Treatment of lateral epicondylitis with platelet-rich plasma, glucocorticoid, or saline. A comparative study

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Background
Lateral epicondylitis (LE) is the most common overuse syndrome and related to excessive wrist extension, known as tendonitis of the extensor muscles of the forearm, and refers to pain and tenderness over the lateral epicondyle of the humerus.
Local corticosteroid injection has short-term benefits in pain reduction, global improvement, and grip strength compared with placebo (saline or lidocaine) and other conservative treatments.
Autologous platelet-rich plasma (PRP) injection has gained popularity within the sports medicine literature because of its presumed safety and ease of use as a potential treatment for any musculoskeletal problems by inducing cell proliferation and promoting the healing process.
This thesis was carried out to assess the effectiveness of different types of injections (PRP, glucocorticoid, and saline) in improving pain and function in patients with LE.
Patients and methods
This study included 45 patients with LE (more than 3 months) between 31 and 58 years of age. All patients were subjected to assessment of history, clinical examination by the visual analogue scale (VAS), functional assessment by patient-rated tennis elbow evaluation (PRTEE), laboratory investigations, and ultrasonography assessment of the elbow.
All the patients were divided randomly into three groups: group I received a saline injection, group II received a PRP injection, and group III received a corticosteroid injection. Patients were reassessed clinically and by ultrasound after 3 months.
Results
The present study showed that VAS and PRTEE scores were highly significantly reduced after injection in group II than group I and group III. Moreover, the reductions in VAS and PRTEE were highly significantly different in group III in comparison with group I.
In terms of ultrasonographic changes and reduction in tenderness, there was a highly significant improvement in group II than group I and group III. Moreover, the reduction was highly significantly different in group III than group I.
Conclusion
PRP injection may offer several therapeutic advantages over corticosteroid injection.

Keywords:
corticosteroid injection, lateral epicondylitis, platelet-rich plasma, tennis elbow

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Introduction

Lateral epicondylitis (LE) is the most frequent type of myotendinosis. It is a painful condition affecting the tendinous tissue of the origins of the wrist extensor muscles at the lateral epicondyle of the humerus, leading to loss of function of the affected limb. Therefore, it can have a major impact on a patient's social and professional life [1].

The incidence of LE is estimated to be four to seven per 1000 patients per year [2], with a prevalence of 1–3%, peaks at 45–54 years of age, and is as common in men as in women [3]. It is a common work-related disorder, with a prevalence up to 14.5% in strenuous jobs [4].

Microscopical studies showed mainly fibroblastic tissue and vascular invasion described as 'angiofibroblast tendinosis' [5].

Ultrasonography (US) is an important diagnostic tool in sports medicine and rheumatology. It is a reliable, noninvasive, widely available, and inexpensive imaging technique for assessing tendon lesions [6].

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The high acoustic contrast with the surrounding tissue makes tendons particularly suitable for US examination [7].

Several studies have described the US findings in tendinopathy in general characterized by increased tendon size, irregularity of the fibrillar appearance, focal hypoechoic areas, power Doppler activity signal, and calcifications [8].

The treatment of LE varies widely, from conservative, nonsteroidal anti-inflammatory drugs, physical therapies including exercise and bracing, and as a last option, injection therapies or surgery. Injection with glucocorticoid (CS) has been the treatment of choice for many years [9].

However, because several studies have shown no long-term effect, the search for alternative treatments has intensified. During the past 10 years, therapies have become available focusing on the use of growth factors as a stimulant of tendon repair [10].

Platelet-rich plasma (PRP) is blood plasma with an increased concentration of autologous platelets, which is now being used as a part of wound treatment, bone healing, alloplastic surgery, and muscle tendon damage [11].

PRP can potentially enhance tendon healing and tissue regeneration by delivering various growth factors and cytokines, thereby affecting cell proliferation, chemotaxis, cell differentiation, and angiogenesis. Among these growth factors are platelet-derived, transforming, vascular endothelial, epidermal, and fibroblast. The theory is that application of PRP intrate ndinously will stimulate the repair mechanisms and promote tendon healing [12].

Our aim was to assess the effectiveness of different types of injections after 3 months (PRP, CS, saline) in reducing pain and improving function in patients with LE.

Patients and method

The study included 45 patients with LE. The local injection treatments were PRP, CS, or isotonic saline, with 15 patients in each treatment arm.

Patients included in the study had pain on the lateral side of the elbow for more than 3 months, and tenderness at the lateral epicondyle on direct palpation and during resisted dorsiflexion of the wrist [13].

