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Clinical Outcomes of Clinico-radiologically Predetermined Patient Specific Multi-site Steroid Injection in Primary Frozen Shoulder: A Prospective Case Series

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Learning Point of the Article:

Intra-articular clinico-radiologically predetermined patient-specific landmark-based multisite steroid infiltration leads to a remarkable reduction in pain as well as significant improvement in range of motion and clinical outcomes in frozen shoulder.

Abstract

Introduction: Frozen shoulder (FS) is characterized by shoulder pain and progressive restriction of the range of motion, for which treatment is aimed at pain relief, improving shoulder function and shortening the course of the condition. Consensus does indeed lean significantly toward conservative management, but choosing the best non-surgical modality can be overwhelming with regards to the myriads of options available and the lack of homogeneity in the literature, which precludes comparability. This led us to design the present case series. Clinico-radiologically predetermined intra-articular and landmark-based multisite betamethasone injection technique yields satisfactory pain relief and improves range of motion (ROM) and clinical outcomes in FS.

Materials and Methods: Patients clinically diagnosed as having primary FS, confirmed by an ultrasound and X-ray of the affected shoulder, were included in the study over a span of 3 years (n - 94). During clinical examination, joint line and bursae were palpated for tenderness. The steroid preparation consisted of 8 mg of betamethasone (4 mg/mL vial) diluted with 8 mL of 2% plain lignocaine. 5 mL of this steroid preparation was injected intra-articularly and the remaining divided among the areas of tenderness and inflammation pre-determined clinically or radiologically by ultrasound. The injections were administered by a single shoulder surgeon, after which physiotherapy was performed for 8 weeks. Follow-up was done at 2, 4, and 8 weeks, during which ROM, Visual Analog Scale (VAS), American Shoulder and Elbow Scoring System (ASES) and Shoulder Pain and Disability Index (SPADI) were evaluated.

Results: Statistically significant differences in pre-injection and post-injection values for the following parameters were noted: Mean abduction, forward flexion and external rotation improved from 124 to 167 degrees (P = 0.001), from 123 to 169 degrees (P = 0.040) and from 26 to 50 degrees (P = 0.009), respectively. The mean ASES score improved from 28.8 to 88.9 (P = 0.001), the mean VAS score decreased from 6.7 to 0.7, while the mean internal rotation improved by 3.5 vertebral levels during the same timelines.

Conclusion: The results of our study demonstrate that intra-articular combined with clinico-radiologically predetermined patient-specific landmark-based multisite steroid infiltration using betamethasone leads to a remarkable reduction in pain as well as significant improvement in ROM and clinical outcomes in FS.

Keywords: Frozen shoulder, betamethasone, anterior approach, intra-articular steroid injection, adhesive capsulitis.

Introduction

Frozen shoulder (FS), also known as adhesive capsulitis, is a

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Author's Photo Gallery

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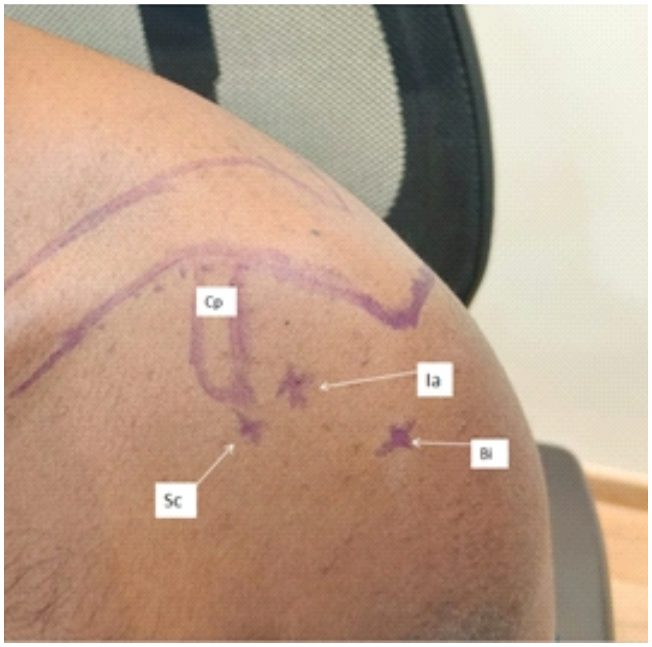


Figure 1: Illustration of surface marking of shoulder for subcoracoid (Sc), intra-articular (Ia) and biceps (Bi) injections and coracoid process (Cp) viewed from anterior.

