Comparative Study of The Efficacy and Functional Outcome of Ultrasound Guided Corticosteroid Injection and Hydro-dilatation in Adhesive Capsulitis of The Shoulder

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ABSTRACT

Background: Adhesive capsulitis (AC), also referred to as frozen shoulder, represents a prevalent condition, characterized by discomfort and a gradual restriction of both active and passive shoulder movements.

Aim of the work: This work aimed at assessing the efficacy and functional outcome of US-guided corticosteroid injection and US-guided hydro-dilatation among cases developing AC of the shoulder.

Patients and methods: Our team conducted a randomized study that included 60 patients of both sexes, with AC of the shoulder. The selected participants underwent a random categorization equally into two groups. **Group 1** administered intra-articular injections under ultrasound guidance with a single injection of 40 mg in 1ml of triamcinolone acetate mixed with 2 ml of 2% lignocaine under strict aseptic condition. **Group 2** administered intra-articular injections of a mixture of 20 ml of normal saline with 5 ml of lignocaine guided by the US after all sterile precautions were secured.

Results: A significant recovery was noted in both groups after 2 and 6 weeks follow up as regards VAS, SPADI score and both active and passive shoulder range of movements with more improvement in the hydro-dilatation group. Additionally, there was a significant difference according to ultrasound findings between before and after treatment in each group.

Conclusions: Both methods could be safely utilized as a first-line of intervention for AC treatment focusing on both pain relief and restoring shoulder range of motion. Hydrodilatation can be employed as an efficacious alternative if corticosteroid is discouraged.

Keywords: Adhesive capsulitis, Hydro-dilatation, Ultrasound guidance, Corticosteroid injection.

INTRODUCTION

Adhesive capsulitis (AC), also referred to as frozen shoulder, represents a prevalent condition, characterized by discomfort and a gradual restriction of both active and passive shoulder movements. It accounts for 2% to 5% of the general population and up to 20% of those developing diabetes mellitus. It may be classified as either primary (idiopathic) or secondary; the latter encompasses local and systemic etiologies, including rotator cuff rupture, hemiparesis, cardiovascular disorders, as well as diabetes mellitus [1, 2].

The pathological process of AC includes forming excessive adhesions across the glenohumeral joint (GHJ) capsule, thus inducing pain, stiffness, as well as limited range of motion [3].

Histological biopsy of the contracted capsule demonstrated the deposition of fibroblast mixed with type 1 and 3 collagen, which would differentiate into myofibroblasts [4].

The objectives of the various therapy modalities are to alleviate pain, improve range of motion, and restore shoulder functionality. Typical treatment modalities involve nonsteroidal anti-inflammatory medications (NSAIDs), corticosteroid injections, physical therapy, manipulation under anesthesia, as well as open surgical release [5]. The intra-articular corticosteroid is extensively employed as a conservative intervention for AC since it is available and cost-effective [6].

AC is proposed as an inflammatory and fibrotic condition. Early intervention with intra-articular corticosteroid injections may mitigate synovitis, restrict capsular fibrosis, while modifying the disease's natural progression [7-9].

Hydrodilatation under ultrasound guidance is widely accepted nowadays the mechanical effect of the injected mixture distends and microruptures the contracted capsule, inducing partial shoulder pain relief and restoring the limited range of motion [4].

This work aimed at assessing the efficacy and functional outcome of US-guided corticosteroid injection and US-guided hydro-dilatation among patients with primary AC of the shoulder.

PATIENTS AND METHODS

This randomized study, included 60 patients, presented with primary AC who were recruited from Outpatient Rheumatology Clinic, Tanta University Hospitals.

Inclusion criteria: Patients presented with restricted range of GHJ motion both actively and passively, with external rotation < 50% of the normal side.

Exclusion criteria: Patients with a previous trauma or a previous shoulder operations, other rheumatic diseases e.g. (Rheumatoid arthritis, osteoarthritis, spondyloarthritis and gouty arthritis), patients with history of intra -articular shoulder injection in the last 6 months, rotator cuff tear and calcific tendinitis.

The participants underwent a random categorization equally into two groups: **Group 1** was administered shoulder intra-articular injections under ultrasound guidance with one dosage of 40 mg in 1 ml of triamcinolone acetate mixed with 2 ml of 2% lignocaine

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under strict aseptic conditions. **Group 2** was administered shoulder intra-articular mixture of 20 ml normal saline in addition to 5 ml of lignocaine under ultrasound guidance and strict aseptic conditions.

