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Frozen Shoulder - Evaluating the Effectiveness of Physical Therapy against Other Interventions Like Corticosteroid Injections, Non-steroidal Anti-inflammatory Drugs (NSAIDs), and Surgical Options – A Literature Review

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ABSTRACT

Frozen shoulder (adhesive capsulitis) is a prevalent musculoskeletal condition characterized by pain and progressive restriction of shoulder joint movement, significantly affecting quality of life. This literature review evaluates the comparative efficacy of physical therapy against other therapeutic interventions, including corticosteroid injections, NSAIDs, and surgical options such as manipulation under anesthesia and arthroscopic capsular release. The study highlights the need for individualized treatment strategies and further research to refine clinical guidelines. The management of frozen shoulder (adhesive capsulitis) requires a tailored approach, considering the stage of the condition and patient-specific factors. Physical therapy remains a cornerstone of treatment, particularly in the frozen and thawing stages, and is most effective when combined with other interventions. While corticosteroid injections demonstrate significant short-term benefits in pain relief and functional improvement, their efficacy diminishes over time unless supported by a structured rehabilitation program. NSAIDs are primarily beneficial for managing inflammation and pain in the early stages but do not significantly alter the course of the condition when used in isolation. Surgical interventions such as manipulation under anesthesia (MUA) and arthroscopic capsular release are reserved for cases resistant to conservative management. Though both surgical options yield comparable outcomes, arthroscopic capsular release is increasingly favored due to its precision and reduced risk of complications compared to MUA. Overall, early intervention with a multimodal strategy incorporating corticosteroid injections, targeted physical therapy, and patient education optimizes outcomes. Future research should focus on identifying patient subgroups that benefit most from specific interventions and on standardizing treatment protocols.

Aim of the Study

The aim of this study is to evaluate the effectiveness of physical therapy in the management of frozen shoulder (adhesive capsulitis) compared to other commonly employed interventions, including corticosteroid injections, non-steroidal anti-inflammatory drugs (NSAIDs), and surgical options. This review seeks to provide a comprehensive analysis of treatment outcomes such as pain relief, functional improvement, range of motion restoration, patient satisfaction, and long-term efficacy. By synthesizing current evidence, the study aims to identify the optimal therapeutic approach or combination of interventions for improving clinical outcomes in diverse patient populations with frozen shoulder.

Materials and Methods

The article was created based on the PubMed and Cochrane databases. The literature was analyzed using the fallow keywords: Frozen Shoulder (Adhesive Capsulitis), Physical Therapy, Intra-articular Corticosteroid Injections, NSAIDs, manipulation under anesthesia (MUA), arthroscopic capsular release (ACR).

Keywords: Frozen Shoulder (Adhesive Capsulitis), Physical Therapy, Intra-articular Corticosteroid Injections, NSAIDs, manipulation under anesthesia (MUA), arthroscopic capsular release (ACR)

INRODUCTION

Understanding Frozen Shoulder Pathogenesis

Overview of Frozen Shoulder

Frozen shoulder, medically known as adhesive capsulitis, is a clinical syndrome characterized by pain and significant restriction of both active and passive shoulder movements. This occurs without notable abnormalities on shoulder radiographs, except for possible findings like osteopenia or calcific tendonitis. [1] Frozen shoulder typically results from a pathological process involving inflammation and fibrosis of the glenohumeral joint capsule, often leading to the formation of excessive scar tissue or adhesions. [2], [3]

There are two primary classifications:

- **Primary (Idiopathic) Adhesive Capsulitis**: This occurs without a clear initiating event or identifiable cause. It is commonly associated with systemic conditions such as diabetes mellitus and thyroid disorders and is thought to involve an inflammatory cascade that transitions into fibrosis.[3], [4]
- **Secondary Adhesive Capsulitis**: This arises following a specific event such as shoulder trauma, surgery, or immobilization. It is often associated with periarticular fractures, joint disorders, or postoperative complications.[4]

Stages of progression

- **Freezing Stage (Stage 1)**:

  Duration: 2–6 months.[5]

  Symptoms: Predominantly characterized by moderate to severe pain and partial restriction of range of motion (ROM). Pain is insidious, often worsens at night, and may be confused with other conditions like rotator cuff tendinopathy.[5]

  Pathology: Intense inflammation of the capsule and synovium with gradual onset of symptoms. ROM progressively worsens over time.[5]

- **Frozen Stage (Stage 2)**:

  Duration: 4–12 months.[5]

  Symptoms: Pain begins to subside, but stiffness becomes more pronounced. In the early phase of this stage, pain still dominates, while later stiffness takes precedence.[5]

  Pathology: Reduction in inflammation with progressive fibrosis of the capsule and ligaments, leading to significant restriction of movement.[5]

- **Thawing Stage (Stage 3)**:

  Duration: 6–26 months.[5]

