Int J Burn Trauma 2024;14(4):65-74
www.IJBT.org /ISSN:2160-2026/IJBT0157048

Original Article

Comparative outcome of ultrasound guided vs. fluoroscopy guided hydrodilatation in adhesive capsulitis: a prospective study

Mehtab Ahmad[1], Mohammad Jesan Khan[2], Mohd Hadi Aziz[2], Rida Fatima[3], Mohd Adnan[4], Adnan Anwer[2], Asad Khan[2], Shivank Khurana[2], Syed Mohd Shoaib[2], Faisal Harun[2]

[1]Department of Radiodiagnosis, J. N. Medical College, Faculty of Medicine, A.M.U., Aligarh, Uttar Pradesh-202002, India; [2]Department of Orthopaedic Surgery, J. N. Medical College, Faculty of Medicine, A.M.U., Aligarh, Uttar Pradesh-202002, India; [3]Raj Scanning Limited, Mahanagar, Lucknow, Uttar Pradesh-226006, India; [4]Department of Orthopaedic Surgery, Teerthankar Mahavir University and Hospital, Moradabad, Uttar Pradesh-244001, India

Received April 6, 2024; Accepted July 24, 2024; Epub August 25, 2024; Published August 30, 2024

Abstract: Background: The incidence of adhesive capsulitis varies from 2-5% in the general population to 20% in people with diabetes. One of the most effective treatment methods is hydrodilatation, which can be done under US-guidance or Fluoroscopic guidance. However, the clinical effectiveness of US-guided injections in comparison to fluoroscopy-guided injections is still debatable. The possibility of severe side effects, the expense, and the time required to carry out this minimally invasive procedure highlight how crucial it is for patients to have a precise intra-articular injection. This study aims to compare the effectiveness of Ultrasound-guided vs. Fluoroscopic guided hydrodilatation for patients with adhesive capsulitis. Methods: Sixty-four patients were randomly selected for hydrodilatation using any one of the techniques. The patients were evaluated for clinical improvements using the visual analog scale (VAS), oxford shoulder score (OSS), and range of motion (ROM). Results: The US-guided group experienced more pain reduction than the fluoroscopy group within the first four weeks ($P < 0.001$). The increase in ROM was much more significant in the US-guided group for the first 8 weeks. Improvement in Abduction and External rotation was much more significant ($P < 0.001$) in the first 4 weeks after hydrodilatation in the US-guided group. The improvement in ROM was maintained on long-term follow-up (mean 24 months), with 45 out of 64 (70.3%) reporting a normal or near normal ROM. On assessing the Oxford shoulder score improvements, the US-guided group's score significantly increased after the first week ($P = 0.003$), but the fluoroscopy-guided group's score increased after the second week. On comparison between the two groups, the amount of score improvement was more significant in the US-guided group than in the fluoroscopy-guided group in the first 4 weeks ($P < 0.001$). Conclusion: US-guided technique for intra-articular injection for patients with adhesive capsulitis provided a quicker pain reduction and a larger improvement in range of motion and overall shoulder functions.

Keywords: Hydrodilatation, frozen shoulder, adhesive capsulitis, fluoroscopy, ultrasound

Introduction

In the general population, 2-5% of people experience shoulder pain, partial or complete rotator cuff tears, subdeltoid or subacromial bursitis, and adhesive capsulitis being the most common causes of shoulder pain. Adhesive capsulitis, as defined by the American Academy of Orthopedic Surgeons, is "A condition of varying severity characterized by the gradual development of global limitation in active and passive shoulder range of motions, where radiographic findings other than osteopenia are absent" [1]. Its incidence varies from 2-5% in the general population to 20% in patients with diabetes [2]. The progression of frozen shoulder is cyclical, starting with a painful "freezing" stage (2-9 months) which is identified by the hypervascularity found during arthroscopy. The condition subsequently advances to a painless "frozen" phase (4-12 months) characterized by a marked restriction of movement although radiographs are normal. The latter stages show synovial tissue contraction and extensive cap-

https://doi.org/10.62347/YHQM4422

sular thickness. Finally, as remodeling occurs and the disease enters a "thawing" phase (5-26 months), patients start to see an improvement in their range of motion [2, 3].

Since it was initially described in 1934, the treatment of adhesive capsulitis has remained an area of continued uncertainty, with little conclusive literature available on the subject [4]. Diathermy, electrotherapy, therapeutic exercises, medication, manipulation under local anaesthesia, local steroid injection, injection of sodium hyaluronate, hydraulic distension, and surgical procedures are just a few of the treatment options that are available and are selected specifically for each patient based on their condition [5, 6].

