Chapter

# Frozen Shoulder: Symptoms, Causes, Diagnosis, and Treatment

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## Abstract

Frozen shoulder, or adhesive capsulitis, is a condition caused by impaired soft tissues and the articular capsule of the shoulder. Although the precise etiology remains unclear, recent evidence identifies elevated serum cytokine levels as part of the process. It is characterized by an insidious and progressive loss of active and passive mobility in the glenohumeral joint presumably due to capsular contracture. Several treatments are recognized and utilized to reduce pain and improve range-of-motion faster than the disease's natural history course. The chapter aims to spread knowledge about this often-misunderstood pathology and to highlight the role of the rehabilitative therapeutic approach.

**Keywords:** shoulder, rehabilitation, pain, physical therapy, complementary therapy, physiotherapy

## 1. Introduction

Frozen shoulder, or adhesive capsulitis, is a condition caused by impaired soft tissues and the articular capsule of the shoulder. Primary frozen shoulder is common, and it is characterized by debilitating conditions. The prevalence is between 2% and 5% that increasing to 10–38% in patients with diabetes and thyroid disease. The age of patients is commonly between 40 and 65 years old, and the incidence appears higher in females than males [1–3]. It may also occur after trauma or in association with other joint diseases, as acromioclavicular osteoarthritis, which is referred to as a secondary frozen shoulder [4].

## 2. Frozen shoulder: clinical definition

Codman defined frozen shoulder as a clinical condition that can hardly be defined, it is complicated to enclose it in a single pathological mechanism, and therefore, even less easy to define its treatment. Instead, the term "adhesive capsulitis" was introduced by Neviaser [5] to describe a tissue inflammation condition and subsequent fibrosis involving the articular capsule of the shoulder. In addition, the definition of "frozen" shoulder refers to pain and immobility correlation. Lack of function causes

the capsule to thicken, making it even more difficult to move. Therefore the functional expression of pathology defines the term "frozen."

Frozen shoulder is characterized by an insidious and progressive loss of active and passive mobility in the glenohumeral joint presumably due to capsular contracture.

Frozen shoulder can be classified as primary or secondary. Primary idiopathic frozen shoulder can be often associated with other diseases, such as diabetes mellitus, thyroid diseases, and Parkinson's disease. Secondary adhesive capsulitis can occur after trauma or immobilization. Frozen shoulder is estimated to affect 2–5% of the general population. A patient who experiments with this pathology can be significantly painful and disabling for some months. It most commonly affects those in their fourth to sixth decades of life and more often occurs in women than in men [6].

## 3. Frozen shoulder: pathophysiology

The pathophysiological mechanism underlying the pathology remains poorly understood. Scientific literature shows a correlation with elevated serum cytokine levels [7]. Although the precise pathophysiology remains unclear, recent evidence identifies elevated serum levels of cytokines as part of the process. Cytokines are polypeptide, non-antigen-specific mediators that act as communication signals between immune system cells and between them and different organs and tissues. Elevated cytokine levels appear predominantly involved in the cellular mechanisms of inflammation and fibrosis sustained in the primary and some secondary frozen shoulder. Bunker et al. [8] defined that a mild lesional event would trigger an inflammatory response that results in excessive production of fibroblasts, which release type I and type III collagen. Fibroblasts differentiate into myofibroblasts, causing the newly deposited type III collagen to contract. This would result in an imbalance between the inflammatory phase and the remodeling underlying the fibrosis.

Rodeo et al. [9] described pathological processes like inflammation and fibrosis: synovial hyperplasia determines a decrease of vascularity. This phenomenon leads to fibrosis in the sub-synovium and synovium of capsular tissue. This condition could be the expression of an immune response [10]. Other studies have shown that frozen shoulder is associated with a dense collagen matrix containing fibroblasts and myofibroblasts, suggestive of a fibrotic process [9, 11–13]. Furthermore, the component of the immune system that is activated is represented by B lymphocytes, mast cells, and macrophages. Several studies have suggested the immune response overlaps with inflammatory synovitis, leading to capsular fibrosis in the later stages [5, 14].

There are many etiopathological hypotheses, and all studies suggest that both inflammation and fibrosis of the joint capsule are regulated by cytokines, growth factors, MMPs, and immune cells. The results of the next studies will provide the control mechanisms of FS and identify new therapeutic targets to identify its treatment [14–16].

