

Phonophoresis in Adhesive Capsulitis (Frozen Shoulder)

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INTRODUCTION

Adhesive capsulitis is a condition characterized by limitation of motion of the shoulder joint with pain at the extremes of motion. It was first described by Putaman in 1882 and later by Codman. The initial presentation is pain, which is generalized and referred to the upper arm, back, and neck. As the pain increases, loss of joint motion ensues. The process is generally self limiting and in most cases resolves spontaneously unless there is an underlying problem.¹ In the early phase, there is marked anterior joint/ capsular tenderness and stress pain in a capsular pattern; later there is painless restriction, often of all movements².

Adhesive capsulitis – also known as frozen shoulder, pericapsulitis, scapulohumeral peri-arthritis or check- rein syndrome³. The condition usually resolves spontaneously after about 18 months⁴. Adhesive capsulitis is a common musculoskeletal disorder mainly affecting middle aged adults⁵. Also self care activities and occupational activities decrease depends on which shoulder is involved, for instance, self care, grooming, combing hair, eating and dressing are impaired if right shoulder is involved for right handed person, on the other hand dressing and perineal care are hampered if left shoulder is involved.

Adhesive capsulitis should be divided into primary and secondary types. Subdivision of secondary adhesive capsulitis into intrinsic, extrinsic and systemic types⁶. Primary adhesive capsulitis and idiopathic adhesive capsulitis are considered identical and not associated with a systemic condition or history of injury. Another classification system based on patient's irritability level (low, moderate and high) that is helpful when making clinical decisions regarding rehabilitation intervention⁷.

A global decrease in shoulder range of motion referring to the actual adherence of the shoulder capsule to the humeral head. Secondary causes include alteration of the supporting structures of and around the shoulder, autoimmune, endocrine or other systemic diseases⁸. Adhesive capsulitis is more common in diabetes mellitus^{2,9,10}, and may be triggered by a rotator cuff tear, local trauma, myocardial infarction or hemiplegia, immobilization from any cause^{2,11}. It occasionally appears after recovery from neurosurgery⁴.

The histological features are reminiscent of Dupuytren's disease, with active fibroblastic proliferation in the rotator interval, anterior capsule and coraco- humeral ligament⁴. Three stages, each lasting 4-6 months, mark the clinical course. The progression of the disease is self- limiting and may occasionally resolve in partial restitution¹².

The loss of range is multi planar, with external rotation and abduction being the most affected. Restricted passive external rotation is diagnostic of CFS and would standardize and may clarify the clinical aspect of diagnosis¹³. Clinically the diagnosis should be suspected with progressive loss of range and diffuse pain despite conservative treatment measures⁹. Apart from slight wasting, the shoulder looks quite normal, tenderness is seldom marked. The shoulder is tender on palpation and both active and passive movements in all directions are restricted⁹. One clinical test alone is generally not sufficient to make a pathoanatomical diagnosis¹⁴.

Idiopathic adhesive capsulitis is a common medical diagnosis for patients seeking physical therapy. Modalities used to treat adhesive capsulitis were dichotomized by pain predominant and stiffness-predominant classifications, which may be more useful than existing classifications¹³. Several treatment options are commonly used, but few have high level evidence to support them¹⁵. Physical therapy play an important role in the treatment of many shoulder pain including adhesive capsulitis¹⁶. Clinical studies do not show clear effects of specific treatment. This may be caused by methodological weaknesses of the trials evaluated and that patient characteristics and placebo effects contribute to the diagnosis¹⁴. The transmission of drugs through the intact skin using ultrasound is called phonophoresis. Griffin and coworkers recommended phonophoresis treatment in common musculoskeletal diseases including adhesive capsulitis of shoulder¹⁷.

Phonophoresis is a variant of ultrasound in which biologically active substances are combined with the coupling medium in the hope that ultrasound will force the active material into tissue¹⁸. For instance, NSAIDs gel is used in combination with coupling medium to enhance pain relief for local action. Although this technique has been in use since the 1960s, neither its effectiveness, penetration, optimal frequency, appropriate coupling mediums/ active materials, nor amount of material lost to the subcutaneous circulation is well established. Although some clinical studies report phonophoresis with a variety of agents successful in terms of improved shoulder range of motion and pain following treatment¹⁸. Perhaps mechanism of transdermal migration could involve increased cell permeability from the thermal effects of ultrasound. Ultrasonic coupling gel is mixed with various chemical substances to produce the phonophoresis coupling agent. Typical phonophoresis treatment parameters are similar to those of standard ultrasound: pulsed mode, 1 MHz transducer frequency, stroking technique, at 1 – 1.5 W/cm², for approximately 5 to 10 min per site¹⁹.

