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Original Article

Anatomical study on the innervation of the elbow capsule☆

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ABSTRACT

Objectives: To put forward an anatomical description of the innervation of the elbow capsule, illustrated through morphological analysis on dissections.
Methods: Thirty elbows from fresh fixed adult cadavers aged 32–74 years, of both sexes, were dissected.
Results: Among the dissected arms, we observed that the median nerve did not have any branches in two arms, while it had one branch in five arms, two branches in two arms, three branches in ten arms, four branches in nine arms and five branches in two arms. The radial nerve did not have any branches in two arms, while it had one branch in two arms, two branches in nine arms, three branches in ten arms, four branches in five arms and five branches in two arms. The ulnar nerve did not have any branches in three arms, while it had one branch in six arms, two branches in four arms, three branches in five arms, four branches in seven arms, five branches in four arms and six branches in one arm.
Conclusions: We observed branches of the radial, ulnar and medial nerves in the elbow joint, and a close relationship between their capsular and motor branches.

Estudo anatômico da inervação da cápsula do cotovelo

Palavras-chave:
Articulação do cotovelo
Cápsula articular
Cadáver
Anatomia

RESUMO

Objetivos: Promover a descrição anatômica da inervação da cápsula do cotovelo com ilustração por meio da morfologia das dissecações.
Métodos: Foram dissecados 30 cotovelos de cadáveres adultos frescos e fixados, com idade entre 32 e 74 anos, de ambos os sexos.

☆ Work performed at the Faculdade de Ciências Médicas e da Saúde de Sorocaba (FCMS), Pontifícia Universidade Católica de São Paulo (PUC-SP), Sorocaba, SP, Brazil.

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Resultados: Observamos, dentre os braços dissecados, dois com nenhum ramo do nervo mediano, cinco com um ramo, dois com dois ramos, 10 com três ramos, nove com quatro ramos e dois com cinco ramos. Quando se trata do nervo radial, dois braços não apresentaram ramos, dois mostraram dois ramos, nove continham dois ramos, 10 contaram com três ramos, cinco tinham quatro ramos e dois tinham cinco ramos. Em relação ao nervo ulnar, tivemos três braços sem ramos articulares, seis com um ramo, quatro com dois ramos, cinco com três ramos, sete com quatro ramos, quatro com cinco ramos e um com seis ramos.
Conclusões: Constatamos ramos do nervo radial, ulnar e medial na articulação do cotovelo, assim como a relação próxima entre os seus ramos capsulares e motores.

Introduction

The first mentions of the nerve branches of the elbow capsule date from 1844, in descriptions of a branch of the cutaneous nerve perforating the brachial muscle and reaching the capsule; branches of the median nerve penetrating the elbow joint; and branches of the ulnar nerve branching out between medial epicondyle and the olecranon. A branch of the radial nerve extending to the long head of the triceps and heading toward the olecranon and posterior capsule was also described.

In 1857, small branches of the musculocutaneous and median nerve extending to the anterior part of the capsule and variable branches of the anterior interosseous nerve appearing between the radius and ulna and innervating the capsule around the radial head were described. With regard to the posterior part of the capsule, a branch derived from the radial nerve that originated from the muscle branch of the lateral and medial head of the triceps brachii muscle was described.

A study conducted in 1877 reported the presence of small filaments from the median nerve going to the anteromedial region of the capsule and branches of ulnar origin going to the posteromedial capsule.

In subsequent years, studies began to describe this subject with greater precision through dissections. From dissections on seven adult elbows and five fetal elbows, the contributions of the four main nerves innervating the elbow capsule (ulnar, median, musculocutaneous and radial) were demonstrated. A study in 1949 only mentioned ramifications going to the olecranon process, and did not describe capsular branches of the radial nerve.

The present-day main anatomy textbooks, such as Gray, Hollinshead, Latarjet and Liard, do not cite the radial nerve.[1–8]

The elbow capsule is extensive and coats the distal extremity of the humerus and proximal extremity of the ulna and radius. Anteriorly and proximally, it is inserted above the fossa of the coronoid process and capitellum. Distally, it adheres medially to the coronoid process of the ulna and laterally to the annular ligament of the radius (Fig. 1A).

Posteriorly and proximally, the capsule adheres above the olecranon fossa, goes around the margin and continues across the entire medial and lateral column, where it covers all of the sigmoid fossa (Fig. 1B).

