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RESEARCH ARTICLE

Nerves Innervating Articular Capsule of Elbow Joints in Turkish Shepherd Dogs (Karabaş - Kangal), Curly Sheep and Native Hair Goats: An Anatomic Study [1]

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Summary

This study was performed to map the sensible nerves (n.) innervating articular capsule of elbow joints in Turkish shepherd dog (Karabash-Kangal), curly sheep *(ovis aries*) and native hair goat *(capra hircus)* and to demonstrate the interspecies variations. Five adult Turkish shepherd dogs, curly sheeps and native hair goats each of different genders were used. Rami articulares of the nerves innervating articular capsule of elbow joints were dissected after routine cadaver preparation methods. Macroscopic and subgross examination revealed that articular capsule of elbow joints was innervated by radial, median, ulnar and musculocutaneous nerves. The number and directions of branches of the nerves ending at articular capsule were as follows: one craniolateral in all species for radial nerve; one cranial in Turkish shepherd dog and one craniomedial in curly sheep and native hair goat for median nerve; one medial in Turkish shepherd dog and one caudomedial in curly sheep and native hair goat for ulnar nerve; and two cranial in Turkish shepherd dog and one cranial in curly sheep and native hair goat for musculocutaneus nerve. As a conclusion, we observed that the number of rami articulares innervating articular capsule was higher in Turkish shepherd dog and native hair goat than in curly sheep. This difference is likely the result of the more athletic body structure and the capacity to move faster of these species than the curly sheep.

Keywords: *Articulatio cubiti, Capsula articularis, Rami articulares*

Türk Çoban Köpeği (Karabaş - Kangal), Kıvırcık Koyunu ve Yerli Kıl Keçisinde Articulatio Cubiti'nin Capsula Articularis'ini İnnerve Eden Sinirler: Anatomik Bir Çalışma

Özet

Türk çoban köpeği, Kıvırcık koyunu ve Yerli kıl keçisinde gerçekleştirilen bu çalışma ile articulatio cubiti'nin capsula articularis'ini innerve eden sensible sinirlerin haritası oluşturularak türler arası farklılıkların ortaya konması amaçlandı. Çalışmada cinsiyet farkı gözetmeksizin 5'er adet Türk çoban köpeği, Kıvırcık koyunu ve Yerli kıl keçisi kullanıldı. Kadavralarda dirsek eklem kapsülünü innerve eden sinirlerin ramus articularis'leri diseke edildi. Yapılan makroskobik ve subgros incelemede dirsek eklem kapsülünün n. radialis, n. medianus, n. ulnaris ve n. musculocutaneus tarafından innerve edildiği saptandı. Nervus radialis'in ramus articularis'lerinin genel olarak craniolateral'den 1; n. medianus'un Türk çoban köpeklerinde cranial'den 1, Kıvırcık koyunu ve Yerli kıl keçilerinde craniomedial'den 1; n. ulnaris'in Türk çoban köpeklerinde medial'den 1, Kıvırcık koyunu ve Yerli kıl keçilerinde caudomedial'den 1; n. musculocutaneus'un ise cranial'den Türk çoban köpeklerinde 2, Kıvırcık koyunu ve Yerli kıl keçilerinde 1 kol ile capsula articularis'te sonlandığı tespit edildi. Sonuç olarak, Türk çoban köpeği ve Yerli kıl keçilerinde capsula articularis'lere giden ramus articularis'lerin sayısının Kıvırcık koyununa oranla daha fazla olduğu görüldü. Bu iki türün Kıvırcık koyununa göre daha atletik ve hareketli olmasının, söz konusu farklılığı oluşturmuş olabileceği kanısına varıldı.

Anahtar sözcükler: *Articulatio cubiti, Capsula articularis, Rami articulares*

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INTRODUCTION

Studies on peripheral nerve injuries, including their diagnosis [1,2] and repair techniques [3,4] carry considerable importance. Recent studies have shown that denervation procedure by removal of periosteum surrounding articular capsule provide analgesia that result in quick mobilization of the animal [5-8]. This has raised the importance of studies concerning innervations of the articular capsule.

Studies on innervation of joints have been implemented on various types of animals including mammalians [9-13], birds [14] and marsupials [15,16]. These studies have all pointed out that joints receive multiple innervations. Researchers [10,17,18] have not defined the exact number of neural branches running into the articular capsule, but always used plural terms in their expressions.

