,27) considered as the superficial arterial set of the plantar surface of the paw. They emerged from the medial plantar artery (superficial division) at the end of the splint bone and appeared just under the skin and on the superficial digital flexors associated with the common plantar digital nerves (Fig. 6/B/71).

Aa. metatarseae plantares: The plantar metatarsal arteries (Fig. 7/B, C/28,29,30) were three in number forming the deep arterial set of the plantar surface of the paw. They originated from the deep plantar arch and coursing distally within the inter-osseous muscles and deep digital flexor muscles. Along its course, each metatarsal artery detaching small branches (Fig. 7/B/arrowhead) to the surrounding muscles and also to supply the metatarsal torus then fused

with the corresponding dorsal artery. The 2nd plantar metatarsal artery (Fig. 7/C/28) detached a short lateral branch (Fig. 7/C/star) proximal to the fetlock joint for the abaxial aspect of the 2nd digit.

Aa. digitales plantares propriae: The proper plantar digital arteries (Fig. 7/B/33) were three in number (II, III and IV) where the 3rd proper plantar digital artery found inter-digitally between the 3rd and 4th digits where it divided into two proper plantar digital arteries coursing on the axial aspects of the 3rd and 4th digits respectively. While the 2nd and 4th proper plantar digital arteries coursing only on the axial aspect of its corresponding digit without division. All of them detached the plantar branches of the interdigital (Fig. 7/B/32), proximal, middle and distal phalanges (Fig. 7/B/double stars) respectively and showed plantar anastomoses on the middle phalanx (Ramus tori digitalis) (Fig. 7/B/34) for the digital torus before its termination as a terminal arch (Fig. 7/B/35).

Venous Drainage:

Proximal to the level of tarsus, there were two saphenous veins, the lateral and medial saphenous veins. Each vein formed from a union of cranial and caudal tributaries in addition to the caudal cutaneous branch (Fig. 3/C/star) that drained the common calcaneal tendon and forming subcutaneous venous network (Fig. 3/B/ arrowhead) covering the calcaneus from both sides.

The cranial tributaries of the lateral and medial saphenous veins found connected in front of tarsus through a short transverse anastomotic branch (Fig. 3/A/43). Distal to this anastomotic branch, the cranial branch (Fig. 1/C/37) of lateral saphenous vein receiving the lateral tarsal vein (Fig. 3/C/42) and the dorsal common digital veins (Fig. 1/C/46,47,48) (II, III and IV) which formed by union of the dorsal proper digital veins (Fig. 3/C/49) (axial and abaxial) which communicated with plantar metatarsal veins at the end of metatarsus. While the cranial tributary of the medial saphenous vein (Fig. 1/C/39) received the medial tarsal vein (Fig. 1/C/41) and the arcuate vein. The later vein received the dorsal metatarsal veins that coursing in the dorsal inter-metatarsal grooves and continued parallel to the proximal perforating artery and vein II (Fig. 1/C/45) to the plantar surface.

We noticed that the dorsal common digital veins II-IV merged to form a common trunk (Fig. 1/C/37) that run proximally as the cranial division of the lateral saphenous vein. Another observation that the dorsal vein, concerning digit II, forming dorsal pedal vein (Fig. 1/A/44) which coming from plantar to dorsal aspect in close contact and medial to the dorsal pedal artery and continued proximally as the cranial division of the medial saphenous vein (Fig. 3/A/39).

The venous drainage of the plantar aspect of hind paw constituted by the long caudal (plantar) branch (Fig. 4/A/38) of lateral saphenous vein, the short caudal branch (Fig. 4/A/40) of medial saphenous vein and the venous arcades (Fig. 3/B/star) of the medial tarsal vein. The dorsal pedal and saphenous veins usually used in venipuncture especially the lateral saphenous vein with its large tributaries on the dorsum of the metatarsus and in some specimens the saphenous veins and common trunk formed by the dorsal common digital veins were normally found congested enough to be identified and punctured.

Nerve supply of the pes

The nerve supply of hind paw represented by only two nerves originated from the sciatic nerve, the small common fibular nerve, and the large tibial nerve.

