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The Arteries, Veins and Nerves in the Antebrachium of the Brown Bear (Ursus arctos)

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The aim of the study is to establish the arterial and venous vessels and the nerves of the forelimb in the Brown bear through macro anatomical dissection and contrast radiography on six thoracic limbs. The vessels and nerves of the target area were dissected and photographed on the previously detached from the body limbs. For the use of contrast radiography barium sulfate solution was introduced through the brachial artery and medio-lateral and craniocaudal images of the forearm were taken. The main arterial and venous vessels, together with the nerve supply were established and subsequently compared with those of the dog and cat. A comparison with the human was also conducted due to the development of the pentadactyl plantigrade limb in these mammals.

Key words: brown bear, artery, vein, nerve, antebrachium

Introduction

Most of the studies of the Brown bear (*Ursus arctos*) are focused on their habitat and geographic expansion [33, 15], their conservation [31, 32] and reproduction [12, 31]. Morpho functional and histological studies of the Brown bear stomach and adrenal glands were conducted in the recent years [25, 26]. From an anatomical perspective the brown bear's musculoskeletal system is broadly researched [21, 7, 17]. Sasaki et al. [24] study the muscles of the hindlimbs of the Malayan sun bear (*Helarctos malayanus*), the Polar bear (*Ursus maritimus*), the Brown bear and the Giant panda (*Ailuropoda melanoleuca*) in relation of their climbing ability. Amaike et al. [1] compared the mobility of the forearm skeleton in the Asiatic (*Ursus thibetanus*), Brown, and Polar bear.

As part of the Caniformia suborder of the Carnivora, the Brown bear brings all the characteristics of their representatives [14, 30]. Among this order the vessels and nerves of the dog (*Canis lupus familiaris*) and the cat (*Felis catus*) have been the most researched [16, 20, 29, 11]. Davis [6] established a resemblance between the blood vessels of the forelimb of the Red panda (*Ailurus fulgens*) and the ursids.

In dogs and cats, the main arterial vessel supplying the antebrachium is the median artery, accompanied by the median vein and nerve, positioned deep between the forearm muscles. Superficially are the antebrachial superficial cranial artery, together with the cephalic vein and the superficial branch of the radial nerve [13, 27]. The cephalic vein is the preferred vessel for blood collecting [4, 2]. Study on the Andean bear (*Tremarctos ornatus*) and Asiatic black bear shows that 10 cm proximal to the carpal joint is most suitable for blood collection by the cephalic vein [19]. Branches of the ulnar nerve are also responsible for the innervation of this region [13].

In our previous study the vessels and nerves of the Brown bear's crus were established and was concluded that their branching patterns bring similarities to those of the cat, dog and human. In this study therefore we examined the arterial and venous vessels, together with the nerves of the forearm of the Brown bear.

Materials and methods

The limbs from four brown bears (two male and two female) were included in this study. The cadavers originate from the Dancing bears park in Belitsa, Bulgaria. The limbs were detached from the body by incising the skin and the muscles. Macro anatomical dissection of the arteries, veins, and nerves of the antebrachium was conducted with subsequent photographing with Lumix DC FZ82 (Panasonic, Japan). For the use of the contrast radiographic study barium sulfate – $BaSO_4$ solution (Milve AD, Bulgaria) prepared according to the manufacturer's instructions was introduced through the brachial artery with 20 ml syringe. The amount of the solution was 50 ml. Images in craniocaudal, and mediolateral projections were made on Eickemeyer® Vet, model E 7239X radiograph. The nomenclature was acquired from Nomina Anatomica Veterinaria 6th edition [24].

Results and Discussion

The cephalic vein (*v. cephalica*) at the antebrachial region of the Brown bear was found on the cranial surface of *m. extensor carpi radialis longus* and *brevis*, as the one in the cat, starting from the radial vein (*v. radialis*), and reaching the angle of the elbow joint (**Fig. 1**), as the one in the dog and cat [13, 28]. At the level of the distal antebrachium receives *v.cephalica accessoria*. The cephalic vein was also established on the x-ray image in mediolateral projection (**Fig. 2**). The cranial superficial antebrachial artery (*a. antebrachialis superficialis cranialis*) was visualized as a trunk that shortly divides into lateral and medial branches. These two vessels accompany the antebrachial part of the cephalic vein on its lateral and medial side (**Fig. 1**). The two arterial branches were flanked laterally and medially accordingly by *r. radialis superficialis – ramus lateralis* and *n. radialis superficialis – ramus medialis* (**Fig. 1**). The separation of *a. antebrachialis superficialis cranialis* and *n. radialis* in the Brown bear was at the level of the proximal antebrachium, unlike dogs, where these divisions are found at the level of the elbow joint. The view of the cephalic vein, bordered medially and laterally by the described arteries and nerves confirmed the described pattern in dog [13].

