



Frozen Shoulder: Diagnosis and Physical Therapy Management

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Abstract:

Background: Frozen shoulder (FS), also referred to as primary idiopathic stiff shoulder, is a condition that causes significant morbidity due to pain and restricted range of motion (ROM). Despite its prevalence, the precise etiology remains unclear. While FS was previously considered self-limiting, recent evidence suggests chronic morbidity in 20-50% of cases.

Aim: To explore the epidemiology, diagnostic criteria, and therapeutic approaches for FS, focusing on physical therapy as a primary management strategy.

Methods: This review synthesizes current literature on FS diagnosis and management. It highlights diagnostic imaging methods, including plain radiography, ultrasound, and MRI, and evaluates the efficacy of various physical therapy interventions. These interventions include stretching exercises, cryotherapy, Mulligan technique, and adjunct therapies like suprascapular nerve blocks.

Results: Epidemiological data show FS affects approximately 4% of the population, predominantly women over 40. Diabetes mellitus and thyroid disorders are significant risk factors. Physical therapy remains a cornerstone of management, with techniques like posterior stretching, extracorporeal shock wave therapy, and cryotherapy demonstrating improvements in pain relief, ROM, and functionality. However, evidence supporting long-term benefits is limited due to small sample sizes and short study durations.

Conclusion: Frozen shoulder significantly impacts quality of life, with limited effective interventions altering its natural history. Early diagnosis, coupled with evidence-based physical therapy techniques, offers the best potential for improving outcomes. However, further research is needed to validate these approaches and identify optimal treatment protocols.

Keywords: Frozen shoulder, adhesive capsulitis, physical therapy, range of motion, pain management, imaging techniques

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Introduction:

Frozen shoulder (FS), also known as primary idiopathic stiff shoulder, is a prevalent condition predominantly affecting middle-aged individuals. Despite extensive investigations, the precise etiology of this disabling disorder remains unidentified. While FS was historically considered self-limiting, recent evidence suggests that it can cause persistent morbidity in 20% to 50% of patients [1]. Although various treatment modalities exist to alleviate pain and temporarily improve range of motion (ROM), no definitive intervention has demonstrated the ability to alter the natural progression or prevent the onset of FS. This article aims to examine the epidemiology and diagnostic criteria of FS, review the existing evidence for both noninvasive and invasive therapeutic approaches, and propose directions for future research.

Terminology and Classification

The clinical syndrome of FS has been referred to by several terms, including adhesive capsulitis, arthrofibrosis, and stiff shoulder. In a 2014 consensus statement, the Upper Extremity Committee of the International Society of Arthroscopy, Knee Surgery, and Orthopedic Sports Medicine (ISAKOS) recommended using “stiff shoulder” as a generic term encompassing all conditions that result in reduced shoulder motion. Specifically, “frozen shoulder” or “primary idiopathic stiff shoulder” describes cases without an identifiable trauma or disease, whereas “secondary stiff shoulder” refers to stiffness due to a known cause, such as surgery or trauma. The committee discouraged the term “adhesive capsulitis,” as it does not accurately reflect the underlying pathology [2]. Nevertheless, the term adhesive capsulitis remains widely used, possibly due to the recognition of intracapsular inflammation and the presence of adhesions described in the Neviassier arthroscopic classification system, which stages FS based on adhesions [3,4]. For this discussion, the term frozen shoulder will be used to denote the clinical syndrome of primary idiopathic stiff shoulder.

Epidemiology

FS affects approximately 4% of the population, with a higher prevalence in women over 40 years of age [1,5]. Diabetes mellitus is the most frequently associated risk factor, with diabetic individuals exhibiting a fivefold increased likelihood of developing FS compared to nondiabetic counterparts. Elevated glycated hemoglobin (A1C) levels further elevate the risk. A 2016 meta-analysis revealed that 13.4% of diabetic patients have FS, while 30% of patients with FS have diabetes [6]. Thyroid disorders also increase FS risk by a factor of 2.69 compared to control groups [7]. Other identified risk factors include stroke, cancer, Dupuytren’s contracture, HLA-B27 positivity, shoulder immobilization, complex regional pain syndrome, and hyperlipidemia. Additionally, studies suggest a higher prevalence of depression and anxiety among FS patients, with evidence indicating that FS often precedes the development of depressive symptoms rather than the reverse [8,9].

