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Effectiveness of dry needling combined with eccentric strength training in lateral epicondylalgia with trigger points

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Abstract

Introduction. Lateral epicondylalgia (LE) is commonly presented with myofascial trigger points (MTrPs) among adults. Dry needling (DN) is used less frequently as a first-line treatment in LE with trigger points, and the short and long-term effectiveness of DN in these populations were not studied. Hence, this study compared the effectiveness of DN with conventional physiotherapy in the population of LE with myofascial trigger points.

Methods. For four weeks, the experimental group (n = 19) received DN with weekly one session, and the control group (n = 19) received therapeutic ultrasound combined with deep friction massage for 2 sessions per week at the active sites of active MTrPs. Both groups performed two eccentric exercises sessions from the 5th to the 6th week. Handgrip, pain and disability scores of patient rated tennis elbow evaluation (PRTEE) at baseline, 4th week, 6th week, and follow-up of 12th week were analysed.

Results. Handgrip strength, pain, and disability scores were significantly improved for the experimental group at 4th week (SMD of 1.21 kg in handgrip, 12.26 in PRTEE scores) and 6th week (SMD of 1.58 kg in handgrip, 10.15 in PRTEE scores) compared to the control group. However, no significant group differences (p > 0.05) after 12th week either grip strength (SMD = 0.84) or PRTEE scores (SMD = 3.74) were obtained.

Conclusions. Dry needling with exercise produced greater short-term improvements in grip strength and disability compared to the control group. However, no significant difference in outcomes was found between groups over a 12-week follow-up period.

Key words: orthopedics, physical activity and sports of handicapped, sport physiotherapy

Introduction

Lateral epicondylalgia (LE) is a condition characterised by lateral elbow pain and dysfunction of common wrist extensors [1]. The prevalence of LE was estimated to be between 1–3% in the general population, with an annual incidence of 4–7 cases per 1000 individuals [2, 3]. The primary cause of LE is a contractile overload that chronically stresses the common extensor tendons near the attachment to the lateral epicondyle of the humerus, commonly affecting the dominant arm. Repetitive movements and forceful activities are positively correlated with LE [3]. LE is characterised by the absence of soft-tissue healing mechanisms and hypovascularisation, which causes incomplete recovery following routine treatments [1]. Previous studies report a reduced handgrip strength and an overall reduction in elbow and hand functions as the hallmark symptoms of LE [4–6].

Myofascial trigger points (MTrPs) are hyperirritable spots within taut bands of skeletal muscle fibres that can produce local and/or referred pain, muscle weakness, and altered movement patterns [7]. A study reported that patients with LE have at least two muscles with active MTrPs and one muscle with latent MTrP within the common extensor muscle group. Further, the study results found MTrPs in the forearm muscles, such as extensor carpi radialis brevis, extensor carpi radialis longus, brachioradialis, and extensor digitorum communis, share similar pain patterns as their habitual lateral elbow and forearm pain [8]. Both active and latent MTrPs are potential causative factors in producing pain and associated movement dysfunctions, where active MTrPs are spontaneously painful and latent MTrPs are painful during manual palpation and muscular activity [7, 8]. Therefore, it is important to find the potential active/latent MTrPs and treat them effectively with appropriate trigger point deactivation therapy.

In the management of LE, various conventional treatments have been used, including manual therapy, therapeutic exercises, and electrotherapy interventions such as therapeutic ultrasound (TUS) [9]. Non-steroidal anti-inflammatory drugs, corticosteroid injection, low-level laser therapy [10, 11], massage, bracing, cryotherapy, and eccentric exercises [12, 13] are often used to reduce pain and disability. However, the results of these multimodal treatments suggest that there is a scope for further study to provide long-term clinical outcomes in the case of LE management [14]. Furthermore, healing mechanisms are not adequately addressed by these interventions and might be the reason for the lack of long-term clinical outcomes in LE.

