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NOTA CLÍNICA

Intraneural distribution of the ulnar nerve

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KEYWORDS
Ulnar nerve;
Anatomy;
Dissection;
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Abstract
Objective: To study the fascicular distribution of ulnar (cubital) nerve in the elbow area in order to apply these fundamentals to the ulnar nerve transfer technique.
Material and method: Twelve cryopreserved arms, injected with latex were dissected. After locating the ulnar nerve, intraneural dissection was performed using magnifying glasses in order to describe its formation and trajectory.
Results: Segregation of the extrinsic fascicles was not well defined in the elbow area as the anatomical variability, in thickness and number, made it difficult to identify its components. A clear morphological differentiation was observed in the elbow and the fascicles destined to form nerve branches were clearly seen distal to the elbow. The ulnar nerve fascicles have a spiral trajectory in its distal progression.
Discussion: The micro-anatomical layout of the ulnar nerve fascicles around the elbow is more complicated than that described in the literature, which makes it advisable to use surgical records to locate the fibres destined for the extrinsic and intrinsic musculature. Sensitive fibres are required to perform the Oberlin technique, or at least the use of an electrical stimulator to identify them.

PALABRAS CLAVE
Nervio cubital;
Anatomía;
Disección;

Distribución intraneural del nervio cubital

Resumen
Objetivo: Estudiar la distribución fascicular del nervio cubital en la zona del codo para aplicar estos fundamentos en la técnica de transferencia nerviosa del cubital.

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Microcirugía;
Transferencia nerviosa

Material y método: Se realizó la disección de 12 extremidades superiores criopreservadas inyectadas con látex. Tras la localización del nervio cubital se disecó intraneuralmente con gafas lupa para efectuar una descripción de su formación y recorrido.
Resultados: En la zona proximal del codo la segregación de los fascículos extrínsecos no estaba definida ya que la variabilidad anatómica, en grosor y número, hizo difícil identificar a sus componentes. En el codo encontramos una diferenciación morfológica clara y distal al codo se apreciaron claramente los fascículos destinados a formar las ramas del nervio. Los fascículos del nervio cubital efectuaban un trayecto en espiral en su progresión distal.
Discusión: La disposición microanatómica de los fascículos del nervio cubital alrededor del codo es más complicado que lo descrito en la literatura, lo que hace recomendable la utilización de registros intraoperatorios para localizar las fibras destinadas a la musculatura extrínseca e intrínseca y fibras sensitivas para efectuar la técnica de Oberlin, o al menos utilizar un estimulador eléctrico para su identificación.

Introduction

The intraneural fascicular distribution of the peripheral nerves is well known[1,2] and with the description of the transfer of fascicles from the extrinsic musculature of the ulnar nerve to revive the *biceps brachii* muscle3, the intraneural anatomy is quite basic. Oberlin et al.[3] recommend the nerve transfer of one or two fascicles of the ulnar nerve to the motor branch of the biceps in the area proximal to the arm and the ulnar nerve approach 4 cm distal to the insertion of the *pectoralis major* tendon in the humerus, with an incision measuring between 8 and 10 cm long, since the motor branch for the *biceps brachii* muscle separates from the musculocutaneous nerve some 12 cm from the acromion. The nerve transfer is carried out at this level, locating the fascicles of the ulnar nerve intended for the extrinsic musculature of the hand (the *flexor carpi ulnaris* and the *flexor digitorum profundus* muscles) reported to be located in the area that is antero-medial to the trunk of the ulnar nerve (1, 2 or 3 fascicles, depending on the case). They emphasize that it is possible to clearly distinguish between the motor fascicles and the sensory fascicles, although they also comment that it is sometimes possible to locate fascicles with a motor response for the extrinsic musculature or intrinsic musculature, pointing out that in those cases, the former should be selectively taken.

The aim of our study has been to examine the distribution and course of the ulnar nerve up to the fascicular level so as to understand better the distribution of these fascicles and apply this insight into the ulnar nerve transfer technique.

Material and method

We used upper limbs (8 right and 4 left) injected with latex in the arterial system. By means of dissection, the ulnar nerve was located proximal to the elbow; and its course was followed to the wrist, identifying its different motor and sensory branches (fig. 1). With the aid of 3 power magnifying glasses, the intraneural dissection of the various fascicles of the nerve was then made, separating the main fascicular groups at the different levels of the course, proximally up to the arm, in the elbow and distally to the hand, and indicating them with different coloured nylon thread.

Results

The intraneural pattern presents continuous crossovers of fibres that are not consistent, such that the more proximal we are in the nerve, the more mixture of fibres we find. This makes it difficult to distinguish the fascicular groups of the main branches of the ulnar nerve as there is any number of other nerve branches serving as fascicular supply. As we progress along the course of the nerve, just proximal to the elbow, the fascicular groups to be dissected become clearer. We find the differentiation of the fascicles destined to form the different branches of the nerve distal to elbow (fig. 2).

