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Original Research Article

Ultrasound-Guided Intra-Articular Steroid Injection Outcomes in Adhesive Capsulitis: A Prospective Observational Study

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Abstract:

Background: Adhesive capsulitis is a common cause of shoulder pain and stiffness, leading to significant functional limitation and reduced quality of life. Intra-articular corticosteroid injections are widely used for symptom control; however, the accuracy of drug delivery may influence clinical outcomes. Ultrasound guidance has been shown to improve injection precision, potentially enhancing therapeutic effectiveness.

Objectives: To assess the clinical outcomes of ultrasound-guided intra-articular steroid injection in patients with adhesive capsulitis of the shoulder in terms of pain relief, functional improvement, and range of motion.

Materials and Methods: This prospective observational study included 40 patients diagnosed with adhesive capsulitis and treated at a tertiary care center over a period of 1.5 years. All patients underwent ultrasound-guided intra-articular steroid injection followed by a standardized physiotherapy protocol. Clinical outcomes were assessed using the Visual Analog Scale for pain, shoulder-specific functional scores, and goniometric measurement of shoulder range of motion. Assessments were performed at baseline and at 2, 6, and 12 weeks post-injection.

Results: A significant reduction in pain scores was observed as early as 2 weeks following injection, with sustained improvement up to 12 weeks. Functional scores improved progressively over the follow-up period, indicating enhanced ability to perform activities of daily living. Range of motion showed significant improvement across all planes, with the most notable gains observed in forward flexion and abduction. No major complications were reported during the study.

Conclusion: Ultrasound-guided intra-articular steroid injection is a safe and effective treatment modality for adhesive capsulitis, providing early pain relief, improved shoulder function, and gradual recovery of range of motion when combined with physiotherapy.

Keywords: Adhesive Capsulitis, Frozen Shoulder, Ultrasound-Guided Injection, Intra-Articular Steroid, Shoulder Pain, Range of Motion.

Introduction

Overview: Adhesive capsulitis is a disabling shoulder condition that leads to considerable pain, long-lasting restriction of daily activities, and deterioration in overall well-being. Although the disorder is often described as self-resolving, symptoms may continue for many months or even years when appropriate management is delayed or absent [1].

Epidemiological data suggest that this condition affects approximately 2–5% of the general population, with a higher frequency observed among individuals between 40 and 60 years of age. A slight predominance has been reported among females. The condition is frequently associated with systemic and metabolic disorders such as diabetes mellitus, thyroid abnormalities, and cardiovascular illnesses [2]. Patients with diabetes tend to experience more severe pain, prolonged symptom persistence, and poorer therapeutic outcomes compared to non-diabetic individuals. Clinically, the disorder presents with persistent shoulder pain, often worsening during nighttime, along with progressive limitation of shoulder mobility in multiple planes. Limitation of outward rotational movement is most pronounced, followed by reduced elevation and inward rotation. The clinical course is generally described as a continuum consisting of an initial painful stage, a phase dominated by stiffness, and a gradual phase of functional improvement, though the duration and severity of these stages vary widely among individuals [3].

From a pathological perspective, the condition is characterized by sustained inflammatory activity within the shoulder capsule, synovial thickening, and gradual fibrotic changes that result in capsular tightening and reduced joint capacity. Microscopic evaluations have revealed increased fibroblast activity, excessive collagen accumulation, and elevated levels of inflammatory mediators within the capsular tissue, contributing to reduced joint flexibility and movement limitation [4]. These pathological mechanisms support early therapeutic strategies focused on symptom control and restoration of shoulder function, particularly during the initial stages of the condition.

Current Management Strategies: Treatment of adhesive capsulitis can be challenging due to the variable clinical course and the presence of multiple contributing factors. The primary goals of management include reduction of discomfort, restoration of shoulder function, and prevention of long-term functional impairment. Both conservative and operative approaches are available, with non-operative care generally recommended as the first line of management for most individuals [5].

