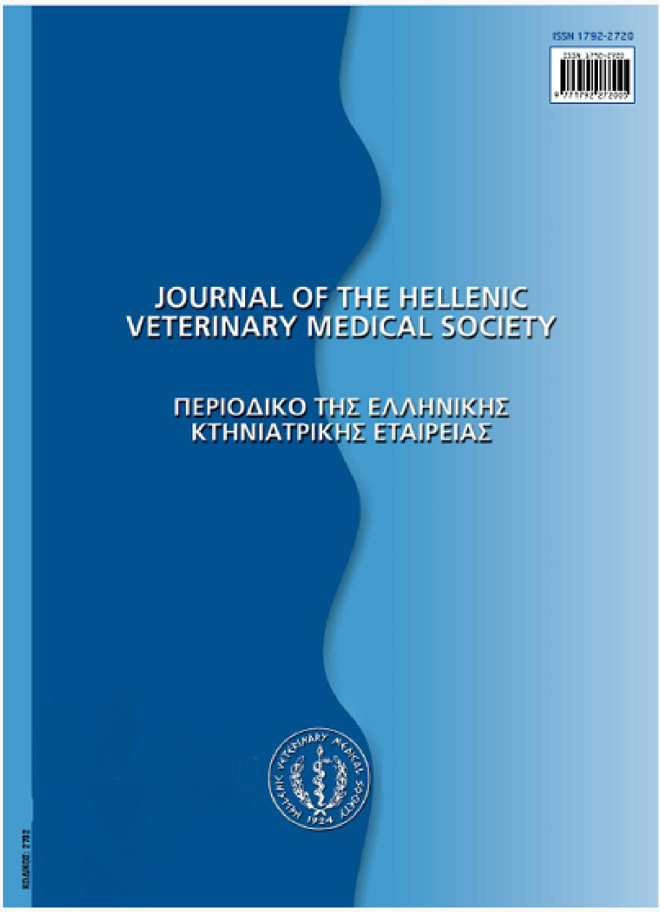
Journal of the Hellenic Veterinary Medical Society

Vol 67, No 3 (2016)



The Vascular Arrangement and Main Branches of Arteria Axillaris in Wing of Sparrowhawk (Accipiter nisus)

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doi: [10.12681/jhvms.15635](https://doi.org/10.12681/jhvms.15635)

J HELLENIC VET MED SOC 2016, 67(3): 171-176
ΠΕΚΕ 2016, 67(3): 171-176

Research article
Ερευνητικό άρθρο

The Vascular Arrangement and Main Branches of Arteria Axillaris in Wing of Sparrowhawk *(Accipiter nisus)*

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ABSTRACT. This study was aimed to determine the vascular arrangement of the wing arteries in the sparrowhawk. For this purpose, wing arteries of eight sparrowhawks were assessed by latex injection method and angiography. Latex injection method was applying to the five materials and barium sulphate solution was injected for angiography in other three materials. It was observed that the arterial blood was mainly provided to the wing by arteria axillaris. The arteria axillaris gave off arteria subscapularis. After branching the arteria subscapularis, it emitted the arteria profunda brachii and arteria supracoracoidea. After ramifying these vessel, the arteria axillaris continued down arteria brachialis. This vessel was giving off the arteria circumflexa humeri from its cranial aspect. In the nearby the cubital fossa the arteria brachialis bifurcated arteria ulnaris and arteria radialis. The arteria ulnaris gave off common stem of arteria recurrens ulnaris et arteria ulnaris profunda. After branching the common stem, the arteria ulnaris proceeded as arteria ulnaris superficialis. The arteria radialis was the deep terminate branch of the arteria brachialis. This vessel bifurcated the arteria radialis profunda and arteria radialis superficialis.

