

Clinical Practice Guidelines for Diagnosis and Non-Surgical Treatment of Primary Frozen Shoulder

Byung Chan Lee, MD¹, Beom Suk Kim, MD, PhD¹, Byeong-Ju Lee, MD, PhD², Chang-Won Moon, MD, PhD³, Chul-Hyun Park, MD, PhD⁴, Dong Hwan Kim, MD, PhD⁵, Dong Hwan Yun, MD, PhD⁶, Donghwi Park, MD, PhD⁷, Doo Young Kim, MD⁸, Du Hwan Kim, MD, PhD¹, Gi-Wook Kim, MD, PhD⁹, Hyun Jung Kim, MD¹⁰, Il-Young Jung, MD, PhD¹¹, In Jong Kim, MD¹², Jae Hyeon Park, MD, PhD¹³, Jae-Hyun Lee, MD², Jaeki Ahn, MD, PhD¹⁴, Jae-Young Lim, MD, PhD¹⁵, Jin A Yoon, MD, PhD², Jong Hwa Lee, MD, PhD¹⁶, Jong-Moon Hwang, MD, PhD¹⁷, Keewon Kim, MD, PhD¹⁸, Kyeong Eun Uhm, MD¹⁹, Kyoung Hyo Choi, MD, PhD²⁰, Kyung Eun Nam, MD²¹, Kyunghoon Min, MD, PhD²², Min Cheol Chang, MD²³, Myung Woo Park, MD²⁴, Nackhwan Kim, MD, PhD²⁵, Hyeng-Kyu Park, MD, PhD²⁶, Seong Hun Kim, MD²⁷, Seoyon Yang, MD, PhD²⁸, Sun Jae Won, MD, PhD²⁹, Sung Gyu Moon, MD, PhD³⁰, Sung Joon Chung, MD⁵, Sungju Jee, MD³¹, Woo Hyung Lee, MD, PhD¹⁸, Yong Bok Park, MD³², Yoonju Na, MD³³, Yu Hui Won, MD, PhD⁹, Yu Jin Im, MD³⁴, Yu Sung Yoon, MD³⁵, Yun Jung Lee, MD³⁶, Yunsoo Soh, MD, PhD⁶, Jae-Young Han, MD, PhD²⁶

For further information on the authors' affiliations, see [Additional information](#).

Objective: Primary frozen shoulder causes significant pain and progressively restricts shoulder movements. Diagnosis is primarily clinically based on patient history and physical examination. Management is mainly non-invasive owing to its self-limiting clinical course. However, clinical practice guidelines for frozen shoulder have not yet been developed in Korea. The developed guidelines aim to provide evidence-based recommendations for the diagnosis and treatment of frozen shoulder.

Methods: A guideline development committee reviewed the literature from four databases (PubMed, Embase, Cochrane Library, and KMBASE). Using the PICO (Population, Intervention, Comparator, and Outcome) framework, the committee formulated two backgrounds and 16 key questions to address common clinical concerns. Recommendations were made using the Grading of Recommendations, Assessment, Development, and Evaluation framework.

Results: Diabetes, thyroid disease, and dyslipidemia significantly increase the risk of developing a frozen shoulder. Although frozen shoulder is often self-limiting, some patients may experience long-term disabilities. Ultrasound and magnetic resonance imaging should be used as adjunctive tools alongside clinical diagnosis, and not as independent diagnostic methods. Noninvasive approaches, such as medications, physical modalities, exercises, electrical stimulation, and manual therapy, may reduce pain and improve shoulder function. Other noninvasive interventions have limited evidence, and their application should be based on clinical judgment. Intra-articular steroid injections are recommended for treatment, and physiotherapy or hydrodilatation with steroid injections can also be beneficial.

Conclusion: These guidelines provide evidence-based recommendations for diagnosing and treating primary frozen shoulder.

Keywords: Frozen shoulder, Risk factors, Diagnosis, Treatment, Guidelines

Received: April 27, 2025

Accepted: May 30, 2025

Correspondence:

Jae-Young Han
Department of Physical and
Rehabilitation Medicine, Chonnam
National University Hospital, 42
Jebong-ro, Dong-gu, Gwangju 61469,
Korea.
Tel: +82-62-220-5198
Fax: +82-62-228-5975
E-mail: rmhanjy@hanmail.net

This manuscript is being simultaneously submitted to both the *Annals of Rehabilitation Medicine* and *Clinical Pain* for consideration, with prior approval from the both editors.