V. mediana cubiti was found at the flexor surface of the elbow joint passing obliquely on the distal end *m. biceps brachii*, connecting the *v. brachialis superfiialis* and *v. cephalica* as we described it in our previous research of the arteries and veins of the elbow in dogs [22, 8]. The median cubital vein was accompanied by the anastomosis between the superficial brachial artery and the collateral radial artery (**Fig. 3**) as the vessels described in dogs and cats [13, 27]. An anastomotic branch between the cephalic and the median cubital vein was detected (**Fig. 1**).

A. interossea communis was established on the level of the proximal part of the pronator quadratus muscle passing through *spatium interosseum antebrachii* and dividing in cranial and caudal branches (**Fig. 4**), like the described vessel in the dog [13, 27], but different from cat, where the cranial and caudal interosseous arteries arise separately from the brachial artery [27, 5]. The cranial interosseous artery was presented as the smaller vessel and coursing on the cranial aspect of *membrana interossea antebrachii* in the deep surface of the proximal end the *m. extensor carpi ulnaris* and the lateral and common digital extensor, confirming the literature data for dogs [13, 27]. On the x-ray image in cranio-caudal projection the ulnar artery (*a. ulnaris*) was found as a branch from the common interosseous artery (**Fig. 2**), like in dogs [13] but unlike cats, where it is a branch of the caudal interosseous artery [27, 5]. On the other hand, during the macro anatomical dissection it was also detected as a branch from the median artery (**Fig. 4**).

The median artery (*a. mediana*) and vein (*v. mediana*) were found between the antebrachial muscles (**Fig. 4**). The median artery was the largest arterial vessel of the forearm as the one in the dog [13]. *A. radialis* was established as a branch of *a. mediana* at the level of the distal radius seen on the dissected (**Fig. 4**) and radiographic image (**Fig. 2**) which is different from the one in the dog and cat, where *a. radialis* starts just proximal to the middle of the forearm [13, 27]. After the arising of the radial artery, the median artery continued as a thin vessel, which joined the palmar arch (*arcus palmaris superficialis*) confirming the described in dogs [13, 10], but unlike cats, where the median artery does not join the arch [9]. The palmar arch and *rete carpi dorsalis* formed by the radial and the caudal interosseous arteries in dogs [13, 10] and cats [9], were established by the present study as formed by the radial and the ulnar arteries similar to the human [3]. Between the dorsal branch of *v. ulnaris* and *v. cephalica accessoria* a venous arch was formed, from which begin the four dorsal common veins, which as branching is specific only to the bear and is absent in dogs, cats, and human. The dorsal branches of *a. radialis* and *a. ulnaris* form a deep arch, from which begin the four dorsal metacarpal arteries, which resemble the blood supply to the human arm [3]. The superficial palmar arch in the brown bear was formed by the palmar branch of *a. radialis*, the thin *a. mediana* and the palmar branch of the ulnar artery, while in the dog and the cat the last artery is substituted with *a. interossea caudalis.*

A division of *n. medianus* into lateral and medial branch (**Fig. 5**) was established like the cat [23], but at a different level – at the distal antebrachium in the Brown bear, while in cats is at the level of the carpus [27]. This separation of the median nerve is different from the branching pattern in dogs, where it divides in three (*n. digitalis palmaris I abaxialis*, *n. digitalis palmarlis communis I* and *n. digitalis palmarlis communis II*), described by Hermanson et al. [13], or human – in proper palmar digital branch and common palmar digital branch [3].

The ulnar nerve (*n. ulnaris*) and its division into palmar (*r. palmaris*) and dorsal (*r. dorsalis*) branch was observed (**Fig. 6**) in the level of the proximal quarter of the radius and ulna, unlike dogs and cats, where this is found in the middle of the antebrachium [13, 27].

The innervation of the forearm is given also by the *n. cutaneus antebrachii cranialis, n. cutaneus antebrachii caudalis, n. cutaneus antebrachii lateralis* and *n. cutaneus antebrachii medialis* (**Fig. 7**). The dorsal abaxial digital nerve for the first digit of the Brown bear was established as a branch of the *n. cutaneus antebrachii medialis* (from *n. musculocutaneus*), which is different from the innervation of this digit in the dog and cat, where it comes from *ramus medialis* of the superficial branch of the radial nerve [13, 27], or human, where it is given by *ramus superficialis* of the radial nerve [3]. *N. cutaneus antebrachii medialis* in dogs reaches the distal part of the antebrachium [13].

