Lupus Open Access

El-Badawy and Fathalla, Lupus Open Access 2016, 1:1

Review Article | Open Access

Suprascapular Nerve Block Followed by Codman's Manipulation and Home Exercises "An Effective Combined Approach in the Rehabilitation of Idiopathic Frozen Shoulder": A Review

El-Badawy MA* **and Fathalla MM**

Department of Physical Medicine, Rheumatology and Rehabilitation, Ain Shams University Faculty of Medicine, Cairo, Egypt

***Corresponding author:** El-Badawy MA, Department of Physical Medicine, Rheumatology and Rehabilitation, Ain Shams University Faculty of Medicine, Cairo, Egypt, Tel: 002 01111434418; E-mail: mohjaelbadawy@gmail.com

Received date: January 04, 2016; **Accepted date:** January 25, 2016; **Published date:** February 17, 2016

Abstract

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. The pathology of idiopathic frozen shoulder is defined as a self-limiting condition of unknown etiology. Pain relief through suprascapular nerve block (SSNB) followed by manipulation and home exercises may be a suitable treatment option in such patients.

Keywords: Adhesive capsulitis; Codman's manipulation; Frozen shoulder; Manipulation; Suprascapular nerve block

Introduction

The term "frozen shoulder" was first used by Codman [1] and thereafter Neviaser [2] noted that the pathology of the condition was actually located at the capsule of the shoulder joint and therefore called it "adhesive capsulitis". The typical findings are pain and a global restriction of movement, with limited passive external rotation being the most notable [3]. Frozen shoulder management presents the clinicians with an opportunity to use all skills to alleviate pain and restore function of the shoulder.

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 anaesthesia when conservative treatment fails, and finally arthroscopic capsular release [4-7]. 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 [8]. 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 [9-12].

Although frozen shoulder is believed to be a benign self-limiting disorder, which tends to be resolved over 1-2 years, authors suggested that patients with significant stiffness are good candidates for manipulation under anaesthesia rather than conventional treatment because conventional treatment of intensive physiotherapy must be carried out for months to years in order to regain the range of motion (ROM) [13,14].

It must be emphasized that even after manipulation of shoulder, a regular supervised physiotherapy is critical to ensure a mobile painless shoulder otherwise significant stiffness quickly return. Multiple shoulder manipulation techniques have been described, including manipulation with steroid injection and manipulation under general or local anaesthesia. Fracturing the humerus during shoulder manipulation is a common complication, in addition to shoulder dislocation, post-manipulation pain, hemoarthrosis, 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 [16,17].

Epidemiology

The prevalence of adhesive capsulitis is 2-5% in a normal population [18,19]. It is more common in females and between the ages of 40 and 60 years [1,20]. A genetic component is reported although the direct mechanisms by which genes influence soft tissue disorders are still unknown [21]. Contra lateral shoulder involvement shoulder involvement reported in up to 20-30% of patients and recurrence in ipsilateral shoulder is unusual [18].

Natural history

The natural history of idiopathic frozen shoulder syndrome is considered benign. Codman [1] and Grey [22] stated that frozen shoulder is a self-limiting condition with complete resolution of pain and recovery of range of motion within a maximum of 2 years from the onset of symptoms.

Deplama [23] reported on three patients who had remained symptomatic five, six and eight years after the onset of symptoms with no indication of improvement.

Murnaghan [24] stated that "the time course of return of shoulder motion is quite unpredictable". The long period of pain and disability reported in cases of frozen shoulder has been the reason for different interventions management.

Pathology of "frozen shoulder"

The pathophysiological process is believed to involve synovial inflammation and fibrosis of the shoulder joint capsule [25]. Cytokines such as Transforming Growth Factor-beta (TGF-β) and Platelet Derived Growth Factor (PDGF) may contribute to the inflammatory process [26]. Hand et al. found a chronic inflammatory response with a chronic inflammatory response with a fibroblastic proliferation suggesting the process to be immunomodulated [25].

Four arthroscopic stages described by Naviaser as inflammatory, freezing, frozen, and thawing [2]. In the inflammatory stage, passive ROM is increased with anaesthesia, 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 anaesthesia 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 [27,28]. On the contrary Lundberg [29] documented periarticular inflammatory changes and thickening of the joint capsule without intra-articular adhesions. Rizk et al. [30] discovered thickening and constriction of the capsule. Ozaki [31] found a contracted and hypertrophied coracohumeral ligament.

