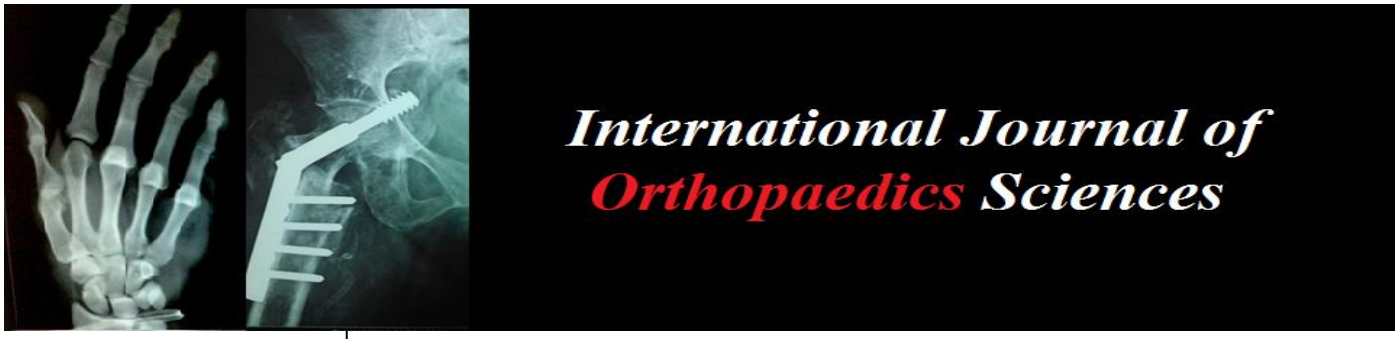

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Effectiveness of platelet rich plasma in chronic tennis elbow

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Abstract
Introduction: Chronic tennis elbow poses a common and often unsatisfactorily addressed clinical challenge. Biologic therapies, such as platelet-rich plasma (PRP) injections, designed to stimulate healing in degenerative tendons by releasing growth factors, exhibit promise *in vitro* studies, yet clinical research remains limited. This study aims to assess the efficacy of PRP in chronic tennis elbow, providing insights into the outcomes of this contemporary treatment modality.
Materials and Methods: Patients diagnosed with chronic tennis elbow, having undergone at least 3 months of unsuccessful conservative treatment, were included after securing written informed consent. PRP, prepared through centrifugation, was administered under ultrasonography guidance at the tendinopathy site within a 4-hour timeframe. Patient evaluation employed the Visual Analogue Score (VAS) and Mayo Elbow Performance Score (MEPS) at intervals of 4, 8, 12 weeks, 6 months, and 1 year.
Results: A cohort of 28 patients meeting inclusion criteria received PRP treatment. The majority exhibited notable improvement in VAS and MEPS scores, with a concurrent ability to return to work within the 12-week follow-up period.
Conclusion: Platelet-rich plasma (PRP) emerges as a potential therapeutic avenue for chronic tennis elbow. Future research endeavors should focus on pinpointing optimal treatment timing, dosage, and the ideal concentration of PRP for enhanced efficacy.

Keywords: Platelet rich, chronic tennis, plasma

Introduction
Lateral epicondylitis, commonly known as tennis elbow, arises from repetitive strain on the wrist's extensor muscles, particularly affecting the common extensor tendon originating from the lateral epicondyle. This condition, the most prevalent form of myotendinosis, has a reported frequency of 1% to 3% within the general non-athlete population. Initially considered an inflammatory process, epicondylitis was redefined in 1979 as the disorganization of standard collagen architecture caused by invading fibroblasts, coupled with an immature vascular reparative response termed "angiofibroblastic hyperplasia". The manifestation of this condition includes pain and functional impairment in daily activities. The treatment approach encompasses both conservative therapy and surgical interventions.
Various studies have evaluated the efficacy of traditional therapies such as oral non-steroidal anti-inflammatory agents, topical and injectable medications (including corticosteroids and botulinum toxins), splinting, physical therapy, and iontophoresis. Despite these efforts, these conventional methods often fail to address the tendon's poor healing properties attributed to inadequate vascularization. Recognizing the intrinsic nature of the tendon, alternative treatments have emerged, aiming to induce inflammation rather than suppress it. The options explored include platelet-rich plasma (PRP), autologous blood, and prolotherapy. These methods leverage the body's natural healing mechanisms, with PRP involving the injection of concentrated platelets derived from the patient's blood and prolotherapy stimulating the inflammatory response by injecting dextrose. It is crucial to note that the effectiveness of these alternative treatments remains a subject of ongoing research, and individual responses may vary. While conservative measures and surgical interventions continue to be part of the overall management strategy for tennis elbow, patients should consult healthcare professionals to determine the most suitable treatment plan based on their specific conditions and needs.