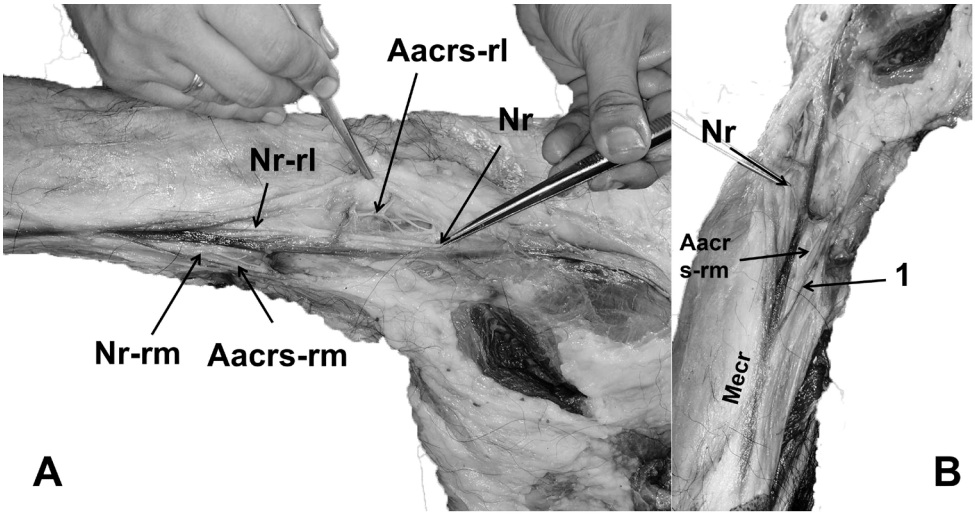

Fig. 1. Dissection appearance of the thoracic limb of the Brown bear; A – lateral view; B – dorsal view; Nr – n. radialis, Nr-rl – lateral branch of n. radialis, Nr-rm – medial branch of n. radialis, Aacrs-rm – medial branch of a. antebrachialis cranialis superficialis, Aacrs-rl – lateral branch of a. antebrachialis cranialis superficialis, Mecr – m. extensor carpi radialis; 1 – anastomotic branch between the cephalic and the median cubital vein

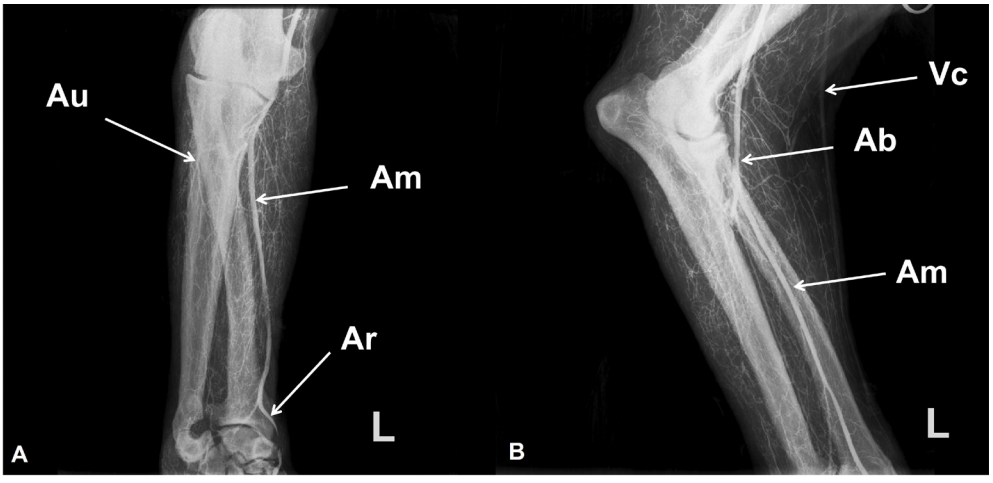

Fig. 2. Radiagraphic image of the Brown bear thoracic limb; A – cranio-caudal projection; B – medio-lateral projection; Au – a. ulnaris, Am – a. mediana, Ar – a. radialis; Vc – v. cephalica, Ab – a. brachialis