A network meta-analysis of non-surgical treatment options for frozen shoulder was carried out by Zhang et al. [7]. One of the most effective methods for treating pain is hydrodilatation. It is challenging to draw firm conclusions for clinical practice and policy due to the wide range of therapies used and the lack of long-term follow-up (i.e., 12 months). The glenohumeral joint hydrodilatation can be done under fluoroscopy guidance or the Ultrasound-guided technique which has no radiation exposure. Several authors have reported the US-guided technique to be more accurate [8]. Extra-articular injections may cause problems such as soft tissue damage, weak tendons, and skin depigmentation. However, the clinical effectiveness of US-guided injections in comparison to fluoroscopy-guided injections is still debatable. The possibility of severe side effects, the expense, and the time required to carry out this minimally invasive procedure highlight how crucial it is for patients to have a precise intra-articular injection. This study aims to compare the effectiveness of Ultrasound-guided vs. Fluoroscopic guided hydrodilatation for patients with adhesive capsulitis.

Materials and methods

Study design

This prospective study was conducted in the Department of Orthopedic Surgery and Department of Radiodiagnosis at J. N. Medical College, A.M.U., Aligarh, from Oct 2018 to Nov 2020.

Inclusion and exclusion criteria

Patients who presented to the Orthopaedic OPD aged between 35 to 70 years with shoulder pain due to soft tissue disorder for more than six weeks with normal X-ray findings and a limitation of passive motion of more than 30 degrees in two or more planes and refractory to physiotherapy were identified. Patients with shoulder pathologies like Rotator cuff tear, previous fracture in the shoulder region, degenerative diseases like osteoarthritis, osteonecrosis, inflammatory joint disease, uncontrolled Diabetes mellitus, other systemic diseases, pregnancy, breastfeeding, poor general health, previous history of any surgery, or > 2 steroid injections were excluded.

After thorough clinical and physical examination, 64 patients (Males-20, Females-44) were included in the study and divided into two groups using the randomization software (https://www.randomizer.org/#randomize). All of the patients provided informed consent, and the study was approved by the institutional ethics committee (D. No. 262/FM), faculty of Medicine, A.M.U., Aligarh. No significant dysfunction suggestive of cervical disc disease or radiculopathy was found during the examination of the cervical region. The shoulder joint X-ray was otherwise normal. The injection mixture for both groups consisted of 40 mg of triamcinolone acetonide, 4 ml of 1% lidocaine, and 4 ml of normal saline.

Rehabilitation program and follow-up

All patients were instructed to use a home-based exercise program to increase ROM thrice daily (15 minutes each time). The curriculum included gentle ROM exercises, wall-climbing exercises, and pendulum exercises.

The patients were followed up after 15 days, one month, 2 months, 6 months, 1 year, and 2 years for clinical improvements, which was assessed by visual analog scale (VAS), oxford shoulder score (OSS), and range of motion (ROM) for each patient.

The VAS was calculated by asking patients to mark on a line to indicate their pain level. The line is 100 mm long and has two endpoints - 0 for "no pain" and 100 for "extreme pain" - rep-

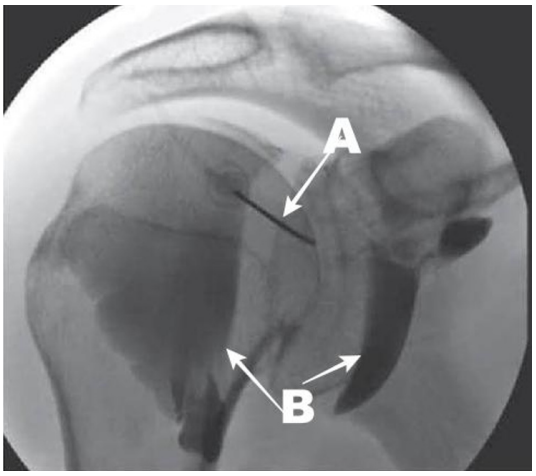

Figure 1. Showing fluoroscopic guided hydrodilatation demonstrating injection of contrast via a 23 gauge needle (A) with the intra-articular spread of contrast along the head of the humerus & glenoid cavity (B).

resenting the two extremes of pain intensity in the VAS.

OSS was calculated using a questionnaire from www.orthopaedicscores.com and the scores were recorded at predetermined intervals on an excel sheet.

Assessment of ROM: Measurements were taken by goniometer.

Forward flexion: With the forearm fully extended at the elbow and arm by the side of the trunk, the patient is asked to flex the arm at the shoulder by moving the upper extremity anteriorly and superiorly above the head.

Abduction: The patient abducts both arms by elevating them laterally until they are above the head, at 180°.

External and internal rotation: The elbow is flexed to 90° and arm is abducted to 90°. The patient is asked to rotate the shoulder externally and internally.

Extension: With the elbow fully extended and the palms supinated, the patient is asked to extend both arms at the shoulder by moving the upper extremities posteriorly.

Statistical analysis: Data analysis was performed using SPSS version 20.0 (IBM Corp., Chicago). The paired t-test was used to analyze differences in the data. Statistical significance was defined as $P < 0.05$.