In the present study, we aimed to determine the innervation of elbow joint in Turkish shepherd dog, Curly sheep and Native hairy goat and define their species-specific characteristics, describe any similarities or dissimilarities between these species, develop a nerve map to be used for surgery of elbow joint and form a basis for further microscopic studies.

MATERIAL and METHODS

Study included 5 adult Turkish shepherd dogs (2 male, 3 female; mean body weight: 34.6±1.52 kg), 5 Curly sheep (1 male, 4 female; mean body weight: 35.8±4.95 kg) and 5 Native hairy goats (2 males, 3 females; mean body weight: 28.4±0.71 kg) that were used as cadavers in student laboratory of Anatomy Department. Animals were anesthetized by xylazine HCl (Rompun® %2, Bayer, Turkey) and ketamine HCl (Ketalar®, Parke-Davis, Turkey). Heparin sulphate (Liquemine®, Roche, Turkey) solution was administered intravenously to prevent coagulation. Blood of the animals were drained from common carotid artery under general anesthesia. Subsequently, animals were fixed by 10% formaldehyde solution and preserved in this solution until dissection. Macroscopic examination of the nerves that terminate in articular capsule was started from their division from the brachial plexus and nerves were followed bilaterally down to medial and lateral aspects of the joints. Dissection of thin and delicate articular branches was performed under Nikon SMZ-10 stereomicroscope. Anatomic terms were determined according to Nomina Anatomica Veterinaria [19]. The Experimental Animals Ethical Committee of Veterinary Faculty of Uludag University approved all experimental protocols (no. 2004/1).

RESULTS

Macroscopic and subgross examination showed that articular capsules of the elbow joints in Turkish shepherd dogs, Curly sheep and Native hairy goat were innervated by articular branches of radial, median, ulnar and musculocutaneous nerves *(Figs 1-2)*.

1- Articular Branches of Radial Nerve

This nerve contributed to innervation of the cranio-lateral aspect of the articular capsule in dogs by 1 (70%) or 2 (20%) branches given off at the flexor side of the elbow joint. In one case (Dog-3, right) 1 branch (10%) that ran on the medial side was found to reach to the cranial of the joint capsule. Target sides of articular branches of radial nerve were proximal of the annular ligament in 6 cases and distal to annular ligament in 4 cases *(Figs 1 a,b)*.

Articular capsules in all specimens of sheep and goat were innervated by articular branches of radial nerve. Deep branch of radial nerve run obliquely from

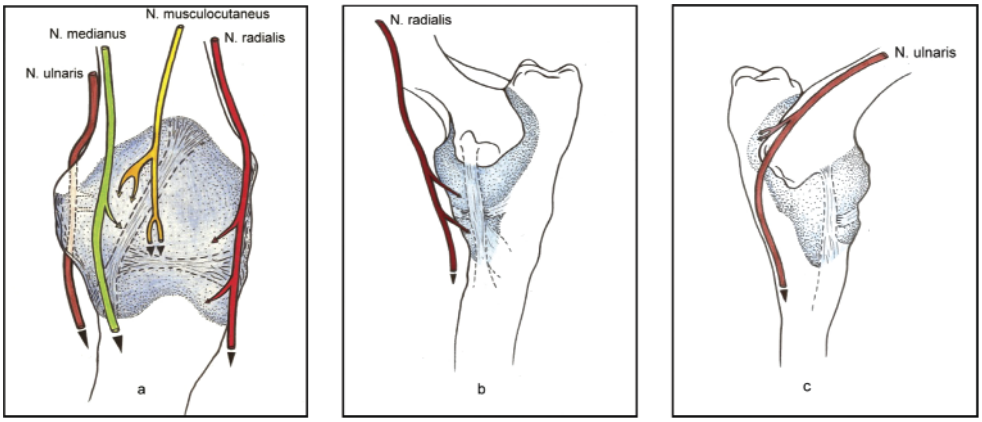

Fig 1. Cranial ***(a)***, lateral ***(b)*** and medial ***(c)*** view of left elbow joint in Turkish shepherd dog

Şekil 1. Türk çoban köpeğinde sol dirsek eklemin ***(a)*** cranial, ***(b)*** lateral ve ***(c)*** medial'den görünümü

midline to lateral on the cranial of elbow joint and gave off several branches to articular capsule *(Figs 2 a,b)*. These branches were found to penetrate the articular capsule from the craniolateral aspect. All specimens of sheep were observed to have 1 (100%) articular branch. Goats showed 1 (80%) or 2 (20%) articular branches *(Table 1)*.

