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Original Research Article

A comparison of outcomes in ultrasonography guided versus landmark guided corticosteroid injection for the treatment of adhesive capsulitis

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ABSTRACT

Background: Adhesive capsulitis is a debilitating disease in an otherwise healthy individual. Intra-articular corticosteroid injections offer a cost-effective, non-operative treatment option. However, it is currently unclear whether an ultrasound-guided injection relieves the symptoms of shoulder pain more effectively than if the injection was delivered landmark-guided.
Methods: Eighty patients with adhesive capsulitis were randomized to two intervention groups - landmark guided and ultrasound (USG) guided. The functional status of the patients was documented prior to the intervention. Following allocation, the intra-articular steroid was administered either under USG guidance or following identification of the site of injection using landmarks. Follow-up was done on day 5, 3 weeks, 6 weeks, and 12 weeks post procedure to document the functional status.
Results: The difference in visual analogue score (VAS) between the two arms was found to be statistically significant in favour of the ultrasound guided technique only on day 5 and day 21. On the other hand, the difference in disability of arm, shoulder, and hand (DASH) score between the 2 arms was found to be statistically significant in favour of the ultrasound guided technique on day 5, 21, 42 and 84. Finally, in our study, both shoulder flexion and abduction on day 84 achieved a statistically significant improvement, favouring the ultrasound guided arm.
Conclusions: Ultrasound guided corticosteroid injections may offer modestly better short-term functional outcome and symptom relief when compared with landmark guided corticosteroids.

Keywords: Adhesive capsulitis, Frozen shoulder, Corticosteroid injection, Intra-articular injection

INTRODUCTION

Adhesive capsulitis, or arthrofibrosis, describes a pathological process in which the body forms excessive scar tissue or adhesions across the glenohumeral joint, leading to pain, stiffness, and joint dysfunction. “Frozen shoulder” is a popular moniker for adhesive capsulitis; it was coined in 1934 by Dr. Codman, in which the contracture of the glenohumeral capsule is a hallmark.[1] He was the first to describe the classic diagnostic criteria for the condition, which include: idiopathic aetiology, global restriction in range of movement of the shoulder, restriction of external rotation, painful at the outset, and normal plain X-ray findings.

Neviaser coined the term adhesive capsulitis to describe a contracted, thickened joint capsule that seemed to be drawn tightly around the humeral head with a relative absence of synovial fluid and chronic inflammatory changes within the subsynovial layer of the capsule.[2] Evidence suggests that the underlying pathologic changes in adhesive capsulitis are synovial inflammation with

subsequent reactive capsular fibrosis. Cytokines, metalloproteinases, and growth factor-beta 1 have been implicated in the process, but the initial triggering event in the cascade is unknown.[2] Increased expression of nerve growth factor receptor and new nerve fibers found in the shoulder capsular tissue of patients with frozen shoulder suggests that neoinnervation and neoangiogenesis in the capsule are important events in the pathogenesis of frozen shoulder.[2]

In 1975, Reeves published a study of the natural history of frozen shoulder syndrome. Three sequential stages were identified: early, painful stage lasting 10 to 36 weeks; intermediate, stiff (frozen) stage characterized by limited motion lasting 4 to 12 months; and recovery stage lasting 5 to 24 months or more.[3]

Reeves noted that the length of the painful period corresponded to the length of the recovery period. Reeves concluded that frozen shoulder syndrome is a self-limiting disorder, lasting an average of 2.5 years, after which full functional recovery may be expected. As Owens-Burkhart restated this relationship, "a short painful period was associated with a short recovery period, and a long painful period was associated with a long recovery".[4]

Risk factors for adhesive capsulitis include female sex, age over 40 years, preceding trauma, HLA- B27 positivity and prolonged immobilization of the glenohumeral joint. It is estimated that 70% of patients with adhesive shoulder capsulitis are women.[5] Additionally, women respond better to treatment[6]. Studies have shown that most patients with adhesive capsulitis (84.4%) fall within the age range of 40 years to 59 years[7]. A study by Prodromidis and Charalambous suggested a genetic predisposition to adhesive capsulitis, noting a higher predilection of this condition in white patients, patients with a positive family history, and patients with HLA-B27 positivity.[8] Adhesive capsulitis is also noted to be associated with diabetes, thyroid disease, cerebrovascular disease, coronary artery disease, autoimmune disease and Dupuytren's disease.[9,10]

