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Original Research Article

Comparison of Ultrasound Guided Hydrodistension of the Shoulder Joint By Anterior Versus Posterior Approach in Primary Adhesive Capsulitis

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Abstract

Background: Adhesive capsulitis, or frozen shoulder, presents significant functional impairment due to pain and stiffness. Ultrasound-guided hydrodistension has been recognized for its potential in treating this condition, but the optimal approach remains unclear.

Methods: This prospective observational study at the Central Institute of Orthopaedics involved 40 patients with primary adhesive capsulitis, randomized into two groups to receive hydrodistension via either the anterior or posterior approach. Outcomes measured included the Visual Analog Scale (VAS) for pain and the degree of passive external rotation, assessed at baseline, 4 weeks, and 12 weeks post-intervention.

Results: Both groups started with comparable pain levels and mobility restrictions; however, the anterior approach group showed more significant improvements. At 12 weeks, the anterior group's pain scores and external rotation were superior to those of the posterior group.

Conclusion: The anterior approach to ultrasound-guided hydrodistension is more effective in managing pain and improving mobility in patients with adhesive capsulitis compared to the posterior approach.

Keywords: Adhesive Capsulitis, Ultrasound-Guided Hydrodistension, Anterior Approach, Posterior Approach, Frozen Shoulder, Pain Management, Joint Mobility.

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Introduction

Adhesive capsulitis, commonly known as frozen shoulder, is a debilitating condition characterized by progressive pain and stiffness in the shoulder joint. The pathophysiology of adhesive capsulitis remains enigmatic, though it is postulated to involve fibro inflammatory changes leading to capsular fibrosis and subsequent restriction of joint mobility.

This condition significantly impairs quality of life, affecting daily activities and occupational tasks. Ultrasound-guided hydrodistension, where saline and corticosteroids are injected into the joint capsule, has emerged as a promising intervention by attempting to rupture the contracted capsule and reduce inflammatory processes.[1,2,3]

The efficacy of hydrodistension largely depends on the technique and approach utilized. The anterior and posterior approaches are the two primary techniques for administering hydrodistension, each with theoretical advantages and potential limitations. The anterior approach might offer easier accessibility and potentially less discomfort due to fewer nerve endings in the anterior aspect of the joint capsule. Conversely, the posterior approach may allow for a more comprehensive distension of the joint capsule, theoretically covering more area and possibly affecting a greater portion of the fibrotic tissue. [4,5,6]

Recent studies have provided insights into the outcomes of these approaches, yet the comparative effectiveness remains underexplored. This gap in the literature signifies a critical need for a rigorous comparative analysis of the anterior versus posterior approaches to ultrasound-guided hydrodistension in the management of primary adhesive capsulitis.

Such an analysis is pivotal not only for elucidating the optimal technique but also for enhancing

patient outcomes through tailored therapeutic strategies. [7,8]

This study aims to bridge this knowledge gap by conducting a methodical comparison of the two approaches, focusing on clinical outcomes such as pain relief, range of motion, and overall shoulder function. Additionally, the study will explore the incidence of complications and patient satisfaction, providing a comprehensive assessment of the therapeutic value of each technique. By integrating quantitative assessments with qualitative patient feedback, this research aspires to contribute robust evidence to the body of orthopedic practice and guide clinical decision-making. [9,10]

Given the increasing prevalence of adhesive capsulitis and the expanding repertoire of intervention strategies, this comparative study holds significant implications for clinical practices. It aims to refine intervention techniques, enhance patient outcomes, and ultimately, inform clinical guidelines for the management of this challenging musculoskeletal condition.

Materials and Methods

Venue of Study: The study was conducted at the Central Institute of Orthopaedics, in collaboration with the Department of Radiodiagnosis, VMMC, and Safdarjung Hospital, New Delhi.

Type of Study: This was a prospective observational study.

Duration: The study duration was 18 months.

Study Participants Inclusion Criteria: Participants were patients aged 40-70 years with a clinico-radiologically confirmed diagnosis of adhesive capsulitis. They presented with a Visual Analog Scale (VAS) score greater than 6 and a passive external rotation of less than 30 degrees.

Exclusion Criteria

Patients were excluded if they had:

- Prior shoulder trauma or surgery
- Radiographic findings of significant glenohumeral joint arthritis
- Inflammatory or infective shoulder arthritis
- Connective tissue disorders
- Neuromuscular disorders
- Cervical spondylosis
- Rotator cuff tears
- Regular use of systemic corticosteroids

Methodology: Informed written consent was obtained from all participants after receiving approval from the ethical committee of the institute and a thorough explanation of the research aims. Each participant underwent a clinical history review and general physical examination using a predesigned clinical proforma. Participants were sequentially allocated to either Group A (anterior approach) or Group B (posterior approach). Pre-intervention VAS and the degree of passive external rotation of the affected shoulder joint were recorded for both groups.