Pathophysiology and Natural History

The pathophysiological mechanisms underlying FS involve an initial inflammatory phase followed by fibrosis and capsular contracture. Biopsies of affected synovial tissue reveal immune cell infiltration, inflammatory and fibrogenic cytokines, macrophages, and subsynovial fibrosis [1,10]. Macroscopically, the shoulder capsule and ligaments are thickened and inflamed, with histological findings showing dense collagen deposition and an abundance of fibroblasts [11]. The clinical progression of FS is typically categorized into three phases. The freezing phase involves

gradual onset of pain and progressive ROM loss, lasting between 3 to 9 months. The frozen phase is marked by significant ROM restriction due to mechanical factors and lasts 4 to 12 months, with pain often improving during this period. The thawing phase involves a gradual recovery of ROM over 12 to 42 months [11]. Alternatively, FS progression has been classified into four arthroscopic stages. Stage I exhibits synovitis without adhesions or contractures. Stage II shows synovitis with loss of the axillary fold, indicative of adhesion formation. Stage III involves resolution of synovitis but significant adhesion development. Stage IV is characterized by advanced adhesions and pronounced restriction of the glenohumeral joint space [4]. While FS is often described as a self-limiting condition, untreated cases may persist for up to three years and result in chronic morbidity [12].

Diagnosis and Classification

Frozen shoulder is a clinical diagnosis, presenting with insidious onset of shoulder stiffness without anatomic, imaging, or systemic abnormalities to explain the symptoms. The hallmark finding is a global reduction in both passive and active ROM, with external ROM typically being the first movement impaired. The Upper Extremity Committee defines global ROM limitation as forward flexion below 100 degrees, external rotation less than 10 degrees, and internal rotation not exceeding the L5 vertebral level [2]. Diagnosis can be challenging, particularly during the freezing phase, as symptoms overlap with other shoulder pathologies, such as rotator cuff injuries, impingement, and labral tears. In these cases, ROM limitations may not yet be apparent, necessitating a thorough clinical evaluation for accurate identification.

Imaging

Plain Radiography

Frozen shoulder (FS) is primarily diagnosed based on clinical assessment; however, plain radiographs are recommended to exclude any underlying osseous abnormalities. These imaging studies assist in identifying alternative pathologies, such as arthropathy or calcific tendonitis. Chronic FS can sometimes lead to osteopenia due to pain-induced inactivity or restricted motion. Despite the clinical emphasis on FS diagnosis, additional imaging modalities are generally unnecessary unless diagnostic uncertainty persists [11].

Ultrasound

The utility of ultrasound (US) in diagnosing FS remains a subject of debate. According to the 2022 American College of Radiology's Appropriateness Criteria for chronic shoulder pain potentially indicative of adhesive capsulitis, US may be considered appropriate, though its usage continues to be contested [13]. A systematic review conducted in 2022 identified 14 distinct sonographic features associated with FS; however, the level of evidence supporting these findings was categorized as "low" to "very low." The majority of the reviewed studies were case-control designs, exhibiting significant risks of sampling bias and lack of blinding [14]. One commonly investigated feature in FS diagnosis is the thickness of the coracohumeral ligament (CHL). Multiple studies have reported increased CHL thickness in affected shoulders. For instance, Tandon et al. [15] compared FS patients to those with painful or asymptomatic shoulders and observed a mean CHL thickness of 1.2 mm in the FS group. A diagnostic threshold of 0.7 mm at the coracoid attachment site was suggested, yielding a sensitivity of 93.1% and a specificity of 94.4%. Similarly, a review by Al Khayyat et al. [16] analyzing 20 relevant studies reported an average CHL thickness of 2.65 ± 0.4 mm in FS patients.