Technique

Fluoroscopic guided hydrodilatation - A noninvasive manometer and pulse oximeter were used to monitor the participants. The patient was positioned in the supine position, and the Glenohumeral joint (GHJ) was focused. Local anesthetic was infiltrated under aseptic precautions. A 23-gauge spinal needle was inserted into the joint and checked under the C-arm. After injecting 1-2 ml of radiopaque contrast, the needle's position was verified by a glenohumeral arthrogram. When the injection material is exclusively visible inside the glenohumeral joint, it denotes a successful injection; when it is seen in soft tissue and the subacromial area, it is unsuccessful. The steroid injection mixture was then injected, and hydrodilatation was done using Normal saline (NS) (**Figure 1**).

US-guided hydrodilatation - The patients were scanned with a near-focused linear transducer of frequency of 15-18 MHz [Toshiba Aplio XG (7-18 MHZ)]. Shoulder US examination was done for any Rotator cuff and subacromial and subdeltoid bursa (SASD) pathology. The patient was positioned supine with the affected shoulder closer to the interventionist. Skin infiltration with local anaesthetic was done under asepsis. A 23-gauge needle is inserted into the joint using an oblique path within the transducer's imaging plane; the tip is viewed in real-time from lateral to medial as it moves from superficial to deep. The steroid injection mixture was instilled into the joint, and hydrodilatation was done using NS. With the correct placement of the needle tip, there was a free flow of injected fluid (**Figure 2**). A video of the technique is also associated (Video S1). The total volume of NS injected ranged from 20-25 ml and depended on the space available and the severity of the disease. Usually, the filling of the subscapular bursa or the patient requesting to terminate the procedure due to severe pain or capsule rupture was considered the endpoint of the hydrodilatation. Active and passive gentle manipulation of GHJ was performed post-procedure.

Results

The present study was comprised of 64 patients with frozen shoulder in total. Of these, 30

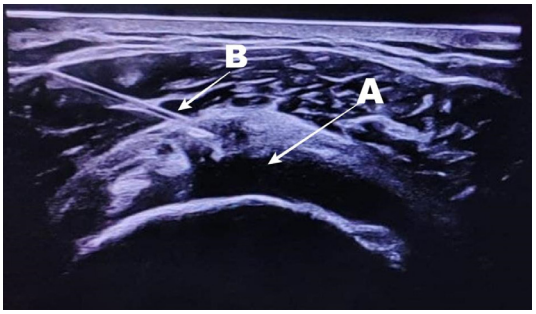

Figure 2. Transverse ultrasound image showing capsular distension after hydrodilatation under USG guidance. Needle (A), Glenohumeral joint (B).

patients (46.8%) were randomly assigned to the US-guided Hydrodilatation group, and 34 patients (53.1%) were assigned to the Fluoroscopy Guided Hydrodilatation group. Forty-four subjects (68.8%) were females, and 20 (31.2%) were males. Only one of the participants (2.4%) was left-handed, and the rest were right-handed (97.6%). In 26 patients (40.6%), the left shoulder was affected, and in 38 (59.4%), the right shoulder was affected. Twenty-five (39%) patients had diabetes, and 5 (7.8%) had hypothyroidism. The mean age of the subjects was 43.3 ± 5.87 years in the US-guided Hydrodilatation group, and the mean age in Fluoroscopy Guided Hydrodilatation group was 46.6 ± 6.18. Gender distribution showed female predominance (68% females). In the US-guided Hydrodilatation group, 16 (53.3%) subjects had a right shoulder problem, whereas 14 (46.6%) had left shoulder trouble. These figures were 22 (64.7%) and 12 (35.3%) in the Fluoroscopy Guided Hydrodilatation group. Twelve patients (40%) in the US-guided Hydrodilatation group and 13 patients (38%) in the Fluoroscopy Guided Hydrodilatation group had diabetes (P = 0.249). Regarding hypothyroidism, 3 (10%) subjects in the US-guided group and 2 (5.8%) in the Fluoroscopy Guided group were affected (P = 0.431). Two (6.6%) of the patients in the US-guided group and 4 (11.7%) in the Fluoroscopy Guided group stopped working because of pain (P = 0.611). Regarding baseline measurements, no difference between the two groups was found to be significant (**Table 1**). The VAS, Range of Motion, and OSS were evaluated between the two groups at 15 days, 1 month, 2 months, 6 months, 1 year, and 2 years following the injection.

VAS

The US-guided group saw significant pain reduction for up to 4 weeks, whereas, in the fluoroscopy-guided group, pain reduction took up to 8 weeks. Statistically, the US-guided group experienced more pain reduction than the fluoroscopy group within the first four weeks (P < 0.001). However, from that point on until the end of the study, there were no significant differences between the two groups. US-guided hydrodilatation showed early relief of pain (**Table 2**).

