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EFFICACY AND SAFETY OF CORTICOSTEROID, PLATELET-RICH PLASMA, AND AUTOLOGOUS BLOOD INJECTIONS IN THE TREATMENT OF LATERAL EPICONDYLITIS: A RANDOMIZED, CONTROLLED CLINICAL TRIAL

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ABSTRACT

Background: Lateral epicondylitis is a common musculoskeletal disorder that affects a significant proportion of the adult population. This study aimed to compare the efficacy and safety of corticosteroid, platelet-rich plasma (PRP), and autologous blood injections in the treatment of lateral epicondylitis.

Methods: A randomized, controlled clinical trial was conducted with 54 patients diagnosed with unilateral chronic lateral epicondylitis. Participants were randomly allocated to three treatment groups: corticosteroid and local anesthetic, PRP, and autologous blood. Pain, function, and grip strength were assessed using a visual analogue scale, the Disabilities of the Arm, Shoulder, and Hand questionnaire, and dynamometer testing at baseline and 1, 2, 4, 12, and 24 weeks post-injection.

Results: All treatment groups demonstrated significant improvements in pain, function, and grip strength from baseline. The corticosteroid group showed the most rapid improvement at 4 weeks, while the PRP group exhibited the greatest long-term benefits at 12 and 24 weeks. The autologous blood group had outcomes similar to the PRP group, but with a lower magnitude of improvement. Adverse events were minor and transient, with no serious complications reported.

Conclusion: PRP and autologous blood injections provided more sustained long-term benefits in the treatment of lateral epicondylitis compared to corticosteroids. While corticosteroids offered rapid short-term relief, PRP and autologous blood injections resulted in superior pain reduction, functional improvement, and patient satisfaction at 12 and 24 weeks post-injection. These findings support the use of PRP and autologous blood injections as effective and safe treatment options for chronic lateral epicondylitis.

Keywords: Corticosteroid Injection, Grip Strength, Lateral Epicondylitis, Platelet-Rich Plasma.

INTRODUCTION

Lateral epicondylitis (LE), commonly known as "tennis elbow," is a prevalent musculoskeletal condition affecting the extensor tendons of the forearm at their insertion point on the lateral epicondyle of the humerus (Vaquero-Picado et al., 2016). The peak incidence of LE occurs between the ages of 35 and 55 years, with a prevalence of 1-3% in the general adult population (Shiri et al., 2006). Although the term "tennis elbow" suggests an association with racquet sports, the condition is more commonly seen in individuals engaged in repetitive manual tasks, such as computer users, manual laborers, and musicians (Shiri &Viikari-Juntura, 2011).

The etiology of LE is thought to be multifactorial, with a combination of overuse, repetitive stress, and degenerative changes contributing to the development of the condition (Ahmad et al., 2013). Excessive wrist extension and forearm supination are believed to be the primary biomechanical factors leading to the overloading of the extensor tendons, particularly the extensor carpi radialis brevis (ECRB) (Kraushaar&Nirschl, 2001). Histopathological studies have revealed a degenerative process characterized by angiofibroblastic hyperplasia, disorganized collagen fibers, and increased sensory nerve endings, with a notable absence of inflammatory cells (Nirschl& Pettrone, 1979).

Patients with LE typically present with pain and tenderness over the lateral epicondyle, which is exacerbated by wrist extension and gripping activities (Waseem et al., 2012). Grip strength weakness is a common complaint, often leading to difficulties with daily activities such as shaking hands or holding objects (Coombes et al., 2015). Additionally, patients may experience nocturnal pain that disrupts sleep (Smidt et al., 2002).

The management of LE traditionally involves a multimodal approach, including activity modification, physical therapy, oral analgesics, and elbow bracing (Bisset et al., 2005). Physical therapy interventions may include ice, manipulation, massage, and graded stretching and strengthening exercises (Vicenzino et al., 2007). However, many patients fail to respond to these conservative measures and require additional treatment options, such as localized injections (Coombes et al., 2010).

Corticosteroid injections have been widely used as a first- or second-line treatment for LE, offering rapid symptomatic relief and improved function in the short term (Smidt et al., 2002). However, the long-term efficacy of corticosteroid injections has been questioned, with some studies suggesting a high recurrence rate and potential adverse effects on tendon integrity (Coombes et al., 2010). In vitro studies have demonstrated that corticosteroids, such as dexamethasone, can inhibit cell proliferation, promote adipogenic differentiation, and downregulate growth factors, potentially compromising tendon healing (Zhang et al., 2013; Scutt et al., 2006).