Aetiology

The primary form of frozen shoulder having an unknown etiology and increased occurrence in patients with metabolic disorders and the secondary one being seen with poor injury or operation^{1, 12, 20}.

Risk factors

- Prolonged immobilization^{1,3}
- Middle age women (40-60 years)¹
- Diabetic patients^{3, 2, 9}
- Thyroid disease (Hyperthyroidism, Hypothyroidism)^{1,3}
- Trauma²
- Stroke³
- Cardiovascular disease¹
- Myocardial infarction^{1, 2}
- Cervical disc disease²¹
- Intrathoracic disorders as TB, carcinoma, emphysema etc^{9, 10}
- Parkinsonism¹
- Post surgical condition due to immobilization¹

PATHOLOGY

The pathophysiology involves a diffuse inflammatory synovitis with subsequent adherence of the capsule and a loss of the normal axillary pouch and joint volume, which leads to a significant loss of motion. Capsular contracture is thought to result from adhesion of the capsular surfaces or fibroblastic proliferation in response to cytokine production¹.

In adhesive capsulitis, the capsule of the shoulder is thickened, and a mild chronic inflammatory infiltrate and fibrosis may be present⁹.

Modern work, such as that of Bunker, shows that adhesive capsulitis is primarily a fibrosing condition affecting the capsule (fibrous bag around a joint) of the shoulder joint. This leads to a tightening up of the coracohumeral ligament (one of the ligaments attaching the shoulder blade to the arm bone), which then restricts passive movement of the shoulder, especially the external rotation²².

History taking and Physical examination

Important points in the history include age, hand dominance, occupational and sport activities including heavy lifting or overhead repetitive movements, history of trauma, onset, location, character, duration, and radiation of the shoulder pain, aggravating and relieving factors, presence of night pain, and the effect on shoulder function. Associated symptoms, such as shoulder swelling, stiffness, restriction of movement, grinding, clicking, instability, or weakness, may also provide useful diagnostic clues³.

Physical examination of the shoulder should be thorough and as well as all areas of musculoskeletal system to exclude other causes of arthritis, it should include an assessment of these areas of the body where a source of referred pain suspected such as the upper abdomen in the case of shoulder tip pain. A systematic approach to the examination is important in order to fully assess all the structures around the shoulder itself. Both shoulders should be examined and any difference between the two sides in terms of power, stability and range of motion noted, taking into account the handedness of the patient. The peripheral pulse and neurological examinations including deep tendon reflexes, sensory and power in both upper limbs should be examined. Always screen the cervical spine in examining a case of shoulder pain²³.

INVESTIGATION

A complete blood cell count, erythrocyte sedimentation rate, serum creatinine, serum uric acid and thyroid function tests are done as a screening panel. Further testing is done if the results suggest the possibility that the patient may have a systemic illness¹. Adhesive capsulitis is more common among diabetics, random blood sugar or fasting and 2 hours after breakfast should be done to exclude diabetes mellitus^{9, 10}. If adhesive capsulitis is associated with other malignant condition, ESR is raised, otherwise ESR is normal²⁴. RA test, c- reactive protein, urine and stool routine examination can be done to exclude Rheumatoid arthritis or seronegative spondyloarthropathy.

Imaging of the shoulder

Plain films are useful as an initial screening test for patients with shoulder pain, ultrasound and MRI are suitable techniques for diagnosing rotator cuff disease²⁵.

X ray

Plain radiographs should include true anteroposterior, lateral view on abduction, axillary, and scapular Y views of the shoulder. The radiography reveals the width of the joint space, soft tissue swelling, periarticular erosions, soft tissue calcification, free joint bodies, periarticular swellings, degeneration changes, dislocation, osteoporosis^{1,26}.

X-rays are normal in adhesive capsulitis, unless they show reduced bone density from disuse. Their main value is to exclude other causes of a painful, stiff shoulder. The value of X-rays in differential diagnosis was under-recognized¹³. The incidence of degenerative changes in the normal population makes it difficult to interpret diagnostic images^{14,27}.

Ultrasonography :

Ultrasound provides a reliable and simple means of identifying rotator cuff pathology, impingement syndrome, shoulder instability, degenerative and inflammatory arthropathies,²⁸ calcific tendinitis and biceps problems⁴. Non traumatic shoulder pain is usually diagnosed adequately from the medical history and a combination of clinical tests. When diagnostic imaging is required, ultrasound should be the first choice¹⁴.

CT Scan

Computed Tomography (CT scan) is useful particularly when enhanced with intraarticular contrast, CT scan can identify cuff tears and labral detachments⁴.