In examining the distribution of the fascicles of the ulnar nerve on an axial view, we see that, overall, there has been a 90° turn during the nerve's progression from the arm to the forearm. This rotation was an external rotation mainly affecting the course of the nerve at the level of the elbow

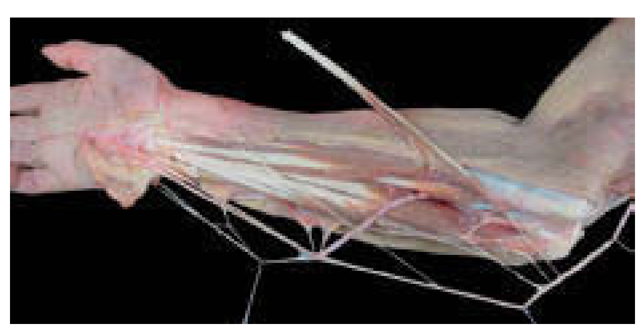

Figure 1 Dissection of the ulnar nerve in the upper right limb with its different branches.

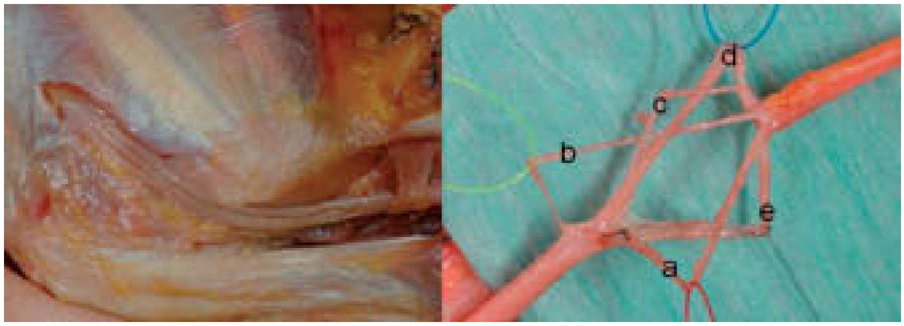

Figure 2 Intraneural dissection of the ulnar nerve proximal to the elbow and at the point where if passes through Osborne's fascia. a) fascicle for the superficial branch; b) fascicle for the deep branch; c) fascicle for the flexor digitorum profundus muscle; d) fascicle for the dorsal branch, and e) fascicle for the flexor carpi ulnaris muscle).

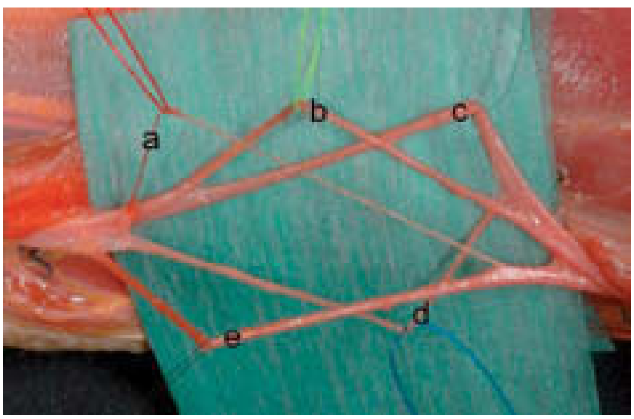

Figure 3 Intraneural dissection of the ulnar nerve distal to the elbow. a) fascicle for the superficial branch; b) fascicle for the deep branch; c) fascicle for the *flexor digitorum profundus* muscle; d) fascicle for the dorsal branch, and e) fascicle for the *flexor carpi ulnaris* muscle.

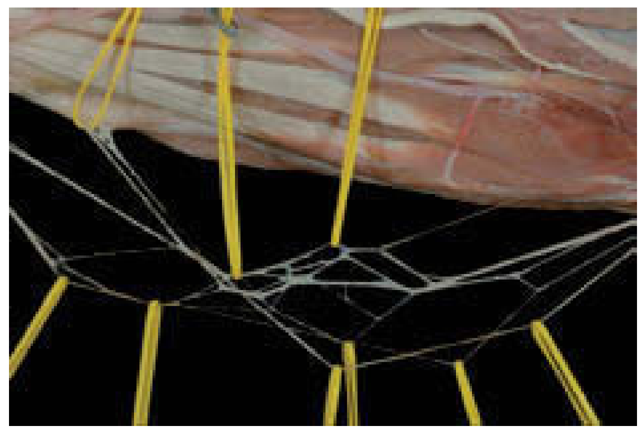

Figure 5 Intraneural dissection of the ulnar nerve in the forearm in which we can see the many interfascicular communications that exist.

