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ORIGINAL ARTICLE

Comparison of the efficacy of corticosteroid, dry needling, and PRP application in lateral epicondylitis

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Abstract

Purpose The aim of this study was to compare the short-term efficacy of dry needling, corticosteroids, and platelet-rich plasma application (PRP) in the management of lateral epicondylitis.

Methods The study included 72 patients diagnosed with lateral epicondylitis divided into three groups of 24 individuals using the sealed envelope method. Group 1 underwent dry needling, Group 2 received 40 mg methylprednisolone acetate, and Group 3 received PRP treatment. Patients were assessed using the visual analog scale (VAS) and the Disabilities of the Shoulder, Arm, and Hand (DASH) score, and Jamar grip strength before treatment and 3rd week and 3rd month.

Results At the 3rd month, the mean VAS score was 1.16 ± 0.56 in dry needling group and 0.75 ± 0.60 in corticosteroids group, showing a statistically significant difference between dry needling and corticosteroids group, and between corticosteroids and PRP group ($p = 0.015$ and $p = 0.000$, respectively). At the 3rd week and 3rd month, VAS scores decreased in each treatment modality group, showing a statistically significant difference between the groups ($p < 0.01$). Jamar grip strength increased over time in all groups. There were no significant differences between the DASH scores of all groups at the 3rd week ($p > 0.05$). DASH scores decreased significantly from the 3rd week to the 3rd month in dry needling and corticosteroids group ($p < 0.01$), while it increased slightly in PRP group during the same period with a statistically insignificant change ($p > 0.05$). DASH scores decreased significantly at the 3rd month for all groups ($p = 0.014$).

Conclusion Dry needling is an effective and safe application for the short-term treatment of lateral epicondylitis.

Keywords Dry needling · Lateral epicondylitis · PRP · Steroid

Introduction

Tennis elbow, or lateral epicondylitis (LE), is a clinical situation that typically presents as lateral elbow pain which usually worsens with wrist movements, often resulting in moderate disability [1]. The condition is typically caused by an overuse injury to the extensor carpi radialis brevis (ECRB) muscle of the forearm and is characterized by tenderness and pain over the lateral epicondyle. The pain can persist for many years and is usually self-limiting [2]. Lateral epicondylitis is clinically described as tenderness and pain over the lateral epicondyle [3]. Lateral epicondylitis affects approximately 1–3% of the population and presents most commonly in middle-age, regardless of gender [4–6]. The first-line treatment for LE is conservative, consisting of oral and topical anti-inflammatory drugs, ice application, and brace use. The first treatment modality for lateral epicondylitis is conservative therapy, which includes oral or topical anti-inflammatory drugs, ice application, and the use of a splint. Such conservative treatment may not relieve some patients' complaints and often invasive second-line treatment options, such as saline injection, platelet-rich plasma injections, or corticosteroids are offered [7, 8]. Corticosteroid injection is more effective in short-term treatment (< 6 weeks) [9, 10] with greater efficacy than both NSAIDs [11] and physical therapy [12], although its long-term treatment efficacy is less effective. There is insufficient evidence for surgery, with a recent systematic review neither supporting nor denying its efficacy for lateral elbow pain. [13]. Given the wide variety of approaches in managing this difficult-to-treat condition, it is not surprising that no

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specific treatment has gained universal acceptance. Platelet-rich plasma (PRP) can increase the soft tissue regeneration processes by releasing platelet-derived growth factors, cytokines, and other proteins that can modulate and stimulate the inflammatory response [14–16]. Chen et al. [17] suggested that PRP is a safe and effective method to support tendon and ligament healing.

Recently, the novel technique of dry needling, tendon needling, needle tenotomy, or tendon fenestration has been introduced as an effective treatment for chronic tendinitis, e.g., Achilles tendinitis, patellar tendinopathy, and rotator cuff diseases [18, 19]. However, there is little data on the benefits of dry needling (also known as percutaneous needle tenotomy or tendon fenestration) as a stand-alone therapy in refractory LE [20]. Repeated percutaneous needle fenestration of the affected tendon origin may develop a healing response by encouraging localized bleeding and fibroblastic proliferation. This procedure may acquire the release of growth factors and promote new vessel formation [18, 21] as well as more regular collagen formation and ultimately the healing of the tendon [22]. The aim of this study was to compare the short-term efficacy of dry needling, corticosteroid injection, and PRP application in the management of LE.

