Conservative therapy in ulnar neuropathy at the elbow (Review)

DANIELA POENARU, FLORINA OJOGA, MIRUNA SANDULESCU and DELIA CINTEZA

Department of Rehabilitation, 'Carol Davila' University of Medicine and Pharmacy, Bucharest 052785, Romania

Abstract. Ulnar neuropathy at the elbow (UNE) is the second most frequent entrapment syndrome in the upper limb after carpal tunnel syndrome. Clinical features are validated through electromyographic and sonographic examination. Although the two aforementioned entrapment syndromes share common pathophysiological traits, the conservative treatment approach for mild and moderate cases of UNE differs from that for median nerve entrapment. The present study identified 23 different types of scientific articles aimed to address this issue. The research stressed the importance of patient education and activity modification. Night splinting offers clinical and functional improvement. Although corticosteroid injections play a role in selected cases, their utility remains to be validated. Physiotherapy trials evaluated ultrasound, low-level laser therapy, diathermy, extracorporeal shock wave therapy and dry cupping. Neurodynamic mobilization may add value to therapeutic approaches and should be a part of it.

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1. Introduction

Ulnar neuropathy at the elbow (UNE) is the second most frequent entrapment neuropathy in the upper limb after carpal tunnel syndrome, and the most frequent site for ulnar compression. Ulnar nerve dysfunction is the result of pressure from surrounding anatomical structures, as well as external forces of friction or traction (1).

The diagnosis of UNE is based on clinical signs and symptoms, and is confirmed by electrophysiological and ultrasonographic studies. The clinical symptoms include paresthesia and numbness distal to the elbow, pain over the medial elbow, and possibly motor loss in the hand and forearm. Repetitive elbow flexion or external pressure at the ulnar aspect of the elbow may provoke or aggravate the symptoms.

2. Classification and staging

In terms of clinical severity, McGowan (2) described three grades: i) Mild (intermittent paresthesia and subjective weakness); ii) moderate (intermittent paresthesia and measurable weakness); and iii) severe (persistent paresthesia and measurable weakness). Later, Dellon (3) refined the definitions of the three stages, considering more clinical signs, including sensory, motor and provocative tests. This is known as the McGowan and Dellon score (4).

Another classification is based on compression localization, including electrodiagnostic and sonographic tools. Electrodiagnostic studies may be performed in the classical way, as sensitive and motor conduction velocities, or as short segment nerve conduction studies. Ultrasound scans are performed with a linear array transducer with high frequency (4-13 Hz, preferably at the higher values of this range). According to the information from electrodiagnostic and ultrasonographic exams, there are mainly two conditions, situated 2-5 cm apart, that generate nerve dysfunction. The first condition affects 15% of patients, and consists of entrapment at 2-3 cm distal to the medial epicondyle under the humeroulnar aponeurosis, in the cubital tunnel. This is considered a true entrapment due to intrinsic compression. The second condition affects the remaining 85% of patients, and consists of compression at the medial epicondyle or ≤4 cm proximally, in the retrocondylar groove. In this situation, apparently there is no anatomical constricting structure, and the nerve is compressed against the underlying bone. This is an external compression due to repeated, prolonged or excessive pressure against a hard support. The two conditions differ from the clinical and therapeutic point of view. The entrapment under a thickened humeroulnar aponeurosis occurs mainly as an expression of workload (heavy chores/activities), with symptoms that last a long time (usually months) and consequently become more severe. Ultrasound examinations show nerve compression and

Correspondence to: Dr Daniela Poenaru, Department of Rehabilitation, 'Carol Davila' University of Medicine and Pharmacy, 37 Dionisie Lupu Street, Bucharest 052785, Romania
E-mail: dnpnr27@gmail.com

proximal thickening, with an appearance of an hourglass. Surgery is the therapy of choice. By contrast, the compression in the retrocondylar groove occurs mostly in cases of prolonged support on hard surfaces (as in computer users, as well as handwriting and drawing professionals). Forearm pronation is an enhancing factor, as it increases the pressure on the nerve. The condition has milder clinical intensity and a shorter evolution, and ultrasound reveals an absence of nerve constriction and moderate nerve thickening compared with those exhibited by the entrapment (first condition). This condition is managed mainly conservatively (5-7).

