Suprascapular nerve block followed by Codman's manipulation and exercise in the rehabilitation of idiopathic frozen shoulder

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Background

Frozen shoulder is characterized by inflammation of the synovial lining and capsule, with subsequent generalized contracture of the glenohumeral joint causing shoulder pain and a gradual loss of both passive and active range of motion. Pain relief through suprascapular nerve block (SSNB) followed by manipulation and home exercises may be a suitable treatment option in such patients.

Objective

The aim of this study was to evaluate the role of SSNB followed by Codman's shoulder manipulation and home exercises in the management of idiopathic frozen shoulder.

Patients and methods

Twenty patients with idiopathic unilateral frozen shoulder underwent SSNB followed by Codman's manipulation of the glenohumeral joint and a home exercise program. Differences in range of motion, visual analog scale for pain, and Shoulder Disability Questionnaire were assessed before manipulation and at 1, 6, and 12 weeks after manipulation.

Results

The mean age of the patients was 52.1 years. Active range of motion increased significantly for flexion, abduction, internal rotation, and external rotation. Significant decrease in visual analog scale and Shoulder Disability Questionnaire scores between baseline and follow-up assessments was observed.

Conclusion

Manipulation under SSNB is a safe, effective, and minimally invasive procedure for relieving pain, improving range of motion, and decreasing disability in patients with idiopathic frozen shoulder.

Introduction

In 1934, Codman described a painful shoulder condition characterized by an insidious onset of pain felt near the insertion of deltoid, inability to sleep on the affected side, restriction in both active and passive elevation as well as external rotation, atrophy of spinati, and normal radiologic appearance. Such painful condition was termed frozen shoulder or adhesive capsulitis [1]. It is a common problem in general practice characterized by inflammation of the synovial lining and capsule, with subsequent capsular contracture leading to shrinkage of the joint cavity [2,3].

Frozen shoulder may be primary idiopathic or secondary to other diseases, such as diabetes, hyperthyroidism, and trauma. It passes through four stages described as inflammatory, freezing, frozen, and thawing. In the inflammatory stage, passive range of motion (ROM) is increased with anesthesia, indicating that ROM is pain limited. Histologically, there are inflammatory infiltrates and hypervascular synovitis with a normal underlying capsule. The freezing stage differs in that passive ROM is similar with or without anesthesia and histologically shows hypertrophic, hypervascular synovitis with capsular scaring. In the frozen stage, pathological specimens show reduced synovitis and dense scar formation in the underlying capsule. The thawing stage represents resolution and no pathological specimens have been described [4,5].

Many treatment options for adhesive capsulitis have been described, including rest, NSAIDs, active and passive mobilization, physiotherapy, intra-articular corticosteroids, intra-articular hyaluronate injection, manipulation under anesthesia when conservative treatment fails, and finally arthroscopic capsular release [6–9]. One of the main goals of treatment is to restore shoulder function through manipulation and therapeutic exercises in which the patient must cooperate and take an active part. The most important factor limiting patients' cooperation in exercise is pain. Hence, regional nerve block, attributable to its role in pain relief, can be used before the exercise

program [10]. Among various nerve block techniques, suprascapular nerve block (SSNB) is an effective and simple method for the management of shoulder pain, with no significant complications reported in over 2000 procedures apart from rare vasovagal episodes [11–14].

Multiple shoulder manipulation techniques have been described, including manipulation with steroid injection and manipulation under general or local anesthesia. Fracturing the humerus during shoulder manipulation is a common complication, in addition to shoulder dislocation, postmanipulation pain, hemarthrosis, tearing of the joint capsule or rotator cuff, and traction injury to nerves [15].

The Codman's manipulation refers to a specific pattern of motion at the shoulder joint leading to an indirect humeral rotation without placing a rotational torque on the humerus, thereby reducing fracture risk during manipulation. This is achieved when the arm performs a closed-loop motion by three consecutive 90° rotations defined as Codman's rotations, each around the respective coordinate axis. Such rotations will lead to an apparently indirect 90° rotation around the longitudinal axis of the humerus [1,16].

This study aimed to evaluate the role of SSNB followed by Codman's shoulder manipulation and home exercises in the management of idiopathic frozen shoulder.

Patients and methods

The methodology of this prospective clinical study was approved by the research ethical committee of Ain Shams Faculty of Medicine and all patients provided written informed consent before participation. This study included 20 patients diagnosed clinically with unilateral idiopathic frozen shoulder. All patients were recruited from the Outpatient Clinic of Physical Medicine and Rehabilitation Department in Ain Shams University Hospitals.