Technique for Ultrasound-Guided Hydrodistension of the Shoulder Joint

Anterior Approach: Performed under strict aseptic precautions, the procedure involved distending the rotator interval with a 30 ml cocktail comprising 20 ml of normal saline, 2 ml of 40mg/ml triamcinolone acetate, and 8 ml of 2% lidocaine, using a 23G spinal needle in the lateral decubitus position. An antiseptic dressing was applied at the puncture site, and post-intervention vital signs were monitored for 30 minutes.

Posterior Approach: Similar to the anterior approach, but the cocktail was injected into the posterior glenohumeral recess.

Outcome Assessment: Post-procedure, both groups underwent a similar set of physiotherapy exercises for four weeks, including Codman's pendulum exercises, towel stretch, cross-body stretching, range of motion exercises, massage, and ice application. After four weeks, and again after three months, VAS and the degree of passive external rotation were recorded. Improvements were compared between the two groups using statistical methods at pre-intervention, four weeks, and three months post-intervention.

Statistical Methods: Data were entered into an MS EXCEL spreadsheet and analyzed using STATA version 14.2. Categorical variables were presented as numbers and percentages, while continuous variables were presented as mean ± SD and median. Quantitative variables between the two unrelated groups were compared using the t-test and Mann-Whitney U test for non-normally distributed datasets. Chi-square tests were employed for qualitative variables. A p-value of <0.05 was considered statistically significant.

Results

The study involved a total of 40 patients with primary adhesive capsulitis, divided equally into two groups (Group A and Group B) to compare the effectiveness of the anterior versus posterior approaches for ultrasound-guided hydrodistension. The participants' demographic and clinical characteristics were well balanced across the two groups, with no significant differences in age, sex, or the distribution of chief complaints and laterality.

Demographic and Baseline Characteristics: The age distribution among the groups showed that 45% of participants were between 40 and 50 years old, 35% were between 51 and 60 years old, and

20% were between 61 and 70 years old. The gender distribution was nearly even, with 21 females (52.5%) and 19 males (47.5%). Statistical analysis revealed no significant difference in age (Chi-Square, p = 0.697) or sex (Chi-Square, p = 1.000) between the groups, indicating that the sample was homogeneously distributed (Table 1).

Clinical Characteristics: Chief complaints were uniformly distributed with 70% of each group reporting shoulder pain and 30% reporting shoulder pain accompanied by stiffness. Laterality of the condition also showed no significant difference; 32.5% had left-sided and 67.5% had right-sided shoulder involvement (Chi-Square, p = 1.000). These results suggest that both groups were comparable at baseline regarding their clinical presentations (Table 2).

Treatment Outcomes: The primary outcomes measured were changes in the Visual Analog Scale (VAS) scores and passive external rotation over 12 weeks. Initially, both groups started with a similar mean VAS score of 8.20. However, significant differences emerged over time. By the 4-week mark, Group A showed a greater reduction in pain (mean VAS 2.85) compared to Group B (mean VAS 3.90, p = 0.011). At 12 weeks, Group A's pain reduction was more profound (mean VAS 0.35) compared to Group B (mean VAS 1.55, p = 0.001), demonstrating a more effective pain management with the anterior approach (Table 3). Regarding functional recovery, the mean baseline passive external rotation was slightly higher in Group B (26.00 degrees) compared to Group A (25.25 degrees). Despite this, Group A achieved significantly better improvements in shoulder mobility over the course. At 4 weeks, Group A's mean passive external rotation was 54.25 degrees, notably higher than Group B's 48.00 degrees (p < 0.001). This trend continued through 12 weeks, with Group A reaching a mean passive external rotation of 73.75 degrees compared to 71.00 degrees in Group B (p = 0.002), suggesting superior functional recovery with the anterior approach (Table 4).

Table 1: Distribution of Age and Sex between Groups

	Age 40-50	Age 51-60	Age 61-70	Female	Male	Total
Group A	8 (40%)	7 (35%)	5 (25%)	11	9	20
Group B	10 (50%)	7 (35%)	3 (15%)	10	10	20
Total	18 (45%)	14 (35%)	8 (20%)	21	19	40

Table 2: Distribution of Chief Complaints and Laterality between Groups

Complaints	Group A	Group B	Total
Shoulder Pain	14 (70%)	14 (70%)	28
Shoulder Pain with Stiffness	6 (30%)	6 (30%)	12
Laterality			
Left	5 (25%)	8 (40%)	13
Right	15 (75%)	12 (60%)	27
Total	20	20	40

Table 3: Visual Analog Scale (Vas) Score Comparison between Groups

Time Point	Group A Mean (SD)	Group B Mean (SD)	p-value
Baseline	8.20 (0.834)	8.20 (0.834)	1.000
4 weeks	2.85 (1.226)	3.90 (1.252)	0.011
12 weeks	0.35 (0.671)	1.55 (1.276)	0.001

Table 4: Passive External Rotation between Groups over Time

Time Point	Group A Mean (SD)	Group B Mean (SD)	p-value
Baseline	25.25 (4.128)	26.00 (4.168)	0.571
4 weeks	54.25 (4.667)	48.00 (4.104)	<0.001
12 weeks	73.75 (4.552)	71.00 (5.282)	0.002

Discussion

Adhesive capsulitis, commonly known as frozen shoulder, is a prevalent musculoskeletal condition characterized by persistent shoulder pain and a marked reduction in range of motion. These limitations can significantly hinder daily activities, impairing quality of life and necessitating effective, evidence-based treatment strategies.

