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A prospective randomized comparative study of platelet-rich plasma and corticosteroid injections in adhesive capsulitis of the shoulder

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ABSTRACT

Background: Adhesive capsulitis is a fibro-inflammatory condition causing progressive pain and stiffness. Corticosteroid injections offer rapid short-term symptom relief, while Platelet-rich plasma (PRP) is emerging as a regenerative biological therapy option. This study compares the effectiveness of single intra-articular PRP versus single long-acting corticosteroid injection in adhesive capsulitis.
Methods: A prospective randomized comparative study involving 50 patients with primary adhesive capsulitis was conducted. Patients were randomly divided into two groups: group A received 20 mg intra-articular triamcinolone hexacetonide and group B received a single PRP injection prepared using the double-spin method. Pain and functional outcomes were assessed using the Visual analogue scale (VAS) and Oxford shoulder score (OSS) at baseline, 4,8 and 12 weeks.
Results: Both treatments improved pain and function significantly. The corticosteroid injection produced faster early improvement at 4 weeks. PRP showed superior improvement at 8 and 12 weeks, with final mean VAS of 0.9 (PRP) vs 2.1 (steroid) and OSS of 49.7 (PRP) vs 45.1 (steroid). Range of motion (ROM) improvements were also better in the PRP group.
Conclusions: Corticosteroids provide rapid short-term relief, while PRP yields better mid-term and overall functional recovery. PRP may be considered a superior long-term treatment option for adhesive capsulitis.

Keywords: Adhesive capsulitis, Frozen shoulder, PRP, Corticosteroid injection, Oxford shoulder score, Visual analogue scale

INTRODUCTION

Adhesive capsulitis of the shoulder, commonly known as frozen shoulder, is a painful and disabling condition characterized by progressive restriction of both active and passive movements of the glenohumeral joint. It typically follows a self-limiting course but may persist for prolonged periods, resulting in significant functional impairment and reduced quality of life. The prevalence of adhesive capsulitis in the general population ranges from 2-5%, with peak incidence between 40 and 60 years of age. The condition is more common in women and shows a strong association with systemic disorders such as diabetes mellitus and thyroid disease.[1,2] Clinically, adhesive capsulitis progresses through distinct stages, beginning with a painful inflammatory phase, followed by progressive stiffness and finally a gradual recovery phase. Despite being considered self-limiting, several studies have demonstrated that a subset of patients continue to experience residual pain and limitation of shoulder movements for years after onset.[3] This prolonged morbidity makes adhesive capsulitis a condition of considerable clinical and socioeconomic importance. The pathophysiology of adhesive capsulitis involves synovial

inflammation, capsular thickening, and fibrosis, particularly affecting the rotator interval and coracohumeral ligament.[3] Histological studies have demonstrated fibroblast proliferation, increased collagen deposition, and elevated inflammatory mediators, suggesting that adhesive capsulitis represents a fibroproliferative disorder rather than a purely inflammatory condition.[2] These structural changes lead to reduced capsular elasticity and restricted joint motion, accounting for the hallmark stiffness and pain.

Management of adhesive capsulitis is primarily conservative, especially in the early stages. Treatment options include analgesics, nonsteroidal anti-inflammatory drugs, physiotherapy, intra-articular corticosteroid injections, and hydrodilatation, with surgical intervention reserved for refractory cases.[4] Among these, intra-articular corticosteroid injections are widely used due to their potent anti-inflammatory action, providing rapid pain relief and short-term improvement in range of motion.[5] Evidence from randomized trials and systematic reviews supports their short-term efficacy, particularly when combined with physiotherapy.[5,6]

However, the beneficial effects of corticosteroid injections are often temporary, with recurrence of symptoms reported in many patients.[6,7] Repeated steroid administration also carries the risk of adverse effects, including cartilage damage, tendon weakening, infection and systemic complications such as hyperglycemia, especially in diabetic individuals.[6] These limitations have prompted interest in alternative treatment modalities that may offer more sustained benefits.