## 4. Frozen shoulder: symptoms

Patients typically demonstrate a characteristic history, clinical presentation, and recovery. Clinical syndromes include pain, a limited range of motion (ROM), and muscle weakness from disuse [17].

The pain has a typical course involving the entire shoulder up to the insertion of the deltoid muscle. The patient reports difficulty sleeping on the affected side and

difficulty in active movement. Clinical examination shows atrophy of the spinate, restriction on passive mobilization, with painful and limited elevation and external rotation.

Pain is localized in the shoulder (in the deltoid region), sometimes in the arm with functional limitation. In patients who have been in pain for a long time, may present medial to the scapula. This happens because incorrect movements of the scapulothoracic are established to compensate for the limitation of the glenohumeral joint [18].

Neviaser et al. [19] elaborated on the natural history of frozen shoulder and distinguished the following stages:

- Stage 1: It is defined as a pre-adhesive stage. It is characterized by erythematous joint inflammation and mild pain in the most extreme degrees of movement. It is often misunderstood because it has a similar clinical presentation to the impingement of the rotator cuff.

- Stage 2. It is the acute–adhesive stage. Patients complain of severe pain up to almost the last degree of movement of the joint. An inflammatory process with thickening of the synovium and change of connective tissue is highlighted.

- Stage 3. Fibrotic or "frozen" stage. At this stage, fibrosis is characteristic of the presence of more mature adhesions. The pain becomes less intense and joint stiffness becomes prevalent.

- Stage 4. At this stage, the restriction on movement remains but without synovitis. In fact, it is defined as the "thawing" phase. Patients present painless stiffness and movement typically improves by remodeling (**Figure 1**).

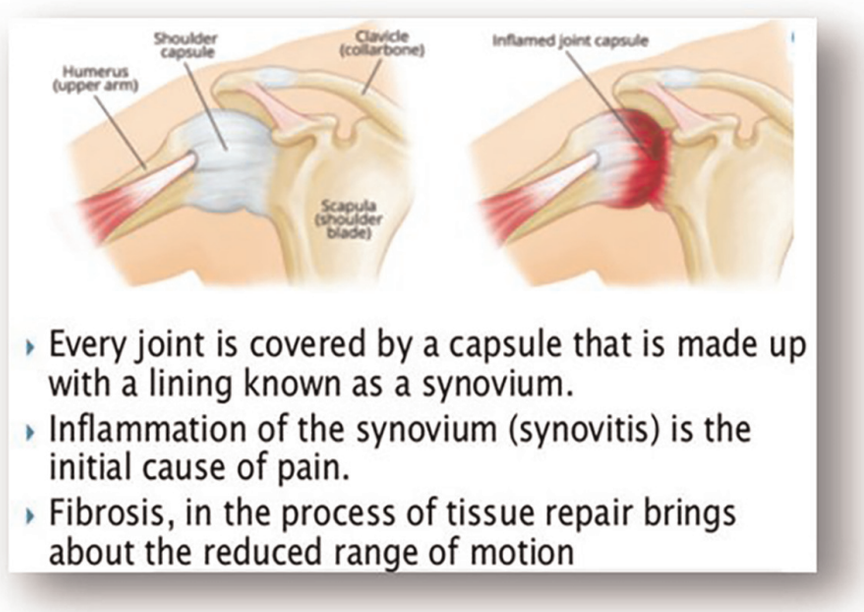


**Figure 1.**
*Natural history of frozen shoulder.*

## 5. Diagnosis

### 5.1 Clinical diagnosis

Primary frozen shoulder is essentially a clinical diagnosis. Frozen shoulder is characterized by an insidious and progressive loss of active and passive mobility in the glenohumeral joint presumably due to capsular contracture. Patients typically demonstrate a characteristic history, clinical presentation, and recovery. Clinical syndromes include pain, a limited range of motion (ROM), and muscle weakness from disuse [20]. To carry out the clinical examination of the shoulder it is necessary to observe the neck and evaluate through a functional examination if the pain comes from the cervical spine. Subsequently, following the standard shoulder examination protocol, it is necessary to proceed with the inspection of the shoulder. Observe if there are scars, reduced Tropism of rotator cuff/deltoid, bone landmarks, and spinal and scapular alignment. People with frozen shoulders have a limited range of both active and passive motion. Next, proceed to palpation to rule out acromioclavicular-induced pain. Following this, proceed with an assessment of shoulder range of motion (ROM). There are four movements that are useful in the examination—flexion, abduction, internal rotation, and external rotation. Flexion , abduction and internal rotation are evaluated with active and passive mobilization, while external rotation is evaluated only with passive mobilization [21].