  Symptoms: Minimal pain with gradual improvement in stiffness and recovery of ROM.[5]

  Pathology: Resolution of inflammation and fibrosis, allowing a progressive return of shoulder mobility.[5]

Pathophysiology

The pathophysiology of adhesive capsulitis involves a transition from a inflammatory phase to a fibrotic phase. During the inflammatory phase, pro-inflammatory cytokines such as interleukin (IL)-1β, IL-6, tumor necrosis factor-α (TNF-α), and cyclooxygenase (COX)-1 and COX-2 are upregulated within the joint capsule and surrounding tissues.[6] These mediators drive an inflammatory response characterized by synovial hyperplasia, increased vascularity, and infiltration of immune cells, including T cells, B cells, macrophages, and mast cells. The inflammation is responsible for pain and early tissue remodeling while initiating pathological mechanisms that set the stage for fibrosis.[4], [7]

As the condition progresses, the fibrotic phase becomes predominant. This phase is marked by fibroblast proliferation and their differentiation into myofibroblasts, which actively deposit type

I and III collagen in the extracellular matrix. This excessive collagen production leads to thickening and contracture of the joint capsule, particularly in the rotator interval and coracohumeral ligament. Additionally, an imbalance between matrix metalloproteinases (MMPs), which degrade connective tissue, and their inhibitors (TIMPs) exacerbates the accumulation of fibrotic tissue, resulting in stiffness and restricted shoulder mobility.[3]

This transition from inflammation to fibrosis highlights the dual nature of the disease process in adhesive capsulitis, where the early inflammatory response contributes to later fibrotic changes, ultimately leading to the hallmark symptoms of pain and joint stiffness. [7], [8]

Epidemiology and Risk Factors

Frozen shoulder has a prevalence of approximately 2-5% in the general population, with higher rates observed in certain populations. It is more common in individuals aged 40-60 years, and women are disproportionately affected, comprising about 70% of cases. [3], [9], [10] The condition is significantly more prevalent among patients with systemic conditions such as diabetes mellitus, with an estimated prevalence of up to 20% in this group, including 10.8% in type 1 and 22.4% in type 2 diabetes. Other associated risk factors include thyroid disorders, such as hypothyroidism and hyperthyroidism, with hyperthyroidism increasing the risk by 1.22 times. Cardiovascular diseases, cerebrovascular events, and autoimmune conditions are also recognized as risk factors.[11] Autoimmune diseases, including rheumatoid arthritis and scleroderma, are associated with frozen shoulder, likely due to chronic inflammation exacerbating capsular fibrosis. Furthermore, up to 52% of patients with adhesive capsulitis may concurrently have Dupuytren’s disease, suggesting a shared pathophysiology involving fibroproliferative changes**.**[4], [12]

METHODS OF TREATMENT

Physiotherapy

Techniques Used in Physiotherapy for Frozen Shoulder

Manual therapy is one of the primary interventions used by physiotherapists to address the stiffness, pain, and restricted movement associated with frozen shoulder (adhesive capsulitis). It involves hands-on techniques aimed at mobilizing the shoulder joint and its surrounding tissues.

Joint Mobilization

Joint mobilization involves the application of slow, passive movements to the glenohumeral joint, typically aimed at improving accessory motions like gliding, sliding, and rolling. These movements target the stiffened capsule and adhesions characteristic of frozen shoulder.[13]

Techniques:

- Posterior Glide: Enhances internal rotation and flexion.[13], [14]
- Anterior Glide: Focuses on improving external rotation and extension.[13], [14]
- Inferior Glide: Helps increase abduction and overall joint mobility.[13], [14]

Grades of mobilization

- Grade I-II mobilization: Gentle oscillatory movements within the range of joint play, primarily for pain relief.
- Grade III-IV mobilization: Larger amplitude movements applied near the limit of joint motion to stretch the capsule and improve range of motion (ROM).

Effectiveness:

Joint mobilization is effective across all stages of frozen shoulder when appropriately tailored to the disease phase. In the **freezing stage**, where pain and inflammation dominate, low-grade mobilizations (Grade I-II) can help alleviate pain and maintain joint play without exacerbating inflammation. Studies suggest that gentle mobilizations combined with pain-relieving modalities like heat therapy can improve patient comfort and compliance.[5], [15], [16] In the **frozen stage**, as stiffness becomes predominant, high-grade mobilizations (Grade III-IV) targeting capsular restrictions are most effective for improving range of motion (ROM). Clinical trials have demonstrated significant improvements in abduction and external rotation through techniques such as posterior glides and combined scapular and joint mobilization.[13], [14] During the **thawing stage**, joint mobilization continues to play a crucial role in enhancing ROM and preventing residual stiffness. Evidence indicates that integrating joint mobilization with active stretching and strengthening exercises at this stage leads to sustained functional recovery and optimized outcomes.[5], [17]

Scapular Mobilization

Scapular mobilization addresses the altered scapulohumeral rhythm that often accompanies frozen shoulder. The scapula’s movements are crucial for proper shoulder mechanics.