Clinical Picture

The diagnosis is made on the basis of medical history and clinical examination. In 1934 Codman [1] proposed the following diagnostic criteria for frozen shoulder:

- Shoulder pain of slow onset.
- Pain felt at the deltoid insertion.
- Inability to sleep on affected side.
- Atrophy of supra- and infra spinatus muscles.
- Restriction of active and passive ROM.
- Painful and restricted elevation and external rotation.

History

Most patients with idiopathic frozen shoulder have no history of shoulder trauma. They usually give a history of insidious onset of pain, followed by a loss of motion. Night and rest pain are common in the early stages.

Clinical examination

The only sign found in the early stages of the disease process is pain experienced at the end range of shoulder motion. Patients presenting with inflammatory and freezing stages have pain on palpation of the anterior and posterior capsule and describe pain radiating to the deltoid insertion. Later on in the disease process, a mild disuse atrophy of the deltoid and supraspinatus muscles can be found. A diffuse tenderness with palpation over the glenohumeral joint can extend to the trapezius and interscapular area [4]. It has been found that complete loss of external rotation is pathognomonic for frozen shoulder [32]. The disease process least affects extension and horizontal adduction movements [33]. Most of the movements in a severely affected frozen shoulder occur at the scapula-thoracic joint.

Special examinations

Plain x-rays mostly reported as normal but some may show periarticular osteopenia due to disuse [34]. These x-rays can assist in excluding other causes of stiff shoulder, such as rotator cuff disease and glenohumeral arthritis [35]. MRI can be helpful in identifying other causes of a stiff shoulder, such as infection or tumors. Laboratory investigations are useful in patients with other medical issues that may lead to secondary frozen shoulder. These include fasting blood glucose, lipid profile and thyroid stimulating hormone.

Management of frozen shoulder

The decision regarding the best treatment option must be individualized to each patient depending on the stage of the disease and clinical symptoms, as there is no consensus on a standard management protocol.

Non-surgical treatment

Medications

Oral non-steroidal anti-inflammatory drugs can be initiated in patients who present with painful limited ROM during the painful freezing phase [6]. Oral steroids have been proposed as a treatment option for frozen shoulder [7]. However, Bushbinder et al. [36] found that, although it did improve the symptoms initially, the effect did not last beyond six weeks. In light of its adverse reactions, some authors suggest that it should not be routinely used for this condition.

Intra-articular steroids

A corticosteroid intra-articular injection has been extensively used in different ways and with different success rates ranging from 44 to 80% [30,37]. A cochrane database review showed that it might be beneficial in the short term and that the effect will not maintained [38]. However, it is more effective when used in combination with other therapies. Carrette et al. [39] found that intra-articular steroids combined with physiotherapy were more effective in improving shoulder ROM than when each of these was used individually. Jacobs et al. [40] also showed that a combination of steroids and distension had the same outcome at two years as manipulation under anaesthesia.

Physiotherapy

Physiotherapy alone is an effective treatment but is a complement to other therapies, especially to improve the range of movement in external rotation [41,42]. The goal should be to stretch the capsule sufficiently to allow normal glenohumeral biomechanics. Diercks et al. [41] compared the outcome of 77 patients after some received intensive physiotherapy (passive stretching and manual mobilization) and other supervised neglect (active exercises within pain-free range and pendulum exercises). The supervised –neglect group showed the best results with 89% of patients' having normal painless shoulders compared to the intensive group with only 63% of patients achieving the same results.

Hydrodilation

Hydrodilation was first described by Andren and Lundberg [43] in 1965, appears to be another good therapeutic intervention for achieving rapid symptomatic relief from adhesive capsulitis [44,45]. It consists of an injection of a solution causing rupture of the capsule by hydrostatic pressure. The solution could be saline solution or combined with corticosteroids [45]. Quraishi et al. [46] showed better results with hydrodilation than manipulation under anaesthesia. They reported that at 6 months follow-up the Constant score showed a statistically significant improvement. However, the ROM had not improved.