A study led by Huang et al showed that, patients with hyperthyroidism have 1.22 times the risk of developing adhesive capsulitis.[11] Patients with cerebrovascular disease, especially those surgically treated for subarachnoid haemorrhage, are more susceptible to developing adhesive shoulder capsulitis.[12] Smith et al showed that Dupuytren's disease was found in 52% of patients (30 of 58) with adhesive capsulitis.[13] It is more common in those with sedentary vocations than in manual laborers. Common to almost all patients are a period of immobility, the causes of which are diverse.[14]

Adhesive capsulitis is a clinical diagnosis made on the basis of medical history and physical exam and is often a diagnosis of exclusion.

Stage 1 is characterized by a gradual onset of pain typically referred to the deltoid insertion. It is usually achy at rest and sharper with movement. Pain at night is common, and patients frequently report an inability to sleep on the affected side. The duration of symptoms is generally less than 3 months. Capsular pain on deep palpation or passive stretch is common. There is an empty end feel at the extremes of motion.

Stage 2 represents a combination of acute synovitis and progressive capsular contracture, which some have called the freezing stage.[15] Pain persists and may be more severe, particularly at night. Motion is restricted in forward flexion, abduction, and internal and external rotation.

Stage 3, the stage of maturation, also referred to as the frozen stage, the predominant complaint is significant stiffness.[16] Pain may still be present at the end range of motion and occasionally at night. Physical examination reveals a sense of mechanical block or tethering at the ends of motion.

Stage 4, the chronic stage, has also been termed the thawing stage.[15] Pain is minimal and a gradual improvement in motion can occur.

The efficacy of intra-articular steroid injections has been extensively studied. Rizk et al compared intra-articular methylprednisolone and lidocaine to an intra-articular lidocaine placebo and 2 control groups who received the same injections intra-bursally.[17] Those treated with the intraarticular steroid did show a more rapid improvement in pain symptoms, but this difference was transient (2-3 weeks).

Bulgen et al randomized 42 patients to 1 of 4 treatment groups: intra-articular injection of methylprednisolone, mobilization with a physiotherapist, ice treatments following proprioceptive exercises, and no treatment.[18] Those treated with steroid injections had the most marked improvement in range of motion at 4 weeks' time. At 6 months, however, there was no difference between the groups. Others have confirmed these results with methylprednisolone injection.[19]

Van der Windt et al randomized 109 patients to receive either 40-mg intra-articular injections of triamcinolone acetonide or physiotherapy 2 times per week for 6 weeks.[20] The authors reported treatment success in 77% of patients treated with injection compared with 46% of those treated with physiotherapy. Success was defined as patients who rated themselves having had a full recovery or much improvement based on pain and functional scales.

Carette et al in a placebo-controlled trial showed that a single, fluoroscopically guided injection of 40 mg of triamcinolone hexactonide produced significantly improved shoulder pain and disability index (SPADI) scores as compared with placebo injection and physical therapy or placebo injection alone.[21]

In a well-designed level I study, Ryans et al confirmed these findings of more rapid improvement in patients treated with intra-articular triamcinolone injection as compared to controls, which dissipates after longer follow-up beyond 6 weeks.[22]

Hazelman in a level IV retrospective review of 130 patients, reported that the efficacy of intra- articular injections of hydrocortisone inversely correlates with the duration of symptoms.[23] This may reflect a greater efficacy in the early, inflammatory stages of the disease. It may be more efficacious in stage 1 or early stage 2 before development of a significant capsular contracture, but this has yet to be proven with higher level evidence.