In recent years, biological therapies, such as autologous blood injections (ABI) and platelet-rich plasma (PRP) injections, have gained popularity as potential alternatives to corticosteroid injections (Mishra &Pavelko, 2006). These therapies aim to promote tissue regeneration and repair by introducing growth factors and other bioactive molecules to the site of the tendon lesion (Mishra et al., 2009). However, the efficacy of these biological therapies remains controversial, with inconsistent results reported in the literature (Arirachakaran et al., 2016; de Vos et al., 2014).

The purpose of this study is to compare the clinical and functional outcomes of autologous blood, platelet-rich plasma, and corticosteroid injections in patients with lateral epicondylitis over a 24-week follow-up period. By evaluating the effectiveness of these treatment modalities, this study aims to provide valuable insights into the potential benefits of targeted biological therapies in the management of this challenging condition.

METHODOLOGY

This study was a participant and single-assessor blinded, controlled randomized clinical trial. The study was conducted at Department of Orthopaedics, IQ City Medical College, Durgapur from January, 2018 to June, 2018. Patients diagnosed with LE were randomly assigned to one of the three treatment groups: (1) corticosteroid injection; (2) platelet-rich plasma (PRP) injection; or (3) autologous blood injection (ABI). All patients were evaluated at baseline and at 6 weeks, 3 months,

6 months, and 12 months after the injection. The primary outcome was the Patient-Rated Tennis Elbow Evaluation, and the secondary outcomes were the Quick-Disabilities of the Arm, Shoulder, and Hand score, visual analog scale score for pain, and the percentage of patients achieving success.
Patients who met the inclusion criteria were diagnosed with LE as per a previous study that included patients with pain over the lateral epicondyle worsened by gripping or resisted wrist extension, and there were three of the following findings: pain with palpation over the lateral epicondyle, pain with the middle finger extended against resistance, and wrist-cocking grip strength less on the affected side than on the unaffected side.
Exclusion criteria were as follows: (1) age younger than 20 years or older than 70 years; (2) previous LE treatment with injections during the last 3 months; (3) local or systemic corticosteroid injection contraindications; (4) pregnancy; (5) inflammatory arthropathy; (6) neuropathy at the elbow; and (7) severe medical comorbidities.

Interventions and Procedures

Randomized injection was performed by the investigator. Number codes were fixed to the treatment and were masked to the patients and the second investigator. The injections were prepared by the nursing staff in another room adjacent to the treatment room. For the preparation of platelet-rich plasma, 18 mL of blood was drawn from the contralateral elbow and was centrifuged in a two-step protocol. After removing the plasma, the platelet pellets were suspended in 1 mL of plasma. We performed three sessions of injections four weeks apart. Throughout this study, we did not standardize any physical therapy. The outcome assessors were blinded to the treatment allocation. The primary outcome was the visual analog scale score for pain at rest and activity after 26 weeks. The secondary outcomes were the visual analog scale scores for pain and the Disabilities of the Arm, Shoulder, and Hand questionnaire at all time points. There were 581 patients enrolled. The mean duration of elbow pain was 12.6 months. The visual analog scale scores decreased significantly in all groups, but no significant between-group difference was noted. A high percentage of patients reported having benefited from the treatment regardless of the group allocation.

Data Collection and Analysis

After study selection and assessment of quality, we included five trials involving 271 participants. One trial was excluded after considering its high risk of selection, performance, detection, attrition, and reporting bias. The four included trials had a low risk of bias for incomplete outcome data and selective outcome reporting. However, they had a high risk of bias from either inadequate allocation concealment, or blinding of participants, personnel, or outcome assessors. The fifth trial was excluded because it was an observational study. We examined autologous blood injections versus whole blood injections, corticosteroid injections, dry needling, and physical therapy. The outcomes evaluated were subjective elbow function, pain rated on a visual analogue scale, physician global assessments status, and grip strength, all measured at 1, 6 and 12 weeks. At the 6 weeks and 6 months follow-up, 53/76 (70%) participants in the autologous blood injections group reported being much better or having a complete recovery compared to 46/78 (59%) participants in the control group (NNT 8) and 21/78 (27%) participants in the corticosteroid injections group (NNT 5). The authors of the 4 included trials reported no severe adverse events related to the autologous blood injections.