The axillary pouch (AP), a key portion of the glenohumeral capsule, is another region of interest. A 2021 case-control study involving 106 FS patients determined that an AP thickness of at least 4 mm offered a diagnostic sensitivity of 93.4% and a specificity of 98% ($P < 0.0001$) [17]. Al Khayyat's review also identified an average AP thickness of 3.34 ± 0.8 mm across FS studies [16]. Increased vascularity and soft tissue within the rotator interval (RI) have also been consistently associated with FS in sonographic assessments. The RI, a triangular anatomical space within the anterosuperior rotator cuff, often shows vascularity changes in FS cases. Al Khayyat's review noted that 36.44% of FS patients had increased RI vascularity. Tandon et al. found increased RI soft tissue in

FS patients, achieving sensitivities and specificities of 86.2% and 92.8%, respectively. Combining multiple sonographic parameters, including CHL diameter, RI soft tissue changes, and dynamic external rotation restriction, resulted in diagnostic sensitivity and specificity of 100% and 87%, respectively [15,16].

Magnetic Resonance Imaging/Magnetic Resonance Angiography

Magnetic resonance imaging (MRI) has historically been considered the gold standard for imaging FS, although imaging is not essential for diagnosis. Jung et al. [18] conducted a 2019 case-control study analyzing MRI scans of 100 FS patients and 100 controls. They identified diagnostic thresholds, including a mean capsular thickness of 4.5 mm in the axillary recess (AR), achieving sensitivities and specificities of 91% and 90%, respectively. Similarly, a capsular thickness of 6 mm in the RI provided a sensitivity of 88% and specificity of 90%. In contrast-enhanced MRI, increased CHL enhancement demonstrated 100% specificity for FS diagnosis [19]. However, non-contrast MRI has shown variable reliability. Chi et al. [20] reported sensitivities and specificities of 76.7% and 53.3%, respectively, based solely on CHL thickening. Combining findings such as RI inflammation and AR thickening reduced sensitivity to 23.3% but improved specificity to 86.7%. A 2021 study further suggested FS diagnosis if the inferior glenohumeral ligament (IGHL) thickness exceeded 4 mm, the superior glenohumeral ligament (SGHL) measured more than 2.0 mm, the RI exceeded 3.6 mm, and the CHL was thicker than 4.6 mm [21]. MRI assessments for FS often involve evaluating the AR capsular thickness, CHL diameter, and ligamentous dimensions, alongside the obliteration of the subcoracoid fat triangle. These parameters collectively strengthen diagnostic confidence in FS cases.

Physical Therapy

Physical therapy has traditionally been regarded as the primary approach for managing frozen shoulder (FS), despite the absence of robust evidence supporting its efficacy in producing long-term outcomes. Within the domain of physical therapy, diverse techniques and modalities have been explored, each demonstrating varying degrees of evidence regarding their effectiveness. A systematic review conducted in 2021 evaluated multiple physical therapy methods. This review identified that approaches such as rotator cuff strengthening, dynamic scapular recognition exercises, sustained posterior stretching, the Mulligan technique (which involves accessory movement combined with end-range stretching facilitated by a therapist during active range of motion), whole-body cryotherapy, extracorporeal shock wave therapy (ESWT), and incorporating lidocaine injections into standard physical therapy demonstrated significant improvements in pain, range of motion (ROM), and functional outcomes. Additionally, the review noted that stretching exercises, group therapy sessions supplemented with modalities, and the use of a static passive stretch device (a mechanical tool enabling gradual passive joint stretching) improved ROM and function, albeit with no measurable effect on pain relief. Similarly, the integration of suprascapular nerve blocks or bee venom acupuncture into standard physical therapy protocols enhanced pain relief and functionality, though they did not influence ROM. However, the review also highlighted several limitations, as most studies assessed outcomes over short durations (less than 12 weeks) and involved small sample sizes, with an average treatment group comprising only 24 participants [22]. In 2014, a Cochrane review examined the efficacy of exercise and manual therapy for treating FS. Due to insufficient evidence, the authors could not determine the relative effectiveness of exercise versus manual therapy when applied separately. Likewise, the review failed to establish whether one form of manual therapy was superior to another. Nonetheless, it concluded that intra-articular steroid injections were likely more effective than exercise or manual therapy during the initial six weeks of treatment, though both approaches had comparable adverse event profiles [23]. Further insights were provided by a 2020 network meta-analysis, which suggested that supplementing steroid injections with home exercise regimens could provide additional mid-term improvements in shoulder pain [24].

