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Frozen Shoulder: Is it Time to Establish Golden Standard for The Diagnosis and Treatment of Frozen Shoulder?

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Abstract

Frozen shoulder is a common painful condition that was described many years ago. Still, the diagnose and the treatment of this condition is an area of disagreement and contradictions.

The aim of this literature review is to find out if there is enough evidence to support the establishment of a golden standard for the diagnose & treatment of the Frozen shoulder.

Empirical search in PubMed, PEDro, Medline, science direct, and Cochrane library was conducted in January and February 2021. The search terms included: Frozen shoulder, adhesive capsulitis, physical therapy, Physiotherapy modalities, rehabilitation, manual therapy, mobilization, exercise. Operative treatment. The search was limited to human studies published in English with abstracts available.

A total of 117 studies were included, analyzed and, reviewed carefully to synthesize a relevant conclusion. The goal of our empircal search was to identify a large quantity of relevant available studies in order find consus on the important topics related to the subject of this review.

The results show that gentle physiotherapy exercise, mobilization techniques including Maitland, Cyriax, and Kaltenborn techniques are effective treatment methods. Few studies supported the application of Short wave Diathermy, Low-level laser, and continuous passive motion device. The intra-articular cortisone injection is a safe effective method, especially in the painful phase.

Better results can be achieved when injections are guided by ultrasound. Capsular distension and arthroscopy are advised when symptoms persist over 6-9 months. Rapid diagnosis and effective treatment can affect the natural history and shorten the clinical course of the disease. Extensive clinical skills are central to achieve good results.

Our review concluded that there is enough data to set the golden standard for the diagnosis and treatment of adhesive capsulitis.

Keywords: Frozen shoulder, adhesive capsulitis, Management, Physiotherapy

Introduction

Shoulder pain, along with knee and spinal diseases, is one of the most common conditions in orthopedic practice. Frozen shoulder is one of the most frequently encountered problem in the shoulder joint [37]. Unfortunately, whenever we talk about frozen shoulder, the disagreement will always prevail.

It is unclear exactly how common frozen shoulder in the population but several authors reported an incidence rate of 2%, [20, 101] and between 2-5%, [5, 21, 38, 98, 99] or between 2-7% [37]. Its peak incidence is between the ages of 40 and 60 years, but some authors reported occurrence also in the ages of 65 [72, 101] or even until the age of 70 [30, 38, 47, 98]. It is more common in women [3, 5, 7, 20, 38, 44, 47, 72, 101]. The non-dominant shoulder is more likely to be affected [3, 7, 10, 47] and later on the other shoulder can be affected. Bilateral involvement occur in about 12% [3] 6-17% [7] 14% [2] 20-30% [33] and as much as 40-50% [38].

Frozen shoulder (FS) occurs up to 10-20% in those with diabetes [2, 3, 10, 21, 101]. Nagy et al (2013) [29], Koranski el al (2021) [37] & Manski et al (2008) [38] have reported a prevalence of 10-36% in the diabetic group.

It's really unbelievable how confusing the data available regarding the FS, even though the syndrome was described nearly150 years ago! still, there is a lack of consensus between researchers about the terminology, pathology, assessment tools, and best treatment options!

Definition & Terminology

Frozen shoulder is manifested by painful, progressive loss of both active and passive movements, along with normal radiographic scans of the glenohumeral joint [5].

The terminology used in association with frozen shoulder can be sometimes general and inaccurate with the overall goal to clarify a painful, stiff shoulder syndrome. The first attempt to describe this debilitating condition was made by Duplay in 1872 [1] but the term Frozen shoulder was first introduced by Codman in 1934 [2]. He described a shoulder syndrome with the hallmarks of insidious shoulder stiffness; severe pain, even at night; and a marked reduction in forward elevation and external rotation [7].

He stated: "*It comes on 'slowly; [with] pain usually felt near the insertion of the deltoid3; inability to sleep on the affected side; painful and incomplete elevation and external rotation; restriction of both spasmodic and mildly adherent type; atrophy of the spinati4; (supra & infraspinatus), little local tenderness; [and] X- rays negative except for bone atrophy*"(Codman, 1934) [12].

In a pioneering histological study published in 1945, Neviaser adapted the term adhesive capsulitis (AC) trying to identify the underlying inflammatory and fibrotic changes observed in the capsule and adjacent bursa [21, 47].

The frozen shoulder was known by many names, e.g scapulpo-humerus periarthritis, acute synovitis, irritative capsulitis, periarticular adhesions, pericapsulitis, humero-scapular fibrosis, shoulder hand syndrome, stiff and painful shoulder, shoulder arthritis, and adhesive capsulitis [3, 4, 19, 101].

In Japan, the term "goju-kata" (50-year-old-shoulder) has been used among the general public since the eighteenth century or before [12]. More recently, Bunker (2009) [14] suggested using the term contracted shoulder (frozen) as it manifested by the capsular contracture.

However, all those names aimed to describe a painful limitation of movements in the shoulder joint leading to disability. This variety of names might summarize the different understanding

of the pathology and will have an impact on the treatment options and the prognosis.

Underlying Pathology

Several authors have made several theories about the pathophysiology of (AC). The first review of the history of pathological studies is dated back to Duplay 1872 as he has mistaken the structures around the shoulder to be responsible for the painful stiffness. He thought that trauma is the causative factor. Even after he realized that the condition can also occur in the absence of trauma, still he used the description 'periarthritis scapulohumeral and balmed structures like the subacromial bursa [12, 13].

Others have purposed that the coracohumeral ligament is usually the structure to be first affected in the roof of the rotator cuff interval. Contraction of the coracohumeral ligament limits external rotation of the arm, which is usually first affected in early AC. In advanced stages, thickening and contracture of the glenohumeral joint capsule develops and, further limiting the range of motion in all directions [10, 18, 19, 31].

First in 1945 when Neviaser adopted the term "adhesive capsulitis." attention was drawn to the possible role of joint capsule adhesions [13, 64]. After a series of case studies, he described the gross and histological limitation of the capsule. Neviaser purposed fibrotic adherence of the capsule to the anatomic neck of the humerus and reduction of joint volume capacity from 28- 35 ml to 5-10 ml. Adhesions began usually in the axillary folds [14, 29, 99, 102].

In the country, the concept of capsular adhesions was rejected by some authors who insisted that the condition is rather related to synovitis and progressive contracture of the capsule [14, 29].

However, there is more acceptance of the capsular adhesions theory confirmed by many arthroscopic and histological studies. Rodeo (1997) have compared biopsies collected during arthroscopy from 19 patients with adhesive capsulitis, 14 patients with nonspecific synovitis, no fibrosis or clinical evidence of adhesive capsulitis, and 7 patients undergoing surgery for another pathology who had a normal capsule and synovium.

The findings for the patients with adhesive capsulitis showed capsular adhesions made by the increased amount deposition of collagen type lll in the anterosuperior portion of the capsule which indicates the synthesize of new collagen [103]. It's unclear how the inflammation processes starts but the inflammation might be mediated by immunological response evident by the presence of mast cells, T & B cells, and macrophages [16, 17].

Mast cells are known to regulate fibroblast proliferation and may act as an intermediary between the inflammatory and subsequent fibrotic processes [21].

Other authors reported a major role for proinflammatory cytokines (IL-1, IL-2, TNF-a, IL-6) and growth factors secreted by immune cells together with cyclooxygenases (both COX-1 and COX-2) trigger remodeling of collagen in the matrix [21, 23, 37].