ROM

There was a statistically significant increase in ROM in both groups up till 8 weeks after that; the ROM improved further, but the increase was not statistically significant. On comparing the two groups, the increase in ROM was much more significant in the US-guided group for the first 8 weeks. Improvement in Abduction and External rotation was much more significant (P < 0.001) in first 4 weeks after hydrodilatation in the US-guided group. The improvement in ROM was maintained on long-term follow-up (mean 24 months), with 45 out of 64 (70.3%) reporting a normal or near normal ROM (**Table 3**).

OSS

Before hydrodilatation, no patients had a normal or near normal OSS (OSS 40-48) in both groups. In the US-guided group, 6 out of 30 patients (20%) reported severe symptoms (OSS 0-19), 24 (80%) reported moderate to severe symptoms (OSS 20-29), and in the Fluoroscopy guided group, 5 (14.7%) reported severe symptoms (OSS 0-19) and 29 (85.3%) reported moderate to severe symptoms (OSS 20-29) at the initial presentation. In the Oxford shoulder score improvements, the US-guided group's score significantly increased after the first week (P = 0.003), but the fluoroscopy group's score increased after the second week. The score improved significantly in the first 4 weeks in the US-guided group; however, it increased significantly for 4 weeks after the first 2 weeks in the fluoroscopy-guided group. On comparison between the two groups, the amount of score improvement was more significant in the US-guided group than in the fluoroscopy-guided group in the first 4 weeks (P < 0.001). However, from that point on until the end of the study,

Table 1. Differences between the two groups regarding baseline characteristics

	Ultrasound Guided Hydrodilatation	Fluoroscopy Guided Hydrodilatation
Total Number of patients (n)	30	34
Sex (Male/female)	9:21 (30:70%)	11:23 (32:68%)
Age (years)	43.3 ± 5.87	46.6 ± 6.18
Duration of symptoms/Chronicity (Months)	7.6 ± 2.5	8.1 ± 2.1
Affected side (Right/Left)	16/14	22/12
Suffering from Diabetes Mellitus	12 (40%)	13 (38%)
Suffering from Hypothyroidism	3 (10%)	2 (5.8%)
Patients who stopped working because of pain	2 (6.6%)	4 (11.7%)

Table 2. Showing VAS Score before and after hydrodilatation

	Ultrasound Guided Hydrodilatation	Fluoroscopy Guided Hydrodilatation
VAS score before intervention	7.9 ± 0.74	7.6 ± 0.77
VAS score 2 weeks after intervention	4.4 ± 1.71	6.6 ± 0.76
VAS score 4 weeks after intervention	3.2 ± 1.84	4.4 ± 0.84
VAS score 8 weeks after intervention	2.2 ± 1.92	2.8 ± 1.92

there were no significant differences between the two groups (**Table 4**). The improvement in OSS was maintained on long-term follow-up (mean 24 months), with 43 out of 64 (67.2%) reporting a normal or near normal function. Fluoroscopy-guided injections were associated with more side effects, with contrast allergy being the most serious one to worry about. The difference between the two groups was not statistically significant.

Discussion

Adhesive capsulitis is characterized by progressively worsening shoulder discomfort and a limitation in range of motion (ROM). Patients frequently have significant limitations in their shoulders' external rotation and abduction. While most cases of frozen shoulder are self-limited, some do not fully recover. Treatment options include diathermy, electrotherapy, therapeutic exercises, medication, manipulation under local anaesthesia, local steroid injection, injection of sodium hyaluronate, hydraulic distension, and surgical procedures. They are selected specifically for each patient based on their condition [5, 6]. The arthroscopic capsular release provides a complete and long-lasting improvement in shoulder pain and function, faster than any other therapeutic modality, but old age patients and patients with comorbidities are not always fit for surgery. Also, the extent of release is debatable [9-11]. Manipulation under anaesthesia stretches the tight shoulder joint capsule [12]. It is a time-efficient procedure that results in the restoration of the ROM of the shoulder joint and reduces the symptoms of a frozen shoulder. Still, complications like humerus fractures, glenoid rim fracture, shoulder dislocation, brachial plexus traction injury, or intraarticular damage to the cartilage or rotator cuff may occur [13-15]. In a study by Leung et al., it was demonstrated that treating frozen shoulders with deep heating by diathermy in conjunction with stretching works better than superficial heating [16]. Joint mobility and exercise were found to be the most successful physical therapy therapies for frozen shoulder syndrome in a meta-analysis by Jewell [17]. It has been demonstrated that transcutaneous electrical stimulation (TENS) greatly increases the range of motion more than heat plus exercise and manipulation [18]. Steroids injected intra-articularly have demonstrated therapeutic results in treating adhesive capsulitis by reducing the inflammatory response, which is one of the pathologic processes and leads to a relatively rapid symptom improvement. Additionally, when properly executed, it results in quicker pain relief and ROM improvement at a lesser cost than conventional physiotherapy, making it a popular choice for outpatients [19, 20]. According to Marx et al., steroid injections offer chemical ablation of the synovi-

