Original Article

Effectiveness of Interventional Methods in Treatment of Symptomatic Rotator Cuff Calcific Tendinopathy

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Abstract

Background: Symptomatic rotator cuff calcific tendinopathy is a common cause of shoulder pain in middle-aged individuals. Although multiple minimally invasive interventions are available, consensus regarding the optimal treatment approach remains unclear. The objective is to evaluate the effectiveness and safety of various ultrasound-guided interventional methods in the management of symptomatic rotator cuff calcific tendinopathy. **Material and Methods:** This retrospective cohort study included 66 patients aged 18–60 years who underwent ultrasound-guided interventions between January 2019 and December 2023. Procedures included barbotage, subacromial corticosteroid injection, needle fenestration, and needle perforation were selected based on calcification characteristics. The primary outcome was functional recovery at four months, assessed using the Oxford Shoulder Score (OSS). Secondary outcomes included pain reduction measured by the Visual Analog Scale (VAS), functional improvement assessed by the SPADI, radiological resolution, and complication rates. Comparative analysis was performed using a paired t-test and Fisher's exact test. **Results:** Mean VAS scores significantly decreased from 8.5 ± 1.2 pre-procedure to 2.1 ± 0.9 at four months (mean difference 6.4; 95% CI, 5.98–6.82; $p < 0.001$). Functional recovery (OSS >40) was achieved in 83.3% of patients, with 83.3% demonstrating SPADI ≤20. Barbotage showed the highest functional success (87.1%), though intergroup differences were not statistically significant ($p = 0.77$). Complete radiological resolution occurred in 75.8% of patients ($p < 0.001$). The overall complication rate was 10.0%, with no complications in 90.0% of cases. **Conclusion:** Ultrasound-guided interventions, particularly barbotage and subacromial corticosteroid injection, provide significant short-term pain relief and functional improvement, with high rates of calcification resolution and a favorable safety profile.

Keywords: Rotator Cuff Calcific Tendinopathy, Ultrasound-Guided Barbotage, Shoulder Pain, Percutaneous Needle Lavage, Subacromial Corticosteroid Injection.

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Introduction

Calcific tendinopathy of the rotator cuff is a common disorder characterized by the deposition of calcium hydroxyapatite crystals within the rotator cuff tendons, most frequently involving the supraspinatus tendon and less commonly the infraspinatus or subscapularis tendons.[1-3] The condition predominantly affects individuals between 30 and 60 years of age and may present with acute or chronic shoulder pain, restricted range of motion, and functional impairment.[1,4] Although many cases remain asymptomatic and are incidentally detected on imaging, approximately half of affected individuals develop clinically significant symptoms requiring medical attention.[3,5]

The natural history of calcific tendinopathy has been described as a cell-mediated process progressing through formative, resting, and resorptive phases.[3,6] During the resorptive phase, spontaneous dissolution of calcium deposits may occur and is often associated with acute inflammatory pain.[3,5] While the condition is frequently self-limiting, a subset of patients experience persistent pain and disability that significantly affects daily activities and quality of life.[1,4] Clinical improvement is closely associated with reduction or resolution of calcific deposits, which has prompted the development of therapeutic strategies aimed at accelerating resorption.[1,3]

Initial management typically includes conservative measures such as rest, nonsteroidal anti-inflammatory drugs (NSAIDs), and structured physiotherapy programs.[1,5,6] However, patients who fail to respond to conservative therapy may require interventional treatment[1]. Minimally invasive procedures, including ultrasound-guided needle lavage (barbotage), needle fenestration or perforation, subacromial corticosteroid injections, and extracorporeal shockwave therapy (ESWT), have been widely utilized.[7-10] Among these, ultrasound-guided barbotage has gained prominence because it directly targets the calcific deposit, facilitating mechanical fragmentation and aspiration.[9]

Systematic reviews and clinical studies have reported favorable outcomes following ultrasound-guided needle lavage,