Inclusion criteria were as follows: shoulder pain and stiffness in one shoulder for at least 4 weeks with a contralateral normal shoulder; restricted active and passive ROM at the glenohumeral joint; no history of recent trauma; no previous injection in the involved shoulder; no history of allergy to local anesthetics; no coagulation disorders; normal blood sugar level; and normal radiograph of the shoulder.

Exclusion criteria included secondary causes of frozen shoulder, such as diabetes mellitus, hyperthyroidism, radiation, surgery, trauma, etc.; bony or neurologic disorders that might be an alternative cause of the shoulder pain; previous open reduction internal fixation for fracture; hemiarthroplasties; total shoulder replacements; and infections.

Baseline assessment

Both shoulders (normal and affected) were clinically assessed for the ROM of abduction, flexion, and external rotation using goniometry, and internal rotation was assessed by the ability of patients to reach their back with their hand as high as possible, and the distance between their thumb and the caudal edge of the contralateral scapula was measured in centimeters [17]. Patients were assessed for pain using a 10 cm visual analog scale (VAS) and the Shoulder Disability Questionnaire (SDQ) was administered [18].

Suprascapular nerve block [14,19]

Solution preparation

A volume of 10 ml solution was prepared for injection (9 ml of 0.5% bupivacaine for nerve block and 1 ml of 0.4% dexamethasone sodium phosphate to increase the duration of nerve blockade).

Technique

Using the Dangoisse technique, a 21 G × 1.5" needle was introduced through the skin 2 cm superior to the midpoint of the scapular spine, parallel to the blade of the scapula and directed inferiorly toward the supraspinous fossa floor (Fig. 1). The needle was advanced in this plane until a bony contact was made with the floor of the suprascapular fossa. The needle must be aspirated to exclude the risk of intravascular

Figure 1

Posterior image of suprascapular nerve block using the Dangoisse technique. Landmarks are indicated as follows: acromion and lateral end of the scapular spine (a), medial end of the scapular spine (b), and midpoint of the scapular spine (c). Note that the needle is aligned 2 cm superior to the midpoint of the scapular spine parallel to the blade of the scapula.

needle placement. Once in place, the 10 ml was injected slowly into the floor of the fossa, bathing the suprascapular nerve to produce SSNB. At this point, the suprascapular nerve gives branches to supply the glenohumeral joint, acromioclavicular joint, and supraspinatus muscle.

Codman's manipulation [1,16]

Codman's manipulation was started 15 min after injection to ensure the achievement of SSNB.

It includes three consecutive 90° rotations called elevation, swing, and descending movements.

(1) *Starting position*: The patient hangs his or her arm along the side with the thumb pointing forward and fingers pointing toward the ground.
(2) *Elevation (first move)*: The arm is elevated 90° in the sagittal plane without rotation about the humeral shaft axis (i.e. thumb points upward and fingers point forward).
(3) *Swing (second move)*: The arm is moved 90° to the coronal plane without rotation about the humeral shaft axis (i.e. fingers now point to the right or left for the right and left shoulders, respectively).
(4) *Descending (third move)*: Finally, the arm is lowered 90° downward (i.e. fingers point to the ground). After these three rotations, the patient will notice that the thumb points to the right or left (for the right and left shoulders, respectively), which means that the arm has rotated by 90°.

Postmanipulation exercises

Each postmanipulation exercise was performed for 10 repetitions.

Figure 2

The patient holds the affected arm with the sound one and attempts to lift the affected arm over the head with the help of the sound limb, performing arm flexion.

Standing position
The patient was asked to hold the affected arm with the sound one and perform arm flexion (attempt to lift the affected arm over the head with the help of the sound limb). The patient was asked to maintain this position for 2 min (Fig. 2).

Sitting position
The patient was asked to touch the scapula with the help of the other hand to gain internal rotation.

Supine position
The patient was asked to place both hands behind the head and attempt to gradually bring the elbows to the level of the bed to gain external rotation (Fig. 3).

Immediate postmanipulation evaluation of ROM was performed.
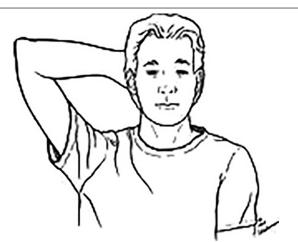
Home exercise program

All patients were given verbal and written instructions regarding a home exercise program, which includes the same postmanipulation ROM exercises, in addition to pendulum exercises for the arm and stretching techniques for the shoulder joint. Home exercises were performed for 10 repetitions, three times daily for 12 weeks. Compliance with the exercise program was monitored through a training diary in which the exercises were documented.