Table 3. Improvement in ROM after hydrodilatation in both groups

	Ultrasound Guided Hydrodilatation	Fluoroscopy Guided Hydrodilatation
Abduction before intervention	91.84 ± 14.04	93.78 ± 6.49
Abduction 2 weeks after intervention	128.7 ± 13.6	101.5 ± 11.8
Abduction 4 weeks after intervention	139 ± 14.7	114 ± 12.8
Abduction 8 weeks after intervention	154.56 ± 14.71	129.80 ± 15.6
Abduction 6 months after intervention	166.5 ± 15.4	142.80 ± 12.4
Abduction 2 years after intervention	168.6 ± 16.7	166.56 ± 16.7
Flexion before intervention	94.19 ± 16.43	96.28 ± 14.8
Flexion 2 weeks after intervention	118.8 ± 14.6	104.6 ± 13.8
Flexion 4 weeks after intervention	136.9 ± 13.8	118.4 ± 12.4
Flexion 8 weeks after intervention	151.66 ± 13.38	134.13 ± 15.88
Flexion 6 months after intervention	162.80 ± 14.5	148.14 ± 16.4
Flexion 2 years after intervention	165.4 ± 13.2	155.15 ± 14.4
Extension before intervention	44.0 ± 8.2	41.1 ± 9.6
Extension 2 weeks after intervention	55.6 ± 9.7	52.3 ± 9.4
Extension 4 weeks after intervention	57.6 ± 8.6	54.6 ± 8.4
Extension 8 weeks after intervention	58.5 ± 7.5	56.5 ± 9.2
Extension 6 months after intervention	58.8 ± 7.4	57.6 ± 7.8
Extension 2 years after intervention	58.6 ± 6.3	58.4 ± 7.2
External rotation before intervention	29.91 ± 5.65	29.47 ± 4.33
External Rotation 2 weeks after intervention	48.2 ± 13.3	41.6 ± 15.6
External Rotation 4 weeks after intervention	60.6 ± 12.4	48.6 ± 15.6
External Rotation 8 weeks after intervention	78.5 ± 4.8	71.2 ± 4.0
External Rotation 6 months after intervention	83.6 ± 7.6	81.5 ± 8.8
External Rotation 2 years after intervention	86.7 ± 6.4	85.8 ± 7.8
Internal rotation before intervention	27.06 ± 4.4	23.81 ± 2.02
Internal Rotation 2 weeks after intervention	51.4 ± 4.8	39.4 ± 4.4
Internal Rotation 4 weeks after intervention	56.5 ± 4.6	46.8 ± 6.6
Internal Rotation 8 weeks after intervention	74.4 ± 3.8	68.1 ± 5.8
Internal Rotation 6 months after intervention	81.6 ± 7.2	80.1 ± 8.3
Internal Rotation 2 years after intervention	84.5 ± 6.2	83.8 ± 7.2

Table 4. Oxford shoulder score

	Ultrasound Guided Hydrodilatation	Fluoroscopy Guided Hydrodilatation
OSS before intervention	24.5 ± 4.8	22.2 ± 4.4
OSS 2 weeks after intervention	34.2 ± 6.4	27.3 ± 7.8
OSS 4 weeks after intervention	39.2 ± 1.7	33.5 ± 4.1
OSS 8 weeks after intervention	40.4 ± 2.3	38.4 ± 8.4
OSS 6 months after intervention	44.6 ± 7.2	42.8 ± 6.8
OSS 2 years after intervention	48.4 ± 6.4	47.8 ± 5.8

tis, decreasing the progression of fibrosis and shortening the course of the illness [21]. With statistical significance ($P < 0.05$), several meta-analyses have shown that both intra-articular steroid injection and distension offer clinically significant advantages over placebo in short-term pain relief [22-24]. Additionally, it was demonstrated that distension offers additional medium-term benefits in external rotation and abduction ($P < 0.05$) over intra-articular steroid injection [25]. Capsular distension is supposed to work by stretching or rupturing the joint cap-

sule, which increases glenohumeral mobility [26]. According to Rizk et al., the primary mechanism by which hydrodilatation reduces pain is by rupturing the capsule, which lessens the strain on the pain receptors in the capsule and periosteal attachments [20]. Additionally, intrinsic and extrinsic factors may contribute to the recovery of the frozen shoulder following hydrodilatation therapy. One potential intrinsic mechanism is that the myofibroblast activity is promoted by the elevated glycosaminoglycan concentration seen in the frozen shoulder joint capsule, which is reversed by the joint distension [27].