Conservative care includes the use of analgesic and anti-inflammatory drugs, supervised rehabilitation programs, structured stretching exercises, joint injections, and patient counseling. Rehabilitation programs are widely implemented and aim to improve shoulder mobility through gradual capsular mobilization and muscle conditioning. However, overly aggressive rehabilitation during the early painful stage may exacerbate symptoms and negatively affect patient compliance.

Injection-based therapies using corticosteroids have been extensively evaluated for symptom control in adhesive capsulitis. These agents exert potent effects on inflammatory pathways, reduce synovial irritation, and may limit excessive capsular thickening when administered during the initial stages of the condition. Evidence from multiple studies suggests that corticosteroid injections provide faster relief of pain and more rapid improvement in shoulder mobility compared to exercise-based therapy alone, particularly over short follow-up periods [6].

Other interventional options, including capsular distension techniques, controlled joint mobilization under anesthesia, and minimally invasive surgical release of the capsule, are generally reserved for cases that fail to respond adequately to conservative measures. Although these interventions may be beneficial, they carry increased procedural complexity, higher risk profiles, and often require anesthesia, making less invasive options preferable whenever feasible. Despite the widespread use of corticosteroid injections, clinical outcomes may vary depending on factors such as precision of delivery, stage of the condition, and individual patient characteristics. Conventional injection techniques relying solely on surface anatomical reference points may lead to suboptimal placement and reduced effectiveness. This limitation has contributed to growing interest in imaging-assisted injection methods to enhance accuracy and therapeutic success.

Role of Ultrasound-Guided Intra-Articular Steroid Injections: Ultrasound guidance has become an essential resource in musculoskeletal procedures because of its real-time imaging, lack of ionizing radiation, affordability, and capacity to verify precise needle positioning. Intra-articular injections guided by ultrasound enable direct observation of the glenohumeral joint, adjacent soft tissues, and neurovascular elements, enhancing both accuracy and safety [7].

Numerous studies have shown that shoulder injections guided by ultrasound have considerably higher accuracy rates than those performed using landmark-guided methods. Precise intra-articular administration of corticosteroids is crucial for achieving the best therapeutic outcome, since extra-articular positioning can result in insufficient symptom alleviation and a higher probability of local complications. Enhanced precision with ultrasound assistance has been linked to improved pain management, quicker functional recovery, and greater patient satisfaction [8].

Ultrasound guidance is particularly advantageous in adhesive capsulitis, where joint space narrowing, capsular thickening, and altered anatomy may make blind injections challenging. In addition, ultrasound allows assessment of associated pathologies such as rotator cuff tendinopathy, bursitis, or effusion, which may influence treatment planning and prognosis. Although existing literature supports the short-term benefits of ultrasound-guided intra-articular steroid injections, variations exist in study design, outcome measures, follow-up duration, and patient populations. Moreover, data from Indian tertiary care centers remain limited, highlighting the need for region-specific clinical evidence.

Rationale and Objectives of the Study: Considering the widespread occurrence of adhesive capsulitis and its considerable effect on routine functioning, there is a clear requirement to assess treatment approaches that are effective, low risk, and capable of delivering consistent pain reduction along with functional recovery. Image-assisted delivery of corticosteroids into the shoulder joint has emerged as a valuable therapeutic option, particularly when implemented during suitable stages of the condition. This investigation was carried out at Dr. S.N. Medical College, Jodhpur,

with the objective of evaluating clinical outcomes following ultrasound-assisted intra-articular corticosteroid administration in individuals diagnosed with adhesive capsulitis. By systematically monitoring changes in pain levels and shoulder function over a predefined observation period, this work seeks to add clinically relevant evidence to the current literature.

Methodology

Study Design and Setting: Patients attending the outpatient clinic with complaints of shoulder discomfort and reduced mobility underwent a detailed clinical assessment. The diagnosis of adhesive capsulitis was established based on patient history, clinical examination, and supporting investigations. Clinical features included gradually developing shoulder pain, progressive restriction of movement involving both voluntary and examiner-assisted motion in multiple directions, and a pronounced reduction in outward rotational movement. Conventional radiographic imaging of the shoulder joint was performed for all participants to rule out traumatic injuries, degenerative joint disease, calcific deposits, and other structural abnormalities affecting bone.