Surgical treatment

Manipulation under anaesthesia

Duplay [47] initially recommended this kind of manipulation as a treatment option for adhesive capsulitis in 1872. It is generally indicated in patients with persistent functional disability in spite of adequate non-operative treatment for 4-6 months. However, opponents cite the risk for dislocation, fracture, nerve palsy, and rotator cuff tears as limitations to this technique [15]. During this procedure, the synovium, the joint capsule especially the inferior axillary pouch of capsule are ruptured, but tears have also been observed to involve the intra-articular long head of biceps and the subscapularis tendon [48]. Some authors [35,49] recommend that an arthroscopic examination be performed before a closed manipulation as they have shown that it helps to reduce stiffness and pain. Physiotherapy is recommended for two to six weeks post-surgery.

Arthroscopic capsular release

The first arthroscopic release was described by Conti in 1979. It is especially recommended in diabetic patients or in patients with post-operative or post-fracture frozen shoulder [50]. Arthroscopy has been considered useful to confirm the diagnosis, to exclude other significant pathology, to classify the stage of the disease and to treat the stiff shoulder with or without manipulation [51]. Potential risks of arthroscopic capsular release include recurrent stiffness, post-operative anterior dislocation and axillary nerve injury at the 6 o'clock position [3]. Pain pumps are suggested to assist in early pain-free mobilization in the first few days. These should be placed in the subacromial space; as some complications have been reported if placed intra-articular [3]. Patients can be started on physiotherapy in hospital and discharged on home exercises that are both passive and active-assisted. Continuous passive motion (CPM) can be helpful in refractory cases [3].

Open surgical release

Open surgical release should be considered in patients for whom arthroscopy is contraindicated or has failed [51]. Traditionally, non-operative management of adhesive capsulitis is recommended for a minimum of six to twelve months before considering operative intervention [52]. However, patients with persistent symptoms and those who have risk factors such as diabetes mellitus or are affected bilaterally might benefit from earlier surgical [53].

SSNB and Codman's manipulation Therapies

Anatomical background

The shoulder joint is supplied primarily by axillary nerve and suprascapular nerve with small branches from the subscapular and lateral pectoral nerves. SSN originates from the upper trunk with contribution from C5-6 and some variable contribution from C4. It travels anterior to the trapezius and parallel to omohyoid, crosses the posterior triangle to enter the suprascapular notch. The superior articular branch comes off 4.5 cm proximal to transverse scapular ligament and continues along with the main nerve beneath the ligament [54]. The SSN then travels towards the spine where it sends a branch to the supraspinatus muscle and winds around the spinoglenoid notch to supply the infraspinatus muscle. In its course along the scapular spine, the inferior articular branch separates from the main nerve and courses obliquely to supply the posterior shoulder joint [55]. SSN supplies 70% of the sensory fibers to the superior and postero-superior shoulder joint, the acromio- clavicular joint, capsule and overlying skin variably [56].

Techniques

Suprascapular nerve block techniques

Traditionally, SSN blockade has been performed via the use of anatomical landmarks. More recently, the use of imaging guidance to more accurately guide needle placement has been described [56]. Various landmark approaches have been described and can be categorized into posterior, superior and lateral approaches. The posterior approach attempts to block the SSN at the level of suprascapular notch [57-61], while the superior approach aims to block the SSN by surrounding the nerve with local anaesthetic on the floor of supraspinous fossa [62,63]. A lateral approach to localize the SSN has also been described [64,65]. Disadvantages of the posterior approach are the potential absence of suprascapular notch in some individuals and the potential risk of pneumothorax. The superior approach may negate these disadvantages. Dangoisse et al. described an indirect SSN block, using anatomical landmarks [63]. This type of approach is easy and decreases the risk of pneumothorax. It can be performed by most trained specialists.

Dangoisse technique

A 25-G needle has to be introduced through the skin 2 cm cephaloid to the midpoint of the spine of the scapula, with the patient sitting and the upper limbs bending beside the body. Anatomic landmarks must be palpated, such as clavicle, acromioclavicular articulation, acromion, scapular spine, and coracoid process. The entire area must be sterilized with alcohol, and then the needle to be advanced parallel to the blade of the scapula until bony contact is made in the floor of the suprascapular fossa (Figure 1). The needle must be aspired before infusion of anaesthetic solution so that there is no risk this solution enters the blood stream directly. This technique has previously been demonstrated to be safe, and it effectively blocks the articular branches of the suprascapular nerve [63]. For treatment of chronic shoulder conditions, injectable steroids usually are added to the local anaesthetic solution (10 ml solution of 0.5% bupivacaine hydrochloride and 40 mg of methyl prednisolone acetate) [65-70]. Local steroid injection blocks transmission through nociceptive C fibers, thus prolonging the effect of the local anaesthetic through alteration of the function of K channel on the excitable tissue [71,72].