The anterior joint capsule is usually thinner and more transparent. It remains under tension when the elbow is extended and relaxes when the elbow is flexed. The greatest capacity of the joint capsule is 30–35 ml at 80° of flexion, when it is fully distended.

In relation to the musculocutaneous nerve, it is known that the area that it innervates is the anterior capsule. This nerve issues a small branch from its main trunk, which penetrates the middle third of the brachial muscle and goes in deeper to reach the anterior part of the humerus and supply the periosteum. It then reaches the elbow capsule, where it divides into a variable number of branches (Fig. 2A). This nerve is the most constant supplier of the capsule, both macroscopically and microscopically. In some cases, this capsule branch may form anastomoses with branches of the median nerve and then continue to the capsule (Fig. 2B). The region of the musculocutaneous nerve may be juxtaposed both to median and to lateral areas.[9–12]

Before passing between the heads of the pronator teres muscle, the median nerve branches out into small sections that go to the capsular region of the anterior medial epicondyle

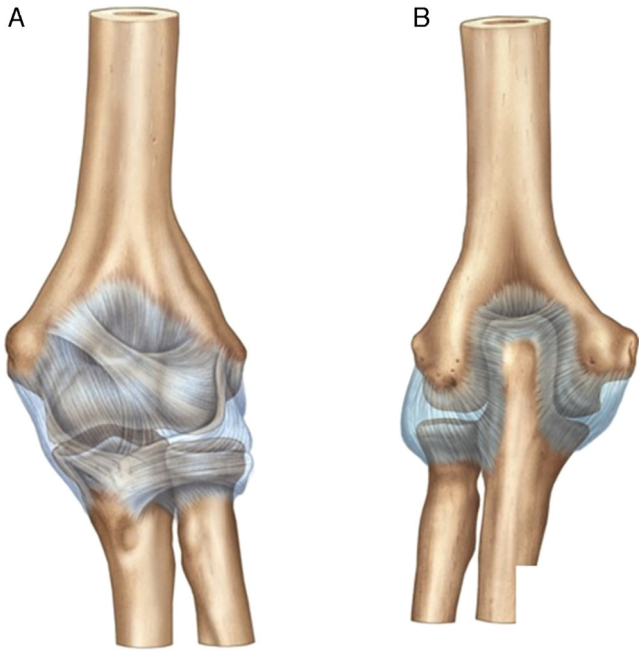

Fig. 1 – Anterior limits of the elbow capsule (A). Posterior limits of the elbow capsule (B).

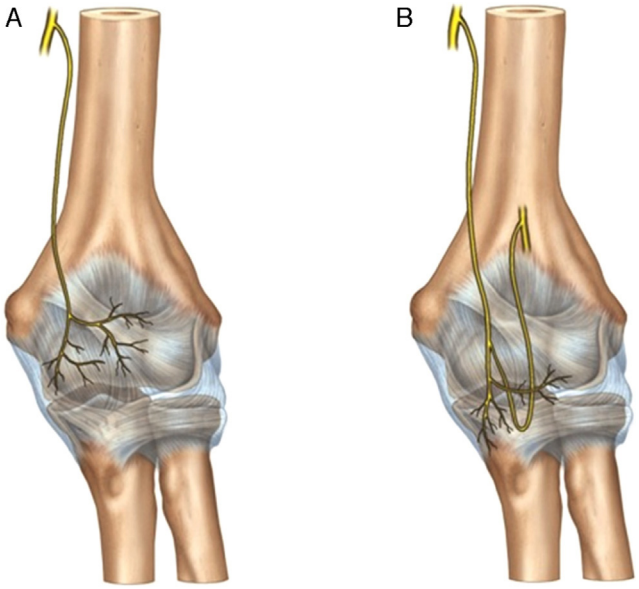

Fig. 2 – Ramification of the musculocutaneous nerve on reaching the elbow capsule (A). The capsule branch may form anastomoses with branches of the median nerve and then continue to the capsule (B).