Patients younger than 18 years, those who had received a CS injection within the previous 3 months, those who had undergone previous LE surgery, and patients with inflammatory diseases (e.g. rheumatoid arthritis, psoriatic arthritis) or neck pain and shoulder pain on the ipsilateral side were excluded from the study.

All patients were subjected to the following:

Full medical history

Assessment of medical history and thorough clinical examination were performed; the visual analogue scale (VAS) was used for pain: It is a numeric scale, with 0 representing no pain and 10 representing the worst pain imaginable [14].

Functional assessment

Functional assessment of the elbow joint was perfo rmed. Patient-rated tennis elbow evaluation (PRTEE) is a 15-item questionnaire designed to measure forearm pain and disability in patients with LE over the past week [15].

The PRTEE consists of two subscales: the pain subscale (0=no pain, 10=worst imaginable), which includes five items: pain at rest, on doing a task with repeated arm movement, and on carrying a plastic bag of groceries, and when pain was at its least and at its worst. The best score is zero and the worst score is 50. The function subscale (0=no difficulty, 10=unable to do) includes a questionnaire related to specific activities (six items) and usual activities (four items): (specific activities+usual activities)/2. The best score is zero and the worst score is 100.

In addition, a total score is calculated on a scale of 100, where it is the sum of both pain and function scales (Total score=pain subscale+function subscale) (0=no disability and the worst score is 100).

Ultrasonography

Ultrasonography was performed using General Electric LOGIC P5 with a multifrequency linear transducer 3–12 MHz (General Electric, Milwaukee, Wisconsin, USA). US was performed by a certified sonographer who was blinded to the clinical diagnosis. The trans ducer is aligned with the long axis of the radius over the common tendon origin. Patients were examined in a sitting position with the elbow flexed to 90, the wrist pronated, and the arm resting on a table.

It is examined by both gray scale and color Doppler US in the longitudinal plane, locating the part characterized by increased tendon size, irregularity of

fibrillar appearance, focal hypoechoic areas, and calcifications [8].

It is graded by ultrasonography as follows: grade 1, hypoechogenicity of the tendon with a conserved fibrillar structure and no other lesions; grade 2: appearance of more hypoechoic regions up to 2 mm in diameter where the fibrillar structure was lost; grade 3, more hypoechoic regions between 2 and 5 mm in diameter with no fibrillar structure; and grade 4, more hypoechoic regions larger than 5 mm in diameter or clearly anechoic [16].

All 45 patients were further subdivided in a blinded manner into three groups: the first group of 15 patients received a CS injection (1 ml triamcinolon 40 mg/ml +2 ml lidocaine 10 mg/ml), the second group of 15 patients received a saline injection (3 ml saline 0.9%), and the third group of 15 patients received a PRP injection. Three of the patients had bilateral complaints; first, an injection was administered with PRP on one side, followed 3 months later by an injection on the other side.

Platelet-rich plasma preparation

Overall, 27 ml of whole blood (autologous) is collected into a 30-ml syringe containing 3 ml sodium citrate (anticoagulant) and then placed in a disposable tube in a centrifuge (Centruion CR 2000, Quadrex Technologies, United Kingdom) for 15 min at a speed of 3.2 (31 000 rpm). Platelets are collected. The outcome of this process is ~3–3.5 ml of PRP. The PRP is injected immediately after preparation. One injection is administered at baseline [17].

The post-treatment protocol was as follows:

(1) Patients were asked not to use or minimally use the arm for 3–4 days.
(2) An elbow splint was placed.
(3) Gentle active range of motion was advised three times a day for 5 min per session.
(4) If an analgesic was needed, acetaminophen was recommended, except for patients who received a PRP injection [18].

Follow-up of all patients was performed according to Krogh *et al.* [17], 3 months after injection by the pain analogue scale, assessment of elbow function by PRTEE and ultrasonography.

Written consent, which was approved by the Ain Shams ethical committee, was obtained from all patients after a full explanation of the study was provided.

Statistical analysis

Descriptive statistics were calculated for all variables of the study. For quantitative variables, the mean, range, SD, and SEM were calculated. For categorical variables, absolute counts as well as percentages were generated.

Student *t*-test was used to compare two groups in terms of quantitative parametric data. Wilcoxon rank sum test (*Z*-test) was used to compare two groups in terms of quantitative nonparametric data. Wilcoxon rank Sign test was used to compare before versus after treatment in the same group for quantitative nonparametric data.