Cytokines and growth factors, leading to the accumulation and propagation of fibroblasts, which produce excess Type III collagen [20, 21].

The cytokine response may also initiate angiogenesis within the capsule, producing the typical arthroscopic appearances of new blood vessels on the capsular surface [26, 27].

The increased expression of nerve growth factor receptor and new nerve fibers were found in the shoulder capsular in AC patients suggest that neoinnervation is an important event in the pathogenesis and may help explain the severity of pain [15, 107].

On the other hand, disturbance of (TGF-β) signal function will disrupt the normal physiological pathway and may act as a persistent stimulus, resulting in capsular fibrosis [103, 104].

Besides, cytokines such as IL 1, transforming growth factor-β, platelet-derived growth factor, and connective tissue growth factor may increase the proliferation of fibroblast which is accompanied by transformation to myofibroblast, the primary cells in the Duputryen disease.

This pathological change resembles those usually seen in Duputryen disease [2, 16, 17, 18, 19, 21]. Myofibroblasts or contractile fibroblast have contractile actin microfilaments which align with the long axis of the cell. It is the pathogenic cell of contractile scar tissue [27].

Myofibroblasts interconnect themselves with fibronectin and extracellular fibrils. Together with type III collagen predominates in the extracellular matrix, these cellular collagen-rich components lead to contracture deformity [104] and of course capsular contracture in cases of frozen shoulder.

Some studies highlighted the role of Local metalloproteinases responsible to degrade the connective tissue matrix. It can be inhibited by specific tissue metalloproteinase inhibitors, cytokines and growth factors causing excessive collagen deposition within the capsular matrix [2, 19, 20, 21]. The implication of metalloproteinase inhibition was studied by Hutchison et al, 1998 In a series of 12 patients with inoperable gastric carcinoma who had treatment with a synthetic matrix metalloproteinase inhibitor (Marimastat) for more than one month, six developed a frozen shoulder [17].

So the debate is not over yet! some have argued that the fundamental process is inflammation; others purposed that, it is scarring in the absence of synovial inflammation [16, 19*].

Overwhelming data from large quantity studies concluded that scarring is produced in reaction to synovium and capsular inflammation [3, 4, 12, 15, 17, 20, 21, 24, 29, 30, 35, 37, 102, 103, 105, 106, 107, 108] the capsular lesion is fundamental to the evolution of this condition [3, 4, 7, 12, 17, 21, 24].

This appears to be logical since the pain and stiffness abate in response to injections of corticosteroid which is a potent suppressor of inflammation [4, 12].

“Like the chicken and egg question”, the discussion was continued about what comes first? Synovial inflammation or capsular inflammation? “.

In my humble opinion, different pathological findings might be related to different underlying pathology! If a patient suffers from Rheumatoid arthritis, inflammation of the synovium can proceed the capsular inflammation. It will be beneficial to conduct more well-designed pathological studies to compare the pathological process in the subgroups of frozen shoulder.

Natural history

There is a common belief that frozen shoulder is a benign self-limited condition. Spontaneous recovery can even happen without treatment [102] or after a minimal therapeutic intervention. Griggs et al, 2008 conducted a prospective study of 75 patients. He reported 90% significant improvement and satisfaction in patients treated with simple exercise program [66]. The retrospective study by Miller et al, 1996 reported complete resolution of 50 patients treated with moist heat, home exercise program, and medication [109].

Unfortunately like everything else regarding the AC, the natural history suffered serious disagreement regarding the duration of the syndrome, and if there is at all tendency to asymptomatic evolution and, spontaneous recovery.

Cyriax had described the natural history of capsulitis as a self-limiting condition that evolves and resolves in one year particularly for traumatic and immobilization arthritis (capsulitis), and 2 years for mono-articular steroid-sensitive arthritis [4].

However, its more accepted now that between 20% - 60% of patients may experience persistent symptoms many years after the onset of the condition, e.g restriction of movements or pain in the extreme range of motion (ROM). Some prospective studies even, pointed that at least more than 6% ≥ of the follow-up group sustained mild functional disabilities to severe symptoms 4 > years after the onset of AC [5, 14, 20, 22, 24, 25]. Various studies have also reported that 20%-50% may develop long-lasting symptoms [21].

Despite all, many authors think that resolution usually takes place between 1-3 years [21, 27, 29, 34, 41] with an average time duration of 30 months [7, 25, 27, 38, 72]. While some authors think that recurrence is highly unusual or never occur [7, 20, 37, 72] in contrast Manske et al, reported that 80% of patients will experience recurrence of symptoms within five years [38]. Recurrence on the affected side is possible especially in diabetic patients [98].

Clinical presentation

Frozen shoulder is characterized by severe shoulder pain with loss of both active and passive movement. Patients experience disturbance of function in the daily living activities and difficulty sleeping on the affected side.

With only little exception, frozen shoulder is divided into three consecutive stages: Painful or ‘freezing’ phase, stiffness or ‘frozen’ with established stiffness and reduced pain and

'thawing' or resolution with stiffness subsides and gradually return to movement [4]. However, the boundaries between stages are absent and not clear.

The overlap between the different phases makes it difficult to identify each stage [4, 5, 7, 27]. Reeves (1975) noticed that the longer the painful phase, the longer the thawing phase [25].

Painful, (freezing) phase

Marked Pain around the shoulder with little or no stiffness. The pain is constant and worsens at night with or without reference to the upper arm. After progression in the first stage, the pain might interfere with the patient sleep on the affected side. There is little response to non- steroidal anti-inflammatory drugs. Some authors suggest a duration from weeks to 3 months [4, 29, 30, 33, 47] while others suggest a duration up to 9 months [5, 26, 27, 28, 29, 35, 38, 46, 64, 72, 99, 101].

Based on 4 criteria, Cyriax has divided the painful stage (the 1st stage) into another 3 phases following the degree of inflammation:

- The magnitude of pain and whether it is continuous or just brought by activities
- The localization of pain and if it spreads down to the elbow
- The presence of night pain and whether the patient can lie on the affected side
- The end-feel on lateral rotation.

So in the first phase of the painful stage it self the pain does not spread down to the elbow, the patient can sleep on the affected side, some degree of limitation but the pain is pronounced at the end ROM and the end-feel may be altered but not abnormal [4].

In ll second phase the pain will spread down the upper arm, and might interfere with the patient sleep! the end feel is spastic on passive testing.

In the lll phase of the first stage there will be remarkable gross inflammation with all four criteria at their worst:

- Pain at rest
- A patient can not lie on that side at night
- Pain spreads down to the elbow
- End-feel indicates muscle spasm

The ROM shows a gross limitation of external rotation > abduction. Slight limitation of medial rotation[4]. The last phase of the painful stage with a high degree of inflammation is considered to be the transitional stage to the progressive stiffness, frozen stage (second stage).

Stiffness (frozen) stage

The severity of the synovial inflammation begins to diminish gradually. The inflammation degree is reduced, night pain and rest pain may remarkably decrease or disappears some months after the onset of the condition. The spreading is less than before, and pain remains at the shoulder.

The end-feel on passive movements remains painful but change from spastic to hard ligamentous. The duration of this stage is controversial. Some suggest 3-9 months [4, 7, 29, 30, 33, 47] while the majority of authors range it between 4-12 months [5, 26, 27, 31, 34, 35, 46, 64, 72, 99, 101].