Patients and methods

The study included 72 patients (44 women [61.1%] and 28 men [38.8%]; mean age: 43.63 ± 7.43 years) diagnosed with LE between November 2018 and June 2020. The patients were randomized using the sealed envelope method and randomly divided into three groups of 24. All patients were informed of the purpose of the study and signed informed consent forms. The study was managed following the Declaration of HELSINKI principles, and ethics committee approval (Decision no. 08, Date: Mar 31, 2021) was obtained from the authors' institute.

Participants with a clinical diagnosis of LE based on symptoms and location of sensitivity with LE determined as elbow pain, sensitivity on lateral epicondyle by palpation, and pain in lateral epicondyle increasing with resistant wrist or finger extension, and did not recover after using medication(NSAIDs), bracing, and home exercise protocole without injection were included in the study. Other inclusion criteria were pain in the lateral side of the elbow that increases with pressure on the lateral epicondyle and extension of the opposite wrist, against extension of the middle finger or passive stretching of the extensor wrist; duration of pain between 4 and 12 weeks; pain intensity equal to 5 or greater on a visual analog scale (VAS) indicating pain; age ranging between 18 and 65; and sufficient cognitive skills to complete the questionnaires. Patients, who had received previous injection treatment for LE; who reported pain with ipsilateral shoulder or cervical problems, previously operated carpal tunnel syndrome, elbow surgery, trauma (humerus, radius, or ulna fracture or joint dislocation), or surgery to the elbow; using systemic or oral steroids; or those with malignancy, or congenital or previously elbow deformity were excluded from the study. Patients received to the first intervention after an average of 2 months. All patients were informed about the aimed of the study, necessary permissions were obtained, and informed consent forms were signed. All of procedures were performed by a single-hand specialist without ultrasound guidance.

In Group 1, dry needling was performed on an outpatient in a standard manner, with the patient sitting on a chair with the forearm in the neutral position and the elbow in 90° of flexion (Fig. 1). The needling site was determined by the examiner using their thumb to locate the point at which patients complained of strong pain around the lateral epicondyle. Dry needling consisted of passing a fine needle (23G) in and out of the long axis of the tendon, without coming out of the skin about 40–50 times to pepper the tendon. The procedure took a total of 2 min, and the treatment was repeated once a week for 3 weeks.

In Group 2, corticosteroid injections of 40 mg methylprednisolone acetate were administered with the patient

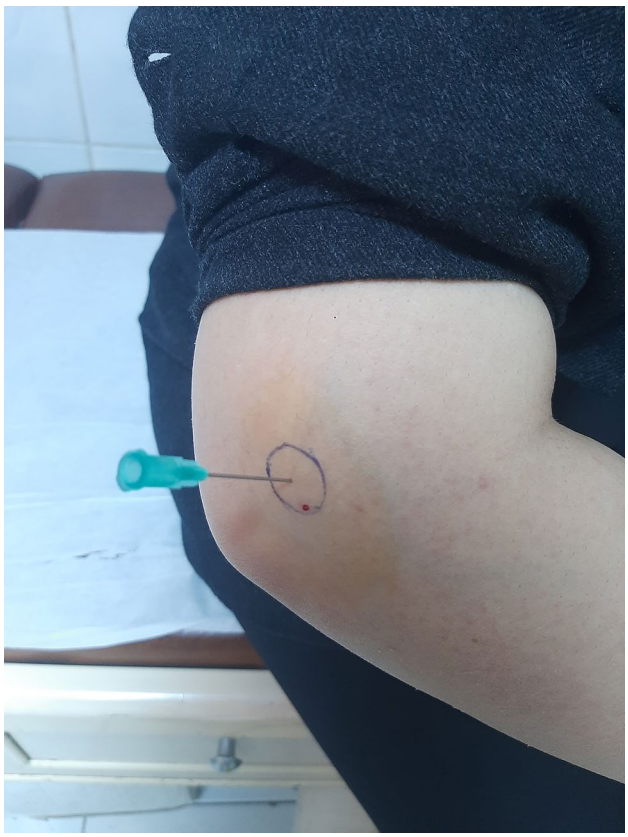

Fig. 1 Dry needling application

seated on a chair and the forearm placed in the neutral position and the elbow in 90° of flexion. Steroid injections were given only once.

