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EVIDENCE-BASED STRATEGIES FOR MANAGING PRIMARY SHOULDER STIFFNESS: A NARRATIVE REVIEW

D. CUCCHI[1], R. COMPAGNONI[2], S. VAN HATTEM[1], F. BRINDISINO[3], P.S. RANDELLI[2,4,5], L. DE GIROLAMO[6]

[1]Department of Orthopaedics and Trauma Surgery, University of Bonn, Bonn, Germany
[2]U.O.C. 1° Clinica Ortopedica, ASST G. Pini-CTO, Milan, Italy
[3]Department of Medicine and Health Science "Vincenzo Tiberio", University of Molise c/o Cardarelli Hospital, C/da Tappino, Campobasso, Italy
[4]Department of Biomedical Sciences for Health, Laboratory of Applied Biomechanics, University of Milan, Milan, Italy
[5]Department of Biomedical Sciences for Health, University of Milan, REsearch Center for Adult and Pediatric Rheumatic Diseases (RECAP-RD), Milan, Italy
[6]Orthopaedic Biotechnology Laboratory, IRCCS Ospedale Galeazzi Sant'Ambrogio, Milan, Italy

Corresponding Author
Davide Cucchi, MD; e-mail: d.cucchi@gmail.com

ABSTRACT – Primary shoulder stiffness is characterized by multiplanar painful restriction of shoulder movement. This condition involves various biological, genetic, hormonal, and metabolic factors. This review outlines the natural history, diagnostic methods, and risk factors and focuses on treatment options based on recent consensus and guidelines works. The condition typically progresses through three phases: pain, movement restriction, and recovery, lasting between 12 to 42 months. Diagnosis relies heavily on clinical examination, medical history, and exclusion of other causes, with imaging techniques like ultrasound and magnetic resonance imaging aiding in assessment.

Risk factors include metabolic disorders such as diabetes, thyroid issues, and cardiovascular risk factors, suggesting that managing these underlying conditions is essential. Conservative treatments, particularly physiotherapy combined with manual therapy, stretching, and home exercise programs, are pivotal for pain reduction and improving range of motion. Additionally, the use of nonsteroidal anti-inflammatory drugs and corticosteroids, both orally and intra-articularly, offers significant short-term benefits. Systemic corticosteroids should be used cautiously due to potential side effects, whereas intra-articular corticosteroid injections are preferred for their efficacy, especially in the inflammatory phase. Alternative treatments like shockwave therapy and nerve blocks show promise, particularly in cases where standard medication is contraindicated. Surgical intervention, primarily through arthroscopic procedures, is reserved for cases that are unresponsive to conservative treatment after three to six months. This comprehensive approach underscores the importance of a multimodal strategy, emphasizing the synergy between corticosteroid injections and physiotherapy as the gold standard for managing primary shoulder stiffness.

KEYWORDS: Primary shoulder stiffness, Adhesive capsulitis, Therapy, Shoulder surgery, Physiotherapy, Frozen shoulder.

INTRODUCTION

Shoulder stiffness is defined as a painful restriction of motion in the glenohumeral joint during both passive and active movements. It is classified into primary (idiopathic) and secondary types, resulting

mainly from surgical interventions and trauma[1]. The diverse causes include molecular biological mechanisms, genetic factors, as well as hormonal, metabolic, and many other comorbidities[1,2]. As varied as the causes of the disease are, the treatment options are equally diverse. The following paper outlines the currently most common therapeutic concepts based on recent consensus and guidelines works[3,4].

NATURAL HISTORY OF PRIMARY SHOULDER STIFFNESS

The natural history of primary shoulder stiffness depends on its origin but generally lasts for an average of 12-42 months. This course is traditionally divided into three phases[5]. Initially, symptoms manifest in the pain phase, lasting 2-9 months, during which the range of motion gradually decreases. Subsequently, the phase of shoulder movement restriction begins (duration: 3-12 months). Finally, the recovery phase leads to the regaining of movement and function. This phase lasts an average of 5-26 months, with some patients fully recovering while others retain deficits[5].

DIAGNOSIS OF PRIMARY SHOULDER STIFFNESS

The diagnosis of primary shoulder stiffness is a clinical diagnosis based on three essential measures: medical history, clinical examination, and – often underestimated – excluding other causes with similar symptoms[2]. In addition to orthopedic and trauma-related diagnoses, such as potential vertebral and muscular causes, consideration should also be given to neurological and internal medical conditions.

