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Original Research Article

Comparative Evaluation of Autologous Platelet-Rich Plasma Injection and Hydrodissection for Functional Recovery in Adhesive Capsulitis of the Shoulder

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Abstract:

Background: Adhesive capsulitis causes shoulder pain, stiffness, restricted movement, and functional disability. This study compared the efficacy and functional outcomes of autologous platelet-rich plasma (PRP) injection and hydrodissection.

Methods: A prospective comparative study was conducted over 1 year among 126 patients with adhesive capsulitis in a tertiary health centre. Patients were divided equally into PRP (n=63) and hydrodissection (n=63) groups. Pain and functional disability were assessed using VAS and DASH scores at baseline, 1, 6, and 12 months. A p-value <0.05 was considered statistically significant.

Results: Both groups showed progressive improvement in pain and function during follow-up. At 12 months, VAS decreased to 2.04 ± 1.24 with PRP and 3.67 ± 1.82 with hydrodissection (p<0.001). DASH scores decreased to 29.16 ± 4.63 and 32.67 ± 3.81, respectively (p<0.001). PRP demonstrated significantly better outcomes from the first month onward.

Conclusion: Both interventions improved pain and functional disability, but PRP provided greater and more sustained improvement over 12 months. PRP may therefore be a promising treatment option for adhesive capsulitis.

Keywords: Adhesive capsulitis; frozen shoulder; platelet-rich plasma; hydrodissection; VAS; DASH.

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Introduction

Adhesive capsulitis of the shoulder, commonly known as frozen shoulder, is a painful and disabling condition characterized by progressive restriction of active and passive glenohumeral movements [1]. It affects approximately 3–5% of the general population and is associated with considerable impairment in shoulder function and quality of life [2]. The pathological process involves inflammation followed by capsular fibrosis, collagen deposition, and contracture, resulting in pain and progressive loss of range of motion [1,2].

The clinical course of adhesive capsulitis is generally described in three stages: the freezing stage, characterized by increasing pain and progressive restriction; the frozen stage, in which stiffness predominates; and the thawing stage, during which movement gradually recovers. Although spontaneous improvement may occur, recovery can be prolonged and incomplete, with persistent pain and functional limitation in a proportion of patients [1-4]. The condition is also strongly associated with diabetes mellitus and other metabolic disorders, making effective treatment particularly relevant in populations at increased risk of prolonged disability [1,5].

Management of adhesive capsulitis includes physiotherapy, analgesics, corticosteroid injections, and interventions such as hydrodilatation or hydrodissection. Hydrodilatation aims to mechanically distend the contracted joint capsule and disrupt adhesions, thereby improving shoulder mobility. However, systematic reviews have reported variable outcomes, with differences in procedural techniques, injectate volume, injection site, and rehabilitation protocols contributing to heterogeneity in treatment response [6,7].

Platelet-rich plasma (PRP) has gained attention as a biological treatment because of its potential anti-inflammatory and tissue-remodelling properties. PRP contains concentrated platelets that release growth factors and other bioactive mediators involved in tissue repair and extracellular matrix remodelling. Recent systematic reviews and meta-analyses have demonstrated improvements in pain, and functional disability following PRP treatment, although variations in PRP preparation and treatment protocols remain important considerations [6–8].

Evidence from clinical studies further supports the therapeutic potential of PRP in adhesive capsulitis. Comparative studies and pooled analyses have reported favourable effects of PRP on pain, functional outcomes, and shoulder mobility when compared with conventional treatment modalities [3-8]. However, the available evidence remains heterogeneous, and the relative effectiveness of PRP compared with mechanical interventions such as hydrodissection has not been adequately established.

Direct comparative evidence between PRP and hydrodissection remains particularly limited. Jeyaraman et al. conducted a prospective comparative study evaluating these two interventions and reported significantly better pain and functional outcomes with PRP [8]. A subsequent systematic review identified this as the only study directly comparing PRP with hydrodissection among the available PRP literature [9,10]. Considering the distinct biological and mechanical mechanisms of these interventions, further comparative evaluation is warranted. Therefore, the present study aimed to compare the efficacy and functional outcomes of autologous PRP injection versus hydrodissection in patients with adhesive capsulitis of the shoulder.