In Group 3, PRP was administered to participants by taking 10 ml of blood from the contralateral antecubital vein of participants. The ACP double syringe containing whole blood was then centrifuged at 1500 rpm for five minutes to separate the red blood cells from the leukocyte poor-PRP. At the end, the supernatant PRP was transferred from the larger outer syringe into the small inner syringe, carefully avoiding mixing. The small inner syringe was unscrewed and fitted with a needle, so that the PRP was ready for use. 5 ml of leukocyte poor- PRP was injected.

Patients were recommended not to use NSAIDs but only paracetamol in case of pain. After all procedures, patients were advised to participate in normal activities and avoid anything that could worsen the symptoms.

Patients were assessed using the VAS and the Disabilities of the Shoulder, Arm, and Hand (DASH) score. The VAS is used to evaluate the pain severity. A horizontal 10-cm-long ruler was used (0 = no pain and 10 = most severe pain). The patients were asked to mark their pain at rest and during movement, separately.

The Disabilities of the Arm, Shoulder, and Hand (DASH) Questionnaire is commonly used as an applicable method to investigate the efficacy of different treatment modalities in the management and improvement of disability in patients with upper limb disorders.

All patients with lateral epicondylitis were evaluated using a Jamar hand dynamometer (Sammons Preston, Inc, Bolingbrook, IL). For the test position, patients were instructed to sit in a chair with their feet flat on the floor, and measurements were performed while the shoulder was in adduction, elbow in 90-degree flexion, and the forearm in the neutral position between the supination and pronation position. Firstly patients were shown how to use the dynamometer. After that the researcher helped support the weight of the dynamometer without restricting its movement. In the test, patients were required to increase their grip force smoothly and to maintain the same strength for approximately 3 secs at the onset of pain. The third range of the dynamometer was used as the standard when measuring and the grip strength was measured in kilogram-force. The PFGS was evaluated 3 times with 1-min rest intervals, and their averages were calculated.

Patients were followed up for a mean period of 8 ± 2.3 months. The mean VAS score, Jamar grip strength, and DASH score were measured at the 3rd week and 3rd month after treatment.

Statistics

Statistical analyses were performed using the Statistical Package for Social Sciences version 22.0 Software for Windows (IBM Corp., Armonk, NY, USA). Values of the continuous variables are summarized as the values of the categorical variables in N (%). The chi-square test was used for group comparisons of the qualitative variables. The assumption of normality was tested using the Kolmogorov–Smirnov and Shapiro–Wilk tests. One-way analysis of variance (ANOVA) was used for intergroup comparisons of the variables showing normal distribution. The statistical level of significance was accepted as $p < 0.05$. The Kruskal–Wallis test was used when data were not normally distributed, while the Mann–Whitney U test was used for post hoc analysis with Bonferroni correction (p value was divided by the number of groups, which was $0.05/3 = 0.016$). Statistical significance was accepted as $p < 0.016$. Paired t test was performed for the normally distributed data, and the level of statistical significance was accepted as $p < 0.05$ to compare the repeated measurements for each group. The Wilcoxon test was used for data that did not show normal distribution. It was determined that in order to test the statistical significance of a difference of at least at 80% power (1-β error), effect size f = 0.40, and 5% error level in terms of changes in the examined variables, at least 22 subjects were required for each group. Sample size calculations were performed using the G*Power v.3.1.9.6 package program (Universität Kiel, Kiel, Germany).

Results

Average age and gender distribution were similar between the groups ($p > 0.05$) (Table 1).

The lowest average pretreatment VAS score was observed in corticosteroids group (8.0 ± 0.83) and the highest in Group 3 (8.25 ± 0.73). At the 3rd month, the mean VAS score was 1.16 ± 0.56 in dry needling group and 0.75 ± 0.60 in corticosteroids group, showing a statistically significant difference between dry needling and corticosteroids group, and between corticosteroids and PRP group ($p = 0.015$ and $p = 0.000$, respectively). At the 3rd week and 3rd month, VAS scores decreased in each treatment modality group, showing a statistically significant difference between the groups ($p < 0.01$). VAS scores decreased in all groups, with the greatest decrease observed in corticosteroids group at the 3rd week.