Shoulder pain appears slowly and radiates to the insertion of the deltoid. The patient reports inability to sleep on the affected side, limitation to active movement, and painful elevation of the shoulder. Progressively atrophy of the spinate appears.

Imaging studies are not necessary for the diagnosis of adhesive shoulder capsulitis but may be helpful to rule out other causes of a painful and stiff shoulder. Usually, resistance in the last degrees of movement is described, this sensation is defined as firm and "leathery." During the examination the pain is prevalent, the patient cannot get to the point where even the examiner would feel the resistance. Therefore it is most frequently described as a feeling of "empty" end [22].

### 5.2 Evaluation scale

It should be used to validate functional outcome measures, such as the disabilities of the arm, shoulder, and hand (DASH), the American Shoulder and Elbow Surgeons shoulder scale (ASES), or the Shoulder Pain and Disability Index (SPADI). The DASH questionnaire consists of 30 questions that inquire about symptoms and functions of the upper limbs.

**Table 1** describes the 30 items that are carried out with the application of the scale. DASH investigates the severity of pain, activity-related pain, tingling, weakness, and stiffness (five items), and the effect of the upper limb problem on social activities, work, sleep, and self-image (four items). These provide a single main score, the DASH function/symptoms (DASH-FS) score, which is basically a summation of the responses on a one-to-five scale, after transformation to a zero (no disability) to 100 (severe disability) scale [23].

The shoulder and elbow surgeons shoulder scale (ASES) is a physician assessment section that includes physical examination and documentation of a range of motion, strength, and instability, and demonstration of specific physical signs. No score is derived for this section of the instrument. The patient self-evaluation section has 11 items that can be used to generate a score. These are divided into two areas—pain (one item) and function (10 items) (**Table 2**).

| **Dash questionnaire** | | | | | |
|---|---|---|---|---|---|
| **Difficulty** | **No** | **Mild** | **Moderate** | **Severe** | **Unable** |
| 1. Open a tight or new jar | **1** | **2** | **3** | **4** | **5** |
| 2. Write | **1** | **2** | **3** | **4** | **5** |
| 3. Turn a key | **1** | **2** | **3** | **4** | **5** |
| 4. Prepare a meal | **1** | **2** | **3** | **4** | **5** |
| 5. Push open a heavy door | **1** | **2** | **3** | **4** | **5** |
| 6. Place an object on a shelf above your head | **1** | **2** | **3** | **4** | **5** |
| 7. Do heavy household chores (e.g., wash walls, wash floors) | **1** | **2** | **3** | **4** | **5** |
| 8. Garden or do yard work | **1** | **2** | **3** | **4** | **5** |
| 9. Make a bed | **1** | **2** | **3** | **4** | **5** |
| 10. Carry a shopping bag or briefcase | **1** | **2** | **3** | **4** | **5** |
| 11. Carry a heavy object (over 10 lbs) | **1** | **2** | **3** | **4** | **5** |
| 12. Change a light bulb overhead | **1** | **2** | **3** | **4** | **5** |
| 13. Wash or blow-dry your hair | **1** | **2** | **3** | **4** | **5** |
| 14. Wash your back | **1** | **2** | **3** | **4** | **5** |
| 15. Put on a pullover sweater | **1** | **2** | **3** | **4** | **5** |
| 16. Use a knife to cut food | **1** | **2** | **3** | **4** | **5** |
| 17. Recreational activities that require little effort (e.g., card playing, knitting, etc.) | **1** | **2** | **3** | **4** | **5** |
| 18. Recreational activities in which you take some force or impact through your arm, shoulder, or hand (e.g., golf, hammering, tennis, etc.) | **1** | **2** | **3** | **4** | **5** |
| 19. Recreational activities in which you move your arm freely (e.g., playing frisbee, badminton, etc.) | **1** | **2** | **3** | **4** | **5** |
| 20. Manage transportation needs (getting from one place to another) | **1** | **2** | **3** | **4** | **5** |
| 21. Sexual activities | **1** | **2** | **3** | **4** | **5** |
| **Disabilities** | | | | | |
| | **Not at all** | **Slightly** | **Moderately** | **Quite a bit** | **Extremely** |
| 22. During the past week, to what extent has your arm, shoulder, or hand problem interfered with your normal social activities with family, friends, neighbors, or groups? | **1** | **2** | **3** | **4** | **5** |
| | **Not limited at all** | **Slightly limited** | **Moderately limited** | **Very limited** | **Unable** |
| 23. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder, or hand problem? | **1** | **2** | **3** | **4** | **5** |