All participants received an identical exercise regimen within the follow-up period, thus restoring and maintaining mobility [(10)]. Exercise programs started with an active assisted range of motion exercise regimen, complemented by modest passive stretching activities such as forward elevation, internal and external rotation, as well as cross-body adduction. All participants performed these exercises five times throughout several 5- to 10-minute periods daily [(11)].

Our team also gathered a comprehensive medical history from all participants, then conducted a thorough clinical as well as local examinations of the affected shoulder and goniometric measurement of both active and passive motion of shoulder (Flexion, external rotation, internal rotation, extension, and abduction) [(12)].

Assessment of pain: by Visual Analogue Score (VAS) for pain.

Functional assessment:
By shoulder pain and disability index Questionnaire (SPADI) [(13)]: The self-administered questionnaire exhibits two dimensions: one for pain, while the other for functional activities.

Laboratory and radiological assessment:
Ultrasonographic assessment of the shoulder: Utilizing SAMSUNG MEDISON (UGEO H60), employing linear array transducers (frequencies falling between 7.5 and 12 MHz) using the following standard scans [(14)] to exclude any secondary causes.

Glenohumeral injection (posterior approach): Targeting the labrum's free edge as well as the cartilage of humeral head underneath the capsule [(15)].

Follow up: After administering injections, all patients were examined and assessed at an interval of 2 and 6 weeks (visit 2, 3).

Ethical Approval: The study is in accordance with the ethical principles of Helsinki and was approved by The Local Research Ethics Committee of Faculty of Medicine, Tanta University. Written informed consents were obtained from all patients after explanation of the therapeutic procedure.

Statistical analysis

SPSS version 26 (IBM Inc., Chicago, IL, USA) was utilized. Quantitative variables were illustrated as mean and SD and the comparison was carried out among both groups with unpaired Student's t-test. Qualitative variables were illustrated as frequency and percentage (%) and analysis was carried out utilizing the Chi-square or Fisher's exact test when appropriate. $P \leq 0.05$ deemed significant.

RESULTS

No significant variances were documented between two groups according to age, gender, occupation and affected shoulder Table (1**)**.

Table (1): Comparison between both groups based on demographic data and affected shoulder

		Group 1 N=30	**Group 2 N=30**	**p. value**
Age		46.57 ± 8.99	49.33 ± 9.27	0.245
Sex	**Male**	12 (40%)	12 (40%)	1.0
	Female	18 (60%)	18 (60%)	
Occupation	**Housewife**	13 (43.3%)	11 (36.7%)	0.598
	Worker	17 (56.7%)	19 (63.3%)	
Affected shoulder	**Right**	18 (60%)	16 (53.3%)	0.602
	Left	12 (40%)	14 (46.7%)	

Data are presented as mean ± SD and number (%).

A significant variance was documented between before, after two weeks and after 6 weeks within each group. Additionally, a significant variance was documented among both groups according to VAS, SPADI score, both active as well as passive (flexion, extension, abduction, adduction, internal rotation, and external rotation) with more improvement in the hydro-dilatation group (Table 2).

Table (2): Comparison between before, after two weeks and follow up after 6 weeks in each group and between the two studied groups according to VAS, SPADI score, active and passive ROM (flexion, extension, abduction, adduction, internal rotation and external rotation)