Keywords: *angiography, arteria axillaris, sparrowhawk, wing arteries.*

INTRODUCTION

Sparrowhawk (*Accipiter nisus*) is known as a small predatory bird from the family Accipitridae. Throughout the world, there are 50 different species of the genus Accipiter. The sparrowhawk is a major predator of small birds, especially sparrows (Baris, 2004; Lehikoinen, 2011). The sparrowhawk has got short and round tips of the wings, a long tail, a hooked beak and curved talons. Hindlimbs and claws are relatively more developed than beak in accipiters (Baris, 2004; Sustaita, 2008). Birds of prey which come from Europe and Asia migrate to Africa using the Eurasian-East African fly-way. Predators, including sparrowhawks, fly over the Eastern Turkey during this migration and they reach to the Erzurum Province in Anatolia (Greenberg and Marra 2004; Gokturk et al., 2008). Moreover, quail hunting with sparrowhawks is an ancestral sport in Anatolia and this traditional sport has been widely performed in northeastern Turkey.

The accipiters seize a large number of birds for food, depending relatively on the prey species available. The ability of a flying bird of prey to capture

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Date of initial submission: 01.06.2015
Date of revised submission: 23.10.2015
Date of acceptance: 30.11.2015

small and large birds in flight requires the raptor to be either very fast, skillfully maneuverable, or both. The accipters' broad wings and long tail allow them maneuverability. Also the fully extended wings and tail serve to decelerate the head and may help the predator make compensative movement successfully just before the strike. Some anatomical data (Peczely, 1964) support for this upon examination of the thoracic vertebrae of select species of accipiters. The heavy elastic ligaments and wide articular capsules were noted as adaptations for flexible flight (Meng, 1959; Peczely, 1964; Storer, 1966; Goslow, 1971).

In birds, the blood is mainly supplied to the head, neck, pectoral region and wing by the truncus brachiocephalicus. Arteria subclavia is originated from the truncus brachiocephalicus and provides the arteries of the pectoral region and the wing. It branches off the truncus pectoralis and arteria coracoidea before giving the arteria axillaris (Fitzgerald, 1969; Nickel et al., 1977).

There are many studies about wing muscles in bird species (Berger, 1953; Hudson and Lanzillotti, 1955; Kovacs and Meyers, 2000; Meyers and Stakebake, 2005; Zhang and Yang, 2013). Vascular organisation in wing arteries of predators are still insufficient despite the large number of wild bird species, the wide range of wing shapes in predatory birds, and variation in flight styles to capture their prey. In literature reviews, we observed that there was no study about wing arteries of sparrowhawk, a predatory bird whose number is gradually decreasing and important in Anatolia. This situation encouraged us to present arterial arrangement of wing in this bird of prey. We believe that our observations in this study will enhance morphological data on the predatory birds.

MATERIALS AND METHODS

In this study, a total of eight wounded and clinically incurable sparrowhawks that provided by certified hunters during the hawk migration season in the Ardesen town of Rize and brought to the clinic (Faculty of Veterinary Medicine, Ataturk University) were used. Their weights ranged from 140 to 250 grams and sex differences were not considered. Under deep anesthesia, blood was drained by cutting off the apex of the heart and the vessels were cleaned out by administering 0.9% of physiologic saline water into the vessels. After the vessels cleaned out, at five materials, a catheter was placed into the ventriculus sinister of the heart and fixed with a ligature on the aorta. Red coloured latex was injected into the arterial blood vessels through the catheter, until the arteries in the pelvic limbs and pectoral limbs became visible. After keeping in tap water at room temperature for 24 hours, to ensure fixation of the latex, the region of the pectoral limbs of the cadavers were thoroughly dissected and revealed wing arteries and its branches were photographed with a digital camera.

Forty five kW doses of barium sulphate solution were injected into the aorta for angiography in other three materials. Angiographies were taken at ventrodorsal position. One hundred kW 30 mAS Poskom brand x-ray were used for angiography.

The terminology used in agreement with the Nomina Anatomica Avium (Baumel et al., 1993). All procedures were carried out in exact accordance with the principles provided by Atatürk University Local Ethical Committee of Animal Experiments.