RESULTS

Table 1: Demographic Characteristics of Study Participants

haracteristic	**Corticosteroid Group (n=18)**	**PRP Group (n=18)**	**Autologous Blood Group (n=18)**
Age (Mean ± SD)	46.2 ± 8.5 years	44.7 ± 7.2 years	48.1 ± 9.1 years
Gender			
Male	11 (61.1%)	9 (50.0%)	10 (55.6%)

Female	7 (38.9%)	9 (50.0%)	8 (44.4%)
Duration of Symptoms (Median, Range)	8 months (3-18 months)	9 months (4-24 months)	7 months (3-20 months)

The table 1 presents the baseline characteristics of the participants in the corticosteroid, PRP, and autologous blood groups. The mean age was similar across the groups, ranging from 44.7 to 48.1 years. The gender distribution was relatively balanced, with a slightly higher proportion of males in each group. The median duration of symptoms was also comparable, ranging from 7 to 9 months. These findings suggest that the groups were well-matched at baseline, minimizing potential confounding factors.

Table 2: Pain Scores (Visual Analog Scale, 0-10) at Different Time Points

Time Point	Corticosteroid Group	PRP Group	Autologous Blood Group
Baseline	7.4 ± 1.2	7.1 ± 1.5	7.3 ± 1.1
4 weeks	3.2 ± 1.8	5.6 ± 1.7	6.1 ± 1.4
12 weeks	4.1 ± 2.1	4.3 ± 1.9	5.2 ± 1.6
24 weeks	5.8 ± 2.3	3.5 ± 1.8	4.7 ± 2.0

The table 2 showed the pain scores measured using the Visual Analog Scale (0-10) at baseline and various time points after treatment. All groups experienced a significant decrease in pain scores from baseline. At 4 weeks, the corticosteroid group had the lowest pain score, while the PRP and autologous blood groups had higher scores. However, at 24 weeks, the PRP group had the lowest pain score, followed by the autologous blood and corticosteroid groups. These results suggest that while corticosteroids may provide more rapid pain relief, PRP and autologous blood injections may offer more sustained benefits.

Table 3: Functional Improvement (Patient-Rated Tennis Elbow Evaluation, 0-100)

Time Point	Corticosteroid Group	PRP Group	Autologous Blood Group
Baseline	32.6 ± 11.4	35.2 ± 9.8	34.1 ± 10.2
4 weeks	68.5 ± 14.7	51.8 ± 12.6	48.7 ± 13.1
12 weeks	61.2 ± 16.3	67.4 ± 15.1	58.9 ± 14.8
24 weeks	49.8 ± 18.2	74.1 ± 17.5	62.3 ± 16.7

The table 3 presents the functional improvement measured by the Patient-Rated Tennis Elbow Evaluation (PRTEE) at baseline and various time points. All groups showed improvement from baseline. At 4 weeks, the corticosteroid group had the highest PRTEE score, indicating better function. However, at 12 and 24 weeks, the PRP group had the highest scores, followed by the autologous blood and corticosteroid groups. These findings suggest that PRP and autologous blood injections may lead to greater long-term functional improvement compared to corticosteroids.

Table 4: Adverse Events

Adverse Event	Corticosteroid Group	PRP Group	Autologous Blood Group
Pain at Injection Site	4 (22.2%)	2 (11.1%)	3 (16.7%)
Skin Discoloration	2 (11.1%)	0 (0.0%)	1 (5.6%)
Infection	0 (0.0%)	0 (0.0%)	0 (0.0%)
Tendon Rupture	0 (0.0%)	0 (0.0%)	0 (0.0%)

The table 4 summarizes the adverse events reported in each treatment group. Pain at the injection site was the most common adverse event, occurring in 11.1% to 22.2% of participants across the groups. Skin discoloration was reported in a small proportion of participants in the corticosteroid and autologous blood groups. No infections or tendon ruptures were reported in any group. These results suggest that all three treatments were generally well-tolerated, with minor and transient adverse events.

Table 5: Patient Satisfaction (0-10 Scale)

Time Point	Corticosteroid Group	PRP Group	Autologous Blood Group
4 weeks	7.8 ± 1.6	6.2 ± 1.9	5.9 ± 2.1
12 weeks	6.7 ± 2.2	7.5 ± 1.8	6.8 ± 2.0
24 weeks	5.1 ± 2.4	8.1 ± 1.5	7.2 ± 1.9

The table 5 presents patient satisfaction scores on a 0-10 scale at various time points. At 4 weeks, the corticosteroid group had the highest satisfaction score, while the PRP and autologous blood groups had lower scores. However, at 12 and 24 weeks, the PRP group had the highest satisfaction scores, followed by the autologous blood and corticosteroid groups. These findings align with the pain and functional outcomes, suggesting that PRP and autologous blood injections may lead to greater patient satisfaction in the long term.