Several prospective studies have examined the efficacy of blind and guided corticosteroid injections for shoulder pain.[24-26] These studies have reported conflicting evidence for the efficacy of blind vs guided injections, with one meta-analysis determining that guided injections provide superior accuracy while other studies reported no significant difference in accuracy between guided and blind injections.[24-26]

Given the uncertainties regarding accuracy and efficacy, our study will examine patient outcomes without addressing the question of accuracy of injection. The proposed study examines the impact on pain, function, and range of motion in ultrasound-guided versus landmark-guided corticosteroid injections for the treatment of adhesive capsulitis.

METHODS

Study type

The study was a randomized controlled trial.

Place of study

The study was conducted at Rajarajeswari Medical College and Hospital, Bengaluru, Karnataka, India.

Study duration

The duration of the study was for 18 months (January 2021 to July 2022).

Ethical approval

The study was approved by the institutional ethics committee.

Selection criteria

Every patient was assessed by the senior author (G. K. M.) before entry into the study. Additional or alternative pathologies were excluded by taking a comprehensive history coupled with a thorough clinical examination. Excluded were patients who had received a steroid injection into the affected shoulder beforehand. Each patient gave full informed consent before entry into the study.

Procedure

The study cohort comprised 80 patients, aged 27 to 88 years, with primary frozen shoulder. A sealed envelope was used to randomize patients to landmark guided or ultrasound guided injection group. The functional status of the patients was documented prior to the intervention. This included assessment of visual analogue score (VAS) and disability of arm, shoulder and hand (DASH) score, as well as the external rotation, flexion and abduction range of motion of the affected shoulder.

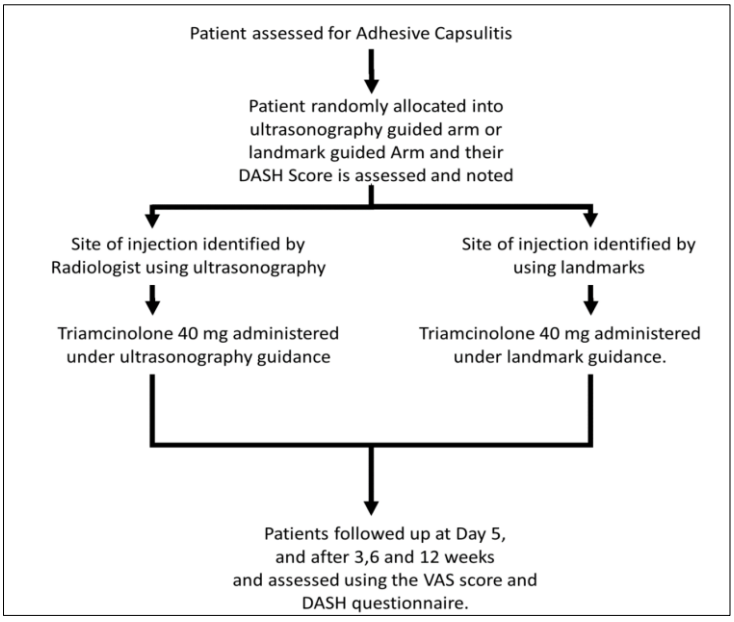

Figure 1: Study design.

The intra-articular steroid was administered either under USG guidance or following identification of the site of injection using landmarks. For both modalities, the injection consisted of 40 mg of triamcinolone (in 1 ml) and 4mL of 2% lignocaine, given either under landmark guidance or ultrasound guidance. In landmark guided injections, the affected shoulder was held between the long finger on the coracoid process and the thumb on the posterior corner of the acromion. The needle was then inserted 1 to 2 cm below the corner of the acromion into the "soft spot" and directed towards the index finger, thereby entering the glenohumeral joint. For ultrasound guided injections, the same combination of corticosteroid and lignocaine was injected into the glenohumeral joint using an Acuson Juniper ultrasound system with linear transducer (12L3) set to a frequency of 3-11 hertz. The patients were followed up on day 5 post procedure and again at 3 weeks, 6 weeks and 12 weeks to document clinical improvement (using the VAS and the DASH questionnaire) and the range of motion (as ascertained by the clinician).

