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Comparison of ultrasound-guided dry needling and platelet-rich plasma injection in the management of refractory lateral epicondyle tendinopathy

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Background: This prospective randomized study aimed to compare the clinical effectiveness of ultrasound-guided dry needling and platelet-rich plasma injections in patients with refractory lateral epicondyle tendinopathy.
Methods: Fifty patients (25 in each group) diagnosed with refractory lateral epicondyle tendinopathy were randomized to receive either ultrasound-guided dry needling or platelet-rich plasma injection. Patients were evaluated before treatment and at 1, 3, and 6 months after the intervention using the visual analog scale, the Quick Disabilities of the Arm, Shoulder, and Hand questionnaire, the Patient-Rated Tennis Elbow Evaluation, and grip strength measurements. All procedures were performed under continuous ultrasound guidance.
Results: Both groups showed significant improvements in pain, function, and grip strength over time. There were no significant differences in grip strength between the groups at any time point. However, patients treated with platelet-rich plasma showed superior outcomes in pain and functional scores, particularly at the 6-month follow-up. No complications were observed in any of the patients.
Conclusions: Both ultrasound-guided dry needling and platelet-rich plasma injections are effective options for refractory lateral epicondyle tendinopathy. Platelet-rich plasma may offer greater clinical benefit, particularly in pain reduction and functional improvement. Further research with larger cohorts is required to establish optimal treatment protocols.
Level of evidence: I.

Keywords: Tennis elbow; Dry needling; Platelet-rich plasma; Conservative treatment; Ultrasonography

INTRODUCTION

Lateral epicondyle tendinopathy, commonly known as tennis elbow, was initially described by Runge in 1873 [1]. This prevalent elbow condition affects 1% to 3% of the general population [2]. Clinically, it manifests as pain and tenderness over the lateral epicondyle of the humerus, often exacerbated by activities involving wrist and finger extension. Repetitive mechanical overload or direct trauma to the wrist extensor musculotendinous unit at the lateral humeral epicondyle is widely considered the primary driver of lateral epicondyle pain [3]. Accumulating evidence indicates that the chronic condition is mainly a degenerative tendinopathy, not a predominantly inflammatory process, resulting from micro-tears and failed or incomplete tendon healing. At the microscopic level, overuse of the extensor carpi radialis brevis (ECRB) tendon is associated with angiofibroblastic hyperplasia and impaired matrix remodeling. Histopathological analyses of chronic cases demonstrate tendon degeneration with disorga-

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nized collagen architecture and reduced tendon integrity [4]. These degenerative changes may translate clinically into pain-related loss of grip strength and functional limitation, which can impose a substantial socioeconomic burden [5].

The primary treatment approach for lateral epicondyle tendinopathy is typically conservative, encompassing topical or oral anti-inflammatory medications, bracing, and stretching. Approximately 80% of patients experience resolution of symptoms within one year through conservative management [6,7]. However, in 4% to 11% of cases, lateral epicondyle tendinopathy progresses to a chronic stage where patients continue to experience discomfort or functional limitations despite medical intervention. Second-line treatments include injections of corticosteroids, platelet-rich plasma (PRP), and saline [8,9]. Nevertheless, the comparative effectiveness of these injection techniques in managing refractory lateral epicondyle tendinopathy remains an area requiring further investigation.

The primary objective of this prospective, randomized controlled study was to compare pain relief and functional outcomes between ultrasound-guided dry needling and PRP injection in patients with refractory lateral epicondyle tendinopathy. These two interventions are widely used in clinical practice and represent distinct treatment strategies. Dry needling aims to stimulate intrinsic tendon healing through controlled mechanical microtrauma, whereas PRP provides a biologically active environment enriched with growth factors to enhance tissue regeneration. By directly comparing these approaches in a randomized design, our study aimed to evaluate their relative clinical effectiveness in patients unresponsive to conventional conservative management.