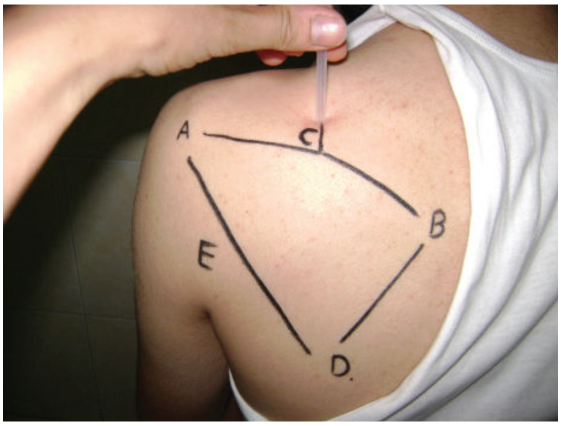

Figure 1: Posterior view of the suprascapular nerve block using the Dangoisse technique. Landmarks are indicated as follows: acromion and lateral end of the scapular spine (a), medial end of the scapular spine (b), midpoint of the scapular spine (c), inferior angle of the scapula (d), and lateral border of the scapula (e). The needle is aligned 2 cm superior to the midpoint of the scapular spine parallel to the blade of the scapula.

Complications

SSNB is a safe procedure with a generally low rate of complications. The largest study retrospectively analyzed 1,005 SSNBs performed by multiple clinicians in multiple centers over a 6-year period reported no major complications [73]. There were only 6 minor adverse events which included transient dizziness (n=3), transient arm weakness (n=2), and facial flushing (n=1) [73].

Codman's Manipulation technique

Codman's manipulation 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° [16,17].

A general law of motion was proposed to answer the question of Codman's paradox, which is stated as when the long-axis of the arm performs a closed-loop motion by three sequential rotations known as Codman's rotations, it produces an equivalent axial rotation angle about the long-axis. The equivalent axial rotation angle equals the angle of swing. Validity of the proposed law of motion is demonstrated by computer simulation of various Codman's rotations [17].

Combined approach of SSNB followed by Codman's manipulation and home exercises

We studied a combined approach including SSNB followed by Codman's manipulation of the glenohumeral joint and a home program of ROM exercises, pendulum exercises for the arm and stretching techniques for the shoulder joint in patients with idiopathic frozen shoulder [74]. We found active range of motion increased significantly for flexion, abduction, internal rotation and external rotation. A significant decrease of visual analog scale and shoulder disability Questionnaire scores between baseline and follow-up assessments at 1, 6 and 12 weeks post manipulation was also observed [74]. Extension of pain relief for 12 weeks post injection is 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. Furthermore, a 'wind down' (a reduction in peripheral nociceptive input) has been suggested [56,75,76]

In this combined approach, instead of manipulating the shoulder under general anaesthesia in the operating room, Codman's manipulation following SSNB was used in the outpatient clinic, thus reducing the risk of general anaesthesia, patient discomfort, and treatment cost. Furthermore, no complications were encountered and patients tolerated the procedure well.

Our results were comparable to those of Hollis et al. [77] who performed Codman's manipulation under general anaesthesia in patients with frozen shoulder in terms of reduction of pain and disability and improvement of ROM. In a previous study, Khan et al. [78] performed manipulation for the glenohumeral joint following SSNB and intra-articular local anaesthesia 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 those of Khan and colleagues, although we used a different type of manipulation, no intra- articular anaesthesia was used and shoulder disability was assessed using the Shoulder Disability Questionnaire. An additional study was performed by Mitra et al. [79] on patients with frozen shoulder in whom SSNB was performed followed by intra-articular shoulder injection with steroid and local anaesthetic, 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 movements showed improvement. Ozkan et al. [80] 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 in the efficacy of SSNB and provide a hope for the management of pain in frozen shoulder.