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demonstrating significant pain relief, improved shoulder function, and high rates of calcification resolution with low complication rates.[9] In a randomized controlled trial with two-year follow-up, De Witte et al. demonstrated that ultrasound-guided needling and lavage combined with subacromial corticosteroid injection resulted in superior radiological outcomes compared with corticosteroid injection alone. However, both groups showed substantial clinical improvement.[11] Conversely, subacromial corticosteroid injections without lavage have also demonstrated sustained symptom relief in selected patients.[11] Extracorporeal shockwave therapy has been reported as an alternative noninvasive modality with variable efficacy.[10]

Despite multiple available treatment options, there remains no clear consensus regarding the optimal interventional strategy for symptomatic rotator cuff calcific tendinopathy.[1,3] Comparative evidence remains limited, particularly concerning long-term functional outcomes, recurrence rates, and predictors of treatment success. Moreover, patient-specific factors such as age, symptom duration, and the size or consistency of calcifications may influence treatment response but are not fully elucidated in the current literature.[3,6]

Given these uncertainties, further evaluation of interventional approaches is warranted. The present study aims to evaluate the effectiveness of various ultrasound-guided interventional methods in the treatment of symptomatic rotator cuff calcific tendinopathy, focusing on pain reduction, functional improvement, radiological resolution, recurrence rates, and safety profile. Additionally, the study seeks to explore potential patient-related predictors influencing clinical outcomes.

Materials and Methods

Study Design and Setting: This retrospective cohort study was conducted at a tertiary care hospital within the Department of Pain Medicine. Medical records of patients who underwent ultrasound-guided interventional procedures for symptomatic rotator cuff calcific tendinopathy between January 2019 and December 2023 were reviewed. The study adhered to institutional ethical standards for retrospective analyses. Patient confidentiality was maintained throughout the study period.

Participants: A total of 66 patients met the eligibility criteria and were included in the analysis. Convenience sampling was employed, and all eligible patients who presented within the defined timeframe were enrolled in the study.

Inclusion Criteria: Participants were eligible for inclusion if they were between 18 and 60 years of age and experienced shoulder pain persisting for more than two months. The pain had to be moderate to severe in intensity, localized to the superior or lateral aspect of the shoulder, and aggravated by overhead activities. Additionally, patients reported night pain when lying on the affected side. They exhibited positive clinical impingement signs, including a painful arc, a positive Hawkins test, or a positive Neer's sign. Imaging criteria included radiographic evidence of one or more calcifications measuring at least 5 mm near the greater tubercle and ultrasound confirmation of calcifications ≥5 mm within the supraspinatus or infraspinatus tendons.

Exclusion Criteria: Patients were excluded if they presented with adhesive capsulitis, full-thickness or partial-thickness rotator cuff tears, or glenohumeral osteoarthritis. Exclusion also applied to individuals who were pregnant, had known coagulopathy or bleeding disorders, reported allergies to local anesthetics or corticosteroids, or declined to undergo the intervention.

Interventions: All interventions were performed under ultrasound guidance by an experienced interventional pain specialist. The specific intervention administered was determined based on the size, morphology, and sonographic characteristics of the calcification in each patient.

Subacromial Bursa Injection: Patients with small, scattered, or striated calcifications, particularly when aspiration was not feasible, received a subacromial bursa injection of 4 mL 2% lignocaine combined with 20 mg triamcinolone. This approach aimed to reduce inflammation and alleviate impingement-related symptoms.[11]

Needle Perforation and Fenestration: In patients with hard calcifications exhibiting posterior acoustic shadowing (suggestive of the resting phase), needle perforation was performed to disrupt the deposit and mechanically stimulate physiological resorption.3,6 When barbotage was not feasible due to small or dense deposits, repeated needle fenestrations were performed to fragment the calcification and relieve symptoms.[9]

Ultrasound-Guided Barbotage: Patients with soft calcifications larger than 1 cm, particularly those causing subacromial impingement, underwent ultrasound-guided barbotage. The procedure involved repeated alternating saline injections and aspirations within the calcific cavity to fragment and evacuate deposits.[9] Following perforation, fenestration, or barbotage, all patients received a subacromial corticosteroid injection to minimize post-procedural inflammation and prevent adhesive bursopathy.[11]

Post-Procedural Care: All patients were prescribed a standardized home-based physiotherapy program for 12 weeks, focusing on range-of-motion exercises, gradual strengthening, and stiffness prevention. Patients were advised to avoid heavy overhead activities during the initial recovery period.