Materials utilized in the study are: injection triamcinolone 40 mg, sterile gloves, sterile dressing set, injection lignocaine 2% (42.6 mg), syringes and needles, and dressing material.

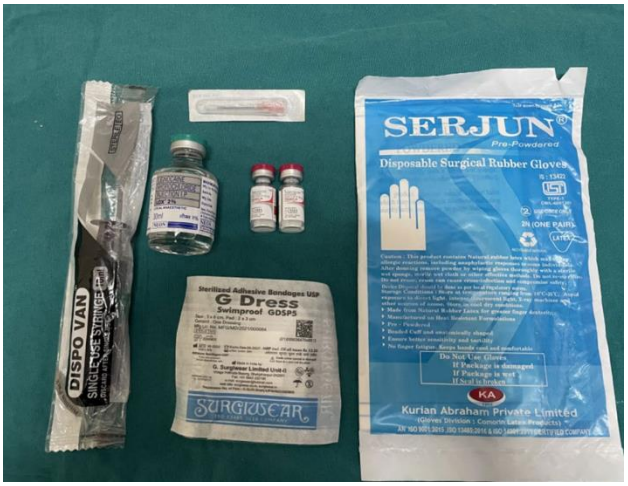

Figure 2: Materials.

Statistical analysis

Data was input into R statistical software for statistical analysis.

RESULTS

Demographics

The 80 patients analysed in the preliminary dataset were randomized into group 1 (landmark) (n=40) and group 2 (ultrasound) (n=40). As demonstrated in Table 1, there were no significant differences in mean age (54 versus 57), number of females (21 versus 23), durations of symptoms in months (7 versus 9), involvement of left shoulder (25 versus 31), involvement of right shoulder (15 versus 9), left hand dominant individuals (3 versus 3), right hand dominant individuals (37 versus 37), % hypothyroidism (10 versus 15), external rotation range of motion on day 0 (47 versus 47) and abduction range of motion on day 0 (67 versus 71), between landmark and ultrasound groups respectively. However, the number of diabetics (22 versus 11) in landmark guided and ultrasound guided groups did achieve a statistical significance of 0.012. Similarly, the flexion range of motion on day 0 (56 versus 69) in landmark and ultrasound guided groups attained a statistical significance of <0.001.

Impact on VAS pain scores

As seen in Figure 3 and Table 2, mean VAS pain scores at initial visit were not statistically significant between the landmark and ultrasound groups. Statistically significant difference in VAS pain scores were seen on day 5 and day 21 follow-up visits, favouring the ultrasound guided group. The landmark group improved from a mean score of 72 at initial visit to a mean of 44 on day 5 and 41 on day 21 follow-up visits. The ultrasound group improved from a mean score of 73 at initial measurement to 33 on day 5 and 31 on day 21 follow-up visit. No significant difference between landmark and ultrasound groups was noted on day 42 and day 84 (p value: 0.069 versus 0.064, respectively) follow-up appointments.

Impact on DASH score

Mean DASH function scores, demonstrated in Table 3 and Figure 4, did not significantly differ between the treatment groups on initial assessment. Both groups demonstrated statistically significant difference in improvement of mean DASH scores between initial measurement and measurements on day 5, day 21, day 42 and day 84. The landmark-guided injection group improved from a mean DASH score of 66 at initial measurement to 42 on day 5, 40 on day 21, and 39 on day 42 and 84. The ultrasound-guided injection group improved from a mean DASH score of 65 at initial measurement to 29 on day 5, and 27 on day 21, 42 and 84.

Impact on ROM measurements in forward flexion, external rotation, and abduction

Figure 5 and Table 4 compare range of motion between landmark and ultrasound groups. With regard to degree of shoulder forward flexion, significant difference was noted between the two groups on initial assessment, as well as on day 84 follow-up. The landmark group demonstrated significant improvement of shoulder flexion range of motion from 56 on initial assessment to 104 on day 84 follow up. The ultrasound group improved from 69 at initial visit to 120 on day 84. Shoulder flexion range of movement on day 84 achieved a statistically significant improvement, favouring the ultrasound guided arm.