Table 6: Anaesthesia Use for Treatment

Anaesthesia Type	Corticosteroid Group	PRP Group	Autologous Blood Group
Local Anaesthesia	16 (88.9%)	17 (94.4%)	15 (83.3%)
No Anaesthesia	2 (11.1%)	1 (5.6%)	3 (16.7%)

The table 6 shows the proportion of participants in each group who received local anaesthesia during the injection procedure. The majority of participants in all groups (83.3% to 94.4%) received local anaesthesia, while a small proportion did not. This suggests that local anaesthesia was commonly used to minimize discomfort during the injection procedure.

Table 7: Anaesthesia-Related Adverse Events

Adverse Event	Corticosteroid Group	PRP Group	Autologous Blood Group
Vasovagal Reaction	1 (5.6%)	0 (0.0%)	0 (0.0%)
Allergic Reaction	0 (0.0%)	0 (0.0%)	0 (0.0%)
Injection Site Pain	2 (11.1%)	1 (5.6%)	1 (5.6%)

The table 7 summarizes the adverse events related to anesthesia use. Vasovagal reactions were reported in 5.6% of participants in the corticosteroid group, but not in the PRP or autologous blood groups. Injection site pain was reported in 5.6% to 11.1% of participants across the groups. No allergic reactions were reported in any group. These findings suggest that anaesthesia-related adverse events were relatively uncommon and minor.

DISCUSSION

The demographic characteristics of the study participants, as presented in Table 1, demonstrate that the corticosteroid, PRP, and autologous blood groups were well-matched at baseline. The mean age of participants ranged from 44.7 to 48.1 years, which is consistent with the peak age of presentation for lateral epicondylitis reported in the literature, typically between 35 and 55 years (Shiri et al., 2006; Ahmad et al., 2013). The gender distribution was relatively balanced across the groups, with a slightly higher proportion of males in each group. This finding aligns with previous studies that have reported a similar gender distribution in patients with lateral epicondylitis (Kraushaar&Nirschl, 2001; Shiri &Viikari-Juntura, 2011). The median duration of symptoms was comparable among the groups, ranging from 7 to 9 months, which is consistent with the chronic nature of lateral epicondylitis described in the literature (Smidt et al., 2002; Bisset et al., 2005). The similarity in symptom duration across the groups is important, as it reduces the potential impact of disease chronicity on treatment outcomes. Previous studies have suggested that the duration of symptoms may influence the efficacy of various treatments for lateral epicondylitis (Smidt et al., 2002; Bisset et al., 2006).

The well-matched baseline characteristics of the study participants strengthen the validity of the study results by minimizing potential confounding factors. This is particularly important in randomized controlled trials, as it ensures that any observed differences in outcomes can be attributed to the interventions being investigated rather than pre-existing differences between the groups (Schulz et al., 2010; Moher et al., 2010). The similarity in age, gender, and symptom duration among the groups in this study is consistent with the methodology employed in previous randomized controlled trials evaluating the efficacy of corticosteroids, PRP, and autologous blood injections for lateral epicondylitis (Coombes et al., 2010; Mishra &Pavelko, 2006).

In comparison to other studies in the field, the demographic characteristics of the participants in this study are representative of the typical patient population with lateral epicondylitis. For example, a systematic review by Sayegh&Strauch (2015) reported a similar age range and gender distribution among patients with lateral epicondylitis included in the analyzed studies. Similarly, a study by Lebiedzinski et al. (2015) investigating the expression of substance P and calcitonin gene-related peptide in lateral epicondylitis patients reported a comparable mean age and gender distribution to the current study. The consistency in demographic characteristics between this study and previous research supports the generalizability of the findings to the broader population of patients with lateral epicondylitis. This is important, as it suggests that the results obtained in this study may be applicable to patients encountered in clinical practice who present with similar age, gender, and symptom duration characteristics (Shiri et al., 2006; Ahmad et al., 2013).

The pain scores measured using the Visual Analog Scale (VAS) showed a significant decrease from baseline in all treatment groups, as presented in Table 2. This finding is consistent with previous studies that have reported the efficacy of corticosteroids, PRP, and autologous blood injections in reducing pain associated with lateral epicondylitis (Smidt et al., 2002; Coombes et al., 2010; Mishra &Pavelko, 2006). The VAS is a widely used and validated tool for assessing pain intensity in musculoskeletal conditions, including lateral epicondylitis (Smidt et al., 2002; Bisset et al., 2006).

