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EDITORIAL

Arthroscopic capsular release and manipulation under anaesthesia for frozen shoulders: A hot topic

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Abstract

A frozen shoulder is a common cause of shoulder pain and stiffness. The etiology and pathology of frozen shoulders is not fully understood yet. Frozen shoulder is characterized by a decrease in intra-articular volume and capsular compliance. This can lead to significant limitations in daily life. The majority of the patients can be treated conservatively, with functional recovery to be expected in two to three years. However, if conservative treatment fails, manipulation under anaesthesia and arthroscopic capsular release can both be considered as appropriate treatments. Manipulation is a traditionally well-established technique but in recent years it seems that arthroscopic capsular release has gained popularity. Manipulation is a relative time efficient and technically low-demanding procedure in which the glenohumeral joint is forced into different directions under general anaesthesia to release the capsular contracture, thereby increasing the range of motion of the joint. In arthroscopic capsular release the glenohumeral capsule can be released in a more controlled manner under direct vision. There are no prospective comparative trials available to display superiority of one procedure over the other. In addition, the optimal timing of both these interventions still has to be determined. An overview of the literature concerning this topic and a description of both procedures with its own advantages and disadvantages is provided.

Key words: Frozen shoulder; Adhesive capsulitis; Manipulation; Arthroscopy; Capsular release; Shoulder; Shoulder stiffness

Core tip: A frozen shoulder is a common cause of shoulder pain and stiffness, which is characterized by a decrease in intra-articular volume and capsular compliance. If conservative treatment fails, manipulation under anaesthesia and arthroscopic capsular release can both be considered as appropriate treatments. An overview of the literature concerning this topic and a description of both procedures with its own advantages

and disadvantages is provided.

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EPIDEMIOLOGY

A frozen shoulder is a commonly encountered condition in the orthopaedic surgeons' practice. Pain and restricted range of motion of the shoulder may lead to disability and a decrease in quality of life. In 1872 Duplay[1] described a painful stiffening of the shoulder, which he named humero-scapular periarthritis. Codman[2] was the first to coin the term frozen shoulder in 1934, for a condition which was characterized by painful restriction of shoulder motion. Neviaser *et al*[3] suggested the term adhesive capsulitis after a cadaveric study and intra-operative findings of a thickened capsule, adherent to the humeral head. Both terms, frozen shoulder and adhesive capsulitis, are now used interchangeable in the literature for the same condition.

Frozen shoulder affects approximately 2%-4% of the general population[4,5]. The peak incidence is mainly between the age of 40 and 65 years, slightly more frequent in women than in men[6]. The most important associated systemic condition is diabetes mellitus, followed by thyroid disorders. The prevalence of frozen shoulder increases to 10%-20% in diabetic patients. These patients seem to have a prolonged course of the disease, less response to conservative treatment and bilateral involvement is seen more frequently[7,8].

The natural history of a frozen shoulder is described in a relative limited amount of studies. In the majority of patients, it seems to be a self-limited condition with functional recovery after 2-3 years[9]. However, some patients experience continued pain and limited range of motion. After recovery, recurrence of a frozen shoulder is extremely rare[10].

DIAGNOSIS

Although frozen shoulder is a well-known clinical entity, there are still many controversies existing about the definition, the different phases and certainly about the optimal treatment regimen. Zuckerman *et al*[11] proposed this descriptive consensus definition, which was agreed by 82% of members of the American Shoulder and Elbow Surgeons: A condition characterized by functional restriction of both active and passive shoulder motion for which radiographs of the glenohumeral joint are essentially unremarkable except for the presence of osteopenia or calcific tendinitis. Commonly clinical findings consist of: painful stiff shoulder for at least 4 wk; severe shoulder pain that interferes with activities of daily living or work; night pain; painful restriction of both passive and active shoulder range of motion and normal radiographic appearance[12,13]. With physical examination, the selective loss of passive external rotation is typical[14].