Patients were not referred for physiotherapy and were advised to take only acetaminophen for pain relief.

Outcome assessment

Patients were reassessed after 1, 6, and 12 weeks following the procedure for ROM, SDQ scores, and

Figure 3

The patient places his hand behind the head and gradually brings the elbow to the level of the bed to gain abduction and external rotation.

10 cm VAS scores for pain intensity at rest and on extreme movement.

The SDQ contains 16 items referring to situations that might be associated with functional limitations in patients with shoulder complaints (Table 1). All items refer to the preceding 24 h. Response options are 'yes', 'no', or 'not applicable'. The response option 'not applicable' was chosen when the condition had not occurred during the past 24 h. Patients completed the questionnaire after a short explanation of the response options. The final SDQ score was calculated by dividing the number of positive responses by the total number of applicable items and multiplying this score by 100. Consequently, the SDQ score can range from 0 to 100, with a higher score indicating more severe disability [18].

Pain was measured using VAS, which comprised a 10-cm line anchored at one end by '0' and at the other end by '10', signifying no pain and worst pain felt by the patient, respectively [20].

Statistical analysis

Outcome measures were assessed at baseline and 1, 6, and 12 weeks after manipulation. Before statistical analysis, the Kolmogorov–Smirnov test was performed to assess the normality of the continuous data. The data showed normal distribution; therefore, a parametric statistical method was performed to analyze the data. A comparison of baseline ROM between affected and nonaffected shoulders was performed using Student's t-tests. Comparison analysis between ROM, VAS, and SDQ at baseline and their values at 1, 6, and 12 weeks after manipulation was performed using the paired t-test. Results were presented as means ± SD.

P values less than 0.05 were regarded as statistically significant.

Results

This study included 20 patients with a male to female ratio of 40 : 60%. Their ages ranged from 40 to 60 years, with a mean of 52.1. The baseline clinical data of patients are shown in Table 2.

There was a marked restriction in the ROM of the affected shoulder in comparison with the contralateral side before manipulation (Table 3).

One week after manipulation, the ROM was significantly increased ($P < 0.05$), whereas VAS at rest and SDQ were significantly decreased ($P < 0.05$), but VAS at activity was not decreased to a significant level ($P > 0.05$) (Table 4).

At 6 and 12 weeks after manipulation, there was a significant increase in the ROM ($P < 0.05$), whereas VAS (at both rest and activity) and SDQ score were significantly decreased ($P < 0.05$) in comparison with baseline (Tables 5 and 6).

Discussion

Frozen shoulder causes pain, tenderness, and stiffness in the affected shoulder. Various treatment modalities, such as physiotherapy, oral cortisone, intra-articular steroid injection, manipulation under anesthesia, and arthroscopic release of adhesions, have been used in an attempt to shorten the duration of shoulder symptoms. However, some patients cannot wait an unpredictable

Table 1 Shoulder disability questionnaire

Shoulder Disability Questionnaire (SDQ)	NA	Yes	No
1. I wake up at night because of shoulder pain.	☐	☐	☐
2. My shoulder hurts when I lie on it.	☐	☐	☐
3. Because of pain in my shoulder it is difficult to put on a coat or a sweater.	☐	☐	☐
4. My shoulder hurts during my usual daily activities.	☐	☐	☐
5. My shoulder hurts when I lean on my elbow or hand.	☐	☐	☐
6. My shoulder hurts when I move my arm.	☐	☐	☐
7. My shoulder hurts when I write or type.	☐	☐	☐
8. My shoulder is painful when I hold the driving wheel of my car or handle bars of my bike.	☐	☐	☐
9. When I lift and carry something my shoulder hurts.	☐	☐	☐
10. During reaching and grasping above shoulder level my shoulder hurts.	☐	☐	☐
11. My shoulder is painful when I open or close a door.	☐	☐	☐
12. My shoulder is painful when I bring my hand to the back of my head.	☐	☐	☐
13. My shoulder is painful when I bring my hand to my buttock.	☐	☐	☐
14. My shoulder is painful when I bring my hand to my low back.	☐	☐	☐
15. I rub my painful shoulder more than once during the day.	☐	☐	☐
16. Because of my shoulder pain I am more irritable and bad tempered with people than usual.	☐	☐	☐

length of time to regain their shoulder activity and undergo treatment with the aim of restoring normal shoulder function at the earliest possible time [21–25].