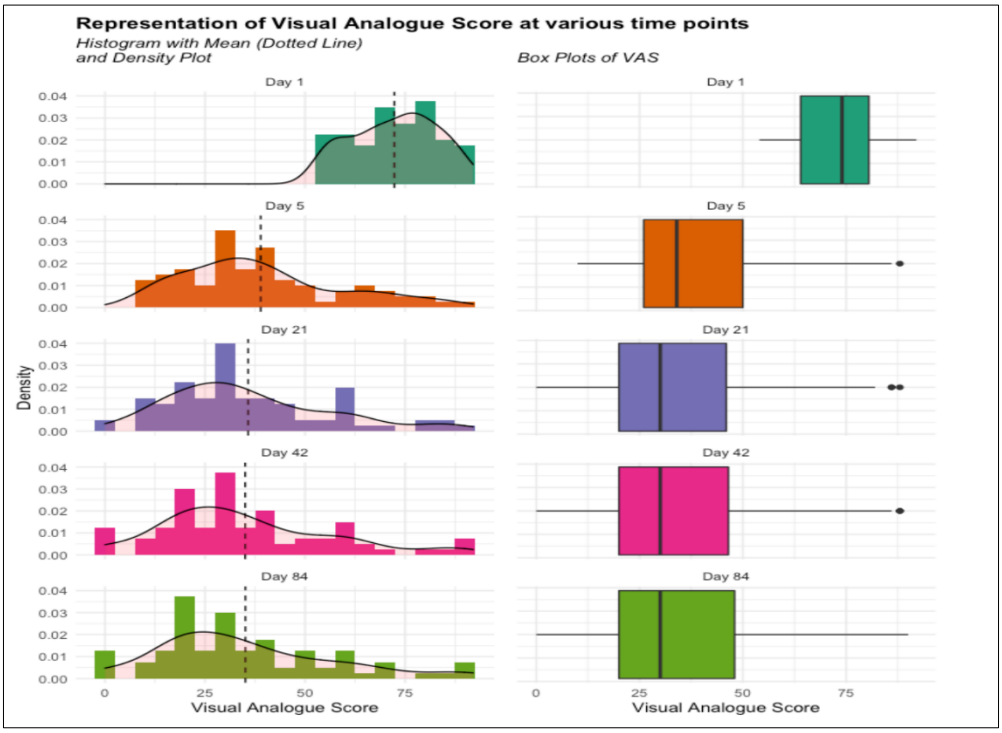

Figure 3: Histogram and horizontal boxplots of VAS at various time periods. The VAS and density of the observed scores is plotted along the X- and Y-axes respectively. On the left, a histogram with density plot and mean VAS (vertical line). On the right, the distribution as box and whisker plots with the median as the dark line and outliers depicted as dots.