Platelet-rich plasma (PRP) has demonstrated effectiveness in treating chronic tendinitis. PRP is rich in platelets, which contain potent growth factors and granules crucial for the healing process in chronic injuries [7, 8]. The elevated concentration of platelets in PRP compared to whole blood has been shown to have a significant impact on the repair process, particularly in the treatment of chronic nonhealing tendinopathies like tennis elbow. For therapeutic efficacy, PRP should ideally have a platelet concentration 3 to 6 times greater than that of whole blood, typically around 200,000 platelets/mm^3.

Maintaining this optimal concentration is crucial, as deviations, either lower or higher, may render the treatment ineffective or even suppress the healing process. Therefore, precision in platelet concentration is considered a critical factor in the success of PRP therapy for chronic tendinopathies. Interestingly, some studies have indicated that the local injection of autologous whole blood may have a more significant therapeutic effect than steroid injections in the treatment of tennis elbow. This suggests that the natural components present in whole blood, aside from platelets, may contribute to a more favourable healing response compared to conventional steroid treatments. In summary, PRP's success in treating chronic tendinitis, including conditions like tennis elbow, can be attributed to its rich platelet content and the associated growth factors. Maintaining the appropriate platelet concentration in PRP is essential for optimal therapeutic outcomes, and the efficacy of PRP may surpass that of traditional steroid injections in certain cases, as demonstrated by studies on local injection of autologous whole blood. Several studies have suggested that local autologous platelet-rich plasma (PRP) may be more effective than corticosteroids in treating tennis elbow. However, there is a limited number of studies directly comparing the efficacy of these two treatments. In 2011, Thanasas *et al.* [6] conducted a comparative study to explore PRP's potential advantages over autologous whole blood for treating chronic tennis elbow. Their findings, assessed six weeks post-therapy, indicated that PRP treatment appeared more effective than autologous blood in reducing pain. Despite the insights provided by studies like Thanasas *et al.*'s [6], a notable limitation is the need for more objective evaluations regarding symptom improvements following whole blood or PRP injection in similar studies. This gap in objective assessment raises questions about the robustness of the evidence supporting the comparative efficacy of these treatments for tennis elbow. Recognizing this gap, the current study was designed to objectively evaluate the effect of PRP injection in cases of chronic tennis elbow that had not shown improvement with conservative treatments. By addressing the need for objective assessments, this study aims to contribute valuable insights into the effectiveness of PRP injection as a therapeutic option for chronic tennis elbow, particularly in cases where conservative treatments have proven ineffective.

Materials and Methods

Study Design: Prospective study.

Study Area: Great eastern medical school and Hospital, Srikakulam.

Study Period: 01-02-2014- 01-02-2015.

This study was undertaken after obtaining permission from the Institutional ethical committee.

Inclusion criteria

1. Patients exhibiting symptoms consistent with chronic tennis elbow were included.
2. Individuals who had previously taken drugs such as paracetamol (500 mg) or ibuprofen (200 mg) three times a day.
3. Patients who had attempted activity modification, specifically avoiding lifting of heavy weights, were considered.
4. Individuals who had undergone a period of rest as part of conservative management for chronic tennis elbow were included.
5. Patients who had undergone physiotherapy, particularly in the form of extracorporeal shock wave therapy, for a duration of 3 months were part of the study.
6. The study specifically included individuals for whom pain, measured using Visual Analog Scale (VAS) and Mayo Elbow Performance Score (MEPS), either persisted without improvement or increased compared to the initial assessment.
7. Patients who did not experience pain reduction or improvement after the aforementioned conservative measures were included in the study.