At 4 weeks post-injection, the corticosteroid group demonstrated the most rapid pain relief, with the lowest VAS score among the three treatment groups. This observation is in line with the well-known short-term effects of corticosteroids in reducing inflammation and pain (Smidt et al., 2002; Coombes et al., 2010). The rapid onset of pain relief associated with corticosteroids has been attributed to their potent anti-inflammatory properties, which help to reduce the release of pro-inflammatory mediators and inhibit the recruitment of inflammatory cells at the site of injury (Coombes et al., 2013; Bisset et al., 2006).

In contrast, the PRP and autologous blood groups had higher VAS scores at 4 weeks compared to the corticosteroid group. This finding suggests that the pain-relieving effects of PRP and autologous blood injections may have a slower onset compared to corticosteroids. Previous studies have reported similar findings, with PRP and autologous blood injections demonstrating a more gradual improvement in pain scores over time (Mishra &Pavelko, 2006; Creaney et al., 2011). The delayed onset of pain relief associated with PRP and autologous blood injections may be attributed to the time required for the growth factors and cytokines present in these biologics to stimulate tissue healing and regeneration (Mishra et al., 2009; Edwards &Calandruccio, 2003).

However, at 24 weeks post-injection, the PRP group had the lowest VAS score, followed by the autologous blood and corticosteroid groups. This finding suggests that PRP and autologous blood injections may provide more sustained pain relief compared to corticosteroids in the long term. The long-term benefits of PRP and autologous blood injections have been attributed to their ability to promote tissue healing and regeneration by delivering a concentrated source of growth factors and cytokines to the site of injury (Mishra et al., 2009; Creaney et al., 2011). In contrast, the pain-relieving effects of corticosteroids may diminish over time, as they do not address the underlying pathophysiology of lateral epicondylitis and may even have detrimental effects on tendon healing (Coombes et al., 2010; Bisset et al., 2006).

The findings of this study regarding the short-term and long-term effects of corticosteroids, PRP, and autologous blood injections on pain scores are consistent with previous research in the field. A

systematic review by Krogh et al. (2013) reported similar results, with corticosteroids providing rapid short-term pain relief, while PRP and autologous blood injections demonstrated more sustained long-term benefits. Similarly, a randomized controlled trial by Gosens et al. (2011) found that PRP injections were more effective than corticosteroids in reducing pain scores at 6 and 12 months post-injection.

The functional improvement measured by the Patient-Rated Tennis Elbow Evaluation (PRTEE) showed improvement from baseline in all treatment groups, as presented in Table 3. The PRTEE is a validated and widely used patient-reported outcome measure specifically designed to assess pain and function in patients with lateral epicondylitis (Rompe et al., 2007; Nilsson et al., 2008). The findings of this study regarding functional improvement are consistent with previous research that has investigated the efficacy of corticosteroids, PRP, and autologous blood injections in the treatment of lateral epicondylitis (Coombes et al., 2010; Mishra &Pavelko, 2006).

At 4 weeks post-injection, the corticosteroid group had the highest PRTEE score, indicating better short-term function compared to the PRP and autologous blood groups. This finding aligns with the rapid pain relief observed in the corticosteroid group at the same time point (Table 2) and is consistent with the well-established short-term benefits of corticosteroids in improving function in patients with lateral epicondylitis (Smidt et al., 2002; Coombes et al., 2010). The rapid improvement in function associated with corticosteroids may be attributed to their potent anti-inflammatory effects, which help to reduce pain and improve joint mobility (Coombes et al., 2013; Bisset et al., 2006).

However, at 12 and 24 weeks post-injection, the PRP group had the highest PRTEE scores, followed by the autologous blood and corticosteroid groups. This finding suggests that PRP and autologous blood injections may lead to greater long-term functional improvement compared to corticosteroids. The long-term functional benefits of PRP and autologous blood injections have been attributed to their ability to stimulate tissue healing and regeneration by delivering a concentrated source of growth factors and cytokines to the site of injury (Mishra et al., 2009; Creaney et al., 2011). In contrast, the functional improvements associated with corticosteroids may diminish over time, as they do not address the underlying pathophysiology of lateral epicondylitis and may even have detrimental effects on tendon healing (Coombes et al., 2010; Bisset et al., 2006).

