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Research Article

A Macroanatomical Study on the Muscles of the Shoulder and Elbow Joint in the Anatolian Bobcat (Lynx Lynx)

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ABSTRACT

This study was performed on their tendons and the muscles of the shoulder and the elbow joint in the two Anatolian bobcats. To achieve the objective, dissection and radiography techniques were applied to two dead materials. In this study, it is observed that the muscles connecting the forelimb to the trunk are composed of the rhomboid and the trapezius muscles called the dorsal group, and consist of the omotransverse, the brachiocephalic, the ventral serrate, superficial and deep pectoral muscles, and the broadest muscle of the back called the ventral group. Although the biceps and triceps of the forearm act on both the shoulder and elbow joints, it has been seen that the deltoid, infraspinous, supraspinous, subscapular and coracobrachial muscles take action on the shoulder joint and the brachial, anconeal muscles move the elbow joint in the Anatolian bobcat. In additional , it has been found that the rhomboid muscle has a cephalic head, the deep pectoral muscle are composed of the cranial, caudal and abdominal portions, the venter of the biceps muscle of the forearm are made by two distinct bellies, the triceps muscle of the forearm belongs distinct five heads in this research. The shoulder and elbow joints suggest that they may play an important role in the adaptation of the Anatolian bobcat not only in the movement but also in the hunting.

Keywords: *Anatolian bobcat (Lynx lynx), muscles of the elbow joint, muscles of the shoulder joint, anatomy*

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INTRODUCTION

Cats are active hunters (Bicnevicius and Van Valkenburg, 1996). The Eurasian lynx, a member of the feline family, is a typical ambush predator that stalks its prey (Krofel et al., 2009). The functional adaptations of the lynx forelimbs are highly complex, enabling them to move and hunt in the snow during winter (Arı et al, 2018). Biewener (1993) described that lynx have a diverse locomotion repertoire, such as trekking in deep snow. Although forelimbs play no propulsive role during trot, they actively acts as struts and absorbs forces and determine stride lengths (English 1974a). The forelimb of all mammals has functionally three segments consisting of the scapula, brachium and antebrachium (Fischer, ab Blickhan 2006). The scapula and the brachium form the shoulder joint, while the brachium and the antebrachium compose the elbow joint. In addition to, forelimb is connected to the body via the muscles (Konig et al., 2012). The muscles attached to the element of the joint are protract, retract and fix to the forelimb (Fischer & Blickhan 2006).

The muscles located in the region between the scapula and the body can be sorted as the dorsal and ventral groups. The dorsal group muscles are contain the trapezius and rhomboid muscle, while the ventral group contain the latissimus dorsi muscle, superficial and deep pectoral, serratus, omotransversal and brachiocephalic muscles.

The trapezius muscle consisted of the thoracal and cervical portions originates from the supraspinal ligament from the third cervical vertebra to the tenth thoracal vertebra in the carnivores (Nickel et al., 1986; Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014), or from the fourth cervical vertebra to the eleventh thoracal vertebra in the Euroasian linx (Viranta et al.). The cervical portion inserts via fibrils onto the suprahamate process and scapular spine in the ocelots (Julik et al., 2012), while it ends to the acromion and the scapular spine in the carnivores. The pars thoracalis of the trapezius muscle inserts via aponeurosis onto the scapular spine (Nickel et al., 1986; Getty, 1995; Konig & Liebich, 2014). The region of the insetion of the thoracal portion is higher on the scapular spine and there is a tendinous area between insertion of the portions of the muscle in the carnivores (Getty, 1995).

The musculus rhomboid is composed of a distinct pars capitis, pars cervicis and pars thoracalis, easily no separated one from the other. The portions of the muscles stem supraspinal ligament in the cervical and thoracal region until at level of the second and third thoracal vertebras (Nickel et al., 1986; Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). In literature (Getty, 1995), it mean that pars thoracalis directly originate from the thoracal vertebra. The aponeurosis formed the portions of the muscle inserts the vertebral border of the scapula, just above insertion of the muscle serratus ventralis (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016).

The omotransverse muscle of the ventral group originates from the wing of the atlas (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). The muscle ends the distal scapular spine and acromion in the Eurasian lynx and carnivores (Getty, 1995; Konig & Liebich, 2014; Viranta et al., 2016). In the ocelot (Julik et al., 2012), the insertion of the muscle was described as the suprahamate process in the left limb, while the scapular portion of the deltoid muscle in the right limb. The muscle protract the shoulder in the carnivores, when the neck is fixed (Getty, 1995). The neck in the position, omotransverse muscle pulls the scapula dorsally and forward in the ocelot. Whereas, when the scapula is stabilized, the muscle extends the neck with bilateral contraction and flexes the neck laterally with unilateral contraction in the ocelot (Julik et al., 2012).

