Surgical Anatomy of the Medial Antebrachial Cutaneous Nerve: Clinical Application in Ulnar Nerve Decompression Surgery in the Elbow

Anatomía quirúrgica del nervio antebraquial cutáneo medial: aplicación clínica en la liberación del nervio cubital en el codo

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Abstract

Introduction Lesion to the posterior branch of the medial antebrachial cutaneous nerve (MACN) is one of the causes of revision of the ulnar nerve decompression surgery in the elbow.

To avoid the morbidity associated with this injury, cadaver dissections were performed to identify this branch in its course through the ulnar tunnel.

Methods We included 20 upper extremities of fresh cadaveric specimens. The posterior branch of the MACN was identified proximal to medial epicondyle and followed past the ulnar tunnel. The number of ramifications and their coordinates were recorded in a Cartesian plane, with the medial epicondyle as the central point.

Results The posterior branch passed proximal and posterior to the medial epicondyle in all specimens, except one. The average of the adjusted *x* value is of 30 mm, and of the adjusted *y* value is -18 mm. Additionally, we determined that the posterior branch passes at an average angle of 30° with respect to the *x* axis.

Conclusion The anatomical descriptions of this branch focused on surgical release of the ulnar nerve in the elbow are limited, and measures are only described in the horizontal plane (from proximal to distal). Schematizing the anatomy of this branch in its course throughout the ulnar tunnel will facilitate its identification during the procedures. However, variability and asymmetry in the branching pattern should be considered.

Keywords

- anatomy
- ulnar tunnel syndrome
- peripheral nerve injury

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Resumen

Introducción La lesión de la rama posterior del nervio antebraquial cutáneo medial (NACM) es causa de revisión de la cirugía de liberación del nervio cubital en el codo. Con el objetivo de evitar la morbilidad que conlleva su lesión, se realizaron disecciones en cadáveres para identificar esa rama a su paso por el canal cubital.

Métodos Se incluyeron veinte extremidades superiores de espécimenes cadavéricos frescos. Se identificó la rama posterior del NACM proximal al epicóndilo medial, y se siguió a lo largo del canal cubital. Se registró el número de ramas y sus coordenadas en un plano cartesiano con el epicóndilo medial como punto central.

Resultados La rama posterior pasó proximal y posterior al epicóndilo medial en todos los espécimenes, excepto en uno. El promedio del valor de *x* ajustado es de 30 mm, y del valor de *y* ajustado es de -18 mm. Adicionalmente determinamos que la rama posterior pasa a un ángulo promedio de 30° respecto al eje *x*.

Conclusión Las descripciones anatómicas de esta rama enfocadas hacia la cirugía de liberación del nervio cubital en el codo son escasas, y las medidas están únicamente descritas en el plano horizontal (de proximal a distal). Esquematizar la anatomía de esta rama a su paso por el canal cubital facilitará su identificación durante el procedimiento. Sin embargo, se debe tener a consideración la variabilidad y asimetría en el patrón de ramificación.

Palabras clave

- anatomía
- síndrome del túnel cubital
- lesión de nervio periférico

Introduction

The medial antebrachial cutaneous nerve (MACN) provides sensory innervation to the medial region of the forearm. Although its pathway in the upper extremity is already described in anatomical books, there are clinical circumstances in which a more precise knowledge is indispensable. As it passes through the elbow, the MACN divides into two main branches, and the posterior branch is in close relation to the ulnar canal. This branch is not only exposed to injury during ulnar nerve decompression surgery at this level, but is also at risk in the medial elbow approach used in trauma surgery. Its identification is of great difficulty, considering it is a very superficial and small structure which can be partially or completely sectioned. Although its lesion is reported as a complication of medial elbow surgery, there are no parameters described to facilitate its location.[1–6]

The objective of the present study is to facilitate the identification of this posterior branch during ulnar nerve decompression surgery in the elbow through measurements regarding specific anatomical points; additionally, although it is not the main purpose, the information provided will also be useful for surgeries requiring medial approaches in the elbow and procedures to block sensitive branches, thus extending the application of the results obtained with the present study.