Due to the diffusion of the steroid away from its target site, improper placement of the steroid may only produce a partial response. Thirty-four patients with shoulder discomfort were evaluated in 2012 by Ogul et al. for the precision of US-guided needle placement. They verified the accuracy by injecting gadolinium and discovered that all injections carried out under the guidance of ultrasound were placed correctly in the glenohumeral joint in 100% of the cases [28]. Similar research by Cicak et al. in 1992 yielded 100% accuracy in needle placement when employing ultrasonic guidance [29]. In 2015, Aly et al. conducted a systematic review covering 13 studies. They claimed that when all efficacy parameters were taken into account, such as improvements in pain, function, and range of motion (ROM) of the joint, US-guided injections produced noticeably better results than blind injections in short-term follow-ups for all shoulder injections, including those in the GHJ, subacromial bursa, biceps tendon sheath, and acromioclavicular joint [30]. Only 42% of glenohumeral joint injections were correctly administered when given blind, according to Eustace et al. There was also a positive correlation between clinical outcomes and accurately placed injections [31]. Earlier research has revealed that compared to the blind technique, the US-guided technique had a greater success rate for intraarticular injection [8]. Direct real-time needle imaging, as it pierces the skin and enters the target site, is possible with ultrasound-guided injections. As a result, we might infer that the precise intra-articular injection of the drug may have significantly influenced the treatment outcomes we saw in the present trial.

An incidental skin dose of a typical chest X-ray is 15 mR (milliroentgen). In contrast, the typical incidental skin dosage during a one-minute fluoroscopic interventional operation is 1-10 R (Roentgen) with a 2 R per minute ray, equivalent to a radiological exposure of 130 times that of a chest radiograph [32]. Thus, a procedure without risk of radiological exposure is preferred. When clinically possible, guided glenohumeral joint injection using ultrasound may be the preferred method since it ensures the correct needle positioning and drug delivery while posing no radiation risk to the patient or practitioner [33].

In a systematic review conducted by Soh et al. in 2011, patients who had US-guided injections saw significantly more significant improvements in joint function and discomfort six weeks after the injection. In our study, there was a significant improvement in pain reduction in both groups. The anti-inflammatory effect of triamcinolone could have caused this. The US-guided group improved more quickly than the Fluoroscopy group during the first four weeks of treatment, but there were no further significant differences between the two groups thereafter until the end of the study. This could be due to the accuracy of injection achieved by US guidance.

The degree of ROM improvement following capsular distension is an important indicator that can be utilized to assess the treatment's efficacy. The limitation of motion in patients with adhesive capsulitis is prominent in external rotation followed by abduction, internal rotation, and flexion [5]. Forward flexion and internal rotation greatly improved after capsular distension, according to Park and Hwang [34], whereas forward flexion, abduction, and external rotation all showed the same favorable effects, according to Choi et al. [35]. Forward flexion and abduction were also greatly improved, according to Kim et al. [36]. According to Bae et al., there was no statistically significant difference between the two groups for forward flexion, abduction, and external rotation for hydrodilatation that was done either by ultrasound or fluoroscopy. However, the improvements in each group were significant [37]. In our study, we observed improvement in ROM in both groups after hydrodilatation, and improvement in the abduction and external rotation was much more significant ($P < 0.001$) in first 4 weeks in the US guided group. The improvement in ROM was maintained on long-

term follow-up (mean 24 months), with 45 out of 64 (70.3%) reporting a normal or near normal ROM.

Adhesive capsulitis has been linked to diabetes mellitus. Diabetic patients have poor results after treatment, according to Pollock et al. [38]. In our series, there were 25 diabetic individuals with primary shoulder capsulitis. These individuals presented with more severe pain. Although less than non-diabetics, the improvement in range of motion was not significantly different from patients without diabetes.

Using ultrasound imaging requires skill; those who are doing the process may not be accurate and may take longer, which could have a poorer result. When performing sonographic capsular distension, accessing the full view of the capsule, as in fluoroscopy, is difficult. Ultrasound imaging, in particular, demands additional resources (trained personnel, imaging equipment, etc.) and places a greater financial burden on the patient. However, its appropriate use can reduce healthcare expenditures and prove to be cost-effective in the long term. Therefore, even though ultrasound-guided shoulder injections have better accuracy than fluoroscopic-guided injections, a switch to ultrasound would require a gradual transition to ensure that practitioners are skilled with the technology.

Our study has several limitations; firstly, a radiologist performed ultrasound-guided injections, and the fluoroscopic guided injections were performed by an orthopedic surgeon. So, two different interventionists performed the procedure in the two groups. Another limitation is the small sample size in our study. For more conclusive recognition of the utility of the US-guided technique, additional studies in multiple centers comparing fluoroscopy with US-guided injections, with the former performed by experienced clinicians and the latter performed by experienced radiologists, are advised. These studies should have larger sample sizes and longer follow-ups.