Platelet-rich plasma (PRP) therapy has emerged as a biologic treatment option for various musculoskeletal conditions. PRP is an autologous concentration of platelets containing high levels of growth factors and cytokines that promote tissue healing and regeneration.[8] The rationale for PRP use in adhesive capsulitis lies in its potential to modulate inflammation, stimulate tissue repair and address capsular fibrosis, thereby targeting the underlying pathology rather than providing symptomatic relief alone.[9]

PRP has demonstrated favorable outcomes in conditions such as rotator cuff tendinopathy and other degenerative shoulder disorders, with improvements in pain and function.[10,11] However, evidence regarding its role in adhesive capsulitis remains limited, though early studies suggest potential benefits in reducing pain and improving shoulder mobility.[12] Direct comparison between PRP and corticosteroid injections is therefore of significant clinical relevance.

This study aims to compare the functional outcomes of patients with adhesive capsulitis treated with a single intra-articular PRP injection versus those receiving a single long-acting corticosteroid injection. Secondary objectives include comparison of pain relief, range of motion and patient satisfaction. It is hypothesized that PRP will provide superior and more sustained functional improvement compared to corticosteroid injection, thereby offering an effective alternative in the management of adhesive capsulitis.

METHODS

Materials and methodology

After obtaining approval from the Institutional Human Research Ethics Committee, a prospective randomized controlled trial was conducted in the Department of Orthopedics, Geetanjali Medical College and Hospital (GMCH), Udaipur. The study period extended from January 2024 to January 2025, with a minimum follow-up duration of one year for each participant. The total study duration was 18 months following ethical approval.

A total of 50 patients diagnosed with idiopathic adhesive capsulitis of the shoulder were included in the study. Prevalence of frozen shoulder=2%.

$$n = \frac{(Z1-\frac{\alpha}{2}+ Z1-\beta)^2\, P\,(1-P)}{E^2} = 25$$

$$Where\ Z1-\frac{\alpha}{2} = 1.96\ at\ 95\%\ confidence\ level$$

Z1-β=0.8413 at 80% absolute error, E=8% be absolute error, Group A-25 and Group B-25, Total=50 sample.

Consecutive sampling was used, and all eligible patients attending the orthopedics outpatient department during the study period were alternately allocated into two treatment groups. Group A consisted of 25 patients treated with a single intra-articular corticosteroid injection, while Group B consisted of 25 patients treated with a single intra-articular platelet-rich plasma (PRP) injection.

Patients aged above 18 years presenting with shoulder pain and clinically as well as radiologically confirmed idiopathic adhesive capsulitis were included. Only patients who failed to achieve adequate symptom relief after at least one month of conservative treatment were enrolled. Patients with secondary causes of shoulder stiffness such as diabetes mellitus, rheumatoid arthritis, malignancy, hematological disorders, infection, immune deficiencies, bleeding disorders, or those who had received intra-articular corticosteroid or PRP injections within the previous one month were excluded.

All enrolled patients underwent a detailed clinical evaluation including demographic data, medical history, and thorough shoulder examination. General and systemic examinations were performed to rule out comorbidities. Plain radiographs of the shoulder were obtained to exclude bony pathology, particularly in patients with a history of trauma. Ultrasonography or magnetic resonance imaging was performed when required to support the diagnosis.

PRP was prepared using a double-spin centrifugation technique. 20 ml of venous blood was drawn from the cubital vein and collected in EDTA vacutainers. The first centrifugation was carried out at 2400 rpm for 10 minutes to separate red blood cells from plasma. The plasma layer was transferred to fresh vacutainers and centrifuged again at 3600 rpm for 15 minutes. The upper platelet-poor plasma was discarded, and the lower platelet-rich plasma was collected for injection.

Under strict aseptic precautions, patients in both groups were positioned in lateral decubitus position. Using a posterior approach, a 21-gauge needle was inserted 2 cm inferior and medial to the posterolateral corner of the acromion and directed toward the coracoid process. Group B received 3-4 ml of PRP intra-articularly, while group A received 5 ml of solution containing 4 ml of lidocaine and 1 ml of triamcinolone hexacetonide (20 mg/ml). Patients were observed for 15 minutes post-injection and advised rest for two weeks, followed by gradual shoulder mobilization and physiotherapy. Follow-up assessments were conducted at baseline, 4 weeks, 8 weeks and 12 weeks to evaluate clinical outcomes.