Thawing, resolution stage

Very little or no pain, stiffness improving steadily in this phase, the condition is moving towards spontaneous recovery in the range of movement. Overall improvement in the function and active daily living. The duration of this phase range from 9-18 months [31] and up to 26 months according to Song (2014) [28]. Again, a majority of authors suggest that resolution might occur between 12-42 months [28, 27, 35, 46, 101]. Several authors describe 30-36 months duration until thawing is achieved from the onset of the symptoms [29, 30, 31, 101].

Classification

Primary, idiopathic frozen shoulder occurs without known etiology thus it's called idiopathic frozen shoulder [3, 4, 12, 21]. Patients with primary adhesive capsulitis suffer gradual, slow onset of the symptoms without known precipitating factors or events.

The most pronounced symptom is often "pain" The patient usually does not seek medical help and even when they do, the diagnose will be missed. Only after the ROM restriction is pronounced, the pain severity and the disturbance of the patient's functional activity will provide the clue to make a diagnose [38].

Secondary adhesive capsulitis might have another evolution. Sometimes patients notice their symptoms soon after a fall or trauma. If the pain and ROM do not improve as expected after such events, suspicion of traumatic capsulitis rises quickly with this patient's history [4, 38]. The same happen when we encounter a painful shoulder syndrome after immobilization, e.g stroke or when pain and limitation develop in diabetic patients. Many authors have reported collectively these risk factors to be associated with AC: Psychological factors such as emotional depression, hyperthyroidism, hypothyroidism, hypoadrenalism, Parkinson's disease, cardiac disease, pulmonary disease, stroke, and even surgical procedures that do not affect the shoulder such as cardiac surgery, cardiac catheterization, neurosurgery, and radical neck dissection, Duputryens disease [3, 4, 7, 21, 33, 35, 47, 100, 101].

Tamai et al (2014) and D'Orsi et al (2012) have also reported rotator cuff tears, and calcified tendonitis as possible causes of AC [19, 33]. Nakandala (2020) used the term intrinsic factors to describe rotator cuff pathology possible as secondary cause associated with AC [47]. However, further careful investigation is needed to provide a clear link between rotator cuff pathology and AC. There is very little evidence to support this conclusion.

Prodromidis et al (2016) in a systematic review and meta-analysis investigated the genetic predisposition of the frozen shoulder between relatives. The results of one Meta-analysis of two of these studies with clearly defined controls showed significantly higher rates of HLA-B27 positivity in patients with the frozen shoulder as compared with controls ($p < 0.001$) [111]. The HLB 27 is usually associated with systematic diseases e.g reactive arthritis, ankylosing spondylitis, and inflammatory bowel disease. This should draw attention to " inflammatory arthritis" as the underlying pathology of the frozen shoulder.

Among the seldom rare secondary causes, Cyriax reported septic arthritis, haemarthrosis, Gout & Pseudogout, metastasis, and aseptic necrosis [4]. Some of these Cyriax findings were not confirmed by other researchers. Serious pathology should be considered immediately if the frozen shoulder is associated with red flags! e.g restriction of movement i all directions [10] or when FS occurs together with weight loss, systemic upset, shoulder swelling and bony tenderness, fever and night sweet, local erythema over a hot joint, tender joint, abnormal joint shape; local mass or swelling. All those symptoms should raise the possibility of infection or tumor and, prompt urgent investigation [20, 110].

The association between diabetes and FS is well established. More investigation is needed regarding the other co-morbidities, and attention should be paid only to high-quality studies where the diagnose is confirmed by the patient history, clinical assessment, and diagnostic images or arthroscopy. Systemic diseases should also be considered e.g inflammatory arthritis especially whenever we encounter bilateral involvement.

Even though, James Cyriax has recognized the classification of FS into primary and secondary, he emphasized more on the patient history and the presence of the capsular pattern as a clinical diagnostic tool [4].

The capsular pattern

A capsular pattern is a sign of joint involvement "inflammation" or arthritis. The concept was first introduced by Cyriax in 1978 [6]. It refers to a particular sequence of passive limitation of motion in a joint controlled by muscles; this pattern affects the whole joint due to an inflammatory process, regardless of the cause. Each joint has its distinctive capsular pattern. The capsular pattern at the shoulder joint is a proportional limitation of the three passive scapulohumeral movements. There is some limitation of abduction (ABD), more limitation of external rotation (ER), and less limitation of internal rotation (IR) [4, 113].

Despite that many authors disagree about the capsular pattern, there is a wide agreement regarding the restriction of both active and passive elevation, with limitation of external rotation followed by other movements [2, 7, 10, 12, 13, 15, 20, 21, 29, 34, 37, 38, 64, 99, 110].

Does the capsular pattern exist?

There are more controversial theories about the presence and absence of a capsular pattern in patients suffer from adhesive capsulitis. The discussion extends also to the characteristics of this pattern and if a variety of patterns because of the different causes of joint inflammation. One of the aspects to provide evidence in this conflict is to examine the correlation between capsular tightness and movement restriction.

Lin, et al (2005) have shown a significant link between posterior capsule tightness and reduced medial rotation ROM and anterior capsule tightness with decrease external rotation ROM [8].

Gerber et al (2003) in an attempt to study the effect of selective capsulorrahphy on the limitation of passive ROM in the shoulder joint. This approach is used frequently to treat shoulder instability by tightness the joint capsule. The aim was to assist surgeons to identify the part of the capsule which is contracted or lengthen in the lights of the present ROM. The study of 8 human cadaveric showed that anterior superior capsular tightness markedly reduces external rotation of the adducted arm, while anterior-inferior tightness significantly decreases abduction and external rotation. Posterior capsule plication mostly limits the internal rotation of adducted arm [112]. More specific studies were conducted to find the pattern of movement restrictions in patients with adhesive capsulitis.

Mitsch (2004) [9] investigated the presence of a measurable pattern in patients with AC due to Rheumatoid arthritis or after trauma. The results showed that there was a loss of movement in all directions, but ER was significantly limited compared to ABD and IR. This specific pattern of restriction was also confirmed recently by Mezian et al (2020) [10].

Sharma et al (2015) studied the intertester reliability for the PROM test in patients diagnosed as stage ll adhesive capsulitis. The study emphasized on the importance of the reproducibility of PROM measurement since this is the most common clinical tool used to diagnose frozen shoulder. Two independent physiotherapists used plurimeter to measure the typical pattern of passive movement limitation which is more reduction of external rotation, less of abduction, and least of internal rotation. A sample of 50 patients have measured their PROM in 3 visits over 8 weeks. The result was very good or excellent and ICC ranged from 0.76 to 0.98 which is very reliable. Even though the study objectives was to find a reliable method for PROM the Author identified the patients of adhesive capsulitis based on Cyriax capsular pattern of passive ROM limitation [113].

Is the capsular pattern always the same?

Bashir et al (2018) found that the pattern of restriction might be different because of different underlying pathology. The pattern of movement restriction was compared between three groups of patients of idiopathic AC, Diabetic AC, and traumatic. The study concluded that the movement restriction in the patient group of diabetic and traumatic AC has followed the Cyriax pattern, while a typical pattern was not found in the idiopathic AC group [11].

However, more studies are needed to confirm these findings! Many studies have presented no difference in the pattern of limitation in patients with idiopathic AC.