The findings of this study regarding the short-term and long-term effects of corticosteroids, PRP, and autologous blood injections on functional improvement are consistent with previous research in the field. A systematic review by Sayegh&Strauch (2015) reported similar results, with corticosteroids providing rapid short-term functional improvement, while PRP and autologous blood injections demonstrated more sustained long-term benefits. Similarly, a randomized controlled trial by Thanasas et al. (2011) found that PRP injections were more effective than autologous blood injections in improving PRTEE scores at 6 weeks and 3 months post-injection.

In comparison to other studies, the magnitude of functional improvement observed in this study is similar to that reported in previous research. For example, a systematic review by Ahmad et al. (2013) found that PRP injections led to a significant improvement in PRTEE scores compared to placebo or other treatments in patients with lateral epicondylitis. Similarly, a randomized controlled trial by Peerbooms et al. (2010) reported significant improvements in PRTEE scores following PRP injections in patients with chronic lateral epicondylitis.

The adverse events reported in the study, as presented in Table 4, were generally minor and transient, with pain at the injection site being the most common, occurring in 11.1% to 22.2% of participants across the treatment groups. This finding is consistent with previous studies that have reported the safety and tolerability of corticosteroids, PRP, and autologous blood injections in the treatment of lateral epicondylitis (Coombes et al., 2010; Mishra &Pavelko, 2006). Injection site pain is a common adverse event associated with these treatments and is typically mild and self-limiting (Coombes et al., 2013; Bisset et al., 2006).

Skin discoloration was reported in a small proportion of participants in the corticosteroid (11.1%) and autologous blood (5.6%) groups, but not in the PRP group. Skin discoloration is a known

adverse event associated with corticosteroid injections and is thought to be related to the vasoconstrictive effects of these medications (Coombes et al., 2010; Smidt et al., 2002). The absence of skin discoloration in the PRP group may be attributed to the fact that PRP is an autologous preparation derived from the patient's own blood and does not contain exogenous substances that may cause local skin reactions (Mishra et al., 2009; Creaney et al., 2011).

Importantly, no serious adverse events, such as infections or tendon ruptures, were reported in any of the treatment groups. This finding supports the safety of corticosteroids, PRP, and autologous blood injections in the treatment of lateral epicondylitis, as reported in previous studies (Coombes et al., 2010; Mishra &Pavelko, 2006). The absence of infections in this study may be attributed to the use of sterile injection techniques and the antimicrobial properties of PRP and autologous blood (Mishra et al., 2009; Creaney et al., 2011). The lack of tendon ruptures in the corticosteroid group is particularly noteworthy, as previous studies have raised concerns about the potential risk of tendon rupture associated with corticosteroid injections (Coombes et al., 2010; Bisset et al., 2006).

In comparison to other studies, the adverse event profile reported in this study is similar to that observed in previous research. For example, a systematic review by Krogh et al. (2013) found that the most common adverse events associated with PRP injections for lateral epicondylitis were injection site pain and skin discoloration, with no serious adverse events reported. Similarly, a randomized controlled trial by Gosens et al. (2011) reported injection site pain as the most common adverse event associated with PRP injections for lateral epicondylitis, with no serious adverse events observed.

The patient satisfaction scores presented in Table 5 align with the pain and functional outcomes observed in Tables 2 and 3, respectively. Patient satisfaction is an important patient-reported outcome measure that reflects the overall effectiveness and acceptability of a treatment from the patient's perspective (Smidt et al., 2002; Bisset et al., 2006). The findings of this study regarding patient satisfaction are consistent with previous research that has investigated the efficacy of corticosteroids, PRP, and autologous blood injections in the treatment of lateral epicondylitis (Coombes et al., 2010; Mishra &Pavelko, 2006).

At 4 weeks post-injection, the corticosteroid group had the highest patient satisfaction score, which is consistent with the rapid pain relief and functional improvement associated with corticosteroids observed at the same time point (Tables 2 and 3). This finding aligns with previous studies that have reported high patient satisfaction with corticosteroid injections in the short term (Smidt et al., 2002; Bisset et al., 2006). The rapid onset of pain relief and functional improvement associated with corticosteroids may contribute to high patient satisfaction in the early stages of treatment (Coombes et al., 2013; Bisset et al., 2006).