Jamar grip strength increased significantly over the follow-up period in all groups ($p < 0.01$).

At the 3rd week, the DASH score was 31.66 ± 6.89 in dry needling group, 32.00 ± 5.05 in corticosteroids group, and 30.75 ± 4.60 in PRP group, showing a statistically

Table 1 Demographic characteristics of the patients

	Dry needling ($n=24$)	Corticosteroids ($n=24$)	Platelet-rich plasma ($n=24$)	P
Age, mean ± SD	46.08 ± 7.44	40.91 ± 7.70	43.91 ± 7.16	0.06
Gender, (F/M)	13 (54.2%)/11 (45.8%)	15 (62.5%)/9 (37.5%)	16 (66.7%)/8 (33.3%)	0.56
Profession				
Non-working	0 (0.0%)	0 (0.0%)	1 (4.2%)	0.378
Farmer	4 (16.7%)	3 (12.5%)	2 (8.3%)	
Tradesman	0 (0.0%)	0 (0.0%)	2 (8.3%)	
Housewife	14 (58.3%)	14 (58.3%)	14 (58.3%)	
Worker	6 (25.0%)	4 (16.7%)	4 (16.7%)	
Officer	0 (0.0%)	3 (12.5%)	1 (4.2%)	

$P < 0.05$ was considered statistically significant; *SD* Standart deviation

insignificant difference between the groups ($p > 0.05$). At the 3rd month, statistically significant differences were observed between dry needling and corticosteroids group, and between corticosteroids and PRP grupu ($p = 0.014$ and $p = 0.000$, respectively). DASH scores decreased significantly from the 3rd week to the 3rd month in dry needling and corticosteroids group ($p < 0.01$), while it increased slightly in PRP group during the same period with a statistically insignificant change ($p > 0.05$). DASH scores decreased significantly at the 3rd month for all groups ($p = 0.014$), with the greatest decrease observed in corticosteroids group.

The results of VAS, grip strength, and DASH measurements are given in Table 2.

Discussion

In this study, we compared the efficacy of percutaneous tendon dry needling, corticosteroid injection, and PRP application. All treatment modalities were found to be effective for LE. While these treatment methods have been studied in the context of LE in the literature, to our knowledge, very few studies compare all three treatment modalities.

Stenhouse et al. [23] compared the results of dry needling with autologous conditional plasma injections in 28 patients with refractory LE. The authors performed dry needling using a 23-gauge needle as a peppering technique in which the needle perforated the tendon 40–50 times during a period of 2 min. Patients were successfully treated at 6 months with a 34% reduction in VAS in the dry needling group and a 48.5% reduction in VAS in the autologous conditioned plasma group. The long-term benefits of dry needling as

Table 2 Clinical findings and p values in intergroup comparisons of repeated measurements

	Dry needling		Corticosteroids		Platelet-rich plasma		Group 1 vs. Group 2	Group 1 vs. Group 3	Group 2 vs. Group 3
	Mean ± SD	p	Mean ± SD	p	Mean ± SD	p	p	p	p
VAS score									
Pretreatment	8.16 ± 0.81	**0.000**	8.0 ± 0.83	**0.000**	8.25 ± 0.73	**0.000**	0.488	0.756	0.291
3rd week	2.33 ± 0.63		2.34 ± 0.64		2.25 ± 0.60		0.987	0.609	0.609
3rd month	1.16 ± 0.56		0.75 ± 0.60		1.58 ± 0.77		**0.015**	0.033	**0.000**
Jamar grip strength									
Pretreatment	38.25 ± 6.96	**0.002**	37.91 ± 6.35	**0.000**	37.33 ± 5.85	**0.004**	0.863	0.741	0.967
3rd week	67.08 ± 14.62		67.83 ± 16.55		70.66 ± 14.47		0.869	0.171	0.299
3rd month	70.33 ± 13.61		72.08 ± 14.85		69.66 ± 15.33		0.673	0.561	0.363
DASH score									
Pretreatment	82.33 ± 9.22	**0.000**	80.58 ± 8.66	**0.000**	84.16 ± 7.37	0.182	0.483	0.535	0.160
3rd week	31.66 ± 6.89		32.00 ± 5.05		30.75 ± 4.60		0.849	0.741	0.453
3rd month	30.00 ± 6.78		26.66 ± 3.23		32.41 ± 4.79		**0.014**	0.159	**0.000**