Besides humeroulnar aponeurosis and retrocondylar compression, ulnar neuropathy may result, in rare situations, from compression from neighboring structures (tumors or the anconeus epitrochlearis muscle), adjacent humeroulnar joint modification (spurs, cysts and ganglions in case of rheumatoid arthritis), bone abnormalities (cubitus valgus) or subluxation of the ulnar nerve over the medial epicondyle with elbow flexion (8).

In terms of nerve dysfunction, as evaluated by electrophysiological studies, Padua *et al* (9) reported five classes of severity: i) Negative UNE with normal findings in all tests; ii) mild UNE, slowing of motor nerve conduction velocity (MNCV) across the elbow and normal sensory action potential (SNAP); iii) moderate UNE, slowing of MNCV across the elbow and reduced amplitude of SNAP; iv) severe UNE, slowing of MNCV across the elbow and absence of ulnar SNAP; and v) extreme UNE, absence of hypothenar motor and sensory response.

3. Search strategy

There are two options for the treatment of UNE: A conservative approach or surgery. The conservative approach is represented by a variety of interventions, with variable results, including patient education, splinting, pharmacological and physiotherapeutic manipulation, and mobilization techniques.

The databases employed in the present study were MEDLINE (through PubMed) (https://pubmed.ncbi.nlm.nih.gov/), the Physiotherapy Evidence Database (https://pedro.org.au/) and the Cochrane Library (https://www.cochranelibrary.com/). The search included all articles available since 1988 until December 2021. The Medical Subject Headings used were 'ulnar neuropathy elbow' and 'conservative treatment'. A total of 319 titles were identified. Upon excluding duplicates and articles referring to surgical therapy, 160 titles were left, the abstracts of which were read, and a total of 26 articles were selected within the following categories: Case reports, case series, pilot studies, observational trials and interventional trials. Two articles were not available as full text. One study containing a case report of a secondary UNE (decompensated rheumatoid arthritis) was excluded as it was managed by treating the underlying condition followed by subsequent surgical interventions.

The full-text articles were independently studied, and the following data were extracted into a Microsoft Excel (v. 2007) file: i) Author; ii) publication year; iii) design; iv) number of participants; v) severity (McGowan-Dellon classification); vi) duration of symptoms; vii) intervention; ix) outcomes; x) assessments; xi) results; and xii) comments (Table I).

The 23 articles included 2 single case reports, 3 case series, 3 pilot studies, 2 retrospective studies and 13 prospective trials [including 4 randomized controlled trials (RCTs)]. The first citations were from 1993 and the last ones from 2021. There was a total of 769 UNE cases.

The studies were conducted following clinical, functional, electrophysiological and sonographic outcomes. There was a relative homogeneity among the outcome categories. Clinical evaluation included pain, paresthesia, sensory discrimination and muscle weakness. Pain at night or during activity was measured using the visual analogue scale. Paresthesia and sensory disturbances were localized on the ulnar margin of the hand, and on the fourth and fifth fingers. Semmes-Weinstein filaments quantified the two-point sensory discrimination between two points. The clinical tests included Tinel's, Froment's and Wartenberg's signs, with the last referring to weakness in ulnar innervated muscles. The strength of the first dorsal interosseous, abductor digiti minimi, flexor carpi ulnaris and flexor digitorum profundus was assessed by the Medical Research Council score (10) between 0 and 5. Motor waste was observed as reduced grip, pinch strength and muscle hypotrophy. Global function of the upper arm was assessed by using the Disabilities of the Arm, Shoulder and Hand questionnaire (11). Electrophysiological evaluation included sensory and motor nerve conduction velocities, or short segment nerve conduction velocities and muscle activity in the aforementioned four muscles. Ultrasound evaluation followed the nerve in the longitudinal and sagittal planes along the cubital tunnel, measuring the cross-sectional area.

4. Results

Natural evolution and patient education. Patient education was instituted in all treatment groups, and consisted of information about the local anatomy and provocative factors, instructions for activity modification (avoidance of precipitating factors), and cushioning or padding according to the activity.

In a previous prospective study, 80 patients with UNE (the majority of which exhibited mild UNE) received only educational information and were evaluated after 3 months. Patient education had two components: Explanation of pathophysiology and activity modification. Outcomes were clinical (signs and symptoms) and electrophysiological parameters. In total, 66% of cases had excellent and good outcomes, with the first results appearing after 1 month and reaching a plateau after 3-20 months. A total of 24% of cases were referred to surgery due to a bad outcome. As for prognostic factors, mild nerve degeneration and no degeneration were associated with a better outcome. No nerves were worsened during the 3-month evaluation period. The study concluded that patient education was safe and had no contraindications. The main indications of the study were that mild and moderate-severity cases, and even high-severity cases, may occasionally benefit (12).