| **Dash questionnaire** | | | | | |
|---|---|---|---|---|---|
| **Difficulty** | **No** | **Mild** | **Moderate** | **Severe** | **Unable** |
| **Severity symptoms in the last week** | | | | | |
| | **None** | **Mild** | **Moderate** | **Severe** | **Extreme** |
| 24. Arm, shoulder, or hand pain. | **1** | **2** | **3** | **4** | **5** |
| 25. Arm, shoulder. or hand pain when you performed any specific activity | **1** | **2** | **3** | **4** | **5** |
| 26. Tingling (pins and needles) in your arm, shoulder, or hand | **1** | **2** | **3** | **4** | **5** |
| 27. Weakness in your arm, shoulder, or hand | **1** | **2** | **3** | **4** | **5** |
| 28. Stiffness in your arm, shoulder, or hand | **1** | **2** | **3** | **4** | **5** |
| **Difficulty** | **No** | **Mild** | **Moderate** | **Severe** | **So much-I cannot sleep** |
| 29. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder, or hand? | **1** | **2** | **3** | **4** | **5** |
| | **Strongly disagree** | **Disagree** | **Neither agree nor disagree** | **Agree** | **Strongly agree** |
| 30. I feel less capable, less confident, or less useful because of my arm, shoulder, or hand problem | **1** | **2** | **3** | **4** | **5** |
| **Work module (optional)** | | | | | |
| This part of the scale is about the impact on working skills (including doing housework). These are four questions that concern five levels of difficulty in using the shoulder during work activities | | | | | |
| **Sports/performing arts module (optional)** | | | | | |
| This part of the scale is about the impact of playing musical instruments or sport or both. These are four questions that concern five levels of difficulty in using the shoulder during work activities | | | | | |

**Table 1.**
*Disabilities of the arm, shoulder, and hand (DASH).*

The final score is tabulated by multiplying the pain score (maximum 10) by 5 (therefore total possible 50) and the cumulative activity score (maximum 30) by 5/3 (therefore, a total possible 50) for a total of 100 [24].

The Shoulder Pain and Disability Index (SPADI) is a self-administered questionnaire that consists of two dimensions, one for pain and the other for functional activities. The pain dimension consists of five questions regarding the severity of an individual's pain [25].

## 5.3 Diagnostic imaging

Radiographic examination is carried out to make the differential diagnosis and exclude other pathologies, for example, calcific tendinitis, rupture of the rotator cuff, arthritis of the glenohumeral, and acromioclavicular joint or a neoplastic process. In

| **Shoulder and elbow surgeons shoulder scale (ASES)** | | |
|---|---|---|
| 1. Usual work | | |
| 2. Usual sport/leisure activity? | | |
| 3. Do you have shoulder pain at night? | Yes | No |
| 4. Do you take pain killers, such as paracetamol (acetaminophen), diclofenac, or ibuprofen? | Yes | No |
| 5. Do you take strong pain killers, such as codeine, tramadol, or morphine? | Yes | No |
| 6. How many pills do you take on an average day? | | |
| 7. Intensity of pain? | Visual analog scales (VAS)—from **10** (pain as bad as it can be) to **0** (No pain at all) | |
| 8. Is it difficult for you to put on a coat? | 1. Unable to do<br>2. Very difficult to do<br>3. Somewhat difficult<br>4. Not difficult | |
| 9. Is it difficult for you to sleep on the affected side? | 1. Unable to do<br>2. Very difficult to do<br>3. Somewhat difficult<br>4. Not difficult | |
| 10. Is it difficult for you to wash your back/do up bra? | 1. Unable to do<br>2. Very difficult to do<br>3. Somewhat difficult<br>4. Not difficult | |
| 11. Is it difficult for you to manage toileting? | 1. Unable to do<br>2. Very difficult to do<br>3. Somewhat difficult<br>4. Not difficult | |

**Table 2.**
*Shoulder and elbow surgeons shoulder scale (ASES).*

patients with frozen shoulder radiographic examination is normal, however, osteopenia of the humerus head may be an indirect sign [26].