Figure 2: Illustration of shoulder surface marking of site for subacromial (SA) injection viewed from posterior

common pathologic condition of the shoulder joint. It is characterized by progressive shoulder pain and restriction of the range of motion (ROM) [1]. The Upper Extremity Committee of ISAKOS defined the term "frozen shoulder" as idiopathic stiff shoulder, that is, without a known cause. Secondary stiff shoulder is a term that should be used to describe shoulder stiffness with a known cause [2]. It has been estimated that 2–5% of the general population suffer from FS, and the most affected age group is between 40 and 60 years [3]. Although considered idiopathic, it has been associated with other medical conditions, especially diabetes and hypothyroidism. Diabetics are considered to be 2–4 times more likely to suffer from FS, while the latter's prevalence rate in pre-diabetics has been found to be 37.5% [4,5]. Based on the description by Neviaser, the course of FS is primarily divided into four phases, namely, the freezing phase spanning over the first 3 months and posing as shoulder pain associated with moderate limitation of ROM, followed by the painful phase lasting from three to nine months characterized by severe pain and further reduction of ROM, leading to the frozen stage in which pain may or may not be present but ROM is significantly reduced and finally ending in the thawing stage (15–24 months) during which there is minimal pain and gradual improvement of ROM [6]. The mainstay of non-surgical management includes non-steroidal anti-inflammatory drugs, oral steroids, intra-articular steroid injections, hydro-dilatation of capsule and physiotherapy, the latter being used either solely or in combination with the previous modalities [7].

However, this initial concept of FS being a self-limiting disease that progresses from painful to stiff phases and ultimately leading to full recovery was not only questionable but affected decision-making process of clinicians toward therapeutic intervention [8]. It is now established that the natural history of FS does indeed entail risks of limited range and suboptimal

Figure 3: Low load, long duration inferior capsular stretch.

Figure 4: Coracohumeral ligament stretch.

function of the shoulder. Thus, the potentially unrealistic assumption of complete resolution with thawing may delay treatment [8, 9], various modalities of which have been proven to be beneficial [10].

Our protocol of administering steroids at multiple sites, including the glenohumeral joint, is strongly supported by recent studies which have found this regimen to be unequivocally superior to single intra-articular steroid injections in pain relief, ROM as well as functional outcomes, without compromising on safety [11,12]. The conundrum of whether to opt for physiotherapy, steroid injection, or a combination of both was resolved by Carette et al., whose study demonstrated that while the steroid-only group experienced significant improvement in pain and range, the pain relief was faster in the combination group. They also concluded that physiotherapy alone was of minimal benefit [13]. The current study is to determine the efficacy of patient-specific multi-site landmark-based steroid injection in combination with a standardized physiotherapy protocol followed at our center in the management of FS.

Table 1: Physiotherapy protocol

Physical therapy (Figs. 3,4,5,6)	
Phases	**Physical therapy**
Phase 1	• Modalities to reduce pain
(3–12 days depending on VAS/Stiffness)	• Mobilization with manual traction
	• Maitland Grade 1 and 2 mobilization techniques: (*Joint mobilization in scapular plane, Manual therapy, Ischemic compression, Inferior capsule stretch*)
	• Pendulum movements with 1 kg
	• For refractory cases - Proprioceptive neuromuscular facilitation
Phase 2	• Grade 3–4 Maitland technique
(2–3 weeks till VAS reaches 4 or 5)	• Switch from manual to myofascial manipulation
	• Isometric strengthening
	• Active assisted ROM
	• Coracohumeral Ligament stretch
Phase 3	• Maitland Grade 4 Mobilization in end range
(3–6 weeks)	• Low load long end range stretch
	• Active ROM
	• Scapular stabilization
	• Neuromuscular reeducation to maintain gain in range
Phase 4	• Maintenance for 3–4 months once or twice weekly home exercises, especially in diabetics
(3–4 months)	

ROM: Range of motion, VAS: Visual Analog Scale

Materials and Methods

We identified patients in the shoulder clinic presenting with symptoms directing to FS and constructed a prospective case series. Patients were clinically examined by the fellowship-trained shoulder surgeon on their presentation at a single shoulder clinic. A detailed history was taken, followed by clinical examination highlighting identification of areas of tenderness over the subacromial space, subdeltoid space, intra-articular joint space, and over the biceps tendon as well as assessing ROM. All patients then underwent plain radiographs as well as an ultrasound study to rule out secondary causes of shoulder pain and stiffness and to identify co-existing pathologies, which could be a contraindication to steroid injection (e.g. rotator cuff tears). In cases where ultrasound scans suggested findings other than those attributable to FS, magnetic resonance imaging was requested. Consecutive 94 patients satisfying the definition of FS by The Upper Extremity Committee of ISAKOS were enlisted randomly between January 2020 and September 2023 for the study. Diabetics were required to achieve optimal

Figure 5: Inferior capsular stretch.