N. fibularis communis: the common fibular nerve (Fig. 1/B/53) divided, proximal to the tarsus, into the N. fibularis superficialis (Fig. 1/B/54) which became more superficial and follow the saphenous artery then originated the Nn. Digitales dorsales communis (Fig. 1/B/57,60,63) that innervate the dorsal aspect of the paw and the N. fibularis profundus (Fig. 2/A/55) which accompanied the cranial tibial artery. At the tarsus, the deep fibular nerve divided into dorsal metatarsal nerves (Fig. 1/B/67) for the dorsal paw innervation.

At the metatarsophalangeal joint, the dorsal common digital and dorsal metatarsal nerves were communicated and giving origins to the axial and abaxial dorsal proper digital nerves (Fig. 1/B/58,59,61,62,64,65).

N. tibialis (Fig. 5/B/68) originated from the sciatic nerve and coursing in combination with saphenous artery and vein cranial to the common calcaneal tendon and in-between the skin layers. At the tarso-crural articulation, the tibial nerve gave origin to the medial (Fig. 5/B/69) and lateral (Fig. 5/B/72) plantar nerves that terminated as the plantar common digital (Fig. 6/B/71) and plantar metatarsal (Fig. 6/B/74) nerves, respectively, which communicated at the end of metatarsus to give origins to the axial and abaxial plantar proper digital nerves (Fig. 7/C/75-80). In addition to the abaxial branch (Fig. 5/A/73) from the lateral plantar nerve supplying the lateral aspect of the 5th digit to provide sensation to the plantar surface of the paw. The tibial nerve trunk continued in close contact with the saphenous artery, coursing near the joint capsule of tarsus, which might be punctured during local anesthesia. However, we performed a Needle-Guided Ultrasonography as a safe guide for the nerve and other structures at this region (Fig. 9).

DISCUSSION

The results which were observed in different avian and mammalian species by (Kang *et al*., 1990) in chicken, (Jones *et al*., 2000 and Farag, 2002) in rabbit, (Rezk and Shaker, 2014) in cat and (Mróz *et al*., 2016) in human were following the current investigation that the main arterial blood supply of the dog pes region formed by a participation between only two arteries, the saphenous and cranial tibial arteries.

Our observations in the present study were in agreement with that reported by (Evans, 1993) in dog and (Funke and Kuhn, 1998 and Rezk and Shaker, 2014) in cat that there was double-layered vascularization of both dorsal and plantar aspects of hind paw with dorsal and plantar common digital and metatarsal arteries respectively originating from the contribution of saphenous, cranial tibial and dorsal pedal arteries.

The superficial arterial set on the dorsum of pes were the dorsal common digital arteries II-IV originating from the saphenous artery (R. cranialis) and cranial tibial artery (R. superficialis) while on the plantar aspect of pes was the plantar common digital arteries II-IV arising from the medial plantar artery of the caudal saphenous branch.

These results were confirmed by (Evans, 1993 and Budras *et al*., 2007) in the dog.

At the level of digits, our investigations were similar to that recorded by (Evans, 1993) in dog, (Farag, 2002 and Rezk and El-Bably, 2012) in rabbit, (Ninomiya *et al*., 2013) in dog and cat and (Rezk and Shaker, 2014) in cat that the dorsal common digital arteries II-IV were small short arteries that divided into medial and lateral dorsal proper digital arteries.

Our results were in accordance with that reported by (farag, 2002) in rabbit, (Dyce *et al*., 2010) in dog, (Rezk and Shaker, 2014) and (Mróz *et al*., 2016) in human, that the cranial tibial artery continued dorsal to tarsus as dorsal pedal artery which gave rise to lateral and medial tarsal arteries and laterally directed arcuate artery which emerged the dorsal metatarsal arteries and caudally directed small artery for tarsal bones and joint capsule then continued as dorsal perforating artery II which directed to the deep plantar surface to constitute a short trunk through anastomosing with the two plantar arteries to constitute the deep plantar arch that gave rise to the plantar metatarsal arteries II-IV.