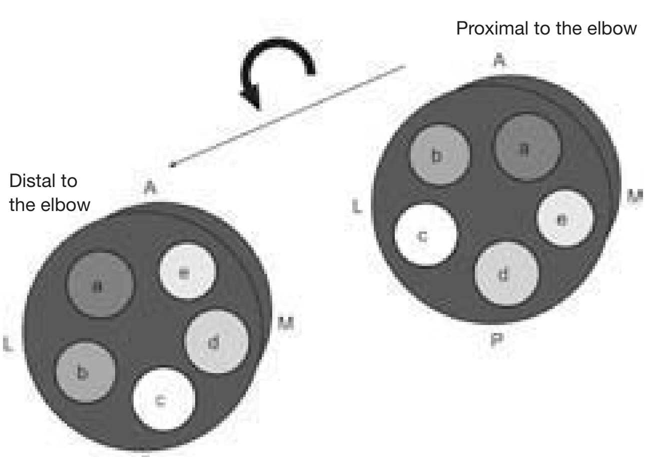

Figure 4 Two axial slices of the right ulnar nerve, proximal and distal to the elbow with the turn made by the fascicles as they pass through the elbow. a) fascicle for the superficial branch; b) fascicle for the deep branch; c) fascicle for the *flexor digitorum profundus* muscle; d) fascicle for the dorsal branch, and e) fascicle for the *flexor carpi ulnaris* muscle).

and we can distinguish the fascicular group belonging to the superficial branch of the ulnar nerve, passing from anterior to antero-lateral; the group for the deep branch ran from antero-lateral to lateral and slightly posterior; for the branch of the *flexor digitorum profundus* muscle, the fibres went from lateral to postero-medial; the group for the dorsal branch was projected from posterior to medial and, finally, the fascicular group for the nerve branch of the *flexor carpi ulnaris* muscle was converted from medial to anterior (figs. 3 and 4). We failed to find differential characteristics in the dissections between the left and right limbs.

Discussion

Interfascicular communications are highly variable, making it difficult to recognize the intraneural distribution of the fascicles of the ulnar nerve (fig. 5). Although it is true that in the dissections carried out we have not found a common pattern to these communications, a much broader study with histomorphometrics and 3D reconstruction would contribute to confirming or ruling out this randomness.

However, the existence of these communications leads us to think that the extrinsic component, postulated for the Oberlin technique, to substitute the motor branch for the *biceps brachii* muscle with a similar fascicular contribution,[4] despite its effectiveness,[5] not only includes an extrinsic motor component, but also possibly an intrinsic motor and even, sensory component. This compels us to recommend intraoperative recordings or, if this is not possible, an electric stimulator to identify each of these components more accurately.

Oberlin's works state that the fascicles that will go on to the extrinsic musculature are preferentially located in the antero-medial area of the ulnar nerve. In his technique, the transfer is made in the proximal segment of the arm, between 4 and 14 cm distal to the insertion of the tendon of the *pectoralis major* muscle in the humerus; the motor branch of the *biceps brachii* muscle originates some 12 cm from the acromion3 5. However, at this level, we were unable to distinguish the fascicles that go on to the *flexor carpi ulnaris* muscle and those that go on to the *flexor digitorum profundus* muscle; nor were we able to distinguish the communications with the fibres that go on to the intrinsic musculature or sensory fibres. In the distal area of the arm, close to the elbow this differentiation is much clearer, although it hinders performance of the original technique described by Oberlin et al.3, since the motor branch of the biceps is much more proximal. The motor branch that goes on to reach the *brachialis* muscle is, however, more distal and is more suitable for carrying out a nerve transfer at this level, making it possible to space the nerve fibres to the intrinsic musculature of the hand, thanks to the fact that they are more dissociated.

On the other hand, the turn observed in the intraneural course of the ulnar nerve meets the same conditions as the external rotation the upper limbs undergo during the 6th-7th week of embryonic development. Even so, there is no clear explanation for the turn occurring mainly at the point where it passes the elbow. The fact that the nerve is coiled makes it more resistant to tensile forces during the flexion-extension movements of the elbow, by acting as a spiral.

The limitation of this study has to do with the constraint of using magnifying glasses to perform the dissection, simulating the conditions we find during nerve transfer surgery; nevertheless, histological examination and a study in fresh nerve tissue are needed to confirm the intraneural fascicular distribution of the ulnar nerve. This would help us to clarify the issue of whether transient paresthesias or motor deficits of the intrinsic musculature some patients present following the Oberlin technique are the result of the intraneural dissection itself or to an injury of these fascicles during intercommunication along their course.

References

1. Sunderland S. Nerve injuries and their repair. Oxford: Churchill Livingstone; 1991.
2. Bonnel F. Histologic structure of the ulnar nerve in the hand. J Hand Surg Am. 1985;10:264-9.
3. Oberlin C, Beal D, Leechavengvons S, Salon A., Dauge MC, Sarcy JJ. Nerve transfer to biceps muscle using a part of ulnar nerve for C5-C6 avulsion of the brachial plexus: anatomical study and report of 4 cases. J Hand Surg. 1994;19:232-7.
4. Osman N, Bhatia A, Cadot B, Geffroy MC, Ledroux D, Oberlin C. Histomorphometry of the ulnar nerve and of its branches. Surg Radiol Anat. 1998;20:409-11.
5. Oberlin C, Durand S, Belheyar Z, Shafi M, David E, Asfazadourian H. Nerve transfers in brachial plexus palsies. Chir Main. 2009;28:1-9.