INTRODUCTION

Frozen shoulder is a prevalent condition characterized by pain and progressive restriction of both active and passive ranges of the shoulder joint. Epidemiological data indicate that approximately 2%–5% of the general population is affected, with a higher incidence observed in individuals aged between 40 and 65 years. Notably, females are more commonly affected than males [1].

The clinical manifestations of frozen shoulder progress through three stages: painful, stiffening, and resolution. Depending on the predominant symptoms, these stages may either occur sequentially or overlap [2].

Diagnosis is primarily clinical, based on patient history and physical examination, assessing both active and passive shoulder movements. In cases where the presentation is atypical or a differential diagnosis is necessary, imaging studies such as ultrasound, computed tomography arthrography, or magnetic resonance imaging (MRI) may be utilized [3,4]. However, the pathophysiological mechanisms of the frozen shoulder remain unclear. A previous study hypothesized that this condition originates from the inflammation of the joint capsule and synovial membrane which lead to fibrosis within the shoulder joint [5]. Histological studies have suggested that immune, inflammatory, and fibrotic changes are associated with this condition [6].

While frozen shoulder is generally considered a self-limiting disorder, patients often endure significant pain and functional impairment during its course, and symptoms may persist for over 2 years in some cases [7,8]. This highlights the need for effective management strategies. However, standardized clinical practice guidelines (CPGs) for the diagnosis and treatment of frozen shoulder in Korea are lacking. Therefore, we developed a CPG for the diagnosis and treatment of primary frozen shoulder.

METHODS

Target population and scope of the clinical guidelines

The CPG was developed for clinicians to treat patients with frozen shoulders at medical institutions in Korea. The target population included adult patients (over 18 years old) diagnosed with primary frozen shoulder [9]. Secondary frozen shoulder was excluded from the guidelines. The guidelines comprise the general principles of frozen shoulder, diagnosis, and imaging tests, as well as noninvasive and injectable treatment options.

Guideline development committee

The CPG development involved a development committee (43 members, including one methodology expert) and an advisory committee (four members). Among the members, 42 were specialists working in the treatment of frozen shoulder (38 rehabilitation medicine specialists, 2 radiologists, and 2 orthopedic surgeons).

Selection of background and key questions

Key questions were selected after reviewing existing international frozen shoulder CPGs [1,10-12] and identifying common issues in the management of frozen shoulder. The committee discussed these issues and eventually selected 2 background and 16 key questions related to clinical practices that would lead to recommendations. These key questions were based on the Population, Intervention, Comparator, and Outcome (PICO) frameworks.

Development process

This CPG was developed for the management of patients with primary frozen shoulder in Korea using a de novo method. Literature searches were conducted from May to November 2023 based on the PICO framework for each key question. Databases such as PubMed, Embase, Cochrane Library, and KMBASE were searched using the search terms listed in [Supplementary Material S1](#). After removing the duplicate documents, a selection process was conducted. Two independent reviewers examined the titles and abstracts of each key question and selected the relevant articles. In the case of discrepancies, a consensus was reached through discussion between the two reviewers. After selecting the articles, the full texts were reviewed, and those that met the criteria were used as evidence. Based on the research design, each study was assessed for risk of bias using appropriate tools: Diagnostic Study Quality Assessment Tool: Quality Assessment of Diagnostic Accuracy Studies-2 [13], Non-randomized Study Quality Assessment Tool: Risk of Bias for Non-randomized Studies 2.0, Randomized Controlled Trial Quality Assessment Tool: Cochrane Risk of Bias for Randomized Studies 2.0 ([Supplementary Material S2](#)). The selected literature was organized according to a pre-agreed-upon evidence-table format ([Supplementary Material S3](#)). After assessing the quality of the literature, data were extracted for each key question. If the study size and design were sufficient and not overly heterogeneous, a meta-analysis was performed using Review Manager software (version 5.4; RevMan) with a random-effects model. If

the studies were too heterogeneous to combine or if quantitative synthesis was not feasible, a qualitative synthesis was applied to summarize the evidence.

After the analysis, the evidence level and recommendation grade for each key question were determined using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) methodology (Table 1) [14]. Based on GRADE, the evidence level was categorized as “high,” “moderate,” “low,” or “very low.” Recommendation grades were classified into five levels: strong recommendation (A), conditional recommendation (B), conditional against (C), strong against (D), and inconclusive (I). If it was difficult to evaluate the recommended grade within these five levels, the final decision was made through expert consensus (Table 2).