METHODS

This single-center, randomized, prospective study was conducted between January 2022 and September 2023 following Ethics Committee approval (Ankara University, No. İ07-436-22) and was registered with ClinicalTrials.gov (NCT07002879). All participants were informed about the study procedures and objectives, and written and verbal informed consent was obtained. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Inclusion criteria were defined as being between 18 and 65 years of age, having a clinical diagnosis of lateral epicondyle tendinopathy based on localized lateral elbow pain exacerbated by resisted wrist or middle finger extension and tenderness over the lateral epicondyle on physical examination, and failure to respond to at least 6 weeks of conservative treatment. Exclusion criteria were the presence of cervical discopathy or upper extremity nerve entrapment (such as radial tunnel syndrome), radiocapitellar arthrosis, uncontrolled metabolic diseases (hypothyroidism, diabetes), bleeding diathesis, a history of previous elbow injection or surgery, pregnancy or lactation, cognitive impairment, and skin compromise at the injection site. Patients who could not attend regular follow-up were also excluded, although no eligible patient met this criterion during recruitment. To maximize retention, the telephone contact information of participants was recorded, and active follow-up (telephone reminders and prompt rescheduling) was used, allowing a ±3-day visit window when needed. Analyses were conducted according to the intention-to-treat (ITT) principle, and because outcome data were complete for all participants, the ITT and per-protocol populations were identical.

A priori sample size calculations were performed using G*Power software version 3.1 (Heinrich-Heine-Universität Düsseldorf). These calculations were based on the primary outcome, defined as the between-group difference in the change in the Patient-Rated Tennis Elbow Evaluation (PRTEE) total score (0–100) from baseline to the 6-month follow-up. The calculation assumed a two-sided α level of 0.05 and a statistical power of 80%. The assumed standardized effect size (Cohen's $d = 0.65$) was selected a priori based on previously published studies on lateral epicondylitis that used PRTEE as the main functional outcome and reported moderate-to-large between-group differences following interventional treatment [10]. This magnitude is consistent with a clinically important change reported for PRTEE (e.g., approximately 11 points on the 0–100 scale for "much better/completely recovered"). Eligible patients were randomly allocated into two groups using the sealed closed-envelope method: 25 patients received ultrasound-guided dry needling, and 25 patients received PRP injection. Given the inherent differences between the interventions, particularly the requirement of blood withdrawal for PRP injection, blinding of the patients was not feasible, and no sham blood draw or placebo procedure was performed.

Demographic and clinical characteristics, including age, sex, body mass index (BMI), occupation, and comorbidities, were collected. Diagnosis of lateral epicondyle tendinopathy was confirmed via Mills, Maudsley, and Thomsen tests, alongside grip strength measurement. Grip strength was measured using a Baseline Hydraulic Hand Dynamometer and compared with the grip strength of the opposite side.

Functional status and pain intensity were evaluated using the PRTEE, visual analog scale (VAS), and Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) questionnaire. Follow-up assessments at 1, 3, and 6 months post-intervention in-

cluded repeat clinical tests, PRTEE, VAS, QuickDASH scoring, and grip strength measurement. All ultrasonographic evaluations and procedures were performed by a single clinician with three years of experience in elbow ultrasonography. Ultrasonographic assessment was performed using a linear array probe on a portable Clarius L7 HD3 4-13 Mhz Linear Scanner (Clarius Mobile Health Corp.) to identify tendinopathic changes. Specific changes included calcifications, full or partial-thickness tears, and diffuse heterogeneous echotexture within the extensor tendon. The ECRB and extensor digitorum communis were identified sonographically with the patient supine (Fig. 1), and the pathological region was marked with a surgical pen.