The diagnosis for inclusion in this study was determined based on specific criteria associated with chronic tennis elbow. Patients considered for participation exhibited three key features: Firstly, the presence of pain localized over the lateral humeral epicondyle, which could potentially radiate distally to the forearm. Second, tenderness upon palpation over the lateral humeral epicondyle was observed. Lastly, individuals experienced exacerbated pain during activities such as gripping, lifting, and resisted extension of the wrist and/or second or third finger. Crucially, these three diagnostic features needed to persist for a duration exceeding three months. Whether or not patients had undergone conservative treatments, such as medication, activity modification, rest, and physiotherapy, did not influence their eligibility for the study. The inclusion criteria focused on identifying individuals with chronic tennis elbow characterized by enduring symptoms and signs, forming a targeted study group for the investigation of platelet-rich plasma (PRP) injection as an intervention.

Exclusion criteria

1. Patients with any existing skin pathology at the proposed injection site were excluded from the study.
2. Individuals experiencing symptoms of tennis elbow for a duration of less than three months were not included in the study.
3. Patients currently on antiplatelet therapy due to conditions such as myocardial infarction, stroke, pregnancy, etc., were excluded.
4. Individuals having more than one tendinopathy were excluded from the study.

These specific exclusion criteria were established to ensure a focused study population, free from potential confounding factors or conditions that could impact the assessment of the effectiveness of platelet-rich plasma (PRP) injection in the treatment of chronic tennis elbow.

Following obtaining written consent, approximately 40 ml of blood was drawn via venepuncture using acid citrate dextrose (ACD) tubes. Platelet count was assessed, and the sample underwent centrifugation initially at a soft spin (3000 rotations per minute). The resulting supernatant plasma was transferred to a sterile tube without anticoagulant and

subjected to a hard spin, yielding platelet-rich plasma (PRP) in the lower 1/3rd and platelet-poor plasma (PPP) in the upper 2/3rd, with platelet pellets formed at the bottom.

After suspending the platelet pellets in a minimal amount of plasma, the platelet count was checked, aiming for 3 to 5 times the baseline count. PRP was then injected within 4 hours under ultrasonography guidance at the pain site with aseptic measures. Post-injection, patients received paracetamol 500 mg thrice daily and wore an arm sling for 4 weeks, after which they were encouraged to resume work and undergo physiotherapy upon pain relief. Follow-ups occurred at 4 weeks, 8 weeks, 3 months, 6 months, and 1 year, where range of motion, visual analogue scale, Mayo elbow performance score, local complications, and the duration until the patient resumed duty were recorded.

Results

A total of twenty-eight patients were included in the study, out of which eighteen were male and ten were female. All the patients were suffering with chronic tendinopathies and gave consent for platelet rich injection. The mean age of study group for the males was 37 years and the females was 40 years.

Pain relief is contemplated when the patient's visual analogue scale decreases by at least 50% compared to the pre-injection visual analogue scale. If the Visual Analogue Scale (VAS) is below 20, the outcome is deemed excellent; if VAS falls within the range of 20 to 49, the result is considered good; for VAS between 50 to 69, the result is categorized as fair, and if VAS exceeds 70, the result is regarded as poor. Among the 26 patients, excellent to good results were achieved, accompanied by substantial pain relief. One patient experienced a fair outcome, while another had a poor result with minimal pain relief (refer to Table 1). The majority of patients reported pain relief approximately 8 weeks post-injection. Notably, only two patients with tennis elbow showed minimal pain relief at the one-year mark.

Table 1: Distribution of patients as per VAS

VAS	Before injection	After 4 weeks	After 8 weeks	After 12 weeks	After 6 months	After 1 year
≥ 70	24	18	5	2	1	1
50-69	3	6	9	4	1	1
20-49	1	2	14	9	3	1
< 20	0	0	0	13	23	25
Total	28	28	28	28	28	28

Elbow function was assessed using the Mayo Elbow Performance Score (MEPS), where an Excellent score is ≥ 90 points, Good is 75–89 points, Fair is 60–74 points, and Poor is <60 points. According to MEPS, the majority of patients achieved a good score around 8 weeks post-injection. At the one-year follow-up, 96.4% of patients obtained scores ranging from excellent to good (refer to Table 2). Only one patient received a fair score at the end of one year.