A paired *t*-test was used to compare two groups in terms of nonparametric data. Comparison of categorical data was performed using the χ^2-test.

P-value is the level of significance, where *P* of more than 0.05 is considered as nonsignificant, *P* less than 0.05 as significant, and *P* less than 0.00l as highly significant.

The HGW program was used for graphical representation.

Data were statistically analyzed and represented using the Statistical package for Social Science (SPSS 15.0.1 for Windows; SPSS Inc, Chicago, Illinois, USA).

Results

Demographic data

This study included three groups as follows: group I (Saline group), group II (PRP), and group III (corticosteroid); their demographic data are presented in Table 1.

Descriptive data

VAS and PRTEE scores

Group I (*Saline*): VAS scores in group I, before the injection, was 63.67±16.3, with a range of 40–90, whereas after injection, mean±SD of VAS was 61.67± 15.88, with a range of 40–90.

Table 1 Comparison between group I, group II, and group III in age, sex, and duration of illness

Variables	Group I (saline)	Group II (PRP)	Group III (CS)
Age (years)			
Mean±SD	38.8±4.9	40.93±8.46	41.67±4.23
Range	30–45	31–58	35–53
Sex [*n* (%)]			
Male	4 (26.7)	4 (26.7)	7 (46.7)
Female	11 (73.3)	11 (73.3)	8 (53.3)
Duration (months)			
Mean±SD	8.53±2	8.53±2	8.53±3.6
Range	6–12	6–12	5–18

In terms of age, sex, and duration of illness, there were no significant differences between the groups, $P>0.05$. CS, glucocorticoid; PRP, platelet-rich plasma.

PRTEE (mean±SD) before injection was 65.3±12.3, with a range of 45–85, whereas after injection, mean± SD of PRTEE was 63.3±12.3, with a range of 40–85.

Group II (*PRP*): The mean±SD of VAS before injection was 65±16.79, with a range of 40–90, whereas after injection, mean±SD of VAS was 7.33±7.52, with a range of 0–20. PRTEE mean±SD before injection was 64.33±13.47, with a range of 40–85. After injection, mean±SD of PRTEE was 6.67±4.88, with a range of 0–15.

Group III (glucocorticoid): Mean±SD of VAS before injection was 68±8.6, with a range of 50–80. After injection, VAS was 36.3±11.8, with a range of 10–50.

PRTEE (mean±SD) before injection was 66.7±12.8, with a range of 40–85. After injection, mean±SD of PRTEE was 28.7±10.8, with a range of 15–50.

Tenderness grade

Group I (*saline*): In terms of the grade of tenderness, 13.3% of patients showed an improvement from grade 3 to grade 2, whereas 86.7% of patients showed no improvement at follow-up 3 months after a saline injection.

Group II (*PRP*): In terms of grading of tenderness in group II, 40% of patients improved from grade 3 to grade 1, whereas 40% of patients showed improvement from grade 2 to grade 0 and 30% of patients showed improvement from grade 1 to grade 0 at follow-up 3 months after a PRP injection as shown in Table 2.

Group III (*CS*): In terms of the grading of tenderness, 20% of patients showed no improvement (0G=20%), whereas 60% of patients showed improvement by one grade (1G=60%), 20% of patients showed improvement by two grades (2G=20%) at follow-up 3 months after a corticosteroid injection as shown in Table 3.

Ultrasound grades

Group I (*saline*): In terms of ultrasound grading, there was no improvement in any of the patients at all grades injected with saline 3 months after injection as shown in Table 4.

Group II (*PRP*): In terms of US grading in group II, there was an improvement in 100% of patients; 13.3% improved by one grade, 66.7% improved by 2G, and 20% improved by three grades (3G) as shown in Table 5.

Group III (*CS*): In terms of ultrasound grading in group III, 13.3% of patients showed no improvement in grade, 73.3% of patients showed improvement from grade 2 to grade 1, and 13.3% of patients showed improvement from grade 2 into grade 0 at follow-up 3 months after a corticosteroid injection as shown in Table 6.

Comparative data

Group I (saline): In terms of VAS and PRTEE scores in group I, there was a significant improvement after injection ($P<0.05$), whereas US grade showed a nonsignificant decrease after injection in group I.

Table 2 Tenderness grading of group II before and after injection of platelet-rich plasma

Variables	Grades	*n* (%)			
		Before	After	Change	
Tenderness	G0	0 (0)	9 (60)	1G	3 (20)
	G1	3 (20)	6 (40)	2G	12 (80)
	G2	6 (40)	0 (0)	3G	0 (0)
	G3	6 (40)	0 (0)		

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction.