A prospective cohort trial on 84 UNE cases, out of which 46 were treated conservatively (education) reported remission in 11% of cases and improvement in 24% of cases. A total of 39% of cases remained stable, while 26% of cases worsened and required surgical intervention. Favorable outcomes were associated with a smaller diameter of nerve at ultrasound examination. Patients with a diameter of nerve >3.5 mm at the

Table I. Studies on UNE and conservative therapies.

First author/s, year	Type of study	UNE cases, n	Severity	Duration of symptoms	Intervention	Outcomes	Assessment	Results, (%)	Comments	(Refs.)
Seror, 1993	Prospective, interventional	22	All grades, including 3 patients with unsuccessful post-operation outcomes and 4 patients with grade 3	0.5-24 months (mean, 8.3 months)	Night splinting, 15-60°, 6 months	Clinical, EMG	Baseline, 6 months	Pain and paresthesia improved, muscle wasting (when present) unchanged	Inhomogenous group regarding severity and symptom duration	(15)
Dellon, 1989	Prospective, interventional	164	All grades of severity	Not specified	Patient education, night splinting 15°, 6 months	Clinical, EMG	Baseline, every 3 months	Symptom free: Grade 1 (43% of grade I patients), grade 2 (34% of grade II patients), grade 3 (20% of grade III patients)	Inhomogenous group regarding severity, no information about symptom duration	(3)
Hong et al, 1996	RCT	12	All grades of severity	4-18 months	Control (splinting, 5 UNEs), Study (splinting + one CS injection, 7 UNEs)	Clinical, EMG	Baseline, 1 month, 6 months	Both groups improved significantly, no significant difference	No stratification according to severity	(20)
Padua et al, 2002	Retrospective, observational	24	Mild and moderate	Not specified	Patient education, 6 months	Clinical, EMG	9-19 months	Untreated patients improved (50), untreated patients stable (29), untreated patients worsened (21)		(14)
Beekman et al, 2004	Prospective, blinded, cohort	46 (conservative treatment)	All grades of severity	3.5 months	Patient education	Clinical, ultrasound	Baseline, 16.3 months	Remission (11), improvement (24), stable (39), worsened (26), ultrasound positive	Inhomogeneous group regarding severity	(13)
Coppieters et al, 2004	Case report	1	Mild	2 months	NDM (gliding and tensioning)	Clinical, functional	Baseline, 1 month, 6 weeks, 10 months	Complete remission	One single case	(31)

Table I. Continued.

First author/s, year	Type of study	UNE cases, n	Severity	Duration of symptoms	Intervention	Outcomes	Assessments	Results, (%)	Comments	(Refs.)
Svernlöv *et al*, 2009	RCT	70	Mild and moderate	3 months	Night splinting (21 UNEs) NDM (gliding)-home-based (15 UNEs) Control, education (15 UNEs)	Clinical, functional, EMG	Baseline, 6 months	All parameters improved, no difference between groups	Symptoms >3 months	(33)
Nakamichi *et al*, 2009	Interventional, prospective	80	Mild	1-60 months	Education	Clinical, EMG	Baseline, 3 months	Excellent and good outcomes (66%), fair (7,5%) and poor (26,5%) nerve degeneration: Absent or mild respond better	Non-laborer patients, compliance was not evaluated	(12)
Oskay *et al*, 2010	Clinical, observational, case series	7	Mild and moderate	4-6 weeks	Ultrasound + NDM (gliding) + cryotherapy, 3 sessions/week, 8 weeks	Clinical, functional	Baseline, 8 weeks, 12 weeks	8 weeks: Pain, grip and pinch strength improved; 12 weeks: Sensation and DASH improved	Small sample, multimodal approach, lack of control group	(32)
Rampen *et al*, 2011	Case series	7	Mild	Not specified	CS injection	Clinical, EMG, ultrasound	Baseline, 6 weeks	57% improved, 29% remained unchanged, 14% aggravated	Small group, lack of control	(21)
Alblas *et al*, 2012	Pilot study	9	Mild and moderate	Not specified	One CS injection	Clinical, EMG, ultrasound	Baseline, 3 months	No complications 63% improved, 13% deteriorated, 36% unchanged	Lack of control, small sample	(18)
Shah *et al*, 2013	Prospective, cohort	25	Mild and moderate	1-41 months (mean, 7 months)	Education + splint, immobilization nighttime, 3 months	Clinical, functional	Baseline, 6 weeks, 3 months, 2 years	Patients improved at 3 months (88), persisted at 2 years	Lack of control group	(17)
Ozkan *et al*, 2015	Randomized, single-blind trial	29	Mild and moderate	5 months	Ultrasound (14 UNEs) low-level laser therapy (15 UNEs)	Clinical, EMG	Baseline, 2 weeks, 1 month, 3 months	Improvement of pain and function at all moments, no statistical difference between groups	Lack of control group	(29)

