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MINIREVIEWS

Frozen shoulder: A systematic review of therapeutic options

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Abstract

Frozen shoulder is a common disease which causes significant morbidity. Despite over a hundred years of treating this condition the definition, diagnosis, pathology and most efficacious treatments are still largely unclear. This systematic review of current treatments for frozen shoulder reviews the evidence base behind physiotherapy, both oral and intra articular steroid, hydrodilatation, manipulation under anaesthesia and arthroscopic capsular release. Key areas in which future research could be directed are identified, in particular with regard to the increasing role of arthroscopic capsular release as a treatment.

Key words: Frozen shoulder; Adhesive capsulitis; Bursitis; Shoulder; Arthroscopic capsular release; Arthrographic distension; Physiotherapy; Steroid; Hydrodilatation

Core tip: Frozen shoulder is a common disease which causes significant morbidity. Despite over a hundred years of treating this condition the definition, diagnosis, pathology and most efficacious treatments are still largely unclear. This systematic review of current treatments for frozen shoulder reviews the evidence base behind physiotherapy, both oral and intra articular steroid, hydrodilatation, manipulation under anaesthesia and arthroscopic capsular release. Key areas in which future research could be directed are identified, in particular with regard to the increasing role of arthroscopic capsular release as a treatment.

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INTRODUCTION

The first recorded description of a frozen shoulder was reported by Duplay[1] in 1872 in his description of a "periarthritis scapulohumeral", though the term frozen shoulder was first used in 1934 by Codman[2], who described the common features of a slow onset of pain felt near the insertion of the deltoid muscle, inability to sleep on the affected side, and restriction in both active and passive elevation and external rotation, yet with a normal radiological appearance. Many patients present with a painful restriction of shoulder motion due to pain inhibition or due to weakness from rotator cuff tears or neurological deficits which appear to form a separate clinical entity

from patients with no underlying cause for their symptoms. Patients with secondary frozen shoulder with a clearly identifiable painful primary shoulder pathology often have a poorer prognosis[3] and often pose the greatest diagnostic challenges, largely due to the heterogenous nature of the primary pathology. Patients with primary idiopathic frozen shoulder, *i.e.*, patients with a painful global restriction of shoulder movement with no other identifiable shoulder pathology form the basis of this review article.

Frozen shoulder is thought to have an incidence of 3%-5% in the general population and up to 20% in those with diabetes[4]. Its peak incidence in between the ages of 40 and 60 and is rare outside these age groups and in manual workers[3] and is slightly more common in women. In terms of consultations to general practice it is thought that the cumulative incidence of consultations is 2.4/1000/year (95%CI: 1.9-2.9)[5]. Bilateral contemporaneous frozen shoulder occurs in 14% of patients whilst up to 20% of patients will develop some form of similar symptoms in the other shoulder[6]. Diabetes is the most common associated disease with frozen shoulder and a patient with diabetes has a lifetime risk of 10%-20% of developing this condition[7,8]. Patients with frozen shoulder have a higher risk of having some form of prediabetic condition with an abnormal fasting glucose or impaired glucose tolerance test[8].

Frozen shoulder starts with a painful phase which leads to stiffness which suggests that there is an initial inflammatory response which evolves into a fibrotic reaction. There is some evidence of this occurring histologically[9] and there are some similarities to the fibrous contractures in Dupuytren's disease[10]. Current models indicate that initial active fibroblastic proliferation in the capsule of the shoulder joint is later accompanied by some transformation of fibroblasts to myofibroblasts[9,10]. This thus causes an inflammatory contracture of the shoulder reducing the capsular volume and ultimately restricting glenohumeral movements. The initiating factors that cause this pathoanatomy are poorly understood[3]. Current approaches consider the key role of matrix metalloproteinases in the construction of the extracellular matrix and in the various cytokines that control collagen deposition. That drugs such as Marimastat (a synthetic matrix metalloproteinase inhibitor) can induce conditions very similar to primary frozen shoulder and Dupuytren's disease[11] is evidence that there may be a common aberrant molecular pathway in these disorders.