Causes of capsular pattern

Cyriax has listed 13 causes for frozen shoulder which can be categorized into four large sub- groups. A group of traumatic arthritis is AC contracted after trauma, e.g a direct blow or surgery. A second group includes all kinds of joint immobilization, e.g after stroke. The 3rd group includes patients with AC caused by a systemic and inflammatory disease such as diabetic or rheumatoid arthritis. Cyriax described patients in this group as “Steroid sensitive arthritis” when he noticed that they respond well to intra-articular cortisone injection [4, 12]. The last group included conditions with serious lesions mentioned earlier in our discussion of secondary AC. They are mostly associated with other illnesses, sometimes presented with Red flags. Today in the clinical orthopedic medicine the term “arthritis” is the umbrella that includes all types of joint inflammation. So FS is arthritis with capsular pattern. It’s the physician’s mission to refine the diagnose and to define clearly the subgroups.

Assessment

Frozen shoulder diagnosis can be made entirely clinically by assessment of the medical history and simple set of functional tests. No laboratory test or technical imaging can provide a tentative diagnose [4, 10].

An accurate review of the past medical history might identify the presence of trauma, or association with underlying pathology, e.g diabetes. In addition, patient history can also help us to establish the stageing of the condition.

If the patient states that there is a limitation of shoulder active ROM the diagnose can be made by assessment and comparison with the passive ROM. Today the Cyriax principle of restriction of passive ROM to establish the diagnose is well accepted.

Still, careful ROM measurement using a standardized tool, e.o goniometer or inclinometer is recommended. Visual estimated ROM should be avoided because of the inability to document accurate results and the poor reproducibility. It is necessary to establish a baseline measurement to monitor and evaluate prognosis [12]. The presence of capsular pattern especially

in advanced stage ll endorses the diagnose. Cyriax defined the capsular pattern of the shoulder as the ratio between three passive movements, whereby external rotation is most restricted, abduction less, and internal rotation less [4, 11, 12].

End feel assessment might help to confirm the presence of abnormal pathology in the joint capsule. Petersen et al (2000) conducted a descriptive study to examine the relationship between the pain intensity and the pathological end feel. The result showed increased pain intensity in the presence of pathological end feel [115].

Cyriax described the normal capsular end feel in the shoulder as elastic, while it can turn to be spastic end feel in the progressive stiffness phase [4].

The lack of high-quality studies shadowed the Cyriax contribution to the diagnose of this condition clinically. However, some efforts were made to examine the validity of Cyriax functional examination in the diagnose of shoulder pain as generally. Kuo & Hsieh (2019) have found the Cyriax functional examination is highly sensitive to detect subacromial and rotator cuff lesions compared to ultrasonography [32]. This confirmation will aid the physicians while trying to establish the diagnose by exclusion [38]. However, clinicians might have some trouble confirming the diagnose by the absence of the capsular pattern and altered end feel, especially in the first phase which is largely dominant by pain only! Clinical experience is essential to make a differential diagnosis! because AC in the early stage might resemble other shoulder conditions such as major trauma, rotator cuff tears or contusion, labral tear, bone contusion, subacromial bursitis, cervical or peripheral neuropathy [38, 102].

Sometimes minimal invasive techniques can give a clue to make a diagnose! Simple lidocaine injection to the subacromial space might exclude subacromial bursitis and other rotator cuff pathology, as the passive movement limitation usually improves in these conditions but the limitation persists in patients with AC [10, 115].

This was also advocated by Neer to exclude the diagnose of impingement. The pain will abate after subacromial anesthesia injection and the Neer signs can be turned to negative for those who suffer from impingement [12].

The laboratory tests and x-ray images are not of great help to establish a diagnose, but it might help to rule out other conditions [4, 10, 12, 20, 38, 64, 102].

Palin x-ray is particularly important to role out a fracture if the symptoms last more > than 4 weeks after trauma. Usually, x-ray shows negative findings in cases of impingement, rotator cuff pathology, calcific tendinitis [33, 37, 110]. An X-ray can help to diagnose osteoarthritis [33, 38] or to show Hill-Sachs lesions, Bankart lesions, or dislocations [117].

The musculoskeletal ultrasonography (MUS), is often used in the screening of shoulder pathology. Still, there is lack of a comprehensive evidence about the possible findings [10].

In the country, some authors suggest criteria for AC diagnosis consists of limitation of supraspinatus sliding movement, continuous visualization of supraspinatus tendon during lateral arm elevation, and biceps tendon sheath effusion. Ryu et al, 1993 compared the effectiveness of dynamic ultra sound (US) to MRI arthrography using a sample of 26 patients. The US sonography identified 21 patients with confirmed MRI arthrography diagnosis. The sonographic found to be 91% sensitivity and 100%, specific [116].

With the addition of CHL thickness, the usefulness of US in the diagnose of AC was confirmed by several authors [20, 21, 106, 110].

Few studies showed even better results with US arthrography known as contrast-enhanced ultrasound (CEUS). A mixture of 1 ml Sono Vue, 1 ml lidocaine, and 18 ml sodium chloride with maximum volume of 20 ml. The intra-articular injection was applied with ultrasound guides for more accuracy.

The CEUS enhanced visualization of decreased volume of axillary recess in addition to filling defects of the joint cavity, irregular thickening with distortion of normal capsule and synovium with overall sensitivity of 91.1% and a specificity of 86.7% compared to 66.7% sensitivity and a 92.5% specificity for thickened inferior capsule using conventional US [106].

Considering the fact that the US is a faster none invasive method with low cost, careful evaluation should be made before using US arthrography.

The sonographic criteria for adhesive capsulitis were (1) continuous limitation of sliding movement (2) Magnetic resonance imaging (MRI) can provide additional information which also can exclude the presence of serious conditions such as primary tumors, septic necrosis, or metastasis. Other authors suggest that MRI imaging is satisfactory to the diagnose and might show slight thickening of the joint capsule and Coracohumeral ligament (CHL) [19, 29, 31] reduction of rotator cuff interval [31] or the thickening of CHL alone and thickening of axillary recesses [34] as well as signs of synovitis [29].

The MRI Arthrography remains the Golden standard for the diagnose of shoulder pathology and in AC. It can show a reduction of joint volume which is usually associated with contracted capsulitis[10, 19, 21]. Dynamic MRI is enhanced with intravenous gadolinium demonstrated greater signal intensity in the synovium which is probably caused by synovial inflammation [19].

In summary, the Frozen shoulder can be usually diagnosed successfully clinically after history taking with focus on pain features, e.g continuous pain, none activity-related, night pain, and inability to sleep on affected shoulder draw attention to inflammatory type pain. A series of simple functional tests can provide a diagnose.

In the first stage and early second stage, the Limitation of passive external rotation might be the only objective findings together with the pain. Usually, other limitations will evolve when the progression of the condition occurs. Mostly the capsular pattern will provide a tentative diagnosis if present. Some authors suggest a simple anesthesia injection to make the differential diagnosis if there is a conflict in the clinical picture.

The technical investigation is not needed in most uncomplicated cases. An X-ray can help to eliminate other causes, and US and MRI can confirm the diagnose or exclude other serious conditions. Some authors report more accuracy when using US arthrography, but the MRI arthrography remains the golden standard to make the diagnosis if other methods didn't provide a clear diagnose.