Table I. Continued.

First author/s, year	Type of study	UNE cases, n	Severity	Duration of symptoms	Intervention	Outcomes	Assessments	Results, (%)	Comments	(Refs.)
vanVeen et al, 2015	Randomized, double-blind, placebo-controlled trial	55	Mild and moderate	>2 months	CS (30 UNEs) Placebo, saline (25 UNEs)	Clinical, EMG, ultrasound	Baseline, 1 month, 3 months	Both groups improved significantly, no difference between groups	Small sample, long duration of symptoms	(24)
Choi et al, 2015	Pilot study	10	Mild and moderate	4-18 months (mean, 9.5 months)	CS injection, guided ultrasound	Clinical, EMG, ultrasound	Baseline, 1 week, 4 weeks	Improvement of symptoms and morphological outcomes followed by improvement of electrophysiological outcomes, no complications	Small number, lack of control	(22)
Shen et al, 2018	Pilot study	10	Moderate	≥6 months	ESWT	Clinical, functional	Baseline, 4 weeks, 8 weeks, 12 weeks	Improvement of symptoms and disability at all moments	Lack of control, small sample	(29)
Lee et al, 2018	Prospective, interventional	10	Not specified	Not specified	CS injection, guided ultrasound	Clinical, ultrasound	Baseline, 2 weeks, 12 weeks	60% improved symptoms (when CSA >10 mm^2), greater CSA was associated with better clinical outcome	Lack of control, small sample	(23)
Stoddard et al, 2019	Case report	1	Mild, failure of conservative treatment, did not stop training	2 months	5% dextrose, hydrodissection	Clinical	72 h, 1 month, 3 months, 5 months	Paresthesia improvement (90), elbow pain persisted at 3 months and reduced at 5 months	No case control, no physical rest	(19)
Anandkumar and Manivasagam, 2019	Case series	3	Mild and moderate	8 weeks	Dry needling, NDM	Clinical, functional	Baseline, sessions 1-4, 6 months	Complete resolution after four sessions, persistence at 6 months	Small sample, dry needling as a special technique	(34)

Table I. Continued.

First author/s, year	Type of study	UNE cases, n	Severity	Duration of symptoms	Intervention	Outcomes	Assessments	Results, (%)	Comments	(Refs.)
Chen *et al*, 2020	Prospective, randomized, double-blind, head-to-head comparative trial	33	Mild and moderate	41-44 months	Dextrose 5% (17 UNEs), CS (16 UNEs)	Clinical, functional, EMG, ultrasound	Baseline, 6 months	Both groups improved significantly, with no difference between them	Small sample, no control (sham) group	(25)
Bilgin Badur *et al*, 2020	RCT, double-blind	61	Mild and moderate	Not specified	Continuous diathermy (31 patients) vs. sham (30 patients)	Clinical, functional	Baseline, following treatment, 1 month, 3 months	Both groups improved at all moments, with no difference between groups	N/A	(27)
Galal *et al*, 2021	RCT	24	Mild and moderate	Not specified	Ultrasound + NDM + physical exercise (12 UNEs) Vs. ultrasound + NDM + physical exercise + dry cupping (12 UNEs) 3 times/week, 6 weeks	Clinical, functional	Baseline, 6 weeks	Improvement in both groups, no difference between groups	No electrophysiological or ultrasound parameters	(30)
Gronbeck *et al*, 2021	Retrospective	66	Mild, failure of conservative therapy	Not specified	One guided ultrasound, CS injection	Clinical	Baseline, 1 month, 3 months	Improved (55), transitory (68), when referred to surgery improved completely (85), did not improved/worsened (45), when referred to surgery improved completely (25)	Small sample, no quantitative parameters	(26)

EMG, electromyography; CS, corticosteroids; RCT, randomized controlled trial; NDM, neurodynamic mobilization; ESWT, extracorporeal shock wave therapy; UNE, ulnar neuropathy at the elbow; N/A, not applicable; DASH, Disabilities of the Arm, Shoulder and Hand questionnaire; CSA, cross sectiona area.

time of diagnosis remained symptomatic regardless of the type of therapy (conservative or surgical) (13).