Table 3 Tenderness grades of group III before and after injection of corticosteroids

Variables	Grades	*n* (%)			
		Before	After	Change	
Tenderness	G1	1 (6.7)	7 (46.7)	0G	3 (20)
	G2	5 (33.3)	8 (53.3)	1G	9 (60)
	G3	9 (60)	0 (0)	2G	3 (20)
				3G	0 (0)

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction.

Table 4 Ultrasound grading of group I before and after injection of saline

Variables	Grades	*n* (%)			
		Before	After	Change	
Ultrasound	G1	2 (13.3)	2 (13.3)		
	G2	10 (66.7)	10 (66.7)	0 G	15 (100)
	G3	3 (20)	3 (20)	1G	0 (0)
				2G	0 (0)
				3G	0 (0)

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction.

Table 5 Ultrasound grading of group II before and after injection of platelet-rich plasma

Variables	Grades	*n* (%)			
		Before	After	Change	
Ultrasound	G 0	0 (0)	15 (100)	0G	0 (0)
				1G	2 (13.3)
	G 1	2 (13.3)	0 (0)	2G	10 (66.7)
	G2	10 (66.7)	0 (0)		
	G3	3 (20)	0 (0)	3G	3 (20)

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction.

Group II (platelet-rich plasma): The VAS score in group II (PRP) showed a highly significant decrease after injection ($P<0.001$).

PRTEE also showed a highly significant decrease after injection in group II ($P<0.001$), tenderness grade showed a highly significant decrease after injection in group II ($P<0.001$) as shown in Fig. 1.

US grade showed a highly significant decrease; in 100% of patients, it changed from grades 1, 2, and 3 to grade 0 after injection in group II ($P<0.001$) as shown in Table 7 and Fig. 2a, b.

Group III (CS): In terms of the VAS score before and after injection in group III, there was a highly significant decrease ($P<0.001$). PRTEE also showed a highly significant decrease after injection in group III ($P<0.001$),

Table 6 Ultrasound grading of group III before and after injection of glucocorticoid

Variables	Grades	*n* (%)		
		Before	After	Change
Ultrasound	G0	0 (0)	2 (13.3)	0G: 2 (13.3)
	G1	1 (6.7)	9 (60)	
	G2	11 (73.3)	4 (26.7)	
	G3	3 (20)	0 (0)	1G: 11 (73.3)
				2G: 2 (13.3)
				3G: 0 (0)

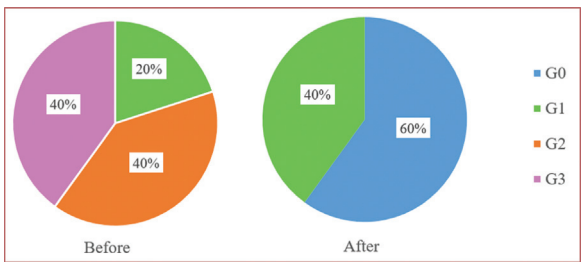
0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction.

Table 7 Ultrasound grading before and after injection of platelet-rich plasma in group II

Ultrasound	Before [*n* (%)]	After [*n* (%)]	χ^2	*P*	Significance
G0	0 (0)	15 (100)			
G1	2 (13.3)	0 (0)			
G2	10 (66.7)	0 (0)	15	0.001	HS
G3	3 (20)	0 (0)			

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction; HS, highly significant.

Figure 1



Comparison before and after injections in group (II) in terms of tenderness grade.

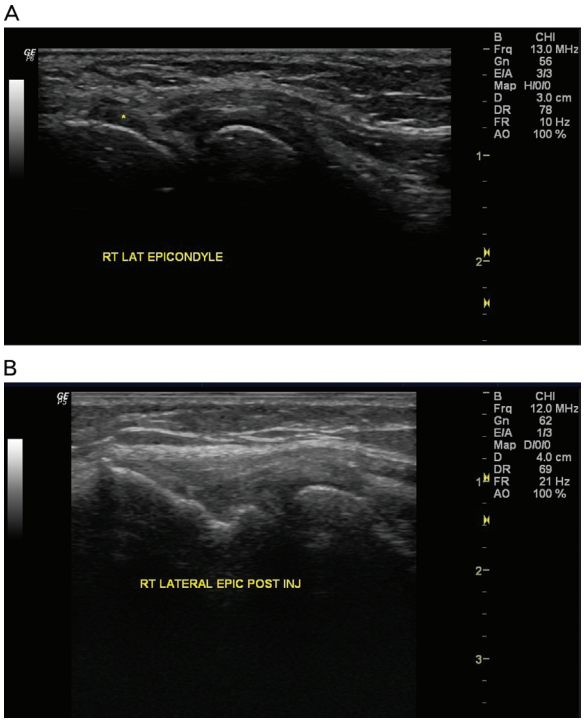
Ultrasound grade showed a significant improvement after injection in group III ($P<0.05$) as shown in Table 8 and Fig. 3a and b.