	Group 1 (N=30)	Group 2 (N=30)	p. value
VAS			
Before	6.83 ± 1.15	6.50 ± 1.14	0.263
After 2 weeks	4.23 ± 1.28	3.93 ± 1.39	0.387
Follow up After 6 weeks	2.00 ± 1.84	1.77 ± 1.72	0.613
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
SPADIA score			
Before	60.33 ± 14.85	58.83 ± 13.88	0.688
After 2 weeks	46.0 ± 9.23	40.67 ± 8.58	**0.024***
Follow up After 6 weeks	33.50 ± 6.45	27.50 ± 8.78	**0.004***
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Active flexion			
Before	98.83 ± 15.66	95.47 ± 17.50	0.436
After 2 weeks	115.34 ± 16.84	128.47 ± 15.50	**0.003***
Follow up After 6 weeks	131.10 ± 18.58	146.33 ± 17.21	**0.002***
P1 Before & After 2 weeks	**0.008***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.006***	**0.001***	
Passive flexion			
Before	95.67 ± 16.72	98.50 ± 13.42	0.473
After 2 weeks	116.24 ± 17.85	129.62 ± 16.84	**0.004***
Follow up After 6 weeks	135.18 ± 19.37	148.17 ± 20.06	**0.013***
P1 Before & After 2 weeks	**0.003***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Active extension			
Before	31.83 ± 6.17	32.83 ± 7.25	0.567
After 2 weeks	37.28 ± 5.17	42.49 ± 5.64	**0.001***
Follow up After 6 weeks	43.26 ± 6.38	50.83 ± 6.31	**0.001***
P1 Before & After 2 weeks	**0.003***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.002***	**0.001***	
Passive extension			
Before	34.83 ± 5.48	36.17 ±5.37	0.087
After 2 weeks	41.59 ± 5.12	48.17 ± 5.27	**0.001***
Follow up After 6 weeks	49.00 ± 6.35	53.67 ± 6.29	**0.006***
P1 Before & After 2 weeks	**0.008***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.006***	**0.001***	
Active abduction			
Before	98.50 ± 13.62	95.50 ± 14.27	0.408
After 2 weeks	114.33 ± 13.79	128.83 ± 15.67	**0.001***
Follow up After 6 weeks	129.42 ± 14.68	141.91 ± 15.83	**0.002***
P1 Before & After 2 weeks	**0.001***	**0.001***	

	Group 1 (N=30)	Group 2 (N=30)	p. value
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Passive abduction			
Before	98.17 ± 15.48	96.00 ± 20.45	0.645
After 2 weeks	114.39 ± 16.35	126.51 ± 17.25	**0.007***
Follow up After 6 weeks	131.83 ± 21.65	145.67 ± 19.99	**0.013***
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Active adduction			
Before	102.39 ± 12.74	97.83 ± 11.93	0.158
After 2 weeks	118.27 ± 13.28	131.58 ± 14.82	**0.001***
Follow up After 6 weeks	132.76 ± 12.18	147.65 ± 14.24	**0.001***
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Passive adduction			
Before	105.29 ± 13.91	101.49 ± 14.29	0.301
After 2 weeks	120.18 ± 13.21	132.75 ± 14.09	**0.001***
Follow up After 6 weeks	134.18 ± 15.63	151.48 ± 14.85	**0.001***
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Active internal rotation			
Before	43.83 ± 9.74	45.50 ± 8.78	0.488
After 2 weeks	55.67 ± 10.29	62.27 ± 9.97	**0.014***
Follow up After 6 weeks	69.67 ± 11.08	78.33 ± 10.52	**0.003***
P1 Before & After 2 weeks	**0.008***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.006***	**0.001***	
Passive internal rotation			
Before	52.50 ± 8.48	55.67 ± 10.08	0.193
After 2 weeks	61.42 ± 9.13	70.61 ± 9.87	**0.001***
Follow up After 6 weeks	70.33 ± 11.25	81.60 ± 11.24	**0.001***
P1 Before & After 2 weeks	**0.002***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.004***	**0.001***	
Active external rotation			
Before	41.33 ± 7.30	40.83 ± 10.09	0.827
After 2 weeks	50.33 ± 6.97	59.82 ± 7.68	**0.001***
Follow up After 6 weeks	64.83 ± 11.10	75.17 ± 19.93	**0.016***
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	
Passive external rotation			
Before	50.83 ± 7.20	51.83 ± 10.63	0.671
After 2 weeks	61.39 ± 9.67	68.28 ± 10.09	**0.009***
Follow up After 6 weeks	72.00 ± 11.11	81.83 ± 12.90	**0.002***
P1 Before & After 2 weeks	**0.001***	**0.001***	
P2 Before & After 6 weeks	**0.001***	**0.001***	
P3 After 2 weeks & After 6 weeks	**0.001***	**0.001***	

Data are presented as mean ± SD. VAS: visual analogue scale. SPADIA: shoulder pain and disability index Questionnaire. * Significant (p value < 0.05).

No significant variance was documented among both groups according to ultrasound findings prior to injection, while a significant variation was noted according to ultrasound findings comparing before and after in each group (Table 3).

Table (3): Comparison between both groups based on Ultrasound findings before and after injection

		Group1 N=30	Group2 N=30	P value
Before	No	0 (0%)	0 (0%)	0.890
	Bursitis	7 (23.3%)	6 (20.0%)	
	Effusion	6 (20.0%)	7 (23.3%)	
	Tendinitis	8 (26.7%)	10 (33.3%)	
	Bursitis, effusion	9 (30%)	7 (23.3%)	
After	No	18 (60%)	15 (50%)	0.874
	Bursitis	2 (6.7%)	2 (6.7%)	
	Effusion	2 (6.7%)	3 (10.0%)	
	Tendinitis	8 (26.7%)	10 (33.3%)	
	Bursitis, effusion	0 (0%)	0 (0%)	
P value		0.001*	0.001*	

Data are presented as number (%).