After skin antisepsis, 2 mL of prilocaine was infiltrated into the skin, subcutaneous tissue, and inflamed tendon to achieve local anesthesia. All interventions were then delivered under continuous ultrasound guidance directly into the marked lesion. (1) Dry needling: an 18-gauge needle was first used to fenestrate the common extensor tendon and lateral periosteum. Once adequate anesthesia was confirmed, an 18-gauge needle was inserted along the longitudinal axis of the tendon (without exiting the skin) and advanced in a "peppering" motion, 40 to 50 passes from superficial to deep layers over approximately two minutes. (2) PRP injection: fifteen milliliters of peripheral venous blood were collected into sterile tubes containing acid citrate dextrose solution A as an anticoagulant at a standard 1:9 ratio (anticoagulant to whole blood). The samples were processed without the use of a commercial PRP preparation kit using a single-spin protocol. Centrifugation was performed at 3,000 rpm (approximately 400 g) for 3 minutes using a benchtop centrifuge equipped with a fixed-angle rotor. Following centrifugation, the plasma layer immediately above and including the buffy coat interface was carefully aspirated under sterile conditions using a syringe to obtain leukocyte-rich-PRP. Care was taken to avoid visible erythrocyte contamination. Approximately 2 mL of PRP was harvested and injected into the lateral epicondylar region under ultrasound guidance. No exogenous activator was used before injection. Platelet concentration was not quantified using an automated hematology analyzer. However, a standardized preparation protocol was applied consistently to all participants.

After the procedure, patients were instructed to apply ice to the treated area up to five times daily for the first 2 weeks and to perform passive stretching of the affected tendon as tolerated. They were also advised to avoid lifting objects heavier than 5 kilograms and to minimize repetitive movements of the treated limb during this early recovery phase. During this period, patients were not permitted to use nonsteroidal anti-inflammatory drugs. After the initial 2-week period, patients were encouraged to gradually resume normal activities to encourage the restoration of full elbow function.

All statistical analyses were performed using Jamovi software (version 2.3.2). The normality of data distribution was assessed using the Shapiro-Wilk test. Continuous variables were presented as mean ± standard deviation and range (minimum–maximum), while categorical variables were expressed as frequencies and percentages. Baseline categorical variables between the two independent groups (e.g., sex and affected side) were compared using the chi-square test or Fisher's exact test, as appropriate. For comparisons between two independent groups, the Student t-test was used for normally distributed continuous variables, and the Mann-Whitney U-test was applied for non-normally distributed data. For within-group comparisons of categorical variables, the McNemar test was used. For continuous variables with two de-

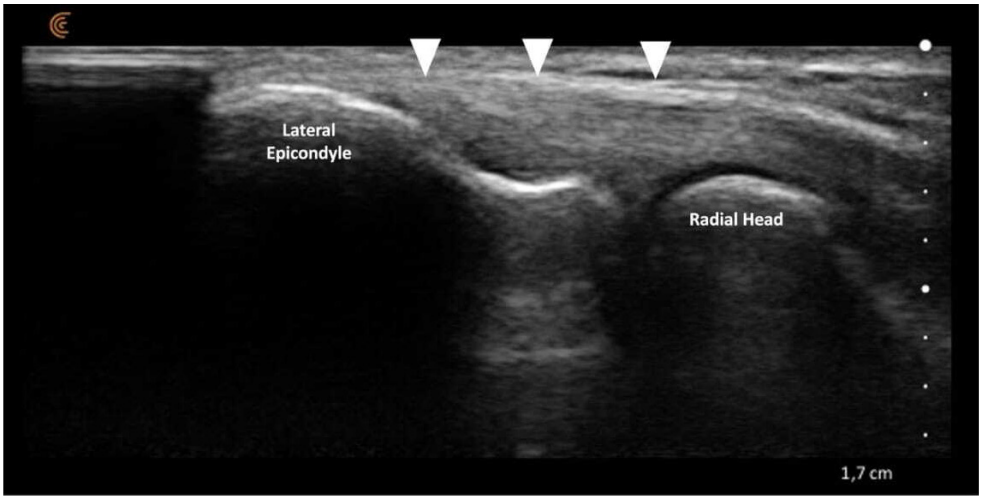


Fig. 1. Ultrasonographic image showing the common extensor tendon indicated by arrows.

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pendent measurements, the Wilcoxon signed-rank test was applied. Repeated measures of non-parametric data involving more than two time points were analyzed using the Friedman test, whereas analysis of variance was used for repeated measures involving parametric data. Post-hoc pairwise comparisons were adjusted using Bonferroni correction to reduce the risk of type I error due to multiple comparisons. A P-value of less than 0.05 was considered statistically significant, with a 95% CI.