The brachiocephalic muscle composed three portions, the cleidobrachial, cleidocephalic and cleidomastoid muscles in the ocelot (Julik et al., 2012). In the carnivores, it is described that the muscle consist of the cleidobrachialis and clediocephalis (Getty, 1995; Konig & Liebich, 2014). The brachiocephalic muscle taken origin from the part of the nuchael ligament at the level of the nuchael crista from the first and third cervical vertebras (Julik et al., 2012) ends to the entire length of the intersectio clavicularis. The cleidobrachial muscle situated in the region between the idge of the cranial aspect of the humerus shafts and intersectio clavicularis is the caudal portion of the brachiocephalic muscle in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014). In the study done on the ocelot (Julik et al., 2012), it has been reported that the insertion tendon of the muscle is fused with the cranial aspect of the tendon of the brachial muscle to end in the area of the proximal ulnar shaft. The caudal portion of the brachiocephalic muscle, called the cleidocephalic muscle, divides into the cleidomastoideus and the cleidocervical muscle in the carnivores clediocephalis (Getty, 1995;

Konig & Liebich, 2014). Whereas, it described that the cleidocephalic and the cleidomastoid muscles are two separate muscles in the ocelot (Julik et al., 2012). Both cleidocervical and cleidomastoid muscles originate the intersectio clavicularis. The cleidocervical muscle insert onto the median raphe in the first half of the cervical region while the latter ends to mastoid process of the temporal bone in the carnivores (Getty, 1995; Konig & Liebich, 2014). In the ocelot, the brachiocephalic muscle originated from intersectio clavicularis inserts onto the nuchal crest and nuchal ligament at the level of I-III cervical vertebra (Julik et al., 2012). The parts of the muscle protract the forelimbs, they extend the muscle extends the neck with bilateral contraction and flexes the neck laterally with unilateral contraction in the ocelot, when forelimb is fixed (Julik et al., 2012).

The broadest of the back arise from the distinct level of the thoracolumbal facia in the carnivores (Getty, 1995; Konig & Liebich, 2014; Viranta et al., 2016). In the ocelot (Julik et al., 2012), for example the region in the 7-9 thoracal vertebra and thirteenth ribs (Julik et al., 2012). The muscle inserts on the medial aspect of the brachium with the teres major muscle in the carnivores (Getty, 1995; Konig & Liebich, 2014; Viranta et al., 2016). In additional to, it described that the insertion of the muscle divides to superficial and profund in the ocelot. When the forelimb is fixed and advanced, the muscle drawns the trunk craniad. The muscle retract the free forelimbs (Julik et al., 2012).

The deep pectoral muscle, orginating the different area of the sternum (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016), has a different number of bellies, for example three bellies as caudal, cranial and abdominal in the ocelot (Julik et al., 2012), two bellies in the Eurasian lynx (Viranta et al., 2016). The bellies fused together extends craniolaterally on the lateral aspect of the sternum to end the medial aspect of the tuberculum majus of the humerus in the Euroasian lynx (Viranta et al., 2016), in additional to the muscle attached the craniomedial border of the humeral shaft in the ocelot (Julik et al., 2012). In the literature (Getty, 1995), the insertion of the muscle has been reported as the tuberculum minus of the humerus in the carnivores.

The superficial pectoral muscle fused with its counterpart at its origin stems from the ventrolateral aspect of the sternum in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). The muscle inserts onto the greater tubercule of the humerus and a ridge of the cranial aspect of the humerus (Julik et al., 2012).

The ventral serrate muscle located among the cervical vertebras (3-7), the ribs (1-8) and the vertebral border of the medial aspect of the scapula divides the cervical and thoracal portions in regard to origin in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). When the forelimb is free, the cervical portion protract the limb. When the forelimb is fixed, the thoracal portion of the muscle drawns the trunk craniad (Julik et al., 2012) and sling the trunk.

The muscles of the shoulder joint grouped by their location are lateral composed of the supraspinatus, infraspinatus, deltoid and minor teres muscles, and medial group muscles consist of the major teres, the subscapular and the coracobrachial muscles in the carnivores (Konig & Liebich, 2014).

The suprascapular muscle of the lateral group, filled supraspinous cavity originates the cranial border of the scapula and scapular spine in the carnivores. The muscle end to attaching the cranial parts of the greater tubercule of the humerus (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). In the study carried out in the ocelot, it has been seen that the muscle belongs to deep and superficial layers (Julik et al., 2012).

The infraspinous muscle entirely filled the infraspinous cavity and attached via a tendon to the lateral aspect of the greater tubercule of the humerus in carnivores.

The minor teres muscle originated via a straight tendon from the caudal border of the scapula that inserts the greater teres tubercule of the humerus (Getty, 1995; Konig & Liebich, 2014; Viranta et al., 2016), while the joint capsule of the shoulder in the ocelot (Julik et al., 2012).