In a recent meta-analysis of randomized trials, eleven randomized controlled trials that compared SSNB with physical therapy, placebo, and intra-articular injections were included, comprising 591 patients. Regarding pain relief, SSNB provided better pain relief for 12 weeks compared with physical therapy and placebo injections, but was not superior to intra-articular injections. Differences in patient populations and use of pulsed radiofrequency did not cause a significant variation in therapeutic efficacy, but guidance using ultrasound showed consistently better effectiveness than guidance using surface landmarks and fluoroscopy [81].

Conclusion

Combined approach of SSNB followed by Codman's manipulation and home exercises proved to accelerate the recovery of idiopathic frozen shoulder. This combined approach is effective and safe to be administered in outpatient clinics by a well-trained physician, offering clear advantages (ease of application, low cost, rare side effects) and considering that the top priority of a pain control program is restoration of function to perform usual ADL. It may prove to be a useful treatment for patients who are unfit or unwilling to consider manipulation under anaesthesia. 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.

Compliance with ethical standards

Conflict of interest

There are no competing interests (financial/potential influence of the contents/ other relationships or activities) involved in this work.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

References

1. Codman EA (1934) Rupture of the supraspinatus tendon and other lesions in or about the subacromial bursa. The shoulder, RE Kreiger.
2. Neviaser J (1945) Adhesive capsulitis of the shoulder: a study of the pathological findings in periarthritis of the shoulder. J Bone Joint Surg 27: 211-222.
3. Laubscher P, Rösch TG (2009) Frozen shoulder: a review. SA Orthopedic Journal Spring: 24-29.
4. Dias R, Cutts S, Massoud S (2005) Frozen shoulder. BMJ 331: 1453-1456.
5. Fernandes MR (2014) Arthroscopic treatment of refractory adhesive capsulitis of the shoulder. Rev Col Bras Cir 41: 30-35.
6. Favejee MM, Huisstede BM, Koes BW (2011) Frozen shoulder: the effectiveness of conservative and surgical interventions – systematic review. Br J Sports Med 45: 49-56.
7. Lorbach O, Anagnostakos K, Scherf C, Seil R, Kohn D, et al. (2010) Nonoperative management of adhesive capsulitis of the shoulder: oral cortisone application versus intra-articular cortisone injections. J Shoulder Elbow Surg 19: 172-179.
8. Borglum J, Bartholdy A, Hautopp H, Krogsgaard MR, Jensen K (2011) Ultrasound-guided continuous suprascapular nerve block for adhesive capsulitis: one case and a short topical review. Acta Anaesthesiol Scand 55: 242-247.
9. Iqbal MJ, Anwar W, Rahman N, Kashif S, Khan A (2012) Suprascapular nerve block in the treatment of frozen shoulder. J Surg Pak 17: 27-31.
10. Yasar E, Vural D, Safaz I, Balaban B, Yilmaz B, et al. (2011) Which treatment approach is better for hemiplegic shoulder pain in stroke patients: intra-articular steroid or suprascapular nerve block? A randomized controlled trial. Clin Rehabil 25: 60-68.
11. Dahan TH, Fortin L, Pelletier M, Petit M, Vadeboncoeur R, et al. (2000) Double blind randomized clinical trial examining the efficacy of bupivacaine suprascapular nerve blocks in frozen shoulder. J Rheumatol 27: 1464-1469.
12. Di Lorenzo L, Pappagallo M, Gimigliano R, Palmieri E, Saviano E, et al. (2006) Pain relief in early rehabilitation of rotator cuff tendinitis: any role for indirect suprascapular nerve block? Eura Medicophys 42: 195-204.
13. Amir-Us-Saqlain H, Zubairi A, Taufiq I (2007) Functional outcome of frozen shoulder after manipulation under anaesthesia. J Pak Med Assoc 57: 181-185.
14. Reeves B (1975) The natural history of the frozen shoulder syndrome. Scand J Rheumatol 4: 193-196.
15. Hamdan TA, Al-Essa KA (2003) Manipulation under anaesthesia for the treatment of frozen shoulder. Int Orthop 27: 107-109.
16. Codman EA (1934) The shoulder. Boston. Mass: Thomas Todd 216-224.
17. Cheng PL (2006) Simulation of Codman's paradox reveals a general law of motion. J Biomech 39: 1201-1207.
18. Hannafin JA, Chiaia TA (2000) Adhesive capsulitis. A treatment approach. Clin Orthop Relat Res 372: 95-109.
19. Castellarin G, Ricci M, Vedovi E, Vecchini E, Sembenini P, et al. (2004) Manipulation and arthroscopy under general anesthesia and early rehabilitative treatment for frozen shoulders. Arch Phys Med Rehabil 85: 1236-1240.
20. Arslan S, Celiker R (2001) Comparison of the efficacy of local corticosteroid injection and physical therapy for the treatment of adhesive capsulitis. Rheumatol Int 21: 20-23.
21. Hakim AJ, Cherkas LF, Spector TD, MacGregor AJ (2003) Genetic associations between frozen shoulder and tennis elbow: a female twin study. Rheumatology (Oxford) 42: 739-742.
22. Grey RG (1978) The natural history of "idiopathic" frozen shoulder. J Bone Joint Surg Am 60: 564.
23. DePalma AF (2008) The classic. Loss of scapulohumeral motion (frozen shoulder). Clin Orthop Relat Res 466: 552-560.
24. Murnaghan JP (1990) Frozen shoulders in the Shoulder. Edited by Charles A. Rockwood JR, and Matsen FA, III. Philadelphia, W. B. Saunders 837-862.
25. Hand GCR, Athanasou NA, Carr AJ (2005) The pathology of frozen shoulder: a chronic inflammation mast cell mediated proliferative fibrosis.
26. Rodeo SA, Hannafin JA, Tom J, Warren RF, Wickiewicz TL (1997) Immunolocalization of cytokines and their receptors in adhesive capsulitis of the shoulder. J Orthop Res 15: 427-436.
27. McGinty JB, Burkhart SS, Johnson DH, Jackson RW, Richmond JC (2002) Operative arthroscopy. (3rd edn), Lippincott Williams and Wilkins, 558-569.
28. Harryman DT, Lazurus MD, Rozencwaig R (2004) The stiff shoulder. In: Rockwood CA, Matsen FA, Wirth MA, Lippitt SB, editors. The shoulder. (3rd edn), Philadelphia: Saunders.
29. Lundberg J (1969) The frozen shoulder. Clinical and radiographical observations. The effect of manipulation under general anaesthesia. Structure and glycosaminoglycan content of the joint capsule. Local bone metabolism. Acta Orthop Scand 119: 1-59.
30. Rizk TE, Pinals RS, Talaiver AS (1991) Corticosteroid injections in adhesive capsulitis: investigation of their value and site. Arch Phys Med Rehabil 72: 20-22.
31. Ozaki J, Nakagawa Y, Sakurai G, Tamai S (1989) Recalcitrant chronic adhesive capsulitis of the shoulder. Role of contracture of the coracohumeral ligament and rotator interval in pathogenesis and treatment. J Bone Joint Surg Am 71: 1511-1515.