Patient Selection Criteria: Individuals between 40 and 70 years of age diagnosed with idiopathic shoulder capsular stiffness were recruited for the study. Participants were required to have persistent symptoms for a minimum duration of six weeks and to show inadequate improvement following initial non-operative measures, including pain-relieving medications and unsupervised home exercise programs.

Participants were not enrolled if the shoulder condition was attributed to identifiable causes such as previous injury, operative intervention, infection, or confirmed rotator cuff pathology on imaging. Additional exclusion factors included degenerative joint disease, inflammatory joint conditions, prior corticosteroid administration to the involved shoulder within the preceding six months, bleeding tendencies, localized skin infection at the proposed injection site, known allergy to the medications used, or poorly regulated diabetes. Pregnant individuals and those unable or unwilling to adhere to follow-up assessments were also excluded. Baseline patient information was documented for all participants, including age, gender, side involved, hand dominance, duration of symptoms, and relevant medical conditions such as endocrine disorders.

Intervention Technique and Procedure: Each participant received an ultrasound-assisted corticosteroid injection delivered into the shoulder joint. The procedure was conducted in a designated intervention room under sterile conditions by an orthopedic specialist with expertise in musculoskeletal ultrasonography.

Patients were seated comfortably with the involved upper limb maintained in a relaxed, neutral alignment. A high-resolution ultrasound probe was employed to locate relevant anatomical structures and to visualize the posterior joint recess. Following standard skin cleansing and sterile draping, local anesthetic was administered at the needle entry site. Using continuous ultrasound visualization, a spinal needle was advanced through a posterior approach into the joint cavity. Accurate placement was verified by direct visualization of the needle tip within the joint space along with unobstructed dispersion of the injected solution.

A standardized injection mixture consisting of corticosteroid and local anesthetic was administered slowly into the joint space. Patients were observed for a short period after the procedure for any immediate adverse reactions. Post-injection instructions were provided, including relative rest of the shoulder for 24 hours and gradual resumption of activities as tolerated.

All patients were advised to follow a standardized physiotherapy protocol starting 48 hours after injection. This included supervised range of motion exercises focusing on pendulum movements, passive stretching, and gradual progression to active-assisted and active exercises. Patients were instructed to avoid aggressive stretching during the initial painful phase and were encouraged to maintain regular compliance with the exercise regimen.

Outcome Measures and Follow-Up: Treatment response was evaluated using established and widely accepted assessment tools. Pain severity was quantified with a numerical rating method ranging from zero to ten. Shoulder performance was evaluated using a condition-specific functional assessment scale. Joint mobility was recorded with the help of a handheld measuring device, documenting movement in forward elevation, sideways lifting, outward rotation, and inward rotation.

Initial evaluations were completed before administration of the injection. Subsequent assessments were carried out at scheduled time points of two weeks, six weeks, and twelve weeks following the procedure. During each review, pain levels, functional performance, and joint mobility were reassessed by the same clinician to ensure consistency and reduce observer-related variation. Any undesirable events or complications related to the injection were systematically recorded. These included temporary worsening of symptoms after the procedure, local or systemic infection, short-term increases in pain, and effects related to steroid

administration. Participants with coexisting diabetes were instructed to closely observe their blood glucose readings for a period of one week after receiving the injection.

Results

A total of 40 patients diagnosed with adhesive capsulitis were included in the final analysis. All patients completed the study protocol and follow-up period, with no dropouts recorded. The majority of patients belonged to the middle-aged group, with a slight female predominance. Involvement of the dominant shoulder was more frequent. Diabetes mellitus was the most common associated comorbidity observed among the study population.