RESULTS

This study included 50 patients (50 elbows). All 50 patients were assessed for eligibility, enrolled, and randomized; there were no exclusions (n=0) and no withdrawals or losses to follow-up during the 6-month study period (CONSORT flow diagram) (Fig. 2). Patients were randomized into two groups: a PRP group (n=25; 10 males, 15 females) and a dry needling group (n=25; 14 males, 11 females). The overall mean age was 50.38±8.63 years (PRP: 51.96±8.05; dry needling: 48.80±9.06), and the mean BMI was 26.18±5.46 (PRP: 25.62±6.19; dry needling: 26.73±4.69). Right-sided involvement was observed in 29 patients and left-sided involvement in 21, with 36 elbows (72%) on the dominant side (PRP: 15 right/10 left; dry needling: 14 right/11 left). Baseline characteristics did not differ significantly between groups (age, sex distribution, BMI, side, and dominance; all P>0.05) (Table 1). The sample size (n=50) was determined a priori based on the expected effect size for the primary outcome.

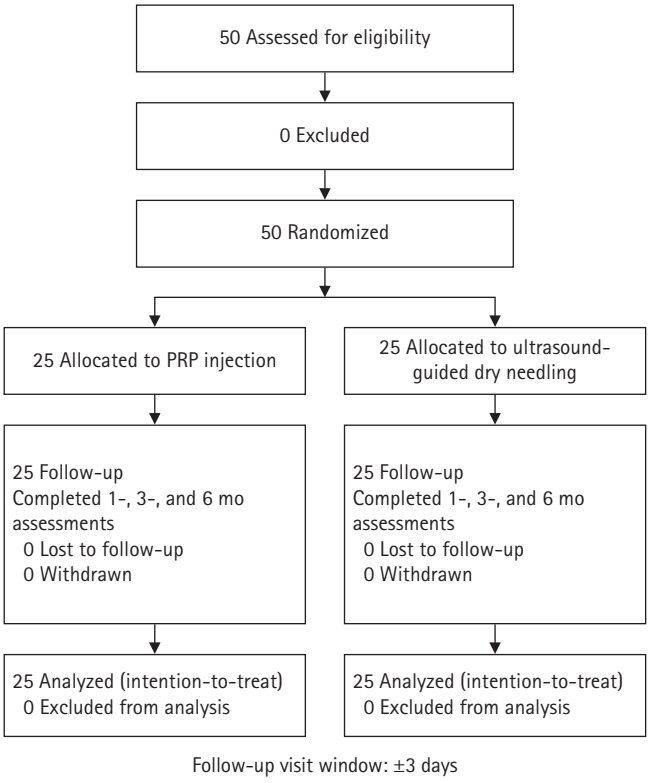


Fig. 2. CONSORT flow diagram. PRP: platelet-rich plasma.

Pre-treatment grip strength measurements of both the unaffected and affected sides, along with grip strength outcomes at 1, 3, and 6 months post-treatment, are presented in Tables 2 and 3 and illustrated in Fig. 3. Overall, a statistically significant increase in grip strength was observed for all patients by the first month (P=0.000). At the 1-month follow-up, the increase in grip strength averaged 2.24 kg (10.8%) in the dry needling group and 1.84 kg (8.8%) in the PRP group. At 3 months, grip strength measurements showed an average increase of 5.52 kg (26.8%) in the dry needling group and 5.96 kg (28.5%) in the PRP group compared to pre-treatment values. At the 6-month follow-up, the dry needling group exhibited an average increase of 6.52 kg (31.7%), while the PRP group showed an average increase of 6.96 kg (33.3%) compared to pre-treatment. There were no statistically significant differences between the groups in grip strength increase at any of the 1, 3, and 6-month follow-up assessments.