In 2002, Padua et al (14) analyzed 30 patients with UNE, 24 of which were untreated and 6 of which were treated surgically. The outcomes were clinical and electrophysiological, both at baseline and 9-19 months later. The untreated group consisted of mild and moderate cases (according to the electrophysiological classification), and received only educational material. In total, 50% of patients in this group reported clinical improvement, while 29% exhibited a stationary condition and 21% reported worsening. From the surgical group (which included moderate, severe and extreme UNE cases), 83% of patients reported improvement while 17% reported worsening. The study concluded that there was a natural tendency of improvement for UNE, at least for mild and moderate cases, provided education is implemented.

Splinting. Splinting prevents flexion of the elbow above a certain value; it may be performed during the night or daytime, and should allow a certain degree of elbow flexion, as well as unrestricted pronation and supination.

Seror (15) studied night splinting (15-60˚) for 6 months in 22 patients with variable symptom duration (0.5-24 months) and all grades of severity, including 4 patients with muscle loss (grade 3 McGowan-Dellon) and 3 with unsuccessful surgical decompression. Assessments were performed at baseline and after 6 months. Clinical improvement was noted in all patients, irrespective of severity, ranging from total to ≥50% improvement. The electrophysiological outcomes improved in all patients; however, when present, clinical and electromyographic muscle wasting persisted (15).

In 1993, Dellon et al (16) published a prospective interventional 8-year study on 128 patients with 164 UNEs and all grades of severity (including patients with grade 3 UNE who refused surgery). The intervention was conservative for 6 months, with patient education and night splinting to prevent flexion >30˚. Assessments were performed every 3 months until improvement or failure. Patients became symptom free in 42% of mild cases, 34% of moderate cases and 20% of severe cases. There was no association between abnormal electrodiagnostic tests and failure of clinical improvement, suggesting that splinting may work even on severe cases (16).

Shah et al (17) followed up 25 patients with mild and moderate UNE receiving education and nighttime splinting (flexion 45˚) for 3 months. Clinical and functional evaluation at 3 months showed 88% improvement and persistence of results at 2 years. Nighttime splinting was well tolerated.

Corticosteroids and other agents. A pilot study on 8 patients with UNE reported that corticosteroid injections (1 ml containing 40 mg methylprednisolone and 10 mg lidocaine hydrochloride) within the cubital tunnel and under ultrasound guidance were safe. After 3 months, there were no complications reported (symptom aggravation or infection at the site of injection), and 5 patients showed improvement of symptoms with no change in ulnar nerve thickness (18).

A case report was published on a 15-year-old female competitive swimmer with cubitus valgus and UNE, who,

after failure of conservative treatment (relative rest, physical therapy, nocturnal splinting and non-steroidal anti-inflammatory drugs), opted for a hydrodissection of the nerve at the distal cubital tunnel using a 5% dextrose solution. The procedure was performed under ultrasound guidance, with an in-plane technique, aiming at the site just before entering the cubital tunnel and obtaining a circumferential anechoic halo around the nerve. The patient did not discontinue training. The results revealed 90% resolution of the paresthesia at 72 h, and at the 1 and 3-months follow-up. The elbow pain remained unchanged during this time interval and improved partially at 5 months. There were no complications (bleeding, infection, pain aggravation or intraneural injection). The procedure was safe and the results satisfactory (19).

In an RCT, Hong et al (20) investigated the effect of adding a corticosteroid injection to splinting. A total of 12 patients with UNE were divided into a control group (consisting of 5 patients who were asked to wear a splint during the nighttime and occasionally during the daytime) and a study group (consisting of 7 patients receiving the same splinting modality with one single corticosteroid injection within the cubital tunnel). Clinical and electrophysiological data were collected at baseline, and at 1 and 6 months. Both groups displayed significant improvement in the outcomes, suggesting that splinting may be an efficient therapy; however, corticosteroid injection did not add any benefit, as the differences between the two groups were not statistically significant.