After determining the evidence levels and recommendation grades, 2 rounds of Delphi consensus were conducted (Supplementary Material S4). In each round, a Likert scale of 9 points was used, with strong (7–9 points), moderate (4–6 points), and weak (1–3 points) agreements. If >70% of the committee members agreed at high or moderate levels, a consensus was reached. If <70% was reached, feedback and revisions were made before the second round of consensus was reached. Even if a recom-

mendation reached >70% consensus, in cases of reasonable requests for modifications, internal working meetings were held to revise the recommendation and check for reapproval in the second round of consensus.

RESULTS

Through the above development and consensus process, a total of 2 background and 16 key questions were summarized, and recommendations were finalized. A summary and recommendations are presented in Tables 3 and 4, respectively. A detailed explanation of the summaries and recommendations for each background and key question is provided below.

Background questions for primary frozen shoulder

1. Does a specific disease or condition increase the risk of developing a frozen shoulder?

Summary of evidence

Diabetes, thyroid disease, and dyslipidemia increase the risk of primary frozen shoulder.

Table 1. GRADE quality level of evidence and meaning

Quality level	Definition
High	We are confident that the estimate of the effect is close to the actual effect.
Moderate	The estimates of the effect appear to be close to the actual effect but may vary considerably.
Low	The confidence in the estimate of the effect is limited. The actual effect may differ significantly from the estimate of the effect.
Very low	There is little confidence in the estimate of the effect. The actual effect will differ significantly from the estimate of the effect.

GRADE, Grading of Recommendations, Assessment, Development, and Evaluation.

Table 2. Grading of recommendations

Strength of recommendations	Definition
A, Strong for recommend	The intervention/diagnostic test can be strongly recommended in most clinical practice, considering greater benefit than harm, evidence level, value and preference, and resources.
B, Conditional recommend	The intervention/diagnostic test can be conditionally recommended in clinical practice considering the balance of benefit and harm, evidence level, value and preference, and resources.
C, Conditional against	The potential harm of this treatment may outweigh its benefits, and considering clinical circumstances or patient/societal values, it is not recommended in most clinical situations.
D, Strong against	The harm of this treatment outweighs its benefits, and considering clinical circumstances or patient/societal values, it is not recommended in most clinical situations.
I, inconclusive	Considering the benefits and harms of this treatment, the level of evidence, values and preferences, and resources, the level of evidence is too low, or the balance of benefits and harms is highly uncertain or highly variable, making it impossible to determine whether to implement the intervention. This means that the use of the treatment cannot be recommended or opposed, and the decision should be left to the clinician's judgment.
Expert consensus ^{a)}	Although there is a lack of clinical evidence, considering the benefits and harms of this treatment, the level of evidence, values and preferences, and resources, its use is recommended based on clinical experience and expert consensus.

Each statement is shown as a combination of the strength of recommendations and level of evidence.

^{a)}In the case of a consensus statement by an expert opinion, the recommendation grade and level of evidence are not indicated.

Table 3. Background questions summary of evidence in primary frozen shoulder

Summary of evidence	
1	Diabetes, thyroid disease, and dyslipidemia increase the risk of primary frozen shoulder.
2	The natural course of a frozen shoulder is generally self-limiting; however, not all patients achieve complete spontaneous recovery.