RESULTS

Arterial blood was mainly provided to the wing by arteria axillaris (Fig. 1:1) in sparrowhawks. The arteria axillaris was originating from the arteria subclavia after the ramifying of the arteria sternoclavicularis and then it was coursing deep into the shoulder. This vessel continued laterally to the ventral side of the articulatio omalis. Here, the arteria axillaris gave off its first prominent branch, the arteria subscapularis (Fig. 1:2). This branch was coursing laterally and it was supplying the musculus subscapularis, musculus serratus ventralis and cranial side of the musculus coracobrachialis caudalis, and musculus supracoracoideus. After

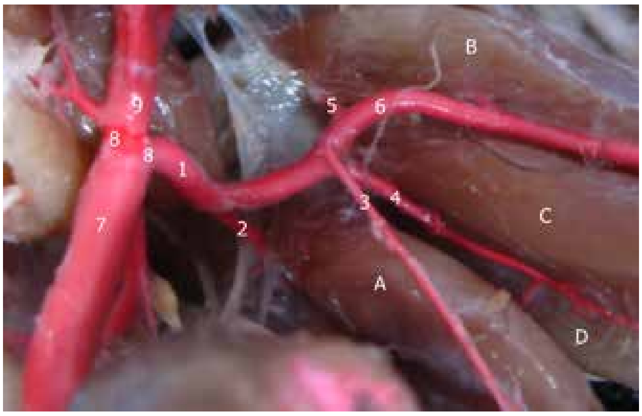

Figure 1. Arteria axillaris and its branches in ventral view. 1. Arteria axillaris, 2. Arteria subscapularis, 3. Arteria supracoracoidea, 4. Arteria profunda brachii, 5. Arteria circumflexa humeri, 6. Arteria brachialis, 7. Truncus brachiocephalicus, A. Musculus coracobrachialis caudalis, B. Musculus biceps brachii, C. Musculus humerotriceps, D. Musculus scapulotriceps, 8. Arteria subclavia, 9. Truncus pectoralis

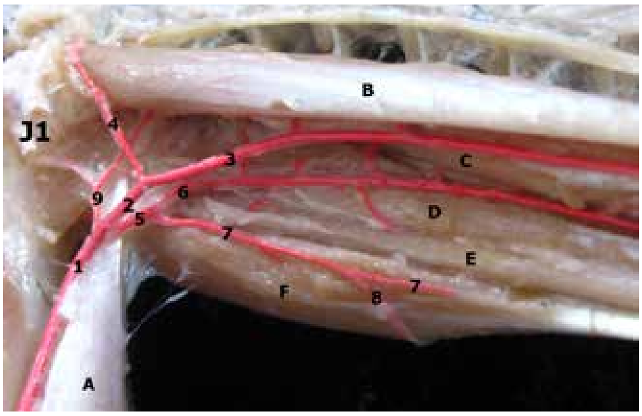

Figure 2. Arteria brachialis and its branches in ventral view. 1. Arteria brachialis, 2. Arteria ulnaris, 3. Arteria ulnaris superficialis, 4. Common stem of arteria recurrens ulnaris et arteria ulnaris profunda, 5. Arteria radialis, 6. Arteria radialis profunda, 7. Arteria radialis superficialis, 8. Rami propatagiales, 9. Arteria recurrens radialis, A. Musculus biceps brachii, B. Musculus flexor carpi ulnaris, C. Musculus flexor digaitorum superficialis, D. Musculus entepicondylo-ulnaris, E. Musculus pronator superficialis, J1. Cubital joint F. Musculus extensor carpi radialis

branching the arteria subscapularis, the arteria axillaris coursed caudally on the cranioventral side of the wing . In this course, it emitted the arteria profunda brachii (Fig. 1:4, 4:3) from its lateral aspect just after emitting the arteria supracoracoidea (Fig. 1:3) from its ventral aspect. The arteria supracoracoidea was carrying blood to the musculus supracoracoideus by passing over ventral surface of the musculus coracobrachialis caudalis. The arteria profunda brachii distributed to the musculus scapulotriceps, musculus deltoideus and ventral part of the musculus humerotriceps (Fig. 1).