Techniques:

- Scapular Elevation and Depression: Improves vertical scapular movement.[14]
- Scapular Protraction and Retraction: Targets the scapula's horizontal plane.[14]
- Circumduction Movements: Combines all scapular directions to restore fluid motion.[14]

Effectiveness:

Scapular mobilization is effective across all stages of frozen shoulder, with its application tailored to the phase-specific characteristics of the disease. In the **freezing stage**, when pain and inflammation are predominant, gentle scapular mobilization reduces pain and helps maintain scapulothoracic rhythm, preventing compensatory patterns. Studies have shown that techniques such as supero-inferior and medio-lateral scapular glides alleviate pain and maintain mobility without exacerbating symptoms. [5], [14]

During the **frozen stage**, where stiffness becomes the primary concern, scapular mobilization enhances the functional movement of the scapulothoracic joint, allowing better engagement of the glenohumeral joint. Clinical research indicates significant improvements in shoulder abduction and external rotation when scapular mobilization is combined with posterior capsule stretching. [14]

In the **thawing stage**, scapular mobilization helps sustain recovery by optimizing shoulder mechanics and restoring normal movement patterns. Evidence supports that incorporating scapular mobilization into active rehabilitation protocols accelerates ROM recovery and minimizes residual dysfunction. [13], [17]

Other physiotherapy techniques

High-Velocity Low-Amplitude (HVLA) Manipulation

Involves a quick, thrusting movement to the joint. Although less commonly used for frozen shoulder due to potential discomfort, it can be effective in specific cases of mechanical restriction. Generally reserved for later stages of frozen shoulder (thawing stage) when stiffness predominates over pain. [18][19]

Myofascial Release

Focuses on the soft tissues around the shoulder joint, including the fascia and muscles, which may become tight and contribute to limited ROM. The technique is based on gentle, sustained pressure applied to the affected areas to release tension. It is used in conjunction with other manual therapy techniques to improve outcomes. [14], [20]

Muscle Energy Techniques (METs)

METs involve a series of isometric muscle contractions performed against resistance, followed by relaxation and passive stretching. Benefits include reduced muscle guarding, enhanced capsular mobility, and improved overall joint motion. [13], [14]

Soft Tissue Mobilization

Addresses tight muscles and connective tissue to improve flexibility and reduce pain. Techniques include deep tissue massage to the deltoid, rotator cuff, and trapezius muscles, as well as trigger point release in areas of localized tension. The benefits of this method include improved circulation and preparation of the shoulder for more intensive mobilization exercises. [20]

Proprioceptive Neuromuscular Facilitation (PNF)

PNF combines active and passive movements to enhance neuromuscular control and ROM. Techniques like "contract-relax" are commonly used to improve specific ranges of motion (e.g., external rotation or abduction). [18], [21]

Ultrasound Therapy in the Treatment of Frozen Shoulder

Ultrasound therapy is a widely used modality in physiotherapy to manage pain and restore function in patients with frozen shoulder. It involves the application of high-frequency sound waves to the affected tissues, promoting deep heat generation and biophysical effects.

Mechanism of Action

Ultrasound therapy for frozen shoulder operates through a combination of thermal and non-thermal effects, along with pain modulation. The thermal effects involve the generation of deep heat (up to 5 cm beneath the skin), which enhances tissue elasticity, extensibility, and blood circulation, aiding in the removal of inflammatory mediators and promoting nutrient delivery for tissue repair. Non-thermal effects include a micro-massage action that stimulates cellular activity and mechanically disrupts adhesions in the shoulder capsule, while also increasing cell membrane permeability to support nutrient exchange and healing. Additionally, ultrasound therapy reduces nerve conduction velocity in pain pathways and modulates local inflammation, thereby lowering pain sensitivity and improving comfort during rehabilitation.[18], [22]

Application Techniques

The application of ultrasound therapy for frozen shoulder involves tailored frequency settings, modes, and treatment durations, often integrated with other modalities for optimal results. Frequencies of 1 MHz target deep tissues, such as the shoulder capsule, reaching depths of 2.5 to 5 cm, while 3 MHz is used for superficial tissues like tendons. Continuous mode, which generates consistent thermal effects, is ideal for the thawing phase to address stiffness, whereas pulsed mode, with non-thermal effects, is preferred in the freezing phase to reduce inflammation. Typical treatment sessions last 5–10 minutes, depending on the size and depth of the affected area. Ultrasound therapy is frequently combined with stretching exercises, manual therapy, or modalities like TENS to amplify its benefits in pain reduction and improved range of motion. [18], [22]