In addition to this basic diagnosis, ultrasound can serve as a cost-effective, readily available diagnostic tool. Ultrasound can observe specific characteristics, such as thickening of the inferior joint capsule, rotator interval, and the coracohumeral ligament and reduced excursion of the supraspinatus tendon. Doppler ultrasound can also detect increased blood flow in the rotator interval. Performing these assessments is not trivial and often requires an experienced examiner. If the diagnosis remains unclear despite these methods, magnetic resonance imaging (MRI) is an option. This can support the suspected diagnosis. In MRI, a thickened joint capsule and rotator interval, increased anterior extracapsular edema, obliteration of the subcoracoid triangle and changes in the axillary recess can be observed[6]. Of course, MRI also serves to exclude other differential diagnoses.

RISK FACTORS FOR THE DEVELOPMENT OF PRIMARY SHOULDER STIFFNESS

The functional restriction in the shoulder caused by capsular fibrosis results from a pathophysiological cascade that ultimately leads to hyperplasia of fibroblasts and hypervascularization of the synovium. This hyperplasia of fibroblasts and hypervascularization of the synovium result from inflammatory processes such as an imbalance of matrix metalloproteinases, overexpression of tumor necrosis factor-α, transforming growth factor-β and its receptor, platelet-derived growth factor and its receptor, hepatocyte growth factor, interleukin-1, and interleukin-6[7,8]. Many common medical conditions are significantly involved in these pathomechanisms. These include metabolic pathologies such as type 1 and 2 diabetes mellitus, hyperlipidemia, hypercholesterolemia, and gout, as well as smoking as an associated cardiovascular risk factor[1,8-10]. Diseases from the rheumatic spectrum, thyroid disorders, tumors, and infections also favor the development of shoulder stiffness[9,11-14]. Therefore, a primary therapeutic measure is to prevent or adequately treat these underlying diseases. If the diagnosis of primary shoulder stiffness is considered, but none of the above-mentioned risk factors are present, it is debatable whether screening for diabetes mellitus should be performed. However, based on current evidence[4], no recommendation can be made for screening for diabetes mellitus in cases of initial diagnosis of idiopathic shoulder stiffness.

CONSERVATIVE THERAPY

Physiotherapy, Manual Therapy, Therapeutic Exercise and Stretching

Among conservative treatment options, physiotherapy undoubtedly holds a crucial position. The combination of manual therapy with active and passive training sessions, stretching exercises, and a home exercise program is particularly promising, primarily for pain reduction and improving range of motion.

This approach, verified in many studies[4], aligns with the most commonly applied measures in current practice. Eccentric training appears to be especially effective in enhancing the range of motion, alleviating pain, and improving muscle strength and functionality. Additionally, proprioceptive training, specifically targeting the rotator cuff and scapulothoracic muscles, can contribute to improvements in pain, function, pain perception, and active movement within a conventional conservative treatment framework. Exercises beyond the pain threshold lead to superior pain relief, especially concerning nighttime pain[15]. Compared to treatments that do not include manual therapy, joint mobilization seems to have a better effect on range of motion and pain reduction in patients with primary idiopathic shoulder stiffness. Therefore, combining joint mobilization with movement therapy is recommended[3]. Stretching, possibly with the aid of devices, appears to be almost obligatory in rehabilitation programs. Adding stretching exercises to multimodal programs with therapeutic exercises seems to increase the range of motion, although evidence for the effect on function and pain remains uncertain. The effects of stretching likely lead to a transformation and restructuring of the extracellular matrix and the restoration of the correct balance between matrix metalloproteinases and their inhibitors. A systematic review by Noten et al[16] examined various mobilization techniques and found that combining different angle and translation mobilization techniques with stretching exercises is advisable. End-range mobilization techniques appear to be more effective in improving glenohumeral joint mobility and function compared to pain-free techniques with a mid-range of motion, with no effects on pain or quality of life observed[16]. An exception appears to be the application of intensive passive stretching exercises in the primary active inflammatory and proliferative phase, which could have an opposing negative influence on the natural course of the disease process. This is likely because myofibroblasts, responsible for the increase in joint stiffness, may be sensitive not only to proinflammatory cytokines responsible for their differentiation and activation but also to mechanical stimuli[17]. The use of muscle relaxation techniques involving the application of heat and manual ischemic compression on the target muscle in a stretched position for around 60-90 seconds results in pain alleviation and enhanced mobility. This implies that the impact of contractile tissue should be taken into account when treating individuals with primary idiopathic shoulder stiffness[18]. The combination of corticosteroid injections and physiotherapy appears to be more effective than physiotherapy or infiltration alone in improving pain and function. Therefore, this combination should be considered as the initial treatment for patients with primary idiopathic shoulder stiffness. Regardless of the type of procedure, the psychosocial component of physiotherapy is crucial[19]. In addition to physiotherapy, shockwave therapy is a supportive measure associated with pain and movement improvement. This may be particularly considered in patients for whom basic medication therapy is contraindicated.