Eccentric strength training has been shown to be an effective treatment for LE. Scientific findings on the effects of eccentric strength training show that eccentric exercises had a significant impact on reducing pain and improving strength and function in patients with LE [15]. A randomised-controlled trial found that a 6-week eccentric exercise regimen was effective in increasing pain-free handgrip and wrist-extensor strength in subjects with long-term LE [12]. A systematic review also found that eccentric exercise was effective in de-

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creasing pain and improving function and grip strength in patients with LE [16].

Acupuncture dry needling (DN) has been shown to induce soft tissue healing and facilitate muscle relaxation through MTrPs deactivation, but few studies have documented the benefits of DN for LE associated with MTrPs [17, 18]. DN may be an alternative method for the effective management of LE by inducing local tissue healing, promoting circulation, fibroblastic activity, collagen synthesis, and MTrPs deactivation [19]. Earlier studies also evidence that DN can suppress the level of nociception and improve muscle relaxation, including connective tissue flexibility [20–22]. Few studies on the effect of needle manipulation suggest that needle rotation improves clinical outcomes significantly. Needle manipulation is a technique used in DN that involves needle rotation and flicking, pistoning, fishing, and periosteal pecking. It can improve the pain threshold and fascia release significantly [23, 24].

There are several established treatments available for managing LE with MTrPs, including minimal arthroscopic surgery, pharmacological agents, corticosteroid injections, physical therapy, DN, low-level laser therapy, and other electrophysical agents [19, 21–23, 25]. However, there is a need for a cost-effective multimodal treatment that addresses LE presented with MTrPs. Recent studies have suggested that DN may be an effective treatment for LE by deactivating myofascial trigger points in patients with LE with MTrPs [19, 21–23]. The immediate effects of DN on reducing pain by stimulating the release of natural pain-relieving substances, promoting muscle relaxation, improving range of motion, increasing blood flow for tissue healing, modulating the nervous system to decrease pain sensitivity, and stimulating tissue repair and remodelling are well documented [26, 27].

Additionally, eccentric exercises have been found to be effective in improving function and grip strength in patients with LE [15, 16, 28]. Eccentric exercise is reported to be an effective way to strengthen tendons to mediate long-term effects. Eccentric exercise triggers biological responses that lead to tendon re-modelling and strengthening. Eccentric exercises also increase the production of growth factors, such as TGF-β, and the synthesis of collagen, which are important for tendon healing and repair [29–31]. Deactivating MTrPs or reducing muscle stiffness of the extensors of the wrist combined with eccentric strength training mediate enhanced healing and improved strength in an effective way that enhances clinical recovery of the wrist tendons [32]. Moreover, there is limited evidence available for the clinical effectiveness of DN combined with eccentric strength training in LE, and previous studies also recommended further study to achieve larger and long-term clinical effects [15, 16, 28]. Hence, this study aimed to investigate the effectiveness of combining DN with eccentric strength training for managing LE with MTrP, specifically focusing on hand grip and patient-related elbow function scores. Furthermore, the study also determined whether the combination of DN and eccentric strength training could result in enhanced and expedited clinical outcomes for individuals with LE with MTrP.

Subjects and methods

Study setting

This study was an assessor-blinded randomised controlled trial with short and midterm follow-up and was conducted between 2019–2021 at University Hospital.

Participants

The study recruited participants diagnosed with unilateral epicondylalgia by orthopaedic consultants using ultrasound. Participants with tennis elbow classification Grades 2 and 3 were included for study participation [33, 34]. The inclusion criteria were a positive Cozen's test, chair test, local tenderness over the lateral epicondyle, presence of MTrPs in the common extensor muscles, and reduced grip strength [35, 36]. There is no "gold standard" for the detection of MTrPs, but manual palpation is commonly used to identify the presence of MTrPs. A hypersensitive spot potentially felt as a palpable nodule within a taut band is a necessary MTrP diagnostic criterion, in addition to either referred pain, local twitch response, or signs of muscular dysfunction. Manual palpation was used for finding MTrPs [8, 19]. The study excluded patients with Grades 1 and 4, a diagnostic ultrasound finding of a complete tear of the common extensor tendons, major systemic illness, hypothyroidism, diabetes mellitus, rheumatoid, osteoarthritis of the elbow, peripheral neuropathies, cervical radiculopathy, shoulder disorders, bleeding disorders, recent fracture or metal implants, and needle phobia [36].