Statistically significant improvements were observed in VAS, QuickDASH, and PRTEE scores in both groups following treatment within the group evaluation (P<0.005). There was no significant difference in VAS, QuickDASH, and PRTEE results between the groups before treatment. When postoperative 3-month and postoperative 6-month PRTEE values were compared between the groups, the results of patients in the PRP group were statistically significantly better (P<0.05). In the intergroup comparison, the increase in QuickDASH scores at postoperative 6 months was significantly higher in the PRP group than in the dry needling group (P=0.039). In the comparison of VAS scores between the groups, the PRP group was also found to be significantly superior at postoperative months 1, 3, and 6 (P<0.005). These results are summarized in Table 4 and illustrated in Fig. 4.

Table 1. Demographic characteristics of the study groups

Characteristic	Dry needling group (n=25)	PRP group (n=25)	P-value
Age (yr)	48.80±9.06	51.96±8.05	0.199
Sex			0.258
Male	14 (56.0)	10 (40.0)	
Female	11 (44.0)	15 (60.0)	
Side			0.774
Right	14 (56.0)	15 (60.0)	
Left	11 (44.0)	10 (40.0)	
Dominance	18 (72.0)	18 (72.0)	1.000
Body mass index (kg/m^2)	26.7±4.7	25.6±6.2	0.478

Values are presented mean±standard deviation or number (%).
PRP: platelet-rich plasma.

Table 2. Comparison of grip strength (kg) before treatment between dry needling and PRP groups over time

Grip strength	Dry needling group	P-value	PRP group	P-value	P-value between groups
Unaffected side	28.36 ± 10.22	0.0003	27.00 ± 11.20	0.000	0.573
Affected side pre-treatment	20.56 ± 6.99		20.88 ± 8.64		0.749

Values are presented mean ± standard deviation.
PRP: platelet-rich plasma.

Table 3. Comparison of grip strength (kg) between dry needling and PRP groups over time

Grip strength	Dry needling group	P-value	PRP group	P-value	P-value between groups
Pre-treatment	20.56 ± 6.99		20.88 ± 8.64		0.749
1 mo post-treatment	22.80 ± 6.85	0.000[a)]	22.72 ± 8.65	0.000[a)]	0.648
3 mo post-treatment	26.08 ± 9.29	0.001[b)]	26.84 ± 10.50	0.000[b)]	0.831
6 mo post-treatment	27.08 ± 9.29	0.000[c)]	27.84 ± 10.54	0.000[c)]	0.831

Values are presented mean ± standard deviation.
PRP: platelet-rich plasma.
[a)]Comparison of strength between pre-treatment and 1 month post-treatment; [b)]Comparison of strength 1 and 3 months post-treatment; [c)]Comparison of strength between 3 and 6 months post-treatment.

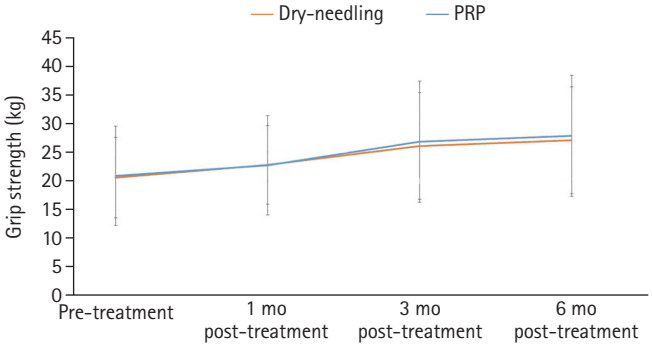


Fig. 3. Comparison of grip strength (kg) between dry needling and platelet-rich plasma (PRP) groups over time.

No major complications such as infection, neurovascular injury, or tendon rupture were observed in any of the patients. However, transient post-injection pain or discomfort was not considered a complication and was not systematically recorded.

DISCUSSION

In this study, we compared the efficacy of dry needling and PRP injections for the treatment of recalcitrant lateral epicondyle tendinopathy. Our results indicate that PRP therapy yields superior functional outcomes compared to dry needling, although no significant difference was observed in grip strength improvement. Although previous studies have compared PRP with needling or tendon fenestration, our study adds a randomized prospective design with ultrasound guidance to standardize intervention delivery and outcome assessment in lateral epicondyle tendinopathy.