The timing and intensity of physical therapy interventions also appear to influence their effectiveness in FS management. Several authors have proposed that physical therapy yields limited benefits during the early "freezing" phase of FS [3,25,26]. However, many studies examining physical therapy for adhesive capsulitis do not specify the clinical phase at which participants were enrolled,

complicating the interpretation of findings [26]. Clinical experience suggests that aggressive passive ROM exercises introduced early in the disease course may exacerbate discomfort without yielding meaningful symptom improvement. The intensity of physical therapy interventions has also been debated. A trial by Diercks and Stevens [27] compared intensive physical therapy to a "supervised neglect" strategy. Over a two-year follow-up, patients assigned to supervised neglect exhibited greater improvements in their Constant score, which evaluates pain, ROM, and disability, than those undergoing active physical therapy. Despite these considerations, the literature affirms a role for physical therapy in FS treatment. While certain modalities and strengthening exercises provide symptomatic relief during the freezing phase, the greatest benefits emerge from rotator cuff strengthening, scapular training, and passive ROM stretching implemented during the frozen and thawing phases. Combining physical therapy with intra-articular steroid injections during these phases is recommended to maximize therapeutic outcomes for patients.

Injection-Based Treatment

The exploration of injection therapies for frozen shoulder (FS) has yielded highly variable findings. When contemplating the incorporation of these therapies, several factors must be considered, including the patient's current level of pain and functional impairment, the discomfort associated with the procedure, the time required for physician visits, and the potential risk of adverse events. Most studies primarily address idiopathic FS, necessitating caution in extrapolating results to secondary stiff shoulder cases. Although many studies highlight statistical differences between treatment groups receiving injections, these differences are often minimal, raising concerns about their clinical relevance. Importantly, none of the injection therapies have demonstrated the capacity to alter the natural course of FS positively or negatively. Nonetheless, all the injectable substances discussed, as detailed below, have been shown to offer short-term reductions in pain or improvements in range of motion (ROM).

Corticosteroids, such as triamcinolone and methylprednisolone, are the most extensively studied injectates. They provide significant short-term benefits for pain reduction and ROM improvement, typically lasting up to 12 weeks. For instance, 20 mg of triamcinolone has shown comparable efficacy to 40 mg, though the latter is associated with more pronounced adverse effects, such as increased blood glucose levels. These injections are generally safe for well-controlled diabetics when appropriate glucose monitoring is advised. Ultrasound (US)-guided injections into the glenohumeral joint offer faster pain relief than subacromial injections, although long-term differences in pain, ROM, or disability between techniques are negligible. The growing body of evidence supporting improved injection accuracy with US guidance suggests its use whenever possible, without delaying treatment when only landmark or fluoroscopy-guided injections are feasible [28–31]. Hyaluronic acid injections into the glenohumeral joint have demonstrated similar outcomes to corticosteroid injections. When used in combination with corticosteroids, there is no significant difference in outcomes at six months compared to either substance used alone. Similarly, platelet-rich plasma (PRP) injections offer comparable short-term benefits in pain relief and ROM improvement when evaluated up to three months [32,33].

Intra-articular injections of botulinum toxin type A have not shown significant differences in pain or ROM outcomes compared to 20 mg triamcinolone, though some improvement in ROM has been observed at eight weeks in small studies. Reported adverse effects of botulinum toxin include increased joint pain and muscle weakness near the injection site [34]. Suprascapular nerve blocks (SSNB), administered at either the suprascapular or spinoglenoid notch, may provide additional benefits for FS management. Although long-term improvements are minimal and clinically debatable, combining SSNB with anesthetic and corticosteroid injections, along with standard physical therapy, appears to maximize therapeutic efficacy without reported complications [35–39]. Hydrodilatation, or intra-articular distention, involves injecting a high-volume mixture of corticosteroids, anesthetics, and saline to stretch or disrupt intra-articular adhesions. While the literature does not agree on an optimal volume, studies suggest capsule-preserving techniques offer superior outcomes. Hydrodilatation improves short-term pain and ROM compared to smaller-volume corticosteroid injections, with repeat procedures showing greater effectiveness. However, risks such as steroid leakage, tissue atrophy, pigmentation changes, and tendon

weakening, though typically mild and self-resolving, must be considered. US guidance or intra-articular pressure monitoring is recommended to mitigate risks associated with capsular rupture [39,40]. Emerging techniques, such as US-guided hydrorelease of the coracohumeral ligament, show promise in FS treatment but require further investigation before routine implementation [41].