Significant p values are written in bold

a stand-alone treatment for LE have been demonstrated elsewhere. In Mishra et al.'s study [24], 225 refractory LE patients were recruited to compare the outcomes of PRP and dry needling. The researchers applied dry needling as a peppering technique in which a 10-L needle penetrated the tendon five times. In another study, Suzuki et al. [25] performed percutaneous tendon needling without ultrasonography for LE that was resistant to conventional nonoperative treatments and showed that the clinical and functional impairment of the elbow was significantly improved. The authors concluded that the tendinous lesion can be needled approximately 20–30 times by fenestration around the lateral epicondyle. Barnes et al. performed a similar type of randomized controlled study that showed improvement in VAS pain scores from 6.4 at baseline to 0.7 after 12 months of treatment in the dry needling group [26]. In our study, the needling site was determined by the examiner using their thumb to locate the point at which patients complained of strong pain around the lateral epicondyle. Dry needling consisted of passing a fine needle (23G) in and out of the long axis of the tendon, without coming out of the skin about 40–50 times to pepper the tendon. The procedure took a total of 2 min, and the treatment was repeated once a week for three weeks. Dry needling was found as effective as corticosteroids and PRP application for lateral epicondylitis in the short-term period.

A recently published meta-analysis evaluating the impact of PRP on tendinopathy compared to placebo or dry needling injections found that PRP did not provide significantly greater clinical benefits versus placebo or dry needling for the treatment of tendinopathy after a 6-month period of follow-up [27]. In addition, a 2014 meta-analysis found no strong evidence that PRP injections were efficacious in the treatment of chronic lateral epicondylar tendinopathy [28]. In our study, all three treatment modalities showed similar results in the long-term.

Several treatment modalities exist for LE, one of the more popular being local corticosteroid injection. Local corticosteroid injections have been reported as effective and cost-effective [29]. In a study investigating the effects of corticosteroid injection on pain and handgrip strength of patients with LE, the authors found that the injection was effective in pain, disability, and damaged hand functions in patients with LE and concluded that positive long-term effects of local corticosteroid injection can be observed in the 3-month duration of treatment effect [30]. A randomized controlled clinical trial [31] compared the effects of local anesthetic injection versus corticosteroid injection in patients with LE using qDASH and VAS scores. The authors found no significant differences between patients in both groups in terms of age, gender, dominant hand, or demographic factors such as work pressure and reported that patients in the corticosteroid group had a considerable response to the treatment three weeks after injection (a three-fold greater effect reaction compared with the control group). However, at 6 and 12 weeks after the injection therapies, the qDASH and VAS scores in the corticosteroid group increased, suggesting recurrence in 34.7% of patients. The authors concluded that corticosteroid treatment has the best short-term treatment results while also having the highest recurrent rates. Our study demonstrated that DASH scores decreased significantly at the 3rd month for all groups, with the greatest decrease observed in corticosteroids group. The literature for corticosteroid does not provide conclusive evidence over the exact volume and type of corticosteroid injections, the exact area of injection, and the injection method (single injection vs. injection using the peppering technique) [10, 32, 33]. Price et al. [32] studied the functional outcomes of three corticosteroid regimens (triamcinolone 10 mg, hydrocortisone acetate 25 mg, and lidocaine 1% [as the control group]) and reported that corticosteroid methods were more effective than local anesthetic injection. However, the authors did not find any significant differences between the two corticosteroid methods. At the 24-week follow-up, the improvement rate in all trial groups was similar, and recurrence was observed in half of the patients undergoing corticosteroid treatment. Corticosteroid injections of 40 mg methylprednisolone acetate were administered in our study. Steroid injections were given only once.