Figure 6: Proprioceptive neuromuscular facilitation with deep breathing.

glycemic control (target of fasting blood sugar <110 mg/dL for at least 7 consecutive days) before receiving the steroid injections. After obtaining informed consent, under sterile precautions, patient-specific multisite steroid injections were performed in a single sitting in the glenohumeral joint and in areas of clinical tenderness as well as in bursae having sonographic evidence of inflammation (Fig. 1 and 2). The steroid injection consisted 8 mg of betamethasone (4 mg/mL) mixed with 6 mL of plain 2% lignocaine. 5 mL of the solution was injected into the glenohumeral joint by an anterior-based approach, and the rest of the solution was injected into the other areas of tenderness/inflammation determined as above. Glenohumeral injection was given using the anterior approach, with the site of injection being 1 cm lateral to the coracoid, medial to the humeral head, and angled slightly superior and lateral. Patients with subacromial inflammation were infiltrated inferior to the posterolateral corner of acromion with the direction slightly lateral, toward the anterolateral corner, and the needle was advanced by 2–3 cm.

Subcoracoid steroid injection was done by direct palpation of the tip of the coracoid process, followed by infiltration laterally and inferiorly. The biceps tendon, however, was not directly infiltrated, and the injection was given around the tendon by palpation of the lips of the bicipital groove in the anteromedial aspect of the proximal arm corresponding to the area of tenderness.

Following the injection, the shoulder joint was immobilized for 24 h. Patients were re-examined after 48 h to rule out complications like infection and neurovascular deficits, following which physiotherapy was initiated. The physiotherapy protocol that we utilize is a comprehensive, structured, evidence-based amalgamation of recognized techniques summarized in Table 1 [14,15,16].

Inclusion criteria

Patients were aged – 18–77 years and satisfying the definition of FS by the Upper Extremity Committee of ISAKOS. Other causes of limitation of ROM were ruled out clinically and confirmed with radiological means.

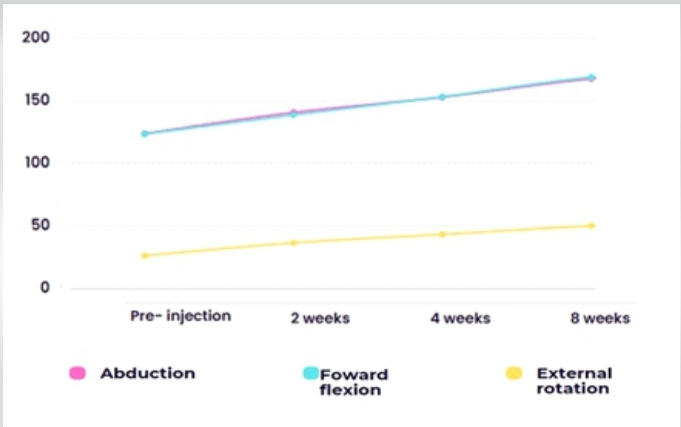
Exclusion criteria

Patients with arthritic changes, calcific deposits, and rotator cuff tears were excluded based on radiological findings. Patients symptomatic in the contralateral shoulder were excluded. Patients with previous shoulder surgery were excluded.

Outcome measurements

ROM and the scores (pre-injection and 2, 4, 8, weeks were measured by one clinical researcher who was blinded to the current study, and the ROM measured with a goniometer. The initial evaluation included the recording of a detailed medical history and clinical examination of the shoulder joint (Active

Graph 2: Functional outcomes and Visual Analog Scale scores at pre-injection and post-injection visits.



Graph 1: Results of range of motion at pre-injection and post-injection visits.

Table 2: Results of ROM at pre-injection and post-injection visits

Timeline	Abduction	Forward flexion	External rotation	Internal rotation (compared to opposite normal shoulder)
Pre-injection	123.7	123.4	26.4	5.0 levels lower
2 weeks	140.5	138.6	36.7	3.9 levels lower
4 weeks	152.7	153	43.4	2.4 levels lower
8 weeks	167.4	168.6	50.2	1.5 levels lower

ROM: Range of motion

and Passive ROM, tenderness in specific bursae around the joint). Pain was determined by a VAS scoring system, and the ASES scoring and SPADI scoring systems were utilised for evaluation of subjective function at each point in the study. Shoulder ROM was measured with the patient seated. Internal rotation at the back was measured by the vertebral level reached with the tip of the thumb.