DISCUSSION

AC of the shoulder represents a severe condition, affecting nearly all daily activities [16]. AC stands as the primary etiology for the shoulder joint pain among middle-aged and elderly cases [17]. The exact cause is still unknown [18-20].

In our research, the majority of our patients showed right shoulder involvement, which highlights the effect of the repetitive microtrauma as a possible cause of AC as **Barua and Chowdhury** [21] reported.

The non-dominant shoulder was less frequently affected. This finding might be due to the pathophysiology of frozen shoulder that remains linked to a loss of motion along with weakened joint structures (ligaments, capsule and synovial sheath as well as rotator cuff) [22]. Our findings agrees with **Hassankhani *et al.*** [23] showed that AC affection in the right shoulder (52%) exhibited greater prevalence in comparison to the left side (41%) while 7% of cases developed a bilateral pathology. While, **Toda** [24] reported that the non-dominant arm is frequently affected as opposed to the dominant arm (58.9% vs 41.1%), with the left arm being more affected in comparison with the right (53.4% versus 46.6%). The larger sample size may explain this difference from our results.

In our study, pain improvement was noticed within the hydrodilatation group and the corticosteroid group after 2 weeks post-injection and 6 weeks follow-up, with more improvement in the hydrodilatation group. Our patients reported slight discomfort during and shortly after hydrodilatation that was followed by pain relief from 15 to 30 minutes after injection. Additionally, a significant enhancement was documented within two weeks and six weeks in each group.

In addition, our results showed that the hydrodilatation group exhibited a significant reduction as regards mean value of SPADI score as opposed to the corticosteroid group after 2 and 6 weeks of injection with a significant improvement after 2 and 6 weeks in ea group.

Corticosteroids have a known anti-inflammatory effect, which helps to reduce inflammation and swelling in the shoulder joint that contributes to pain and disability and it has been used as a first choice in injection in AC. Locally, corticosteroids help to prevent adhesions by decreasing the rate of fibrous tissue formation, which further improve joint mobility and reduce pain [25].

In our study, hydrodilatation had nearly equal and sometimes better results for pain and function, this effect might be related to the mechanical effect of the injected fluid on the pain and the pressure receptors within the joint and can be responsible for the early pain relief symptoms reported by our patients. **Pimenta *et al.*** [26], who carried out a study on 149 consecutive cases who developed AC. They prospectively participated and underwent a categorization into: **Group (i)** included 39 cases administering hydrodilatation of the glenohumeral joint (GHJ) with capsular rupture, while **group (ii)** involved 110 participants who underwent treatment utilizing GHJ hydro-dilatation with capsular preservation. They addressed that disabilities associated with the arm, shoulder, and hand (DASH) as well as VAS scores within both groups showed a significant improvement as opposed to their baseline within all time-points after therapy. Additionally, **Wu *et al.*** [27] documented a prospective, single-blinded randomized controlled trial on 62 patients with AC that underwent a categorization into **group A**: US-guided hydrodilatation with hyaluronic acid + physical therapy (N = 31) and **group B**: Physical therapy alone (N = 31). They found a higher decrease as regards SPADI score and pain score between the baseline and 6 weeks and between the baseline and 12 weeks in hydrodilatation group. **Wang *et al.*** [28] carried out a prospective double-blind, randomized controlled trial on 84 cases developing AC intervened **(A)** ultrasound-guided hydro dilatation with 4 mL of triamcinolone acetonide (TA) (40 mg) + 4 mL 2% lidocaine hydrochloride + 12 mL normal saline or (B) hydrodilatation with 1 mL of TA (10 mg) + 4 mL 2% lidocaine hydrochloride + 15 mL normal saline via the posterior GHJ recess. They addressed significant improvements as regards the SPADI score as well as VAS scores at baseline and at 6 weeks following injection within both groups regardless of the dose of

corticosteroid injections, which highlights the effect of mechanical distension of GHJ capsule.

In the last decade, many studies demonstrated the effectiveness of hydrodilatation whether alone or combined with corticosteroid, which offers a suitable alternative and a safe line of treatment for AC [29 -34].