The deltoid muscle of the lateral group consisted of the scapular and acromial heads situates the caudolateral aspect of the scapular spine in the carnivores. The scapular head stems via a aponeurosis from infraspinous muscle and the acromion in the carnivores (Getty, 1995; Konig & Liebich, 2014; Viranta et al., 2016). In the ocelot, the origin of the head has been also described as suprahamate process of the scapula (Julik et al., 2012).

The acromion head arises from the acromion in the Eurasian lynx and carnivores (Getty, 1995; Konig & Liebich, 2014; Viranta et al., 2016), while the suprahamate process occurs in the ocelot (Julik et al., 2012). The two heads of the muscle inserts via tendinous fibers onto the deltoid ridge of the humerus (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). In addition, some fibers end at the lateral aspect of the lateral head of the triceps brachii and brachialis muscles in the ocelot (Julik et al., 2012).

The subscapular of the medial group, consisted of a variable number of the muscles bundles according to animal species, stems from the medial aspect of the scapula (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). The number of the muscles bundels are six or seven in the Eurasian lynx (Viranta et al., 2016), while six are in the left limb and nine are in the right limb of the ocelot (Julik et al., 2012). The bundles of the subscapular muscle fused with each other inserts via a broad tendon onto the lesser tubercule of the humerus. The muscle acts as the flexor and the medial collateral of the shoulder joint.

The major teres of the medial group, originating from the caudal border of the scapula, travel distally to end the teres major tuberosity of the humerus.

The coracobrachial muscle situated deep to the subscapular muscle originates from the supraglenoid tubercule and inserts onto the caudal aspect of the humerus in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016).

The muscles of the elbow joint are primarily responsible for the extention and flexion of the elbow joint, but also fixe the limb during the stance phase of the locomotion. Some of these muscles, as the biceps and the triceps of the forearm act on both the shoulder and the elbow joint, while others, for example the brachial, the anconeus and the tensor muscle of the brachial facia only move the elbow joint (Konig & Liebich, 2014).

The biceps of the forearm bridging the shoulder and the elbow joint take origin via a strong tendon from supraglenoid tubercule (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). The origin tendon of the muscle passes through the intertuberal groove in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014). As soon as the tendon emerges from the groove, it turns into a large, fusiform muscle belly on the cranial aspect of the forearm (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). The muscle inserts onto distinct areas of the antebrachium, for example the lateral coronoid process of the ulna and the radial tuberosity of the radius in the Euroasian lynx (Viranta et al., 2016) and carnivores (Getty, 1995), and only radial tuberosity in the ocelot (Julik et al., 2012). The biceps of the forearm extend the shoulder joint while it flex the elbow joint. In addition, the muscle stabilizes the elbow joint when standing in the ocelot (Julik et al., 2012).

The brachialis muscle emerging from the proximal of the humeral shaft (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016) entirely fills the spiral groove in carnivores (Getty, 1995). The muscle inserts via a thin tendon onto the medial border of the ulna in the Eurasian lynx (Viranta et al., 2016) and ocelot (Julik et al., 2012). Whereas, it ends to ulnar tuberosity in the carnivores (Getty, 1995). The brachial muscle flexes the elbow joint in the ocelot (Julik et al., 2012).

The tensor muscle of the facia antebrachii originates from the superficial aspect of the latissimus dorsi (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016) and inserts onto the caudal aspect of the olecranon and the facia antebrachii in carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016).

The anconeus muscle emerging from the lateral supracondylar crest of the humerus attaches the olecranon and the lateral border of the proximal ulna (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014). In the ocelot (Julik et al., 2012), it has been reported that the origin of the muscle posses two sesamoid bones in the left while three sesamoid bones in the right.

The triceps of the forearm composed of five heads in the Eurasian lynx (Viranta et al., 2016) and ocelot (Julik et al., 2012), while the same muscle consist of four heads in the carnivores (Getty, 1995; Konig & Liebich, 2014). No expressing the accesory medial head in the carnivores (Getty, 1995), another heads called as the long, lateral, medial and accessory heads in the lynx (Viranta et al., 2016) and ocelot (Julik et al., 2012). The long head of the muscle originating the caudal border of the scapula ends via a stout tendon to the olecranon in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). In addition to, it take origin from the neck of the scapula in the ocelot. The lateral head attaching the long head of the triceps of the forearm emerges from the proximal humeral shaft and the neck of the humerus (Julik et al., 2012). The medial head of the triceps of the forearm originating the medial aspect of the proximal humeral shaft fuses with the accessory heads of the triceps of the forearm and inserts onto the medial aspect of the olecranon in the carnivores. The accessory head of the triceps of the forearm emerges from the caudal aspect of the proximal humeral shaft and fuses with the medial head of the same muscle (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). The medial accessory of the triceps of the forearm stems the medial supracondylar crest of the distal humerus and attaches to the medial aspect of the olecranon (Julik et al., 2012; Viranta et al., 2016). The triceps of the forearm stabilize the elbow joint during standing (Julik et al., 2012). Due to the lack of anatomical descriptions for the muscles connecting the axial skeleton and forelimb, as well as the muscles of the shoulder and elbow joint in the Anatolian bobcat, our current study aims to provide a comprehensive macroanatomy of these muscles.