32. Binder AI, Bulgen DY, Hazleman BL, Roberts S (1984) Frozen shoulder: a long-term prospective study. Ann Rheum Dis. 43: 361–364.

33. Thierry D (2005) Adhesive capsulitis. E medicine 11: 7.

34. Binder AI, Bulgen DY, Hazleman BL, Tudor J, Wraight P (1984) Frozen shoulder: an arthrographic and radionuclear scan assessment. Ann Rheum Dis 43: 365-369.

35. Sheridan MA, Hannafin JA (2006) Upper extremity: emphasis on frozen shoulder. Orthop Clin North Am 37: 531-539.

36. Buchbinder R, Hoving JL, Green S, Hall S, Forbes A, et al. (2004) Short course prednisolone for adhesive capsulitis (frozen shoulder or stiff painful shoulder): a randomised, double blind, placebo controlled trial. Ann Rheum Dis 63: 1460-1469.

37. Ryans I, Montgomery A, Galway R, Kernohan WG, McKane R (2005) A randomized controlled trial of intra-articular triamcinolone and/or physiotherapy in shoulder capsulitis. Rheumatology (Oxford) 44: 529-535.

38. Buchbinder R, Green S, Youd JM (2003) Corticosteroid injections for shoulder pain. Cochrane Database Syst Rev : CD004016.

39. Carette S, Moffet H, Tardif J, Bessette L, Morin F, et al. (2003) Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: A placebo-controlled trial. Arthritis & rheumatism 48: 829-838.

40. Jacobs LG, Smith MG, Khan SA, Smith K, Joshi M (2009) Manipulation or intra-articular steroids in the management of adhesive capsulitis of the shoulder? A prospective randomized trial. J Shoulder Elbow Surg 18: 348-353.