As for the long-term effectiveness **Watson *et al.*** [30] reported that the benefits of hydro-dilatation was maintained for more than 2 years post-injection among cases developing primary and secondary GHJ joint contracture linked to rotator cuff pathology.

In the current study ultrasound examination of the affected shoulder revealed the presence of bursitis, effusion, chronic tendinitis, bursitis that was attributed to AC pathologic process and there was a significant improvement in these findings especially joint effusion and bursitis after injection in both groups revealing the reversal of a known part of the pathologic process and effectiveness of both lines of treatment. Supporting our results, **Catapano *et al.*** [35] who conducted a systematic review to evaluate the efficacy of hydrodilatation with corticosteroid for the AC treatment. They concluded that combining hydrodilatation using corticosteroid injections strongly accelerates the recovery of a pain-free ROM.

Limitations: Our research was limited by the short follow-up period as AC is characterized by its long disease duration, the repetition rate and interval duration between injections still needs to be studied separately.

CONCLUSIONS

Hydrodilatation exhibited similar effectiveness to intra-articular corticosteroid injection in AC targeting both pain relief and restoration of ROM. Hydro dilatation could be safely utilized as a first-line treatment for AC and as a safe alternative if corticosteroid is discouraged.

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REFERENCES

1. **Hsu E, Anakwenze A, Warrender J, Abboud A (2011):** Current review of adhesive capsulitis. J Shoulder Elbow Surg., 20: 502-14.
2. **Neviaser S, Neviaser J (2011):** Adhesive capsulitis of the shoulder. J Am Acad Orthop Surg., 19: 536-42.
3. **Le V, Lee J, Nazarian A, Rodriguez K (2017):** Adhesive capsulitis of the shoulder: review of pathophysiology and current clinical treatments. Shoulder Elbow, 9: 75-84.
4. **Jeyaraman M, Ramesh R, Prajwal G, Dhamsania J (2018):** The comparative and prospective study on Efficacy and functional outcome of autologous platelet rich plasma injection vs hydrodissection in adhesive capsulitis of shoulder. Int J Res Orthop., 4: 12-33.
5. **Guyver P, Bruce D, Rees J (2014):** Frozen shoulder–A stiff problem that requires a flexible approach. Maturitas., 78: 11-6.
6. **Roh H, Yi R, Noh H, Lee Y, Oh H, Gong S et al (2012):** Intra-articular corticosteroid injection in diabetic patients with adhesive capsulitis: a randomized controlled trial. Knee Surgery, Sports Traumatology, Arthroscopy, 20: 1947-52.
7. **Dias R, Cutts S, Massoud S (2005):** Frozen shoulder. BMJ., 331: 1453-6.
8. **Yoon H, Lee Y, Lee J, Kwack S (2013):** https://orcid.org/0000-0003-0431-1984 Optimal dose of intra-articular corticosteroids for adhesive capsulitis: a randomized, triple-blind, placebo-controlled trial. Am J Sports Med., 41: 1133-9.
9. **Wang K, Ho V, Hunter-Smith J, Beh S, Smith M, Weber B (2013):** Risk factors in idiopathic adhesive capsulitis: a case control study. Journal of shoulder and elbow surgery, 22: e24e9.
10. **Griggs M, Ahn A, Green A (2000):** Idiopathic adhesive capsulitis. A prospective functional outcome study of nonoperative treatment. J Bone Joint Surg Am., 82: 1398-407.
11. **Williams R (1999):** Disorders of the shoulder: diagnosis and management: Lippincott Williams & Wilkins, Pp: 541-561.
12. **Moen H, de Vos J, Ellenbecker S, Weir A (2010):** Clinical tests in shoulder examination: how to perform them. Br J Sports Med., 44:370-5.
13. **Tveitå K, Ekeberg M, Juel G, Bautz-Holter E (2008):** Responsiveness of the shoulder pain and disability index in patients with adhesive capsulitis. BMC Musculoskelet Disord., 9: 161.
14. **Backhaus M, Burmester R, Gerber T, Grassi W, Machold P, Swen A et al (2001)**: Guidelines for musculoskeletal ultrasound in rheumatology. Ann Rheum Dis., 60: 641-9.
15. **Zwar B, Read W, Noakes B (2004):** Sonographically guided glenohumeral joint injection. Am J Roentgenol., 183: 48-50.
16. **Palmer W, Bancroft L, Bonar F, Choi A, Cotten A (2020):** Glossary of terms for musculoskeletal radiology. Skeletal Radiol., 49: 1-33.
17. **Millar L, Meakins A, Struyf F, Willmore E, Campbell L, Kirwan D et al (2022):** Frozen shoulder. Nat Rev Dis Primers, 8: 59.
18. **Alshehri M, Alsalman M, Alsebayel M (2023):** Adhesive capsulitis following COVID-19 vaccination: a case report and review of literature. J Surg Case Rep., 2023: 1-3.
19. **Korkoman J, Alammari S, Alqahtani H, AlQahtani A (2023):** The incidence of adhesive capsulitis and COVID-19 pandemic effect. JSES International, 7: 2406-9.
20. **Harris E, Eng J (2006):** Individuals with the dominant hand affected following stroke demonstrate less impairment than those with the nondominant hand affected. Neurorehabil Neural Repair, 20: 380-9.
21. **Barua S, Chowdhury M (2014):** Phonophoresis in adhesive capsulitis (frozen shoulder). Chattagram Maa-O-Shishu Hosp Med College J., 13: 112-33.
22. **De la Serna D, Navarro-Ledesma S, Alayón F, López E, Pruimboom L (2021):** A comprehensive view of frozen shoulder: A mystery syndrome. Front Med (Lausanne), 8: 120-33.
23. **Hassankhani E, Pettersson H, Hassankhani S, Hassankhani G (2022):** Prevalence of diabetes and its effect on the course and treatment of frozen shoulder. Open J Orthop., 12: 463-73.