Pain Outcomes: Pain intensity, assessed using the Visual Analog Scale, showed a significant and progressive reduction following ultrasound-guided intra-articular steroid injection. At baseline, most patients reported moderate to severe pain, particularly during night-time and shoulder movements above shoulder level. This pain significantly interfered with sleep and daily activities.

At the two-week follow-up, a marked reduction in pain scores was observed in the majority of patients. Early pain relief was evident, allowing improved tolerance to shoulder movements and physiotherapy exercises. By the six-week follow-up, pain scores demonstrated further improvement, with many patients reporting only mild discomfort at the extremes of motion.

At the twelve-week follow-up, pain relief was sustained across the cohort. Most patients reported minimal or no pain during routine activities, including dressing and overhead use of the affected limb. The trend of progressive reduction in mean pain scores across follow-up intervals is illustrated in Figure 1. Statistical analysis confirmed that the reduction in pain scores at each follow-up visit compared to baseline was significant.

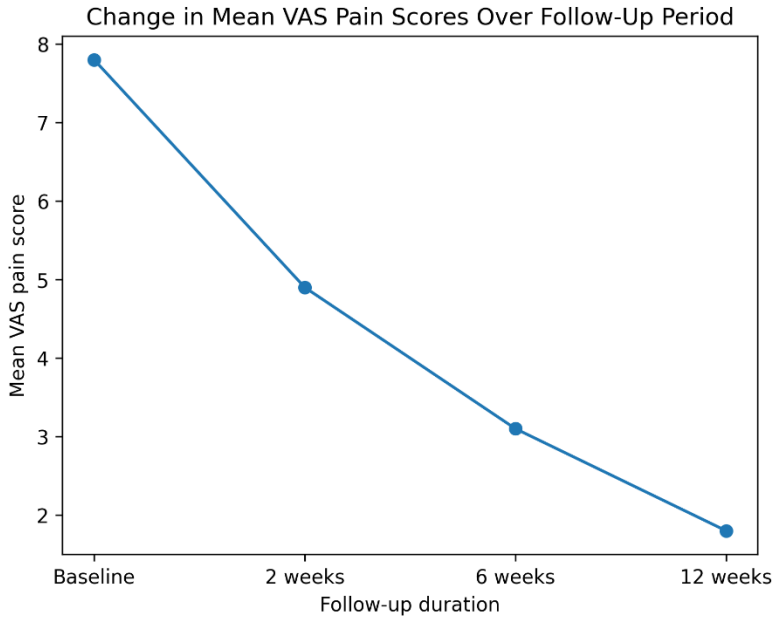

Figure 1: Change in Mean Visual Analog Scale (VAS) Pain Scores Over Follow-Up Period

Functional Outcomes: Functional assessment revealed significant improvement following the intervention. At baseline, patients experienced notable limitations in activities of daily living, including grooming, bathing, and reaching overhead. Functional disability scores were high, reflecting the combined impact of pain and restricted mobility.

At the two-week follow-up, functional scores showed early improvement, corresponding with pain reduction. Patients reported increased ease in performing basic daily tasks and improved sleep quality. By six weeks, functional recovery became more pronounced, with most patients regaining independence in routine activities.

At the twelve-week follow-up, functional scores approached near-normal levels in a large proportion of patients. Patients expressed greater confidence in using the affected shoulder and reported improved overall quality of life. The sustained improvement in functional outcomes over time supports the effectiveness of ultrasound-guided intra-articular steroid injection as a therapeutic intervention.

Range of Motion Outcomes: At the two-week follow-up, mild improvements in range of motion were noted, primarily attributed to reduced pain allowing better participation in physiotherapy. By

six weeks, a substantial increase in shoulder mobility was observed, particularly in forward flexion and abduction. External rotation showed consistent improvement, although it remained the most restricted movement.

At the final twelve-week assessment, most patients achieved functional ranges of motion sufficient for routine daily activities. The progressive improvement in shoulder mobility across follow-up visits is depicted in Figure 2. Statistical analysis showed that improvements in range of motion from baseline to final follow-up were significant across all planes.