41. Diercks RL, Stevens M (2004) Gentle thawing of the frozen shoulder: a prospective study of supervised neglect versus intensive physical therapy in seventy-seven patients with frozen shoulder syndrome followed up for two years. Journal of Shoulder and Elbow Surgery 13: 499-502.

42. Ginn K, Cohen M (2005) Exercise therapy for shoulder pain aimed at restoring neuromuscular control: a randomized comparative clinical trial. Journal of Rehabilitation Medicine 37: 115-122.

43. Andren L, Lundberg BJ (1965) Treatment of Rigid Shoulders by Joint Distension During Arthrography. Acta Orthop Scand 36: 45-53.

44. Gavant ML, Rizk TE, Gold RE, Flick PA (1994) Distention arthrography in the treatment of adhesive capsulitis of the shoulder. J Vasc Interv Radiol 5: 305-308.

45. Fouquet B, Griffoul I, Borie MJ, Roger R, Bonnin B, et al. (2006) Adhesive capsulitis: evaluation of a treatment coupling capsular distension and intensive rehabilitation. In Annales de réadaptation et de médecine physique: revue scientifique de la Société française de rééducation fonctionnelle de réadaptation et de médecine physique 49: 68-74.

46. Quraishi NA, Johnston P, Bayer J, Crowe M, Chakrabarti AJ (2007) Thawing the frozen shoulder: A Randomised Trial Comparing Manipulation Under Anaesthesia With Hydrodilatation. Journal of Bone & Joint Surgery 89: 1197-1200.

47. Duplay S (1872) De la peri-arthrite scapulo-humerale et des raideurs de l'epaule qui en sont la consequence. Arch Gen Med 20: 513-542.

48. Reeves B (1966) Arthrographic changes in frozen and post-traumatic stiff shoulders. Proc R Soc Med 59: 827-830.

49. Andersen NH, Søjbjerg JO, Johannsen HV, Sneppen O (1998) Frozen shoulder: arthroscopy and manipulation under general anesthesia and early passive motion. J Shoulder Elbow Surg 7: 218-222.

50. Holloway GB, Schenk T, Williams GR, Ramsey ML, Iannotti JP (2001) Arthroscopic capsular release for the treatment of refractory postoperative or post-fracture shoulder stiffness. J Bone Joint Surg Am 83-83A: 1682-7.

51. Waldburger M, Meier JL, Gobelet C (1992) The frozen shoulder: diagnosis and treatment. Prospective study of 50 cases of adhesive capsulitis. Clin Rheumatol 11: 364-368.

52. Levine WN, Kashyap CP, Bak SF, Ahmad CS, Blaine TA, et al. (2007) Nonoperative management of idiopathic adhesive capsulitis. J Shoulder Elbow Surg 16: 569-573.

53. Eljabu W, Klinger HM, von Knoch M (2016) Prognostic factors and therapeutic options for treatment of frozen shoulder: a systematic review. Archives of orthopaedic and trauma surgery 136: 1-7.

54. Aszmann OC, Dellon AL, Birely BT, McFarland EG (1996) Innervation of the human shoulder joint and its implications for surgery. Clin Orthop Relat Res : 202-207.

55. Ritchie ED, Tong D, Chung F, Norris AM, Miniaci A, et al. (1997) Suprascapular nerve block for postoperative pain relief in arthroscopic shoulder surgery: a new modality? Anesth Analg 84: 1306-1312.

56. Chan CW, Peng PW (2011) Suprascapular nerve block: a narrative review. Reg Anesth Pain Med 36: 358-373.

57. Wertheim HM, Rovenstein EA (1941) Suprascapular nerve block. Anesthesiology 2: 541-545.

58. Moore DC (1979) Block of the suprascapular nerve. In: Moore DC, editor. Regional block (4th edn), Springfield: Charles C Thomas Co.

59. Gordh T (1979) Suprascapular nerve block. In: Eriksson E, editor. Illustrated handbook in local anaesthesia. (2nd edn), Copenhagen: Munksgaard.

60. Katz J (1951) Atlas of regional anaesthesia. 2nd edn. Norwalk: Appleton; 1994.

61. Granirer LW (1951) A simple technic for suprascapular nerve block. N Y State J Med 51: 1048.

62. Breen TW, Haigh JD (1990) Continuous suprascapular nerve block for analgesia of scapular fracture. Can J Anaesth 37: 786-788.