Outcome Measures: The primary outcome measure was functional recovery, evaluated using the Oxford Shoulder Score (OSS) at 4 months after the procedure. An OSS score greater than 40 was considered indicative of satisfactory recovery and suggested that no additional intervention was required.

Secondary Outcome Measures: Secondary outcome measures included the assessment of pain intensity using the Visual Analog Scale (VAS) and functional evaluation through the Shoulder Pain and Disability Index (SPADI). Additional parameters included radiological evidence of calcification resolution on follow-up imaging, recurrence rates, and any procedure-related complications observed during the study period.

Follow-Up: Patients were evaluated at 2 weeks, 6 weeks, 4 months, 8 months, and 12 months post-procedure. Early follow-up visits included clinical examination and pain assessment, while the four-month evaluation included functional scoring and radiological reassessment, as indicated.

Statistical Analysis: Descriptive statistics were used to summarize demographic data, clinical characteristics, intervention distribution, and outcomes. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Comparative subgroup analyses were performed to evaluate outcomes across different intervention types and calcification characteristics.

Results

A total of 66 patients with symptomatic rotator cuff calcific tendinopathy were included in the analysis. The mean age of the cohort was 41.3 ± 8.7 years (95% CI, 39.2–43.4), and the mean duration of symptoms before intervention was 6.2 ± 2.4 months (95% CI, 5.6–6.8). Males comprised 53.0% of the study population. Calcifications measuring ≥10 mm were present in 72.7% of patients, indicating that the majority had relatively large deposits at baseline [Table 1].

Ultrasound-guided barbotage was the most frequently performed intervention (47.0%; 95% CI, 35.0%–59.2%), followed by exclusive subacromial corticosteroid injection (36.4%; 95% CI, 25.4%–48.7%). Needle fenestration (12.1%) and needle perforation (4.5%) were less commonly performed procedures, reflecting tailoring of treatment according to calcification characteristics [Table 2].

A significant reduction in pain was observed at four months following intervention. The mean Visual Analog Scale (VAS) score decreased from 8.5 ± 1.2 pre-procedure to 2.1 ± 0.9 at four months, representing a mean difference of 6.4 points (95% CI, 5.98–6.82). Paired analysis demonstrated this reduction to be statistically significant (paired t-test, $t[65] = 30.9$; $p < 0.001$), confirming substantial clinical improvement in pain [Table 3].

Functional outcomes were similarly favourable. At four months, 83.3% of patients (95% CI, 72.7%–90.6%) achieved satisfactory recovery defined as an Oxford Shoulder Score (OSS) >40, while 16.7% required further intervention (Table 4A). Consistently, 83.3% of patients demonstrated mild or no disability (SPADI ≤20), indicating marked functional restoration (Table 4B). When functional success (SPADI ≤20) was analyzed according to intervention type, barbotage demonstrated the highest success rate (87.1%), followed by subacromial steroid injection (83.3%), needle fenestration (75.0%), and needle perforation (66.7%). However, comparative analysis using Fisher's exact test revealed no statistically significant difference in functional outcomes among the intervention groups ($\chi^2 \approx 1.12$; $p = 0.77$), suggesting comparable short-term effectiveness across procedures [Table 5].