Table 4. Key questions recommendations in primary frozen shoulder

	Recommendation	Grade (Evidence)
Ultrasound	Ultrasound alone is not recommended for diagnosing primary frozen shoulders without a clinical history or physical examination. However, this modality may serve as an adjunct tool for ruling out other conditions	C (very low)
MRI	MRI alone is not recommended for diagnosing primary frozen shoulders in the absence of a clinical history or physical examination. MRI can be used as an adjunct to exclude other conditions.	C (very low)
Deep heat therapy	Deep heat therapy should be performed based on the clinician's judgment in patients with primary frozen shoulder, owing to insufficient evidence regarding its effectiveness.	I (very low)
Electrical stimulation therapy	Electrical stimulation therapy could be considered for pain relief in patients with primary frozen shoulder.	B (very low)
Oral steroid	Insufficient evidence is available to determine the strength and direction of the recommendation for oral steroid treatment in patients with primary frozen shoulders.	I (very low)
Oral NSAID	Oral NSAID should be performed based on the clinician's judgment in patients with primary frozen shoulder, owing to insufficient evidence regarding its effectiveness.	I (very low)
Manual therapy	Manual therapy including range of motion exercises may be considered for improving upper limb function and shoulder range of motion in patients with primary frozen shoulder.	B (low)
Self-stretching exercise	Self-stretching may be considered as an adjunctive management for primary frozen shoulder, if appropriate exercise prescription and patient adherence are ensured.	Expert consensus
Strengthening exercises	Shoulder strengthening exercises may improve pain and functional recovery in patients with primary frozen shoulder. However, owing to the insufficient number of studies, the decision to implement strengthening exercises should be based on the clinical judgment of healthcare professionals.	I (very low)
Intra-articular steroid injection	1. Intra-articular steroid injections should be considered to improve shoulder pain and upper limb function in patients with primary frozen shoulders.	B (low)
	2. A combination of intra-articular steroid injection and physical therapy should be considered to improve shoulder pain and upper limb function in patients with a primary frozen shoulder.	B (low)
Image-guided injection	There is insufficient evidence to support the clinical superiority of ultrasound-guided intra-articular steroid injections in patients with primary frozen shoulders. However, ultrasound-guided intra-articular steroid injections should be considered based on the clinician's level of expertise.	Expert consensus
High dose of intra-articular steroid injection	There is insufficient evidence regarding the effects of different intraarticular steroid doses in patients with primary frozen shoulder. Therefore, the steroid dosage should be determined based on the clinician's clinical judgment.	I (low)
Hydrodilatation	Hydrodilatation could be considered in conjunction with intraarticular steroid injections to improve shoulder pain and upper limb function in patients with primary frozen shoulder.	B (low)
Hyaluronic acid	Intra-articular steroid injections should be considered before intra-articular hyaluronic acid injections to improve shoulder pain and upper limb function in patients with primary frozen shoulders. However, if intra-articular steroid injection is not feasible, hyaluronic acid injection may be considered, based on the judgment of the clinician.	Expert consensus
Suprascapular nerve block	Suprascapular nerve block could be considered for pain relief in patients with primary frozen shoulders.	B (very low)
MUA	MUA for primary frozen shoulder has insufficient clinical evidence to support its efficacy and carries the risk of complications (e.g., fractures and rotator cuff tears). Therefore, intra-articular steroid injections should be considered before MUA.	Expert consensus

MRI, magnetic resonance imaging; NSAID, non-steroidal anti-inflammatory drug; MUA, manipulation under anesthesia.

(1) Diabetes mellitus

Four cohort studies [15-18] and 7 case-control studies [19-25] have reported an association between diabetes and frozen shoulder.

In 4 cohort studies, Huang et al. [15] utilized a national database and reported an adjusted hazard ratio (HR) of 1.32 (95% confidence interval [CI], 1.22-1.42) for diagnosed diabetes and frozen shoulder. Lo et al. [16] also used a national database and reported an adjusted HR of 1.67 (95% CI, 1.46-1.91). Kim et al. [17] reported the adjusted HRs for prediabetes, newly diagnosed type 2 diabetes, and existing type 2 diabetes as 1.08 (95% CI, 1.08-1.09), 1.31 (95% CI, 1.29-1.34), and 1.47 (95% CI, 1.45-1.49), respectively. Chan et al. [18] reported an adjusted odds ratio (OR) of 1.84 (95% CI, 1.58-2.15) for diabetes with HbA1c levels >7%.

In the 5 case-control studies that performed multivariate analysis, Tzeng et al. [19] utilized a national database and reported an adjusted OR of 1.51 (95% CI, 1.44-1.57) for diagnosed diabetes. Park et al. [20] reported adjusted ORs of 2.46 (95% CI, 1.83-3.31) for diabetes diagnosed with HbA1c $\geq 6.5\%$ and 1.78 (95% CI, 1.61-1.98) for fasting glucose ≥ 126 mg/dL. Park et al. [21] reported an adjusted OR of 1.98 (95% CI, 1.16-3.39) for diabetes diagnosed with HbA1c levels $\geq 6.5\%$. Li et al. [22] reported an adjusted OR of 3.24 (95% CI, 1.78-5.88) for a history of diabetes mellitus. Sarasua et al. [23] reported adjusted ORs of 1.37 (95% CI, 1.17-1.61) for diagnosed type 1 diabetes and 1.22 (95% CI, 1.14-1.29) for diagnosed type 2 diabetes. A case-control study by Wang et al. [24] that only performed univariate analysis reported an OR of 3.05 (95% CI, 1.40-6.61) for diabetes mellitus.

Another case-control study by Austin et al. [25] indirectly compared the prevalence of medication use using a national database for controls. Among patients with frozen shoulder aged ≥ 20 years, the population proportion using diabetes medication was 18.4% (95% CI, 12.9-25.7), which was significantly higher than that in the control group (7.6%; 95% CI, 6.7-8.5). The authors did not report any additional statistical measures.

