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Feasibility of a fascial flap to avoid anterior transposition of unstable Ulnar nerve: A cadaver study☆

Marco D'Orio [a], Camillo Fulchignoni [a, 1], Rocco De Vitis [a, *], Marco Passiatore [b], Giuseppe Taccardo [a], Luciana Marzella [c], Alberto Lazzerini [c]

[a] Department of Orthopaedics, Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy
[b] Bone and Joint Surgery Department, ASST – Spedali Civili, Brescia, Italy
[c] Galeazzi Orthopaedic Institute, Milano, Italy

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ABSTRACT

Background: Compression of the ulnar nerve at the elbow is the second most frequent site of nerve compression in the upper limb. Upon release, anteposition of the nerve may be necessary to avoid dislocation of the latter when unstable. Numerous techniques are described in the literature (subcutaneous transposition, intramuscular transposition, subfascial transposition, medial epicondylectomy …), none of which is without complications. Based on Han's work, the authors propose a technique of covering the ulnar nerve with epicondylar fascial flap, avoiding transposition, but ensuring good stability of the ulnar nerve.

Methods: As part of the SICM (Italian Society of Hand Surgery) cadaver dissection course (ICLO, Verona, Italy) the authors dissected 36 elbows, of which 20 presented subluxation of the ulnar nerve after its decompression. The fascial flap was therefore made on these 20 elbows, coming from 14 different donors (9 men, 5 women) with an average age of 78 years. The diameter of the ulnar nerve was then measured (at the level of the passage in the cubital canal), the diameter of the newly formed canal, the difference between the two previous measurements (residual space in the flexed elbow canal), and it was verified whether the ulnar nerve was unstable once covered by the flap.

Results: The mean diameter of the ulnar nerve was 5.1 mm (range 4–6), while the mean diameter of the neo-canal was 10.1 mm (range 8–11) in elbow extension and 8.9 mm (range 7–10) in elbow flexion. The remaining space in the flexed elbow canal was 3.8 mm (range 3–5).
In none of the 20 cases the ulnar nerve was dislocated after having made the fascial flap.

Conlusions: In light of the results obtained, the authors think that the use of the epicondylar fascial flap may be a solution to keep in mind to avoid dislocation of the ulnar nerve when it becomes unstable following its decompression. This work obviously needs clinical confirmation on living patients.

Level of evidence: V.

1. Introduction

Ulnar nerve entrapment at the elbow, also known as cubital tunnel syndrome, is the second most common compression neuropathy in the upper limb after carpal tunnel syndrome.[1] Several surgical options have been reported in literature emphasizing the controversy surrounding management of cubital tunnel syndrome.[2] Surgical treatment can be divided in three main groups: Decompression of the nerve alone,[3,4] decompression with ulnar nerve anterior transposition (which could be subcutaneous, submuscular, intramuscular or subfascial)[2,5–9] and medial epicondylectomy.[5,8,10] These last two options are more invasive procedures, requiring significant manipulation of the nerve (the anterior transposition) or a risk of destabilization of the elbow (the epicondylectomy) but are indicated as an adjunct procedure if

☆ The study was performed at ICLO (Verona, Italy), an authorized institution for cadaveric studies, between October 2021 and January 2022 in accordance with ethic committees' approval.

* Corresponding author. Creator of the described technique. Istituto di Ortopedia e Traumatologia, Università Cattolica del Sacro Cuore, Largo Francesco Vito 1, 00168, Roma, Italy.
E-mail address: rocco.devitis@policlinicogemelli.it (R. De Vitis).

[1] Contributed equally to this work with: Marco D'Orio.

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decompression results in nerve instability with the ulnar nerve visibly subluxing during flexion-extension movements of the elbow. However, both these techniques present a series of disadvantages due to the major vulnerability of the Ulnar nerve to injury by contusion, stretching or strangulation.[1] Ulnar nerve subluxation, as described by Childress in 1975 and classified as Type A, is a partial dislocation of the ulnar nerve in which the nerve stops on the tip of the medial aspect of the epicondyle upon flexion at the elbow of 90° or more, differently if the nerve crosses completely, from posterior to anterior, the medial epicondyle is classified as luxation (Childress Type B).[11] The new technique the authors are introducing in this article, is designed to solve the nerve instability after decompression, without anterior transposition, thus ensuring nerve protection. This technique consists in creating a new wider coverage for the Ulnar nerve, with an epicondylar fascial flap (EFF), according to ulnar wrapping described by Han.[1] The authors performed a cadaveric study on 20 elbows, to investigate the kinematic feasibility of this new technique.