Table 2: Distribution of patients as per MEP score

MEPS Score	Before injection	After 4 weeks	After 8 weeks	After 12 weeks	After 6 months	After 1 year
≥90	01	03	07	20	24	26
75 – 89	03	07	16	07	03	01
60 – 74	16	14	04	01	01	01
< 60	08	04	01	00	00	00
Total	28	28	28	28	28	28

The study revealed that the quality of platelet count in platelet-rich plasma (PRP) had a notable impact on the outcomes. When the platelet count in PRP injections was less than 3.5 times the baseline level, two out of two patients experienced fair to poor results. In cases where the platelet count in PRP injections ranged from 3.5 to 5.5 times the baseline level, all patients reported significant pain relief. Additionally, when the platelet count in PRP injections exceeded 5.5 times the baseline level, all patients achieved excellent results in chronic lateral epicondylar tendinopathy (refer to Table 3).

Table 3: Quality of PRP Compared with Results

Quality of PRP (increase in concentration compared to the baseline platelet count)	No. of Patients	Result according to VAS	Result according to MEPS
< 3.5	02	Excellent - 00	Excellent - 00
		Good - 00	Good - 00
		Fair - 01	Fair - 01
		Poor - 01	Poor - 01
3.5 – 5.5	22	Excellent - 21	Excellent - 21
		Good - 01	Good - 01
		Fair - 00	Fair - 00
		Poor - 00	Poor -00
>5.5	04	Excellent - 04	Excellent - 04
		Good – 00	Good - 00
		Fair - 00	Fair - 00
		Poor - 00	Poor -00

Discussion

The discussion revolves around the prevalent issue of elbow epicondylar tendinosis and the various available treatment options. Prompt relief from symptoms is not only crucial for patients but also economically advantageous. In cases where rest and simple treatments prove unsatisfactory, patients often explore alternative options. Physical therapy and analgesics are commonly recommended, but a recent meta-analysis has raised concerns about the lasting value of physical therapy. Corticosteroid injections, despite their widespread use, come with potential drawbacks such as subcutaneous atrophy and the possibility of inducing permanent adverse changes within the tendon, making their long-term efficacy questionable. Extracorporeal shock wave therapy, another popular treatment, has faced scrutiny as a recent randomized double-blind study suggested it may not be more effective than a placebo.

Biologic treatments in orthopaedics, including platelet-rich plasma (PRP), are emerging as promising options. PRP, known for its role in wound healing, has been utilized in the treatment of recalcitrant plantar fasciitis and various chronic tendinopathies. A study by Barrett and Erredge reported a 78% success rate with PRP treatment for lateral epicondylar tendinopathy, with no worsening of symptoms post-treatment and no reported complications. The current study under discussion is a prospective interventional study conducted in a tertiary care hospital, aiming to address the objectives of the research. In this study, 40 patients diagnosed with chronic lateral epicondylar tendinopathy received PRP injections at the local site under ultrasound guidance. This approach emphasizes the importance of exploring innovative treatments, such as PRP, in the management of chronic tendinopathies, particularly when traditional methods prove inadequate. The ultrasound-guided administration adds a layer of precision to the treatment, potentially enhancing its effectiveness.

Various studies have investigated the use of platelet-rich plasma (PRP) as a treatment for chronic lateral epicondylitis, and the findings consistently suggest positive outcomes. Mishra and Pavelko (2006) [1] treated 140 patients with chronic lateral epicondylitis using PRP injections. At the final follow-up, which had a mean duration of 25.6 months (range: 12 - 38 months), they reported an impressive 93% reduction in pain compared to pre-treatment levels. In a similar study, Hechtman *et al*. (2011) [11] treated 31 patients with epicondylitis that did not respond to conservative treatment for six months. The overall success rate was reported at 90%, with notable improvement in patient satisfaction from 5.1 ± 2.5 at 1 month to 9.1 ± 1.9 at the last follow-up. Another study by Peerbooms *et al*. (2010) [2] compared the results of two groups of patients suffering from lateral epicondylitis. The first group (n = 51) received PRP injections, and the second group (n = 49) received corticosteroid injections. After a 1-year follow-up, the PRP group showed a 73% success rate compared to a 51% success rate in the corticosteroid group.