Lateral epicondyle tendinopathy is the most common cause of lateral elbow pain [2,11,12]. In cases unresponsive to conservative measures such as pharmacological therapy and splinting, a spectrum of treatment options ranging from minimally invasive procedures to open surgery exists [6]. However, no consensus has been reached regarding the superiority of a particular treatment modality or the optimal timing of intervention. Currently, less invasive techniques that offer promising functional outcomes are increasingly favored, although debates regarding their comparative efficacy persist.

Due to its increasing accessibility and its role in guiding minimally invasive treatments, ultrasonography is being used more frequently in the treatment of lateral epicondyle tendinopathy [13,14]. However, its operator dependence and the potential to prolong the duration of minimally invasive procedures are considered disadvantages. The success rates of ultrasound-guided injections for lateral epicondyle tendinopathy have been widely investigated. In a cadaveric study, Keijsers et al. [15] demonstrated that approximately 60% of injections intended for the ECRB tendon were delivered intra-articularly.

PRP is an autologous plasma preparation with a high concentration of platelets that may support tendon healing by delivering a supraphysiological level of growth factors and cytokines. It reinitiates the healing cascade in degenerative tendon tissue and promotes coagulation, cell recruitment and proliferation, angiogenesis, and extracellular matrix remodeling [16]. However, there is no clear consensus in the literature regarding the optimal PRP preparation method, dosage, or number of treatment sessions. Although PRP may exacerbate symptoms in the early post-injection period due to its pro-inflammatory effects, symptom improvement is generally observed as tissue remodeling becomes more prominent. In our study, consistent with expectations, there was no significant difference in symptomatic scores between PRP and dry needling in the early period due to inflammation-related pain

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Table 4. Comparison of quickDASH, PRTEE, and VAS scores within and between groups over time

	Dry needling group		PRP group		Between-group P-value
QuickDASH					
Pre-treatment	62.08 ± 12.69		61.36 ± 12.82		0.842
1 mo post-treatment	41.08 ± 8.41	0.000[a]	40.60 ± 8.54	0.000[a]	0.842
3 mo post-treatment	20.36 ± 4.13	0.000[b]	20.08 ± 4.30	0.000[b]	0.815
6 mo post-treatment	12.56 ± 2.55	0.000[c]	11.08 ± 2.40	0.000[c]	0.040
PRTEE					
Pre-treatment	70.04 ± 14.02		64.96 ± 15.54		0.290
1 mo post-treatment	79.24 ± 6.46	0.000[a]	80.64 ± 6.53	0.000[a]	0.471
3 mo post-treatment	89.44 ± 4.74	0.000[b]	93.24 ± 2.22	0.000[b]	0.000
6 mo post-treatment	91.76 ± 3.03	0.000[c]	95.60 ± 1.71	0.000[c]	0.000
VAS					
Pre-treatment	6.80 ± 1.12		6.92 ± 1.04		0.696
1 mo post-treatment	4.92 ± 0.95	0.000[a]	3.80 ± 0.87	0.000[a]	0.000
3 mo post-treatment	2.84 ± 1.03	0.000[b]	1.64 ± 1.04	0.000[b]	0.000
6 mo post-treatment	1.44 ± 0.87	0.000[c]	0.56 ± 0.51	0.000[c]	0.000

Values are presented mean ± standard deviation.
QuickDASH: Quick Disabilities of the Arm, Shoulder and Hand, PRTEE: Patient-Rated Tennis Elbow Evaluation, VAS: visual analog scale, PRP: platelet-rich plasma.
[a]Comparison of strength between pre-treatment and 1 month post-treatment; [b]Comparison of strength 1 and 3 months post-treatment; [c]Comparison of strength between 3 and 6 months post-treatment.