(Fig. 3A). A joint branch may also occur, which develops more proximally to the elbow, posteriorly to the bifurcation of the brachial artery, and joins the musculocutaneous nerve to innervate the anterior capsule (Fig. 3B). The anterior interosseous nerve gives rise to a small filament that supplies

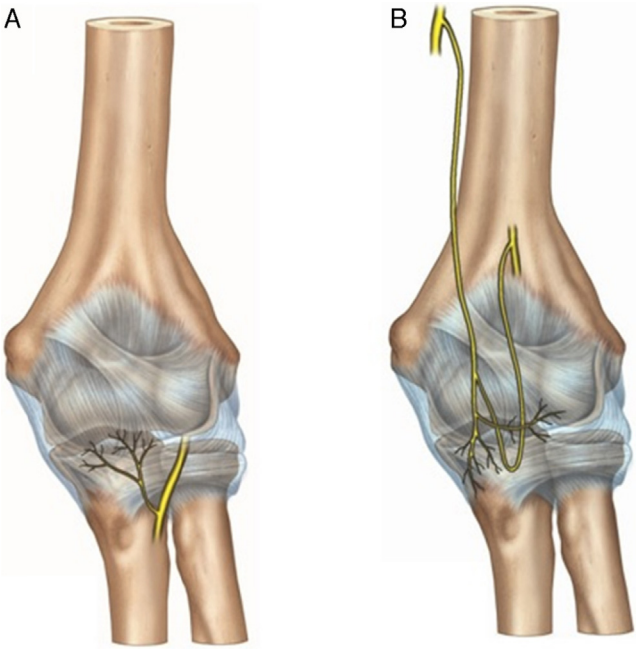

Fig. 3 – Ramification of the median nerve in small sections that go from the anterior medial epicondyle toward the capsule region (A). Union of the median nerve with the musculocutaneous muscle for innervating the anterior capsule (B).

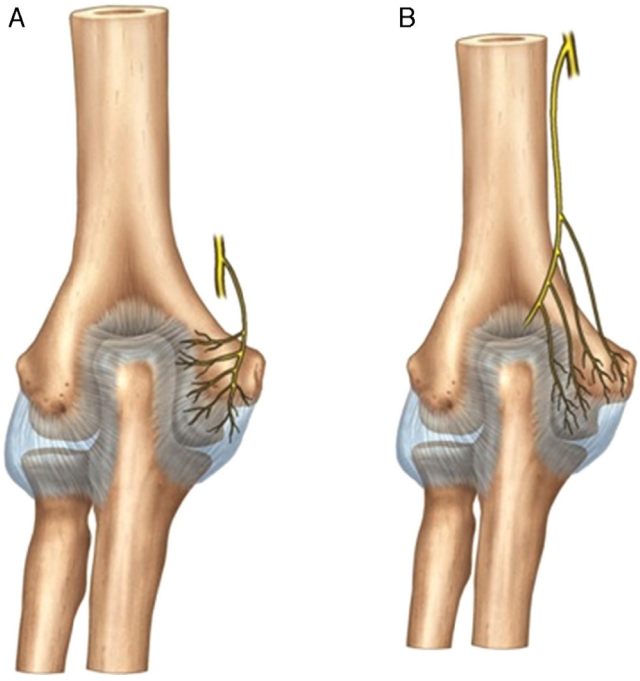

Fig. 4 – Branches of the ulnar nerve beginning in the groove between the medial epicondyle and the olecranon (A). Joint branches originating above the cubital tunnel (B).

the posteroinferior part of the capsule, adjacent to the ulna. Thus, the median nerve usually innervates the anteromedial part of the joint capsule and this area may be overlain by the musculocutaneous nerve.[13–15]

The ulnar nerve usually appears as three branches, which begin at the sulcus between the medial epicondyle and the olecranon (Fig. 4A). Joint branches that arise several centimeters above the cubital tunnel have been described (Fig. 4B). These supply the posteromedial part of the capsules and the neighborhood of the medial epicondyle and olecranon, both in the cubital tunnel. This area may be overlain by the radial nerve.[16–18]

A descending branch is issued from the main trunk of the radial nerve, and this follows the lateral head of the triceps muscle. When it reaches the olecranon, it bifurcates to the capsule in the region of the olecranon fossa (Fig. 5A). There is also a small filament that arises from the branch going to the anconeus muscle and innervates the posterolateral region of the capsule (Fig. 5B). In some cases, the posterior and proximal capsules, which involve the extremity of the olecranon, are innervated by thin branches from the ulnar collateral nerve, which is a branch of the main trunk of the radial nerve (Fig. 5C). This region may be overlain by ulnar innervation. Regarding the anterior capsule, after this passes through the intramuscular septum of the supinator muscle, it generally divides into small branches that may form anastomoses with structures of the musculocutaneous nerve (Fig. 5D).[18–25]

Thus, it is clear that the anterior part of the capsule is usually innervated by the musculocutaneous nerve. This may be overlain laterally by branches of the radial nerve and medially by branches of the median nerve (Fig. 6A). The posterior capsule is innervated medially by the ulnar nerve