2- Articular Branches of Median Nerve

In dogs, articular branches were terminated at middle of the proximodistal distance of the cranial aspect of articular capsule. This area is mediodistal to the site of entry of articular branch of musculocutaneous nerve to the capsule. Only one specimen (Dog-2, left) nerve was terminated at the craniomedial of joint capsule *(Fig 1a)*. Number of branches was 1 (100%) for all animals *(Table 1)*.

In sheep and goats this nerve gave off a fine branch to the pronator teres muscle at the level of elbow joint and then split into two branches. Caudal of these two branches run below the flexor carpi radialis muscle and gave off several branches to articular capsule at this level. In all specimens median nerve was found to give off articular branches to articular capsule. It was remarkable that the nerve supplied articular capsule with 1 (100%) branch in all sheep specimens and this branch always passed into the capsule through the craniomedial aspect. Number of branches determined in goats was 1 (80%) or 2 (20%). All of these branches were shown to terminate at the craniomedial of articular capsule *(Table 1)*.

3- Articular Branches of Ulnar Nerve

In dogs, ulnar nerve gave off articular branch to articular capsule of elbow joint during its course at the medial of the elbow joint between medial epicondyle and olecranon, and between the ulnar head of the flexor carpi ulnaris muscle and flexor digitalis superficialis muscle. Number of branches was commonly 1 (80%). In two specimens 2 separate secondary articular branches (20%) were observed. In all specimens articular branches were localized at the medial part of the articular capsule *(Figs 1 a,c)*.

In sheep and goats, ulnar nerve showed a convex turn between the medial epicondyle and olecranon process to give off branches to the articular capsule. All specimens of sheep and goats showed contribution of the articular branches of ulnar nerve at the caudomedial part of the articular capsule *(Figs 2 a,c)*. Number of these branches was 1 or 2 in sheep and goats *(Table 1)*.

4- Articular Branches of Musculocutaneous Nerve

Musculocutaneous nerve was found to give off articular branches to articular capsule in all dog specimens. All articular branches running into articular capsule originated from either distal part of the muscular branch of the musculocutaneous nerve or initial part of the medial antebrachial cutaneous nerve. Number of these branches was 1 (50%) in 5 specimens. In the other 5 specimens 2 separate secondary branches (50%) were given off from a single stem. Articular branches were usually localized at the cranial side of the articular capsule, proximal to the insertion of biceps brachii muscle *(Fig 1a)*.

In sheep and goats, a nerve that originated from median nerve at the distal half of the humerus was found to give off the distal muscular branch distally. Articular branches from this nerve were observed to contribute capsular innervation of the elbow joint. Articular branches were localized to cranial side of articular capsule. In sheep specimens nerve was terminated as 1 (60%) or divided into two separate branches (40%). In goats articular branches entered the articular capsule as 1 (60%) or 2 (20%) branches or as 2 divisions after split of one articular branch (20%).

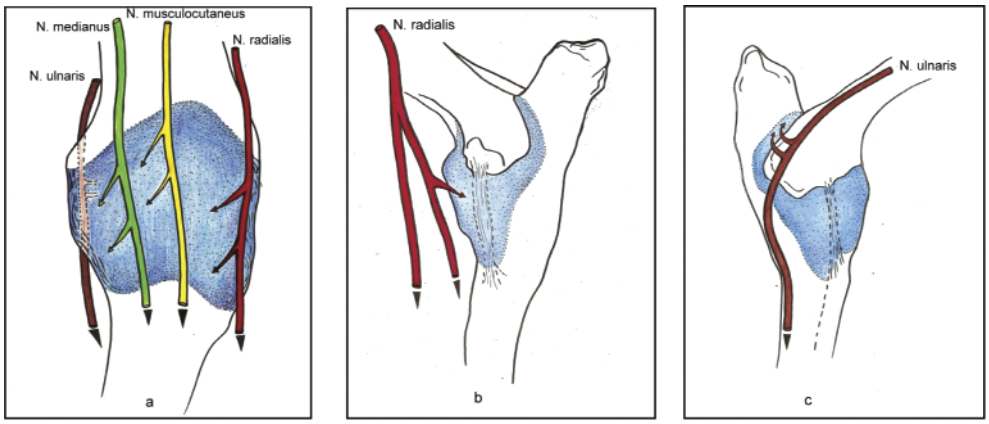

Fig 2. Cranial ***(a)***, lateral ***(b)*** and medial ***(c)*** view of left elbow joint in Curly sheep and Native hair goats