Materials and Methods

Study Design and Study Population: This prospective comparative study was conducted over a 1-year study period in the Department of Orthopaedics of a tertiary care hospital. The study included 126 patients clinically diagnosed with adhesive capsulitis of the shoulder. Following Institutional Ethics Committee approval, eligible patients were enrolled after obtaining written informed consent. Participants were randomly assigned in a 1:1 ratio to the PRP or hydrodissection group using a computer-generated randomization sequence. Block randomization was used to maintain balanced allocation between the groups.

Sample Size: The sample size was calculated for comparison of the mean DASH scores between the two independent treatment groups using $n = 2\left(Z_{\alpha/2} + Z_{\beta}\right)^2 \sigma^2/d^2$, assuming a two-sided α of 0.05, 80% power, an expected between-group difference of 5 points, and an expected standard deviation of 8.23 points [11,12]. The calculated sample size was 54 participants per group. Allowing for approximately 15% attrition, 63 participants were recruited in each group, resulting in a total sample size of 126.

The participants were divided equally into two groups of 63 patients each:

- **Group A (n = 63):** Patients who received autologous platelet-rich plasma (PRP) injection.
- **Group B (n = 63):** Patients who underwent hydrodissection of the shoulder.

Blinding of participants and treating clinicians was not feasible because of the distinct nature of the two interventions.

Eligibility Criteria: Patients presenting with a painful and stiff shoulder, clinically diagnosed with adhesive capsulitis, and showing inadequate improvement following conservative treatment for at least 1 month were included. Participants who consented to the assigned intervention and were available for regular follow-up were enrolled.

Patients with haemoglobin <10 g/dL, platelet count <105,000/μL, local infection, septicaemia, HIV infection, hepatitis B or C infection, systemic disorders affecting treatment, or corticosteroid injection at the affected site within the preceding month were excluded. Patients unwilling to undergo the proposed intervention were also excluded.

Baseline Evaluation: All participants underwent detailed clinical examination to confirm adhesive capsulitis and exclude other causes of painful restriction of shoulder movement. Baseline investigations included complete blood count, erythrocyte sedimentation rate, C-reactive protein, renal function tests, random blood glucose, and screening for HIV and hepatitis B. Radiographic evaluation of the affected shoulder was also performed. Disease duration was recorded in months from symptom onset to the time of intervention.

Pain and functional disability were assessed using the Visual Analogue Scale (VAS) and Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire.

Treatment Procedure: In both groups, the glenohumeral joint was approached posteriorly, approximately 1 cm inferior to the acromial angle, under sterile conditions.

Participants in Group A received 3 mL of autologous PRP, prepared from venous blood, into the shoulder joint under fluoroscopic guidance.

Participants in Group B underwent hydrodissection under fluoroscopic guidance using 20 mL of normal saline combined with 5 mL of lignocaine to distend

the capsular structures and facilitate separation of adhesions.

Following the procedure, gentle shoulder mobilisation was performed. All participants received instructions for a home-based shoulder-strengthening programme. Paracetamol was advised for pain relief when required, and participants were instructed to avoid weight-bearing through the affected limb for 2 weeks. Cuff-and-collar support was provided during the immediate post-procedural period.

Outcome Assessment: Participants were evaluated before treatment and subsequently at 1, 6, and 12 months. The primary outcome was pain assessed using the VAS, while the secondary outcome was functional disability assessed using the DASH questionnaire. Treatment outcomes were compared between the PRP and hydrodissection groups at each follow-up assessment.

Statistical Analysis: Data were analysed using IBM SPSS Statistics version 20.0. Continuous variables were presented as mean ± standard deviation and categorical variables as frequency and percentage. Between-group comparisons of VAS and DASH scores were performed at baseline and at 1, 6, and 12 months. Normality testing, within-group and repeated-measures analyses, missing-data imputation, adjustment for baseline age imbalance, confidence intervals, effect sizes, and multiple-comparison correction were not performed in the original analysis because an unadjusted comparative approach was used at each predefined follow-up time point. VAS was considered the primary outcome and DASH the secondary outcome. A p-value <0.05 was considered statistically significant.

Results

The study included 126 patients with adhesive capsulitis of the shoulder, with 63 patients each in the PRP and hydrodissection groups. The mean age was 52.46 ± 10.02 years in the PRP group and 56.83 ± 9.74 years in the hydrodissection group, with a statistically significant difference between the groups (p=0.018). Males constituted 58.7% and 61.9% of the PRP and hydrodissection groups, respectively, while females accounted for 41.3% and 38.1%, with no significant difference in sex distribution (p=0.71). The mean disease duration was 5.8 ± 2.1 months in the PRP group and 6.1 ± 2.3 months in the hydrodissection group, with no significant difference between the groups (p=0.46) (Table 1).