Table 2 Baseline clinical data

	mean ± SD
Pain duration at onset (months)	7.15 ± 2.83
VAS score (at rest) (0-10)	6.95 ± 1.32
VAS score (at extreme shoulder movement) (0-10)	8.05 ± 1.23
ROM	
Shoulder flexion (°)	81.05 ± 15.86
Shoulder abduction (°)	78.19 ± 12.63
Shoulder internal rotation (cm)	31.89 ± 3.23
Shoulder external rotation (°)	18.69 ± 2.29
Baseline SDQ score (0-100)	83.40 ± 10.33

ROM, range of motion; VAS, visual analogue scale; SDQ, Shoulder Disability Questionnaire

Table 3 Range of motion of affected shoulders compared to normal side before manipulation

Observations	Affected shoulder (Mean ± SD)	Normal shoulder (Mean ± SD)	Significance
Flexion (°)	81.05 ± 15.87	165.50 ± 5.45	0.00
Abduction (°)	78.19 ± 12.63	160.61 ± 10.40	0.00
Internal Rotation (cm)	31.89 ± 3.23	3.50 ± 2.70	0.00
External Rotation (°)	18.69 ± 2.29	75.56 ± 2.90	0.00

A simple and effective method for shoulder pain relief is the regional SSNB, which shows a greater relief from symptoms compared with placebo, and a faster and complete reduction in pain compared with intra-articular steroid injection [26]. In addition, Ozkan *et al.* [27] reported that SSNB may effectively increase patient's pain tolerability, which in turn helps patients to tolerate physical therapy.

After SSNB, shoulder pain diminishes and an effective therapeutic exercise program can be performed. The suprascapular nerve provides sensory fibers to ~70% of the shoulder joint and has afferent, efferent, and sympathetic fibers. The efferent fibers innervate the supraspinatus and infraspinatus muscles, whereas the afferent fibers distribute to the articular capsule, ligaments of the glenohumeral and acromioclavicular joints, the periosteum, and tendons of the scapula. Hence, significant pain relief can be achieved if the nerve block is performed before it gives its articular branches. The most appropriate site is around the suprascapular notch, in which the nerve can be located easily [28].

Table 4 Comparison of ROM, VAS and SDQ at baseline and one week post manipulation

Observations	Pre-manipulation (Mean ± SD)	One week Post-manipulation (Mean ± SD)	Significance
Flexion	81.05 ± 15.87	110.40 ± 16.71	0.00
Abduction	78.19 ± 12.63	123.27 ± 14.15	0.00
Internal Rotation (cm)	31.89 ± 3.23	22.68 ± 4.24	0.00
External Rotation	18.69 ± 2.29	45.23 ± 5.92	0.00
VAS at rest	6.95 ± 1.31	5.79 ± 1.21	0.00
VAS at extreme movement	8.05 ± 1.23	7.91 ± 1.23	0.07
SDQ	83.39 ± 10.33	53.18 ± 10.24	0.00

VAS (visual analogue scale); SDQ (Shoulder Disability Questionnaire)

Table 5 Comparison of ROM, VAS and SDQ at baseline and 6 weeks post manipulation

Observations	Pre-manipulation (Mean ± SD)	Post-manipulation 6 weeks (Mean ± SD)	Significance
Flexion	81.05 ± 15.87	131.81 ± 16.40	0.00
Abduction	78.19 ± 12.63	145.55. ± 12.79	0.00
Internal Rotation (cm)	31.89 ± 3.23	14.39 ± 3.75	0.00
External Rotation	18.69 ± 2.29	55.18 ± 5.95	0.00
VAS at rest	6.95 ± 1.31	2.73 ± 0.69	0.00
VAS at extreme movement	8.05 ± 1.23	2.67 ± 0.73	0.01
SDQ	83.39 ± 10.33	26.23 ± 6.62	0.00

VAS (visual analogue scale); SDQ (Shoulder Disability Questionnaire)

Table 6 Comparison of ROM, VAS and SDQ at baseline and 12 weeks post manipulation