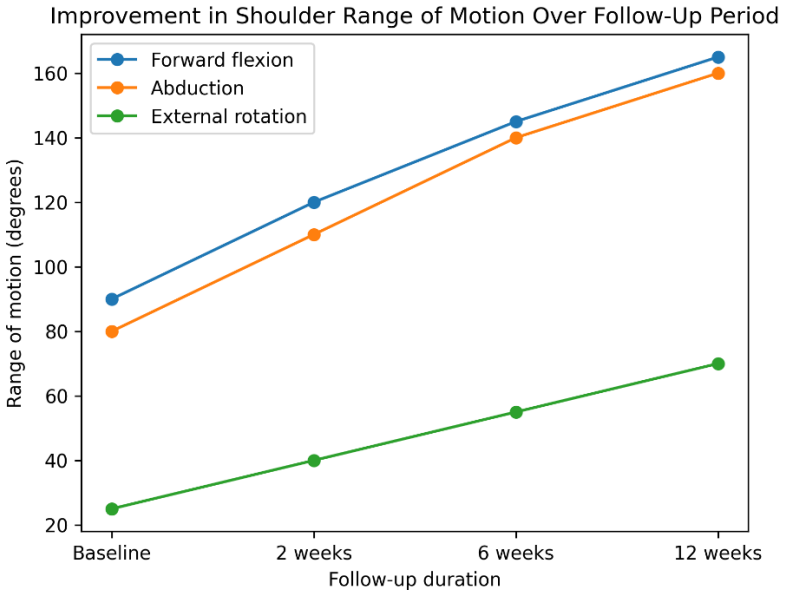

Figure 2: Improvement in Shoulder Range of Motion Over Follow-Up Period

Complications and Safety Profile: No major procedure-related complications were observed during the study period. A small number of patients experienced transient post-injection pain, which resolved within 24 to 48 hours with conservative management. No cases of infection, neurovascular injury, or local tissue atrophy were reported.

Patients with diabetes mellitus demonstrated transient elevations in blood glucose levels following injection, which normalized within a few days with appropriate monitoring. Overall, ultrasound-guided intra-articular steroid injection was found to be a safe and well-tolerated procedure in this study population.

Discussion

Adhesive capsulitis is a challenging shoulder disorder due to its prolonged clinical course, variable response to treatment, and significant impact on daily functioning. The present study evaluated the outcomes of ultrasound-guided intra-articular steroid injection in patients with adhesive capsulitis and demonstrated significant improvement in pain, shoulder function, and range of motion over a short- to mid-term follow-up period. These findings support the role of accurately delivered intra-articular corticosteroids as an effective conservative treatment modality in the management of this condition.

The most notable finding of this study was the early and sustained reduction in pain following ultrasound-guided steroid injection. Pain relief was evident as early as two weeks post-injection and continued to improve up to twelve weeks. This early pain reduction is clinically important, as pain is the primary factor limiting shoulder movement and patient participation in physiotherapy during the initial stages of adhesive capsulitis. Similar observations have been reported in previous studies, where intra-articular corticosteroids provided rapid symptomatic relief compared to physiotherapy alone or placebo injections [9,10]. The anti-inflammatory action of corticosteroids likely reduces synovitis and capsular inflammation, which are central to the pathophysiology of adhesive capsulitis.

Functional improvement observed in this study closely paralleled pain reduction. Patients reported improved ability to perform activities of daily living such as dressing, grooming, and overhead tasks within weeks of the intervention. By the final follow-up, a majority of patients had regained near-normal shoulder function. This aligns with existing literature suggesting that pain control plays a crucial role in restoring shoulder function, particularly when combined with a structured rehabilitation program [11]. Ultrasound-guided injection may enhance functional outcomes by

ensuring precise drug delivery into the glenohumeral joint, thereby maximizing therapeutic efficacy.