The VAS score and reduction in PRTEE after injection were highly significant in group II than group I ($P<0.001$) as shown in Table 9.

Meanwhile, the VAS score and reduction in PRTEE after injection were highly significant in group III than group I ($P<0.001$).

Changes in the VAS score and reduction in PRTEE were highly significant in group II than group III ($P<0.001$) as shown in Table 10.

Figure 2



(a) Longitudinal scan of the common extensor tendon showing a hypoechoic region of 3 mm (grade 3) with loss of the fibrillar pattern of the common extensor tendon before a platelet-rich plasma (PRP) injection. (b) 3 months after PRP injection, the same patient showed normal fibrillar structure and homogenous echogenicity of the common extensor tendon.

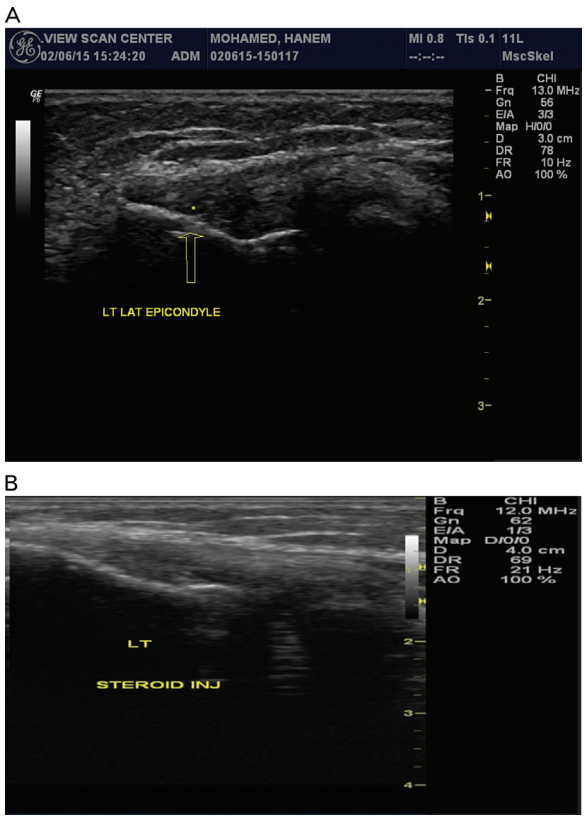
Table 8 Ultrasound grading before and after injection of glucocorticoid in group III

Ultrasound	Before [*n* (%)]	After [*n* (%)]	χ^2	*P*	Significance
G0	0 (0)	2 (13.3)			
G1	1 (6.7)	9 (60)			
G2	11 (73.3)	4 (26.7)	10.68	<0.05	S
G3	3 (20)	0 (0)			

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction; S, significant.

Reduction in tenderness was highly significant in group III than group I ($P<0.001$),

Figure 3



(a) Longitudinal scan of the common extensor tendon showing a hypoechoic region of 2 mm (grade 2) and loss of fibrillar structure of common extensor origin before a corticosteroid injection. (b) 3 months after a corticosteroid injection, a preserved fibrillar structure with hypoechogenicity of the common extensor tendon was observed (grade 1).

After injection, group II showed a highly significant improvement than group III ($P<0.001$).

The change in tenderness grade reduction was highly significant in group II than group III ($P<0.001$).

Before injection, US grades were identical in group I and group II ($P>0.05$), whereas after injection, group II showed a highly significant improvement in US grade ($P<0.001$) than group I.

The reduction in US grade was highly significant in group II than group I ($P<0.001$) as shown in Table 11.

After injection, group III showed a significant improvement in US grade ($P<0.05$) than group I.

The change in US grade reduction was highly significant in group III than group I ($P<0.001$) as shown in Table 12.

Before injection, the US grade showed identical results in group II and group III ($P>0.05$).