MRI

MRI is the technique of choice for most other complex shoulder problems and for patients with normal plain films and nonspecific pain. Monoarthropathies, tumours and osteonecrosis will all be detected by MRI²⁵. For patients with symptoms and signs suggesting instability, it can demonstrate associated anomalies of the capsule, labrum, glenoid and humeral head⁴. MRI is mainly indicated as part of a preoperative assessment and upon a specific indication. For diagnosis of the rotator cuff, MRI is as good as ultrasound^{14,27}.

Arthroscopy

Arthroscopy can be useful to diagnose (and treat) intraarticular lesions, detachment of the labrum or capsule and impingement or tears of the rotator cuff. Arthroscopy is said to be the best means by which superior labrum, anterior and posterior (SLAP) tears may be diagnosed⁴. Arthroscopy is not useful for either diagnosis or treatment of adhesive capsulitis but may be useful for recognition of the stages of the disease²⁹.

Magnetic resonance arthrography

Using magnetic resonance arthrography, a sensitivity of 91% and a specificity of 93% have been reported in the detection of pathological labral conditions. For identifying rotator cuff partial undersurface tears, MRA has been shown to be more sensitive and specific than MRI alone⁴. MRA is usually reserved for the assessment of shoulder instability²⁵.

Differential Diagnosis: ^{3, 4, 8, 30, 31, 32, 33}

1. Cervical radiculopathy
2. Impingement syndrome
3. Calcifying supraspinatus tendinitis
4. Osteoarthritis of the acromioclavicular joint
5. Osteoarthritis of the glenohumeral joint
6. Rotator cuff tears/ arthropathy
7. Rheumatoid arthritis
8. Reactive arthritis
9. Recurrent dislocation of the shoulder
10. Infection in and around the shoulder
11. Tuberculosis of the shoulder joint
12. Biceps tendon instability and tendinitis
13. Neuralgic amyotrophy
14. Reflex sympathetic dystrophy syndrome
15. Milwaukee shoulder
16. Cardiac ischaemia
17. Chronic lung disease, Lung cancer
18. Post mastectomy

Treatment

Aim of treatment is directed to the shoulder for the purposes of:

- Relieving pain⁴
- Prevent further stiffening and restoring range of joint motion of shoulder⁴
- Restoring muscular strength and function of shoulder³⁴

Individualized treatment is necessary following thorough evaluation of patient symptoms and stage of the disease³⁵. As the condition is often self-limited, observation and reassurance may be considered; however, this may not be acceptable to many patients because of the painful and debilitating nature of the condition. Nonsurgical treatments include analgesics (eg, acetaminophen, nonsteroidal anti-inflammatory drugs), oral prednisolone, and intra-articular corticosteroid injections. Home exercise regimens and physical therapy are often prescribed. Arthroscopic capsular release has gained popularity over the years and offers a predictably good treatment in patients with adhesive capsulitis³⁶. Surgical treatments include manipulation of the joint under anaesthesia and capsular release^{7, 12, 15}.

Treatment should be adjusted to these stages. Recommendations include analgesics and joint injections in the first stage and physiotherapy in combination with manual therapy in the second and third stages¹². Continuous passive motion (CPM) is an established method of preventing joint stiffness and of overcoming it³⁷. The addition of deep heating to stretching exercises produced a greater improvement in pain relief, and resulted in better performance in the activities of daily living and in range of motion than superficial heating³⁸. A rehabilitation model based on evidence and intervention strategies matched with irritability levels is proposed. Exercise and manual techniques are progressed as the patient's irritability reduces. Response to treatment is based on significant pain relief, improved satisfaction, and return of functional motion. Patients who do not respond or worsen should be referred for an intra-articular corticosteroid injection or passive exercise under interscalene block. Patients who have recalcitrant symptoms and disabling pain may respond to either standard or translational manipulation under anesthesia or arthroscopic release^{7, 12}.

Pharmacologic treatment: ^{1,3, 8,39}

Nonsteroidal anti-inflammatory drugs (NSAIDs) for instance, Naproxen, piroxicam, indomethacin, diclofenac, ibuprofen etc. help to relieve pain and inflammation. Muscle relaxants are helpful in the early stages of the disease when spasm is predominant. Low-dose antidepressant medications (e.g., 10 mg of amitriptyline taken at night) may help to avoid a cycle of sleep disturbance leading to a chronic pain syndrome and fibromyalgia. Intra-articular steroid injection has proven benefit in the management of adhesive capsulitis. The early use of intraarticular corticosteroid injections during stage 1 and 2 in order to decrease the initial inflammatory stage in an attempt to reduce the development of fibrosis.

Exercise: ^{4, 40,41}

The natural history of adhesive capsulitis is a matter of controversy. Management of true capsular restriction of motion (ie, true adhesive capsulitis) begins with gentle, progressive stretching exercises.