Surgical Treatment

Surgical intervention for adhesive capsulitis is generally reserved for patients who do not respond to conservative management, with less than 10% of cases requiring surgery. The timing of surgical consideration remains contentious, with some recommendations suggesting a minimum of six months of conservative treatment, while others propose a window between six and nine months for optimal outcomes. Younger patients or those with more severe and progressive symptoms are more likely to require surgery [3,11,25,42–44]. Two primary surgical techniques are available: manipulation under anesthesia (MUA) and arthroscopic capsular release (ACR). MUA, a traditional procedure, involves manually mobilizing the shoulder through its full ROM under anesthesia to break adhesions. Conversely, ACR employs arthroscopic visualization to release parts of the capsule, often supplemented by gentle MUA. Variations of ACR include releasing the rotator interval, coracohumeral ligament, superior subscapularis fibers, and, in some cases, the posterior or inferior capsule to improve internal rotation, despite potential risks to the axillary nerve [25,45,46]. Clinical evidence comparing MUA and ACR suggests minimal differences in outcomes. Systematic reviews and trials, such as the UK FROST trial, have shown no significant differences in pain relief, functional improvement, or cost-effectiveness between these techniques. MUA has been associated with lower costs, while ACR provides superior visualization of interventions during surgery. However, both procedures carry risks, including fractures, rotator cuff tears, and, in ACR, medical complications such as infections or thromboembolic events. Despite these risks, ACR remains preferred among surgeons due to its technical advantages during the procedure [3,11,25,47–53].

Efficacy of Different Types of Physical Therapy:

High-Intensity Laser Therapy (HILT) in Pain Management

HILT has gained traction over the last decade as a promising modality for pain management, particularly in conditions such as osteoarthritis, low back pain, and epicondylalgia. Current randomized controlled trials (RCTs) are extending its potential application to other musculoskeletal disorders, building upon the existing evidence for low-level laser therapy (LLLT). LLLT has shown significant efficacy in managing frozen shoulder (FS), with evidence supporting pain reduction and improved range of motion (ROM) [54]. This has led to its recommendation for FS management [55, 56]. Consequently, it is plausible to hypothesize similar benefits for HILT, considering its shared fundamental mechanisms, although further evaluation is required for validation. This systematic review aimed to analyze the analgesic effects of HILT in patients with FS compared to other physical therapies. Key findings suggest that HILT may be effective in reducing pain and disability but does not significantly improve shoulder ROM. However, due to heterogeneity in study designs and methodological limitations, these findings necessitate cautious interpretation, affecting the overall reliability of evidence-based recommendations.

Pain Intensity

HILT demonstrated superior efficacy in alleviating pain intensity when compared to conventional physical therapies such as transcutaneous electrical nerve stimulation (TENS), ultrasound (US), and therapeutic exercises, with or without placebo HILT. Despite this, follow-up assessments revealed no significant differences, suggesting that HILT's benefits are predominantly short-term. Therefore, HILT may be preferable when rapid pain relief is a clinical priority. A mean reduction of 2.23 cm on the visual analog scale (VAS) surpasses the minimally clinically important difference (MCID) of 1.2 cm (95% CI: 0.4–1.8), establishing both statistical and clinical significance [57, 58].

All studies analyzed incorporated HILT alongside therapeutic exercises and/or electrotherapy, underscoring the potential synergistic effects of combined interventions. Therapeutic exercises are fundamental in FS management, contributing to pain