After injection, group II showed a highly significant improvement in US grade ($P<0.001$) than group III.

The change in US grade reduction was highly significant in group II than group III ($P<0.001$) as shown in Table 13 and Fig. 4.

Table 9 Comparison between group I (saline) and group II (platelet-rich plasma) in terms of visual analogue scale and patient-rated tennis elbow evaluation

Variables	Time	Group I [mean±SD/SEM (range)]	Group II [mean±SD/SEM (range)]	*t*/*Z*	*P*	Significance
VAS	Before	63.67±16.79 (40–90)	65±16.79 (40–90)	*t*=0.22	>0.05	NS
	After	61.67±15.88 (40–90)	7.33±7.52/1.94 (0–20)	*Z*=11.97	<0.001	HS
	Change	−2±3.1/0.8 (−10 to 0)	−57.67±10.99 (−75 to −40)	*Z*=4.77	<0.001	HS
PRTEE	Before	65.33±12.31 (45–85)	64.33±13.47 (40–85)	*t*=0.212	>0.05	NS
	After	63.33±12.34 (40–85)	6.67±4.88/1.26 (0–15)	*Z*=16.53	<0.001	HS
	Change	−2±0.95 (−10 to 5)	−57.67±10.99 (−75 to −40)	*Z*=4.74	<0.001	HS

HS, highly significant; PRTEE, patient-rated tennis elbow evaluation; VAS, visual analogue scale score.

Table 10 Comparison between group II (platelet-rich plasma) and group III (glucocorticoid) in the visual analogue scale score and patient-rated tennis elbow evaluation

Variables	Time	Group II [mean±SD/SEM (range)]	Group III [mean±SD/SEM (range)]	*t*/*Z*	*P*	Significance
VAS	Before	65±16.79 (40–90)	68±8.61 (50–80)	*t*=0.615	>0.05	NS
	After	7.33±7.52/1.94 (0–20)	36.33±11.87 (10–50)	*Z*=7.99	<0.001	HS
	Change	−57.67±10.99 (−75 to −40)	−31.67±12.63 (−60 to −10)	*Z*=4.11	<0.001	HS
PRTEE	Before	64.33±13.47 (40–85)	66.67±12.77 (40–85)	*t*=0.487	>0.05	NS
	After	6.67±4.88/1.26 (0–15)	28.67±10.76/2.7 (15–50)	*Z*=7.20	<0.001	HS
	Change	−57.67±10.99 (−75 to −40)	−38±14.24/3.6 (−70 to −10)	*Z*=3.67	<0.001	HS

HS, highly significant; PRTEE, patient-rated tennis elbow evaluation; VAS, visual analogue scale score.

Table 11 Comparison between group I (saline) and group II (platelet-rich plasma) in ultrasound grading

Variables	Group I [*n* (%)]	Group II [*n* (%)]	χ^2	*P*	Significance
Before					
G1	2 (13.3)	2 (13.3)			
G2	10 (66.7)	10 (66.7)	0	>0.05	NS
G3	3 (20)	3 (20)			
After					
G0	0 (0)	15 (100)			
G1	2 (13.3)	0 (0)			
G2	10 (66.7)	0 (0)	30.000	<0.001	HS
G3	3 (20)	0 (0)			
Change					
0G	15(100)	0 (0)			
1G	0 (0)	2 (13.3)			
2G	0 (0)	10 (66.7)	30.000	<0.001	HS
3G	0 (0)	3 (20)			

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction; HS, highly significant.

Table 12 Comparison between group I (saline) and group III (glucocorticoid) in the ultrasound grade

Variables	Group I [*n* (%)]	Group III [*n* (%)]	χ^2	*P*	Significance
Before					
G1	2 (13.3)	1 (6.7)			
G2	10 (66.7)	11 (73.3)	0.38	>0.05	NS
G3	3 (20)	3 (20)			
After					
G0	0 (0)	2 (13.3)			
G1	2 (13.3)	9 (60)			
G2	10 (66.7)	4 (26.7)	12.02	<0.05	S
G3	3 (20)	0 (0)			
Change					
0G	15(100)	2 (13.3)			
1G	0 (0)	11 (73.3)			
2G	0 (0)	2 (13.3)	22.94	<0.001	HS
3G	0 (0)	0 (0)			

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction; HS, highly significant; S, significant.