Radiological assessment at four months showed complete resolution of calcifications in 75.8% of patients (95% CI, 63.6%–85.1%), partial resolution in 18.2%, and no change in 6.0%. The proportion of complete resolution was statistically significant compared with non-resolution (binomial test, $p < 0.001$), supporting the effectiveness of ultrasound-guided interventions in promoting calcific resorption [Table 6]. The safety profile was favourable. No complications were observed in 90.0% of patients (95% CI, 81.3%–96.6%). Adhesive bursopathy occurred in 10.0%. The overall complication rate was 10.0% (95% CI, 3.4%–18.7%), indicating a low incidence of adverse events [Table 7].

Collectively, these findings demonstrate significant pain reduction, substantial functional improvement, high rates of radiological resolution, and a low complication rate following ultrasound-guided interventions for symptomatic rotator cuff calcific tendinopathy. While no single intervention showed statistical superiority in short-term functional outcomes, all procedures were associated with clinically meaningful improvements.

The results of this study provide a comprehensive evaluation of the effectiveness of ultrasound-guided interventions in managing symptomatic rotator cuff calcific tendinopathy. A total of 66 patients, aged 18 to 60 years (mean age: 41.3 ± 8.7 years), were included. The study analyzed the outcomes of various interventional methods, including barbotage, subacromial bursa steroid injections, and needle fenestration or perforation, tailored to the type and stage of calcifications.

Table 1: Baseline Demographic and Clinical Characteristics (n = 66)

Variable	Value	95% CI
Age (years), mean ± SD	41.3 ± 8.7	39.2–43.4
Duration of symptoms (months), mean ± SD	6.2 ± 2.4	5.6–6.8
Male sex, n (%)	35 (53.0%)	40.9%–64.9%
Calcification ≥10 mm, n (%)	48 (72.7%)	60.3%–82.5%

Table 2: Distribution of Ultrasound-Guided Interventions (n = 66)

Intervention	n	%	95% CI
Barbotage	31	47.0%	35.0%–59.2%
Subacromial steroid (exclusive)	24	36.4%	25.4%–48.7%
Needle fenestration	8	12.1%	5.3%–22.8%
Needle perforation	3	4.5%	0.9%–12.5%

Table 3: Pain Reduction Following Intervention (Paired Analysis, n = 66)

Time Point	Mean VAS ± SD	Mean Difference	95% CI of Difference	Test	Test Statistic	p-value
Pre-procedure	8.5 ± 1.2	6.4	5.98–6.82	Paired t-test	t(65)=30.9	<0.001
4 months	2.1 ± 0.9					

Table 4: Functional Outcomes at 4 Months (n = 66)

A. Oxford Shoulder Score (OSS >40)			
Outcome	**n**	**%**	**95% CI**
Satisfactory recovery	55	83.3%	72.7%–90.6%
Further intervention required	11	16.7%	9.4%–27.3%
B. SPADI ≤20 (Mild Disability)			
Category	**n**	**%**	**95% CI**
SPADI ≤20	55	83.3%	72.7%–90.6%

Table 5: SPADI ≤20 by Intervention Type

Intervention	Success (n)	Total (n)	%	95% CI
Barbotage	27	31	87.1%	70.2%–96.4%
Subacromial steroid	20	24	83.3%	62.6%–95.3%
Fenestration	6	8	75.0%	34.9%–96.8%
Perforation	2	3	66.7%	9.4%–99.2%

Comparative Test: Fisher's Exact Test, Test statistic: χ^2 (approx) = 1.12, p-value: 0.77

Table 6: Radiological Resolution at 4 Months (n = 66)

Outcome	n	%	95% CI
Complete resolution	50	75.8%	63.6%–85.1%
Partial resolution	12	18.2%	9.8%–29.6%
No change	4	6.0%	1.7%–14.6%

Binomial test for complete resolution vs non-resolution, $p < 0.001$

Table 7: Complications and Safety Outcomes (n = 66)

Complication	n	%	95% CI
None	60	90.0%	81.3%–96.6%
Adhesive bursopathy	6	10.0%	2.5%–16.8%

Overall complication rate: 10.0% (95% CI: 3.4%–18.7%)