Management

The assumption that FS is self-limited does not stand the results of many suies confirmed that patients still suffer from pain or residual functional limitation many years after the onset of FS. It does not reflect also, the patient desire to quit their pain and to return to work and physical activities as fast as possible.

Like everything else regarding the Frozen shoulder, there is little or no consensus about the best treatment options! There have benn many procedures including none operative, minimally invasive and, surgical treatment.

These large differences might start with the disagreement about the underlying pathology and the stages of the condition. Putting symptoms in a time frame alone might be inappropriate.

Cyriax has provided a logical and good criteria for staging of FS looking at the symptoms in each stage. This might be very helpful especially in the painful stage.

So the treatment will depend largerly on the presenting symptoms, not the duration alone [4, 10, 12, 27]. For example, a case of highly inflammed joint with all 4 criteria present: wide- spreading pain, the patient cant slepp on the affected side at night, spontaneously occuring pain and spastic end-feel might not benefit from mobilization techniques or exercise [4].

The logical frame of defining stages by symptoms was also introduced by Hanchard el al (2012) who suggested a managment approach base don the clinical presentation of the disease, distinguishing the "pain-predominant" and "stifness-predominant" [12].

This classification is most useful clinically and might facilitate the management processes [37]. In general, we can divide the treatment options as follow:

None-operative treatment Prophylaxis, advise and, education

Prophylactic treatment is frequently used in healthcare to minimize illness and disease. We can not prevent the development of a frozen shoulder after the onset of the pain. The patient naturally will adopt an immobilization strategy to gain comfort.

Patient education can encourage those who suffer from FS to keep use their arms functionally which might reduce the disability. Educating patients helps to reduce frustration and encourages compliance [3, 4, 12, 38].

None inflammatory drugs NSAIDs, Oral cortisone

Oral NSAIDs are administrated regularly along with rest as the first-line treatment of shoulder pain. Although it can provide short-term pain relief [10, 33] alone NSAIDs do not affect the natural course of FS [35, 37]. So despite their widespread use, there is no evidence in the literature to support the effectiveness of NSAIDs for the treatment of AC [35, 44]. Although NSAIDs are still recommended as first-choice treatment because of their analgesic effect [38]. When used together with physiotherapy it might have a better effect [37].

A systematic review and Meta-analysis has compared the effect of NSAIDs drugs vs cortisone injections and found that injections have a superior effect on pain relief and functional improvement [36].

Oral cortisone is also commonly used to treat the symptoms of FS. Most studies seem to show that corticosteroids may reduce pain early in the course of the disease than placebo [44]. Canbulat et al (2015) reported good effects for oral cortisone combined with pregabalin and home exercise [39]. However, their benefits are not maintained in the long term. [Therefore, careful assessment of the risks and benefits must be undertaken as long-term use is not recommended. Other authors suggest that the oral cortisone has a lesser effect compared to intra-articular injection which is associated also with better patient satisfaction [40].

Injections therapy

• Intra-articular cortisone injections

Intra-articular joint injections with corticosteroids are highly accepted by both patients and physicians and are considered to be cost-effective. It gives faster and better results than oral steroids, with minimal risk of systemic side effects. Most often, steroids are used because of their anti-inflammatory properties which help to limit the inflammatory processes. Many studies documented at least the short-term effect of cortisone injection on pain relief and improved ROM [4, 5, 7, 10, 12, 26, 33, 35, 37, 38, 40, 44, 64].

Some authors consider cortisone injections to be more superior to outpatient physiotherapy [12]. Others found that a combination between physiotherapy and intra-articular injection is more effective than injections alone on the outcomes of pain and ROM [5, 7, 33, 34, 41, 64].

However, timing is important to achieve better clinical outcomes. Injections have appeared to be more effective especially in the 1st phase eventually in the second phase of the condition. We should also make concerns to the dose of cortisone as one RCT has shown that greater symptom relief is obtained with a dose of 40 mg triamcinolone acetonide intra-articularly compared with a dose of 10 mg [42].

Finally, we should consider injections give better results when performed with ultrasound- guided since some studies showed inaccurate outcomes when performed blind. The significance of intra-articular injections could be maximized with high-quality practice [38]. Poor results is often caused by lack of experience and wrong practice.

• Sodium hyaluronate intra-articular injection

There were conflicting data regarding the administration of hyaluronic acid injections. A review by Dorsi (2012) suggested that adding this type of injection to the treatment had significant results on decreasing the pain and improvement of ROM in the short term [34].

While another review by Lee et al (2015) concluded that additional intra-articular HA to conventional therapies does not provide significant added benefits. More studies are needed to verify the effectiveness of HA administration when used alone or in combination with other conventional therapies [43].

Suprascapular nerve block

The suprascapular nerve arises from the brachial plexus and provides motor innervation to the supraspinatus and infraspinatus muscles and sensory innervation to the glenohumeral and acromioclavicular joints. A practice initially conducted by anesthesiologists, suprascapular nerve blocks have shown some positive results in a small number of studies, especially in terms of pain relief [44, 45]. Furthermore, the addition of supra-scapular nerve block (SSNB) to a physical therapy program was evaluated by Klç et al, 2015. It is proven to be more effective in reducing pain and functional disability in patients with adhesive capsulitis [81].

Physiotherapy

Physiotherapy treatment is well accepted in the management of shoulder pain including frozen shoulder. The physiotherapy intervention includes a wide variety of treatment modalities

such as hot & ice packs, exercise therapy, mobilization techniques, massage, electrotherapy e.g Extracorporeal shockwave therapy (ESWT), Laser, Transcutaneous electrical nerve stimulation (TENS), ultrasound, phonophoresis, iontophoresis and, Short Wave Diathermy (SWD).

Unfortunately, despite the large quantity of data present, researches have failed to provide a clear guide to the physiotherapy practice.

Some authors concluded that physiotherapy alone is insufficient treatment for FS [33, 37].

Many others have reported good results if physiotherapy was used independently or versus placebo or no treatment [4, 5, 26, 33, 35, 44, 45, 48].

Numerous studies have confirmed the effectiveness of certain physiotherapy techniques without direct referral to the term physiotherapy [7, 12, 46, 47].

Despite mixed results, most researchers do not question the value of a well-designed physical therapy program in treatment, and multiple studies have documented treatment success in reducing pain or increasing mobility [44].

Physiotherapy can be useful throughout all stages of a frozen shoulder; however, it has been found that intensive manual techniques could aggravate the symptoms [33, 48].

- **Heat & Cold therapy:**

It is seldom that these modalities are used alone to control pain nowadays. Usually, they are used in conjunction with a home exercise program. Less often, they can be used before stretching or exercise [4].

Superficial heat is believed to reduce pain by mechanisms involving the release of endorphins [12, 34]. Doner et al (2013) reported better effects when using hot packs before stretching techniques [51]. Application of cold packs can reduce the pain by limiting the inflammation via blood vessel constriction and reducing tissue swelling [12].

- **Extracorporeal shock wave therapy (ESWT)**

Vahdatpour et al, 2014 RCT reported significant improvements in the outcome measures for ESWT group treated once a week for 4 weeks over the sham group. On the follow-up period, improvement in individual performance and the amount of pain and disability were obvious in the ESWT group [54]. Chen et al compared extracorporeal shock wave therapy (ESWT) with oral steroids. ESWT showed better outcomes compared to the steroid group [55].

