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

Mahmoud El Tayeb Nasser², Ahmed Z. El Yasaki², Reem M. Ezz El Mallah², Amal S.M. Abdelazeem³

²Department of Physical Medicine, Rheumatology and Rehabilitation, Faculty of Medicine, ³Physical Medicine, Mansheyet El Bakry Hospital, Ain Shams University, Cairo, Egypt

Correspondence to Dr. Reem M. Ezz Elmallah, PhD, 13 Gesr El Suez Heliopolis, postal code 11331, Cairo, Egypt Tel: +20 101 007 4441; fax: 0224500848; e-mail: reemelmallah@gmail.com

Received 20 August 2016
Accepted 7 September 2016

Egyptian Rheumatology & Rehabilitation 2017, 44:1–10

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

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].

This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 License, which allows others to remix, tweak, and build upon the work noncommercially, as long as the author is credited and the new creations are licensed under the identical terms.
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 hyperechoic 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 intratendinously 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 performed. 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 transducer 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 triamcinolone 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 (Centruine 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 \( \chi^2 \)-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 0.001 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.
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.

**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.

| Variables | Grades | Before | After | Change |
|-----------|--------|--------|-------|--------|
| Tenderness | G0 | 0 (0) | 9 (60) | 1G 3 (20) |
| G1 | 1 (6.7) | 7 (46.7) | 0G 3 (20) |
| G2 | 2 (13.3) | 8 (53.3) | 1G 9 (60) |
| G3 | 3 (20) | 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.

| Variables | Grades | Before | After | Change |
|-----------|--------|--------|-------|--------|
| Tenderness | G1 | 2 (13.3) | 2 (13.3) | 0G 0 (0) |
| G2 | 10 (66.7) | 10 (66.7) | 0G 0 (0) |
| G3 | 3 (20) | 3 (20) | 1G 2 (13.3) | 2G 10 (66.7) | 3G 0 (0) |

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

| Variables | Grades | Before | After | Change |
|-----------|--------|--------|-------|--------|
| Ultrasound | G0 | 0 (0) | 15 (100) | 0G 0 (0) |
| G1 | 2 (13.3) | 0 (0) | 2G 10 (66.7) |
| G2 | 10 (66.7) | 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 ($P<0.001$), Ultrasound grade showed a significant improvement after injection in group III ($P<0.05$) as shown in Table 8 and Fig. 3a and b.

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.

**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) | 2G: 11 (73.3) |
|           | G2     | 11 (73.3) | 4 (26.7) | 3G: 0 (0) |
|           | G3     | 3 (20) | 0 (0)  | 1G: 11 (73.3) |

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 $[n (%)$] | $\chi^2$ | $P$ | 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.

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

| Ultrasound | Before $[n (%)$] | After $[n (%)$] | $\chi^2$ | $P$ | 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 ($P<0.001$), 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) | 7.3±7.52/1.94 (0–20) | Z=11.97 | <0.001 | HS |
| Change    | −2±3.10/0.8 (−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     | 7.3±7.52/1.94 (0–20) | 36.3±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=4.77 | <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.
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

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

| Variables | Group I [n (%)] | Group II [n (%)] | χ² | P     | Significance |
|-----------|-----------------|-----------------|-----|-------|--------------|
| Before    |                 |                 |     |       |              |
| G1        | 2 (13.3)        | 2 (13.3)        |     |       |              |
| G2        | 10 (66.7)       | 10 (66.7)       | 0   | >0.05 |              |
| 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 (%)] | χ²  | 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)            | 0.381| >0.05 | NS           |
| 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)           | 3 (20)            |     |       |              |

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 (%)] | χ²  | 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.
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 corticosteroid 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 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 degeneration. 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 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.

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

References
1 Silverstein B, Welp E, Nelson N. Claims incidence of work-related disorders of the upper extremities. Am J Public Health 1995; 88: 1827–1833.
2 Verhaar JA. Tennis elbow: anatomical, epidemiological and therapeutic aspects. Int Orthop 1994; 18:263–267.
3 McCormack RR, Irman RD, Wells A, Berentsen C, Imbus HR. Prevalence of tendinitis and related disorders of the upper extremity in a manufacturing workforce. J Rheumatol 1999; 17:958–964.
4 Shiri R, Viikari-Juntura E. Lateral and medial epicondylitis: role of occupational factors. Best Pract Res Clin Rheumatol 2011; 25:43–57.
Kraushaar BS, Nirschl RP. Tendonitis of the elbow (tennis elbow). Clinical features and findings of histological, immunohistochemically and electron microscopy studies. J Bone Joint Surg Am 1999; 81:259–278.

Fredberg U, Bolvig L. Significance of ultra-sonographically detected asymptomatic tendinosis in patellar and achillis tendons of elite soccer players: a longitudinal study. Am J Sports Med 2002; 30:488–491.