Randomisation methods

Informed consent was obtained from eligible patients once they were educated on the possible therapeutic and adverse effects of treatments before any allocation of treatment [37]. The patients were equally allocated in two groups with an allocation ratio of 1:1 using a simple random sampling method. There are 40 computer-generated random numbers given by the statistician to an office assistant, one who allocated participants in any one of the treatment groups. This method involves randomly selecting a subset of participants from a population, where each member of the population has an equal chance of being selected [38]. The assessor was blinded to the allocation of treatment, which is an important aspect of clinical trials to reduce detection bias. Furthermore, participants were informed not to reveal their allocated interventions to the assessor [39].

Sample size

The sample size calculation was performed to achieve a minimum sample size to obtain a significant between-group effect size ($\Delta = 0.5$) with a 95% confidence interval ($\alpha = 1.96$) and 80% power ($1\text{-}\beta = 0.84$) at a 0.05 significance level. The sample size estimation was performed using a paired *t*-test. The calculated sample size was 36 participants. To account for a 10% dropout rate ($n = 3$), the decision was made to recruit a minimum of 40 participants ($n = 20$ in each group) to achieve meaningful between-group differences in both primary outcomes. However, the research team included 38 participants for randomisation in this trial [4].

Dry needling intervention

In the experimental intervention group, the patient's forearm was positioned in pronation with a semi-flexed elbow and comfortably rested over a pillow. The area of skin over the lateral elbow and extensor muscle belly was cleaned with 70% isopropyl alcohol. The common tendinous origin of the extensor carpi radialis longus and brevis, extensor digitorum, and extensor carpi ulnaris muscles were marked approximately 1–2 cm distal to the lateral epicondyle. Then, the MTrP areas of the forearm's common extensor muscles were identified,

and the area above the trigger points was marked. Safe needling and hygienic procedures were followed to minimise the risk of adverse events and needle stick injuries [19].

The patients in the DN group were informed about the possible pinprick sensation, dull ache, and local muscle twitches while deactivating the trigger points. The areas of the needling sites (i.e., maximum tender spots confirmed through the manual palpation) were cleaned prior to the penetration of acupuncture needles. First, static DN was performed into the tendinous origin of muscles with 15–25 mm length (0.25 mm thick) needles and kept in position for 10–12 min. Then, MTrPs in the muscle belly of the forearm extensors were deactivated using deep DN techniques (using suitable length needles, i.e., 30–50 mm, according to the muscle's thickness and trigger point's depth) by eliciting local twitch responses through gentle 'to' and 'fro' movements of the needle [19, 40]. Following the deactivation of MTrPs, the needles were placed in the inserted state for 10–12 min (Figure 1). The needles over the common extensor muscle origin and MTrP sites within the muscle belly of common extensor muscles were rotated in the opposite direction with caution to stretch the tightened myofascial. The areas were compressed manually using sterilised dry cotton immediately after the removal of needles [19, 40]. This procedure was performed once weekly (twice in cases where sensitised latent MTrPs were found) for four consecutive weeks with the interval of 3–7 days between the two consecutive sessions to provide adequate time for cellular functional recovery and to minimise post-needling soreness [19]. The DN was administered by a certified DN practitioner, and patients were informed about the possible occurrence of muscle soreness and heaviness in the needled areas. They were also informed not to perform vigorous exercise immediately (24–48 hours) after the DN procedure.

Therapeutic ultrasound and deep friction massage

In the control group, TUS (Intellect Mobile Ultrasound, Chattanooga, JKR International LLC) was applied to promote the healing of micro-tearing in the origin of the forearm common extensor muscles, particularly around the lateral epicondylar area. The TUS, with an intensity of 0.3–0.8 w/cm^2, was applied (through the coupling media) to the tissues for 8 min in a single session per day (5–6 days in a week) for two consecutive weeks [9, 10]. After the application of TUS over the muscular origin, deep friction massage was applied over the MTrPs of the muscle twice weekly for four consecutive weeks. The therapist's index finger was positioned on the MTrPs area, and the middle finger was placed over the dorsal aspect of the index finger to increase the reinforcement pressure [41]. The pad of the index finger was moved in a circular motion with optimal pressure over the trigger points for a few minutes to desensitise the MTrPs and induce muscle relaxation [13].