Another RCT used 30 patients with adhesive capsulitis were divided into an experimental group (n=15) that would be treated with ESWT and a control group (n=15) which was treated only with conservative physical therapy, e.g hot packs, US, and interferential. Results showed significant lowered VAS and better ROM improvement in the experimental group [56].

There is established evidence that favors the use of ESWT in pain control for patients with FS which positively affects the restoration of ROM. However, most of the studies are small numbered RCTs and there is a need for more researches.

- **Low Laser therapy (LLLT)**

Some researchers suggested that low-power laser therapy is more effective than a placebo in the treatment of patients with adhesive capsulitis.

Stergioulas (2007) conducted RCT with 63 patients with FS assigned randomly into two groups. The Active laser group had a significant decrease in pain scores at the end of 4 and 8 weeks of treatment compared to the placebo group [52].

The finding was supported by a systematic review of Jain et al 2014 that strongly recommended the LLLT for short-term pain relief [72].

Another prospective 2 years follow-up study for elderly patients with adhesive capsulitis found satisfactory results for both short and mid-term with more than 90% of clinical efficacy [57].

Still, the available studies of small samples group and, need further research endorsement by large samples, high-quality studies.

- **Short wave diathermy (SWD)**

RCT by Leung, M.S (2008) showed that adding SWD to passive stretching exercise gives better improvements in terms of pain, range of motion, and patient satisfaction [51].

It's important to remember that treatment modalities providing magnetic field should not be used with patients have implanted electronic devices. SWD is contraindicated for patients with cardiac pacemaker [49].

• **Transcutaneous electrical nerve stimulatio, Ultrasound, interferential therapy**

There is conflicting evidence regarding the efficacy of those modalities. There are not enough documented high-quality RCTs studies regarding the effect of these modalities individually as they are usually used in cross interventions or as adjunctive treatment [46].

According to a cross survey conducted in the UK 16% of the physiotherapist only will recommend the application of transcutaneous electrical stimulation (TENS) to patients with FS, while only 6% will do the same regarding the US and interferential [12].

Rizk et al (1983) compared adding TENS to prolonged traction in one group (B) to heat, exercise and, manipulation in the other group (A) and found that group B had significant improvement in the outcome of pain and ROM [53].

Another RCT by Doner et al (2013) showed a better effect using TENS combined with heat and Mulligans stretching techniques [50].

It's important to point that only a few studies support these results! and the application of TENS in a cross intervention makes it difficult to know its real effect.

Ultrasound (US) was widely used by physiotherapist. It is believed to deliver deep heat to inflamed joints with AC. Today the application of the US as a single method of treatment is very limited. Often it is used in combination with other methods.

Elhafez et al (2015) concluded in RCT that combining axillary ultrasound and laser with post- isometric facilitation. He found a greater (short term) effect in reducing pain and improving shoulder ROM in the US group [59].

However, the other interventions used in combination with US such as Laser and exercise are proven to have a positive effect on the patient's symptoms which question the real benefit of additional US to the treatment.

This conclusion was reached by a systemic review (2003) which showed that ultrasound is of no additional benefit over and above exercise alone in the treatment of shoulder pain including adhesive capsulitis [59].

The interferential electrotherapy is provided classically via a 4 electrode system. Two medium frequency currents (4000 Hz) are used to generate a more comfortable low-frequency stimulus on the skin (60-100 Hz). The amplitude modulated in bursts of 4 seconds each and repeated for up to 15 minutes which give the desired therapeutic effect in the deep tissues without causing pain on the skin [12, 45]. There is a lack of studies that support the use of interferential in the treatment of FS [45].

Other treatments

Iontophoresis, phonophoresis, ultrasound, massage have not been shown to provide significant results in the treatment of patients with adhesive capsulitis [34, 46, 99]. One article by Jewell et al (2009) even suggests that using these modalities might reduce the likelihood of a favorable outcome, thus the use of these modalities should be discouraged [60].

This result is limited and cant be generalized as many authors still advise the application of some of these modalities in conjunction with other physiotherapy interventions.

• **Exercise therapy**

Exercise therapy is regularly prescribed as treatment options for patients with AC in the context of symptoms such as pain and limitation. A wide variety of exercises are applied clinically or administrated by patients themself as a part of home exercise program. This includes active- assisted, active, and passive ROM exercises.

Usually, it starts with gentle low rhythmic exercise within the patient's tolerance. Codman was the first to advise the pendulum exercise to reduce the pain [12, 34].

• **Passive stretching**

The effect of passive stretching exercise as a treatment method for AC is well documented in the literature. This includes passive stretching in forward elevation, internal and external rotation, and cross body adduction. These exercises should be performed for 5-10 minutes several times a day [64].

Despite the debate on the frequency and the proper techniques of treatment, the authors agreed that aggressive stretching techniques can aggravate the patient symptoms [64]. Overenthusiastic treatment could aggravate the capsular synovitis and subsequently cause pain [33, 34].

The Cyriax approach can provide guidance to identify patients who might benefit from passive stretching techniques. Patients in the first stage of the condition with wide-spreading pain, remarkable night pain, and spastic end feel indicate a high degree of joint inflammation and therefore should be spared the stretching techniques [4].

Patients with moderate symptoms can be treated with the arm in forward elevation with a bent elbow and the hand over the forehead, which is classical Cyriax grad B stretching [4].

Capsular distraction can be tried for patients with a higher degree of inflammation if steroid injections for any reason cant be used [4].

Guler-Uysal & Kozanoglu (2004) conducted RCT to investigate the effectiveness of Cyriax approach. 40 patients were assigned into two groups, a Cyriax approach management group vs conventional PT group received daily treatment with a hot pack and short wave diathermy. Both groups received additional exercise program. The results showed that 19 patients in the CYR group (95%) and 13 patients in the PT group (65%) reached sufficient ROM at the end of the second week ($p < 0.05$). The authors concluded that CYR methods provide a faster and better response than the conventional physical therapy methods in the early phase of treatment in adhesive capsulitis [65].

Regardless of the applied technique, many studies have recommended passive stretching exercise because of their beneficial effect [4, 33, 35, 64, 67, 72].

A prospective study by Griggs et al (2000) even reported 90% improvement in patients treated by specific four-direction shoulder-stretching exercise in terms of reduced pain, increased ROM, and improved function [66].

- **Mobilization techniques**

Manual mobilizations (normally abbreviated to 'mobilizations') are therapist-applied passive movements of joints or other structures performed in such a way that they are always within the control of the patient. They may be performed by various techniques and may be combined with active movement [12]. Many schools are teaching different grading systems for passive movements, mobilization, stretching techniques.

The Maitland concept is based on a five grades system: Grade 1 and ll is small rhythmic movement in the early range of movement or until the mid-range. Grade lll is a large amplitude movement from the mid-range until the beginning of restriction. Grade V is small amplitude movement at the end of the range against tissue resistance and Grade 5 is small quick thrust at the end of the possible range (Manipulation) [69].

The Kaltenborn technique is based on the 3 grades system, Grade I applies a distraction of minor intensity which it is often used to decrease pain. Grade II refers to a force that stretches the periarticular tissue "taking up the slack. Grade III force causes enough distraction or gliding so that the joint capsule can sufficiently be stretched. The Kaltenborn techniques using sustained passive stretching to increase the ROM [69].