Grassi W, Filippucci E, Farina A, Cervini C. Sonographic imaging of tendons. Arthritis Rheum 2000; 43:969–976.

Allen GM, Wilson DJ. Ultrasound in sports medicine: a critical evaluation. Eur J Radiol 2007; 62:79–85.

Cytiax J, Troisier O. Hydrocortisone and soft-tissue lesions. Br Med J 1953; 2:966–968.

Krogh TP, Bartels EM, Ellingsen T, Pedersen KS, Buchbinder R, Fredberg U, et al. Comparative effectiveness of injection therapies in lateral epicondylitis: a systematic review and network meta-analysis of randomized controlled trials. Am J Sports Med 2013; 41:1435–1446.

Aspenberg P, Virchenko O. Platelet concentrate injection improves achilles tendon repair in rats. Acta Orthop Scand 2004; 75:93–99.

Borzini P, Mazzucco L. Tissue regeneration and in loco administration of platelet derivatives: clinical outcome, heterogeneous products and heterogeneity of the effector mechanisms transfusion. Transfusion 2005; 45:1759–1767.

Regan W, Grondin P, Morrey BF. Lateral epicondylitis (tennis elbow). In: DeLee J, Drez D, Miller M, editors. DeLee and Drez’s Orthopaedic, 3rd ed. Philadelphia, PA: Saunders Elsevier 2009.

Roddiguez CS. Pain measurement in the elderly: a review. Pain Manag Nurs 2001; 2:38–46.

Faes M, Van den Akker B, De Lint JA, Koolcos JGM, Hopman MTE. Dynamic extensor brace for lateral epicondylitis. Clin Orthop Relat Res 2006; 442:149–157.

Mata-Castrillo M, Jaén-Díaz JI, Cerezo-López E, López-Castro F, Barceló-Galindez JP, De la Fuente J, Ballús-Mata R. Sonographic findings for the common extensor tendon of the elbow in the general population. J Ultrasound Med 2010; 12:1717–1724.

Krogh TP, Fredberg U, Pedersen KS, Christensen R, Jensen P, Ellingsen T. Treatment of lateral epicondylitis with platelet-rich plasma, glucocorticoid or saline: a randomized, double-blind, placebo-controlled trial. Am J Sports Med 2013; 41:625–635.

Mishra A, Woodall J, Vieira A. Treatment of tendon and muscle using platelet-rich plasma. Clin Sports Med 2009; 125:113–115.

Yadav R, Kothari SY, Borah D. Comparison of local injection of platelet rich plasma and corticosteroids in the treatment of lateral epicondylitis of humerus. J Clin Diagn Res 2015; 7:5–7.

Ferrari M, Zia S, Valbonesi M. A new technique for hemodilution, preparation of autologous platelet-rich plasma and intraoperative blood salvage in cardiac surgery. Int J Artif Organs 1987; 10:47–50.

Antiu A, Andia I, Sanchez M, Azofra J, Del Mar Zalduendo M, Fuente M. Autologous preparations rich in growth factors promote proliferation and induce VEGF and HGF productions by human tendon cells in culture. J Orthop Res 2005; 25:281–286.

Antiu A, Sánchez E, Norden A, Norden P, Orive G, Andia I. New insights into and novel applications for platelet-rich fibrin therapies. Trends Biotechnol 2006; 5:227–234.

Shiri R, Vilkar-Juntura E, Varonen H, Heliovaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. Am J Epidemiol 2006; 164:1065–1074.

Otoshi K, Takegami M, Sekiguchi M, Onishi Y, Yamazaki S, Otani K, et al. Chronic hyperglycemia increases the risk of lateral epicondylitis: the locomotive syndrome and health outcome in Aizu Cohort study. Springer plus 2015; 4:407.

Gautam VK, Verma S, Batra S, Bhatnagar N, Arora S. Platelet-rich plasma versus corticosteroid injection for recalcitrant lateral epicondylitis: clinical and ultrasonographic evaluation. J Orthop Surg (Hong Kong) 2015; 23:1–5.

Chaudhury S, de La Lama M, Adler RS, Gulotta LV, Skonieczki B, Chang A, et al. Platelet-rich plasma for the treatment of lateral epicondylitis: sonographic assessment of tendon morphology and vascularity. Skeletal Radiol 2013; 42:91–97.

Ailtay T, Günl A, Özçan H. Local injection treatment for lateral epicondylitis. Clin Orthop Relat Res 2002; 398:127–130.

Borrione P, Gianfrancesco AD, Pereira MT, Pigozzi F. Platelet-rich plasma in muscle healing. Am J Phys Med Rehabil 2010; 89:854–861.

Marx RE. Platelet-rich plasma: evidence to support its use. J Oral Maxillofac Surg 2004; 62:489–496.