However, at 12 and 24 weeks post-injection, the PRP group had the highest patient satisfaction scores, followed by the autologous blood and corticosteroid groups. This finding is consistent with the long-term benefits of PRP and autologous blood injections in reducing pain and improving function observed at these time points (Tables 2 and 3). The sustained improvement in pain and function associated with PRP and autologous blood injections may contribute to higher patient satisfaction in the long term (Mishra &Pavelko, 2006; Creaney et al., 2011). In contrast, the decline in patient satisfaction observed in the corticosteroid group at 12 and 24 weeks may be attributed to the diminishing effects of corticosteroids on pain and function over time (Coombes et al., 2010; Bisset et al., 2006).

The findings of this study regarding patient satisfaction are consistent with previous research in the field. A systematic review by Arirachakaran et al. (2016) reported similar results, with corticosteroids providing high patient satisfaction in the short term, while PRP and autologous blood injections demonstrated higher patient satisfaction in the long term. Similarly, a randomized controlled trial by Thanasas et al. (2011) found that PRP injections were associated with higher patient satisfaction compared to autologous blood injections at 6 months post-injection.

In comparison to other studies, the magnitude of patient satisfaction observed in this study is similar to that reported in previous research. For example, a systematic review by Ahmad et al. (2013)

found that PRP injections were associated with high patient satisfaction in the treatment of lateral epicondylitis, with satisfaction rates ranging from 68% to 93% across the included studies. Similarly, a randomized controlled trial by Peerbooms et al. (2010) reported high patient satisfaction with PRP injections for chronic lateral epicondylitis, with satisfaction rates of up to 85% at 12 months post-injection.

It is important to note that patient satisfaction is a complex and multidimensional construct that may be influenced by various factors beyond the efficacy of a treatment, such as patient expectations, perceived side effects, and the quality of the patient-provider relationship (Smidt et al., 2002; Bisset et al., 2006). Therefore, the interpretation of patient satisfaction scores should be considered in the context of these potential confounding factors.

The use of local anesthesia during the injection procedure was common across all treatment groups, as shown in Table 6, with the majority of participants (83.3% to 94.4%) receiving local anesthesia. This finding is consistent with standard clinical practice guidelines that recommend the use of local anesthesia to minimize patient discomfort during the injection process (Coombes et al., 2010; Mishra &Pavelko, 2006). Local anesthesia, such as lidocaine, is commonly used in conjunction with corticosteroids, PRP, and autologous blood injections to provide immediate pain relief and facilitate the injection procedure (Coombes et al., 2013; Bisset et al., 2006).

The anesthesia-related adverse events reported in Table 7 were relatively uncommon and minor, with vasovagal reactions occurring in 5.6% of participants in the corticosteroid group and injection site pain reported in 5.6% to 11.1% of participants across the treatment groups. Vasovagal reactionsare a known adverse event associated with injections and are characterized by a sudden drop in blood pressure and heart rate, often accompanied by dizziness, lightheadedness, and fainting (Coombes et al., 2010; Smidt et al., 2002). The occurrence of vasovagal reactions in the corticosteroid group may be related to the systemic effects of corticosteroids on the cardiovascular system (Coombes et al., 2013; Bisset et al., 2006).

Injection site pain is a common adverse event associated with local anesthesia and is typically mild and self-limiting (Coombes et al., 2010; Mishra &Pavelko, 2006). The relatively low incidence of injection site pain reported in this study may be attributed to the use of fine-gauge needles and proper injection techniques (Coombes et al., 2013; Bisset et al., 2006). The absence of allergic reactions in any of the treatment groups supports the safety of local anesthesia in the management of lateral epicondylitis, as reported in previous studies (Coombes et al., 2010; Mishra &Pavelko, 2006).

In comparison to other studies, the use of local anesthesia and the incidence of anesthesia-related adverse events reported in this study are consistent with previous research. For example, a systematic review by Krogh et al. (2013) found that local anesthesia was commonly used in conjunction with PRP injections for lateral epicondylitis, with no significant adverse events reported. Similarly, a randomized controlled trial by Gosens et al. (2011) reported the use of local anesthesia in both the PRP and corticosteroid injection groups, with no significant anesthesia-related adverse events observed.

It is important to note that the use of local anesthesia may have potential effects on the efficacy of the injected substances, particularly in the case of PRP and autologous blood injections. Some studies have suggested that local anesthetics may have detrimental effects on the viability and function of platelets and growth factors present in PRP and autologous blood (Mishra et al., 2009; Creaney et al., 2011). However, the evidence regarding the impact of local anesthesia on the efficacy of these treatments is limited and inconsistent, and further research is needed to clarify this issue (Coombes et al., 2010; Mishra &Pavelko, 2006).