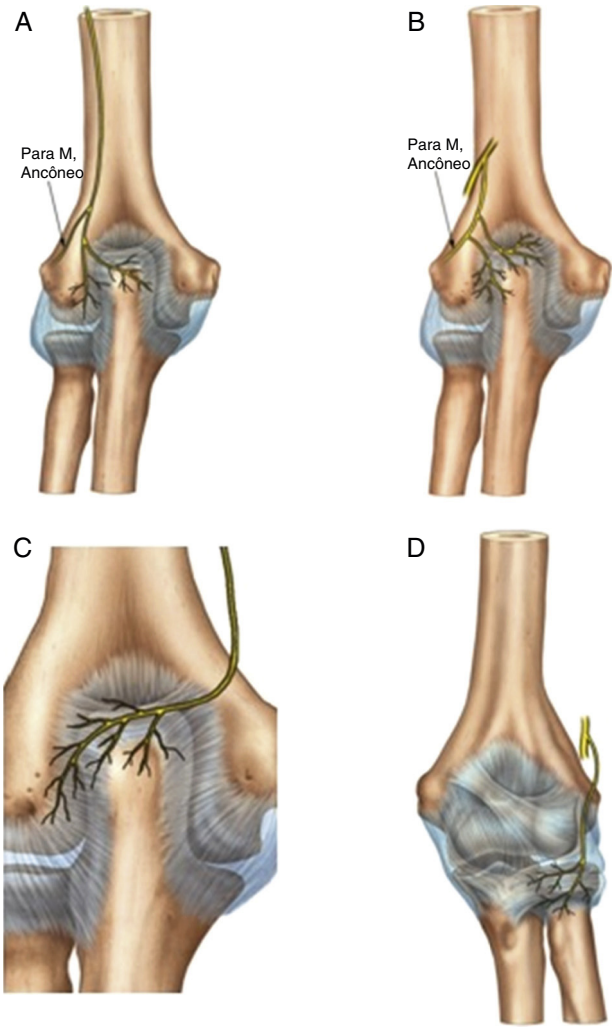

Fig. 5 – Bifurcation of the radial branch to the capsule in the region of the olecranon fossa (A). Innervation of the posterolateral region of the capsule (B). Branch of the main trunk of the radial nerve (C). Anastomoses of ramifications of the radial nerve with structures of the musculocutaneous nerve encompassing the anterior capsule (D).

and laterally by the radial nerve, and there is a central area of mutual innervation (Fig. 6B).

At this juncture, dissections on fresh and fixed cadavers become necessary in order to prove and enrich these studies with greater detail.

Just like all joint capsules, the elbow capsule is closely linked to the bones and is surrounded by muscles, which clearly shows the difficulty in precisely establishing which structures reach it, especially the nerves that branch out to structures adjacent to the capsule. Thus, careful and detailed dissection is needed, especially with regard to the upper limbs, in which the anatomy is rich in details and variations.

There are few studies relating to innervation of the elbow capsule, and the results have presented divergences and have sometimes been incomplete. Therefore, elucidation of this difficult topic was sought here, through an anatomical description based on dissection of 30 elbows from cadavers, based on the above review of the literature.

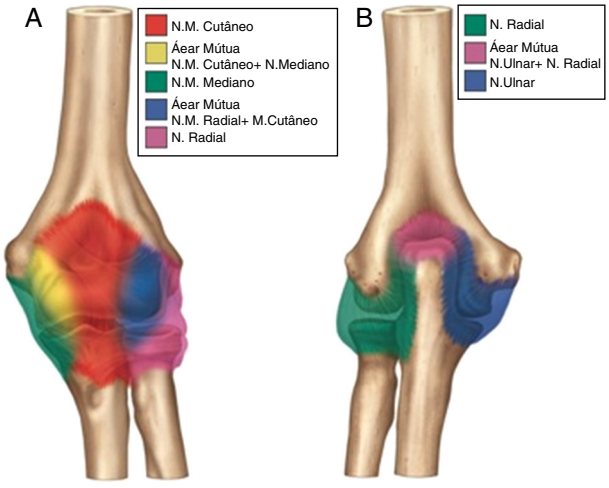

Fig. 6 – Innervation of the anterior capsule (A). Innervation of the posterior capsule (B).

The objective of this study was to provide an anatomical description of the innervation of the elbow capsule and to illustrate data that are poorly elucidated in the current medical literature, from the morphology of the dissections. Moreover, this study sought to demonstrate the morphology of the main nerves and their ramifications to the elbow capsule, identify the locations of nerve insertions of the elbow capsule and compare the findings from dissections with the information in the medical literature.