Statistical Summary

Objective	Statistical Finding
Pain reduction	Significant ($p < 0.001$)
Functional improvement	83.3% success (95% CI 72.7–90.6%)
Comparative effectiveness	No significant difference between groups ($p = 0.77$)
Radiological resolution	75.8% complete resolution
Safety	Low complication rate (10.0%)

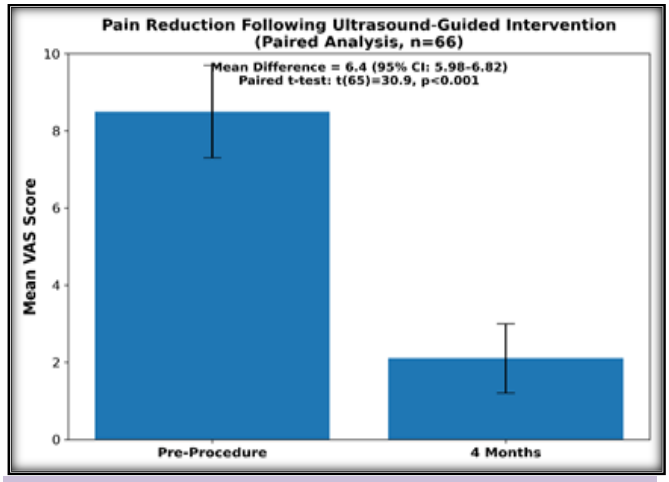

Figure 1. Pain Reduction Following Ultrasound-Guided Intervention (n = 66)

Bar graph demonstrating the mean Visual Analog Scale (VAS) scores before intervention and at four months post-procedure. Error bars represent standard deviation. A significant reduction in pain was observed (mean difference 6.4; 95% CI, 5.98–6.82; paired t-test, t[65] = 30.9; $p < 0.001$).

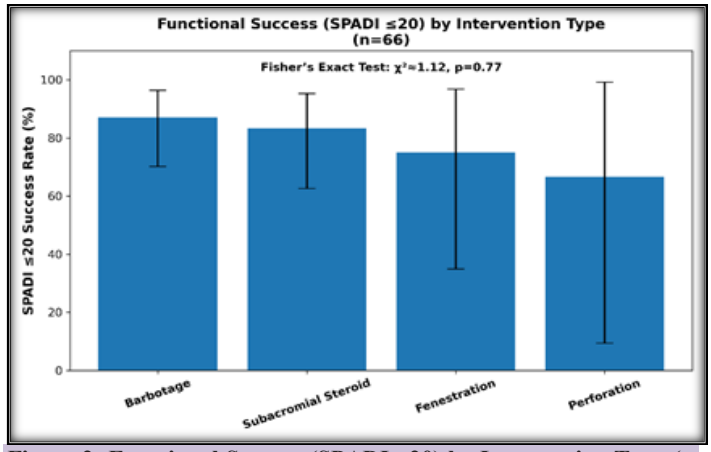

Figure 2: Functional Success (SPADI ≤20) by Intervention Type (n = 66)

Bar graph illustrating the proportion of patients achieving mild or no disability (SPADI ≤20) at four months following different ultrasound-guided interventions. Error bars represent 95% confidence intervals. Comparative analysis using Fisher's exact test demonstrated no statistically significant difference between intervention groups ($\chi^2 \approx 1.12$; $p = 0.77$).