63. Dangoisse MJ, Wilson DJ, Glynn CJ (1994) MRI and clinical study of an easy and safe technique of suprascapular nerve blockade. Acta Anaesthesiol Belg 45: 49-54.

64. Barber FA (2005) Suprascapular nerve block for shoulder arthroscopy. Arthroscopy 21: 1015.

65. Feigl GC, Anderhuber F, Dorn C, Pipam W, Rosmarin W, et al. (2007) Modified lateral block of the suprascapular nerve: a safe approach and how much to inject? A morphological study. Reg Anesth Pain Med 32: 488-494.

66. Shanahan EM, Ahern M, Smith M, Wetherall M, Bresnihan B, et al. (2003) Suprascapular nerve block (using bupivacaine and methylprednisolone acetate) in chronic shoulder pain. Ann Rheum Dis 62: 400-406.

67. Gorthi V, Moon YL, Kang JH (2010) The effectiveness of ultrasonography-guided suprascapular nerve block for perishoulder pain. Orthopedics 33.

68. Jeon WH, Park GW, Jeong HJ, Sim YJ (2014) The comparison of effects of suprascapular nerve block, intra-articular steroid injection, and a combination therapy on hemiplegic shoulder pain: pilot study. Ann Rehabil Med 38: 167-173.

69. Adey-Wakeling Z, Crotty M, Shanahan EM (2013) Suprascapular nerve block for shoulder pain in the first year after stroke: a randomized controlled trial. Stroke 44: 3136-3141.

70. Taskaynatan MA, Yilmaz B, Ozgul A, Yazicioglu K, Kalyon TA (2005) Suprascapular nerve block versus steroid injection for non-specific shoulder pain. Tohoku J Exp Med 205: 19-25.

71. Shrestha BR, Maharjan SK, Shrestha S, Gautam B, Thapa C, et al. (2007) Comparative study between tramadol and dexamethasone as an admixture to bupivacaine in supraclavicular brachial plexus block. JNMA J Nepal Med Assoc 46: 158-164.

72. Colombo G, Padera R, Langer R, Kohane DS (2005) Prolonged duration local anaesthesia with lipid–protein–sugar particles containing bupivacaine and dexamethasone. J Biomed Mater Res A 75: 458-464.

73. Shanahan EM, Shanahan KR, Hill CL, Ahern MJ, Smith MD (2012) Safety and acceptability of suprascapular nerve block in rheumatology patients. Clin Rheumatol 31: 145-149.

74. El-Badawy MA, Fathalla MM (2014) Suprascapular nerve block followed by Codman's manipulation and exercise in the rehabilitation of idiopathic frozen shoulder. Egyptian Rheumatology and Rehabilitation 41: 172.

75. Birklein F, Schmelz M (2008) Neuropeptides, neurogenic inflammation and complex regional pain syndrome (CRPS). Neurosci Lett 437: 199-202.
76. Schaible HG (2007) Peripheral and central mechanisms of pain generation. Handb Exp Pharmacol 177: 3-28.
77. Hollis R, Lahav A, West HS Jr (2006) Manipulation of the shoulder using Codman's paradox. Orthopedics 29: 971-973.
78. Khan JA, Devkota P, Acharya BM, Pradhan NM, Shreshtha SK, et al. (2009) Manipulation under local anesthesia in idiopathic frozen shoulder--a new effective and simple technique. Nepal Med Coll J 11: 247-253.
79. Mitra R, Harris A, Umphrey C, Smuck M, Fredericson M (2009) Adhesive capsulitis: a new management protocol to improve passive range of motion. PM R 1: 1064-1068.
80. Ozkan K, Ozcekic AN, Sarar S, Cift H, Ozkan FU, et al. (2012) Suprascapular nerve block for the treatment of frozen shoulder. Saudi J Anaesth 6: 52-55.
81. Chang KV, Hung CY, Wu WT, Han DS, Yang RS, et al. (2015) Comparison of the Effectiveness of Suprascapular Nerve Block with Physical Therapy, Placebo, and Intra-articular Injection in Management of Chronic Shoulder Pain-a Meta-analysis of Randomized Controlled Trials. Archives of physical medicine and rehabilitation 15: 01476-01478.