Şekil 2. Kıvırcık koyun ve Yerli kıl keçisinde sol dirsek eklemin **(a)** cranial, **(b)** lateral ve **(c)** medial'den görünümü

Table 1. *Origin, number and innervation area of nerves innervating in articular capsule of elbow joint in Turkish shepherd dogs, Curly sheep and Native hair goats*

Tablo 1. *Türk Çoban Köpeği, Kıvırcık Koyunu ve Yerli Kıl Keçisi'nde dirsek eklem kapsülünü innerve eden sinirlerin kökeni, sayısı ve bölgesi*

Animal/Animal no		Side	N. radialis	N. medianus	N. ulnaris	N. musculocutaneus
			Number and innervation area of rr. articulares	Number and innervation area of rr. articulares	Number and innervation area of rr. articulares	Number and innervation area of rr. articulares
Turkish Shepherd Dogs	Dog-1	R L	1 Craniolateral 1 Craniolateral	1 Cranial 1 Cranial	1 Medial 1 Medial	1 (2 Sek.) Cranial 1 (2 Sek.) Cranial
	Dog-2	R L	2 Craniolateral 2 Craniolateral	1 Cranial 1 Craniomedial	1 Medial 1 Medial	1 Cranial 1 (2 Sek.) Cranial
	Dog-3	R L	1 Cranial 1 Craniolateral	1 Cranial 1 Cranial	1 Medial 1 (2 Sek.) Medial	1 Cranial 1 Cranial
	Dog-4	R L	1 Craniolateral 1 Craniolateral	1 Cranial 1 Cranial	1 Medial 1 (2 Sek.) Medial	1 (2 Sek.) Cranial 1 (2 Sek.) Cranial
	Dog-5	R L	1 Craniolateral 1 Craniolateral	1 Cranial 1 Cranial	1 Medial 1 Medial	1 Cranial 1 Cranial
Curly Sheeps	Sheep-1	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	1 Cranial 1 Cranial
	Sheep-2	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	1 (2 Sek.) Cranial 1 (2 Sek.) Cranial
	Sheep-3	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	2 Caudomedial 2 Caudomedial	1 (2 Sek.) Cranial 1 (2 Sek.) Cranial
	Sheep-4	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	1 Cranial 1 Cranial
	Sheep-5	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	1 Cranial 1 Cranial
Native Hair Goats	Goat-1	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	1 Cranial 1 Cranial
	Goat-2	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	2 Caudomedial 2 Caudomedial	1 (2 Sek.) Cranial 1 (2 Sek.) Cranial
	Goat-3	R L	1 Craniolateral 1 Craniolateral	2 Craniomedial 2 Craniomedial	2 Caudomedial 2 Caudomedial	1 Cranial 1 Cranial
	Goat-4	R L	1 Craniolateral 1 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	1 Cranial 1 Cranial
	Goat-5	R L	2 Craniolateral 2 Craniolateral	1 Craniomedial 1 Craniomedial	1 Caudomedial 1 Caudomedial	2 Cranial 2 Cranial

DISCUSSION

In general, capsular innervation of elbow joints in domestic mammalians is supplied by median nerve and ulnar nerve [20], with occasional contribution of musculocutaneous nerve [21,22]. There is a study on sheep that reported contribution of these nerves but the musculocutaneous nerve to the innervation of joint capsule [22]. Studies on dogs [13] and cattle [23] have shown that capsule of elbow joint was innervated by articular branches of radial nerve, median nerve, ulnar nerve and musculocutaneous nerve.

In our study, articular capsule of elbow joints in dogs, sheep or goats have been shown to be innervated by contributions from radial, musculocutaneous, median and ulnar nerve, as reported in the literature [13,23]. However articular branches demonstrated several differences for their origination, course and sites of entry.