Table 1: Comparison of demographic characteristics between the PRP and hydrodissection groups

Demographic variable	Group A: PRP (n=63)	Group B: Hydrodissection (n=63)	P value
Sex, n (%)			
Male	37 (58.7)	39 (61.9)	0.71
Female	26 (41.3)	24 (38.1)	
Age (years)			
Mean ± SD	52.46 ± 10.02	56.83 ± 9.74	0.018
Range	36–72	39–77	
Disease duration (months), mean ± SD	5.8 ± 2.1	6.1 ± 2.3	0.46

At baseline, the mean VAS score was comparable between the PRP and hydrodissection groups (8.94 ± 0.55 vs. 9.12 ± 0.42; p=0.068). Following treatment, VAS scores progressively decreased in both groups. However, the PRP group demonstrated significantly lower pain scores at 1 month (6.31 ± 1.17 vs. 7.14 ± 1.12), 6 months (3.58 ± 1.71 vs. 4.91 ± 1.48), and 12 months (2.04 ± 1.24 vs. 3.67 ± 1.82), with p<0.001 at each follow-up assessment (Table 2).

Table 2: Comparison of VAS scores between the PRP and hydrodissection groups at different follow-up periods

Follow-up Assessment	Group A: PRP (Mean ± SD)	Group B: Hydrodissection (Mean ± SD)	P value
Pre-procedure	8.94 ± 0.55	9.12 ± 0.42	0.068
1 month	6.31 ± 1.17	7.14 ± 1.12	<0.001
6 months	3.58 ± 1.71	4.91 ± 1.48	<0.001
12 months	2.04 ± 1.24	3.67 ± 1.82	<0.001

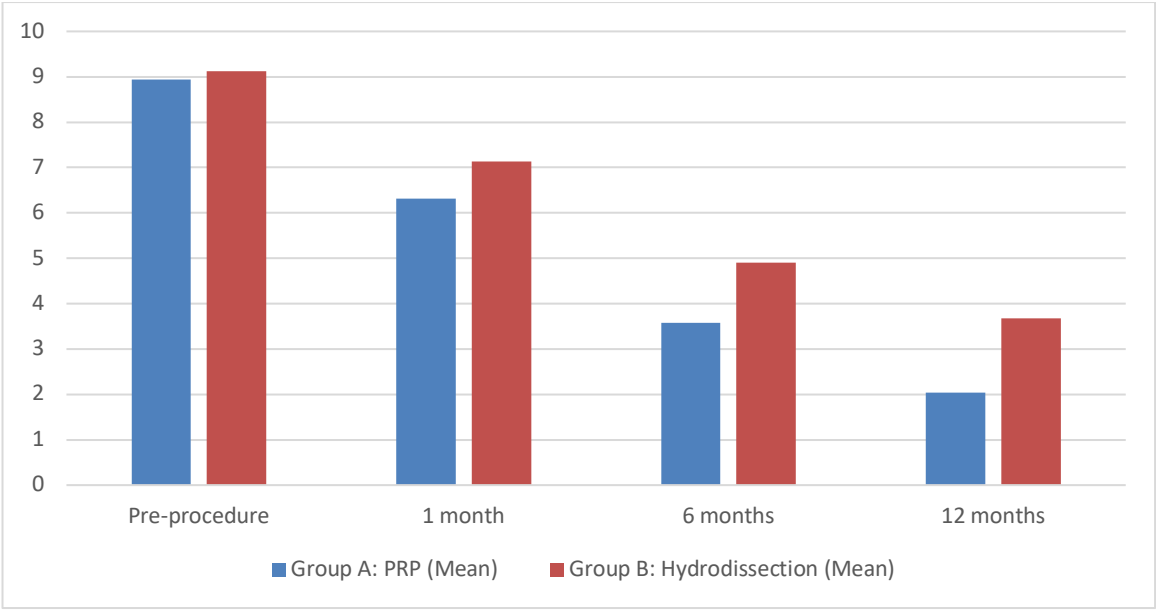

Figure 1: Comparison of mean VAS scores between the PRP and hydrodissection groups at different follow-up periods