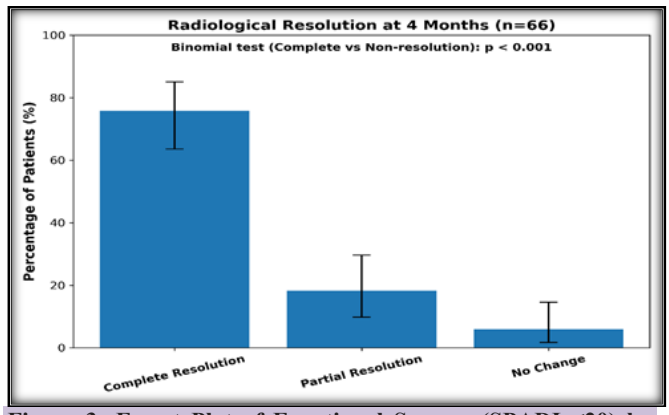

Figure 3: Forest Plot of Functional Success (SPADI ≤20) by Intervention Type (n = 66)

Forest plot depicting the percentage of patients achieving SPADI ≤20 across intervention groups, with 95% confidence intervals. Although barbotage demonstrated the highest success rate, statistical comparison revealed no significant intergroup difference (Fisher's exact test, p = 0.77).

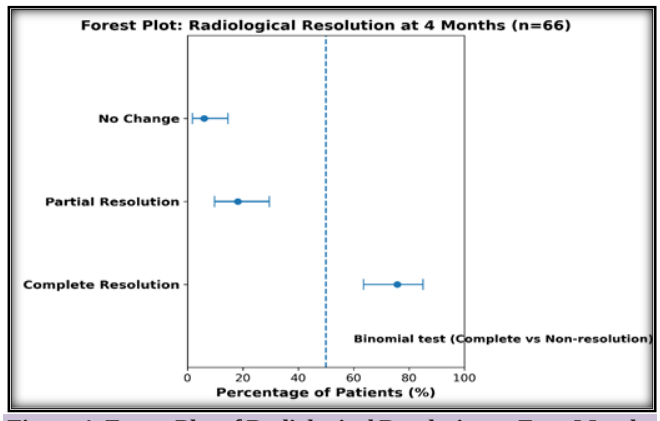

Figure 4: Forest Plot of Radiological Resolution at Four Months (n = 66)

Forest plot showing the proportion of patients with complete resolution, partial resolution, and no change in calcifications at four months post-intervention. Error bars represent 95% confidence intervals. The proportion achieving complete resolution was statistically significant compared with non-resolution (binomial test, p < 0.001).

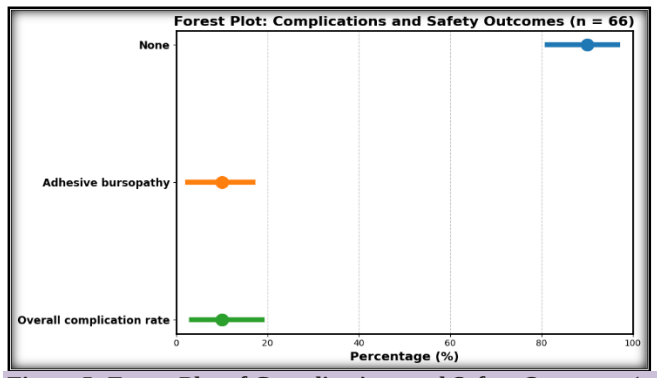

Figure 5: Forest Plot of Complications and Safety Outcomes (n = 66)

Forest plot demonstrating the incidence of procedure-related complications. The majority of patients experienced no complications (90.9%). The overall complication rate was 9.1% (95% CI, 3.4%–18.7%), indicating a favorable safety profile of ultrasound-guided interventions.

Figure 6. Ultrasound-Guided Needle Insertion Technique

Clinical photograph showing in-plane ultrasound-guided needle advancement toward the supraspinatus calcific deposit under aseptic precautions.