Study limitation

The lack of a control group and the short follow-up period can be considered limitations of the current study. Further studies to examine whether the treatment effects are maintained in the long-term is warranted. The primary purpose of this study was not to examine the effectiveness of dry needling, corticosteroids, or PRP, but to compare the effects of these three treatment modalities. As the local ethics committee did not allow for patients to be left untreated completely, we were unable to form a control group. An additional limitation is that diagnosis of LE was only made clinically, and patients were not subjected to diagnostic imaging (e.g., ultrasonography, magnetic resonance imaging). Furthermore, while we found successful results with dry needling, results may vary as a function of the technique used.

Conclusion

Dry needling appears to be as an effective treatment modality as corticosteroid injection or PRP application for LE at 3 weeks and 3 months. We observed that elbow pain was improved significantly after dry needling application. To our

knowledge, dry needling is an effective and safe application for the short-term treatment of LE.

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Declarations

Conflict of interest The authors declare no conflicts of interest.

References

1. Waugh EJ (2005) Lateral epicondylalgia or epicondylitis: what's in a name? J Orthop Sports Phys Ther 35:200–202
2. Hudak PL, Cole DC, Haines AT (1996) Understanding prognosis to improve rehabilitation: the example of lateral elbow pain. Arch Phys Med Rehabil 77(6):586–593. https://doi.org/10.1016/s0003-9993(96)90300-7
3. Hsieh LF, Kuo YC, Lee CC (2018) Comparison between corticosteroid and lidocaine injection in the treatment of tennis elbow: a randomized, double-blinded, controlled trial. Am J Phys Med Rehabil 97:83–89
4. Vaquero-Picado A, Barco R, Antuña SA (2016) Lateral epicondylitis of the elbow. EFORT Open Rev 1:391–397
5. Luk JK, Tsang RC, Leung HB (2014) Lateral epicondylalgia: the midlife crisis of a tendon. Hong Kong Med J 20:145–151
6. Bhabra G, Wang A, Ebert JR (2016) Lateral elbow tendinopathy: development of a pathophysiology based treatment algorithm. Orthop J Sports Med 4:2325967116670635
7. Ozkut AT, Kilinçoğlu V, Ozkan NK, Eren A, Ertaş M (2007) Extracorporeal shock wave therapy in patients with lateral epicondylitis. Acta Orthop Traumatol Turc 41:207–210
8. Tsikopoulos K, Tsikopoulos I, Simeonidis E, Papathanasiou E, Haidich AB, Anastasopoulos N et al (2016) The clinical impact of platelet rich plasma on tendinopathy compared to placebo or dry needling injections: a meta-analysis. Phys Ther Sport 17:87–94
9. Lewis M, Hay EM, Paterson SM, Croft P (2005) Local corticosteroid injections for tennis elbow: does the pain get worse before it gets better? Results from a randomized controlled trial. Clin J Pain 21(4):330–334
10. Assendelft WJ, Hay EM, Adshead R, Bouter LM (1996) Corticosteroid injections for lateral epicondylitis: a systematic overview. Br J Gen Pract 46(405):209–216
11. Smidt N, van der Windt DA, Assendelft WJ, Deville WL (2002) Corticosteroid injections, physiotherapy, or a wait-and-see policy for lateral epicondylitis: a randomized controlled trial. Lancet 359:657–662
12. Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B (2006) Mobilization with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: a randomized trial. BMJ 333(7575):939
13. Buchbinder R, Johnston RV, Barnsley L, Assendelft WJJ, Bell SN, Smidt N (2011) Surgery for lateral elbow pain. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD003525.pub2
14. Andia I, Rubio-Azpeitia E, Maffulli N (2015) Platelet rich plasma modulates the secretion of inflammatory/angiogenic proteins by inflamed tenocytes. Clin Orthop Relat Res 473(5):1624–1634
15. Galatz LM, Gerstenfeld L, Heber-Katz E, Rodeo SA (2015) Tendon regeneration and scar-formation: the concept of scarless healing. J Orthop Res 33(6):823–831