Conclusion

Compared to the fluoroscopy technique, we discovered that the US-guided technique for intra-articular injection for patients with adhesive capsulitis provided a quicker pain reduction and a larger improvement in range of motion and overall shoulder functions. Therefore, we believe that the US-guided injection technique can be a helpful treatment option that leads to earlier improvements in patients with adhesive capsulitis.

Disclosure of conflict of interest

None.

Abbreviations

US-guided, Ultrasound guided; OSS, Oxford shoulder score; VAS, Visual analog scale; GHJ, Glenohumeral Joint; ROM, Range of Motion.

Address correspondence to: Mohd Hadi Aziz, Department of Orthopaedic Surgery, J. N. Medical College, Faculty of Medicine, A.M.U., Aligarh, Uttar Pradesh-202002, India. Tel: +91-8961004910; E-mail: mohdhadiaziz@gmail.com

References

[1] Griggs SM, Ahn A and Green A. Idiopathic adhesive capsulitis. A prospective functional outcome study of nonoperative treatment. J Bone Joint Surg Am 2000; 82: 1398-407.

[2] Itoi E, Arce G, Bain GI, Diercks RL, Guttmann D, Imhoff AB, Mazzocca AD, Sugaya H and Yoo YS. Shoulder stiffness: current concepts and concerns. Arthroscopy 2016; 32: 1402-14.

[3] Hakim AJ, Cherkas LF, Spector TD and MacGregor AJ. Genetic associations between frozen shoulder and tennis elbow: a female twin study. Rheumatology (Oxford) 2003; 42: 739-42.

[4] Codman EA. The shoulder: rupture of the supraspinatus tendon and other lesions in or about the subacromial bursa. Boston: Thomas Todd; 1934. pp. 216-224.

[5] Park SK, Nam MH and Yune SH. Hydraulic management of frozen shoulder. J Korean Acad Rehabil Med 1992; 16: 147-53.

[6] Cho KH, Song JY, Lee H, Kim JS and Rhee YG. The effect of subacromial bursa injection of hyaluronate in patients with adhesive capsulitis of shoulder joint: multicenter, prospective study. J Korean Acad Rehabil Med 2002; 26: 73-80.

[7] Zhang J, Zhong S, Tan T, Li J, Liu S, Cheng R, Tian L, Zhang L, Wang Y, Liu F, Zhou P and Ye X. Comparative efficacy and patient-specific moderating factors of nonsurgical treatment strategies for frozen shoulder: an updated systematic review and network meta-analysis. Am J Sports Med 2021; 49: 1669-79.