Effectiveness of using ultrasound therapy

Ultrasound therapy offers multiple benefits for managing frozen shoulder, particularly when combined with other treatments. It significantly reduces pain, as evidenced by improved pain scores in patients receiving ultrasound with exercises compared to placebo or no treatment. By reducing stiffness in the capsule and surrounding tissues, it facilitates stretching and enhances the effectiveness of range of motion (ROM) exercises. Ultrasound also promotes tissue healing through improved circulation and cellular activity. Additionally, it is a non-invasive and cost-effective alternative to surgical or pharmacological options. Systematic reviews and meta-analyses have highlighted its efficacy in pain reduction and mobility improvement, with studies showing superior outcomes when ultrasound is combined with stretching exercises compared to either modality used alone.[18], [22]

Electrostimulation in the Management of Frozen Shoulder

Electrostimulation, particularly **transcutaneous electrical nerve stimulation (TENS)** and other related modalities, is an effective physiotherapeutic tool for managing frozen shoulder.[23] It focuses on pain reduction and facilitating active rehabilitation by modulating nerve activity and improving circulation.[17]

Mechanism of Action

Electrostimulation functions through multiple mechanisms to address pain and facilitate recovery in frozen shoulder. Pain modulation is achieved via TENS, which operates on the Gate Control Theory by stimulating sensory nerves to block pain signal transmission to the brain, while also increasing the release of endorphins, providing both immediate and long-term pain relief. [23] Improved circulation is facilitated by low-frequency electrical stimulation, which enhances localized blood flow, delivering nutrients to the affected area and aiding in the removal of inflammatory by-products. Additionally, neuromuscular electrical stimulation (NMES) activates muscle contractions, helping to maintain muscle tone and prevent atrophy in the shoulder girdle during periods of limited mobility.[17], [18], [20]

Application Techniques

Electrostimulation applications for frozen shoulder include TENS for pain management, NMES for improving strength and range of motion (ROM), and iontophoresis for localized anti-inflammatory treatment.[23], [24] TENS involves placing electrodes around the painful shoulder area, often near the suprascapular and deltoid regions, operating at frequencies of 50–100 Hz for acute pain relief or 2–10 Hz to release endorphins in chronic conditions. NMES is used to stimulate muscle contractions and enhance neuromuscular coordination, targeting the deltoid, trapezius, or rotator cuff muscles to support functional recovery when movement is limited. Iontophoresis applies electrical currents to deliver anti-inflammatory medications, such as corticosteroids, transdermally, reducing inflammation in the shoulder capsule and aiding in pain relief and mobility restoration.[17], [18], [20]

Effectiveness of using Electrostimulation

Electrostimulation offers multiple benefits in managing frozen shoulder, particularly in providing immediate and effective pain relief during the acute (freezing) phase, enabling patients to engage more actively in other rehabilitation methods.[20], [23] It enhances the tolerability and effectiveness of manual therapy and stretching exercises by reducing associated discomfort. Additionally, neuromuscular electrical stimulation (NMES) prevents muscle atrophy by preserving strength and tone in peri-scapular muscles during periods of limited mobility.[23] Being non-invasive and associated with minimal risks when used correctly, electrostimulation is a safe and accessible option for most patients, including those who may not tolerate pharmacological treatments.[17], [18], [20], [24]

CORTICOSTERIOD INJECCTIONS

Mechanism of Action of Corticosteroid Injections

Corticosteroids are potent anti-inflammatory agents that modulate multiple pathways involved in the pathophysiology of frozen shoulder (adhesive capsulitis). Their primary effects are mediated through:

- **Suppression of Inflammation**
  Corticosteroids downregulate pro-inflammatory mediators, including cytokines such as **tumor necrosis factor-alpha (TNF-α)**, **interleukin-1 (IL-1)**, and **interleukin-6 (IL-6)**. These cytokines contribute to synovitis and the chronic inflammatory state characteristic of the "freezing" stage of frozen shoulder. [18], [25]

- **Reduction of Fibroblast Activity**
  Corticosteroids inhibit the activity and proliferation of fibroblasts, which are responsible for producing extracellular matrix components such as collagen. Excessive fibroblast activity leads to capsular thickening and fibrosis in frozen shoulder. By suppressing fibroblast activity, corticosteroids help prevent or reduce the progression of capsular contracture. [26]

- **Decrease in Vascular and Neural Hyperplasia**
  Corticosteroids reduce **neoangiogenesis (formation of new blood vessels)** and **neoinnervation (growth of nerve fibers)**in the joint capsule. These processes are associated with the increased pain and sensitivity seen in frozen shoulder. Suppression of vascular endothelial growth factor (VEGF) and nerve growth factor (NGF) by corticosteroids contributes to alleviating these symptoms. [26]

- **Modulation of Immune Response**

  Corticosteroids interfere with the recruitment and activation of immune cells, such as macrophages, mast cells, and T-cells. These cells play a critical role in perpetuating the inflammatory cascade. The suppression of immune cell activity reduces the release of alarmins (e.g., high-mobility group protein B1 [HMGB1]) and other inflammatory mediators that exacerbate pain and stiffness. [26], [27]