Medical Therapy

Alternative conservative therapeutic options involve pharmacological interventions. Notably, nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids are significant in this context. Regarding NSAIDs, both selective and non-selective NSAIDs, as well as cyclooxygenase-2 inhibitors, have proven to be effective. It is recommended that these be accompanied by physiotherapy[20]. The use of opioids, although common in clinical practice, has not been extensively studied in clinical trials and is not recommended as the first-line treatment due to the associated side effects of this class of medications[3,4]. Another effective pharmacological therapy involves corticosteroids, which can be administered either orally or locally intra-articularly, the latter being a more locally invasive procedure. In the case of oral corticosteroids used in the treatment of primary shoulder stiffness, the administration typically follows a stepwise reduction in dosage over several days to weeks. Systemic oral intake of prednisolone has demonstrated superiority over placebo in pain reduction, function, and range of motion recovery, but only up to 6 weeks after intake[21]. The advantage rapidly diminishes upon discontinuation of prednisolone, with a tendency for a better outcome in the placebo group noted 12 weeks post-intervention, suggesting a rebound phenomenon[21]. It is important to note that in the referenced study[21], patients had to take 30 mg of prednisolone daily for three weeks, which carries a significant side effect profile, although no related side effects were recorded in the small patient cohort during the 12-month follow-up. Nevertheless, systemic corticosteroid administration should be approached with caution. It is crucial to be aware that simultaneous use of corticosteroids and NSAIDs systemically significantly increases the risk of gastrointestinal bleeding.

In addition to taking corticosteroids systemically, they can also be administered intra-articularly, which is particularly beneficial in the initial inflammatory phase. Compared to physiotherapy alone,

intra-articular cortisone injection yields short-term better clinical results and should, therefore, be considered a gold standard treatment option[4]. Local corticosteroid infiltration is superior to short-term systemic intake and leads to a faster reduction of symptoms. Considering contraindications and application guidelines[2-4], intra-articular cortisone injection should be preferred over oral cortisone application. Infiltration in the glenohumeral joint is described as the most effective technique and is recommended as the gold standard, although periarticular/subacromial cortisone applications can also achieve a therapeutic effect. Despite higher infiltration safety, intra-articular cortisone injection can still be performed without radiologically guided puncture (e.g., ultrasound, fluoroscopy)[3,4]. Based on the recommendations in the available literature[4,22], it seems reasonable to perform 1-3 infiltrations weekly or every two weeks from the time of diagnosis. Although there are some indications of the use of platelet-rich plasma for the treatment of primary shoulder stiffness, there is currently insufficient scientific evidence to support its superiority over corticosteroid injections. Infiltrative treatment with local anesthetics is a quick and straightforward procedure that can provide immediate pain relief before or during physiotherapy sessions. Given the purely symptomatic nature of the treatment and the potential toxicity of local anesthetics to joint cartilage, the number of injections should be kept as minimal as possible. The lack of efficacy of hyaluronic acid injections was discussed in a systematic review by Lee et al[23], while a more recent four-arm randomized study[24] suggested a possible role of a combination of hyaluronic acid with cortisone injections; however, hyaluronic acid as a sole infiltrative procedure is not superior to other treatments and is therefore not recommended for the treatment of primary shoulder stiffness[4,23,24].

Other Non-Operative Procedures

Shockwave therapy is recommended as an alternative treatment method for diabetic patients with poor blood sugar control, especially when corticosteroid treatments are contraindicated[25-28]. Laser therapy, combined with exercises to stretch the joint capsule, may alleviate pain, but it does not significantly impact joint stiffness. Other applications of physical therapy [ultrasound, heat therapy, cold therapy, transcutaneous electrical nerve stimulation (TENS), electromagnetic fields, iontophoresis] are not recommended, as the evidence[4,29,30] does not indicate any benefits. Other conservative treatment alternatives encompass procedures involving regional anesthesia, followed by rigorous physiotherapeutic exercises and stretching. Established preferences in this category include the administration of a suprascapular nerve block, a brachial plexus block, and a selective block of the C5 and C6 nerve roots. When conducted under ultrasound guidance, a suprascapular nerve block demonstrates superior beneficial outcomes, particularly in terms of range of motion and pain perception in the short-to-medium term, when compared to either corticosteroid injection alone or standalone physiotherapy. Similarly, the combination of a brachial plexus block and selective block of C5 and C6 roots, coupled with shoulder manipulation, yields comparable effects to the suprascapular nerve block, albeit with lower supporting evidence[31,32].