Range of motion improvement across all planes was another important outcome of this study. External rotation, which is typically the most restricted movement in adhesive capsulitis, showed consistent improvement over the follow-up period, although it remained relatively limited compared to other movements. Forward flexion and abduction demonstrated more rapid and pronounced gains. These findings are consistent with previous reports that intra-articular steroid injections improve capsular extensibility indirectly by reducing pain and inflammation, allowing patients to better tolerate stretching exercises [12]. The gradual nature of range of motion recovery observed in this study reflects the underlying fibrotic component of adhesive capsulitis, which requires time and sustained rehabilitation to resolve.

The use of ultrasound guidance represents a key strength of the intervention evaluated in this study. Several studies have demonstrated that landmark-guided glenohumeral injections have variable accuracy, with a significant proportion of injections failing to reach the intra-articular space [13]. Ultrasound guidance allows real-time visualization of the needle, joint capsule, and surrounding structures, thereby improving accuracy and reducing the risk of complications. Improved accuracy has been associated with better clinical outcomes and higher patient satisfaction in shoulder injections [14]. In adhesive capsulitis, where capsular thickening and joint space narrowing are common, ultrasound guidance becomes particularly valuable.

Safety is an important consideration when using corticosteroid injections. In the present study, no major complications were observed. Minor post-injection discomfort was transient and self-limiting. Patients with diabetes mellitus experienced temporary elevations in blood glucose levels, which were manageable with monitoring. These findings are consistent with previous reports indicating that intra-articular steroid injections are generally safe when appropriate patient selection and precautions are followed [15]. The absence of serious adverse events in this study further supports the safety profile of ultrasound-guided intra-articular steroid injection.

The results of the present investigation hold meaningful relevance for routine patient care, particularly in healthcare environments with limited resources. Shoulder capsular stiffness frequently affects individuals in their economically active years, contributing to work limitations and reduced daily functioning. Image-assisted delivery of corticosteroids into the shoulder joint represents a low-risk and economical therapeutic option that can be administered in an outpatient setting. This approach has the potential to decrease reliance on more aggressive interventions such as forced joint mobilization under anesthesia or minimally invasive surgical release. Timely administration of accurately placed corticosteroid injections may shorten the symptomatic course and enhance overall recovery [16].

Despite the encouraging outcomes, several constraints should be acknowledged. The number of participants included was modest, which may restrict the wider applicability of the findings. In addition, the absence of a comparison group receiving alternative management, such as non-guided injections or rehabilitation alone, limited the ability to directly contrast treatment approaches. The observation period was confined to twelve weeks, and outcomes beyond this timeframe were not evaluated. Given the prolonged and variable course of this condition, extended monitoring would be valuable in assessing the persistence of clinical improvement. Furthermore, the role of disease phase at the time of intervention was not examined separately, which may have influenced individual responses to treatment.

Further research involving larger participant groups, rigorously designed comparative studies, and extended follow-up durations is necessary to clarify the relative benefits of ultrasound-assisted injections. Future investigations should also aim to identify patient subgroups most likely to respond favorably. The inclusion of advanced imaging metrics and patient-centered outcome instruments may offer additional insight into treatment effectiveness and recovery patterns.

Conclusion

In this prospective study, patients demonstrated early reduction in pain as well as sustained improvement in shoulder function and mobility when the intervention was combined with a structured physiotherapy program. Accurate intra-articular delivery of corticosteroids using ultrasound guidance appears to enhance therapeutic outcomes by ensuring precise needle placement, improving drug efficacy, and minimizing procedural complications. The minimally invasive nature of the procedure, along with its favorable safety profile, makes it a practical option in routine clinical practice, particularly in tertiary care settings. Early pain control facilitates better patient participation in rehabilitation, which is essential for long-term recovery in adhesive capsulitis. Although the study was limited by a relatively small sample size and short follow-up duration, the consistent improvements observed across multiple outcome measures highlight the clinical value of this approach. Ultrasound-guided intra-articular steroid

injection may reduce the need for more invasive interventions when used appropriately in the disease course. Further large-scale, controlled studies with longer follow-up are recommended to confirm these findings and to establish standardized treatment protocols.

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