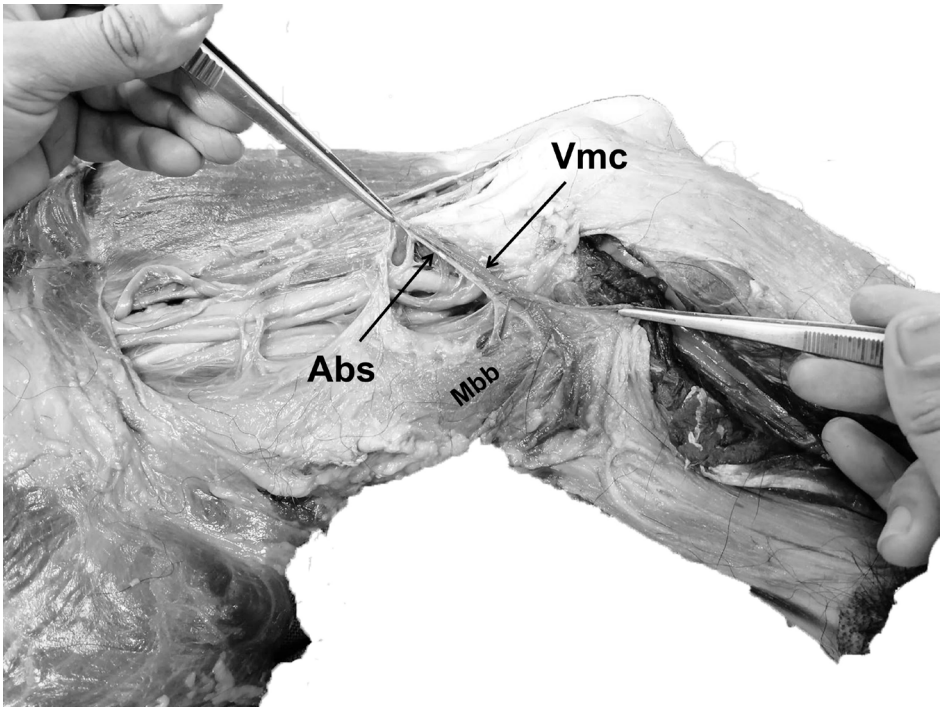

Fig. 3. Dissection appearance of the thoracic limb of the Brown bear, elbow level; Abs – a. brachialis superficialis; Vmc – v. mediana cubiti, Mbb – m. biceps brachii

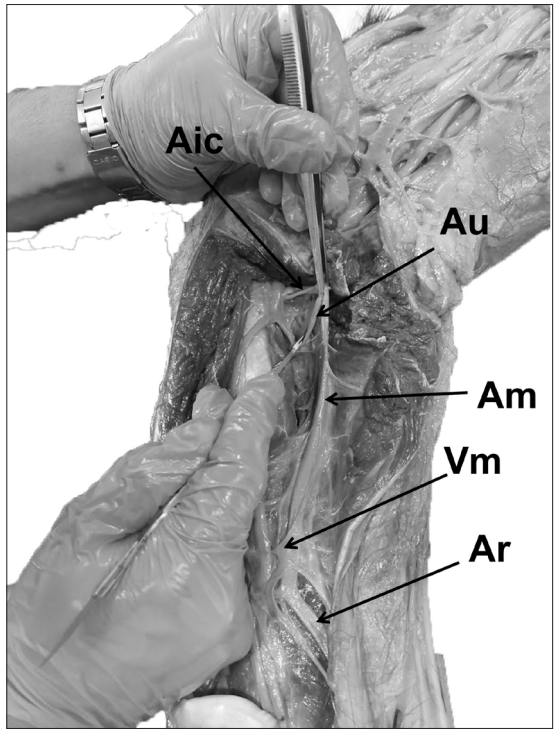

Fig. 4. Dissection appearance of the thoracic limb of the Brown bear, level of the antebrachium, medial view; Aic – a. interossea communis, Au – a. ulnaris, Am – a. mediana, Vm – v. mediana, Ar – a. radialis