The baseline DASH scores were also comparable between the PRP and hydrodissection groups (77.62 ± 5.11 vs. 78.16 ± 4.94; p=0.56). A progressive reduction in DASH scores was observed in both groups during follow-up, indicating improvement in functional status. The PRP group showed significantly better functional outcomes at 1 month (62.14 ± 4.76 vs. 65.71 ± 6.83; p=0.002), 6 months (44.03 ± 6.47 vs. 48.91 ± 4.72; p<0.001), and 12 months (29.16 ± 4.63 vs. 32.67 ± 3.81; p<0.001) compared with the hydrodissection group (Table 3).

Table 3: Comparison of DASH scores between the PRP and hydrodissection groups at different follow-up periods

Follow-up Assessment	Group A: PRP (Mean ± SD)	Group B: Hydrodissection (Mean ± SD)	P value
Pre-procedure	77.62 ± 5.11	78.16 ± 4.94	0.56
1 month	62.14 ± 4.76	65.71 ± 6.83	0.002
6 months	44.03 ± 6.47	48.91 ± 4.72	<0.001
12 months	29.16 ± 4.63	32.67 ± 3.81	<0.001

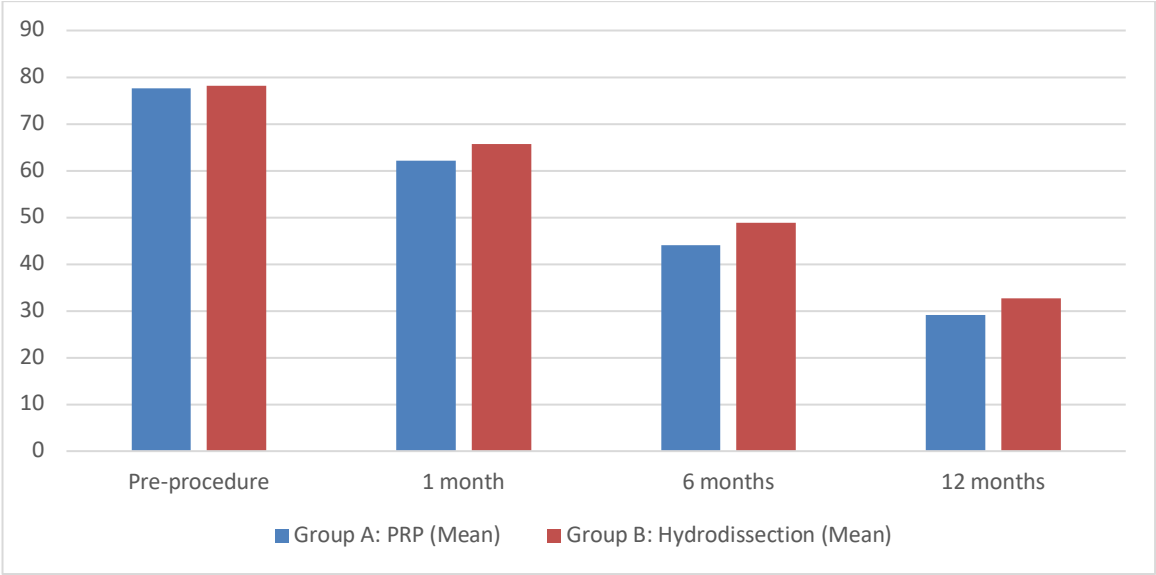

Figure 2. Comparison of Mean DASH Scores Between the PRP and Hydrodissection Groups at Different Follow-up Periods

Discussion

The present study showed that both PRP and hydrodissection produced clinically meaningful improvement in adhesive capsulitis, but the advantage of PRP became progressively more evident during follow-up. This pattern is more informative than the baseline-to-final change alone because baseline VAS and DASH scores were comparable between the groups, although a statistically significant difference in age was observed, with participants in the hydrodissection group being older on average. The divergence in outcomes appeared after treatment and was maintained through 12 months; however, the baseline age imbalance should be considered when interpreting the between-group differences in treatment outcomes. The finding is particularly relevant to the only published direct comparison by Jeyaraman et al., in which PRP was compared with the same hydrodissection protocol and produced significantly better pain, functional and ROM outcomes [9]. The consistency between the two studies suggests that the difference may not simply reflect the mechanical release produced by hydrodissection. PRP may additionally influence the inflammatory–fibrotic environment of the contracted capsule through platelet-derived mediators and growth factors. This interpretation is supported by Blanchard et al., who found that 62 of 67 comparative ROM assessments (93%) favoured PRP at the longest follow-up across 19 studies, although the authors also emphasized heterogeneity in PRP preparation and treatment protocols [2].