- **Inhibition of Matrix Metalloproteinases (MMPs)**

  MMPs are enzymes involved in extracellular matrix remodeling and are overexpressed in frozen shoulder. Corticosteroids downregulate MMPs, particularly MMP-1 and MMP-3, which contribute to pathological fibrosis by dysregulating the balance between matrix degradation and regeneration. [26], [27]

- **Stabilization of Cellular Membranes**

  Corticosteroids stabilize lysosomal membranes, reducing the release of proteolytic enzymes that contribute to tissue degradation and inflammation in the joint.[17], [18]

- **Modulation of Pain Pathways**

  Corticosteroids decrease the production of prostaglandins by inhibiting phospholipase A2 and cyclooxygenase-2 (COX-2). Prostaglandins are key mediators of pain and inflammation, and their suppression provides significant analgesia. [17], [18]

- **Target of Injection**

  In frozen shoulder, corticosteroid injections are typically administered intra-articularly into the glenohumeral joint or subacromial space. Accurate delivery ensures direct action on inflamed and fibrotic tissues, maximizing efficacy while minimizing systemic exposure. [18], [24]

Efficacy of Corticosteroid Injections

Short-Term Efficacy

Studies consistently show significant pain reduction following intra-articular corticosteroid (IA CS) injections within 6 weeks. A systematic review noted that IA CS injections were superior to both physiotherapy and no treatment for alleviating pain, with a mean difference of approximately 1.0 point on the Visual Analog Scale (VAS)[18], [25]

Another meta-analysis found IA CS to provide rapid pain relief, making it particularly effective in the inflammatory "freezing" stage of adhesive capsulitis.[24], [27]

IA CS injections significantly enhance shoulder function, as measured by tools like the Oxford Shoulder Score (OSS) and Constant-Murley Score, within the first 6-12 weeks. Patients reported improved ability to perform daily activities.[18], [28]

Short-term benefits were often more pronounced when combined with physiotherapy, suggesting a synergistic effect.[16], [17], [18]

Significant improvements in Range of Motion, especially in flexion and abduction, are observed within 6 weeks of corticosteroid administration. These improvements support early-stage physical rehabilitation efforts by reducing inflammation and pain-related limitations Comparison of Treatment. [14], [18], [29]

Mid-Term Efficacy (3–6 Months)

Some studies found that the benefits of corticosteroids persist up to 6 months, although the degree of improvement diminishes over time compared to the short-term gains. [18], [28]

A randomized trial comparing corticosteroid injections with NSAIDs reported sustained functional benefits and slightly superior pain control at 6 months.[30]

When corticosteroid injections are followed by structured physical therapy, the mid-term outcomes improve. This combination helps maintain the ROM gains achieved during the early phase. [17], [18]

Long-Term Efficacy (Beyond 6 Months)

Corticosteroid injections are less effective beyond 6 months, with outcomes converging with those of placebo or other conservative treatments.[18], [28] A meta-analysis found that while corticosteroids improve early pain and function, they do not significantly alter the long-term natural history of frozen shoulder, which often resolves over 1-3 years. **[18], [26]** Pain and stiffness may recur in some patients, particularly if the underlying risk factors, such as diabetes or thyroid dysfunction, are not addressed. [18], [30], [31]

Adverse Effects of Corticosteroid Injections

Local Adverse Effects

Corticosteroid injections can lead to several localized complications, primarily affecting the soft tissues and skin around the injection site. Soft tissue weakening, particularly of tendons and ligaments, is a concern with repeated injections, increasing the risk of tendon rupture, especially in the rotator cuff. Skin changes such as localized atrophy, discoloration, or subcutaneous fat loss are relatively common but typically transient and primarily cosmetic. Joint infections, although rare, remain a serious risk, underscoring the importance of aseptic technique during administration. Other localized effects include temporary increases in pain (steroid flare) and rare cases of hematoma formation if blood vessels are inadvertently punctured during the procedure. [14], [17], [25], [32]

Systemic Adverse Effects

Systemic effects of corticosteroid injections, though infrequent with localized use, can include transient hyperglycemia, particularly in diabetic patients, necessitating close monitoring of blood sugar levels post-injection. Prolonged or frequent use may suppress the hypothalamic-pituitary-adrenal axis, leading to adrenal insufficiency, and in rare cases, contribute to osteoporosis or systemic immunosuppression, raising susceptibility to infections. Some individuals might experience Cushingoid symptoms, such as weight gain or facial swelling, due to systemic absorption, especially after multiple injections. These systemic risks emphasize the need for careful patient selection and adherence to recommended limits on the frequency and dosage of corticosteroid injections. [14], [17], [30], [32]

NONSTEROIDAL ANTI-INFLAMMATORY DRUGS (NSAIDs)