Ultrasound is an essential tool for diagnosing shoulder disorders. However, the role of ultrasound in assessing and diagnosing adhesive capsulitis has not been fully studied. Sonography had high diagnostic accuracy for the diagnosis of adhesive capsulitis using a combination of parameters, such as coracohumeral ligament (CHL) thickness, rotator interval (RI) thickness, and hypervascularity, axillary recess (AR) thickness [27, 28].

Several studies have shown that the CHL is thickened and stiffened in adhesive capsulitis on ultrasound [29–31] .Other researches correlate AR thickening as a key diagnostic finding of adhesive capsulitis [32] and approximately the AR cutoff value for adhesive capsulitis diagnosis was 4 mm [28].

RI vascularity is a sign of adhesive capsulitis, but controversy remains in the literature about hypervascularity of the RI in adhesive capsulitis [33].

Magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) may reveal thickening of capsular and pericapsular tissues as well as a contracted glenohumeral joint space. Sliding movement of the supraspinatus tendon [34].

Arthrography is rarely indicated in the diagnosis of frozen shoulder syndrome. It is an invasive procedure that is painful and costly and does not necessarily provide diagnostic insight but it may be associated with a therapeutic articular injection of corticosteroids as a therapeutic intervention [35].

## 6. Treatments

The goal of the treatment of adhesive capsulitis is to restore the shoulder to a painless and functional joint [36, 37].

### 6.1 Pharmacological treatment

Initial treatment is aimed at reducing inflammation and pain. Analgesic and anti-inflammatory drugs are used. Aspirin and paracetamol are the most used and with fewer side effects, the dosage is similar to that used in osteoarthritis. Among the nonsteroidal anti-inflammatory drugs (NSAIDs) the most commonly used are ibuprofen, which has the lowest incidence of side effects, naproxen, and diclofenac [38].

Corticosteroids (for which the generic term "steroids" is usually used) strongly suppress all stages of acute and chronic inflammation. In relation to frozen shoulders, they may be injected intra-articularly (directly into the joint) or taken orally. Intra-articular injections of corticosteroids are the most used method. Corticosteroid intra-articular injections demonstrate short-term (4–6 weeks) benefits. Literature reported a moderate effect of corticosteroid injections on pain, external rotation ROM, and disability at 6 weeks, and only small effects after 12 weeks [39, 40]. Corticosteroid injections have been shown to be as effective as exercise for treating frozen shoulder, particularly when provided in the early stages of the pathology. Blanchard et al. [41] suggested that corticosteroid injections have a greater effect when compared to physical therapy when utilized within the first 6 weeks of treatment, although these differences diminished over time.

The injection of sodium hyaluronate (defined as distension or hydrodilation therapy) into the glenohumeral joint for the treatment of adhesive capsulitis results in an improvement in pain and range of motion, similar to the effects of corticosteroid injection but with fewer side effects. Hyaluronic acid has anti-inflammatory properties and it is similar the synovial fluid that occurs naturally in the joints. It works by acting like a lubricant and shock absorber in the joints and helps the joints to work properly [42].

These lubricating effects of hyaluronate have led to use in orthopedic surgery as well, via prevention of adhesion formation after both wrist and finger flexor tendon repair [43]. Thus, extrapolation to the treatment of stiff shoulder and adhesive capsulitis has demonstrated success and improvements in range of motion, pain, and function.