Eccentric strength training

After 4 weeks of interventions, both groups were treated with isometric exercises during the 5th week, 3–4 times a day with 40–60 s holds, thrice per week, followed by isotonic and eccentric strength training for the consequent 3 weeks [34]. Participants progressed into isotonic to eccentric exercises if pain levels were reduced to 5 on the patient-rated tennis elbow evaluation (PRTEE) pain scores and as tolerated. Eccentric exercise training using dumbbells using weight ranges of 2.5–5 kgs, depending on patients' ability and preference was carried out by the patients under the supervision of the principal investigator. The patients were given a suitable-weight dumbbell to hold in the affected hand with the extended wrist and asked to lower the dumbbell toward the wrist flexion within the patient's control. Dumbbell lowering manoeuvres were repeated for a maximum of 10 repetitions in a single session per day, weekly thrice for 3 weeks [12]. After the 8th week, the participants performed unsupervised strengthening exercises using suitable weight dumbbells or Therabands a minimum of twice a week until the 12th week.

Outcome measures

The outcome measures were pain and function of the elbow, which were assessed using the PRTEE questionnaire. The PRTEE allows patients to rate their levels of tennis elbow pain and disability from 0 to 10 and consists of 2 subscales. The PAIN subscale (0 – no pain, 10 – worst imaginable) has 5 items, and the function subscale (0 – no difficulty, 10 – unable to do) measures specific activities (6 items) and usual activities (4 items). In addition to the individual subscale scores, a total score can be computed on a scale of 0–100 (0 – no pain and disability, 100 is the worst pain and maximum disability of the elbow), where pain and functional problems are weighted equally [42].

Handgrip strength was measured with a handheld dynamometer (BASELINE® – hydraulic hand dynamometer). The affected upper limb was placed on the table with an extended elbow, and the grip strength was assessed by asking the patients to hold and press the resistible bar of the dynamometer as quickly as possible with maximum force generation for a minimum of 3 times and the maximum grip strength reading in pounds was taken as the outcome [43]. All the outcome scores were assessed on day one (baseline) before the treatment and the 4th week, 6th week, and 12th week of follow-up.

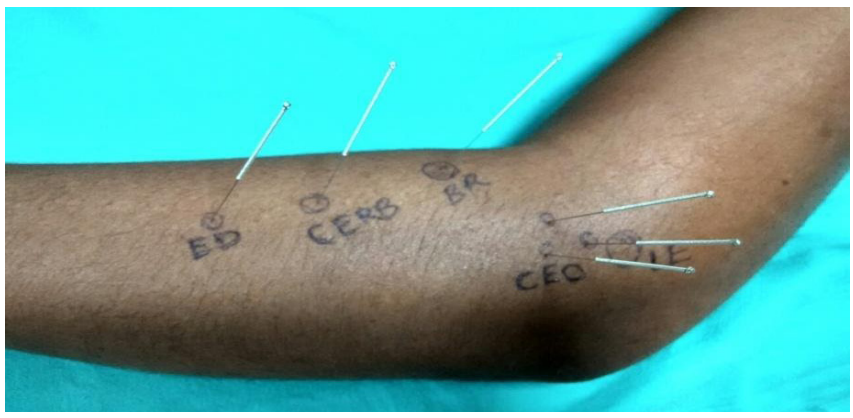

Figure 1. Dry needling in the extensor digitorum (ED), extensor carpi radialis bravis (ECRB), brachioradiallis (BR), common extensor origin sites (CEO) and lateral epicondyle (LE)

Statistical analysis

All the statistical analyses were performed using the SPSS version 21 statistical tool. The alpha level was set at 5% with a 95% confidence interval. The categorical variables such as gender and side affected presented in frequency (percentage) and the continuous data (age, duration of LE, handgrip strength, and PRTEE scores) were presented using means (standard deviations). Friedman and Kruskal–Wallis tests were respectively used to find the within and between-group differences in the pain, disability, and grip strength scores.