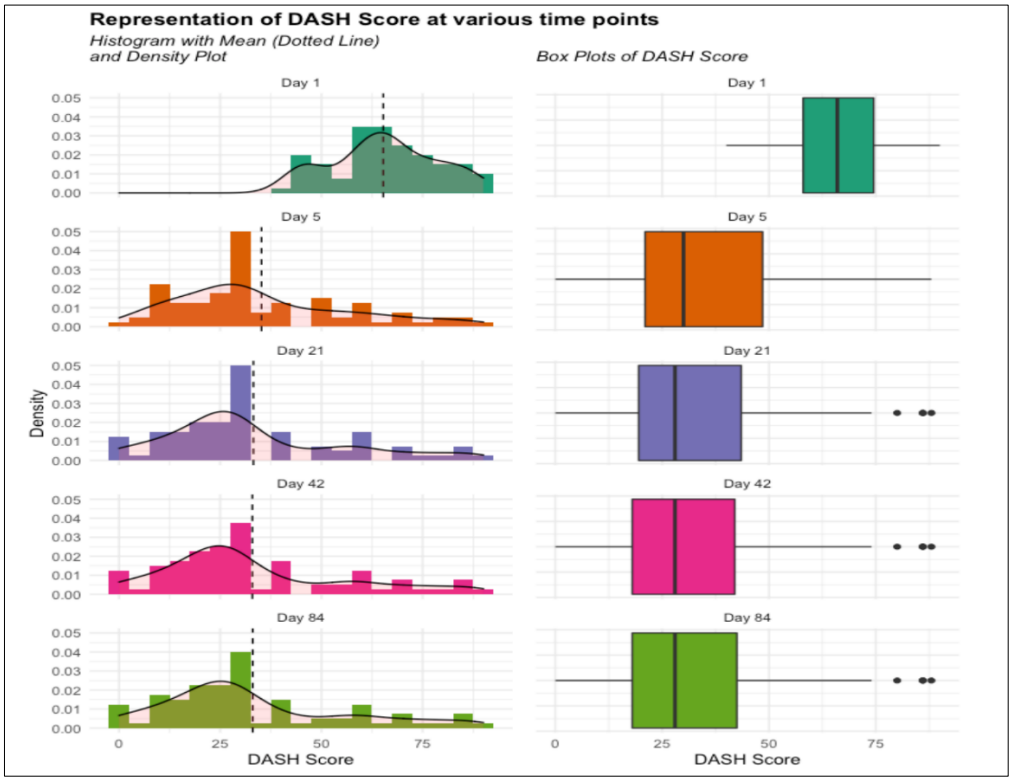

Figure 4: Histogram and horizontal boxplots of the DASH Score at various time periods. The DASH scores and density of the observed scores is plotted along the X- and Y-axes respectively. On the left, a histogram with density plot and mean DASH Score (vertical line). On the right, the distribution as box and whisker plots with the median as the dark line and outliers depicted as dots.