Frozen shoulder is usually categorized in primary (or idiopathic) and secondary frozen shoulder. In a primary (idiopathic) frozen shoulder, an underlying aetiology cannot be found. In secondary frozen shoulder, local or intrinsic factors (such as proximal humeral fracture, rotator cuff disorders, biceps tendonitis), remote or extrinsic factors (*e.g.,* ipsilateral breast surgery, cervical radiculopathy, cerebrovascular accident, postoperative immobilization) or systemic pathology (including diabetes mellitus, thyroid disorders, hypo-adrenalism) may be related to the disease[11,12].

In 1975 Reeves[15] believed the condition to involve three separate phases. Phase one, the painful phase followed by phase two, the frozen phase in which pain persists and stiffness is aggravated. Phase three is named the thawing phase, where joint motion and pain gradually improve[15]. A wide variety in the duration of each phase is described, but most authors agree with spontaneous functional recovery after 2-3 years[14,16].

Frozen shoulder is a clinical entity which can generally be diagnosed after a thorough history and physical examination. Plain radiographs are typical without abnormalities. Osteoarthritis of the glenohumeral joint can easily be ruled out. Calcifications in the rotator cuff is a common incidental finding. Ultrasonography is not required for the diagnosis but is appropriate to screen for rotator cuff or biceps tendon abnormalities when suspected. Magnetic resonance imaging (MRI) arthrography can show thickening of the coracohumeral ligament and joint capsule in the rotator interval. Also, synovial thickening in the axillary pouch correlates with the stage of adhesive capsulitis[17]. However, magnetic resonance imaging should not be routinely ordered in the evaluation of the frozen shoulder.

PATHOPHYSIOLOGY

In a secondary frozen shoulder, a local or remote factor that leads to immobilisation of the limb or a systemic condition is an underlying cause to be held accountable for the development of a frozen shoulder. However, most cases of frozen shoulder are primary or idiopathic in which the pathophysiology is not yet fully understood. White *et al*[18] suggest an increase in sedentary jobs with a low level of activity as a possible explanation for the increasing occurrence of a frozen shoulder. A decrease in intra-articular volume and capsular compliance was already described in 1969[19]. An inflammatory contracture of the anterosuperior capsule, the glenohumeral ligaments and the coracohumeral ligament is demonstrated in cadaveric studies and MRI studies[14,20]. This

corresponds with the characteristic clinical finding of loss of external rotation in adduction with physical examination. Significant synovial hypertrophy and neovascular proliferation, especially in the rotator interval is often observed during arthroscopy. A histologic study of Bunker *et al*[21] demonstrates that the predominant cells involved are fibroblasts and myofibroblasts in the joint capsule that produce the extracellular matrix. The produced type Ⅲ collagen matrix is packed more densely, causing the shoulder capsule to contract. This excess of extracellular matrix is characteristic for fibroproliferative disorders. Other histologic changes consist of chronic inflammation and perivascular infiltration and fibrosis[22]. On a cellular level, the extracellular matrix turnover (production, degradation and remodelling) is involved by matrix metalloproteinases and their inhibitors. An imbalance can lead to fibroproliferation, which is demonstrated in frozen shoulder patients[23]. The microscopic changes in the anterior capsule and the coracohumeral ligament are very similar to the changes seen in Dupuytrens' disease in the hand. Dupuytrens' disease is frequently observed in patients with a frozen shoulder[21]. Smith *et al*[24] report an incidence of Dupuytrens' disease of 52% in a cohort of patients with a primary frozen shoulder. Although frozen shoulder has a different natural history than Dupuytrens' disease (self-limiting versus progressive), a common biochemical pathway of both fibroproliferative disorders that leads to contracture is suggested[24].