A case series of 7 patients with mild UNE receiving one ultrasound-guided injection of 1 ml corticosteroid (triamcinolone) plus lidocaine assessed clinical (signs and symptoms), electrophysiological and sonographic outcomes. After 6 weeks, the symptoms of 4 out of the 7 patients improved, while in 2 patients they remained unchanged and in 1 they were aggravated; these latter 3 patients were referred to surgery. The study considered corticosteroid injections to be a viable alternative to surgery (21).

A pilot study investigated 10 patients with UNE receiving one corticosteroid injection (2 ml containing 40 mg triamcinolone and 1% lidocaine) under ultrasound guidance (in-plane technique) to release the nerve by hydrodissection. Clinical, ultrasound and electrophysiological outcomes were evaluated at baseline, and at 1 and 4 weeks. Clinical signs improved significantly at 1 and 4 weeks. Ultrasound cross-sectional area improved significantly at 4 weeks, while the majority of the electrophysiological parameters did not register a significant difference (with the exception of motor velocity conduction across the elbow increased at 4 weeks). The study concluded that clinical and morphological improvement occurred before the electrophysiological changes (22).

A prospective interventional trial followed up 10 patients with UNE at 2 and 12 weeks after ultrasound-guided injection of 1 ml betamethasone (6 mg) and 1 ml lidocaine (1%) at the location of maximum swelling. Clinical improvement was noted in 6 out of 10 patients, and was associated with a nerve cross-sectional area >10 mm^2. Thus, corticosteroid injection may be efficient in a subset of patients with increased cross-sectional area (23).

A randomized double-blind placebo-controlled trial on 55 UNE cases of mild-to-moderate severity compared one

local injection with corticosteroid (1 ml containing 40 mg methylprednisolone and 10 mg lidocaine) vs. placebo (1 ml saline). All participants received educational material, and the injection was performed under sonographic guidance in the long axis view. Outcomes were clinical, electrodiagnostic and sonographic parameters evaluated at baseline and 3 months later. A success rate of 30% was noted in the corticosteroid group vs. 28% in the placebo group, with no significant difference. Certain additional results emerged. Namely, the cross-sectional area of the ulnar nerves diminished in the corticosteroid group due to local anti-inflammatory effects, but remained above the cut-off value, thus possibly explaining the lack of influence on the outcome. Irrespectively of group allocation, patients with motor conduction block tended to respond better to treatment. Generally, the only predictive factor for a favorable outcome was the duration of the symptoms (the shorter the duration, the better the outcome). It was presumed that inflammation was important in the first 4-6 weeks, since corticosteroids did not appear to play a role if symptoms lasted >2 months (24).

In 2020, a randomized, prospective, double-blind clinical trial compared corticosteroid vs. 5% dextrose in one perineural hydrodissection injection of 33 UNE cases. The intervention was performed under ultrasound guidance, and patients received either 5 ml dextrose (5%) or 3 ml triamcinolone and 2 ml saline around the cubital nerve. Both groups showed significant improvement in clinical, functional and electrophysiological parameters after 6 months, with no statistically significant difference between them (25).

In 2021, a retrospective study on 66 UNE cases assessed the short-term effect (at 1 and 3 months) of one ultrasound-guided corticosteroid injection in mild cases that failed to respond to conservative therapy. In total, >50% of the patients reported symptom improvement, although various patients reported only a transitory improvement. Those patients with transitory improvement were referred to surgery and experienced complete symptomatic recovery. Patients who did not experience symptomatic improvement upon corticosteroid injection and were referred to surgery did not exhibit any subsequent improvement. The study suggested the potential utility of ultrasound-guided corticosteroid injections in identifying good candidates for surgery. Patients who did not respond to corticosteroid injections may be affected by additional health conditions (26).

Physiotherapy. A double-blind RCT on 61 patients with mild and moderate UNE evaluated the effect of shortwave diathermy (31 patients) vs. sham (30 patients). Diathermy was applied on the elbow region in a continuous mode of 27.12 Hz for 20 min per day, maintaining a distance of 2 cm, for 5 sessions per week for 2 weeks. Patient education and splinting were implemented in both groups. Clinical and functional outcomes were evaluated at 2 weeks, and at 1 and 3 months. Both groups improved equally at 2 weeks, and at 1 and 3 months, without significant differences between them. Improvement of symptoms was considered to be the result of splinting and patient education. Diathermy was not found to have significant benefits, at least in the form used in the study. It was concluded that additional research on diathermy was required (27).