The biomechanics of frozen shoulder indicate that the primary pathology can be correlated to contractures of individual structures in the capsule. Gerber demonstrated[12] with capsulorrhaphy in cadaveric experiments that restriction of the anterosuperior capsule (including the rotator interval, superior glenohumeral ligament and coracohumeral ligament) produces restriction of external rotation in the adducted shoulder whilst anteroinferior capsular restriction produces restriction of external rotation in the abducted shoulder. Posterior capsular restriction reduces internal rotation of the shoulder and may be present in more severe forms of frozen shoulder[12].

This disorder is thus one of the most common musculoskeletal problems seen in orthopaedics[4]. However, despite the ubiquity of this condition and the advances in shoulder surgery over the last fourteen decades there are still many unknowns in deciding what the best treatment options are for this condition[6].

OPERATIVE INTERVENTIONS

Arthroscopic capsular release

Initial recommendations suggested that arthroscopy has no place in the treatment of frozen shoulder[13]. However in the present day arthroscopic capsular release has become increasingly commonplace[3,4,14]. The technique requires general anaesthesia and an examination under anaesthesia to document the preoperative range of motion. Standard posterior and anterior portals are made, a diagnostic arthroscopy is performed to confirm the diagnosis and a synovectomy of the rotator interval is performed. The capsular release starts with excision of the rotator interval to the under surface of the conjoint tendon, the release is extended inferiorly posterior to the tendon of subscapularis down to the five o'clock position. Some surgeons advocate release of the superior edge of subscapularis[15], though this is highly controversial. The superior release is then extended to reach the long head of biceps and is continued to release the coracohumeral ligament in the plane between the superior glenoid and supraspinatus. If internal rotation of the shoulder is significantly restricted then the camera portal can be reversed to facilitate a posterior capsular release. Some surgeons complete the inferior release with a gentle manipulation but some surgeons advocate a full 360 degree capsulectomy under direct vision whilst accepting the higher risk of iatrogenic injury the axillary nerve[14]. A randomised study by Chen *et al*[16] demonstrated that not performing any form of inferior release, such as a manipulation at the end of surgery, results in poorer functional outcome and range of motion at three months post intervention, though these differences are not maintained at longer follow up points.

A systematic review was conducted using the following search strategy '{"joint capsule release" (MeSH Terms) OR ["joint"(All Fields) AND "capsule" (All Fields) AND "release"(All Fields)] OR "joint capsule release"(All Fields) OR ["capsular"(All Fields) AND "release"(All Fields)] OR "capsular release"(All Fields)} AND {"bursitis"(MeSH Terms) OR "bursitis"(All Fields) OR ["frozen"(All Fields) AND "shoulder"(All Fields)] OR "frozen shoulder"(All Fields)}' in PubMed on May 11th 2014. Embase and cochrane databases were also searched with the same search strategy and the references of selected journals were scanned to try to

Table 1 Reviewed studies investigating arthroscopic capsular release as a treatment for primary frozen shoulder

Ref.	Year	Patients	Outcome measure(s)	Outcome score pre intervention (standard deviation or range)	Outcome score post intervention (standard deviation or range)	Complications
Smith *et al*[6]	2014	136	OSS, VAS	19.2 (7.4)	38.1 (8.6)	One portal site superficial infection - treated oral antibiotics
Jerosch *et al*[17]	2012	91	Constant	42 (19-58)	85 (36-100)	One shoulder infection - debridement required
Le Lievre *et al*[18]	2012	43	Likert		All 43 pain free on Likert score at 5-12 yr from surgery	Nil
Waszczykowski *et al*[19]	2010	16	Modified constant score (0-75), ASES	19.3	65.9	Nil
Cinar *et al*[20]	2010	26	Constant, UCLA	30.4 (6.2)	82 (18.2)	Nil
Baums *et al*[21]	2006	30	ASES, VAS, SF36	35 (10-70)	91 (62-96)	One case of delayed healing of portal site (no infection), one haematoma
Klinger *et al*[22]	2001	36	Constant	29 (14-51)	66 (35-91)	Nil
Ogilvie-Harris *et al*[23]	1997	17	ASES	2 patients mild pain, 6 in moderate pain, 8 in severe pain	11 pain free, 4 in mild pain, 1 in moderate pain, 1 in severe pain	Nil
Segmüller *et al*[24]	1995	24	Modified constant score	10/20	18/20	Nil

OSS: Oxford shoulder score; ASES: American shoulder and elbow score; VAS: Visual analogue pain score; UCLA: UCLA shoulder score; SF36: Short form 36.

find more studies.