Observations	Pre-manipulation (Mean ± SD)	Post-manipulation 12weeks (Mean ± SD)	Significance
Flexion	81.05 ± 15.87	143.27 ± 15.20	0.00
Abduction	78.19 ± 12.63	153.61. ± 12.45	0.00
Internal Rotation	31.89 ± 3.23	7.75 ± 2.90	0.00
External Rotation	18.69 ± 2.29	63.03 ± 4.71	0.00
VAS at rest	6.95 ± 1.31	1.54 ± 0.57	0.00
VAS at extreme movement	8.05 ± 1.23	1.28 ± 0.56	0.01
SDQ	83.39 ± 10.33	10.11 ± 2.77	0.00

VAS (visual analogue scale); SDQ (Shoulder Disability Questionnaire)

Various SSNB techniques have been described in which Dangoisse *et al.* [14] performed indirect SSNB using an anatomical landmark approach that is easy, decreases the risk of pneumothorax, can be performed by most trained specialists as it has a short learning curve, and can be performed without the need to image the area by ultrasound or fluoroscopy [11–14,27]. Hence, the Dangoisse technique for SSNB was used in our study and it was safe and well tolerated by our patients.

Local steroid injection blocks transmission through nociceptive C fibers, thus prolonging the effect of the local anesthetic through alteration of the function of K channel on the excitable tissue [29,30]. Hence, steroids were added to the anesthetic used in SSNB in our study.

The only adverse event during the course of our study was with one female patient who experienced a vasovagal collapse following SSNB. She recovered quickly, and manipulation was carried out successfully.

In the treatment of frozen shoulder, the physician attempts to relieve discomfort for the patient and restore motion and function. When conservative treatment fails, manipulation of the shoulder under general anesthesia is performed. Any rotational torque placed on the arm during manipulation can cause fracture humerus. Codman's technique prevents any rotational torque to the humerus, thus reducing the risk for humerus fracture [31]. In our study, instead of manipulating the shoulder under general anesthesia in the operating room, Codman's manipulation following SSNB was used in the outpatient clinic, thus reducing the risk of general anesthesia, patient discomfort, and treatment cost. Our results were as good as those of Hollis *et al.* [31] who used general anesthesia for the reduction of pain and disability and improvement of ROM. In addition, in our study no complications were encountered and patients tolerated the procedure well.

The results of our study showed that patients with idiopathic frozen shoulder benefit from SSNB using bupivacaine and dexamethasone followed by Codman's manipulation and active assisted ROM exercises at home. There was a statistically significant improvement of ROM, in addition to a significant reduction in pain and disability as measured by VAS and SDQ, respectively. In addition, pain relief extended for 12 weeks after injection, thus extending beyond the pharmacological effect of the drug. There are many possible explanations, including a decrease in central sensitization of dorsal horn nociceptive neurons. In addition, depletion of substance P and nerve growth factor in the synovium and afferent C fibers of the glenohumeral joint after the blockade may also contribute to the long-term relief. In addition, a 'wind down' (a reduction in peripheral nociceptive input) has been suggested [32–34].

In 2009, Khan *et al.* [35] used manipulation for the glenohumeral joint other than Codman's following SSNB and intra-articular local anesthesia in patients with idiopathic frozen shoulder, showing a significant decrease in VAS and increase in ROM; however, shoulder disability was not assessed. Our results were similar to that of Khan and colleagues, although we used a different type of manipulation: no intra-articular anesthesia was used and shoulder disability was assessed using SDQ in our study.

An additional study was performed by Mitra *et al.* [36] on patients with frozen shoulder in whom SSNB was performed followed by intra-articular shoulder injection with steroid and local anesthetic, and finally manipulation was performed in flexion and abduction movements only. The results of our study are in accordance with those of Mitra and colleagues, although our patients were not subjected to the risk of intra-articular injection and the manipulation technique used in our study included rotational movements, thus improving ROM in internal and external rotations, in addition to flexion and abduction, in contrast to the study by Mitra and colleagues in which only flexion and abduction showed improvement.

In 2014, Ozkan *et al.* [27] reported an improvement in shoulder pain following SSNB. Their study varied from ours, as they included only 10 patients with frozen shoulder secondary to diabetes mellitus, which was excluded from our study; no manipulations were performed and shoulder disability was not assessed. Yet, the results of Ozkan and colleagues support our results and provide hope for the management of pain in frozen shoulder.

According to the results of our study, SSNB followed by Codman's manipulation and home exercises accelerates the recovery of idiopathic frozen shoulder. This combined approach is effective and safe to be administered in outpatient clinics by a well-trained physician and reduces the time spent at a hospital; further, there are economic benefits as patients are able to return to work sooner without the need for hospitalization or spending time in physical therapy sessions. However, this needs to be proved by a longer follow-up study involving a larger patient sample.

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