#### *6.1.1 Physical therapy*

##### *6.1.1.1 Ultrasound*

A common clinical practice among physical therapists is the use of ultrasound prior to capsular and soft tissue stretching techniques based upon its thermal and mechanical effects. Ultrasound is used to manage several soft-tissue conditions, such as tendinitis, bursitis, and muscle spasm; reabsorb calcium deposits in soft tissue; and

reduce joint contractures, pain, and scar tissue. Used in conjunction with hot packs, muscle spasms and muscle guarding may be reduced [44]. The effect of ultrasound therapy at a frequency of 1 MHz, unlike the hot pack that produces surface heating, is a heating in the deeper tissues due to the increase in blood flow resulting in an analgesic muscle relaxant effect and wash out of pain mediators. Ultrasound therapy is used in association with the electric current that produces a modulation of muscle tone or further modulates pain. Robertson et al. [45] reported the usage of ultrasound therapy (UST) clinically in the rehabilitation of patients with frozen shoulders. Direct contact is the most common method that therapist applies ultrasound. It consists in the application of a transducer that is pressed gently into conductive gel and against the skin.

It is recommended that ultrasound be applied in a pulsed mode at low intensity (0.5–1.0 W/cm$^2$) during the acute phase of inflammation to minimize the risk of aggravating the condition and to accelerate recovery, and that continuous ultrasound at high enough intensity to increase tissue temperature be applied in combination with stretching to assist in the resolution of chronic phase, only if the problem is accompanied by soft tissue shortening [46–48]. In a guideline it is reported that therapeutic ultrasound (US) was effective in the treatment of calcific tendonitis of the shoulder, there was no evidence that it was beneficial for other forms of shoulder pain (e.g., capsulitis, bursitis, tendonitis) [49].

The use of ultrasound therapy is indicated as a treatment for the painful phase of adhesive capsulitis and is indicated in the literature alone or in therapy with other therapies (stretching, mobilization, transcutaneous electrotherapy, and laser therapy) with a type B degree of evidence (there is research-based evidence to support the recommendation) [50]. Other studies have shown efficacy not superior to other therapies [51].

#### *6.1.1.2 Transcutaneous electrical nerve stimulation (TENS)*

TENS consists of low-frequency electrical pulses (generated by a small, portable unit) transmitted to the tissues through electrodes on the skin. The pulses stimulate peripheral nerves in such a way as to suppress the perception of pain. TENS therapy determines analgesia by different mechanisms—by causing interactions between types of nerve fibers, resulting in a "block" on the transmission of pain signals to the brain; or by releasing hormones that block pain receptors in the central nervous system. The effects of transcutaneous electrical nerve stimulation (TENS) for the treatment of adhesive capsulitis seem to be superior in comparison to stretching exercise [52].

#### *6.1.1.3 Electromagnetic therapy*

Electromagnetic fields (EMFs) provide a noninvasive, safe, and easy method to treat pain with respect to musculoskeletal diseases. Magnetic field therapy was applied to promote bone healing, treat osteoarthritis and inflammatory diseases of the musculoskeletal system, alleviate pain, enhance healing of ulcers, and reduce spasticity [53, 54]. This mechanism could promote the resolution of pain by accelerating the removal of inflammatory substances. PEMF stimulates chondrocyte proliferation, differentiation, and extracellular matrix synthesis through the release of anabolic morphogens, such as bone morphogenetic proteins and anti-inflammatory cytokines [55].

Pulsed electromagnetic field (PEMF) therapy has been reported to produce anti-inflammatory and bone-healing effects, but it is unclear whether—it is more or less effective than placebo, or whether other electrotherapy modalities are an effective adjunct to exercise for the treatment of frozen shoulder.

#### *6.1.1.4 Extracorporeal shock wave therapy (ESWT)*

ESWT has been recently receiving attention for the treatment of the frozen shoulder. Extracorporeal shock waves therapy (ESWT) represents a valid tool for a wide range of disorders, both in orthopedics and rehabilitative medicine (tendon pathologies, bone healing disturbances, vascular bone diseases), but also in dermatology and vulnology (wound healing disturbances, ulcers, painful scars), neurology (spastic hypertonia and related disturbances), some andrologic disturbances (induratio penis plastica and erectyle disfunctions), and cardiology (in relation to ischemic heart diseases) [56]. ESWT is a treatment method that applies extracorporeal shock waves to lesions to aid revascularization and stimulate or reactivate the healing of bones and connective tissues such as tendons, thereby relieving pain and improving functions. Data suggest that in the field of tendinopathies ESWT can be considered not only as a symptomatologic therapy but rather a real curative treatment, able to relieve pain and inflammation in the short-medium term but also to positively interfere with tendon structure in a regenerative way [57]. In doing this, it causes changes in cells' metabolism and the permeability of endothelial cell tissues, leading to pain relief and having positive effects on soft tissues [58]. A recent systematic review demonstrated the effectiveness and safety of ESWT for frozen shoulder; ESWT determines the reduction of pain intensity, and it improves shoulder function, quality of life without adverse events [59].