The temporal pattern in the present study is also important when compared with trials using corticosteroid or other injection controls. Kothari et al. found PRP to produce better ROM, VAS and QuickDASH outcomes than corticosteroid and ultrasound therapy at 12 weeks, while Lin et al. reported that pain initially improved in both PRP and procaine groups but continued to decline with PRP after 3 months, whereas it increased in the procaine group [13,14]. These observations provide a possible explanation for the progressively greater separation between the groups in the present study: the early response may partly reflect reduction in pain and mechanical restriction, whereas the longer-term difference may reflect continued tissue remodelling and recovery. This interpretation is strengthened by the 2025 meta-analysis of randomized trials comparing PRP with corticosteroids, which found no significant difference in VAS at 1–3 months but significantly better VAS and DASH outcomes with PRP at 6 months, together with superior abduction and rotational ROM [15]. Thus, the sustained superiority of PRP in the present study is consistent with the broader evidence that its relative benefit may become more apparent with longer follow-up rather than immediately after injection.

The functional findings deserve separate consideration because improvement in pain does not necessarily equate to restoration of shoulder function. The marked reduction in DASH in both groups, with a greater reduction following PRP, suggests that the intervention influenced disability as well as symptom severity. This agrees with the systematic review by Blanchard et al., in which all studies reporting DASH demonstrated improvement after PRP and the comparative data generally favoured PRP [2]. Similarly, the meta-analysis by Pretorius et al. concluded that PRP provides favourable improvements in pain, disability and ROM compared with corticosteroid and physiotherapy, although the magnitude of benefit varied across outcomes and follow-up periods [9]. The present results therefore fit within a broader pattern rather than representing an isolated PRP effect. Nevertheless, differences in PRP preparation, platelet concentration, injection frequency, disease stage and concurrent rehabilitation across studies make direct numerical comparison difficult. The functional advantage observed here should consequently be interpreted as evidence of a comparative treatment effect under the present protocol, rather than proof that PRP is universally superior irrespective of technique.

The improvement following hydrodissection in the present study is also clinically relevant and should not be interpreted as treatment failure. Hydrodilatation can provide short-term improvement by mechanically distending the contracted capsule and disrupting adhesions; however, its longer-term comparative effectiveness remains less certain. Saltychev et al. found only a small effect on pain and ROM and no significant pooled effect on disability, whereas the 2023 meta-analysis by Poku et al. reported at least transient improvements in disability and passive external rotation compared with intra-articular corticosteroid injection [16,17]. More importantly, the most recent systematic review, comprising 103 studies and 9,951 patients, found substantial variation in hydrodilatation technique, with no significant advantage over corticosteroid injection alone for pain, SPADI, abduction or forward flexion at 12 weeks, although external rotation was better [18]. This variability is particularly relevant to the present study because hydrodissection outcomes may depend on injection volume, anatomical target, imaging guidance and capsular distension achieved. Taken together, the present findings suggest that hydrodissection remains capable of producing meaningful clinical improvement, but PRP may offer a more sustained advantage in pain and functional recovery; importantly, the limited number of direct PRP-versus-hydrodissection studies means

that this conclusion warrants confirmation through adequately powered randomized trials.

The prospective comparative design, significant baseline age imbalance, and absence of reported allocation and blinding procedures may have introduced selection or measurement bias. Therefore, the observed treatment differences should be interpreted cautiously.

Conclusion

The present study demonstrates that both autologous platelet-rich plasma injection and hydrodissection are effective in improving pain and functional disability in patients with adhesive capsulitis of the shoulder; however, PRP produced a significantly greater and more sustained improvement in VAS and DASH scores over the 12-month follow-up period. The findings suggest that, beyond the mechanical capsular distension achieved with hydrodissection, the biological effects of PRP may contribute to prolonged symptomatic and functional recovery. Therefore, autologous PRP injection may be considered a promising treatment option for adhesive capsulitis, although further well-designed randomized controlled studies with standardized treatment protocols and larger populations are warranted to establish its comparative effectiveness.

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