Results

In this study, 102 patients were screened for eligibility, out of which 38 were selected, and 19 were allocated to each group. The remaining 64 patients were excluded, with 19 declining to participate due to personal reasons and 45 not meeting the inclusion criteria. The patients in the two groups underwent 8 weeks of treatment, and all were reported for the short and midterm follow-up assessment with 0% dropout (Figure 2).

The baseline demographic and clinical characteristics of patients between the groups were homogeneous ($p > 0.05$). The mean age of patients was 34 years, with female patients ($n = 24$) being more in number than men ($n = 14$) and the number of right elbows affected ($n = 22$) individuals being higher than the left side ($n = 16$). The duration of the LE was calculated from the day of the initial occurrence of pain in the elbow. According to the descriptive data, the mean duration of LE was about 6 months and 40–50% had a reduction in grip strength in the affected side compared to the normal side. The baseline scores of PRTEE and tenderness grades showed moderate to severe elbow pain and associated dysfunctions among patients who participated in this study (Table 1).

Table 1. Comparison of baseline characteristics of patients

Variables ($n = 38$)	Experimental group ($n = 19$)	Control group ($n = 19$)	p-value
Age (years), mean ± *SD*	34.95 ± 4.35	33.74 ± 4.59	0.41[t]
Gender [*n* (%)]			
male	6 (31.6)	8 (42.1)	0.11[c]
female	13 (68.4)	11 (57.9)	
Side affected [*N* (%)]			
right	10 (52.6)	12 (63.2)	0.33[c]
left	9 (47.4)	7 (38.8)	
Duration in weeks	6.37 (1.46)	5.79 (1.32)	0.21[t]
PRTEE scores (mean ± *SD*)			
pain score (0–50)	31.84 ± 2.91	30.58 ± 3.82	0.26[t]
functional score (0–50)	33.63 ± 3.92	32.32 ± 4.10	0.32[t]
total score (0–100)	65.47 ± 6.65	62.89 ± 7.82	0.28[t]
Handgrip strength (mean ± *SD*)			
unaffected side (US)	27.42 ± 3.91	28.58 ± 5.66	0.47[t]
affected side (AS)	14.11 ± 2.79	15.00 ± 3.90	0.42[t]
grip strength difference (US-AS)	13.32 ± 2.38	13.58 ± 2.45	0.74[t]

PRTEE – patient-rated tennis elbow evaluation, US – unaffected side, AS – affected side, t – indicate p-value of student t-test, c – indicate p-value of χ^2 test

Friedman test results indicated a significant change in grip strength, pain, and disability among patients in both groups (Table 2). According to the Kruskal–Wallis test result, after 4 weeks of intervention, the group treated with DN showed greater improvement in grip strength and PRTEE (PRTEE) scores compared to the group treated with TUS and deep friction massage. Similarly, significant between-group differences were observed in the change score of grip strength, PRTEE, and tenderness grade in the 8th week in favour of the group treated by DN combined with eccentric elbow extensor strengthening. However, no significant differences were observed in the 12th week's follow-up outcomes when the aver-