reduction, ROM improvement, and enhanced functionality [55]. The analgesic and thermal effects of HILT, particularly when applied prior to stretching exercises or proprioceptive neuromuscular facilitation techniques, may amplify these benefits [55]. These findings are consistent with systematic reviews that highlight the superiority of LLLT combined with exercise in reducing FS pain compared to isolated exercise interventions, with notable improvements evident by the fourth week. Studies by Kim (2015), Atan (2021), and Ordahan (2023) also corroborate that the integration of HILT with exercise leads to significant post-treatment pain reduction. This positions HILT as an advantageous alternative to LLLT, offering greater versatility through thermal effects, deeper tissue penetration at longer wavelengths, and faster energy delivery [59]. Electrotherapy modalities enhance analgesia by modulating pain mechanisms such as activating the descending noradrenergic or serotonergic pathways or stimulating β -endorphin release [60, 61]. When combined with HILT, these mechanisms may result in enhanced pain relief through reduced nerve conduction velocity, suppression of inflammatory mediators, and improved circulatory clearance of these substances [61, 62]. Studies by Jeon (2017) and Uysal (2022) reinforce this, showing superior pain reduction in experimental groups using HILT and electrotherapy. The choice of therapeutic exercises or electrotherapy should align with the FS progression stage. Resistance and mobility exercises are optimal during the painful phase, while stretching and pain management with electrotherapy are more suitable in the freezing phase [54]. When employing HILT, leveraging its thermal effects during the freezing stage may enhance joint capsule and soft tissue viscoelasticity, offering a key advantage over LLLT [55, 63].

Shoulder Range of Motion (ROM)

Although RCTs indicated ROM improvements with HILT, these gains were not superior to conventional physiotherapy for shoulder flexion, abduction, or external rotation. An average increase of 8.8° in flexion (95% CI: $-2.36, 20.3$) and 3.4° in abduction (95% CI: $-6.9, 3.5$) was observed. However, these values fall below the suggested MCIDs for flexion ($12^\circ \pm 4^\circ$) and abduction ($7^\circ \pm 2^\circ$), confirming no statistically or clinically significant improvements in ROM with HILT [63]. The lack of significant differences in flexion and external rotation during follow-up further emphasizes the comparable long-term efficacy of HILT and conventional therapies. Pooled mean differences (MDs) below the MCID also reinforce the limited clinical advantages of HILT over conventional physiotherapy. This aligns with findings from LLLT studies, where lasers are strongly recommended for pain relief but not for ROM improvement. Potential explanations for ROM-related outcomes include HILT-induced muscle relaxation, enhanced tissue viscoelasticity, and the interruption of pain-related spasm cycles [64- 67]. To optimize ROM gains, integrating core exercises and shoulder mobilizations with HILT may be advisable [55].

Disability

Disability-related outcomes reported by the RCTs are inconsistent; however, the meta-analysis indicates a pooled effect of 10.1% (95% CI: $-16.5, -3.7$) favoring HILT. The MCID for the Shoulder Pain and Disability Index (SPADI) is between 10% and 16%, corresponding to 8–13 points, affirming both clinical and statistical significance [68]. Unfortunately, limited follow-up data precluded a meta-analysis for long-term disability outcomes. Pain and disability are interlinked, with reduced pain directly influencing lower disability levels. SPADI emphasizes this relationship, as its pain-related sections significantly affect overall disability scores [69, 70]. Chronic pain-associated disabilities restrict daily activities, impair mental health, and diminish quality of life, underscoring the importance of effective pain management [70, 71]. HILT, while primarily targeting analgesia, also demonstrates secondary benefits by mitigating fear-induced movement avoidance, which contributes to functional limitations and chronicity [71].

Recommendations

Variability in HILT parameters such as fluency (J/cm^2), duty cycles (%), and pulse frequencies (Hz) was observed across studies, whereas more consistency was noted in wavelength, maximum power output (W), and energy delivered (J). Based on the analyzed evidence, the recommended clinical protocol includes:

- A wavelength of 1.064 nm for deeper tissue penetration.

- An average power output of 8 W.
- Initial energy settings of 400 J.
- Scanning techniques along the anterior and posterior deltoid muscle edges, combined with spot applications on sensitive points.
- A regimen of 12 sessions over 3 to 4 weeks.

Given the chronic nature of FS, multiple sessions are often required. While the immediate effects of HILT remain unclear due to the absence of in-treatment assessments in RCTs, these recommendations aim to provide a consistent framework for clinical application and future research endeavors.