[8] Yi TI, Kim ST, Kim DH, Kim JS, Park JS and Lee JH. Comparison of blind technique and ultrasonography guided technique of intraarticular injection of the shoulder. J Korean Acad Rehabil Med 2006; 30: 45-50.
[9] Neviaser AS and Hannafin JA. Adhesive capsulitis: a review of current treatment. Am J Sports Med 2010; 38: 2346-56.
[10] Gallacher S, Beazley JC, Evans J, Anaspure R, Silver D, Redfern A, Thomas W, Kitson J and Smith C. A randomized controlled trial of arthroscopic capsular release versus hydrodilatation in the treatment of primary frozen shoulder. J Shoulder Elbow Surg 2018; 27: 1401-6.
[11] Boutefnouchet T, Jordan R, Bhabra G, Modi C and Saithna A. Comparison of outcomes following arthroscopic capsular release for idiopathic, diabetic and secondary shoulder adhesive capsulitis: a systematic review. Orthop Traumatol Surg Res 2019; 105: 839-46.
[12] Dodenhoff RM, Levy O, Wilson A and Copeland SA. Manipulation under anesthesia for primary frozen shoulder: effect on early recovery and return to activity. J Shoulder Elbow Surg 2000; 9: 23-6.
[13] Loew M, Heichel TO and Lehner B. Intraarticular lesions in primary frozen shoulder after manipulation under general anesthesia. J Shoulder Elbow Surg 2005; 14: 16-21.
[14] Birch R, Jessop J and Scott G. Brachial plexus palsy after manipulation of the shoulder. J Bone Joint Surg Br 1991; 73: 172.
[15] Amir-Us-Saqlain H, Zubairi A and Taufiq I. Functional outcome of frozen shoulder after manipulation under anaesthesia. J Pak Med Assoc 2007; 57: 181-5.
[16] Leung MS and Cheing GL. Effects of deep and superficial heating in the management of frozen shoulder. J Rehabil Med 2008; 40: 145-50.
[17] Jewell DV, Riddle DL and Thacker LR. Interventions associated with an increased or decreased likelihood of pain reduction and improved function in patients with adhesive capsulitis: a retrospective cohort study. Phys Ther 2009; 89: 419-29.
[18] Rizk TE, Christopher RP, Pinals RS, Higgins AC and Frix R. Adhesive capsulitis (frozen shoulder): a new approach to its management. Arch Phys Med Rehabil 1983; 64: 29-33.
[19] Bulgen DY, Binder AI, Hazleman BL, Dutton J and Roberts S. Frozen shoulder: prospective clinical study with an evaluation of three treatment regimens. Ann Rheum Dis 1984; 43: 353-60.
[20] Rizk TE, Pinals RS and Talaiver AS. Corticosteroid injections in adhesive capsulitis: investigation of their value and site. Arch Phys Med Rehabil 1991; 72: 20-2.
[21] Marx RG, Malizia RW, Kenter K, Wickiewicz TL and Hannafin JA. Intra-articular corticosteroid injection for the treatment of idiopathic adhesive capsulitis of the shoulder. HSS J 2007; 3: 202-7.
[22] Kitridis D, Tsikopoulos K, Bisbinas I, Papaioannidou P and Givissis P. Efficacy of pharmacological therapies for adhesive capsulitis of the shoulder: a systematic review and network meta-analysis. Am J Sports Med 2019; 47: 3552-60.
[23] Sun Y, Zhang P, Liu S, Li H, Jiang J, Chen S and Chen J. Intra-articular steroid injection for frozen shoulder: a systematic review and meta-analysis of randomized controlled trials with trial sequential analysis. Am J Sports Med 2017; 45: 2171-9.
[24] Wang W, Shi M, Zhou C, Shi Z, Cai X, Lin T and Yan S. Effectiveness of corticosteroid injections in adhesive capsulitis of shoulder: a meta-analysis. Medicine (Baltimore) 2017; 96: e7529.
[25] Lin MT, Hsiao MY, Tu YK and Wang TG. Comparative efficacy of intra-articular steroid injection and distension in patients with frozen shoulder: a systematic review and network meta-analysis. Arch Phys Med Rehabil 2018; 99: 1383-1394, e6.
[26] Tveitå EK, Tariq R, Sesseng S, Juel NG and Bautz-Holter E. Hydrodilatation, corticosteroids and adhesive capsulitis: a randomized controlled trial. BMC Musculoskelet Disord 2008; 9: 53.
[27] Price FM, Levick JR and Mason RM. Changes in glycosaminoglycan concentration and synovial permeability at raised intra-articular pressure in rabbit knees. J Physiol 1996; 495: 821-33.
[28] Ogul H, Bayraktutan U, Yildirim OS, Suma S, Ozgokce M, Okur A and Kantarci M. Magnetic resonance arthrography of the glenohumeral joint: ultrasonography-guided technique using a posterior approach. Eurasian J Med 2012; 44: 73-8.
[29] Ćićak N, Matasović T and Bajraktarević T. Ultrasonographic guidance of needle placement for shoulder arthrography. J Ultrasound Med 1992; 11: 135-7.
[30] Aly AR, Rajasekaran S and Ashworth N. Ultrasound-guided shoulder girdle injections are more accurate and more effective than landmark-guided injections: a systematic review and meta-analysis. Br J Sports Med 2015; 49: 1042-9.
[31] Eustace JA, Brophy DP, Gibney RP, Bresnihan B and FitzGerald O. Comparison of the accuracy of steroid placement with clinical outcome in patients with shoulder symptoms. Ann Rheum Dis 1997; 56: 59-63.

[32] Van Holsbeeck MT and Introcaso JH. Sonography of the shoulder. In: Ptasznik R, editors. Musculoskeletal ultrasound, 2nd edition. St. Louis: Mosby Inc.; 2001. pp. 504-505.
[33] Choudur HN and Ellins ML. Ultrasound-guided gadolinium joint injections for magnetic resonance arthrography. J Clin Ultrasound 2011; 39: 6-11.
[34] Park GY and Hwnag SE. Comparison of intraarticular steroid injection with and without capsular distension in adhesive capsulitis of the shoulder. J Korean Acad Rehabil Med 2016; 24: 1174-9.
[35] Choi ES, Kim JS, Lee YS, Shin BS, Ko YJ and Park SH. Arthrographic findings of frozen shoulder and therapeutic effect of distension arthrography. J Korean Acad Rehabil Med 2001; 25: 278-83.
[36] Kim JS, Kwon JY, Lee WI and Kim JM. The additional effect of tear after passive exercise during distension arthrography in patients with frozen shoulder. J Korean Acad Rehabil Med 2008; 32: 324-6.
[37] Bae JH, Park YS, Chang HJ, Kim MJ, Park KY, Jin SH and Lee EH. Randomized controlled trial for efficacy of capsular distension for adhesive capsulitis: fluoroscopy-guided anterior versus ultrasonography-guided posterolateral approach. Ann Rehabil Med 2014; 38: 360.
[38] Pollock RG, Duralde XA, Flatow EL and Bigliani LU. The use of arthroscopy in the treatment of resistant frozen shoulder. Clin Orthop Relat Res 1994; 30-6.