2. Materials and methods

Among the thirty-six available upper limbs, the authors performed their EFF technique on twenty elbows. The remaining sixteen were excluded from this study as the ulnar nerve did not subluxate during flexion-extension movements of the elbow after its decompression

Among the twenty elbows used, 11 were right's and 9 were left's, from fourteen different donors (9 men, 5 women) with a mean age of 77.7 years old (range 69-89). The upper limbs were used within 72 hours from death, and were preserved at a temperature of -5°C. The study was performed at ICLO (Verona, Italy), an authorized institution for cadaveric studies, between October 2021 and January 2022 in accordance with ethic committees' approval. EFF technique was performed by two hand surgeons (MD and CF). The technique was created by RDV. The diameter of the ulnar nerves and of the new tunnels, were measured manually with a millimeter caliber by the same surgeon (CF), to reduce measurements bias. The tunnel diameter was measured both in flexion and in extension, from the roof to the floor, in maximum dilatation achieved with a surgical forceps.

2.1. Operative procedure

A curvilinear skin incision (6–8 cm) overlying the course of the ulnar nerve, midway between the olecranon and the medial epicondyle is performed. The deep fascia is divided through blunt dissection and the ulnar nerve is identified, in the post condylar groove, by sharply dividing the fascial roof between the medial epicondyle and olecranon, known as Osborne's ligament. The neurolysis is performed following the nerve in a proximal to distal direction, incising the aponeurosis between the two heads of the flexor carpi ulnaris muscle, the so-called Osborne's band. Finally, the ulnar nerve is also released proximally to the elbow, underneath the Arcade of Struthers. Once confirmed that no residual compression is present, the nerve is examined for subluxation by moving the elbow to the highest degrees of flexion-extension range of motion. In case of significant subluxation, a rectangular superficial fascial flap, 3 × 1.5 cm (Fig. 1), belonging to the flexor muscles enthesis, immediately distal to medial epicondyle insertion, is elevated from volar to dorsal (Fig. 2) and overturned to cover the Ulnar nerve in its groove (Fig. 3), creating a new wider roof (Fig. 4). The elevated fascial flap is firmly anchored to the soft tissue of the Ulnar bed through absorbable sutures. This fascial flap mimics the olecranon epitrochlear ligament restraining the unstable ulnar nerve on a more superficial plane once neurolysis has been performed. The gliding of the Ulnar nerve is then checked again to ensure that there is no compression or subluxation during elbow movements. The skin is then closed with simple interrupted nylon

Fig. 1. Elbow surgical access and flap design.

Fig. 2. Raised fascial flap.

Fig. 3. Fascial flap sutured over the ulnar canal at the elbow.

Fig. 4. Space under the new tunnel.

sutures and a soft compressive dressing is applied.

2.2. Outcomes

The aim of this study is to assess the feasibility of the EFF technique, insuring a non-compressive protection of the ulnar nerve avoiding its subluxation. Therefore, for each specimen on which the EFF technique was performed the authors measured the ulnar nerve diameter (in mm), the diameter of the new tunnel (both in elbow extension and flexion), the authors then calculated the difference between those two previous measures (Δ = "diameter of the new tunnel in elbow flexion" - "ulnar nerve diameter"), and finally they assessed whether the ulnar nerve still subluxate during flexion-extension movements of the elbow after the EFF technique was performed. Results are presented case by case and as mean with standard deviation (SD).

3. Results

Results are presented in Table 1. Among the twenty available upper limbs, mean ulnar nerve diameter at the elbow was 5.1 mm (SD = 0.6, range 4–6). After the EFF technique was performed the mean diameters of the new tunnels, measured with a millimeter caliber by the same surgeon (CF), were of, respectively in extension and in flexion, 10.1 mm (SD = 1.0, range 8–11) and 8.9 mm (SD = 0.9, range 7–10).

The mean difference between "diameter of the new tunnel in elbow flexion" and "ulnar nerve diameter" (Δ) was 3.8 mm (SD = 0.7, range 3–5).