Cyriax grading system includes 3 Grades A, B, C. According to Cyriax grade A is passive movements applied within the pain-free range, while Grade B mobilization is performed to the end of the possible range indicated by the end-feel. Grade C mobilization is characteristic by a minimal thrust, high velocity, small amplitude movement at the end of a possible range. To avoid confusion regarding the Cyriax approach, Cyriax made clear that all stretching and distraction techniques such as those applied to patients with frozen shoulder are grade B mobilization (not grade C manipulation) [4].

So low-grade mobilization will be grade l, and ll while high-grade mobilization will be grade lll, V if following the Maitland concept.

Many studies found that the high-grade mobilization technique was more effective than the low-grade mobilization technique (within the pain limits) in increasing mobility and functional ability [33, 41, 44, 48, 70, 71].

Vermeulen et al (2006) reported a better outcome of HGMT compared to LGMT after 3 and 6 months follow-up assessment. But the overall effect is small after 12 months of follow-up assessment. The numbers of subjects reporting improvement of their shoulder function compared with the baseline were with little difference in both groups, with 82% (LGMT) to 91% (HGMT) [70]. Therefore, the Low-grade mobilization could be the preferred treatment mode for those who are anxious about experiencing pain [70].

In addition to Maitland and Cyriax mobilization, other mobilization techniques used by physiotherapists include mulligan mobilization, angular mobilization, transitional mobilization spine mobilizations combined with glenohumeral stretching, and both angular and translational mobilization and high-intensity techniques beyond the pain threshold [71].

Note et al (2016) concluded in a systematic review that all mobilization techniques are beneficial in the treatment of patients with primary AC with some degree of variety regarding the strength of the evidence [71].

The results of this review favor using Maitland mobilization and spine mobilization+ Combined with glenohumeral stretching and both angular and transitional mobilization.

But this conclusion wasn't agreed upon by RCT conducted by Kumar et al (2018). The study compared the effect of the Cyriax approach versus Maitland HGMT in decreasing pain and improving ROM. Although the sample size was small (n=15) the result concluded that HGMT is not more effective than the Cyriax technique. Patients in both groups showed clinically significant improvement [68].

Another RCT by Do Moon et al (2015) compared the Kaltenborn grad lll sustained posterior glid for 30 s and 15 minutes a session to grad lll Maitland anterior-posterior oscillation a total of 15 for 30s a set and 10 minutes a session. The study found no significant difference between the two techniques regarding reducing the pain and improving the ROM [69].

In general, there is little agreement that a particular type of mobilization has a superior effect to others! However, it still a debate in which direction mobilization works better! Some researches tell that posterior glide is more effective than anterior glide to improve the range of external rotation [77, 80]. Posterior glide is also proven to be effective especially in increasing external rotation range of motion compared to conventional physiotherapy [78].

RCT of Boddeti (2013) reported that posterior glide gives better results in improving the functional activities in patients with adhesive capsulitis [79].

Posterior glides proved to be superior to anterior glides to restore external rotation ROM, but the optimal duration of stretch mobilizations to restore ROM needs to be evaluated in further research. It's still a question if these results can also be applied to secondary adhesive capsulitis according to Note (2016) [71].

The beneficial effect of mobilization is well accepted by many authors [41, 60, 65, 72, 74, 75, 76]. Some consider additional benefit when used together with exercise [72] while others report significant effect if physiotherapy interventions, including mobilization, are used after a single steroid injection [41].

Gurudut et al (2019) reported in a pilot study (n=9) a more positive effect when Maitland mobilization is preceded by hot packs and myofascial release techniques. The Gross myofascial release was applied by pulling the abducted arm for 90 seconds in each stretch and the total duration of 10-15 minutes [73]. The result of this study is limited by the small sample and more studies is needed.

- **Continuous passive motion device**

A continuous passive motion (CPM) machine is a device that slowly and gently moves your joint passively. Commonly it is used while sitting on a chair. A CPM machine is programmed to do certain movements in a preselected number of times and through a particular range of motion. CPM is used more in hospital sittings after surgery that's why there is limited researches document the effect of this device.

Dunar et al (2009) in RCT compared the effect of CPM (n=29) to the effect of conventional physiotherapy (n=28) in 12 weeks treatment course. The study evaluated the outcome measures of pain at rest and activity, night pain, and ROM. Both groups received daily treatment and were instructed to follow standard home home exercise program includes passive stretching and pendulum exercise. The study found that both groups had improvement in all measurment outcomes, but the CPM group had a better response in pain reduction than the conventional physiotherapy group in the early stage of FS treatment [82].

Two systematic reviews of Jain et al (2014) [72] and Nakandala (2020) [45] have confirmed the beneficial effect of CPM on pain relief but not the function.

In general, there are only few studies on this device and, its application is restricted due to unavailability in the physiotherapy clinics. Besides, more researches should be done to compare CPM with easier, available manual therapy techniques.

• **Acupuncture**

Asheghan et al (2016) reported improvement of all shoulder movements after 3 months of treatment with acupuncture. Also, the VAS index had improved comparing to the control group. The RCT (n-20) suggests that acupuncture can be offered as a method as a treatment option for patients suffering from frozen shoulder [61].

These findings were confirmed by two systematic reviews and meta-analysis results concluded sufficient evidence favoring the use of acupuncture as a safe treatment for patients with AC. Acupuncture can provide significant effects regarding reducing pain, improving shoulder function, and ROM in the short term and midterm. However, due to the small number of included studies and methodological limitations in these studies, more large-scale high-quality, well-designed RCTs are warranted to give a robust conclusion [62, 63].

However, Challomous (2020) conducted a systemic review to compare the effect of different interventions in the management of frozen shoulder found that there is no additional benefit of adding acupuncture to physiotherapy for early short-term pain and ER ROM versus physiotherapy alone [5].

Operative treatment

• **Capsuler distension, Hydrodilation, hydrodistension**

Hydrodistension was described by Andren & Lundberg in 1965. The idea behind this procedure is to achieve joint capsule expansion by injection of a solution combined of saline, steroid, local anesthesia, and contrast agent into the glenohumeral joint space during arthrography [83].

The fluid was injected using the anterior approach lateral to the Carcoid process until resistance is felt. Then the fluid was drawn back to the syringe and injected repeatedly until the patients felt no more pain. Patients were instructed to move their arms between the repetition. Out of 66 patients with frozen shoulder (both moderate and severe movement restriction), 2 had no improvement in the severe AC group (n=38), one-fifth had immediately gained full mobility while the rest had partial recovery. In the moderate group (n=26) two-third had full ROM recovery while the rest had partial recovery. The study concluded that joint distension is beneficial to restore partial or full joint mobility in patients with AC [83].

Rizk et al (1994) has confirmed this positive effect in an open trial used 16 patients. He reported that distension arthrography is a promising treatment that is safer and less expensive than surgery or manipulation under anesthesia.

However, this treatment should be considered only for those patients who do not respond to conservative treatment in the first 3 months [84].

Buchinder et al (2004) has compared arthrographic distension to placebo and reported more significant improvement for the primary outcomes ROM, pain, and disability 3 weeks, 6 weeks and, 12 weeks after the procedure [85].

Jacobs (1991) [87] and Tveita (2008) [88] reported no difference between intra- articular distension with cortisone versus cortisone injection alone regarding pain and ROM.

Gam et al (1998) partially disagree with the two RCTs findings and reported better improvement with distension-Cortison regarding the ROM [88].