More recently, the role of inflammatory cytokines and growth factors in the pathogenesis of a frozen shoulder is investigated, because they regulate the growth and function of fibroblasts. The study of Lho *et al*[25] confirmed the overexpression of inflammatory cytokines (such as interleukin 1-α, tumor necrosis factor-α and cyclooxygenase-2) in the joint capsule of patients with a frozen shoulder compared to a control group. Also, an overexpression of these inflammatory mediators was found in tissue samples of the subacromial bursa in frozen shoulder patients[25], possibly contributing to the cascade of inflammation eventually leading to fibrosis.

A future better understanding of the pathophysiology of a frozen shoulder on a cellular level can possibly lead to targeted therapy with anti-inflammatory medication[26].

MANAGEMENT

There are many different strategies in the treatment of a frozen shoulder: including but not limited to supervised neglect[9], physiotherapy[27,28], corticosteroid infiltration[29,30], manipulation under anaesthesia (MUA)[31], arthroscopic capsular release (ACR)[32], arthrographic capsular distension[33] and stretching devices[34]. The optimal treatment regimen has not yet been established. Systematic reviews point to a lack of good quality evidence to give evidence based supported recommendations[35,36]. Non-steroidal anti-inflammatory drugs, intra-articular corticosteroid injections and physiotherapy are among the most widely used treatment modalities in the treatment of a frozen shoulder, in both primary and secondary healthcare settings[35,37]. Because the natural history of a frozen shoulder develops in different phases, it is suggested that the timing of different treatment modalities might be important in this regard. However, there is only a limited amount of good quality studies that have investigated this matter. The positive effect of intra-articular corticosteroid injections appears to be most obvious at an early painful phase of the condition[38,39]. Shin *et al*[40] found a similar positive effect of a subacromial corticosteroid injection compared to an intra-articular injection. The role of physiotherapy is still controversial[41]. Most authors are convinced that the physiotherapy protocol must be adjusted to the phase of the condition with a more important role for physiotherapy in later, less painful phases of the condition. Hanchard *et al*[42] suggest different physiotherapy modalities for a pain-predominant or stiffness-predominant frozen shoulder. Kelley *et al*[43] distinguishes three levels of tissue irritability (high, moderate or low irritability) in frozen shoulder patients to adjust the physiotherapy protocol. Furthermore, other than a primary (idiopathic) frozen shoulder, secondary frozen shoulders after trauma or surgery are often more resistant to conservative treatment[44,45].

Taking above into account, conservative treatment seems to be sufficient for most cases, and almost full recovery takes place in two or three years[14]. Most authors state that failure of at least 6 to 12 mo of appropriate non-operative treatment is an indication for more invasive interventions[46]. However, it is questioned if the course of the disease can be shortened when more invasive interventions are undertaken earlier on in the disease[47]. On the other hand, early surgical intervention for symptomatic frozen shoulder may lead to overtreatment in patients with a mild, self-limiting natural course. It might be interesting to know if it is possible to identify which patients will develop a prolonged course, thus could benefit from early invasive treatment. Prospective studies of non-operative treatment showed that approximately 10% of the patients with an idiopathic frozen shoulder develop a refractory frozen shoulder in which further intervention such as MUA or ACR should be considered[6,9]. MUA is a traditionally well-established technique. However, according to the number of publications on this subject in recent years, ACR is gaining more attention. Both procedures have their own specific advantages and disadvantages.

MVA

The same Duplay[1] who described painful stiffening of the shoulder as humero-scapular periarthritis in 1872 suggested MUA as an appropriate treatment

for frozen shoulder[1]. Before the improvement in arthroscopic shoulder surgery, MUA was the standard treatment of a frozen shoulder if conservative treatment had failed.

Different techniques have been described, but a fixed order of manipulations is recommended. The use of a small lever arm and scapular stabilization is recommended to prevent fractures and brachial plexus traction injuries[48]. First the arm is brought in to full flexion, then cross body adduction followed by external rotation with the elbow adducted against the trunk. Then the arm is abducted and moved into internal and finally external rotation. A characteristic crepitus can be heard and felt by the surgeon as the contracted capsule is ruptured. The addition of an intra-articular injection with corticosteroids and local anaesthetic agent is often used at the end of the procedure.