Table 13 Comparison between group II (platelet-rich plasma) and group III (glucocorticoid) in ultrasound grading

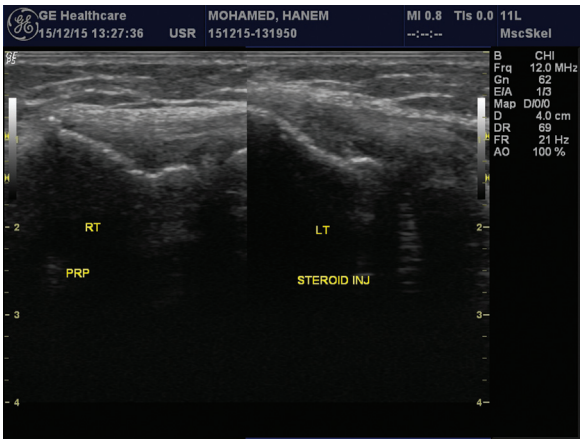
Variables	Group II [*n* (%)]	Group III [*n* (%)]	χ^2	*P*	Significance
Before					
G1	2 (13.3)	1 (6.7)			
G2	10 (66.7)	11 (73.3)	0.381	>0.05	NS
G3	3 (20)	3 (20)			
After					
G0	15 (100)	2 (13.3)			
G1	0 (0)	9 (60)			
G2	0 (0)	4 (26.7)	22.94	<0.001	HS
G3	0 (0)	0 (0)			
Change					
0G	0 (0)	2 (13.3)			
1G	2 (13.3)	11 (73.3)			
2G	10 (66.7)	2 (13.3)	16.56	<0.001	HS
3G	3 (20)	0 (0)			

0G, no grade reduction; 1G, reduction of one grade; 2G, two-grade reduction; 3G, three-grade reduction; HS, highly significant.

Discussion

LE is one of the most common causes of musculoskeletal pain involving the common extensor origin of the forearm. This disorder arises as a result of repetitive manual work involving overexertion of the wrist and finger extensors and leads to significant disability in terms of the quality of daily life activities. Clinically, it

Figure 4



Comparison between platelet-rich plasma (PRP) and glucocorticoid after injection in the same patient showing greater improvement in homogeneity of the right side (PRP) than the left side.

involves both direct and indirect tenderness at the lateral epicondyle [19].

Autologous PRP was first used by Ferrari *et al.* [20], following an open heart surgery, to avoid excessive transfusion of homologous blood products. Since then, autologous PRP has been used safely and documented in many fields including orthopedics, sports medicine, dentistry, ENT, neurosurgery, ophthalmology, urology, and wound healing, as well as cosmetic, cardiothoracic, and maxillofacial surgery.

PRP is increasingly being used in the treatment of chronic nonhealing tendon injuries including the elbow, patella, and the Achilles. Studies suggest that PRP can affect inflammation and soft tissue healing [21] as platelets contain an abundance of growth factors and cytokines that are essential for soft tissue healing and bone mineralization [22].

This prospective study included 45 patients; their age ranged from 31 to 58 years, with mean±SD (38.8±4.9) in group I (saline injection), mean±SD (45.93±8.46) in group II (PRP injection), and mean±SD (41.67±4.23) in group III (corticosteroid injection), with no significant difference between the groups.

The study by Shiri *et al.* [23]found that LE is prevalent in patients aged 45–54 years old. The study by Otoshi *et al.* [24] showed that LE is prevalent in individuals between 40 and 59 years of age. However, Gautam *et al.* [25] reported that LE is prevalent in patients aged 18–60 years old. This variation in age may be because of the predisposing factors such as mechanical overloading and overuse.

The reduction in the VAS scores was highly significant in group II than group I and group III. Moreover, the reduction was highly significant in group III than group I.

Meanwhile, Yadav *et al.* [19] carried out a study on 65 patients with LE and divided them randomly into two groups: group A was treated with a single injection of 1 ml PRP with an absolute platelet count of at least one million platelets/mm^3 and group B was treated with a single injection of 1 ml (40 mg) methyl-prednisolone. Pain was assessed using the VAS. It showed greater improvement with a corticosteroid injection after 15 days and 1 month than with PRP; however, at the end of 3 months, improvement in pain was highly significant in the PRP injection group than the corticosteroid group ($P<0.0001$). The superior effect of cortico steroid early in the course of treatment in the study by Yadav *et al.* [19] may be because of its anti-inflammatory effect, whereas the late positive effect noted in the PRP group over the corticosteroid effect that was also observed in our study may be because of the high healing power of the PRP over the corticosteroid.

The reduction in the PRTEE score was highly significant in group II than group I and group III and was highly significant in group III than group I.