(2) Thyroid disease

One cohort study [26] and three case-control studies [19,20,27] reported an association between frozen shoulder and thyroid disease. Huang et al. [26] conducted a retrospective cohort study using a national database and reported an adjusted HR of 1.22 (95% CI, 1.03-1.45) for hyperthyroidism.

Among the 3 case-control studies that performed multivariate

analyses, Tzeng et al. [19] used a national database and reported an adjusted OR of 1.34 (95% CI, 1.23-1.46) for thyroid disorders. Park et al. [20] reported an adjusted OR of 2.10 (95% CI, 1.36-3.15) for subclinical hypothyroidism, which was defined as elevated thyroid-stimulating hormone with normal serum thyroxine levels. However, statistical significance was not observed for hyperthyroidism (serum thyroxine >1.70 ng/dL) or hypothyroidism (serum thyroxine <0.93 ng/dL) in the univariate analysis; hence, these conditions were excluded from the multivariate analysis. Jacob et al. [27] conducted a case-control study using a national database and reported an adjusted OR of 1.11 (95% CI, 1.06-1.17) for thyroid disorders.

(3) Dyslipidemia

One cohort study [28] and 4 case-control studies [19,20,29,30] reported an association between dyslipidemia and the development of frozen shoulder.

In a cohort study, Wang et al. [28] used a national database and reported an adjusted HR of 1.50 (95% CI, 1.41-1.59) for hyperlipidemia. In 2 case-control studies that performed multivariate analysis, Tzeng et al. [19] used a national database and reported an adjusted OR of 1.42 (95% CI, 1.37-1.49) for hyperlipidemia. Park et al. [20] used criteria from the National Cholesterol Education Program Adult Treatment Panel III and reported an adjusted OR of 1.60 (95% CI, 1.18-2.16) for dyslipidemia. Specifically, the adjusted ORs were 1.47 (95% CI, 1.16-1.86) for hypercholesterolemia, 1.97 (95% CI, 1.50-2.58) for high low-density lipoprotein (LDL) cholesterol, 1.65 (95% CI, 1.24-2.20) for low high-density lipoprotein (HDL) cholesterol, and 1.34 (95% CI, 1.06-1.69) for high non-HDL cholesterol.

In 2 case-control studies that performed univariate analysis, Sung et al. [29] reported ORs of 1.79 (95% CI, 1.37-2.34) for hypercholesterolemia, 1.61 (95% CI, 1.21-2.14) for calculated high LDL cholesterol, 1.64 (95% CI, 1.19-2.27) for measured high LDL cholesterol, 1.44 (95% CI, 1.06-1.95) for high HDL cholesterol, and 1.65 (95% CI, 1.26-2.15) for high non-HDL cholesterol. Park et al. [30] reported significant associations between increased levels of total cholesterol (OR, 1.03; 95% CI, 1.02-1.05), LDL cholesterol (OR, 1.04; 95% CI, 1.02-1.06), triglycerides (OR, 1.01; 95% CI, 1.00-1.01), and non-HDL cholesterol (OR, 1.03; 95% CI, 1.02-1.05) with an increased risk of developing frozen shoulder.

Thus, diabetes, thyroid disorders, and dyslipidemia were consistently associated with frozen shoulders, supporting the evidence that these three conditions are major risk factors for this

condition. Based on these findings, a comprehensive risk factor assessment, including medical history and serum diagnostic tests, may be necessary during the initial evaluation of patients with frozen shoulders. This approach can provide patients with prognosis-related information based on risk factors, and help establish tailored treatment and management plans.

2. Does the natural course of a frozen shoulder have a self-limiting nature?

Summary of evidence

The natural course of a frozen shoulder is generally self-limiting; however, not all patients achieve complete spontaneous recovery.

(1) Shoulder range of motion

Three randomized controlled trials (RCTs) [31-33] and 5 observational studies [7,8,34-36] reported shoulder range of motion (ROM). Owing to the heterogeneity in the measurement indices and control groups, meta-analysis was not feasible.