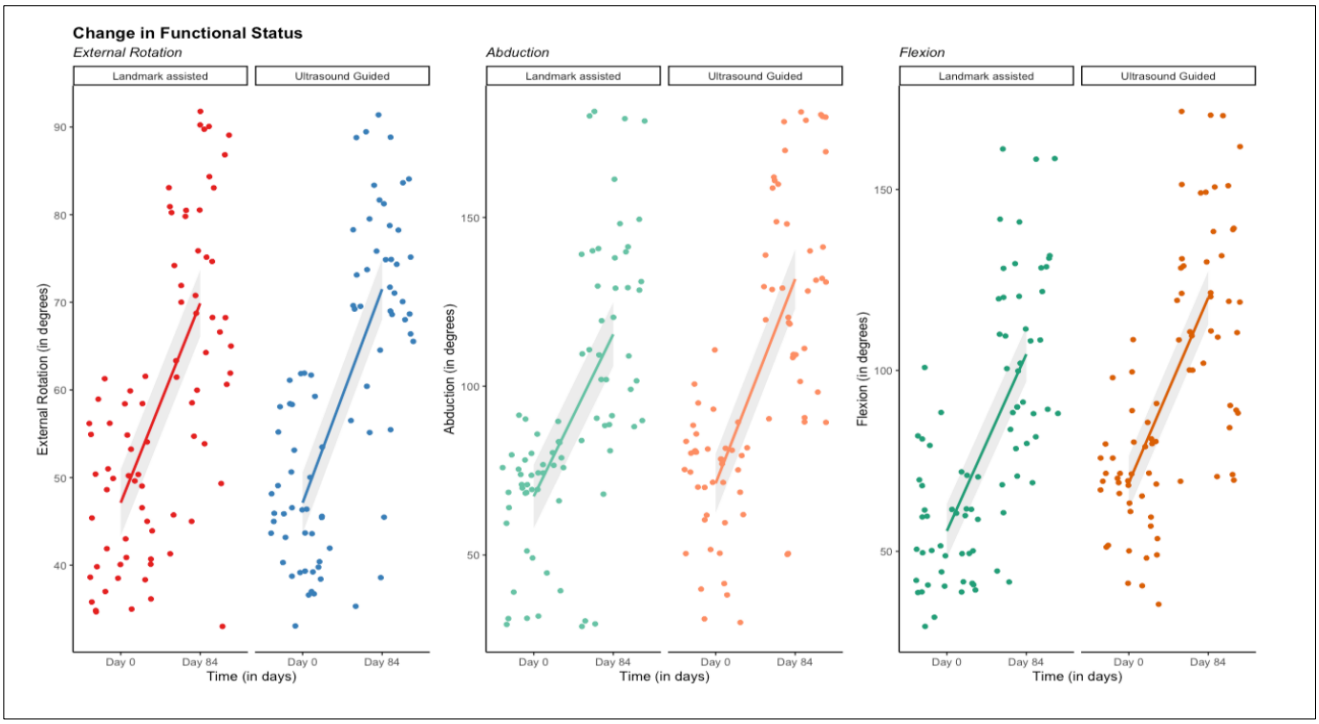

Figure 5: Change in functional status of the affected shoulder. Day of assessment (day 0/day 84) and range of motion (in degrees) are plotted along the X- and Y-axes respectively. The line from day 0 to day 84 depicts the mean change in range of motion and the dots depict the range of motion of each individual.

Table 1: Baseline characteristics stratified by intervention, N=80.

Characteristic	Overall, N=801	LMG, N=401	USG, N=401	P value[2]
Age (in years)	55 (17)	54 (16)	57 (18)	0.36
Female gender	44 (55)	21 (52)	23 (57)	0.65
Duration of symptoms (in weeks)	8 (4)	7 (3)	9 (4)	0.25
Shoulder involved				0.14
Left	56 (70)	25 (62)	31 (78)	
Right	24 (30)	15 (38)	9 (22)	
Dominant hand				>0.99
Left	6 (7.5)	3 (7.5)	3 (7.5)	
Right	74 (92)	37 (92)	37 (92)	
Diabetes present	33 (41)	22 (55)	11 (28)	0.012
Hypothyroidism present	10 (12)	4 (10)	6 (15)	0.50
External rotation (day 0)	47 (8)	47 (8)	47 (8)	>0.99
Abduction (day 0)	69 (18)	67 (18)	71 (19)	0.27
Flexion (day 0)	62 (18)	56 (16)	69 (17)	<0.001

[1]Mean (SD); n (%); [2]Wilcoxon rank sum test; Pearson's Chi-squared test; Fisher's exact test

Table 2: Visual analogue score.

VAS	Overall, N=80[1]	Intervention arm				
		LMG, N=40[1]	USG, N=40[1]	Difference[2]	95% CI[23]	P value[2]
Day 1	72 (11)	72 (11)	73 (10)	-1.6	-6.3, 3.1	0.50
Day 5	39 (20)	44 (20)	33 (18)	11	2.5, 19	0.012
Day 21	36 (20)	41 (21)	31 (18)	9.5	0.71, 18	0.035
Day 42	35 (21)	39 (23)	31 (19)	8.7	-0.68, 18	0.069
Day 84	35 (22)	40 (24)	31 (19)	9.1	-0.53, 19	0.064

[1]Mean (SD), [2]Welch two sample t-test, [3]CI=confidence interval

Table 3: Disability of arm, shoulder and hand score.

DASH score	Overall, N=80[1]	Intervention arm				
		LMG, N=40[1]	USG, N=40[1]	Difference[2]	95% CI[23]	P value[2]
Day 1	65 (13)	66 (14)	65 (11)	1.4	-4.4, 7.1	0.64
Day 5	35 (21)	42 (22)	29 (19)	13	3.8, 22	0.006
Day 21	33 (22)	40 (23)	27 (20)	13	3.1, 22	0.010
Day 42	33 (23)	39 (24)	27 (20)	12	2.3, 22	0.016
Day 84	33 (23)	39 (24)	27 (20)	12	2.7, 22	0.013

[1]Mean (SD), [2]Welch two sample t-test, [3]CI=confidence interval

Table 4: Functional outcome.