Materials and methods

Thirty elbows from fresh and fixed adult cadavers of both sexes were dissected. There were 12 right arms and 18 left arms and the ages ranged from 32 to 74 years.

For the dissections, routine laboratory materials were used: non-sterile latex gloves, scalpels, anatomical tweezers, rat-tooth tweezers, Kelly tweezers, Iris Golgran scissors, Mayo scissors, needle holders and cotton thread.

A standard medial cutaneous incision was made, which resulted in exposure of the subcutaneous tissue and enabled access to the intermuscular septum. The ulnar nerve was found to be positioned behind the proximal extremity of the septum. This was preserved and then was dissected along the anterior surface of the medial head of the triceps muscle.

In the elbow, the ulnar nerve passes behind the medial epicondyle of the humerus and is medial to the ulnar collateral ligament and olecranon. It follows the humerus distally, reaches a deep position and rests on the short flexor of the fingers. The dissection was terminated at this level.

The median nerve was exposed through using the original incision. The anterior skin flap was pulled back laterally in order to expose the anterior structures of the elbow region. The cutaneous and subcutaneous tissues were removed without damaging the deeper tissues. The median nerve was investigated anteriorly, where it functions in close proximity to the brachial artery.

The median nerve extends to the brachial muscle and the medial portion of the intermuscular septum, and the biceps

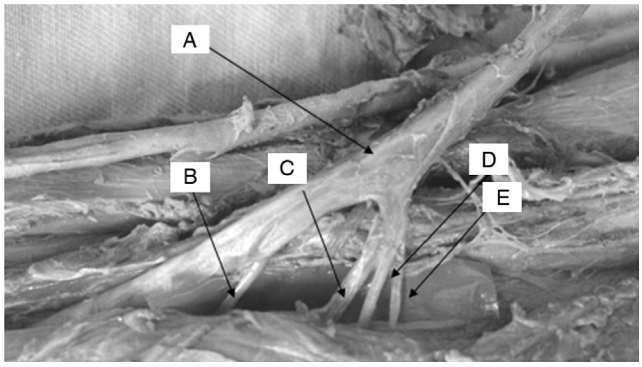

Fig. 7 – Median nerve (A) and its four joint branches (B–E).

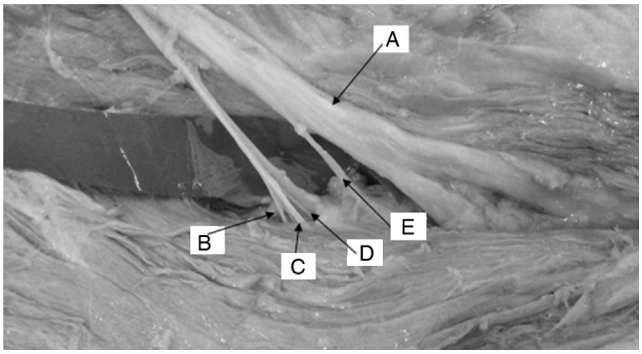

Fig. 8 – Radial nerve (A) and its four joint branches (B–E).

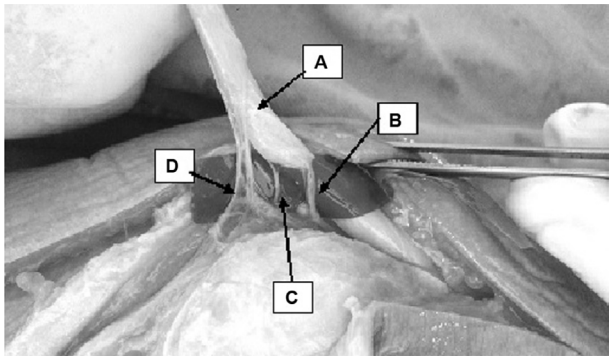

Fig. 9 – Ulnar nerve (A) and its three joint branches (B–D).

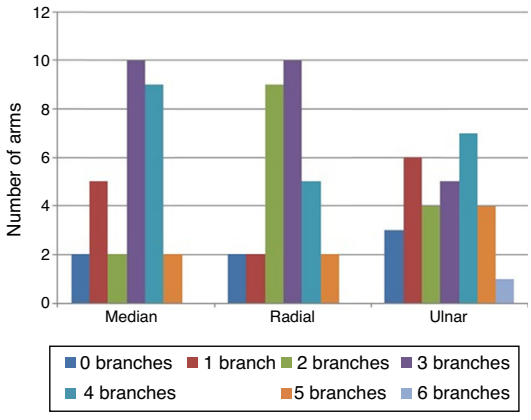

Fig. 10 – Number of cadavers with the respective number of branches found in each nerve.

muscle is lateral to this. In the elbow region, the nerve is located in a deep plane, beside the brachial artery. At this point, the bicipital aponeurosis is located anteriorly to the nerve.