A pilot study on 10 UNEs (7 patients) of grade 2 (moderate) used extracorporeal shock wave therapy (ESWT) on the ulnar nerve proximal to the inlet of the cubital tunnel. The site of application was the swollen nerve as detected on ultrasound examination. ESWT was prescribed in the radial form, in 2,000 shots, at 4 Barr and 5 Hz, in 3 weekly sessions. Assessments were performed at baseline, and at 4, 8 and 12 weeks, and included clinical and functional outcomes. The results showed a significant improvement of symptoms and disability during the 12-week follow-up, and a good tolerance of the procedure (28).

An RCT on 29 patients with grade 2 cubital tunnel syndrome compared therapeutical ultrasound (11) and low-level laser therapy (LLLT) (12) for 10 daily sessions for 2 weeks. Ultrasound was applied in water as a transmission vector on the compression site with the following parameters: Frequency, 1 MHz; transducer area, 5 cm^2; intensity, 1.5 W/cm^2; duration, 5 min; and continuous mode. LLLT used a 905-nm wavelength, mean output power of 25 mW, 30 sec per point and 4 points around the entrapment site. The outcomes were clinical and electrophysiological, and were assessed at baseline, after 2 weeks, and after 1 and 3 months. Both groups improved significantly. At the 1 and 3-month follow-up, differences between the ultrasound and LLLT groups did not reach significance (86.7 vs. 82.3% at 1 month and 73.3 vs. 64.7% at 3 months). The study hypothesized a better effect of ultrasound on all outcomes due to the difference between groups at baseline, with patients subjected to ultrasound being more affected initially. However, the absence of a control group and the spontaneous natural evolution of UNE toward healing are factors that may have influenced the conclusions of the study (29).

A previous RCT compared a control group (12 UNEs) receiving therapeutic ultrasound, neurodynamic mobilization (NDM) and therapeutical exercise, with a study group (12 UNEs) receiving the same program supplemented by dry cupping alongside the nerve pathway in the upper limb in neurodynamic position. UNE staging was mild and moderate, and the therapy was performed 3 times/week for 6 weeks. Ultrasound was used in the pulsed form, at 1 W/cm^2 for 15 min. Clinical and functional assessment showed improvement in both groups, with no significant differences among them. The study concluded that dry cupping added no benefit to the rehabilitation program (30).

NDM receives interest from researchers. A case report on a patient with 2-month-old post-traumatic mild cubital tunnel syndrome, who attended 6 NDM sessions (gliding and tensioning) over 1 month, performed clinical and functional assessments at baseline, at 6 weeks and at 10 months. The evolution was favorable, with symptom disappearance and test normalization during the study (31).

A case series study followed up 7 patients with UNE of mild and moderate severity, who were included in a rehabilitation program that consisted of a local ultrasound application (an NDM sliding technique and a cold pack application), 3 times/week for 8 weeks. Clinical and functional assessments were conducted at baseline, and at 8 and 12 weeks. The majority of clinical parameters improved at 8 weeks, while the sensory and functional outcomes improved at 12 weeks. There

were numerous limitations in the study, including the fact that it was a small-cohort clinical observational study, it did not include a control group and it evaluated a multimodal therapy (combining different therapeutical agents with a potential effect on nerves). The study was conducted on patients with symptoms of short duration and with nerves in the subacute phase of healing (32).

A previous RCT included 51 patients with UNE lasting for >3 months, who were divided into three groups: i) Night splinting to prevent flexion >45˚ (21); ii) NDM with gliding exercises as a home-based program (12); and iii) control (15 patients receiving educational information). Assessments were conducted at baseline and 6 months with clinical, functional and electromyographical measurements. The results revealed a significant improvement in all parameters and for all groups at 6 months. No differences were noted between the groups. An equal number of patients (n=2) from every group underwent surgery due to treatment failure. It was concluded that patient education and the natural evolution of the disease lead to as much improvement as splinting or NDM alone (33).