MATERIAL AND METHODS

The study was conducted on two female Anatolian bobcats (cadaver I was 6.9 kg and cadaver II was 7.6 kg in weight, respectively). The animals were obtained from Republic of Turkey Ministry of Forestry and Water Affairs Sivas Branch Manager. After the animals died of natural causes (Cumhuriyet University was delivered dead lynx in Sivas in order to conduct the post-mortem examination (2016. www.sivas.ormansu.gov.tr/sivas/Anasayfa/ resimli Haber). They were immediately transported to the Department of Anatomy of Faculty of Veterinary Medicine at Cumhuriyet University. The animals were fixed with 10% formalin via the carotid common artery to prepare the cadavers. Then, the forelimbs of the cadavers were dissected and photographed with a Canon 50D camera. Radiographic images of manus were taken in dorso-palmar position using PCMAX-100H® (led input voltage: 3.3 VDC, 2A: Korea). The terminology used in the manuscript is in accordance with the prevailing veterinary nomenclature (Nomina Anatomica Veterinaria, 2012).

RESULTS

In this study, the shoulder joint is composed of the glenoid cavity of the scapula and the head of the humerus, while the elbow joint is composed of the trochlea of the humerus and the proximal parts of the antebrachium, radiographically (Figure 1/A).

The trapezius muscle located in the region between the cervical and thoracal portions of the vertebral column and the lateral aspect of the scapula is triangle form (Figure:1/B) in all specimens. The portion of the muscle (Figure:1/B) emerging from the thoracal portion situates in the caudal of the dorsal scapula and is in the right triangle form that its long upright edge attach to the midline of the thoracal portion of the backbone while its short upright edge end at the caudal border of the dorsal half of the scapular spine in two cadaver. Whereas, another edge (Figure:1/B), the ventral border of the muscle, fused with the broadest muscle of the back in all cadavers. The fibres of the portion travels cranioventrally to insert onto the caudal aspect of the dorsal scapular spine in all materials. The cervical portion of the trapezius muscle (Figure:1/B) originates from the dorsal half of the cranial border of the scapular spine and attaches to the midline of the cervical portion of the backbone in all specimens. The venral border of the portion (Figure:1/B) The fibres extended craniodorsally to the vertebral column fuses with the dorsal border of the omotransversal and cleidocervical muscle in the two cadavers.

The rhomboid muscle (Figure:1/D) situated under the trapezius muscle belongs to three portions, called cephalic, cerviacal and thoracal portions. The cephalic portion originated from the nuchal crest and extends caudally on the lateral aspect of the cervical region to end the cranial angle of the scapula. The cervical portion stems the middle line of the cervical area of the back and inserts the cranial area of the dorsal border of the scapula in all specimens. The thoracal portion is located between the middle line of the back and the caudal area of the dorsal border of the scapula in the interscapular region in cadavers. Both the cervical and the thoracal portion is seen as individual muscle fibres, while the cephalic portion is uniform in the two specimens. The cephalic portion appears to be the longest. Whereas, the thoracal portions are shorter than the cervical portions in the two cadavers.

The fibres of the omotransverse muscle (Figure:1/D) emerging from the ventral half of the scapular spine, the hamate process and the lateral aspect of the acromial portion of the deltoid muscle extend caudocranially to pass under the cleidocervical muscle. The muscle ends the caudal crest of the wing of the atlas in the two specimens.

The broadest of the back muscle Figure:1/B,D) orginating from the area of the thoracolumbal facia between the eighth thoracal and the second lumbal vertebra is situated under the skin on the lateral aspect of the thorax in the two cadavers. The dorsal border of the muscle fused with the thoracal portion runs cranioventrally on the lateral aspect of the thorax to attach to the medial aspect of the brachium under the triceps brachium muscle and the deep pectoral muscle in the two specimens. The minor teres muscle takes its origin from the medial aspect of the muscle near the dorsal border in the two cadavers. The origin width of the broadest back muscle is thicker than the insetion width of the muscle.

The ventral serrate muscle (Figure:1/B,C,D) situated between forelimb and trunk is formed by the cervical and the thoracal portions in all samples. The thoracal portion of the muscle stemming the external aspect of the ventral half of the first eight ribs as distinct interdigitates extends dorsocranially to the medial aspect of the scapula to end the medial aspect of the dorsal border of the scapula in the two cadavers. The fascicles of the muscles orginating from first four ribs lies deep to the dorsal scalene muscle. The portion is wider in the origo area than the intertio area in all specimens. The cervical portion of the muscle arising from the transverse process of C3-C7 and T1 ascendns dorsocaudadly to the medial aspect of the dorsal border of the scapula in all samples. Its insertion is covered by the dorsal scalene muscle in the two cadavers.