After ramifying the arteria supracoracoidea and arteria profunda brachii, the arteria axillaris displayed craniolateral curvature and continued down arteria brachialis (Fig.1:6, 2:1, 4:4). This vessel was giving off the arteria circumflexa humeri (Fig. 1:5) from its cranial aspect of this curvature. The arteria brachialis was the distal continuation of the arteria axillaris from neck of the humerus to the ventral region of the cubital joint or distal portion of the humerus. During in this course, the arteria brachialis was proceeding into the muscular sulcus between the musculus biceps brachii and musculus humerotriceps which it supplied (Fig. 1, 2). At the ventromedial region of the cubital joint, arteria brachialis bifurcated arteria ulnaris (Fig. 2:2, 4:5) and arteria radialis (Fig. 2:5, 4:8). These arteries were coursing parallel to each other throughout the antebrachium . While the arteria ulnaris was reaching the carpal and metacarpal region, the arteria radialis was supplied the muscles of the antebrachium region.

The arteria ulnaris gave off its first branch the common stem of arteria recurrens ulnaris et arteria ulnaris profunda (Fig. 2:4, 4:6) after a short course from its origin and continued as the arteria ulnaris superficialis (Fig. 2:3, 3:1, 4:7) until the carpal joint. The arteria recurrens ulnaris was spreading over the caudodorsal portion of the cubital joint and supplied to this joint, musculus flexor carpi ulnaris and feathers of this region. The arteria ulnaris profunda was a thinner branch and a minor artery originating from the common stem and it distributed into the musculus flexor carpi ulnaris. After branching the common stem of arteria recurrens ulnaris et arteria ulnaris profunda, the arteria ulnaris proceeded as arteria ulnaris superficialis between the musculus flexor digitorum superficialis and caudal border of musculus flexor carpi ulnaris by supplying these muscles (Fig. 2). The arteria radialis (Fig. 2:5, 4:8) was the deep terminate branch of the arteria brachialis. Most of the sections of this artery dispersed in the antebrachial portion of the wing. This ves-

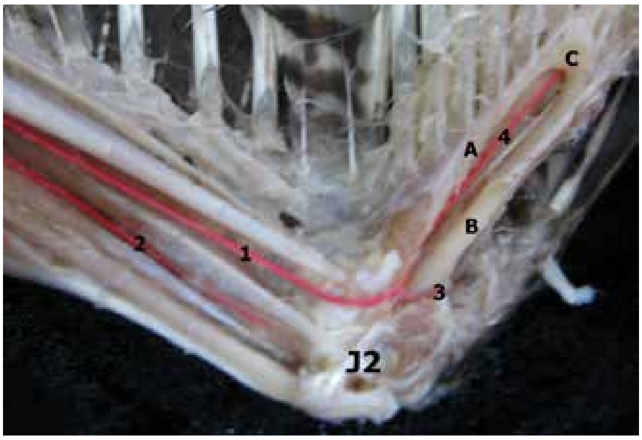

Figure 3. Terminal branches of arteria brachialis in ventral view. 1. Arteria ulnaris superficialis, 2. Arteria radialis profunda, 3. Ramus metacarpalis ventralis, 4. Arteria metacarpalis interossea, A. Os metacarpale minus, B. Os metacarpale majus, C. Symphysis metacarpalis distalis, J2. Carpal joint