Inclusion criteria

Clinical studies investigating arthroscopic capsular release to treat primary idiopathic frozen shoulder; studies in English.

Exclusion criteria

Review articles; studies investigating arthroscopic capsular release in conjunction with another surgical procedure; studies with less than fifteen participants; Double publication of data.

Studies on patients with secondary frozen shoulder: 76 Studies were identified; 18 articles were shortlisted for further review following application of eligibility criteria on published abstracts.

Closer examination of these studies revealed: 2 studies included data that had been published twice; 4 studies were not available in English; 2 studies reported results on arthroscopic capsular release and subacromial decompression; One study investigating a mixture of primary and secondary frozen shoulder with no separation of data analysis.

Nine studies[6,17-24] were eligible for review and the results of the data abstraction are compiled in Table 1. This review includes the treatment of 419 patients with primary frozen shoulder. All studies demonstrated a rapid statistically significant increase in postoperative shoulder function following capsular release. Five studies used the Constant-Murley score as the primary outcome measure. The Constant-Murley score is a commonly used measure of shoulder function which unfortunately has very little formal validation[25]. Other outcome measures used with more validation include the oxford shoulder score in Smith *et al*[6], Likert score in Le Lievre *et al*[18] and American shoulder and elbow score in Waszczykowski *et al*[19] and Baums *et al*[21]. None of the studies included any comparative control groups which forms the largest weakness in the current evidence base behind arthroscopic capsular release. Overall, the evidence reviewed demonstrates that arthroscopic capsular release appears to be a safe and effective treatment that can provide a rapid improvement in patient reported shoulder function.

Manipulation under anaesthesia

In this technique a general anaesthetic is administered and the shoulder joint capsule is gently stretched by moving the humerus into flexion, abduction and finally (optionally) by moving the adducted humerus into external rotation. Great care must be taken to minimise the lever arm used and to maximise the surface area of the arm to which pressure is applied. The largest risk in this procedure is of iatrogenic damage to the upper limb including, humeral fracture, glenohumeral dislocation, rotator cuff tears, glenoid fractures, brachial plexus injuries, labral tears and haematomas[14]. It has been demonstrated in post manipulation arthroscopy[26] that the typical appearances are of haemarthrosis and capsular tearing but other lesions often seen include iatrogenic superior labral anterior posterior tears, partial subscapularis ruptures and rupture of the anterior labrum. Manipulation under anaesthesia has been shown to be an efficacious treatment[27]. However, the results of manipulation when compared to hydrodilation[28] and steroid injection[29] are equivocal at best.

Non-operative treatments

Hydrodilation (arthrographic distension): This

treatment involves the injection of local anaesthetic into the capsule at a pressure high enough to distend and stretch the joint capsule. This procedure first described by Andren *et al*[30] does not need to be performed in the operating theatre but is often associated with poor tolerance due to the painful nature of the distension[4]. Buchbinder *et al*[31]'s systematic cochrane review of hydrodilation searched MEDLINE, EMBASE, CINAHL and CENTRAL databases from 1966 till November 2006 for studies investigating hydrodilation type procedures in the treatment of frozen shouder. These searches were repeated from November 2006 till May 2014 and a total of 7 extra studies were identified two of which were randomised comparative studies[28].

Buchbinder *et al*[32]'s randomised controlled study of 46 patients compared hydrodilatation to placebo and demonstrated a statistically and clinically significant improvement in functional outcome scores (shoulder pain and disability index) to 6 wk following intervention but this was not maintained at follow up points beyond this.