Group and parameter	Overall, N=80[1]	Intervention arm				
		LMG, N=40[1]	USG, N=40[1]	Difference[2]	95% CI[23]	P value[2]
Day 0						
External rotation	47 (8)	47 (8)	47 (8)	0.00	-3.7, 3.7	>0.99
Abduction	69 (18)	67 (18)	71 (19)	-3.9	-12, 4.2	0.34
Flexion	62 (18)	56 (16)	69 (17)	-13	-21, -6.1	<0.001
Day 84						
External rotation	71 (14)	70 (15)	72 (13)	-1.6	-7.8, 4.5	0.60
Abduction	124 (37)	115 (38)	132 (34)	-16	-33, -0.22	0.047
Flexion	112 (30)	104 (29)	120 (28)	-16	-28, -2.8	0.018

[1]Mean (SD), [2]Welch two sample t-test, [3]CI=confidence interval

For shoulder external rotation measurements, there was no significant difference found between groups on initial assessment and day 84 of follow-up. Additionally, both the landmark group and the ultrasound guided group failed to demonstrate a statistically significant improvement on day 84. The landmark group improved from mean shoulder external rotation of 47 degrees on initial assessment to 70 degrees on day 84. The ultrasound group improved from mean shoulder external rotation of 47 degrees at initial visit to 72 degrees on day 84.

The degree of shoulder abduction did not differ significantly between groups on initial assessment; however, it did demonstrate a statistically significant difference in favour of the ultrasound group on day 84 measurements. The landmark group improved from a mean of 67 degrees shoulder abduction at initial measurement to 115 degrees on day 84. The ultrasound group improved from a mean of 71 degrees at baseline to 132 degrees on day 84.

DISCUSSION

Adhesive capsulitis is a self-limiting condition in the vast majority of patients and is often treated conservatively. However, the symptoms may take as long as 2-3 years to resolve completely. With shoulder joint mobility being the key to improvement in quality of life, it is essential that symptomatic relief be the cornerstone of therapy.

On the whole, our study demonstrated significant difference in the ability of ultrasound-guided versus landmark-guided corticosteroid injections into the glenohumeral joint to improve patient self-reported pain and function or clinician-measured range of motion in shoulder forward flexion and abduction.

Our results are consistent with those of a study by Ucuncu et al examining ultrasound-guided vs landmark-guided injections for treatment of shoulder pain pathologies and noted that patients injected under ultrasound guidance had significantly improved pain and functional outcomes compared with patients injected via landmark guidance at 6-week follow-up.[27] However, the Ucuncu study utilized injections in the subacromial space whereas our study injected into the glenohumeral joint.

In contrast, a prior randomized controlled trial by Lee et al examining landmark-guided versus ultrasound-guided intra-articular injections for adhesive capsulitis, did not find any statistical difference between the two treatment groups at the 6-week follow-up visit.[28]

Ideally, the study would have included a control group undergoing no treatment; however, this would not have been an ethically acceptable study design as both the treatment modalities proposed in this study had a benefit over conservative management. Future work in the field can consider injecting a mix of corticosteroid and contrast dye to visualize the accuracy of injection.

CONCLUSION

In conclusion, our study revealed improvements in pain, joint function (as reported by patients) and range of motion (as ascertained by the clinician) to be better when

corticosteroids are administered under ultrasound guidance. The two scores used revealed improved short-term scores in the VAS and persistently better scores in the DASH score. Both flexion and abduction showed significant improvement in the ultrasound guided arm as opposed to the landmark guided arm when compared at 84 days. However, this comes with a caveat that these results may not be generalizable to the larger population. Ultrasound guided corticosteroids may offer modestly better short-term functional outcome and symptom relief when compared with landmark guided corticosteroids. However, it is prudent to also account for the added requirement of sophisticated equipment and skilled manpower that is required for successful administration of corticosteroids under ultrasound guidance. Therefore, although ultrasound guidance may offer certain benefits over landmark guidance, it may not be feasible and universally applicable in all patients.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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