Mechanism of Action:

NSAIDs exert their effects primarily by inhibiting cyclooxygenase (COX) enzymes (COX-1 and COX-2), leading to a reduction in prostaglandins, which are mediators of pain, inflammation, and fever. In frozen shoulder, NSAIDs target the inflammatory components present during the initial painful (freezing) stage, helping to manage pain and reduce localized inflammation in the joint capsule. [17], [30]

Efficacy of NSAIDs

Short-Term Efficacy:

NSAIDs effectively reduce pain during the "freezing" phase (initial 2–9 months) when inflammation is predominant. By inhibiting prostaglandin synthesis, NSAIDs alleviate pain and improve the patient's ability to perform daily activities. [17], [27]

Pain relief allows better participation in physical therapy, which is crucial for maintaining shoulder mobility. [13], [26] Although NSAIDs do not directly improve ROM, their pain-relieving effects enable patients to engage more effectively in exercises and physical therapy that target joint stiffness. [14], [27] Studies indicate that NSAIDs combined with physical therapy lead to better ROM outcomes than NSAIDs alone. [13], [14]

Long-Term Efficacy:

The long-term efficacy of NSAIDs is limited as the inflammatory component subsides during the "frozen" and "thawing" stages (lasting up to 24 months). Pain at this stage is less inflammatory and more related to fibrosis and mechanical restriction, where NSAIDs have minimal impact. [26], [33] Persistent pain may require alternative treatments such as corticosteroid injections, hydrodilation, or surgical interventions.[24], [28] NSAIDs do not significantly influence long-term ROM recovery. Improvements in ROM depend more on interventions like physiotherapy, joint mobilization, and in severe cases, surgical procedures. [14], [26] Long-term ROM outcomes are more closely tied to the natural progression of frozen shoulder and the effectiveness of a comprehensive rehabilitation program.[22], [27]

Table 1. Comparison of short and long term effectiveness of NSAIDs

Outcome	Short-Term (0–6 months)	Long-Term (>6 months)
Pain Relief	Effective in reducing inflammatory pain	Limited; alternative therapies often required
Range of Motion (ROM)	Improvement when combined with physical therapy	Minimal direct impact; ROM depends on other treatments
Role in Disease Course	Symptomatic relief during inflammatory phase	No impact on fibrotic progression or recovery

SURGICAL TREATMENT

Types of procedures

- **Manipulation Under Anesthesia (MUA):**
  The joint is manipulated to tear adhesions while the patient is under anesthesia. This approach is often combined with an intra-articular corticosteroid injection to reduce inflammation and improve post-operative range of motion. [25], [30], [34]

- **Arthroscopic Capsular Release:**
  Minimally invasive surgery performed to excise scar tissue and release adhesions in the joint capsule. This technique is increasingly preferred due to its precision and ability to target specific areas like the rotator interval or posterior capsule.[5], [27]

- **Hydrodilatation (Arthrographic Distension):**
  While less invasive, this procedure involves injecting saline, steroid, and local anesthetic under imaging guidance to stretch the joint capsule. It may be combined with surgical techniques when other treatments fail.[5], [18], [35]

- **Open Capsular Release:**
  Reserved for refractory cases, this involves a more extensive release of the joint capsule through open surgery. This option is considered for patients who do not respond to arthroscopic methods. [17], [27]

Adjunctive Physiotherapy Post-Surgery:

Regardless of the surgical approach, post-operative rehabilitation is crucial for restoring mobility and preventing recurrence. Early structured physiotherapy is often emphasized to maximize functional outcomes.[36]

Effectiveness of surgical treatment

Arthroscopic Capsular Release (ACR)

Effectiveness Summary:

Arthroscopic capsular release (ACR) is highly effective in improving range of motion (ROM), reducing pain, and restoring function in advanced cases of frozen shoulder.[37] Its minimally invasive nature enables precise targeting of adhesions, although recovery may be slower compared to manipulation under anesthesia (MUA). Patients undergoing ACR demonstrated greater improvements in ROM and functional scores compared to MUA at both 3 and 12 months. [27], [28] ACR was also associated with significant pain reduction and long-term functional recovery, particularly in patients with severe adhesive capsulitis. [5] Furthermore, ACR achieved the highest levels of patient satisfaction and long-term functional improvement among surgical options, especially in refractory cases. [28]

Manipulation Under Anesthesia (MUA)

Effectiveness Summary:

MUA provides rapid pain relief and functional improvement, particularly in early-stage or mild cases, but its long-term benefits are inferior to arthroscopic capsular release (ACR). MUA has been effective in improving range of motion (ROM) and pain scores in diabetic patients, although outcomes tend to plateau by 24 weeks. [30] It offers faster recovery compared to physiotherapy for short-term pain relief and ROM improvement, but these benefits are less sustained over time. [5] While MUA is less effective than ACR in severe cases, it provides quicker recovery in mild-to-moderate cases. However, the procedure carries a higher risk of complications, such as fractures and soft tissue injuries. [28], [38]