It is seen that the brachiocephalic muscle (Figure:1/D) is composed of three parts as the cleidobrachial, cleidocervical and cleidomastoid muscles in the two samples. The cleidobrachial muscle originating from the medial aspect of the proximal ulnar shaft runs craniodorsally along the cranial border of the brachium to inserts to the entire caudal border of the intersectio clavicularis, the fibrous remnant of the clavicula, in the two Anatolian bobcat cadavers. Along its course, the muscle lies on biceps brachii and is fused with the cranial border of the superficial pectoral muscle. The cleidocervical muscle takes its origin from the nuchal ligament at the level of C1-C3 and from the nuchal crest in all specimens. Then, it continues caudoventrally on the lateral aspect of the cervical region to ends the entire cranial border of the insectio clavicularis at just the cranial area of the shoulder joint in all cadavers. The cleidomastoid muscle located between the mastoid process and intersectio clavicularis extends deep to the cleidocervical muscle in the lateral aspect of the cervical region.

The superficial pectoral muscle (Figure:1/B,C) take originating from the ventrolateral aspect of the cranial portion of the sternum extends mediolaterally to inserts the greater tubercle and the humeral shaft in the two Anatolian bobcat cadavers. Its cranial border is fused with the cleidobrachial muscle, while its caudal border is fused with the cranial portion of the profund pectoral muscle in the two specimens.

It can be seen that the profund pectoral muscle (Figure:1/C) is composed of three bellies as cranial, middle and caudal bellies in all samples. The cranial belly stems the ventrolateral aspect of the cranial half of the sternum and inserts the greater tubercle of the humerus and the caudal border of the superficial pectoral muscle in the two cadavers. The middle belly originating from the ventrolateral aspect of the middle sternum continues craniolaterally to ends the caudal border of the cranial belly of the profund pectoral muscle in all materials. The caudal belly arises from the ventrolateral aspect of the xiphoid process and the caudal third of the sternum ascends craniodorsally to ends the middle belly and the external aspect of the ribs in both cadavers.

The deltoid muscle (Figure :1:F) crossing the shoulder joint is composed of two parts called as the scapular and the acromial parts in the lateral aspect of the shoulder joint in the all specimens. The scapular part originating from the caudal border of middle third of the spine of scapula via a aponeurosis runs cranioventrally on the infraspinous muscle to inserts the caudal edge of the acromial part at level of the caudal area of the shoulder joint and just caudal to the deltoid ridge in two Anatolian bobcat cadavers. The acromial part arising from the acromion and the hamate process travels proximodistally on the cranial aspect of the shoulder joint to ends the deltoid ridge of the humerus in all samples. The parts resembling a triangle is thinner in the intertion area than the origin area.

In the two cadavers, the major teres muscle (Figure:1/E,F,G) stems the poximal third of the caudal edge of the scapula via flesly muscle fibres. The muscle continues craniodistally to pass under the long head of the triceps brachii the level of the half of the caudal edge of the scapula. Then, the teres major muscle travels craniodistally on the medial aspect of the long head of the triceps brachii to inserts via an aponeurosis the medial aspect of the proximal third of the humeral shaft in all specimens. Its aponeurosis locates to just near the coracobrachialis muscle and the tendon of the biceps brachii muscle in the medial aspect of the proximal humeral shaft in the two Anatolian bobcat cadavers.

The infraspinous muscle (Figure:1/B,D,E) filling in the infraspinous cavity arises from the cavity and the caudal border of the scapular spine, extends craniadistally under the deltoid muscle to pass over the lateral aspect of the shoulder joint in two cadavers. The muscle inserts via a aponeurosis the lateral aspect of the greater tubercle of the humerus under the deltoid muscle. The belly stemming the distal third of the caudal border of the scapula joins the supraspinous muscle in all samples.

The supraspinous muscle (Figure:1/B,D,E) covering a strong facia fills entirelly the supraspinous cavity and travels craniodistally in the cavity to passes over the cranial aspect of the shoulder joint in all samples. The thinner medial part of the muscle inserts the minor tubercle of the humerus, while the stronger lateral part of the muscle ends the greater tubercle of the humerus via a tendon in the Anatolian bobcat. The biceps brachii tendon passes through the area in the two insertion tendon.

The subscapular muscle (Figure:1/B,D,G) belongs six to seven bellies situates on the medial aspect of the scapula in two cadavers. The muscle bellies filling entirely the subscapular cavity continue distally to pass over the medial aspect of the shoulder joint in all samples. The muscle inserts the minor tubercle of the humerus to just near the insertion of the coracobrachial muscle in all specimens.

The coracobrachial muscle (Figure:1/F) originating from the coracoid process at the level of the medial distal third of the scapula pass over the medial aspect of the shoulder to attaches to the caudomedial aspect of the proximal third of the humeral shaft in the cadavers.