Thanasas *et al*. (2011) [6] treated two groups of patients with lateral epicondylitis, with the first group (n = 14) receiving PRP injections and the second group (n = 14) receiving injections of autologous blood. The study concluded that PRP treatment yielded superior short-term results, although there was no statistically significant difference in elbow function at follow-up. Creaney *et al*. (2011) [12] compared the results of two groups of patients with lateral epicondylitis, with the first group (n = 80) receiving PRP injections and the second group (n = 70) receiving autologous blood injections.

After a 6-month follow-up, the PRP group showed a 66% success rate compared to a 72% success rate in the autologous blood injection group. Gosens *et al*. (2011) [2] conducted a study comparing the results of two groups of patients with chronic lateral epicondylitis. The first group (n = 51) received leukocyte-enriched PRP injections, and the second group (n = 49) received corticosteroid injections. After a 2-year follow-up, the DASH scores of the corticosteroid group returned to baseline levels, while those of the PRP group significantly improved. Chaudhury *et al*. (2012) treated six patients with baseline ultrasound-confirmed tendinosis of the common extensor tendon using PRP injections under sonographic control. At the 6-month follow-up, five patients demonstrated improvement in tendon morphology.

Overall, these studies collectively support the efficacy of PRP injections in reducing pain and improving outcomes in patients with chronic lateral epicondylitis, providing valuable insights into the potential benefits of PRP as a therapeutic option for this condition.

Limitations of the study

Absence of Randomized Control Group: The study lacked a randomized control group, limiting its ability to draw direct comparisons with alternative treatments or a placebo.

Small Number of Patients**:** Another limitation was the small sample size, which may affect the generalizability and statistical power of the findings. A larger sample could provide more robust insights.

Pilot Investigation Design: The study was designed as a pilot investigation, indicating that it served as an initial exploration rather than a comprehensive and definitive analysis of the effectiveness of platelet-rich plasma (PRP) for chronic tennis elbow.

Study Design and Future Directions

Pilot Investigation Focus: The study explicitly states its role as a pilot investigation, suggesting that its primary aim was to test feasibility and gather initial data. As such, the limitations identified are inherent to its preliminary nature.

Upcoming Double-Blind, Placebo-Controlled Trial: A noteworthy aspect is the acknowledgment of the study's limitations, coupled with a proactive approach for improvement. A double-blind, placebo-controlled, prospective multicenter trial has been approved. This decision indicates a commitment to addressing the identified shortcomings and advancing the research to a more rigorous level.

Future Prospects for Better Evaluation: The approval of the upcoming trial indicates a strategic move to conduct a more comprehensive and methodologically robust investigation. This design choice aims to provide a higher level of evidence to better evaluate PRP as a treatment for chronic tennis elbow.

Focus on Patients Who Failed Conservative Treatment: The study emphasizes its focus on patients who have failed conservative treatment. This underscores the importance of exploring alternative therapeutic options for individuals who have not responded positively to traditional approaches.

Conclusion

This study demonstrates the effectiveness of platelet-rich plasma (PRP) injection under ultrasound guidance as a successful treatment for chronic tennis elbow. Notably, 28 patients experienced significant pain relief after one year, indicating that PRP's impact is gradual but enduring. PRP emerges as a highly effective non-surgical option, and its

consideration is recommended before opting for surgical intervention. Importantly, a platelet count in PRP less than 3.5 times the baseline showed less excellent results, though this observation is based on a small subset of patients (n=3), cautioning against broad generalization. Conversely, when the platelet count exceeded 3.5 times the baseline, the likelihood of achieving good results increased. This study underscores PRP's potential as a therapeutic choice for chronic tennis elbow, emphasizing the importance of optimal platelet count for enhanced outcomes.

Conflict of Interest
Not available

Financial Support
Not available

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