### 6.2 Physiotherapy

Several studies have examined the effect of joint mobilization in patients with adhesive capsulitis, and although there is evidence that it may be beneficial, there is little evidence to support superior efficacy over other interventions [60–62].

Joint mobilization procedures are primarily directed to the glenohumeral joint to reduce pain and increase motion and function in patients with adhesive capsulitis. Mobilization techniques improve the normal extensibility of the shoulder capsule and stretch the tightened soft tissues to induce beneficial effects. Mulligan's mobilization-with-movement (MWM) treatment techniques, could be used. The most important points of the Mulligan Concept include the active participation of the patient and the elimination of pain during therapy [63]. A recent review of the literature analyzed 16 controlled clinical trial (CCT) or randomized controlled trial (RCT) studies that used MWMs demonstrating efficacy on pain and disability [64].

Also, stretching exercises appear to influence pain and improve ROM. The Harvard Special Health Report offers some stretching exercises that are effective in the treatment of adhesive capsulitis—pendulum stretch, towel stretch finger walk, cross-body reach, armpit stretch, starting to strengthen, outward rotation, inward rotation. These exercises can be performed with the physiotherapist or carried out as a home program [65].

No evidence exists to guide the optimal frequency, number of repetitions, or duration of stretching exercises. Stretching beyond painful limits may result in poorer

outcomes. Therefore, stretching intensity that matches the given level of tissue irritability is indicated.

### 6.3 Manual myofascial therapy

Manual therapy may include myofascial work to release abnormal tension and restore mobility and function and identify fascial restrictions using motion testing and palpation.

In the myofascial treatment could be used simple techniques for muscle treatment and joint manipulations, such as:

- lateral elongation, a force applied with a right angle to the longitudinal axis of the muscle fascicles.

- linear extension and removal of the insertion points, with force applied proximally and distally to a dysfunctional area or muscle insertions, with longitudinal and parallel direction to the muscle fascicles.

- linear shortening and rapprochement of insertion points, with force applied proximally and distally to a dysfunctional area or muscle insertions, with longitudinal and parallel direction to the muscle fascicles.

- deep pressure, constant pressure on a zone of retraction or muscle tension or close to its bony insertion [66].

### 6.4 Minimally invasive treatments

#### *6.4.1 Acupuncture*

Acupuncture can be used to treat the pain of the frozen shoulder. It involves inserting needles into the skin at sites that vary from case to case and also depend on the practitioners' school of thought. Traditional Chinese medicine regarded acupuncture as an effective measure in aborting the signs and symptoms of frozen shoulder and in preventing future recurrence.

In the treatment of frozen shoulder, as in many other diseases, one in long, 30 gauge, disposable, sterilized, filiform needles are usually used. The sides of the application are defined as local points and distal points [67].

An integration approach can be ear acupuncture in the treatment of the frozen shoulder. According to traditional Chinese medicine, the sensitive spots on the auricle are anatomically and pathologically related to the affected shoulder joint [68] (**Figure 2**).

##### *6.4.1.1 Kinesio taping (KT)*

Kinesio taping is a complementary therapy based on the application of an elastic membrane that allows relieving pain. The effect on pain is pain modulation through pain gate control theory. The epidermis is equipped with a series of nerve receptors that, if subjected to a series of external stimuli, communicate with the underlying muscles. As a result, depending on how they are placed, the tapes can inhibit a contracted muscle or facilitate lymphatic flow, decreasing pain and inflammation [69]. The application KT