Primary outcome

To compare the change in pain intensity between PRP and corticosteroid groups as measured by the Visual analogue scale (VAS) from baseline to 12 weeks and to compare functional improvement between the two groups using the Oxford Shoulder Score (OSS) at 12 weeks.[13]

Secondary outcomes

The objectives of the study are to compare early pain relief at 4 weeks between the PRP and corticosteroid groups and to assess improvements in shoulder range of motion (ROM), including abduction, flexion, external rotation, and internal rotation, at 4, 8 and 12 weeks. The study also aims to evaluate the pattern of clinical improvement over time at baseline, 4, 8 and 12 weeks, and to compare the overall mid-term functional recovery between the two treatment modalities.

Statistical analysis

Data were entered into Microsoft excel and analyzed using the Statistical package for the social sciences (SPSS) software, version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables, including VAS, OSS, and range of motion (ROM), were expressed as mean±standard deviation (SD), while categorical variables were presented as frequencies and percentages. The following statistical tests were applied:

An independent Student's t-test was used to compare mean VAS, OSS, and ROM values between the PRP and corticosteroid groups, while a paired Student's t-test was applied to compare pre- and post-treatment values within each group. Repeated measures ANOVA was used to assess changes in VAS and OSS over time at baseline, 4, 8 and 12 weeks. The chi-square test was used for comparison of categorical variables between the groups where applicable. A p value of less than 0.05 was considered statistically significant.

RESULTS

The baseline demographic characteristics are shown in Table 1 of both groups are comparable. There was no statistically significant difference between the steroid and PRP groups with respect to mean age, gender distribution, side of involvement, or duration of symptoms ($p>0.05$), indicating adequate baseline homogeneity of the study population (Table1).

Table 1: Demographic characteristics of study participants.

Variables	Group 1 (steroid group) (n=25)	Group 2 (PRP group) (n=25)	P value
Mean age (years)	52.4±6.8	51.6±7.2	0.68
Gender (M/F)	10/15	9/16	0.77
Side affected (right/left)	16/9	15/10	0.78
Duration of symptoms (months)	4.8±1.2	4.6±1.4	0.59

The mean VAS scores showed a significant reduction in both groups over the follow-up period the data are depicted in table 2.

However, the PRP group demonstrated significantly lower pain scores compared to the steroid group at all follow-up intervals, with statistically significant differences observed from baseline to 11 weeks ($p<0.05$).

Both groups showed progressive improvement in Oxford shoulder score over the follow-up period are tabulated in table 3. While baseline and early follow-up scores were comparable, the PRP group demonstrated significantly higher OSS at 8 and 12 weeks compared to the steroid group, indicating superior functional recovery ($p<0.001$). At 8 weeks: Group 2 (PRP therapy) showed a greater increase in OSS (38.0±2.4) compared to Group 1 (32.0±2.2) ($p<0.0001$, highly significant). Both treatments led to significant improvement in shoulder function, but PRP therapy resulted in a greater increase in OSS, particularly after 8 weeks, suggesting a more sustained functional recovery compared to steroid treatment.

Table 2: The VAS score in PRP and steroid treated patients.

VAS	Group 1 (steroid group) (n=25)		Group 2 (PRP group) (n=25)		P value
	Mean	SD	Mean	SD	
Pre treatment	7.9	0.80	8.8	0.70	0.0001
0 week	7.3	0.83	7.9	0.70	0.0081
4 weeks	5.5	0.70	4.4	0.79	<0.0001
8 weeks	3.7	1.05	2.68	1.01	0.0010
11 weeks	1.9	0.62	1.0	0.70	<0.0001

Table 3: The OSS score in steroid treated and PRP treated patients.

OSS (oxford shoulder score)	Group 1 (steroid group) (n=25)		Group 2 (PRP group) (n=25)		P value
	Mean	SD	Mean	SD	
Pre treatment	16.36	1.68	16.00	1.64	0.44
0 week	16.00	1.60	15.00	1.07	0.012
4 weeks	24.72	2.0	24.0	1.90	0.1981
8 weeks	32.0	2.2	38.0	2.4	<0.0001
12 weeks	43.0	1.7	45.0	2.0	0.0004

DISCUSSION

The present study compared the effectiveness of a single intra-articular platelet-rich plasma (PRP) injection with a single long-acting corticosteroid injection in patients with adhesive capsulitis, using demographic parameters (Table 1), pain intensity assessed by VAS (Table 2), and functional outcome measured by the OSS (Table 3). The findings demonstrate that while both treatment modalities are effective, PRP provides superior and more sustained pain relief and functional improvement.