Concerning to (Evans, 1993) in dog, the plantar metatarsal arteries were three where the third one called interdigital artery which divided at level of fetlock joint into two axial arteries of third and fourth digits while the second and fourth plantar metatarsal arteries continued without division along the axial aspect of second and fifth digits respectively, a result which simulated our observations in this study.

Our observations were in agreement with the reports of (Rezk and Shaker, 2014) in cat that the medial and lateral proper plantar digital arteries detached plantar branches for the proximal, middle and distal phalanges respectively also showed plantar anastomoses for metatarsal and digital torii for the metatarsal and digital torus and then terminated as a terminal arch.

From clinical point of view, it was very important surgically to anatomically investigate the hind paw venous drainage and its return toward the limb proximity to be able to differentially diagnose many lesions that might be either congenital or acquired as a result to trauma, neoplasm, infections or iatrogenic such as the incidence of thrombosis or arteriovenous fistula between the saphenous vein and artery that resulted in swelling of pes region (Tobias *et al*., 2001, Sackman, 2003, Ettinger and Feldman, 2005, Culp *et al*., 2014 and Vagney *et al*., 2018) in dog and cat.

Our observations in the present study confirmed the results of (Degner *et al*., 1993, Pavletic, 1999 and Elliott, 2014) in dog that the saphenous veins connected at dorsum of tarsus through an anastomotic branch which considered as the superficial dorsal arch and also connections between the venous arcades of medial tarsal vein and caudal branch of medial saphenous vein forming a characteristic network.

Our investigation in the current study revealed that the cranial branch of medial saphenous vein constituted by the dorsal pedal vein and medial tarsal vein that draining the proximal plantar half of pes while the lateral saphenous vein formed by a cranial branch with its lateral tarsal vein, long caudal branch without any connection between them and the caudal cutaneous branch draining the lateral aspect of calcaneus which did not have been mentioned by the previous literatures in dog.

Our results were similar to (Evans and De Lahunta, 2013) in the dog that the 3rd and 4th dorsal common digital veins anastomosed to constitute a common trunk that received the second one forming the cranial tributary of the lateral saphenous vein.

Pavletic (1999) and Elliott (2014) in dog reported that the presence of the medial saphenous vein more superficial accompanied by the caudal branch of the saphenous artery and tibial nerve exposing them to damage during performing a transverse surgical incision, a result which was similar to our investigations in the present study.

The tarsus and metatarsus contained a more superficially distributed venous network just under the skin of pes and considered the most commonly attended regions to the clinic due to deep abrasive wounds after road traffic accidents in addition to the lack of skin elasticity that made a challenge with wound closure. Wherefore, Cornell *et al*. (1995) in cat and Elliott (2014) in dog apply a saphenous conduit flap, a technique that brought the blood supply to wounds with a poor blood supply for excellent healing based on good knowledge with the vascular anatomy of the pes region.

Our results were in accordance with Evans and De Lahunta (2010) and Kumar (2015) in dog that the dorsal axial and abaxial proper digital veins drained into dorsal common digital veins II-IV that communicated with plantar metatarsal veins at the distal end of the metatarsus.

We noticed the same observations of Kumar (2015) in dog that the dorsal common digital veins II-IV merged to form a common trunk that run proximally as the cranial division of the lateral saphenous vein. Another observation that the dorsal vein, concerning digit II, forming dorsal common digital vein II which coming from plantar to dorsal aspect in close contact to the dorsal pedal artery and continued proximally as the cranial division of the medial saphenous vein.

Evans and De Lahunta (2010) and Schummer *et al*. (2013) in dog revealed that the medial plantar vein was short vein considered as a continuation of the caudal branch of medial saphenous vein on the plantar surface anastomosed with the medial tarsal vein while the main venous drainage of whole plantar surface is the long caudal branch of saphenous vein then divided into superficial and deep branches. The later branch forming the deep plantar arch which gave the plantar metatarsal veins II-IV coursing in the inter-metatarsal grooves while the former continued distally giving the plantar common digital veins II-IV that divided into axial and abaxial proper plantar digital veins, where communicated with the dorsal set through interdigital veins. A result that was similar to our investigation.