Three studies compared hydrodilation with steroid to intra articular steroid injection alone[33-35]. Gam *et al*[33]'s and Corbeil *et al*[34]'s studies had weaknesses in study construction especially with regard to randomisation systems, elimination of systematic bias and in sample size calculation. Tveitå *et al*[35]'s study on the other hand is a well constructed study which scores highly against the Consort criteria[36]. Gam *et al*[33], Corbeil *et al*[34] and Tveitå *et al*[35] all failed to demonstrate any statistically significant differences in functional outcome compared to steroid injection at any outcome point. Gam *et al*[33] did report an increase in the range of shoulder motion of the hydrodilation group as compared to the steroid group. However, given that range of motion is an unvalidated and poor measure of shoulder function it is difficult to make generalisable recommendations on this evidence. Khan *et al*[37] compared hydrodilation and physiotherapy to physiotherapy alone in 36 patients in this quasi randomised and underpowered study. Khan *et al*[37] demonstrated statistically significant improvements in range of motion at eight weeks but no differences in visual analogue pain scores.

Jacobs *et al*[38] reported results of a three way randomised study comparing a mixture of low volume local anaesthetic and air, intra articular steroid and local anaesthetic with air and steroid. Though this study claims to be investigating arthrographic distension, the low volumes used (3 mL of air in distension group) mean that the study design does not pass the test of face validity. Given that all comparative studies use twenty to forty millilitres of saline, which is many orders of magnitude less compressible than air, it seems very unlikely than any patients capsule was distended in any meaningful way in this study.

Quraishi *et al*[28] reported results of small randomised study comparing hydrodilation to manipulation under anaesthesia. Though no differences were found in Constant score at any point up to six months following intervention both groups made a clinically significant improvement following intervention.

The major side effect of hydrodilation appears to be of pain during the procedure[32,33,35] though Gam also reported one instance of stroke which was not thought to be related to the intervention.

This systematic review of hydrodilatation demonstrates that this technique appears to efficacious but there is no good evidence to suggest any superiority to other treatments. High quality randomised studies comparing hydrodilatation to other common treatments, such as arthroscopic capsular release, are needed.

Physiotherapy

Most patients are initially prescribed a course of physiotherapy prior to referral to a surgeon. The aim behind most regimens is to prevent further reduction in range of motion and eventually to increase the range of motion in the affected shoulder. Passive mobilisation and capsular stretching are two of the most commonly used techniques. Despite the near universal use of physiotherapy as a first line treatment for frozen shoulder there is very little high quality evidence to support its use. Cochrane reviews have demonstrated that the current literature base shows that physiotherapy alone has little to no benefit as compared to control groups[39]. There are a number of adjuncts that are often used with physiotherapy including extracorporeal shockwave therapy, electromagnetic stimulation, acupuncture and the use of lasers, none of which have been subjected to investigation with randomised controlled studies[3].

Steroid injection

Steroid injection is an another almost ubiquitous intervention in frozen shoulder. Multiple cochrane reviews have noted the eventual location of a blind glenohumeral or subacromial injection is highly variable[31,40]. The most recent cochrane review collates the information from 26 very heterogenous studies[40] and concludes that there is at best a small short term benefit to steroid injection alone for frozen shoulder but that the evidence base is poor. The difficulty in extracting the effect of steroid from that of physiotherapy, an intervention with which it is often combined in studies has long been noted[41].

Oral steroid

This treatment is rarely prescribed by surgeons, however to date, five trials have been conducted investigating oral steroid therapy, comparing steroid to placebo[32,42], no treatment[43], intra articular injection[44] and in conjunction with manipulation under anaesthesia[45]. These trials were reviewed in a systematic cochrane review in 2006[46] and showed that there is a mild short term (under 6 wk) benefit to oral steroid therapy but

that this is not maintained in the longer term. This small short term benefit must be offset against the well known side effects and risks of oral steroid therapy.

CONCLUSION

Frozen shoulder is a common disease which causes significant morbidity. Despite over a hundred years of treating this condition the definition, diagnosis, pathology and most efficacious treatments are still largely unclear. This review of the recent evidence base highlights key areas for future research in particular with regard to the increasing role of arthroscopic capsular release as a treatment. High quality adequately powered randomised controlled trials comparing the most common interventions to a sham procedure would be the ideal way to improve the current evidence base. However these are difficult studies to construct and recruit for. Frozen shoulder can be such an intensely painful condition that in severe cases one could consider that an option of no treatment as part of a control group could be considered to be unethical. Given these real world problems in construction of clinical trials the optimum area to concentrate further research is in comparing treatments like arthroscopic capsular release to hydrodilatation with an adequately powered high quality randomised controlled trial.

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