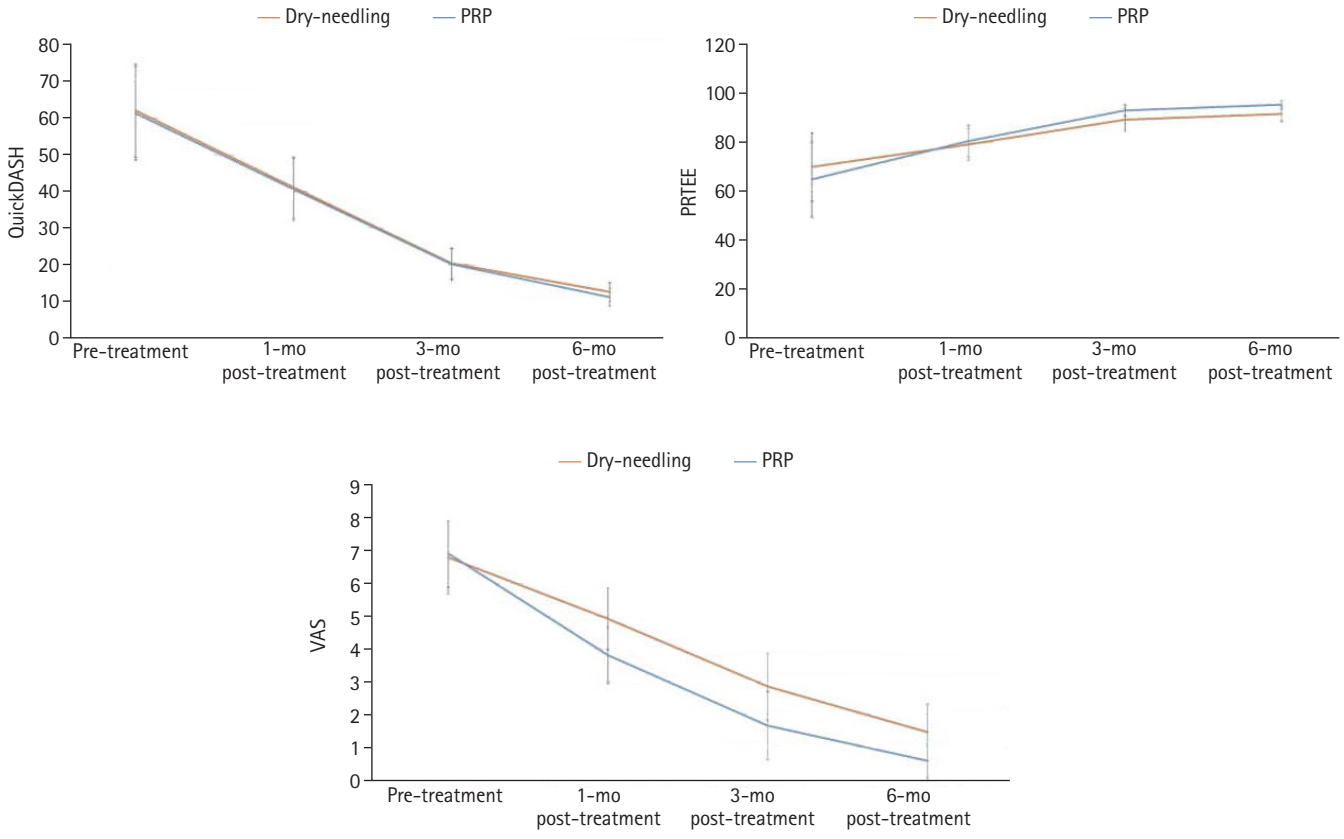


Fig. 4. Comparison of Quick Disabilities of the Arm, Shoulder and Hand (quickDASH), Patient-Related Tennis Elbow Evaluation (PRTEE), and visual analog scale (VAS), scores within and between groups over time.

and functional impairment.

In a study by Gosens et al. [17], 50 patients with lateral epicondyle tendinopathy were treated with PRP and 50 with corticosteroid injections and assessed using VAS and DASH scores. Although both groups benefited from treatment, PRP demonstrated a statistically significant advantage over corticosteroids at two years of follow-up. Similarly, in our study, although there was no significant difference between the groups at the first-month follow-up, patients in the PRP group showed greater improvements in functional scores from the third month onward compared to those in the dry needling group.