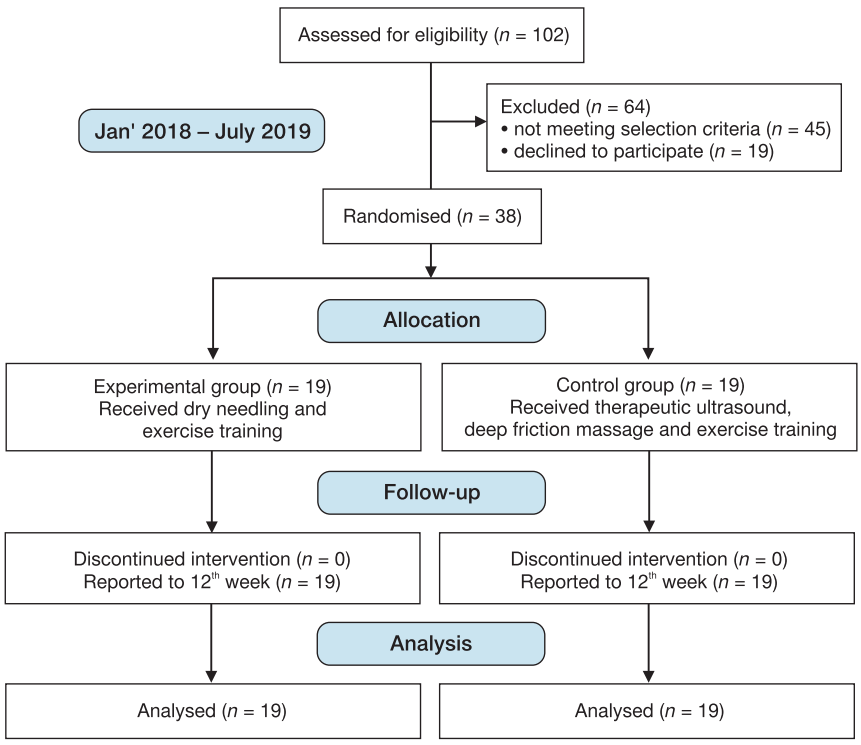

Figure 2. Study flow chart

Table 2. Within the group's analysis of grip strength, PRTEE, pain, and disability scores among the experimental and control groups

Outcome measures	Group	Mean ± *SD* of outcomes at different timeline period				χ^2-value	*p*-value
		baseline	week 4	week 8	week 12		
Grip strength	exp.	14. 11 ± 2.79	23.68 ± 3.11	26.16 ± 3.67	25.58 ± 3.15	51.944	< 0.001*
	con.	15 ± 3.90	23.37 ± 4.70	25.47 ± 4.87	25.63 ± 3.62	45.823	< 0.001*
PRTEE	exp.	65.47 ± 6.65	9.53 ± 3.24	4.47 ± 3.17	1.74 ± 1.66	56.230	< 0.001*
	con.	62.89 ± 7.82	19.21 ± 5.39	12.05 ± 5.34	2.89 ± 1.88	56.714	< 0.001*
PRTEE pain	exp.	31.84 ± 2.91	4.32 ± 1.57	0.89 ± 1.24	0.11 ± 0.46	55.584	< 0.001*
	con.	30.58 ± 3.82	8.79 ± 3.14	4.79 ± 3.07	0.58 ± 0.90	55.887	< 0.001*
PRTEE disability	exp.	33.63 ± 3.92	5.00 ± 2.24	3.53 ± 2.14	1.63 ± 1.42	54.300	< 0.001*
	con.	32.32 ± 4.10	10.42 ± 2.78	7.26 ± 2.84	2.32 ± 1.42	56.714	< 0.001*

PRTEE – patient-rated tennis elbow evaluation, exp. – experimental group, con. – control group
* statistical significance for Friedman test at 5% alpha level (95% CI)

Table 3. Between-group comparisons of average improvement at different timeline periods using the Kruskal–Wallis test

Outcome measures	Average change of scores (mean ± *SD*)					
	week 4		week 8		week 12	
	exp.	con.	exp.	con.	exp.	con.
Grip strength	9.58 ± 1.74	8.37 ± 1.34	12.05 ± 2.27	10.47 ± 1.78	11.47 ± 1.90	10.63 ± 1.67
	χ^2 = 4.699, *p* = 0.03*, C'*d* = 0.78		χ^2 = 4.567, *p* = 0.03* C'*d* = 0.77		χ^2 = 2.022, *p* = 0.155, C'*d* =0.46	
PRTEE	55.95 ± 4.69	43.68 ± 3.64	61.01 ± 4.26	50.84 ± 4.89	63.74 ± 5.46	60.00 ± 6.64
	χ^2 = 25.9139, *p* = 0.001* C'*d* = 2.92		χ^2 = 22.041, *p* = 0.001* C'*d* = 2.22		χ^2 = 3.394, *p* = 0.06, C'*d* = 0.61	
PRTEE pain	27.52 ± 2.26	21.78 ± 1.91	30.94 ± 2.19	25.79 ± 2.76	31.74 ± 2.83	30.00 ± 3.48
	χ^2 = 24.261, *p* = 0.001*, C'*d* = 2.74		χ^2 = 21.088, *p* = 0.001*, C'*d* = 2.06		χ^2 = 2.612, *p* = 0.106, C'*d* = 0.54	
PRTEE function	28.63 ± 3.09	21.89 ± 2.60	30.11 ± 2.38	25.05 ± 2.82	32.00 ± 2.81	30.00 ± 3.37
	χ^2 = 22.798, *p* = 0.001*, C'*d* = 2.34		χ^2 = 19.710, *p* = 0.001*, C'*d* = 1.94		χ^2 = 3.379, *p* = 0.07, C'*d* = 0.64	