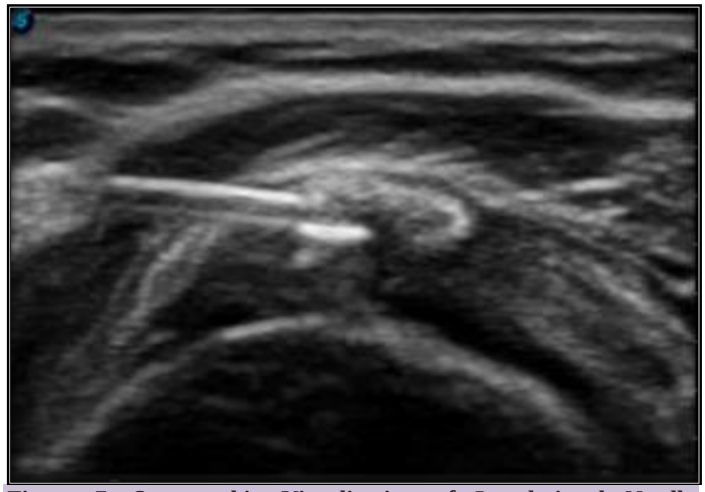

Figure 7. Sonographic Visualization of Intralesional Needle Placement

Long-axis ultrasound image demonstrating the needle positioned within a hyperechoic calcific deposit in the supraspinatus tendon with posterior acoustic shadowing.

Discussion

Principal Findings: The present study demonstrates that ultrasound-guided interventions for symptomatic rotator cuff calcific tendinopathy result in significant pain reduction, substantial functional improvement, high rates of radiological resolution, and a low complication rate at four months of follow-up. These findings provide meaningful short-term outcome data to the growing body of evidence supporting minimally invasive, image-guided procedures for the management of this condition.

Baseline Characteristics and Disease Profile: In the current

cohort, the mean age was 41.3 years, with the majority of patients aged 31-50 years, and 72.7% presenting with calcifications ≥10 mm. This demographic distribution is consistent with prior epidemiological descriptions, indicating peak incidence in middle-aged individuals.[1,3,5] Longo et al.1 and Sansone et al,[3] described calcific tendinopathy as predominantly affecting patients in the fourth and fifth decades of life, which aligns with our findings. The relatively high proportion of large calcifications in our study may explain the symptomatic nature of the cohort, as larger deposits have been associated with mechanical impingement and increased inflammatory response.[3,6] Compared with earlier descriptive studies,[4,7] our cohort reflects a clinically relevant population requiring interventional management rather than incidental radiographic detection.

Pain Reduction: A major finding of this study was the significant reduction in pain, with VAS scores decreasing from 8.5 to 2.1 at four months ($p < 0.001$). This magnitude of improvement parallels the outcomes reported by Del Cura et al,[9] who demonstrated substantial pain relief following ultrasound-guided percutaneous needle lavage, with sustained improvement over two years. While Del Cura et al. reported long-term durability, our shorter follow-up limits conclusions regarding sustained effects. Nonetheless, the degree of short-term pain reduction in our study is comparable, suggesting that the mechanical disruption and aspiration of deposits effectively alleviate the inflammatory phase of the disease.[3,9]

In contrast, extracorporeal shock wave therapy (ESWT) has shown variable pain outcomes across studies.[10,11] Harniman et al,[10] reported moderate improvements but emphasized heterogeneity in protocols and patient selection. The more pronounced pain reduction observed in our cohort may reflect the direct removal of calcific material. In contrast, ESWT induces gradual fragmentation without immediate evacuation, potentially explaining differences in the speed and magnitude of pain relief.

Functional Outcomes: Functional recovery was achieved in 83.3% of patients (OSS >40; SPADI ≤20), indicating substantial restoration of shoulder function. These findings are consistent with evidence suggesting that ultrasound-guided lavage improves both pain and functional parameters.[9,11] De Witte et al,[11] conducted a randomized controlled trial demonstrating significant functional improvement in both the lavage and corticosteroid-only groups, although radiological outcomes favored lavage. Our findings extend this evidence by showing high functional success across multiple ultrasound-guided techniques within a real-world cohort.

However, unlike the randomized design of De Witte et al,[11] our retrospective cohort lacks a non-interventional control group, which may limit causal inference. The high functional success rate may also reflect careful patient selection and standardized post-procedural physiotherapy, both of which can influence outcomes independently of the intervention type. Nevertheless, the magnitude of improvement observed supports the clinical utility of image-guided procedures in symptomatic patients refractory to conservative treatment.