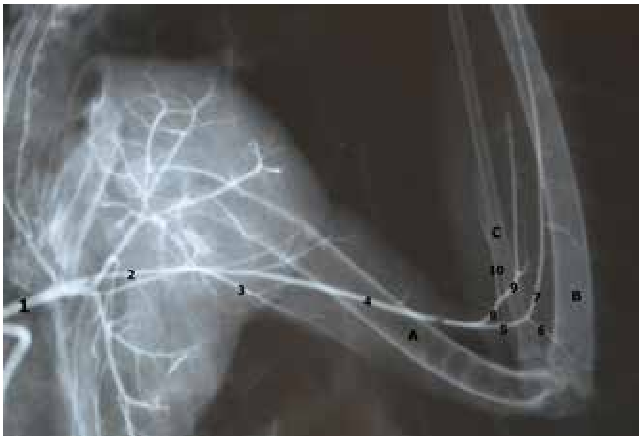

Figure 4. Angiography of the arteria axillaris and its branches.1.Truncus brachiocephalicus, 2. Arteria axillaris, 3. Arteria profunda brachii, 4. Arteria brachialis, 5. Arteria ulnaris, 6. Common stem of arteria recurrens ulnaris et arteria ulnaris profunda, 7. Arteria ulnaris superficialis, 8. Arteria radialis, 9. Arteria radialis profunda, 10. Arteria radialis superficialis et rami propatagiales, A. Humerus, B. Ulna, C. Radius

sel firstly gave off a thin branch, arteria recurrens radialis (Fig. 2:9), to supply ventromedial region of the cubital joint and musculus flexor carpi ulnaris. After this ramification the arteria radialis bifurcated into arteria radialis profunda (Fig. 2:6, 3:2, 4:9) and arteria radialis superficialis (Fig. 2:7) on the cranioventral side of the musculus pronator superficialis and musculus extensor carpi radialis. The arteria radialis profunda was coursing to the carpal joint, as parallel to the arteria ulnaris superficialis, and gave off several smaller vessels which were distributed on the musculus entepicondylo-ulnaris (anconeus medialis) and musculus flexor digitorum superficialis. The arteria radialis profunda was terminating as a tiny branch at the distal portion of the radioulnar articulation (Fig. 3). Arteria radialis superficialis gave thin branches (rami propatagiales) (Fig. 2:8) on the dorsolateral and ventral surfaces of the musculus extensor carpi radialis, and then directed distally. This artery wasn't reaching the carpal joint.

At the distal portion of the carpal joint, the arteria ulnaris superficialis bifurcated to arteria metacarpalis interossea (Fig. 3:4) and ramus metacarpalis ventralis (Fig. 3:3). While arteria metacarpalis interossea proceeded in the spatium intermetacarpalis, between the os metacarpale minus et majus, the ramus metacarpalis ventralis supplied the carpal joint.

DISCUSSION

In contrast to mammals, in birds, the arteria axillaris is a branch of the arteria subclavia and not the continuation of that vessel (Nickel et al., 1977). This artery proceeds outward into the wing as the arteria brachialis (Gobeil, 1970). The arteria axillaris divides typically into two trunks: the arteria brachialis and humeralis. There is considerable variation in the distribution of the branches in some bird species (Fisher, 1955). The arteria brachialis passing over the musculus triceps brachii and dividing at about the middle third of the upper arm or at the elbow into the arteria ulnaris and the arteria radialis (Berger, 1956; Nickel et al., 1977).