PRTEE – patient-rated tennis elbow evaluation, exp. – experimental group, con. – control group
* statistical significance for the Kruskal–Wallis test at 5% alpha level (95% confidence interval), C'*d* – Cohen's *d* effect size

age improvements of the two groups were analysed. These results suggest that both groups benefited from interventions, and significant improvements were noted in grip strength, pain, and disability scores among the LE patients. However, the effect sizes obtained were larger in the DN group (Table 3).

Effect size and percentage improvement

According to the results presented in Table 3, the effect sizes for clinical outcomes such as pain, disability, and grip strength were calculated using Cohen's *d* effect size calculation. The 4th and 8th weeks showed a large effect size (Cohen's $d > 0.8$), while the 12th week showed a medium effect size in favour of DN combined with eccentric strength training. In terms of percentage improvement, the Minimum Clinically Important Difference (MICD) reported for LE was 37% for "much better" and 22% for "a little better" in the PRTEE score. In this study, the MICD achieved after the DN group in the 4th week was 50.91% compared to the control group's 32.34%.

Harms

During the 4 weeks of DN, none of the 19 patients reported external bleeding from the needling sites, aggravation of pain, excessive muscle soreness, or numbness post-needling. The patients in the DN group had satisfied treatment outcomes after 4 weeks of treatment, and no patient experienced a recurrence of symptoms during the follow-up period. However, six patients from the conventional physical therapy group reported the occasional occurrence of elbow-related pain during the period between the third month and one-year follow-up.

Discussion

This randomised controlled trial aimed to establish the deactivation of MTrPs and tissue healing using DN with needle manipulation. The study aimed to promote muscle flexibility and strength through eccentric strength training as an experimental intervention in patients diagnosed with LE with MTrPs. The objective was to determine if the combination of DN, including needle manipulation and eccentric strength training, may yield greater and faster midterm clinical outcomes compared to conventional physical therapy.

According to analysed data, after 4 weeks of treatment in both groups, patients had improvements in pain, elbow dysfunction, grip strength, and tenderness [5, 29]. However, the comparison of treatment outcomes between the two groups showed greater improvement in the experimental group, which had received DN and eccentric strength training. At the 12th

week, the DN group had sustained higher but non-significant marginal improvements in clinical outcomes, which were obtained in the 8th week compared to the control group. This suggests that DN treatment in CTE may produce significant benefits in the context of enhancing grip strength and patient-rated outcome scores.

The tenderness over the common extensor origin was reduced significantly by the 4th week, with Grade 0 tenderness in both groups, which indicates that TUS can reduce the inflammatory response and tenderness. However, the sustainability of TUS on tenderness was not equal to DN. Six participants (31.57%) from the control group experienced mild tenderness in the extensor origin, whereas only one participant (5.26%) experienced mild tenderness in the experimental group in the 8th week (Table 3).

The experimental group in this study showed a higher proportion of participants progressing into isotonic and eccentric group training compared to the control group during weeks 4 to 8 of training. This may be attributed to the additional benefits, such as pain reduction due to DN. The significant differences in the clinical outcomes among the participants of the experimental group might be an indication of enhanced therapeutic mechanisms such as MTrPs deactivation, tissue healing, and relaxation of myofascial structures.

In 2013, Stenhouse et al. [44] studied the effects of DN compared to autologous injection over a six-month period and their study results suggested standalone DN treatment to be effective in improving functional outcomes in LE. This study's short-term follow-up result goes along with the findings of the Stenhouse et al. study. However, the current study's experimentation with DN and evidence-based isometric and isotonic exercise training significantly contributed to the short-term outcomes.