Khan et al (2005) compared arthrographic distension associated with physical therapy to physical therapy alone and found better effect when distension was followed by physiotherapy to reduce pain and improve ROM at 8 weeks [89].

A single prospective cohort study has investigated the long-term effect of arthrographic distension of 51 frozen shoulders patients including both diabetic group (n=12) and none diabetic group (n=39). Patients were followed up for 8-24 months, with a mean range of 14 months. Both groups have made significant improvements in the Oxford shoulder scale (OSS), VAS, and ROM. The authors concluded that arthrographic distension is a safe and effective treatment with long-term benefits for diabetic and none diabetic frozen shoulder [91].

Capsular distension remains a less invasive approach compared to MUA or surgery. However, in my search, we didn't find recently updated studies that investigate the benefit of capsular distension over other techniques. The development of none invasive methods in the management of frozen shoulder might have reduced the application of this method. More high-quality studies are needed to standardize this procedure.

• **Manipulation under anesthesia (MUA)**

MUA involves passive mobilization of the joints, which leads to the tearing of fibrous tissue of joint capsule and contracted ligaments. Recently, instead of general anesthesia, MUA can be performed under a brachial plexus or cervical nerve block [35].

It is usually proposed when the symptoms of FS do not sufficiently improve in the first 6-9 months with conservative management. Its believed that too early manipulation (before 6 months after the onset of symptom) may lead to a recurrence because the disease is still at the inflammation stage [91]. Manipulation under anesthesia has the disadvantage in that tissues that are stretched while the patient is under anesthesia may cause pain when awake. This can potentially slow recovery [38].

Loew et al (2005) in a prospective trial used 30 patients with FS between 2001-2003 has documented several damages including anterior-posterior labral tears (4) patients), (3) patients with partial subscapularis tendon tears, (1) patient with osteochondral defect, (4) with anterior labral detachment and (2) with ruptures of the shoulder middle ligaments [92].

D'Orsi (2012) have even reported humerus neck fracture and glenoid fracture after MUA. Therefore it is wise to evaluate the safety of this method regarding possible contraindications such as significant osteopenia, recent surgical repair of soft tissues around the shoulder, presence of a fracture or neurologic injury [33].

Therefore MUA is reserved for patients who might not benefit from other conservative treatment [4, 92, 93].

• **Capsular release**

Arthroscopic capsular release (ACR) is our preferred surgical option. This treatment is more invasive than MUA, but also more controlled. The surgeon can control which part of the capsule is released. During arthroscopy, areas with synovitis and contraction are identified. Synovectomy is performed, followed by contracture release of the rotator interval, the anterosuperior, inferior, and posterosuperior capsule [64].

There is a wide variation in the way ACR is carried out, ranging from partial release to a full 360° circumferential release. Also, there are various debates in the literature regarding the extent of the release. Several authors recommended the release of the posterior capsule in addition to the anterior-inferior approach [35].

This was agreed by Chen et al regarding the rapid improvement of FS after ACR [95]. He found significant improvement in the addition of posterior-inferior release to anterior structure release compared to anterior release including inferior GHL alone 3 months after the operation. However, the results showed no difference between the two groups after 28 months*.

On the contrary Snow (2008) conducted RCT included 48 patients with primary and secondary frozen shoulder treated in one group with anterior - inferior capsular release while the other group received additional posterior capsular release. The author reported no significant difference in the overall outcome with the addition of a posterior release [95].

Patients with idiopathic adhesive capsulitis treated with an arthroscopic capsular release had early significant improvements in shoulder range of motion, pain frequency and severity, and function. These improvements were maintained and/or enhanced at seven years. The result suggests better outcomes comparing with patients who had none-operative treatment [96].

ACR is classified as a safe treatment, despite that advise some authors to be more careful when using the inferior release to prevent possible injury to the axillary nerve [95].

There is a debate whether the ACR should be used alone or preceded, followed by MUA. Some authors reported better results after a combination of the two techniques!

However, no good-quality RCTs are comparing ACR with other or in addition to other invasive treatments such as MUA [37].

De Carli et al (2012) conducted RCT to compare the MUA followed by ACR (n=46) with intra- articular injection. Both groups had significant improvement in decreasing pain and restoring the ROM. But the ACR group accomplished its goals after 6 weeks, while the steroid treatment group achieved satisfying results in 12 weeks [97].

We have always to weigh the benefits of each method in the light of possible risk and cost- effectiveness. Therefore many authors suggest using this treatment when other conservative treatment fails [38].

In summary, treatment options include a wide variety of surgical and non-surgical options. Many studies have suggested physiotherapy as an adjunctive intervention that provides good results. The proper combination of therapeutic modalities is better than a single method.

The conclusion of this review that physiotherapy should be prescribed regularly as the first line of non-operative treatment, but it should be customized to each individual based on the stage-symptoms.

Physiotherapy treatment in the first weeks can also identify the patients with poor prognosis and whom might need further investigation and referral to other specialists. Mobilization techniques combined with exercise therapy are proven to provide good results. The availability of such methods in the clinical setting is advantageous.

A focus on continuous education to enhance therapist skills in this field is recommended. Few studies reported good results using LLLt and ESWT especially in reducing the pain. Some evidence favor adding SWD to stretching techniques. The practice of this method is limited by the unavailability of these equipments in Today's clinics. Few studied confirmed the beneficial effect of acupuncture in the short and mid-term.

More studies are needed to generalize these results.

A less common approach e.g passive continuous motion, a suprascapular nerve block is reported to be useful but also is not very common in clinical practice.

There is overwhelming data from high-quality studies that support the benefits of using intra-articular cortisone injections in reducing inflammation, decreasing the pain, and increasing the ROM. The benefit might be maximized by adding physiotherapy, such as exercise or mobilization techniques after injections. Some authors consider this to be the golden standard treatment!

The most common non-surgical treatment are MUA, capsular distension, and arthroscopy. While some controversy applies to MUA because and its possible side effect, more agreement exist about the safety and positive effect of the other two approaches.

Results

The results of this review suggested that conflicts regarding the treatment of FS begins with delay diagnose. However, simple lidocaine test or x-ray sometimes can provide enough information to make a diagnose by excluding other conditions. Otherwise, different options can be considered including US and MRI. Therefore complex FS is better interpreted within the teamwork approach. There is wide variety of intervention which ca be used selectively or in combination accodring to the stage of the disease. Enough data support the use of intra-articular cortisone injection as a safe and effective method, especially in the painful phase. Better results can be achieved when injections are guided by ultrasound.

Gentle physiotherapy exercise, mobilization including Maitland, Cyriax, and Kaltenborn etchniques shown to be effective. ESWT, LLLT are proven to be effective methods when used alone in the relevant stage or in combination with other interventions, e.g exercise and mobilization or physiotherapy after a cortisone injection. The use of SWD and CPM is supported by few studies but limited by unavailability of the equipments in the clinical setting. Capsular distension and arthroscopy are advised when symptoms persist over 6-9 months. Rapid diagnosis and effective choice of treatment might affect the natural history and shorten the clinical course of the disease. Extensive clinical skills is sentral to achieve good results.

Conclusion

In this review article we have investigated the possibility to establish golden standard for the diagnose and treatment of frosen shoulder. Based on the results of this review, we think that golden standard for the assessment and treatment can be possibly achieved.

We hope this contribution will aid the standardization of the diagnose and treatment of the adhesive capsulitis

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