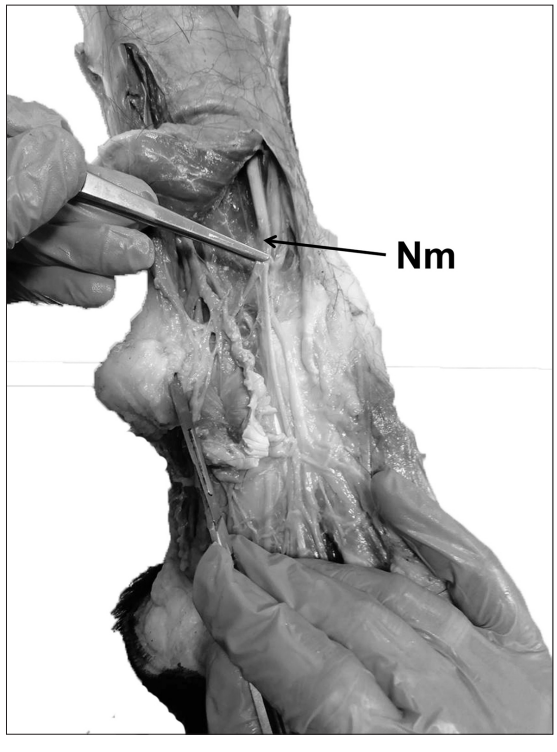

Fig. 5. Dissection appearance of the thoracic limb of the Brown bear, level of the carpus, dorsal view; Nm – n. medianus

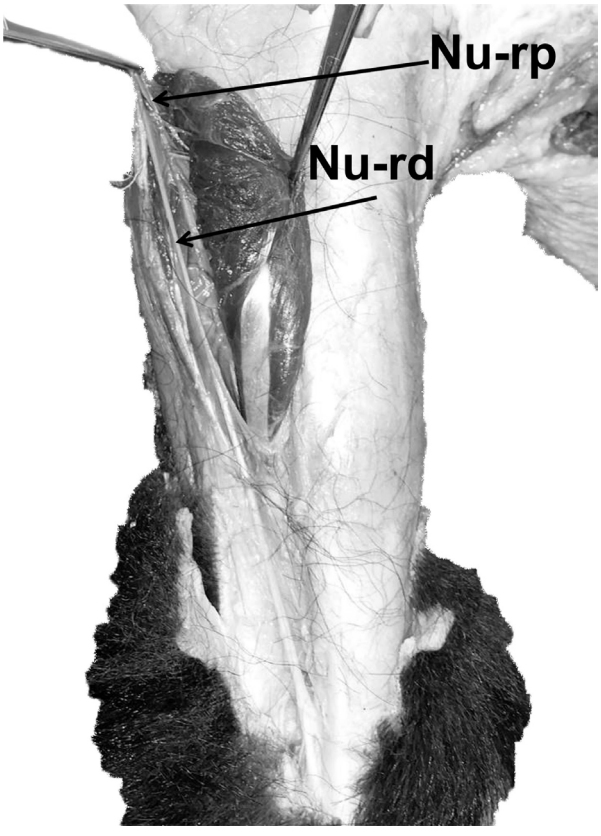

Fig. 6. Dissection appearance of the thoracic limb of the Brown bear, level of the antebrachium, lateral view; Nu-rp – palmar branch of the ulnar nerve; Nu-rd – dorsal branch of the ulnar nerve

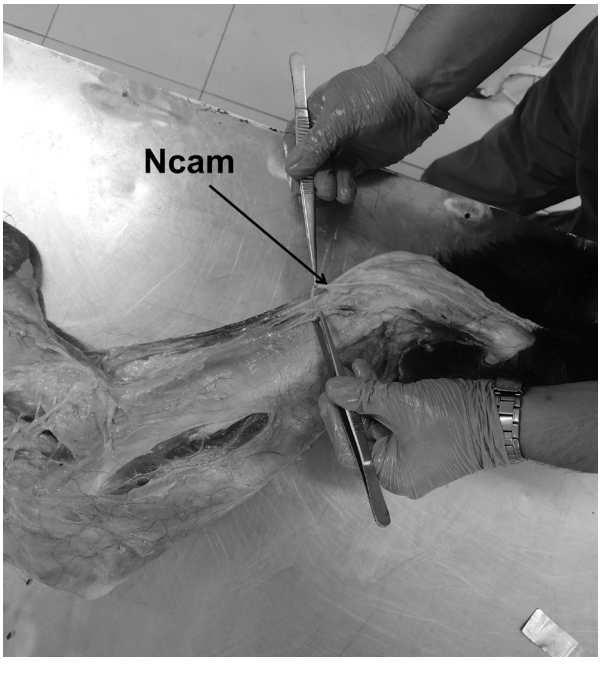

Fig. 7. Dissection appearance of the thoracic limb of the Brown bear, medial view; Ncam – n. cunateus antebrachia medialis

Conclusion

To our knowledge this is the first study to describe the arteries, veins, and nerves of the Brown bear's forearm. From the conducted anatomical dissections and radiographic investigations, we can conclude that their blood vessels and nerves bring characteristics not only of the different representatives from the Carnivora order, but also of the human.

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