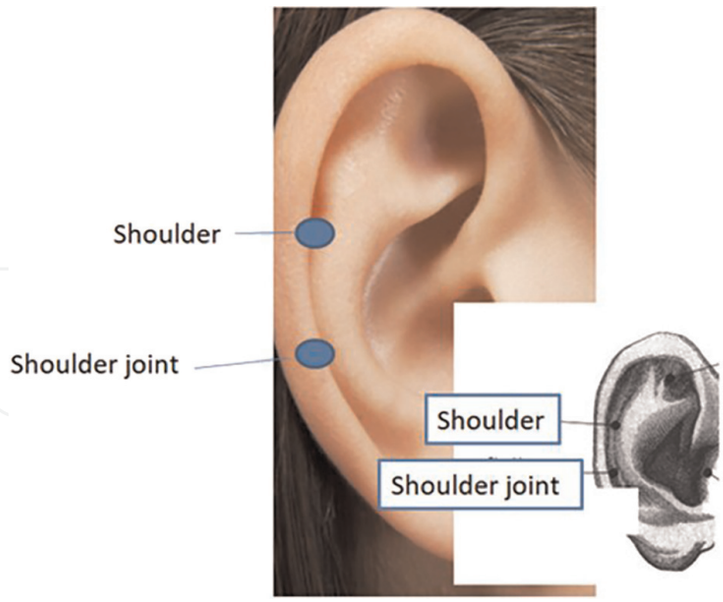


**Figure 2.**
*Ear acupuncture in the treatment of frozen shoulder.*

can produce local physiological changes that resulted in therapeutic effects, such as the relief of pain (pain gate mechanism, reducing muscle spasm) and improvement in ROM (tissue extensibility) [70, 71].

## 6.5 Operative treatments

### *6.5.1 Arthroscopic capsular release and manipulation under anesthetic (MUA)*

Arthroscopic treatment is usually indicated in patients who do not respond to drug and/or rehabilitation therapy. Usually, during this procedure, a manipulation under anesthetic (MUA) is carried out as in this way, it is possible to reduce the potential damage by allowing it to be performed with less force. In addition to a general anesthetic, it is normal for a regional nerve block to be given. This causes postoperative numbness and enables the patient to get moving at the earliest possible stage. Intensive physiotherapy is regarded as essential to a good outcome.

## 6.6 Postural educational program

After a period of unconditioning typical of the acute phase of pain and contracture, it is necessary to learn again the correct body schema and achieve the complete recovery of postural control. It is possible through a progressive recovery of good motor control, thanks to the muscular selective reinforcement with the increasing development of strength in different patterns of movement, both the proprioceptive recovery. In the last rehabilitation phase it is necessary to restore the sensorimotor skills including proprioception static and dynamic balance either with aquatic rehabilitation therapy or through platform swing walkway, which is a common way to improve gait pattern through activation of sensory stimuli (visual, auditory, vestibular, and somatosensory) [72, 73].

| | |
|---|---|
| 0–2 weeks | Physical therapy<br>Injection therapy<br>Medication therapy<br>Mobilization and manual therapy |
| 2–4 weeks | Full passive range of motion should be achieved by 2–4 weeks<br>Scapular and glenohumeral joint mobilization<br>Begin rotator cuff retraining and strengthening, focus on restoring proper biomechanics |
| 4–8 weeks | Progressive strength training contingent upon perfect biomechanics<br>Development of independent home and gym program (aquatic microgravity environment) |
| 8–10 weeks | Progression into normal activity and exercise program<br>Long home maintenance program to include daily<br>ROM exercises, rotator cuff program, and postural educational program |

**Table 3.**
*Summary of therapeutic strategies.*

### *6.6.1 Summary of therapeutic strategies*

See **Table 3**.

## 7. Conclusion

Often a rehabilitative success is defined by the return of normal motion rather than pain-free functional motion, but adhesive capsulitis is a challenging condition for both the physical therapist and patient. In fact, the healing process takes months to restore full mobility without pain, considering the presence of dense fibrotic tissue and the months of collagen remodeling required to recover soft tissue length. The rehabilitation of frozen shoulder is frequently prolonged despite multiple therapeutic methods because of the difficulty of acting on the degenerative process of the cartilage matrix and the progress of adhesive capsulitis. It is important to the diagnosis process and assessment to choose the best intervention or a combination of strategies for each patient. Although in scientific literature, a definition of the best rehabilitation approach is still needed, following an integrated, multifaceted, and combination of evidence-based approaches, therapeutic success can be achieved!

## Disclosure

The author reports no conflicts of interest in this work.

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