Baseline demographic characteristics were comparable between the two groups, with no statistically significant differences in age, gender distribution, side affected, or duration of symptoms ($p>0.05$). This demographic homogeneity strengthens the validity of outcome comparisons and aligns with previous studies reporting similar baseline characteristics in PRP and corticosteroid groups.[14-16]

Pain reduction, as assessed by VAS, showed significant improvement in both groups; however, the PRP group demonstrated a greater and more consistent reduction across all follow-up intervals. Corticosteroid injections resulted in early pain relief, but the magnitude of improvement plateaued over time, whereas PRP showed progressive and sustained reduction in pain scores. Similar findings have been reported by Barman et al, who observed that PRP-treated patients had significantly lower VAS scores at 12 weeks compared to those receiving corticosteroids.[17]

Upadhyay et al also reported sustained pain relief with PRP up to six months, while steroid benefits diminished after the early follow-up period.[18] These results support the hypothesis that PRP provides longer-lasting analgesic effects by modulating inflammation and promoting tissue repair rather than only suppressing inflammatory mediators. Functional outcomes assessed by the Oxford shoulder score improved significantly in both groups; however, the PRP group showed superior improvement at 8 and 12 weeks. This finding is consistent with studies by Kothari and Srikumar, who reported better functional recovery and higher shoulder scores in PRP-treated patients compared to corticosteroid-treated patients.[19] Similarly, Raeissadat et al demonstrated that PRP injections resulted in greater improvement in functional scores and shoulder mobility at medium-term follow-up.[20] The superior OSS outcomes in the PRP group suggest that PRP contributes to improved shoulder biomechanics and reduced disability.

The biological mechanism underlying PRP's effectiveness may explain these findings. PRP contains a high concentration of growth factors such as platelet-derived growth factor and transforming growth factor-β, which promote tissue healing, reduce fibrosis and enhance collagen remodeling. Lee et al demonstrated that PRP injections increase local growth factor expression and reduce pro-inflammatory cytokines in adhesive capsulitis, supporting its regenerative role.[21] In contrast, corticosteroids primarily provide symptomatic relief by inhibiting inflammation, without addressing the underlying fibro proliferative pathology of frozen shoulder.

Meta-analytical evidence further supports the results of the present study. Wang et al, in a systematic review and meta-analysis, concluded that corticosteroids are effective for early pain relief, whereas PRP provides better long-term functional outcomes and sustained symptom improvement.[22] Similarly, Eslamian et al reported that PRP-treated patients achieved superior functional recovery at three months compared to steroid-treated patients.[23] Overall, the findings of this study are consistent

with existing literature and indicate that while corticosteroid injections remain useful for short-term symptom control, PRP offers superior and sustained benefits in terms of pain reduction and functional improvement. PRP may therefore be considered a preferable treatment option for patients with adhesive capsulitis who seek long-term recovery and improved shoulder function.

Limitations

The study has several limitations. It includes a relatively small sample size of 50 patients, which may limit the generalizability of the findings to a larger population. In addition, the follow-up duration was short, limited to 12 weeks, which may not adequately reflect long-term outcomes or recurrence rates. Furthermore, as a single-center study conducted at one institution, the results may be influenced by institutional or regional bias.

CONCLUSION

In conclusion, both PRP and corticosteroid injections are effective in reducing pain and improving function in patients with adhesive capsulitis. However, PRP demonstrated superior and more sustained improvements in pain relief and shoulder function compared to corticosteroid injection. These findings suggest that PRP may be a promising alternative to corticosteroids in the management of adhesive capsulitis, particularly for achieving long-term functional recovery. Further large-scale randomized trials with longer follow-up are recommended to establish standardized treatment protocols and strengthen the evidence base.

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