In birds, the arteria axillaris is a branch ramifying from the arteria subclavia and it is not a continuation of that artery as in mammals (Doguer and Erencin, 1964; Nickel et al., 1977). Similarly, it was reported that the arteria axillaris was a branch of the arteria subclavia on the left side of the body in the long-legged buzzard (Erdogan ve Kilinc, 2014). Likewise, it was stated that the arteria axillaris was a branch ramifying independently from the arteria subclavia in Eurasian bittern (Erdogan, 2012) and it was always a separate vessel in the Whooping Crane (Fisher, 1955). In accordance with these reports, examined in this study, the arteria axillaris was also ramifying from the arteria subclavia as separate vessel in the sparrowhawk (Fig. 1:1). However, Fitzgerald (1969) designated that the arteria axillaris was the continuation of the subclavian artery in the quail. The arteria subscapularis arose from the arteria axillaris with a short distance from its origin in the quail (Fitzgerald, 1969). It is the first branch of the arteria axillaris and it supplies the musculus subscapularis in the bird species (Nickel et al., 1977). Likewise, in domestic birds, this artery takes its origin from arteria axillaris (Doguer and Erencin, 1964). Similar to the reports of Fitzgerald (1969), Nickel et al. (1977), Doguer and Erencin (1964), we observed that the arteria subscapularis (Fig. 1:2) originated from the arteria axillaris and supplied the musculus subscapularis, musculus serratus ventralis, cranial side of the musculus coracobrachialis caudalis, and musculus supracoracoideus. In contrast to these data, it was noticed that the arteria subscapularis originated from arteria carotis communis in the whooping crane (Fisher, 1955) and arteria cervicalis superficialis in birds belonging to the Gruiformes (Glenny 1947) and Galliformes (Glenny 1951).

In some forms the arteria supracoracoidea shares a common stem with the arteria subscapularis and pierces the membrana sternocoracoclavicularis to enter musculus supracoracoideus (Baumel et al., 1993). This situation was also indicated in Herring gull and this common stem was named as arteria coracoscapularis (Gobeil, 1970). However, we detected that the arteria supracoracoidea (Fig. 1:3) was a branch originated alone from arteria axillaris in the sparrowhawk. It was noted that the arteria profunda brachii arose from the arteria axillaris in the coturnix quail (Fitzgerald, 1969) and domestic birds (Doguer and Erencin, 1964), and supplied the heads of the musculus triceps brachii (Nickel et al., 1977). Similarly, we observed that the arteria profunda brachii (Fig. 1:4, 4:3) was emerging from the arteria axillaris and distributed to the musculus scapulotriceps, musculus deltoideus and the musculus humerotriceps.

The wing was supplied by the arteria brachialis in Turkey Vultures. The arteria brachialis divided into the radial and ulnar arteries. These were nearly parallel to each other throughout the length of the wing (Arad et al., 1989). Gobeil (1970) reported that the arteria axillaris ran outward to the wing as the arteria brachialis in the Herring gull. Furthermore, it was noted that the arteria brachialis divided into the arteria ulnaris and arteria radialis nearby the cubital joint in bird species (Nickel et al., 1977). The arteria brachialis divided into arteria ulnaris and arteria radialis in the cubital fossa of ostrich (Bezuidenhout and Coetzer, 1986). Similar course and bifurcation pattern of the arteria brachialis (Fig.1:6, 2:1, 4:4) were also determined in the sparrowhawk. In contrast to the report of Doguer and Erencin (1969) in domestic birds, it was detected that the bifurcation of the arteria brachialis was not in the middle of the humerus in the present study.

In the quail (Fitzgerald, 1969) the arteria ulnaris coursed to the carpus, from which point it continued as the arteria metacarpalis. Likewise, in our study, we observed that the arteria ulnaris superficialis reached to the carpus and proceeded as the arteria metacarpalis interossea from carpal joint to the symphysis metacarpalis distalis (Fig. 3:4). The arteria ulnaris profunda was described as a substantial artery in some birds, but was a minor artery in Gallus and Columba (Baumel et al., 1993). The arteria ulnaris profunda (Fig. 2:4, 4:6) was a small artery in the sparrowhawk as in Gallus and Columba. It was reported that most part of the arteria radialis supplied structures in the antebrachium, it was little or no distribution in the carpal and metacarpal region in bird species (Baumel et al., 1993) as in the sparrowhawk (Fig. 2:5, 4:8).

In summary, we firstly determined the vascular arrangement and main arteries of the sparrowhawk wing in the present study by using latex- injected materials and the angiographic images. We believe that the results of this study will contribute to anatomical data in birds of prey.

CONFLICT OF INTEREST STATEMENT

The authors of this article declare that they do not have any conflicting interests.

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