Our observations were in agreement with (Haghighi *et al*., 1991 and Rasmussen *et al*., 2006) in dog and (Medina *et al*., 2014) in African lion who reported that the saphenous nerve originated from the femoral nerve that considered as a muscular and cutaneous nerve accompanied by saphenous artery and medial saphenous vein. It innervated the skin of the dorsomedial tarsus and proximal aspect of the second digit of the hind paw.

Our results in dogs were similar to the observations of (Schummer *et al*., 2013 and Evans and De Lahunta, 2013) in dog and (Medina *et al*., 2014) in African lion who revealed on the dorsum of hind paw, that the superficial fibular nerve forming the dorsal common digital nerves

which accompanied by dorsal commons digital veins II, III, and IV, which further divided to give its own dorsal proper digital nerves and innervate the axial and abaxial surfaces of the corresponding digit, in accompany by the dorsal proper digital veins.

The fibular nerve and its branches of dorsal common digital and dorsal metatarsal nerves innervate the flexors of the tarsus, the extensors of the digits, skin of the dorsum of tarsus, metatarsus, and digits. While the tibial nerve, and its branches of plantar common digital and plantar metatarsal nerves, innervates the extensors of the tarsus, the flexors of the digits, and the plantar aspect of tarsus, metatarsus, and digits (Evans and Christensen, 1979, O'Connor and Woodbury, 1982 and Rasmussen *et al*., 2006).

(Budras *et al*., 2007, Mahler and Adogwa, 2008, De Lahunta and Glass, 2009 and Evans and De Lahunta 2013) differentiated between the course and thickness of both the fibular and tibial nerves in dogs and cats. Though, De Lahunta and Glass (2009) revealed that the injury of the tibial nerve might, therefore, resulted in a diminished soleus muscle tone in the cat, leading to increased tarsal joint angle and a plantigrade posture.

Our investigations revealed that the medial plantar digital nerve emerged from the tibial nerve at the level of tarsometatarsal joint and was found to be in a close association to the medial plantar artery and continued together distally till the middle of the metatarsal bones to divided into the plantar common digital nerves and arteries II-IV respectively then continued medially to give the plantar proper digital II abaxial nerve, a result which simulated the reports of (Evans and De Lahunta, 2013 and Dayer *et al*., 2017) in dog and (Medina *et al*., 2014) in African lion but the later author did not mention the plantar proper digital II abaxial nerve.

Medina *et al*. (2014) in African lion had reported that the lateral plantar nerve was wider and flatter than the medial plantar one, where it gave a deep branch that was introduced between the interosseous muscles, and a branch that continued towards the digits as a plantar proper digital IV to innervate opposite surfaces of digits IV and V. these results did not meet our observations in the present study and the reports of (Evans and De Lahunta, 2013) in dogs that the lateral plantar nerve giving medially the plantar metatarsal nerves II-IV and support a lateral branch which became the plantar proper digital IV abaxial nerve.

Our observations were in accordance with all the previous literatures that the plantar common digital nerves and the plantar metatarsal nerves were communicated at the level of the metatarsophalangeal articulation and giving the origins of the well-defined plantar proper digital nerves II-IV which further divided to support both axial and abaxial aspects of its mine digit as well as a fine branches supporting the metatarsal and digital tori.

Conclusions

These results concluded that the good anatomical knowledge about the arterial, venous and nerve distribution was helpful as a guide for catheterization, puncturing and anesthesia. The main sites of venipuncture of hind paw of dogs were the common trunk formed by the three dorsal common digital veins and the dorsal pedal vein. The common fibular nerve was difficult to be sonographically appeared but could be felt and locally infiltrated by anesthetics at the point of fusion made by the cranial tributaries of medial and lateral saphenous veins proximal to the tarsus. The tibial nerve could be felt on the caudal side of the tarsal joint where it could be anesthetized with special care to avoid puncture of joint capsule or the caudal branches of saphenous artery and vein with the aid of Needle-Guided Ultrasonographic technique.

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