Material and Methods

Twenty upper extremities from fresh cadaveric specimens were included. The sample size was determined based on descriptive anatomical studies[7–9] of the posterior branch of the MACN published to date in fresh or formalin-treated cadavers, which have a sample size $\leq$ 20 specimens. Studies[10–14] performed in patients have larger sample sizes; however, these are not descriptive anatomical studies, because, when performing revision surgery in these patients due to the persistence of symptoms, not only the findings are described, but also an intervention is performed, and clinical outcomes are measured.

Dissections were performed at x3.5 magnification. The posterior branch of the MACN superficial to the fascia was identified 6 cm proximal to the medial epicondyle (►**Fig. 1**). Once identified, the area of interest was divided into 4 by drawing a Cartesian plane with quadrants of 1 cm x 1 cm in order to facilitate the measurement of the coordinates of the location of the branches. The area of interest has the following limits:

- Distal boundary: 6 cm distal to the medial epicondyle.
- Proximal boundary: 6 cm proximal to the medial epicondyle.
- Anterior boundary: basilic vein.
- Posterior boundary: olecranon and ulnar crest.

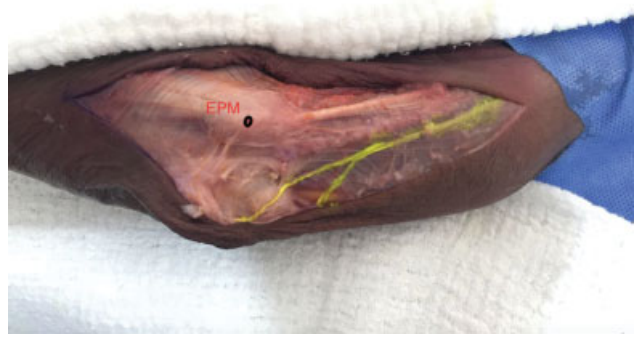

Fig. 1 Photograph of the surgical dissection in a cadaver. The posterior branch of the medial antebrachial cutaneous nerve (MACN) is highlighted in yellow. Abbreviation: EPM: medial epicondyle.

This zone of interest was defined based on the results of previous studies that determine that the MACN branch becomes posterior between 6 cm proximally and 6 cm distally to the medial epicondyle. The limits in the horizontal plane are not described in detail in the literature, so they were established based on the fact that medial approaches for ulnar nerve decompression do not require dissection beyond these established limits. The number of branches and their coordinates in the area of interest were described for each of the specimens. Considering the variability that may be found in the results, an average of the ulnar length of the specimens measured from the tip of the olecranon to the ulnar styloid was taken. This average was used to establish a ratio with the ulnar length of each specimen, which was taken as a reference to determine the results of the final measurements.

Results

Twenty upper extremities of fresh cadavers were included (11 right-handed and 9 left-handed); 18 extremities corresponded to male cadavers, and 2 to a female cadaver.

The average ulnar length from the tip of the olecranon to the tip of the styloid was of 254 mm. The ratio between this average and the value of the ulnar length of each specimen was taken as a reference to determine the results of the final measurements, which are represented as adjusted *x* and *y* values (►**Table 1**).

Regarding the number of branches, one posterior branch was identified in 70% of the specimens, 2 branches, in 25%, and 3 branches, in 5%.

During the dissections, crucial steps were identified to facilitate the location of these branches. The posterior branch of the MACN was identified deep in the subcutaneous cellular tissue and superficial to the muscle fascia in all specimens. In 95% of the specimens, the posterior branch of the MACN passed proximally and posteriorly to the medial epicondyle. Only in one specimen it passed distally and anteriorly to this anatomical point (►**Fig. 2**: specimen 9b). The adjusted values of *x* and *y* of this specimen were not taken into account for the final average.

Using the same measuring and recording instruments, the measurements were presented in a standardized way. The average adjusted value of x was of 30 mm, and the average adjusted value of y was of -18 mm. Additionally, with this schematic representation, we were able to determine that the posterior branch passes at an angle of 30° on average in relation to the *x* axis.

With the results obtained, we were able to build a schematic representation in a Cartesian plane with the medial epicondyle as the origin in order to determine an anatomical pattern of this branch as it passes through the ulnar tunnel in the elbow (►**Fig. 3**).