The biceps tendon was pulled back laterally to achieve adequate exposure of the median nerve. Thus, the branches of the nerve were observed at this level for dissecting the radial nerve.

A lateral approach to the elbow was then used separately. At the proximal extremity of the cadavers, the radial nerve was easily found, together with the brachial artery in the spiral groove of the humerus, between the lateral and medial heads of the triceps. The nerve was seen to pass through the brachial muscle and, when this was limited to the tendon, it crossed the capsule of the elbow joint. Upon reaching the supinator muscle, it separated into two parts: the posterior interosseous branch and the superficial branch of the radial nerve. The musculocutaneous nerve was not precisely dissected in all the cadavers and thus was excluded from this study.

This study was approved by the research ethics committee.

Results

Among the dissected arms, we observed two arms with no branches of the median nerve, five with one branch, two with two branches, ten with three branches, nine with four branches and two with five branches. Fig. 7 shows a sample from dissection of the median nerve.

With regard to the radial nerve, two arms did not present any branches, two had one branch, nine had two branches, 10 had three branches, five had four branches and two had five branches. Fig. 8 shows a dissected arm with the radial nerve and its branches exposed.

In relation to the ulnar nerve, there were three arms with no joint branches, six with one branch, four with two branches, five with three branches, seven with four branches, four with five branches and one with six branches. Fig. 9 presents a dissected arm showing the ulnar nerve and its respective joint branches.

Table 1 correlates the number of joint branches found in the nerves studied, in each arm dissected.

From Fig. 10, the frequencies of the different numbers of joint branches in each nerve can be seen. It is clear that the most frequent findings were three joint branches for the median nerve, three for the radial nerve and four for the ulnar nerve.

Discussion

There are few anatomical or clinical studies in the literature, in relation to the patterns or routes of innervation of the elbow joint structures. Morrey[6] cited “a few small branches” that branch out to the elbow joint in the cubital tunnel and called this the “most obvious source of innervation”. He also mentioned the presence of a few small joint branches of the

Table 1 – Results found from the dissections.

	Right arm	Left arm	Median (joint branches)	Radial (joint branches)	Ulnar (joint branches)	Musculocutaneous (joint branches)
1	X		4	3	2	0
2	X		4	3	3	0
3		X	5	4	3	0
4	X		4	5	4	0
5		X	2	2	3	0
6		X	4	3	5	0
7	X		4	4	5	0
8		X	3	4	5	0
9	X		5	2	6	0
10		X	3	5	4	0
11		X	4	3	5	0
12		X	3	2	4	0
13	X		3	3	4	0
14		X	3	2	3	0
15	X		1	2	1	0
16		X	3	3	0	0
17		X	4	4	4	0
18		X	3	0	1	0
19	X		3	0	1	0
20		X	4	2	2	0
21		X	3	2	4	0
22		X	0	3	3	0
23	X		2	2	2	0
24	X		4	3	1	0
25	X		1	3	1	0
26		X	1	4	4	0
27		X	3	1	0	0
28		X	1	2	1	0
29		X	1	3	2	0
30	X		0	1	0	0
Total	12	18	2.833333	2.6667	2.7667	0

median nerve that originate before the motor branches to the pronator teres, radial carpal flexor and long palmar muscles.

Gonzalez et al.[10] suggested that the ulnar nerve emits branches to the elbow in a position posterior to the medial epicondyle of the humerus, while Watchmaker et al.[26] only identified two branches in their study on 15 ulnar nerves. Thomas et al.[11] described the posterior interosseous nerve, but not its anatomical relationship with the elbow joint.

Conclusion

We observed branches of the radial, median and ulnar nerves in the elbow joint capsule, which demonstrates their importance in the innervation of this region.

Therefore, this study, together with other studies that consider the roles of the median, ulnar and radial nerves in the innervation of the elbow capsule, constitute a useful basis for use of denervation techniques on the elbow joint for relieving the pain of arthritis and other chronic diseases in the elbow.

Conflicts of interest

The authors declare no conflicts of interest.

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