The brachial muscle (Figure:1/B) arising from the lateral side of the proximal third of the humeral shaft immediatelly distal to the insertion of the deldoid muscle descendens craniodistally in the spiral groove of the humeral shaft in all research materials. The muscle pass under the lateral head of triceps brachii and the brachioradial muscle in the cranial aspect of the distal third of the humeral shaft, then, crosses the cranial aspect of radioulnar joint. It inserts into the medial side of the ulna via a thin tendon and the medial coronoid process of the ulna in the two Anatolian bobcat cadavers.

The biceps muscle (Figure:1/F) of forearm composed of two belly stems the supraglenoid tubercle via a strong and thick tendon and its origo tendon pass through the intertuberal groove in the two cadavers. At the level of the proximal third of the humeral shaft, the tendon becomes two bellies of the muscle. The bellies continue distally parallel to the cranial aspect of the humeral shaft to passes through the area between the origo of the ulnar flexor and extensor of the carpus in both research materials. The biceps muscle of the forearm passes over the cranial aspect of the elbow joint and then ends the radial tuberosity and distal to the lateral coronoid process of the ulna in all specimens.

The triceps muscle (Figure:1/B) of the forearm filling the triangle between the caudal border of the scapula, the brachium and the olecranon is composed of five heads, called the long, lateral, medial, accesory and medial accesory heads in all samples. The long head originating from the middle-third of the caudal border of the scapula passes through the major teres muscle and the lateral head in the caudal region of the scapula. The head that can be seen both medial and the lateral aspect of the brachium travels parallel to the humeral shaft to becomes the tendon in the distal third of the humeral shaft in the all specimens. The tendon ends attaching the medial aspect and the olecranal tuber in the research materials. The lateral head arising from lateral aspect of the proximal third of the humeral shaft deep to the insertion parts of the deltoid muscle continues caudally on the lateral aspect of the brachium to ends via aponeurosis on the lateral aspect of the olecranon in the cadavers. The medial head originating from the medial aspect of the proximal third of the humeral shaft travels caudodistally deep to long head to turns into a tendon at level of the middle third of the humeral shaft. The tendon descends deep to the long head to attaches the medial aspect of the olecranon in the research materials. The accesory head stems the medial aspect of the humeral shaft in the half of the brachium and runs caudodistally on medial aspect of the humeral shaft deep to the long head to ends the medial aspect of the olecranon in all specimens. The medial accessory head that can be seen as the shortest head take originates from the medial supracondylar ridge to inserts into the medial aspect of the olecranon in all materials.

The anconeus muscle situated in the area between the distal third of the humeral shaft and the olecranon lies deep to the triceps muscle of the forearm in two cadavers. The muscle is fused with the capsule of the elbow joint while passing over it.

The tensor muscle of the antebrachial facia (Figure:1/B,D) stemming the distal third of the caudal border of the scapula via an aponeurosis extends caudodistally on the medial aspect of the long head to become a broad aponeurosis in the distal third of the brachium. Its aponeurosis attaches to the medial aspect of the olecranon in the Anatolian bobcat cadavers.