16. Hudgens JL, Sugg KB, Grekin JA, Gumucio JP, Bedi A, Mendias CL (2016) Platelet rich plasma activates pro-inflammatory signaling pathways and induces oxidative stress in tendon fibroblasts. Am J Sports Med 44(8):1931–1940
17. Chen X, Jones A, Park C, Vangsness CT Jr (2018) The efficacy of platelet rich plasma on tendon and ligament healing: a systematic review and meta-analysis with bias assessment. Am J Sports Med 46(8):2020–2032
18. Krey D, Borchers J, McCamey K (2015) Tendon-needling for treatment of tendinopathy:a systematic review. Phys Sportsmed 43:80–86
19. Tsikopoulos K, Tsikopoulos I, Simeonidis E, Papathanasiou E, Haidich AB, Anastasopoulos N et al (2016) The clinical impact of platelet-rich plasma on tendinopathy compared to placebo or dry needling injections: a meta-analysis. Phys Ther Sport 17:87–94
20. McShane JM, Shah VN, Nazarian LN (2008) Sonographically guided percutaneous-needle tenotomy for treatment of common extensor tendinosis in the elbow: is a corticosteroid necessary? J Ultrasound Med 27:1137–1144
21. Mattie R, Wong J, McCormick Z, Yu S, Saltychev M, Laimi K (2017) Percutaneous-needle tenotomy for the treatment of lateral epicondylitis: a systematic review of the literature. PM R 9:603–611
22. James SLJ, Ali K, Pocock C, Robertson C, Walter J, Bell J et al (2007) Ultrasound guided dry needling and autologous blood injection for patellar tendinosis. Br J Sports Med 41(8):518–522. https://doi.org/10.1136/bjsm.2006.034686
23. Stenhouse G, Sookur P, Watson M (2013) Do blood growth factors offer additional benefit in refractory lateral epicondylitis? A prospective, randomized pilot trial of dry needling as a stand-alone procedure versus dry-needling and autologous conditioned plasma. Skelet Radiol 42:1515–20
24. Mishra AK, Skrepnik NV, Edwards SG, Jones GL, Sampson S, Vermillion DA et al (2014) Efficacy of platelet rich plasma for chronic tennis elbow:a double-blind, prospective, multicenter, randomized controlled trial of 230 patients. Am J Sports Med 42:463–471. https://doi.org/10.1177/0363546513494359
25. Suzuki T, Iwamoto T, Matsumura N, Nakamura M, Matsumoto M, Sato K (2019) Percutaneous tendon-needling without ultrasonography for lateral epicondylitis. Keio J Med. https://doi.org/10.2302/kjm.2019-0004-OA
26. Barnes DE, Beckley JM, Smith J (2015) Percutaneous ultrasonic tenotomy for chronic elbow tendinosis: a prospective study. J Shoulder Elbow Surg 24:67–73. https://doi.org/10.1016/j.jse.2014.07.017
27. Tsikopoulos K, Tsikopoulos I, Simeonidis E, Papathanasiou E (2016) The clinical impact of platelet rich plasma on tendinopathy compared to placebo or dry needling injections: a meta-analysis. Phys Ther Sport 17:87–94
28. De Vos RJ, Windt J, Weir A (2014) Strong evidence against platelet-rich plasma injections for chronic lateral epicondylar tendinopathy: a systematic review. Br J Sports Med 48:952–956
29. Chard MD (2003) Regional and wide spread pain. In: Hochberg MC, Silman AJ, Smolen JS, Weinblatt ME, Weisman MH (eds) The elbow. Rheumatology, 3rd edn. Mosby, Philadelphia, pp 631–41
30. Genc H, Cakit BD, Saracoglu M (2010) The effects of local steroid injection on pain, disability, and hand functions in patients with lateral epicondylitis. J Musculoskelet Pain 18:49–57
31. Mardani-Kivi M, Karimi-Mobarakeh M, Karimi A (2013) The effects of corticosteroid injection versus local anesthetic injection in the treatment of lateral epicondylitis: a randomized

single-blinded clinical trial. Arch Orthop Trauma Surg 133:757–763
32. Price R, Sinclair H, Heinrich I, Gibson T (1991) Local injection treatment of tennis elbow–hydrocortisone, triamcinolone, and lignocaine compared. Br J Rheumatol 30(1):39–44
33. Bellapianta J, Swartz F, Lisella J, Czajka J, Neff R, Uhl R (2011) Randomized prospective evaluation of injection techniques for the treatment of lateral epicondylitis. Orthopedics 34(11):e708–e712. https://doi.org/10.3928/01477447-20110922-13