The ulnar nerve didn't subluxate from its groove in any of the specimens after the EFF technique was performed.

4. Discussion

The size of the cubital tunnel plays a central role in the pathogenesis of Cubital Tunnel syndrome, since it physiologically decreases by 55% during elbow flexion.[1] Simultaneously, during elbow flexion, the Ulnar nerve is subjected to a lengthening of approximately 4–7 mm.[12] This compression and stretching condition, can lead, in some cases, to an ischemic damage and inflammation of the nerve, with a reduction of its function.

Nowadays there is no consensus about the best surgical treatment for patients diagnosed with cubital tunnel syndrome, in fact therapeutic approach can change according to surgeon's preference.[13–15] Every surgical technique presents its disadvantages, in fact the anterior transposition of the Ulnar nerve, especially if subcutaneous, increases the risk of nerve damage by contusions or stretching. This same risk condition, could be reproduced also after medial epicondylectomy. To avoid this superficial exposure, some authors reported sub or intra-muscular nerve burial after anterior transposition,[1–3,5–7,13,14,16,17] but this procedure, on the other hand, could lead sometimes to a cicatricial contracture with strangulation of the nerve and a subsequent neuritis.[16] Strangulation of the nerve was described also at the medial intermuscular septum, if it is not properly incised when the Ulnar nerve is being transposed.

The introduction of subfascial method brought less scarring and fast recovery compared to the submuscular and intramuscular

Table 1
Specimen biological data and results.

Specimen number	Age	Sex	Side	Ulnar nerve diameter	New tunnel diameter in extension	New tunnel diameter in flexion	Δ	Subluxation after EFF technique
1	69	M	L	5	10	9	4	no
1 bis	69	M	R	5	10	9	4	no
2	82	M	L	6	11	9	3	no
3	85	W	R	5	9	8	3	no
4	73	W	L	5	10	8	3	no
4 bis	73	W	R	5	10	8	3	no
5	89	M	R	5	11	10	5	no
6	87	M	R	6	10	9	3	no
7	71	M	L	5	10	9	4	no
7 bis	71	M	R	6	11	10	4	no
8	77	M	R	5	11	9	4	no
9	81	W	L	4	8	7	3	no
9 bis	81	W	R	4	8	7	3	no
10	79	W	L	4	9	8	4	no
10 bis	79	M	R	5	11	10	5	no
11	88	M	R	5	10	9	4	no
12	70	M	L	5	11	10	5	no
13	76	W	L	5	10	9	4	no
14	77	M	L	6	11	10	4	no
14 bis	77	M	R	6	11	9	3	no
Mean (SD)	77.7 (6.4)	/	/	5.1 (0.6)	10.1 (1.0)	8.9 (0.9)	3.8 (0.7)	/

Age is in years old, diameters and Δ are in millimeters. M = man; W = woman; L = left; R = right.

methods, positioning the nerve in a separation plane occurring between the fascia and muscles.[18] Otherwise, the surgical technique presented by the author of this article, allows the nerve to adhere less and to glide easily because it runs inside the healthy and nontraumatic fascia surface, maintaining the protection granted by the medial epicondyle. Furthermore, authors believe that this technique could be applied also in Ulnar nerve primary instability, not due to cubital tunnel release, because the new tunnel is located more proximally and superficially than the natural one, so it could provide greater stability.

It could be argued that the use of the fascia from the flexor muscle enthesis could weaken those muscles force. Of course, this cadaveric study cannot confirm or deny this affirmation. Though the authors believe, based on their clinical experience and literature[19] on surgeries for tennis elbow in which the extensor muscle enthesis is dissected without weakening of these muscles, that using a small flap of fascia should not decrease flexor muscles force.

According to the present study, authors believe the EFF technique is feasible in both males and females with unstable ulnar nerve after neurolysis, avoiding more invasive procedures. Moreover, the eventual use of this technique in vivo would not compromise in anyway further surgery with a more traditional technique in case of in vivo unsuccess. Therefore, authors encourage clinical application of this technique in spite of the limitation of this study due to its cadaveric aspect.

Declaration of competing interest

The authors declare that they and their families have no known competing financial or personal relationships that could be viewed as influencing the work reported in this paper.

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