Table 1 Anatomic description and results

Specimen number	Specimen name	Gender	Side	Ulnar length (mm)	Ratio	Number of branches	Coordinates (x; y) (mm)	X (mm)	Y (mm)	Adjusted X (mm)	Adjusted Y (mm)
1	1	Male	Right	275	1.080550098	1	(+30; -25)	30	−25	32.42	−27.01
2	2a	Male	Left	290	1.139489194	1	(-50; -30)	50	−30	56.97	−34.18
3	2b	Male	Right	290	1.139489194	2	(+50; NA) (0; 0)	50	0	56.97	0
4	3a	Male	Left	258	1.013752456	1	(-45; -25)	45	−25	45.62	−25.34
5	3b	Male	Right	258	1.013752456	1	(NA; -30)		−30	0	−30.41
6	4a	Male	Left	250	0.982318271	1	(-25; -10)	25	−10	24.56	−9.82
7	4b	Male	Right	250	0.982318271	1	(+10; -15)	10	−15	9.82	−14.73
8	5a	Female	Right	215	0.844793713	1	(+25; -20)	25	−20	21.12	−16.9
9	5b	Female	Left	215	0.844793713	2	(-20; -15) (-25; NA)	20	−15	16.9	−12.67
10	6a	Male	Left	235	0.923379175	3	(-30; -19) (NA)	30	−19	27.7	−17.54
11	6b	Male	Right	230	0.903732809	2	(+58; -19) (NA)	58	−19	52.42	−17.17
12	7a	Male	Left	230	0.903732809	1	(-38; -23)	38	−23	34.34	−20.79
13	7b	Male	Right	230	0.903732809	1	(+13; -5)	13	−5	11.75	−4.52
14	8a	Male	Right	270	1.060903733	1	(+20; -20)	20	−20	21.22	−21.22
15	8b	Male	Left	265	1.041257367	2	(-40; NA)(NA)	40		41.65	0
16	9a	Male	Right	280	1.100196464	1	(+56; -25)	56	−25	61.61	−27.5
17	9b	Male	Left	270	1.060903733	1	(+36; +15)	−36	15	−38.19	15.91
18	10a	Male	Right	230	0.903732809	1	(+35; -20)	35	−20	31.63	−18.07
19	11a	Male	Left	270	1.060903733	2	(-15; -18) (-21; NA)	15	−18	15.91	−19.1
20	11b	Male	Right	270	1.060903733	1	(+9; -12)	9	−12	9.55	−12.73
				254.05		1.35				26.7	−15.69
								30.53	−18.81	30.31	−17.61

Note: *NA (not applicable): refers to the fact that the branch does not cross the *x or y* axes, depending on the case.

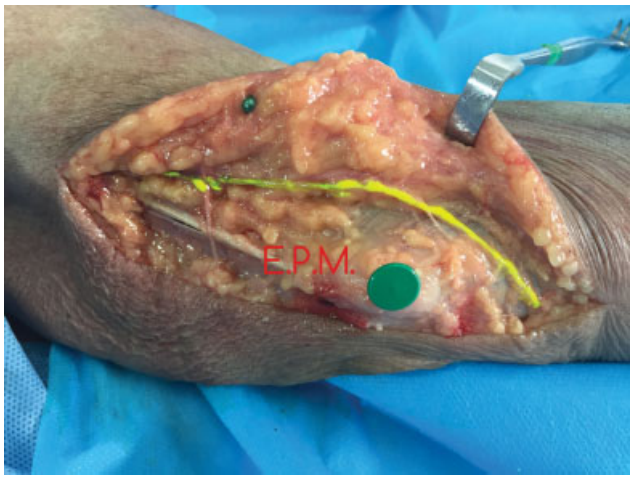

Fig. 2 Case 9b: Only case that crossed the elbow anterior to medial epicondyle.