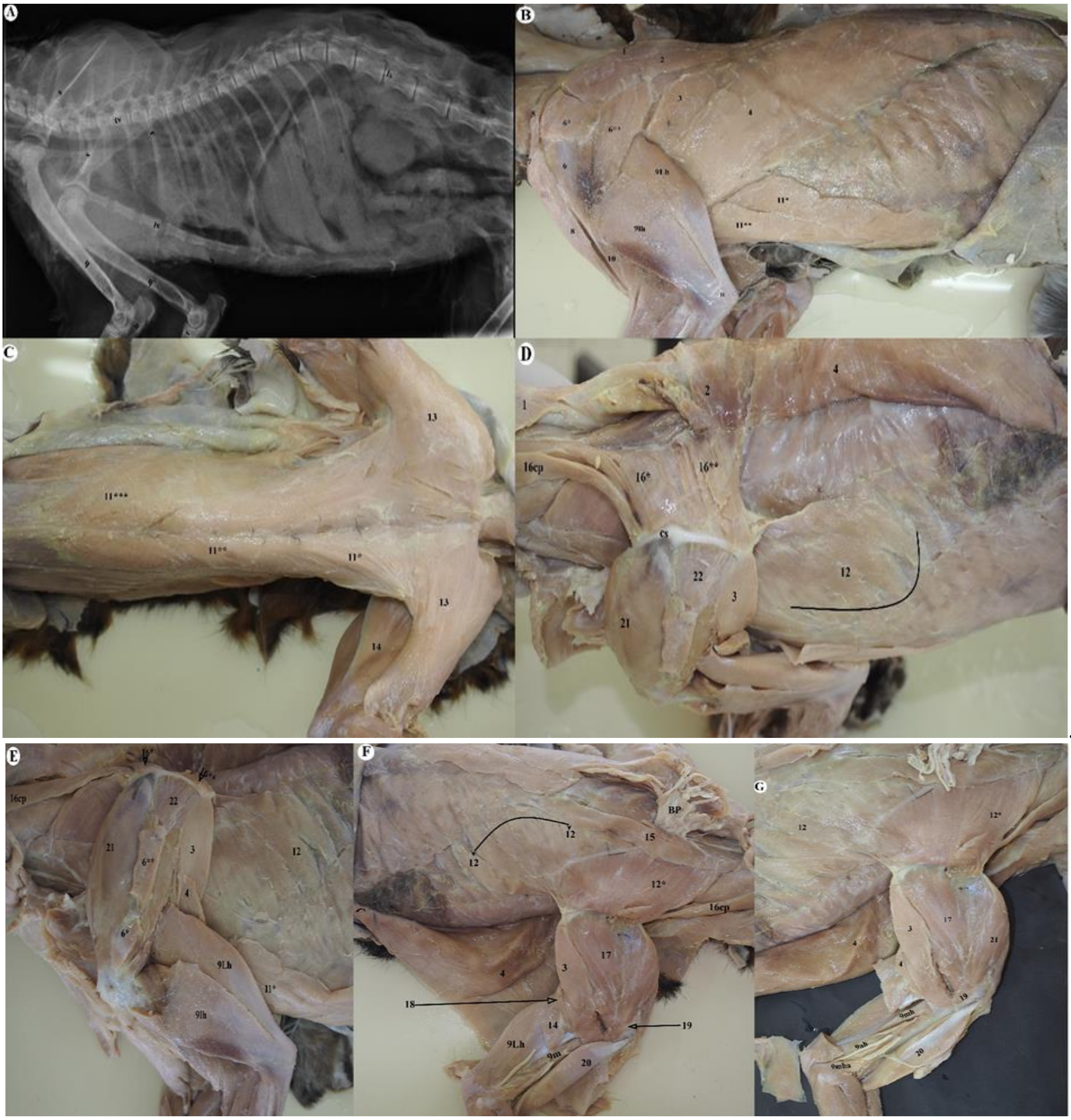

Figure.1. *Radiography and lateral photography of the shoulder and elbow joint.*

A. Radiography of the shoulder and elbow joint muscles
B. Lateral view of the shoulder and elbow joint muscles
C. Ventrodorsal view of the shoulder and elbow joint muscles
D. Dorsoventral view of the shoulder and elbow joint muscles
E. Deep lateral view of the shoulder and elbow joint muscles
F. Medial view of the shoulder and elbow joint muscles
G. Deep medial view of the shoulder and elbow joint muscles
cs. Cartilago scapula
s. Scapula
2.The thoracal portion of the trapezius muscle
3.The teres major muscle
7. The cleidocephalic muscle
8. The brachiocephalic muscle
9. The triceps muscle of the forearm (TMF)
9 m. Medial head of (TMF)
9lh. Lateral head of (TMF)
9Lh. Long head of (TMF)
9mah. Medial accesory head of (TMF)
9a. Accesory head of (TMF)
10. The brachial muscle
11. The deep pectoral muscle (DPM)
11*. The caudal portions of (DPM)
11**.The cranial portion of (DPM)

1.The cervical portion of the trapezius muscle
tv. Thoracal vertebrae
c. Costae
h. Humerus
u. Ulna
r. Radius
o. Olecranon
st. Sternebrae
4.The broadest muscle of the back
5.The omotransverse muscle
6.The deltoid muscle
6*. The acromial part of the deltoid muscle
6**. The scapular part of the deltoid muscle
11***.The abdomianal portions of (DPM)
12.The thoracal portion of the ventral serrate muscle
12*.The cervical portion of the ventral serrate muscle
13. The superficial pectoral muscle
14. The tensor muscle of the antebrachial facia
15. The ventral sclane muscle
16. The rhomboid muscle
16*. The cervical portion of the rhomboid muscle
16**. The thoracal portion of the rhomboid muscle
16cp. The cephalic portion of the rhomboid muscle
17. The subscapular muscle
18. The minor teres muscle
19. The coracobrachial muscle
20.The biceps muscle of the forearm (BMF)
21. The supraspinous muscle
22. The infraspinous muscle

DISCUSSION

In this study, as has been described in the previous literature (Konig et al., 2012), the muscles attaching the elements forming the shoulder and elbow joints are sorted as muscles of the shoulder and elbow joints, connecting the forelimb to trunk.

The muscles connecting the forelimb to the trunk are grouped a dorsal group composed of the rhomboid and the trapezius muscles, and the ventral group consisted of the omotransverse, the brachiocephalic, the ventral serrate, superficial and deep pectoral muscles, the broadest muscle of the back, depicted previously by literature (Nickel et al., 1986; Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014). As previously described (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016), the rhomboid of the dorsal group is also composed of the cervical and thoracal portion in the research. But, it has been previously observed the cephalic portion of the rhomboid muscle in this study. The insertion and origo area, and the parts of the trapezius muscle are expressed in the literature (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016) are similar to the observation of the study.