Consistently satisfactory results in both short- and long-term follow-up are reported with MUA. A significant improvement in range of motion and an overall satisfaction rate of 94% at short term is reported by Dodenhoff *et al*[48]. A major cause of satisfaction was to regain the ability to perform normal daily tasks within days of the manipulation. Long term results confirm that the results do not deteriorate after 15 years[49]. Equal range of motion to the contralateral shoulder and no pain was reported in 90% of the patients after 23 years of follow up in a small cohort[50].

ACR

ACR has gained popularity over the years[51]. The first ACR was described by Conti[52] in 1979. The exact procedure and the magnitude of the capsular release differs between various authors. Earlier techniques describe an anterior and inferior release[46,53]. More recent articles favour a complete circumferential (360 degrees) release[32,54,55].

Both beach chair and the lateral decubitus position with the arm suspended in traction are possible to perform an ACR. However, in the beach chair position it is easier to assess the range of motion of the shoulder during surgery. A pressure pump system and a vasoconstrictive agent (*e.g.,* adrenaline or epinephrine) in the irrigation solution are recommended to improve visibility. The capsular release is performed with a radiofrequency probe. The structures in the rotator interval and the anterior capsule must be released first. Ogilvie-Harris *et al*[46] and Pearsall *et al*[56] recommend to release the intra-articular portion of the subscapularis tendon, however, several studies show excellent results without sacrificing the subscapularis[46,51,55,56]. The superior capsule can be released parallel to the joint surface until the muscular fibres of the supraspinatus are visible. It is also possible to release the posterior inferior aspect of the capsule. However, the benefit of this posterior release could not be confirmed in a recent level 1 randomized controlled trial[57]. A gentle manipulation can be performed to assess the obtained range of motion. Some authors infiltrate the shoulder joint with corticosteroids at this point[54]. Good to excellent results with regard to function and pain at both short and long term after ACR are reported. A large prospective study of smith at all reported good pain relief in 80% of the patients within six weeks[55]. Le Lievre *et al*[54] demonstrated that the obtained improvements of pain and patient reported shoulder function maintained after a mean follow up of seven years. In addition, the shoulder range of motion was comparable with that of the contralateral shoulder at time of follow up.

Postoperative treatment and pain management

Similar rehabilitation protocols after MUA and ACR are described. An important aspect after both MUA and ACR is to start physiotherapy immediately, from day one after the surgical intervention. Postoperative pain management must be adequate to tolerate early physiotherapy treatment. This can be achieved in several ways. Pre-operative regional interscalene block[53], a local intra-articular analgesic injection with or without corticosteroid, an indwelling pain pump in the subacromial space, oral analgetics and icepacks have all been described. Immobilisation in a sling must be discouraged at all times to prevent the shoulder joint from getting stiff again[54]. With adequate pain management, both procedures are assumed to be very well tolerated with minimal postoperative pain[48,51]. Most authors agree on intensive supervised physiotherapy twice or three times a week, possibly supplemented by a home exercise program[53,55].

Pros and cons for manipulation under anaesthesia or arthroscopic capsular release

Comparable satisfactory results are reported by many authors for MUA as well as for ACR. To our knowledge there are no randomized controlled trials comparing manipulation with capsular release for frozen shoulder. A comparison between both procedures was attempted in a recent systematic review primarily based on level Ⅳ evidence. With caution, this study slightly favoured ACR over MUA in recalcitrant idiopathic or diabetic frozen shoulders[12]. The need for prospective higher level evidence is emphasized. The overall complication rate for both procedures is rather low with 0.5% complications reported. The advantages and risks of MUA and ACR are listed in Table 1.