Several studies have evaluated the effects of different needling therapies on LE and produced notable therapeutic benefits for patients. A systematic review and meta-analysis found low-level evidence in favour of acupuncture, but not electroacupuncture, for pain, related disability, and strength in LE of musculoskeletal origin over the short term [17]. Another study found that ultrasound-guided tendon DN provides comparable therapeutic efficacy to open-release surgery in patients with chronic lateral epicondylitis. Moreover, ultrasound-guided tendon DN allows for an earlier return to work and may be less costly than open-release surgery [45]. In terms of clinical efficacy, current study findings clearly evidence that the intervention protocol is effective for producing a higher therapeutic benefit and cost-effectiveness as compared to the published literature on acupuncture and ultrasound-guided tendon DN for individuals with LE.

A pilot study found promising therapeutic benefits in chronic lateral elbow tendinopathy by using adipose-derived mesenchymal stromal cell (ASC) injections [46]. Similarly, prolotherapy using 25% dextrose and local corticosteroid injection has been shown to be more effective in reducing pain and improving function compared to local corticosteroid injections alone [47]. Another randomised clinical trial found a regimen of three sessions of radial extracorporeal shock wave therapy to be significantly more effective than one session of prolotherapy with 20% dextrose regarding pain and function in the management of chronic tennis elbow in short term follow-up [18]. The treatments using ASCs injection, prolotherapy, corticosteroid injection, and radial extracorporeal shock wave therapy were also shown to have therapeutic benefits, especially in the short term. In comparison with these studies, the current study's findings suggest that DN combined with supervised and unsupervised eccentric exercises produced significant midterm benefits.

Another aspect of the current study is the implementation of progressively changing evidence-based strength training (isometric-isotonic-eccentric) for patients with LE. A pilot study on an eccentric exercise program applied to patients with LE concluded that a daily intervention of eccentric exercises performed at home was effective in increasing hand strength without pain. This evidence shows that there is a clear indication for the implementation of eccentric strength training for better and faster clinical recovery in patients with LE [48]. However, a scapular muscle-strengthening program, in addition to local therapy, did not provide any additional benefit in patients with lateral elbow tendinopathy [49]. Therefore, future studies should compare the efficacy of DN combined with eccentric strength training with and without a scapular muscle-strengthening program. This may help clinicians understand the role of shoulder-level MTrPs in producing pain in patients with LE.

A study by Rahman et al. [50] found that 2 weeks of TUS was not superior to local corticosteroid injections in LE. The current study used ultrasound for 4 weeks with the combination of deep friction massage and exercise training, which also produced acceptable clinical improvements in PRTEE pain and disability. Therefore, the clinical uses of TUS can be increased when it is applied in combination with deep friction and/or exercise training. The combined application of TUS, deep friction massage, and eccentric strengthening exercises can be an alternative option for treating LE patients who are not willing to undergo invasive treatment techniques such as DN. In recent years, the clinical use of DN is evolving, and this study's results also show convincing evidence for the clinical usefulness of this novel technique. However, the study suggests that larger sample studies are required to affirm these results to strengthen the results of this study. Hand dominance may be a potential co-variate for predicting clinical outcomes in LE. Therefore, the absence of subgroup analysis in this study is another limitation. It is important to conduct a subgroup analysis to identify the effect of hand dominance on clinical outcomes in LE. This will help better understand the relationship between hand dominance and clinical outcomes in LE.

Conclusions

DN has been found to be clinically more effective than conventional physiotherapy for pain relief, movement quality, and grip strength in patients with LE. This study has shown that DN can reduce pain intensity and related disability with large effect sizes compared to a comparative group. However, more research is needed to determine the long-term effects of DN on LE. Overall, DN is considered a safe and cost-effective method of treatment and can be used as an alternative method of intervention for LE.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by Institutional Ethics Committee of Nitte Institute of Physiotherapy (approval No.: NIPT/IEC/Min/2015-16/dated 09-03-2016).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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