Acupuncture and Physical Therapy:

A significant reduction in pain was observed among patients undergoing a combined regimen of acupuncture and physical therapy. The pooled standardized mean difference (SMD) of -0.891 , with a confidence interval (CI) ranging from -1.518 to -0.264 , suggests a moderate effect size. These findings substantiate the effectiveness of this integrative approach in managing pain, particularly in cases of frozen shoulder, where traditional treatments often yield limited success. The observed heterogeneity indicates variability in the implementation or outcomes of the interventions, potentially due to differences in clinical settings or patient populations. The study's pooled odds ratio (OR) of 3.693 for the clinical effective rate demonstrates a notable improvement when acupuncture is combined with physical therapy. This enhancement may be attributed to the synergistic mechanisms of acupuncture, including improved circulation, reduced inflammation, and muscle relaxation. These findings advocate for an integrative treatment model, suggesting that patients with frozen shoulder may benefit more from this combined approach than from conventional physical therapy alone. Such evidence has significant implications for clinical guidelines, encouraging the inclusion of acupuncture as a complementary therapy for frozen shoulder. The efficacy of this combined therapy on both active and passive ranges of motion underscores its comprehensive impact on frozen shoulder treatment. Addressing both pain and functional mobility reflects the condition's multifaceted nature and highlights the importance of a personalized approach to treatment. Tailoring interventions to individual patient needs and response patterns is essential for achieving optimal outcomes [72].

The results align with existing research emphasizing acupuncture's role in managing musculoskeletal pain. Previous studies have consistently demonstrated that acupuncture enhances pain relief and functional recovery when used alongside physical therapy. This study extends these findings by quantifying the effect size and focusing on the specific condition of frozen shoulder. The pain relief may be attributed to acupuncture-induced endorphin release, which complements the joint mobility and strength improvements facilitated by physical therapy. Together, these therapies address both the symptoms and underlying causes of frozen shoulder, providing a holistic treatment approach. A key strength of this study is its systematic and comprehensive analysis, which included a diverse range of studies and participants. Sensitivity analysis further reinforced the credibility of the findings. Despite these strengths, the study is not without limitations. The substantial heterogeneity observed among included studies suggests variability in acupuncture techniques, physical therapy protocols, and practitioner qualifications, which may affect the generalizability of the results. Moreover, the limited number of studies in certain analyses reduces the robustness of some conclusions [72].

The heterogeneity identified in this meta-analysis stems from variations in acupuncture practices, including needle placement, insertion depth, and session duration, as well as differences in physical therapy protocols. Additionally, the practitioners' skill levels, experience, and certification may significantly influence treatment effectiveness. This variability complicates the interpretation of results, indicating that treatments categorized as "acupuncture" or "physical therapy" are not uniformly administered. To enhance the reliability and applicability of findings, future research should prioritize standardizing treatment protocols and specifying practitioner qualifications. Comprehensive documentation of acupuncture

techniques and physical therapy methods, alongside detailed practitioner training and certification records, would reduce variability and enable more definitive conclusions regarding the efficacy of these therapies [72].

As dry needling gains popularity in physical therapy practices across the United States, it is essential to delineate its relevance to the current findings. Unlike traditional acupuncture, which is grounded in Eastern medicine's energy pathways and flow concepts, dry needling focuses on targeting myofascial trigger points based on Western medical principles. While both techniques involve needle insertion, their methodologies, objectives, and therapeutic outcomes differ significantly. Our study primarily evaluated traditional acupuncture techniques and did not directly assess the effects of dry needling. Thus, the applicability of these findings to dry needling practices should be interpreted cautiously. Future research is needed to specifically investigate dry needling's efficacy in treating frozen shoulder and similar musculoskeletal conditions. Such studies would clarify whether the benefits observed with traditional acupuncture extend to dry needling, providing a clearer basis for its integration into clinical practice. This study demonstrates the potential benefits of combining acupuncture with physical therapy for treating frozen shoulder, a condition that profoundly affects patients' quality of life. The findings underscore the promise of integrative treatment approaches, highlighting the need for further research to optimize these therapies. By addressing both symptomatic and functional aspects of frozen shoulder, the combined approach offers a comprehensive treatment pathway, advocating for its consideration in clinical practice and future guidelines [72].