The results related to the insertion and origo area of transverse muscle of the ventral group that obtained from the research are same the description in the literature (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). Although the statements related to the origin area of the the broadest muscle of the back in the Euroasian lynx (Viranta et al., 2016) are similar to the findings of the research, it has been previously found that the muscle give origin to the minor teres muscle in the Anatolian bobcat. In addition , it has been observed that the muscle ends at the deep pectoral muscle in the study materials. As depicted by Viranta et al., (2016) in the Euroasian lynx, it has been found that the thoracal portion of the ventral serrate muscle originates from the external aspect of the ribs as 8 interdigitates and inserts the medial aspect of the dorsal border of the scapula in the Anatolian bobcat. But, the evidence that first four interdigitates are covered by scalene muscle has been firstly stated in the research.

Although it has been stated that the deep pectoral muscle belongs to two bellies as cranial, caudal and abdominal in the Euroasian bobcat (Viranta et al., 2016), it is observed that the muscle is composed of three bellies as cranial, caudal and abdominal in the Anatolian bobcat, as described by Julik et al., (2012) in the ocelot. Besides connecting this muscle to the greater tubercle of the humerus, as depicted by the literatür (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016), the study showed that it has been also attached to the caudal border of the superficial pectoral muscle in the Anatolian bobcat. It has been seen that the muscle fused with not only the deep pectoral muscle but also the cleidobrachial muscle in this research.

As stated by the literature in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016), it has been also seen that the brachiocephalic muscle composed of two portions, the cleidobrachial muscle of the portions situated the area between the intersectio clavicularis and antebrachium, the cleidocephalic muscle the portions located in the area between that and the cranium in this research. As reported in the carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014), the ocelot (Julik et al., 2012) and Euroasian lynx (Viranta et al., 2016), it has been found that The brachiocephalic muscle is composed of the cleidocervical and cleidomastoid muscle in the Anatolian bobcat.

The muscles of the shoulder joint grouped as the medial and lateral of the shoulder joint, be depicted previsouly in the literatur carnivores. In addition the muscles as the biceps and a few heads of triceps of the forearm act on the shoulder of the elbow joints in this sudy, as stated in the studies on carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). As stated in the literature carnivores (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014), the medial group muscles of the shoulder are composed of the subscapular and the coracobrachial muscle, while the lateral group muscles of the joint are consisted of the deltoid, the infraspinous and the supraspinous muscle in the research. In the research, it has been seen that the deltoid muscle is consisted of the acromial and the scapular heads, as expressed in the ocelot (Julik et al., 2012), Eurosian lynx (Viranta et al., 2016) and carnivores (Getty, 1995; Konig & Liebich, 2014). Although it has been found that the insertion, location and origo of both portions are similiar to the descriptions in the literature (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016), in the research, it has been obseved that the scapular portion inserts to the caudal border of the acromial portion in two samples. The insetion, the course and the origo of both the supraspinous, subscapular and the infraspinous muscles are similar to the statements in the ocelot (Julik et al., 2012), Eurosian lynx (Viranta et al., 2016) and carnivores (Getty, 1995; Konig & Liebich, 2014). As stated by Viranta et al, (2016), it has been also found that the subscapular muscle belongs to the number of six to seven bellies in the study carried out on the Anatolian bobcat.

The muscles of the elbow joint are composed of the brachial, the biceps and triceps of the forearm muscle and the tensor muscle of the facia antebrachii, as stated by literature (Getty, 1995; Konig & Liebich, 2014). In this study, it has been seen that the brachial muscle attaches to the medial side of the ulna via a thin tendon and the medial coronoid process of the ulna, depicted in the Eurasian lynx by Viranta et al, (2016). In this study, it has been found that the biceps of the forearm consisted of two bellies contrary to description in the the acelot (Julik et al., 2012) and Eurasian lynx (Viranta et al., 2016) originates from the supraglenoid tubercle via strong and thick tendon as reported in the carnivores by lileratür (Getty, 1995; Julik et al., 2012; Konig & Liebich, 2014; Viranta et al., 2016). It has been observed that the triceps muscle of the forearm composed of five heads as the long, lateral, medial, accesory and medial accesory situated in the triangle region between the caudal border of the scapula, the brachium and the olecranon. The finding obtained from the research is similar to the statement in the acelot (Julik et al., 2012) and Eurasian lynx (Viranta et al., 2016).

CONCLUSION

As a result, it has been found that the rhomboid muscle has a cephalic head, the deep pectoral muscle are composed of the cranial, caudal and abdominal portions, the broadest muscle of the back resembles a triangle and also inserts to the superficial pectoral muscle, the venter of the biceps muscle of the forearm are made by two distinct bellies, the triceps muscle of the forearm belongs distinct five heads in this research. The strong and developed muscles of the connected forelimb to the trunk, shoulder and elbow joints suggest that it may play an important role in the adaptation of the Anatolian bobcat not only in the movement but also in the hunting.

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ETHICAL APPROVAL

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