24. **Toda K (2018):** Left and non-dominant shoulders were more frequently affected in patients with frozen shoulder: A systematic review and meta-analysis. J Orthop Muscular Syst., 7: 20- 44.
25. **Bal A, Eksioglu E, Gulec B, Aydog E, Gurcay E, Cakci A (2008):** Effectiveness of corticosteroid injection in adhesive capsulitis. Clin Rehabil., 22: 503-12.
26. **Pimenta M, Vassalou E, Klontzas M, Dimitri-Pinheiro S, Ramos I, Karantanas H (2024):** Ultrasound-guided hydro-dilatation for adhesive capsulitis: capsule-preserving versus capsulerupturing technique. Skelet Radiol., 53: 253-61.
27. **Wu Y, Hsu C, Tsai Y, Huang R, Wang A, Wang C (2024):** Efficacy of combined ultrasound-guided hydro-dilatation with hyaluronic acid and physical therapy in patients with adhesive capsulitis: A randomised controlled trial. Clin Rehabil., 38: 202-15.
28. **Wang C, Hsu C, Wang A, Wu T, Chang V (2023):** Comparative effectiveness of corticosteroid dosages for ultrasound-guided glenohumeral joint hydro-dilatation in adhesive capsulitis: A randomized controlled trial. Arch Phys Med Rehabil., 104: 745-52.
29. **Oh H, Sung S, Oh H, Jo H (2021):** Comparative analysis of intra-articular injection of steroid and/or sodium hyaluronate in adhesive capsulitis: prospective, double-blind, randomized, placebo-controlled study. JSES Int., 5: 1091-104.
30. **Watson L, Bialocerkowski A, Dalziel R, Balster S, Burke F, Finch C (2007):** Hydro-dilatation (distension arthrography): a long-term clinical outcome series. Br J Sports Med., 41 (3): 167-73.
31. **Ashraf A, Sheikh I, Sabir N (2019):** Comparison between Hydro dilatation and intra articular steroid injection in patients with frozen shoulder in term of pain relief and range of movement. J Islam Int Med Coll., 14: 116-20.
32. **Asghar K, Ahmad T, Asghar K, Ahmad T, Maqbool N (2018):** Functional outcome of hydro-dilatation versus intra-articular corticosteroid injection in patients with frozen shoulder. J Rawalpindi Med Coll., 22: 137-9.
33. **Griesser J, Harris D, Campbell E, Jones L (2011):** Adhesive capsulitis of the shoulder: A systematic review of the effectiveness of intra-articular corticosteroid injections. JBJS., 93: 1727-33.
34. **Rasool A, Khan R, Rashid M, Umair M, Israr H (2023):** Comparison of intra-articular steroid injection versus hydro-dilatation with saline and corticosteroid for the treatment of refractory adhesive capsulitis of the shoulder. Professional Med J., 30: 971-6.
35. **Catapano M, Mittal N, Adamich J, Kumbhare D, Sangha H (2018):** Hydro-dilatation with corticosteroid for the treatment of adhesive capsulitis: A systematic review. Pm R., 10: 623-35.