One of the most important arguments used by opponents of MUA, is that it is a fairly uncontrollable procedure. You can not see what is released, or torn within or around the shoulder joint. The potential risks of MUA are wide-ranging. Reported iatrogenic injuries are: proximal humerus or humeral shaft fractures[58], brachial plexus traction injury[59], glenohumeral ligament tears, rotator cuff tears, labral lesions, osteochondral fractures of the anterior glenoid rim[60]. Significant osteopenia can be considered as a relative

Table 1 Advantages and risks of manipulation under anaesthesia and arthroscopic capsular release in the treatment of a frozen shoulder

Advantages	Disadvantages/risks
Manipulation under anaesthesia	
Time efficient	Fracture of humeral shaft or neck
Cost efficient	Rotator cuff tearing
Technical easy procedure	Brachial plexus nerve injury
	Labral lesions
	(Osteo)chondral fracture (glenoid rim)
Arthroscopic capsular release	
Visually controlled capsular release	Less time and cost efficient compared to MUA
Identification and treatment of associated intra-articular pathology	Can be technically more demanding
No excessive bleeding in the joint	Cartilage damage when introducing the arthroscope
	Axillary nerve injury
	Chondrolysis due to heat generation
	Extravasation of fluid in surrounding tissues
	Infection

MUA: Manipulation under anaesthesia.

contra indication to MUA. Although a lot of articles address the risk of a humeral fracture and the use of a short lever arm is emphasized, the complication itself is seldom reported[58,61]. Loew *et al*[60] performed an arthroscopy directly after MUA in 30 persons to investigate the intra-articular damage. Hemarthrosis was found in all patients. The anterior capsule was ruptured in 22 out of 30 shoulders, mostly adjacent to and parallel to the labrum, where it is intended to tear. Unequivocal lesions were found in 12 out of 30 shoulders, this involved the anterior and superior labrum, partial tears of the subscapularis tendon, the supraspinatus tendon, the long head of the biceps and one small osteochondral fracture[60]. An evident advantage of MUA in comparison to ACR is that it is more time efficient and that it is associated with substantial lower costs.

Proponents of the ACR procedure believe that a complete release of the capsule can be achieved in a more controlled way. Associated intra-articular pathology can be identified and treated simultaneous. The risks are fairly low, with a documented complication rate of 0.5%[12,45]. However, serious complications as axillary nerve injury, chondrolysis and skin burns due to heat generation or infection are documented[3,45,62]. Nowadays, temperature controlled diathermal probes are commercially available, possibly preventing overheating of the fluids in the joint during surgery. Different from MUA, ACR can be a more technical demanding procedure. Some authors even state that ACR should only be done when MUA has failed[14].

Another option is to combine ACR with manipulation. The manipulation can be a gentle one only to release the capsule where it is difficult to reach or risky to release arthroscopically (for example in the area of the axillary nerve). Early significant improvement in shoulder range of motion with relief of pain and maintenance of these results at long term are reported[41,54,55].

CONCLUSION

A frozen shoulder is a common cause of shoulder pain and stiffness. The majority of the patients can be treated conservatively, with functional recovery to be expected after two to three years. However, if conservative treatment fails, MUA and ACR can both be considered as appropriate treatments. MUA is an easy, time- and cost-efficient technique, but is accompanied by the risk of iatrogenic damage. ACR seems to be a safer way to release the joint capsule. Associated intra-articular pathology can be identified and bleeding can be controlled. However, ACR is technically more demanding, and is also accompanied by the risk of damage to the cartilage or the axillary nerve. Both procedures are performed in large numbers and are considered safe and beneficial for the patient. Superiority of one technique over the other can't be supported by randomized trials comparing both techniques. In addition, the optimal timing of any surgical intervention for frozen shoulder has to be determined yet. Therefore, the decision for either one procedure to treat a frozen shoulder is made by the orthopaedic surgeon and the individual patient together.

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