A case series reported the outcomes of 3 patients with mild and moderate UNE, and with failure of conservative treatment (splinting, physiotherapy and mobilization) who were subjected to dry needling for four sessions (twice a week) and daily NDM. Clinical and functional outcomes were assessed at every dry needling session, and after 6 months, the patients showed improvement, with complete resolution on the fourth session, which persisted after 6 months. Dry needling is considered to induce analgesia through different mechanisms, including gate control, endogenous opioids release and local angiogenesis (release of vasoactive substances). Dry needling is a complex procedure requiring special training and evaluation according to local severity, irritability and tolerance (34).

It is worth mentioning that certain experts recommend the use of the Priessnitz' wrap, although, to the best of our knowledge, there are no studies on this topic. Based on the local effect of tissue cooling and local hyperemia, the wrap may reduce nerve swelling and inflammation, which is visible on ultrasound examination (35).

Discussion. The conservative approach reviewed in the aforementioned studies included patient education, splinting, local injections, physiotherapy and NDM.

Patient education and activity modification were found to be safe, easy to teach and efficient, with a mean duration of implementation of 3 months and without adverse effects. A response was recorded in 35-66% of cases of mild and moderate severity, with an improvement at 1 month and a plateau between 3-20 months. Severe cases or those with surgical failure may also improve after 3 months of education and activity modification. Importantly, controlled trials used as a sham group patients who received only education, as it is not ethically correct to refrain from a minimal beneficial intervention.

Splinting was used mainly during the nighttime and rarely during the daytime. An angle of 45˚ or a night orthosis limiting flexion between 15-60˚, or above 30˚ for 3 to 6 months were implemented for mild and moderate cases, with a rate of success between 76 and 88%. There is evidence that neither patient education or night splinting are efficient in mild or moderate cases, and it may be of interest to document the results of their association.

Local injections were performed under sonographic guidance to target the inlet of the cubital tunnel or the site of maximum swelling, or to release the nerve by hydrodissection. Corticosteroids were mainly preferred, but 5% dextrose was also common. The procedure was considered safe, with no complications such as bleeding, infection or symptom aggravation due to intraneural injection. When studied in particular cases or pilot trials without case controls, corticosteroids improved clinical and functional outcomes, suggesting their ability to identify good candidates for surgery when symptoms improved temporarily after injection. Compared with the outcomes of education only with saline (sham) or dextrose, corticosteroids failed to add a significant benefit.

These results are in contradiction to the improvement observed in carpal tunnel syndrome when local injections with corticosteroids were used (36). Median nerve entrapment is mainly due to flexor tenosynovial thickening, whereas ulnar neuropathy mainly consists of two focal neuropathies (humeroulnar aponeurosis and retrocondylar groove). In the study by Podnar and Omejec (37), it was hypothesized that, in carpal tunnel syndrome, corticosteroids act on the adjacent tenosynovium and reduce pressure on the median nerve, whereas in UNE, there is less surrounding soft tissue, and the compression is rather intermittent. In UNE cases, even if the ulnar nerve swelling decreased after corticosteroid injection, neither the clinical or electrophysiological parameters changed significantly.

Studies on physiotherapy are scarce (only one trial for every physical agent). Short-wave diathermy, therapeutical ultrasound, LLLT and dry cupping did not provide significant improvement of outcomes. A pilot study on ESWT suggested a possible benefit for moderate cases; however, further research is needed.

NDM became of interest when research on its use in carpal tunnel syndrome reported clinical and functional improvement (38). A previous case report mentioned a good outcome for a mild UNE. However, when compared with the outcomes of night splinting or education alone, NDM did not add any significant improvement (31).

The combination of various forms of conservative therapy (physiotherapy, NDM and cryotherapy) in mild and moderate cases suggested that, at least in the early subacute phase, there may be a statistically significant difference in outcomes.

A previous report on dry needling for a case of conservative therapy failure suggested clinical resolution. However, the technique needed special training and seemed not to be accessible to all physicians (34).

5. Conclusions

The second most frequent entrapment neuropathy in the upper limb, cubital syndrome, in its mild and moderate severity forms, is treated with conservative therapy. The central issue remains patient education and nighttime splinting, as these

interventions are safe, easy to apply, with significant improvement. Local injections, physiotherapy and manual therapy (NDM) may add value to the management plan for UNE.

Availability of data and materials

Not applicable.

Authors' contributions

DP and FO performed the database search and compared the selected articles. DC analyzed the selected articles and performed supplementary scanning. MS gathered the relevant data and created Table I. All authors read and approved the final manuscript. Data authentication is not applicable.

Ethics approval and consent to participate

Not applicable.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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