- Shoulder mobilizing exercises to increase range of motion are the following
 - a. Codman/ pendulum exercise
 - b. Wall climbing, pulley, wand exercises
 - c. Exercise in Chandler position
- Strengthening exercises when necessary in the form of resistant exercise with dumb-bell, weight, shoulder wheel etc. Within the regained range of motion strengthening exercises are started as an isometric program progressing to resistant strengthening through the full arc of motion.

● Codman/ pendulum exercise

These are self mobilization techniques that use the effects of gravity to distract the humerus from the glenoid fossa. They help relieve pain through gentle traction and oscillating movements and provide early motion of joint structures and synovial fluid. No weight is used initially. When the patient tolerates stretching, a weight is added to the hand or as wrist cuffs to cause further distraction force. To direct the stretch force to glenohumeral joint, stabilize the scapula against the thorax manually or with a belt.

● Wall climbing exercise

Walking fingers up the wall while the shoulder is held in abduction and in forward flexion. Line or length is marked in the 1st visit which is monitored thereafter in subsequent follow up visits.

● Shoulder wheel

Circumduction of the shoulder joint clockwise and anti-clockwise using shoulder wheel. Also resistance can be applied within the wheel and exercise can be progressively done against resistance to strengthening the muscles as well.

● Wand exercises

When a patient has voluntary muscle control in an involved upper extremity but needs guidance or motivation to complete the ranges of motion in the shoulder, a dowel rod (cane, wooden stick, T- bar, or similar object) can be used to provide assistance.

● Overhead pulley exercise

Pulley system can be effectively used to assist an involved extremity in performing ROM. Stretching the shoulder flexion, abduction, internal and external rotation by using overhead pulley.

Three to four types of exercises may be advised at a time for few repetitions each type three or four times daily, otherwise exercise itself would increase pain if it is not advised and carried out properly.

Physical measures:¹

- Deep heat such as ultrasound, microwave diathermy, short wave diathermy
- Superficial heat such as infrared, hot pack and wax bath
- Ice pack
- Transcutaneous electrical nerve stimulation

Thermotherapy in adhesive capsulitis

The physiological responses of the heat are as follows: ^{17, 19}

1. Increases blood flow by vasodilatation, so increases oxygen and nutrition at the site
2. Decreases chronic inflammation by washing out the inflammatory exudates
3. Decreases pain and joint stiffness
4. Increases tendon and collagen extensibility

Ultrasound therapy: ^{17, 19}

Ultrasound is a deep heating modality that uses high frequency acoustic vibration above the human audible spectrum (i.e. >20000Hz)¹⁹. Therapeutic ultrasound involves the use of high frequency acoustic energy to produce thermal and non thermal effects in tissue. The most commonly used frequency is 1 MHz^{17,19}. A transducer operating at therapeutic frequencies will produce a beam with a greater angle of divergence if the diameter of the transducer is small than if it is large¹⁷. The World Health Organization and the International Electrical Commission both recommend limiting spatial average intensity to 3 W/cm².¹⁹ Most clinically used intensities of therapeutic ultrasound are in the 0.1 – 2.5/ 3 W/cm² according to machine. The wave length is approximately 0.15 cm¹⁷. duration generally over 5 to 10 minutes per site to obtain optimal heating of joint tissues located right in the front of the bone. Temperature reaches up to 46⁰C (114.8⁰F) in deep tissues are easily achieved with ultrasound¹⁹.

Phonophoresis: ^{17,42}

It is also known as sonophoresis or ultrasonophoresis. This implies the movement of drugs through intact skin into the subcutaneous tissues under the influence of ultrasound. Many drugs are absorbed through the skin very slowly, using usually high frequency ultrasound. Phonophoresis relies on perturbation of the tissues causing more rapid particle movement through the skin, thus encouraging absorption of the drug. Topical NSAIDs like naproxen/ diclofenac gel can be introduced through the skin for relief of pain locally specially in patients who have peptic ulcer disease, bronchial asthma or renal failure. UST itself is relieving pain and stiffness by its mechanism of action, but here, with addition of NSAIDs gel, it gives an additional effect of pain relief of that area. Drugs used are steroids, anti-inflammatories and local anaesthetics⁴².

PROGNOSIS

Adhesive capsulitis is regarded as distinct clinical entity showing a benign and regular course.³¹ Patients with more severe pain and functional limitations before treatment had relatively worse outcomes⁴³. It is a self limiting disease, may take up to 18 months to improve completely⁴.

PREVENTION

To prevent the problem, a common recommendation is to keep the shoulder joint fully moving. Often a shoulder will hurt when it begins to freeze. Because pain discourages movement, further development of adhesions that restrict movement will occur unless the joint continues to move full range in all directions (adduction, abduction, flexion, rotation and extension). Physical therapy in the form of exercises with few repetitions two to three times daily could prevent the development of adhesive capsulitis.

DISCLOSURE

All the authors declared no competing interest.