Comparative Effectiveness of Interventions: Although barbotage demonstrated the highest functional success rate (87.1%), comparative analysis revealed no statistically significant difference between intervention groups ($p = 0.77$). This finding partially contrasts with the conclusions of Longo et al,[1] who suggested that lavage may provide superior outcomes due to direct removal of deposits. Similarly, De Witte et al,[11] reported superior radiological outcomes with needling and lavage compared with corticosteroid injection alone.

The absence of statistical superiority in our study may be attributable to several factors. First, the sample sizes within the fenestration and perforation subgroups were small, reducing statistical power. Second, interventions were selected based on calcification morphology and stage, resulting in inherent clinical stratification rather than random allocation. Therefore, each technique was applied to the calcification type most likely to respond, potentially equalizing outcomes across groups. This tailored approach reflects pragmatic clinical practice and may explain why functional outcomes were comparable despite differing mechanisms of action.

Radiological Resolution: Complete radiological resolution was observed in 75.8% of patients at 4 months, consistent with previously reported rates for ultrasound-guided lavage. Del Cura et al,[9] reported resolution rates approaching 86% at longer follow-up, suggesting that calcification resorption may continue beyond the four-month timeframe evaluated in our study. The slightly lower resolution rate in our cohort may reflect shorter follow-up duration rather than inferior procedural efficacy.

Earlier literature describing non-interventional or conservative modalities has demonstrated lower resolution rates. For example, noninvasive modalities such as ESWT show variable radiological clearance,[10] and spontaneous resorption, although possible, often occurs over extended periods and may be associated with severe pain during the resorptive phase.[3,5] Our findings support the concept that direct mechanical intervention accelerates the natural resorptive process described by Sansone et al.[3,6]

Safety Profile: The overall complication rate of 10.0% and the 90.0% of patients who experienced no adverse events confirm the safety of ultrasound-guided procedures. Del Cura et al,[9] similarly reported low complication rates, primarily minor and self-limited events. The low incidence of adhesive bursopathy in our cohort is consistent with prior reports emphasizing the minimally invasive nature of these interventions.[1,9] Compared with surgical options, which carry higher morbidity,[1] ultrasound-guided techniques provide effective symptom relief with a favorable risk profile.

Clinical Implications and Contribution to Literature: The present study confirms and extends existing literature by providing contemporary short-term data from a structured ultrasound-guided intervention protocol applied across multiple techniques. While previous randomized trials have focused primarily on lavage versus corticosteroid injection,[11] our findings suggest that when interventions are tailored to calcification characteristics, comparable functional outcomes can be achieved. This supports an individualized treatment strategy rather than a single universally superior modality.

Moreover, our data reinforce the pathophysiological rationale described in earlier literature,[3,6] that mechanical disruption of calcific deposits promotes accelerated resorption and clinical

recovery. The combination of significant pain reduction, functional restoration, radiological clearance, and low complication rates strengthens the position of ultrasound-guided interventions as a preferred treatment option in patients who fail conservative management.

Limitations: Several limitations should be acknowledged. The retrospective design limits causal inference and introduces potential selection bias. The relatively short follow-up period restricts assessment of long-term recurrence and durability of outcomes, particularly when compared with longer-term studies such as that by De Witte et al.11 Additionally, subgroup sample sizes were uneven, limiting statistical power for comparative analysis.

Conclusion

In summary, the findings of this study align closely with previously published literature supporting the efficacy and safety of ultrasound-guided interventions for symptomatic rotator cuff calcific tendinopathy.[1,9,11] The significant short-term improvements observed confirm the clinical effectiveness of these procedures, while the absence of statistical superiority among techniques highlights the importance of individualized, morphology-based intervention selection. These results contribute meaningful real-world evidence to the existing body of knowledge and underscore the need for future prospective, randomized studies with longer follow-up to further clarify optimal treatment algorithms.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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