Manipulation under anesthesia or nerve block has not shown[3,4] superior benefits compared to other therapies, such as physiotherapy or corticosteroid injection, and is considered an obsolete procedure. If considered, the optimal timing for manipulation under anesthesia is between 6 and 9 months from the onset of symptoms. Major complications are anecdotal, while intra-articular lesions are more frequently described but do not appear to significantly compromise clinical outcomes[3,4,33,34].

Hydro-dilatation, a method widely used for the past 50 years, involves introducing fluid into the joint capsule, leading to internal stretching of the capsule and tearing of contractile tissue. However, no superiority of this method over other conservative treatment options has been demonstrated[35]. Alternative medicine approaches appear to be partially safe and effective, but there are no high-quality studies comparing them to established treatments, so they cannot be recommended[3,4].

SURGICAL TREATMENT

Due to the self-limiting course of the disease and generally effective basic therapy, surgical intervention plays a rather secondary role. However, if the aforementioned conservative therapeutic options do not show results, the surgical approach proves to be a viable option. Most studies[4,38] suggest that an initial period of three to six months should be dedicated to conservative treatment, a recommendation supported by recent consensus and guidelines works. Excellent outcomes have been demonstrated[36-38] in

terms of pain reduction, functional recovery, and range of motion. In this context, arthroscopic procedures are preferred over open arthrolysis, and this is the most commonly employed method in practice. Usually, the anterior-inferior capsular release is performed with additional gestures if necessary, but they seem to provide no additional benefits[39]. Arthroscopic arthrolysis typically involves decompression of the rotator interval, the release of the coracoacromial ligament, and potentially the subscapularis tendon, both intra- and extra-articularly, along with a perilabral capsulotomy between 270° and 360°; concurrently, tenolysis/tenotomy/tenodesis of the long head of the biceps tendon can be performed. Most studies[36-39] suggest that anterior-inferior capsule release, when indicated, is a sufficient technique to achieve better results. Additional procedures, such as coracohumeral ligament release or posterior capsular release, may be performed at the discretion of the surgeon in specific cases, but none of them seem necessary to achieve better outcomes compared to the classical technique. It is important to note that in the studies[38] available, the patients' symptoms had been present for several months, and conservative therapeutic measures had been carried out for only three to six months before the decision for the operative procedure. This indicates less about the need for surgical escalation than it does about the potential prolongation of the diagnostic process, suggesting that intervention might be warranted earlier.

CONCLUSIONS

Shoulder stiffness, a common condition often linked to various prevalent health issues, is typically identified through clinical assessment. The recommended first-line treatment approach involves a multimodal strategy, underscoring the synergistic advantages derived from the combination of corticosteroid injections and physiotherapy. In considering alternatives to conventional medication, shockwave therapy emerges as a viable option, complemented by laser therapy, primarily designed for pain relief, which exhibits promising outcomes. However, it is crucial to note that other electrophysical measures, intra-articular platelet-rich plasma and anesthetic injections, and alternative medicine approaches currently lack substantial evidence to support their efficacy. While oral corticosteroids showcase short-term effectiveness compared to a placebo, intra-articular corticosteroid injections have been proven to be markedly superior and should be therefore considered as gold standard treatment, advocating for a regimen of one to three injections administered on a weekly or bi-weekly basis, starting from the time of diagnosis. Surgical intervention should only be considered after exhausting evidence-based conservative measures over a period of three to six months.

Ethics Approval

Ethical review and approval were waived for this study since no animal or human participants were included.

Informed Consent

This study did not involve human subjects. Therefore, written informed consent was not necessary.

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Authors' Contributions

D. Cucchi: study design, manuscript draft.
R. Compagnoni: study design, manuscript revision.
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P.S. Randelli: manuscript revision, supervision.
L. De Girolamo: study design, manuscript revision.
All authors provided final approval of the version of the article to be published.

ORCID ID

D. Cucchi: 0000-0001-6284-7977
R. Compagnoni: 0000-0001-8259-8488
F. Brindisino: 0000-0001-8950-8203
P.S. Randelli: 0000-0001-9331-820X
L. De Girolamo: 0000-0002-9979-3092

Conflict of Interest

D. Cucchi, R. Compagnoni, S. Van Hattem, and F. Brindisino have no conflict of interest to disclose.
P.S. Randelli is a paid consultant for Medacta, Arthrey, Microport, and Depuy.
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Data Availability

Data sharing does not apply to this article as no datasets were generated or analyzed during the current study.

AI Disclosure

Artificial intelligence was not used to create any original intellectual content presented in this article.

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