Results

The sample size consisted of 94 patients diagnosed with primary adhesive capsulitis, and data were collected from February 2020 to September 2023. The study population comprised 36 men (38%) and 58 women (62%), who were at a mean age of 52.6 ± 10.7 years (range 18–77 years). The mean duration of symptoms was 5.1 months ± 2.5 months (range 1–12 months). 25 (26%) patients reported a history of diabetes mellitus. About 9 (10%) patients reported a history of hypothyroidism. The female population was higher by 70%. We also noted in our study that in 53 cases, the left shoulder was affected while the right shoulder was affected in the remaining 41 cases. Out of the 94 patients, 51 patients had subacromial tenderness (54%), 31 patients had sub-coracoid tenderness (33%), and 29 patients had tenderness around biceps tendon (31%). Table 2 and Graph 1 depict the results of ROM pre-injection and at 2, 4, and 8 weeks post-injection. Similarly, the functional outcomes and VAS scores are shown in Table 3 and

Table 3: Functional outcomes and VAS scores at pre-injection and post-injection visits

Timeline	ASES	SPADI	VAS scoring
Pre-injection	28.8	86.8	6.7
2 weeks	38.5	79.8	3.5
4 weeks	76.8	57.7	1.8
8 weeks	88.9	25	0.7

ASES: American Shoulder and Elbow Scoring system, SPADI: Shoulder Pain and Disability Index, VAS: Visual Analog Scale

Graph 2. Abduction, forward flexion and external rotation are all displayed in degrees.

Statistical analysis

The differences in ROM, VAS and functional outcomes between pre-injection status and during post-injection visits were assessed using a paired samples test (Table 5), while the statistical significance of these differences was evaluated by a Wilcoxon signed ranks test (Table 6).

Discussion

In the quest of the ideal treatment for FS, different steroids, injection sites, techniques, and frequency of injection have been studied. As reported by the Consensus Survey of Shoulder Specialists, conservative management remains the most popular as the first line of treatment, and 63% of participants agreed that steroids have a beneficial role [1]. However, despite the abundance of therapeutic modalities, there remains a paucity of guidelines regarding the treatment ladder in the management of FS. There is no definitive guideline as to when to change from one treatment modality to another. However, it is generally acceptable to wait for 3 months before declaring any conservative treatment ineffective [17].

The choice of betamethasone for our study is supported by its high potency (more than 6 times that of triamcinolone) and long half-life of 8.5 days [18, 19]. Furthermore, its solubility reduces its propensity to crystallize, a process which has been incriminated in post-steroid flare reaction [20].

With regards to the injection technique, White et al had demonstrated that 95% (19 out of 20 patients) of anterior-based injections were accurate compared to a mere 50% (10 out of 20 patients) amongst

Table 4: Comparison of our results with those of Rashid *et al*. [26]

Scoring and range of motion	Rashid *et al*.			Our study		
	Pre injection	6th week	3 months	Pre injection	4th week	8th week
VAS	5.9	2.2	1.1	6.7	1.8	0.7
FF	123	156.1	169	123	153	167
ER	34	59.2	66	28	43.4	52
ABD	80	109.6	134	123	152.7	166

VAS: Visual Analog Scale, FF: Forward flexion, ER: External rotation, ABD: Abduction

Table 5: Paired samples test

Scoring duration	Paired differences				
	Mean	Standard Deviation	95% Confidence Interval of the Difference		Sig. (2-tailed)
Pair 1			Lower	Upper	
ASES Pre-inj - 2 weeks	−9.66	2.95	−10.26	−9.06	0
Pair 2					
ASES Pre-inj - 4 weeks	−48.04	4.22	−48.91	−47.18	0
Pair 3					
ASES Pre-inj - 8 weeks	−60.09	4.21	−60.95	−59.22	0
Pair 4					
SPADI Pre-inj - 2 weeks	7.06	11.24	4.76	9.37	0
Pair 5					
SPADI Pre-inj - 4 weeks	29.1	9.3	27.19	31	0
Pair 6					
SPADI Pre-inj - 8 weeks	61.82	11.36	59.49	64.14	0
Pair 7					
VAS Pre-inj - 2 weeks	3.28	1.24	3.02	3.53	0
Pair 8					
VAS Pre-inj - 4 weeks	4.96	1.37	4.68	5.24	0
Pair 9					
VAS Pre-inj – 8 weeks	6.02	1.34	5.75	6.3	0