Hydrodilatation

Effectiveness Summary:

Hydrodilatation is an effective treatment for short-term pain relief and mild improvements in range of motion (ROM). [35] It is a less invasive option, particularly suitable for patients with early or moderate frozen shoulder, though it is less effective in advanced cases. In the short term, hydrodilatation provides pain relief and functional improvement comparable to manipulation under anesthesia (MUA), but it is less effective for enhancing ROM in severe cases. [5], [28] Combining hydrodilatation with corticosteroids has been shown to enhance early symptom relief. [28] A systematic review identified hydrodilatation as a viable alternative for patients seeking to avoid surgery, although it has limited efficacy in fully restoring ROM. [24], [39]

Combined MUA and Corticosteroid Injections

Effectiveness Summary:

Adding corticosteroid injections to manipulation under anesthesia (MUA) enhances short-term outcomes, particularly in pain reduction and improvements in range of motion (ROM).

Patients receiving MUA combined with intra-articular corticosteroid injections experience faster pain relief and improved ROM compared to MUA alone. [25], [30] This combination therapy is associated with better short-term functional outcomes; however, it does not provide additional long-term benefits over standalone MUA. [25], [30], [40]

Open Capsular Release

Effectiveness Summary:

Open capsular release is an effective treatment for the most severe cases of frozen shoulder, particularly in patients who do not respond to less invasive treatments such as arthroscopic capsular release (ACR) and manipulation under anesthesia (MUA). This procedure has been shown to provide significant improvements in range of motion (ROM) in refractory cases and yields favorable long-term functional outcomes. However, its higher complication rates compared to less invasive options make it a reserved choice for unresponsive patients. [5], [27]

Table 2. Comparison of invasive forms of treatment

Surgical Method	Pain Relief	ROM Improvement	Long-Term Function	Recommended For
Arthroscopic Capsular Release	Significant and sustained [26], [27]	Excellent, especially external rotation [27]	High, particularly in severe cases [5]	Severe or refractory cases.
Manipulation Under Anesthesia	Rapid but less sustained [5], [28], [30]	Moderate[5], [28]	Moderate[5]	Early-stage or mild cases
Hydrodilatation	Comparable to MUA short-term[28]	Limited in severe cases[24]	Low to moderate[5]	Early or moderate cases.
MUA + Corticosteroids	Enhanced short-term relief[25]	Better than MUA alone[30]	Aligns with MUA[28]	Rapid symptom control.

Open Capsular Release	Significant but invasive [27]	High[5]	High[27]	Severe, refractory cases

COMPARISON OF TREATMEN

1. Early-Stage/Freezing Stage

Recommended Treatments:

Primary Options:

Intra-articular Corticosteroid Injections:

- Best for patients with significant pain and early ROM loss.
- Particularly effective for rapid pain relief. [5], [18]

NSAIDs:

- For patients contraindicated for corticosteroids or as an adjunct to reduce inflammation and enable physiotherapy. [5], [24], [30]

Adjunct Therapy:

Pain-Relieving Physiotherapy:

- Includes gentle stretching, heat, ultrasound, or diathermy. Avoid aggressive mobilization. [5]

Special Considerations:

- Diabetic patients: Adjust corticosteroid use to avoid blood glucose spikes.
- Those with NSAID intolerance: Alternative analgesics like paracetamol or ECSWT.[5]

2. Mid-Stage/Frozen Stage

Recommended Treatments:

Primary Options:

Physiotherapy:

- Structured ROM and stretching exercises to regain mobility
- Home exercise program to sustain progress.[5], [30]

Hydrodilatation:

- For patients with severe ROM limitations or capsular tightness.[18], [35]

Adjunct Therapy:

- Occasional NSAIDs or corticosteroid injections for patients with residual pain.
- ECSWT for pain relief and functional recovery.[5]

Special Considerations:

- Older adults: Emphasis on physiotherapy to minimize surgical risks.
- Comorbidities (e.g., cardiac issues): Non-invasive options like ECSWT or acupuncture.[5], [18]

3. Late-Stage/Thawing Stage

Recommended Treatments:

Primary Options:

Physiotherapy:

- Focus on functional recovery through ROM and strengthening exercises. [5]

Active Mobilization:

- Transition to active and resisted exercises for muscle strengthening.

Special Considerations:

- No surgical interventions are generally required.

4. Refractory or Severe Cases

Characteristics:

Persistent symptoms beyond 6–9 months despite conservative therapy.

Significant functional limitations.