Dry needling is a widely used and effective method in the treatment of lateral epicondyle tendinopathy. Studies suggest that dry needling provides superior outcomes compared to other conservative treatment modalities. In a recent systematic review and meta-analysis, dry needling was found to significantly reduce pain and improve function in patients with lateral epicondyle tendinopathy [18]. Similarly, a prospective controlled study conducted by Uygur et al. [10] demonstrated marked clinical improvement in patients who received dry needling.

In a study by Stenhouse et al., dry needling and autologous plasma injections were compared in 28 patients with resistant lateral epicondyle tendinopathy. At six months, a 34% reduction in VAS scores was observed in the dry needling group and a 48.5% reduction in the autologous plasma group, indicating successful treatment outcomes. Similarly, we found that dry needling was effective at 6 months across all scoring systems. The difference in our study was that the procedure was performed with ultrasound guidance, and the grip strength was measured. Although there was no difference in grip strength, the functional results were superior in the PRP group.

In a retrospective study by Gaspar et al. [19], 93 patients were compared after PRP and dry needling. Evaluation with VAS and PRTEE scores, and grip strength measurements over an average of 40 months, showed that the PRP group had higher grip strength measurements compared to the dry needling group, although the difference was not statistically significant. Similarly, we found that grip strength increased by an average of 31.7% in the dry needling group and 33% in the PRP group, with no significant difference between the groups. The absence of a statistically significant difference in grip strength may be attributed to both injection methods exerting their effects through similar pathophysiological mechanisms. Specifically, each intervention may modulate inflammation, promote tissue regeneration, and facilitate tendon healing via overlapping biological pathways.

Although better improvement in pain and function was observed in the PRP group, the absence of a significant intergroup difference in grip strength can be explained biomechanically and temporally. The clinical effect of PRP may largely provide early pain reduction and patient-reported functional improvement through the modulation of inflammation/nociception [20]. In contrast, grip strength depends on tendon–muscle unit remodeling, neuromuscular adaptation, and progressive loading, and therefore may emerge later than symptomatic improvement. In addition, grip strength measurement can be influenced by several factors, including testing protocol, patient effort, hand dominance, and measurement variability. Thus, even in the presence of clinical improvement, small intergroup differences may remain within the range of measurement variability [21].

This study has several limitations. First, the relatively small sample size may limit the generalizability of our findings. Second, the follow-up period was limited, which restricts the conclusions on long-term outcomes. Third, our definition of refractory disease may be considered early in the context of tendon pathology. We included patients who failed at least 6 weeks of conservative treatment, whereas chronic or truly refractory lateral epicondyle tendinopathy is often defined as symptoms persisting for 3–6 months. Accordingly, enrolling patients after 6 weeks may have introduced potential confounding due to spontaneous improvement during this timeframe. In addition, a formal group × time interaction analysis was not performed. Therefore, differential temporal effects between groups should be interpreted with caution. Our a priori sample size calculation was based on PRTEE (our primary outcome) rather than grip strength. Consequently, the absence of statistically significant between-group differences in grip strength should be interpreted cautiously and does not exclude a potential difference, as the study may have been underpowered for this secondary outcome (i.e., risk of a type II error). Finally, the absence of a sham control and blinding represents an additional limitation. PRP requires venipuncture and injection, whereas dry needling does not. Therefore, participants were probably aware of their treatment allocation, which may have introduced performance and placebo-related bias, particularly in subjective outcome measures.

CONCLUSIONS

Both treatment methods demonstrated clinical success. However, PRP therapy showed superior results at 6 months, particularly in clinical scores. From a clinical perspective, PRP appears to be a potentially beneficial option for patients with lateral epicondyle tendinopathy. Nevertheless, further studies are needed to determine optimal treatment protocols and evaluate cost-effectiveness.

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Conceptualization: MMT, MA. Data curation: YK. Investigation: MMT. Supervision: UB, MA. Writing – original draft: MMT. Writing – review & editing: MMT. All authors read and agreed to the published version of the manuscript.

Conflict of interest

None.

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Data availability

Contact the corresponding author for data availability.

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