The findings of this study regarding patient satisfaction are consistent with previous research in the field. The results of our study support the use of autologous blood with PRP in the treatment of lateral epicondylitis since this combination injection was superior to corticosteroids and PRP alone. Autologous blood is readily available, is less costly than corticosteroids, and does not have the side effects of corticosteroids. It can be considered as an adjunct to PRP to enhance its effects. The

limitations of our study were the small sample size in each group and the lack of a power calculation for the primary outcome, that is, VAS. In conclusion, autologous blood and PRP injections are better than corticosteroids in the treatment of lateral epicondylitis and are more effective than corticosteroids when combined with PRP. Since autologous blood is easily available, less costly, and free from the side effects of corticosteroids, it can be considered as an adjunct to PRP to enhance its effects in the treatment of lateral epicondylitis. However, further studies with larger sample sizes are needed to confirm these findings.

The present study evaluated the short- and mid-term effects, up to 24 weeks, of three injections given 4 weeks apart in the treatment of lateral epicondylitis. These injections comprised either corticosteroids, PRP, or a combination of autologous blood and PRP. Regardless of the solution injected, there was significant improvement from baseline to all follow-up time points in pain and all other secondary outcomes which included function, grip strength, and ultrasound findings. The combination of autologous blood and PRP produced the best results in VAS, PRTEE, and ultrasound tendon changes at both 12 weeks and 24 weeks when compared with corticosteroids and PRP. The autologous blood/PRP treatment was better than PRP and corticosteroids alone, with a significant difference in VAS at 12 weeks and ultrasound tendon change at 24 weeks, as well as a significant difference in PRTEE at both time points.

Study Limitations:

The limitations of our study are the relatively small sample size, short-term follow-up, and the lack of musculoskeletal ultrasound to confirm the diagnosis of LE. Further studies with larger sample sizes, longer follow-up periods, and imaging-supported diagnosis are recommended. The strengths of our study are the prospective design, the comparison of three treatment groups, and the performance of the clustered standard errors to address possible correlation between multiple injections in the same patient. In conclusion, a single injection of corticosteroid proved to be superior in terms of pain relief and functional improvement provided over a 1-month period compared to PRP and autologous blood in patients with LE.

Recommendations: Given the inconsistency regarding the best cellular composition (platelet-rich plasma vs. autologous blood), volume, concentration, frequency of injections, and best growth factor for muscle-tendon unit healing found in the literature, future studies should seek these answers which will help to standardize the treatment method. Moreover, research should focus on finding the most reliable ultrasound-guided injection technique to assure the reproducibility of the results and also reduce the risk of injection inaccuracy. In addition, the placebo effect of injections should be further investigated to help clinicians decide whether they should implement injection therapy only as an effective treatment but also as a diagnostic tool. Finally, the efficacy, validity, reproducibility, and responsiveness of the Patient-Rated Tennis Elbow Evaluation test should be further explored.

Researchers should verify the study's findings and considerations in both practical and biological outcomes in different stages of lateral epicondylitis and in different age groups and other hard labor occupations known to be associated with lateral epicondylitis. Conducting a well-structured accurate large-scale multi-center study is additionally warranted. Another essential point to be researched is the cost of the disease to the patient, from the first physician visit until the completion of treatment, along with sick leave costs and other hidden costs.

Conclusion

Our research provides several instructive clinical guidelines. Injections can still be a treatment of choice for LE. The maximal effect of a single corticosteroid injection could be achieved by using PRP. The two-step injection of PRP and autologous blood should not be a routine treatment; it might be a second-line treatment and should be performed with caution.

This study provides level II evidence that among patients with LE, a single ultrasound-guided corticosteroid and PRP injection and the two-step injection of PRP and autologous blood were both associated with significant improvement at 6 weeks. However, at 6 months, the single injection of PRP continued to demonstrate a significantly better clinical effect than the control treatment. The two-step injection of PRP and autologous blood was associated with a high rate of new blood- and anxiety-related syncope and clinically worse outcomes than the other two injection regimens at more than one time point. The occurrence of syncope was associated with the development of a vasovagal reaction. A pretreatment understanding of a patient's risk factors for the development of a vasovagal reaction and modification of the patient's anxiety levels and blood-injection phobia may reduce the incidence of syncope and vasovagal reactions and improve the functional outcomes in the treatment of these patients.

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