During its course radial nerve has been found to give off more than one [24-26] branches to the cranial of the capsule of elbow joint in goats and sheep, one branch to the distal part of the lateral wall in sheep [26] and 1 [12] or more than one [13] branches to craniolateral

part in dogs. In our study, courses of the articular branches that gave off further branch or branches to articular capsule supported the existing data in the literature [20-22,27] and articular capsule was found to be innervated craniolaterally by 1 branch in sheep, and 1 or 2 branches in goats, and cranially by 1 branch or craniolaterally by 1 or 2 branches in dogs.

In cattle, median nerve that arise from the middle part of brachial plexus have been shown to supply caudal [20-22,27], craniomedial [21] or medial [23] parts of the articular capsule. In sheep, caudomedial part of the articular capsule is supplied by the branch of the median nerve [26], and median nerve gives of 1, or rarely 2 articular branches at the medial side of the joint [24,28]. In our study, course and relations of median nerve in sheep and goats was consistent with the literature [20,22,28]. In sheep and goats, articular branches joined the articular capsule at the craniomedial aspect. Number of articular branches determined was usually 1, and occasionally 2.

Studies on dogs have demonstrated that median nerve gives off at least one articular branches to cranial [13], craniomedial [28] or medial part [12] of the capsule of elbow joint. In our study, termination of articular branches on articular capsule was consistent with the literature [13,28].

In sheep, ulnar nerve gives 1 branch to the caudal part and 2-3 branches to medial part [26], whereas in cattle it gives 1 branch to the medial part [21], and more than one branches to the caudomedial [23] part of the articular capsule. Similarly, in our study ulnar nerve was found to give off 1 or 2 branches to the caudo-medial of articular capsule in sheep and goats.

Ulnar nerve has been shown to give off articular branches to articular capsule between medial epicondyle and olecranon [12,28,29]. Target sites for these articular branches have been defined as caudal [29], caudomedial [11] or medial [12] of the articular capsule. Staszky [13], in his detailed study on dogs, has observed the articular branches on the medial side of the articular capsule in 18 of 19 specimens. Two articular branches have been determined in 3 specimens; whereas 1 articular branch was determined 15 specimens. In our study, articular branches were usually observed as 1 and occasionally two branches in the medial side of the articular capsule.

In cattle, musculocutaneous nerve has been found to divide into several fine articular branches at the distal 1/3 of the humerus [21], and 3-4 of these branches reach the articular capsule at the dorsomedial of the elbow joint [23]. In our study, articular branches that originated from musculocutaneous nerve were terminated at the cranial part of the articular capsule in sheep and goats. In sheep, number of these branches was 1 (60%) or 1 branched divided into two secondary branches (40%). In capra, number of these branches was 1 (60%) or 2 (20%); or 1 branched divided into two secondary branches (20%).

In his study on dogs Staszyk [13] has determined that articular branches to elbow joint originated from either distal muscular branch of musculocutaneous nerve or the initial part of the medial antebrachial cutaneous nerve. In dogs, distal muscular branch gives off 1 [12,28] or more than one branch to cranial [22], and usually 1 occasionally 2 articular branches to craniolateral of the articular capsule [13]. In our study, articular branches to articular capsule were found to originate from distal muscular branch in 2 specimens and from medial antebrachial cutaneous nerve in 8 specimens. All of these branches were observed to terminate at the cranial part of the articular capsule. Number of the articular branches was 1 in five specimens and 1 branch was divided into two secondary branches in five specimens.

As for conclusion; articular capsule of elbow joint in Turkish shepherd dog, Curly sheep and Native hairy goat is supplied by radial nerve, median nerve, ulnar nerve and musculocutaneous nerve. Articular branches of radial nerve in these animals usually terminated at craniolateral part as 1 branch; articular branches of median nerve terminated at cranial part as 1 branch in Turkish shepherd dogs, at craniomedial as 1 branch in Curly Sheep and Native Hairy Goats. Articular branches of ulnar nerve terminated at medial part as 1 branch in Turkish Shepherd Dogs, at caudomedial as 1 branch in Curly Sheep and Native Hairy Goat.

Finally, articular branches of musculo-cutaneous nerve terminated at cranial as 2 branches in Turkish Shepherd Dogs, and 1 branch in Curly Sheep and Native Hairy Goats. Relatively higher number of articular branches reaching articular capsule in Turkish Shepherd Dogs and Native Hairy Goats compared to Curly Sheep was attributed to more athletic and speedy nature of these two mammalian species compared to sheep.

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