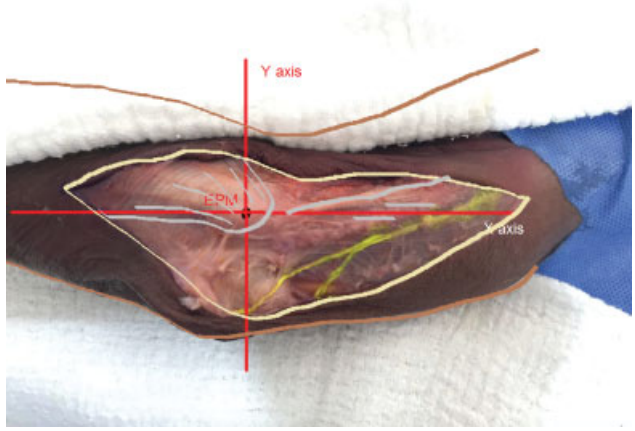

Fig. 3 Schematic representation of the branches in a Cartesian plane. Abbreviation: EPM: medial epicondyle.

Discussion

The crucial steps to facilitate the location of these branches are described in the present study. In 95% of the specimens, the posterior branch passes proximally and posteriorly to the medial epicondyle. This finding is comparable to that of Masear et al.,[15] who reported that 90% of the branches cross proximally or at the level of the medial epicondyle. The direction of the branches as they pass through the ulnar canal, from anterior and superior to posterior and inferior, depicted schematically in the present study (►**Fig. 3**) was previously reported by Race and Saldana.[12]

As in the work by Dellon and MacKinnon,[1] between one and three branches were identified in all specimens, and although the measurements in the current study are not presented as ranges, which is a favorable aspect, these results are comparable to those found in previous studies.[1,12,13,15,16]

It is important to highlight new and important aspects. The first is the information on the depth of these branches, which has not been previously described and is of great importance ,considering that their superficial position puts them at greater risk during anatomical dissection. Another important aspect not reported in previous studies[1,12,13,15,16] corresponds to the numerical values in millimeters to locate these branches. Unlike other studies[1,12,13,15,16] that provide very wide measurement ranges and locate the branches only in the horizontal (x) axis, the schematic representation of the results obtained in the present study is made through coordinates in a Cartesian plane in the horizontal (x) and vertical (y) planes, which brings greater precision and facilitates their location.

The present study provides information on the depth of the branches and their location through measurements in two axes in relation to a single reference point.

We consider that the results will have implications for future research since the technique for the identification of these branches is easy to apply and can be extrapolated to the clinical practice, which will have a major impact, taking into account that the ultimate goal is to avoid complications secondary to the injury of these branches during ulnar nerve decompression surgery in the elbow. Additionally, the results can be applied to other areas of medicine, since these branches are at risk not only with this approach. Identifying the posterior branch of the MACN will facilitate the use of nerve block techniques useful in anesthesia as well as neurectomies, if indicated.

The recommendations based on the results obtained constitute a guide for the identification of these branches during surgery. The scalpel incision should be only on the skin, since the location of these branches deep in the subcutaneous cellular tissues turn them susceptible to injury, especially in thin patients. It is important to keep in mind that although a single branch was the most frequent pattern in the present study, a careful dissection should always be performed in order to avoid injuring other small ramifications that originate from the main branch.

It is recommended to start dissection 30 mm proximally to the medial epicondyle and proceed distally and inferiorly at an angle of 30° in relation to the x axis.

It is important to take into account the percentage of variability found (5%) in the present study. These measurements are a guide to facilitate the identification of these branches, and in no case these recommendations should be categorical. Since the present is an anatomical study, a high variability in the results obtained may limit its scope, considering that the points of study will be less precise.

Conclusions

The approach to ulnar nerve decompression surgery in the elbow requires identification and protection of the posterior branch of the MACN, regardless of the surgical technique employed. Although the complication rates are low, it is clear in the literature that injury to this branch constitutes one of the main causes of complication and revision due to the presence of neuropathic symptoms at the elbow.

By the methodology applied in the present study, the anatomy of this branch as it passes through the ulnar canal in the elbow was schematized. These results constitute a guide to identify these branches and thus avoid their injury during

the procedure; however, variability and asymmetry in the branching pattern should be taken into consideration in order to avoid complications. It is necessary to extend these data with clinical studies, since the final goal is to reduce the incidence of complications in patients.

Conflict of Interests
The authors have no conflict of interests to declare.

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