Recommended Treatments:

Primary Options:

Manipulation Under Anesthesia (MUA):

- For patients with significant stiffness unresponsive to conservative therapy
- Best for non-diabetic patients with frozen-stage capsular tightness.[5]

Arthroscopic Capsular Release (ACR):

- Preferred for severe cases or when MUA is contraindicated (e.g., osteoporosis or rotator cuff tear risks)[5], [18]

Adjunct Therapy:

- Post-surgical physiotherapy is essential to maintain regained ROM. [5]

Special Considerations:

- Diabetics: Prefer ACR over MUA due to higher complication rates with MUA [5] .

5. Patients with Specific Needs:

Diabetic Patients:

Challenges: Higher severity and prolonged disease course. Increased risk of complications with invasive procedures.[31], [43]

Treatment:

Early-stage: Low-dose corticosteroid injections with physiotherapy. [5]

Mid-stage: Hydrodilatation or ECSWT to minimize risks associated with steroid use.[5], [18]

Refractory stage: ACR is preferred over MUA. [5], [18]

Elderly Patients:

Challenges: Limited tolerance for invasive procedures.

Treatment:

Non-surgical approaches like physiotherapy, hydrodilatation, or ECSWT.[5]

Athletes and Manual Workers:

Goals: Rapid functional recovery and return to activities.

Treatment:

Aggressive physiotherapy with or without corticosteroid injections.[18]

MUA or ACR for severe stiffness.[18]

Table 3. Overall Comparison Summary

Intervention	Pain Relief	ROM Recovery	Best Stage	Key Advantage	Limitations
Corticosteroid	High (Short-Term)	Moderate	Freezing	Rapid relief, easy to administer	Short-term effect without PT
Physiotherapy	Moderate	High (Long-Term)	Frozen, Thawing	Essential for long-term recovery	Requires adherence, slower onset
NSAIDs	Low	Low	Freezing	Easy access, adjunct to PT	Limited efficacy on its own
Hydrodilatation	Moderate	Moderate	Frozen	Non-invasive capsular release	Procedural expertise required
MUA	Moderate	High	Frozen	Immediate ROM improvement	Risk of complications
ACR	Moderate	High	Frozen	Precise capsular release	Expensive, surgical risks
ECSWT	Moderate	Moderate	Frozen, Thawing	Alternative for complex cases	Evidence still emerging

CONCLUSIONS

The management of frozen shoulder (adhesive capsulitis) requires a nuanced approach that evaluates the effectiveness of various interventions, particularly physical therapy, in comparison with other treatment modalities such as corticosteroid injections, NSAIDs, and surgical options. Physical therapy emerges as the cornerstone of treatment due to its pivotal role in restoring range of motion (ROM), improving functional outcomes, and mitigating pain, especially in the frozen and thawing stages. Techniques such as joint mobilizations, manual stretching, and targeted strengthening exercises demonstrate consistent long-term benefits in enhancing shoulder mobility and function.

Corticosteroid injections, on the other hand, provide significant short-term relief from pain and inflammation, particularly in the freezing stage. Their efficacy diminishes without a structured physical therapy regimen, underscoring the necessity of a combined approach. NSAIDs are primarily effective in reducing pain and inflammation during the early stages but do not significantly influence the overall disease course or long-term outcomes. While ultrasound and electrostimulation modalities amplify the benefits of physical therapy, their standalone efficacy is limited.

In cases resistant to conservative management, surgical interventions such as manipulation under anesthesia (MUA) and arthroscopic capsular release (ACR) offer viable solutions. Among these, ACR has shown superior precision and fewer complications, making it the preferred surgical option for severe or refractory cases. However, these invasive measures necessitate rigorous postoperative rehabilitation to maintain the surgical gains in ROM and functionality.

Ultimately, early intervention using a multimodal approach, integrating physical therapy with other treatments tailored to the stage of the disease and patient-specific factors, yields the most favorable outcomes. Physical therapy, especially when combined with adjunct therapies such as corticosteroids or hydrodilatation, remains the most effective non-invasive treatment option. Future research should focus on refining these treatment combinations, identifying patient subgroups that respond best to specific therapies, and establishing standardized protocols to enhance recovery and minimize disability associated with frozen shoulder. This comprehensive evaluation underscores the importance of an evidence-based, patient-centric approach in managing this complex condition.

Table 4. Overview of Treatment Assignment by Patient Groups

Patient Group	Stage	Recommended Treatment
General Population	Freezing Stage	Corticosteroids + gentle physiotherapy
	Frozen Stage	Physiotherapy ± hydrodilatation
	Thawing Stage	Physiotherapy (ROM and strengthening)
Diabetic Patients	Freezing Stage	Low-dose corticosteroids ± ECSWT
	Frozen Stage	Hydrodilatation + physiotherapy

	Refractory Cases	ACR over MUA
Elderly Patients	Any Stage	Conservative (NSAIDs, ECSWT, physiotherapy)
Athletes/Manual Workers	Freezing Stage	Corticosteroids + aggressive physiotherapy
	Frozen/Refractory	MUA or ACR for rapid recovery

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