Conclusion:

Frozen shoulder (FS) remains a complex and debilitating condition, often leading to chronic morbidity despite being previously labeled as self-limiting. Its pathophysiological journey through phases of inflammation, fibrosis, and capsular contracture underscores the importance of early and accurate diagnosis. Clinical evaluation remains the cornerstone for identifying FS, though imaging modalities like ultrasound and MRI provide valuable support, especially in cases with diagnostic uncertainty. Physical therapy has long been the mainstay of FS management, with an array of modalities demonstrating varying degrees of efficacy. Techniques such as dynamic scapular recognition exercises, sustained posterior stretching, and the Mulligan technique have shown promise in improving ROM and reducing pain. Adjunct therapies, including suprascapular nerve blocks, bee venom acupuncture, and lidocaine-assisted protocols, further enhance pain relief and functionality. Nonetheless, the limitations of existing studies—short durations and small sample sizes—underscore the need for more robust research to validate these findings. A significant challenge in FS management is its multifactorial nature, compounded by associated conditions like diabetes mellitus and thyroid disorders. These comorbidities not only increase FS risk but may also influence its progression and treatment outcomes. This necessitates a tailored approach to management, addressing both the underlying risk factors and the physical manifestations of the condition. Future research should aim to establish long-term, standardized treatment protocols and explore innovative interventions capable of altering the disease's natural history. Greater emphasis on large-scale, multicenter trials will help to bridge existing gaps in knowledge and provide clinicians with actionable insights. Ultimately, integrating physical therapy with emerging therapeutic modalities offers the best opportunity for improving patient outcomes in this challenging condition.

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المخلص:

الخلفية: الكتف المتجمد (FS) ، المعروف أيضًا باسم تيبس الكتف الأولي مجهول السبب، هو حالة تسبب إعاقة كبيرة بسبب الألم وتقييد مدى الحركة (ROM). على الرغم من شيوعها، لا تزال الأسباب الدقيقة غير واضحة. في حين كان يُعتقد سابقًا أن الكتف المتجمد حالة ذاتية التحسن، تشير الأدلة الحديثة إلى وجود إعاقة مزمنة في 20-50% من الحالات.

الهدف: استكشاف وبائيات الكتف المتجمد ومعايره التشخيصية والأساليب العلاجية مع التركيز على العلاج الطبيعي كاستراتيجية أساسية للإدارة.

الطرق: تستعرض هذه المراجعة الأدبيات الحالية حول تشخيص وإدارة الكتف المتجمد. تسلط الضوء على طرق التصوير التشخيصي، بما في ذلك التصوير الشعاعي البسيط، والموجات فوق الصوتية، والرنين المغناطيسي، وتقيّم فعالية تدخلات العلاج الطبيعي المختلفة مثل تمارين التمدد، والعلاج بالتبريد، وتقنية موليجان، والعلاجات المساندة مثل حجب العصب فوق الكتف.

النتائج: تُظهر البيانات الوبائية أن الكتف المتجمد يصيب حوالي 4% من السكان، خاصة النساء فوق سن الأربعين. يُعتبر داء السكري واضطرابات الغدة الدرقية من عوامل الخطر الرئيسية. يظل العلاج الطبيعي حجر الزاوية في الإدارة، مع تقنيات مثل التمدد الخلفي، والعلاج بموجات الصدمة خارج الجسم، والعلاج بالتبريد، التي أظهرت تحسينات في تخفيف الألم، ومدى الحركة، والوظيفة. ومع ذلك، فإن الأدلة التي تدعم الفوائد طويلة المدى محدودة بسبب صغر حجم العينات وقصر مدة الدراسات.

الخلاصة: يؤثر الكتف المتجمد بشكل كبير على جودة الحياة، مع وجود تدخلات فعالة محدودة لتغيير مسار تطوره الطبيعي. يقدم التشخيص المبكر، إلى جانب تقنيات العلاج الطبيعي القائمة على الأدلة، أفضل فرصة لتحسين النتائج. ومع ذلك، هناك حاجة إلى مزيد من الأبحاث للتحقق من صحة هذه الأساليب وتحديد البروتوكولات العلاجية المثلى.

الكلمات المفتاحية: الكتف المتجمد، التهاب المحفظة اللاصق، العلاج الطبيعي، مدى الحركة، إدارة الألم، تقنيات التصوير.