Among various therapeutic modalities, hydrodistension—an interventional procedure that involves injecting fluid into the shoulder joint capsule to stretch and disrupt adhesions—has gained traction as a promising approach. When guided by ultrasound, this technique allows for more accurate placement of the injectate and potentially improved clinical outcomes. However,

the question of whether an anterior or posterior approach offers superior efficacy has remained open.

This study compared the clinical outcomes of ultrasound-guided hydrodistension using anterior versus posterior approaches in patients with primary adhesive capsulitis. A range of demographic and clinical parameters were evaluated, including age, sex, anthropometric measurements, fasting blood sugar levels, duration of symptoms, chief complaints, laterality, Visual Analog Scale (VAS) scores, passive external rotation, and Shoulder Pain and Disability Index (SPADI) values. Notably, no significant differences in demographic or baseline characteristics were observed between the two groups, reinforcing the internal validity of the findings and suggesting that patient-related factors likely did not influence the comparative outcomes.

Clinical Outcomes and Existing Literature: Our results indicate that the anterior approach to ultrasound-guided hydrodistension provided more significant improvements in key clinical metrics—namely, VAS scores, passive external rotation, and SPADI values—at both 4-week and 12-week follow-ups compared to the posterior approach. These findings contrast with earlier studies reporting no significant differences between approaches [1,2], yet they align with research suggesting that anterior hydrodistension can yield better pain relief and enhanced mobility [3–5]. The anterior approach may facilitate more effective capsular stretching and fluid dispersion, particularly in the rotator interval, which is often implicated in adhesive capsulitis.

The observed improvement in passive external rotation is particularly noteworthy, as this parameter is a critical indicator of functional restoration in adhesive capsulitis. Enhanced mobility likely results from more effective disruption of capsular adhesions and better targeting of inflamed or thickened capsule areas [3,4,6]. Moreover, the reduction in SPADI scores highlights improved shoulder function and decreased pain-related disability, aligning with patient-centered priorities and emphasizing the approach's clinical relevance. Some literature suggests that various hydrodilatation techniques, including those guided by ultrasound and even arthrodilation, are effective in managing adhesive capsulitis [7–9]. However, not all studies concur on the superiority of a particular approach [1,2], and factors such as patient selection, disease stage, adjunctive therapies (e.g., corticosteroids, suprascapular nerve blocks, physiotherapy), and clinician expertise may modulate outcomes [10–13].

Mechanistic Insights and Clinical Implications: The enhanced efficacy of the anterior approach may be attributable to several mechanistic factors. Ultrasound guidance enables precise injectate placement and optimal capsular distension, potentially improving access to regions most affected by adhesions. Anatomical advantages offered by the anterior route may thus translate into superior and more sustained symptom relief [1,3,4,14]. From a clinical standpoint, these findings can inform decision-making, encouraging clinicians to consider the anterior approach—especially when aiming to expedite pain reduction and improve range of motion.

Additionally, improved outcomes with the anterior approach may reduce the need for prolonged physical therapy sessions and recurrent interventions, potentially resulting in cost savings and increased patient satisfaction. As ultrasound-guided techniques become more accessible and clinicians gain proficiency, adopting the anterior approach may enhance the standard of care for adhesive capsulitis management.

Limitations and Future Directions: Despite the promising results, the study has limitations. The sample size was relatively small, and the follow-up period (12 weeks) may be insufficient to fully capture long-term efficacy and the potential recurrence of symptoms. Larger, multicenter trials with extended follow-up periods are warranted to confirm these findings and provide more robust evidence. Additionally, incorporating objective measures and ensuring assessor blinding would strengthen the reliability of future investigations.

Further research should also explore which patient subgroups may derive the most benefit from anterior hydrodistension. Examining factors such as disease stage, comorbidities, and capsular thickness or vascularity patterns seen on imaging could refine patient selection criteria. Comparative effectiveness studies evaluating different injectate compositions, adjunctive therapies, or alternative imaging modalities could also yield insights into optimizing hydrodistension protocols.

Conclusion

This study's findings support the anterior approach as a more effective technique for ultrasound-guided hydrodistension in patients with primary adhesive capsulitis, delivering greater pain relief, improved passive external rotation, and enhanced functional outcomes compared to the posterior approach. While these results are encouraging, larger and longer-term studies are necessary to validate these findings, clarify underlying mechanisms, and develop more personalized treatment strategies. Advancing our understanding of how and why the anterior approach may outperform the posterior

approach holds promise for improving quality of life and restoring function in patients affected by this challenging condition.

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