This was in contrast to Krogh *et al.* [17], who carried out a randomized-controlled study that included 60 patients with LE divided into three groups. The local injection treatments included a CS injection of 1 ml triamcinolon 40 mg/ml+2 ml lidocaine 10 mg/ml and a saline injection of 3 ml, and 3–3.5 ml of PRP. All patients were assessed at 1 month and at 3 months by ultrasonography and PRTEE score. The study found that in terms of PRTEE at 1 month, CS was superior to both PRP and saline, but at 3 months, there was no statistically significant difference among the three groups.

In ultrasound evaluation, there was a highly significant improvement in tendon echogenicity, thickness and color Doppler activity in group II than group I and group III, and a highly significant improvement in group III than group I.

This study is in agreement with Gautam *et al.* [25], a randomized study of 30 patients aged 18–60 years with recalcitrant (>6 months) who were randomized into two groups: group I received a PRP injection and group II received a corticosteroid injection.

Patients were assessed using the VAS for pain and Disabilities of the Arm, Shoulder and Hand Scale score. Ultrasound evaluation of the common extensor origin was performed. At 6 months, the number of patients positive for various ultrasonographic findings generally decreased. PRP appeared to enable biological healing of the lesion, whereas corticosteroids appeared to provide short-term, symptomatic relief, but resulted in tendon degene ration. Improvement in tendon morphology was greater after PRP injection than after corticosteroid injection.

Similar to Chaudhury *et al.* [26], a pilot study was carried out on six patients with LE, who had a baseline ultrasound confirming tendinosis of the common extensor tendon. Patients received a single 3-ml PRP injection under ultrasound guidance. Gray scale images of the injected elbow were obtained at baseline and were repeated at 1 and 6 months after injection. Five patients showed improved tendon morphology using ultrasound imaging 6 months after PRP injection (one patient was lost to follow-up).

In contrast, in the study of Krogh *et al.*[17], a total of 60 patients with chronic LE were randomized (1 : 1 : 1) to receive either a blinded injection of PRP, saline, or CS. Ultrasound evaluation for LE after 3 months showed that corticosteroid injection reduced both color Doppler activity and tendon thickness compared with PRP and saline.

However, local corticosteroid injection is one of the most common invasive interventions with consistent and satisfactory results, and hence, it has become the gold standard for comparison of newer therapies. Altay *et al.* [27] reviewed thirteen randomized-controlled trials and found that corticosteroid injection is effective for pain relief and improving grip strength compared with other conventional therapies. The exact mechanism of action of a local steroid injection is uncertain. However, PRP is an ideal autologous biological blood-derived product that releases high concentrations of platelet-derived growth factors on injection that enhance tendon healing because of effects on angiogenesis and collagen synthesis. Various growth factors and cytokines in PRP include platelet-derived growth factors (PDGF-αα, PDGF-ββ, PDGF-αβ), transforming growth factor beta (TGF-β1, TGF-β2), fibroblast growth factor, insulin-like growth factor-1 and 2 (IGF-1, IGF-2), vascular endothelial growth factor, epidermal growth factor, Interleukin-8, keratinocyte growth factor, and connective tissue growth factor [28]. Platelets release more than 95% of the presynthesized growth factors within one hour of activation. This initial burst is followed by the steady synthesis and secretion of growth factors for the rest of their life span [29].

The present study therefore is an attempt to compare the clinical efficacy of PRP versus corticosteroid and saline. It compared the effectiveness of leukocyte-enriched PRP with standard corticosteroid treatment for LE and found that at short-term follow-up, both groups showed a significant improvement in pain and function, but over the long-term follow-up, pain and functional scores returned to baseline for the corticosteroid group, whereas those for the PRP group remained high. We observed a better response with a local corticosteroid injection in the initial follow-up visits; however, at three months, the improvement was significantly better in the PRP group, which was supported by the ultrasonographic findings of a uniform fibrillar pattern and tendon echogenicity in the PRP group compared with the corticosteroid and saline group.

Conclusion

A PRP injection offers several therapeutic advantages over a corticosteroid injection as it is well tolerated, with minimal or no side effects. Moreover, it has a longer duration of action and enables greater healing as it leads to a more homogenous tendon arrangement, which was documented by ultrasound. As PRP leads to a reduction in pain intensity and functional disability in daily life activities, we recommend its use as an alternative to a corticosteroid injection in occupational as well as sport injuries.

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Conflicts of interest

There are no conflicts of interest.

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