ASES: American Shoulder and Elbow Scoring system, SPADI: Shoulder Pain and Disability Index, VAS: Visual Analog Scale, Inj: Injection

the posterior approach [21]. Our decision to opt for the anterior approach is further supported by Deng et al. who reported that a decrease in VAS was consistently better at each follow-up, and the improvements in functional scores and external rotation were faster and more significant when using the anterior approach rather than the posterior approach for intra-articular steroid injection in FS [22].

Another area of variability in practice is the use of ultrasound-guided (US-guided) versus landmark-based steroid injections. While the accuracy of US-guided injections is higher (90% vs. 76.2%), this difference was not found to be statistically significant in a cohort study of 41 patients by Raeissadat et al. Improvements in pain, functional scores and ROM (except for extension), albeit more in the US-guided group, failed to reach statistical significance [23]. The lack of significant clinical benefit of US-Guided compared to landmark-based steroid injections was echoed by a Cochrane study, which concluded that there was no advantage in term of pain, function, shoulder ROM or safety in using the former technique [24]. Rather more evident was the fact that US-Guided injections would be more costly and time-consuming [23].

We have strived to base our practice on best available evidence and robust scientific reasoning, but the ultimate litmus test remained our results. The mean VAS score decreased from a pre-injection value of 6.7–0.7. This improvement was significantly higher than that achieved by Amos et al who treated their patients by US-Guided triamcinolone injections and reported a mean VAS score reduction from 5.6 to 3.0 [25]. Interestingly, this reduction occurred over a mean of 2.1 months, whereas our results demonstrate a comparable VAS of 3.5 at a mere 2 weeks and a VAS of 1.8 at 4 weeks only. Rashid et al. [26] evaluated the efficacy of a single intra-articular injection of methylprednisolone combined with physiotherapy and physiotherapy alone (Table 4). The authors concluded that the results were significantly better in the combination group. The mean VAS score in the combination group decreased to 1.1 from 5.9 at 3 months. The VAS score had reached 2.2 by 6 weeks post-injection. The mean SPADI score improved from 62.5 to 33.0 at 6 weeks and 18.9 at 3 months in his patients, compared to 86.8 at pre-injection to 25.0 at 8 weeks in our study. They also reported a mean increase in internal rotation by 7 levels by 6 weeks and 9 levels by 3 months compared to an improvement of 3.5 levels by 8 weeks. An explanation to this discrepancy could be the fact that his patients overall had a more significantly reduced internal rotation that our patients – the mean internal rotation was S3, whereas the most severely restricted internal rotation was S1 in our study group. Our study betamethasone has high potency, long half-life, and good solubility, which improves external rotation faster with anterior approach steroid injection. These landmark-based multisite steroid injections are not as accurate

Table 6: Wilcoxon signed ranks test

Scoring duration	ASES Pre-inj - 2 weeks	ASES Pre-inj - 4 weeks	ASES Pre-inj – 8 weeks	SPADI Pre-inj – 2 weeks	SPADI Pre-inj – 4 weeks	SPADI Pre-inj – 8 weeks	VAS Pre-inj – 2 weeks	VAS Pre-inj – 4 weeks	K VAS Pre-inj – 8 weeks
Z	−8.431[a]	−8.427[a]	−8.429[a]	−4.862[b]	−8.421[b]	−8.420[b]	−8.479[b]	−8.478[b]	−8.482[b]
Asymptotic Significances (2-tailed)	0	0	0	0	0	0	0	0	0

[a]Based on negative ranks. [b]Based on positive ranks. ASES: American Shoulder and Elbow Scoring system, SPADI: Shoulder Pain and Disability Index, VAS: Visual Analog Scale, Inj: Injection

as US-guided injections.

Conclusion

The results of our prospective case series demonstrate that clinico-radiologically predetermined landmark-based multisite steroid infiltration using betamethasone leads to a remarkable reduction in pain as well as significant improvement in ROM and function in the treatment of FS.

Clinical Message

Clinically, landmark-based multisite betamethasone steroid infiltration, guided by clinical and radiological assessment, appears to be an effective, simple, and minimally invasive treatment option for frozen shoulder, providing significant pain relief and improvement in shoulder motion and function.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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