Kivimäki et al. [31] reported that in a control group, flexion improved from 109° to 154°, abduction improved from 80° to 154°, external rotation improved from 18° to 61°, and internal rotation improved from 42 to 12 cm after a follow-up of 12 months. No statistically significant difference was observed compared with the intervention group (manipulation under anesthesia, MUA). Russell et al. [32] reported that in the control group, flexion improved from 96° to 146° and external rotation improved from 16° to 49° over 12 months, but these improvements were significantly smaller than those in the intervention groups (exercise class and multimodal physiotherapy) ($p < 0.001$). Diercks and Stevens [33] compared ROM as a subcomponent of the Constant-Murley Score at 24 months in both the control and intervention (physiotherapy) groups. No differences were observed in flexion, abduction, or internal rotation. However, external rotation improved from 2 to 10 points in the control group, which was greater than the 2- to 8-point improvement in the intervention group. The fact that the statistical significance of the ROM component alone was not specified needs to be noted and warrants careful interpretation.

In a cohort study by Binder et al. [7], flexion, abduction, and external rotation improved from 144° to 156°, 134° to 146°, and 40° to 52°, respectively, at an average follow-up of 36 months. However, 12% of the patients had severe ROM limitations (total ROM sum reduced by >25% compared with normal adults),

and 28% had mild ROM limitations, although objective numerical values were not specified. In a cohort study by Vastamäki et al. [8], ROM recovered to 94% of the unaffected side over an average follow-up of 9 years, with no statistically significant difference compared to the intervention groups (physiotherapy and MUA). Specifically, flexion improved from 101° to 157°, abduction improved from 89° to 175°, external rotation improved from 26° to 52°, and internal rotation improved from the hip to the first lumbar vertebra in the scratch test. Tae et al. [34] reported that after an average follow-up of 3.6 years, 19 of 20 patients responded that they had no ROM restrictions; however, objective measurements were not conducted, limiting interpretability. Dudkiewicz et al. [35] reported that at a mean follow-up of 9.2 years, flexion improved from 47.8° to 93.2°, external rotation from 25.0° to 89.4°, and internal rotation from 34.5° to 91.1°. However, this pre-post study lacked a control group, and flexion remained limited at 93.2° even at follow-up. Reeves [36] followed patients for 5–10 years and found that 16 of 41 (39%) had fully recovered ROM, whereas 22 patients (54%) had residual ROM limitations but did not experience restrictions in daily activities.

(2) Shoulder function

Three RCTs [31-33] and four observational studies [8,34-36] assessed shoulder function. Among the RCTs, Russell et al. [32] reported that in the control group, the Constant-Murley Score improved from 41.7 to 72.0 at the 12-month follow-up but remained below the 80-point threshold, indicating normal shoulder function. In the intervention group, the score improved from 37.5 to 88.1, with a statistically significant difference ($p = 0.002$). The Oxford Shoulder Score was also significantly higher in the intervention group; however, the authors did not provide the exact numerical values. Kivimäki et al. [31] evaluated “work ability” using a 10-point scale and reported that the control group improved from 5.9 to 8.2 over 12 months, which was not significantly different from the intervention group. Diercks and Stevens [33] reported that at 24 months, the Constant-Murley score improved from 28.6 to 88.8 in the control group, which was significantly greater than the improvement (30.0 to 79.6) observed in the intervention group ($p = 0.004$).

In a cohort study by Vastamäki et al. [8], at an average follow-up of 9 years, the Constant-Murley Score was 83, with no significant difference compared to the intervention group. Tae et al. [34] assessed functional scores based on movements in daily life and exercise, and reported that the control group scored

an average of 93 after a mean follow-up of 3.6 years, indicating “normal shoulder function;” the significant from the intervention group being not significant. In an observational study, Dudkiewicz et al. [35] reported that 53 of 54 (98%) patients resumed their normal daily lives. Reeves [36] reported that 38 of 41 (93%) patients had functional recovery in terms of work performance or hobbies. However, both studies lacked objective measures, requiring cautious interpretation.

(3) Pain

Two RCTs [31,32] and three observational studies [7,8,34] assessed pain. Due to the heterogeneity in the measurement indices and control groups, meta-analysis was not feasible. Among the RCTs, Russell et al. [32] reported that the pain component of the Constant-Murley Score improved from 18.7 to 34.0 at the 12-month follow-up; however, statistical significance and exact values at each follow-up point were not provided. The Oxford Shoulder Score was consistently higher in the intervention group; however, pain-specific values and statistical significance were not specified. Kivimäki et al. [31] assessed pain using an 11-point numeric rating scale and found that the control group improved from 6.4 to 2.2 at 12 months, while the intervention group improved from 6.6 to 1.5; however, the between-group difference was not statistically significant.

In a cohort study by Vastamäki et al. [8], the mean visual analogue scale (VAS) score at 9 years was 0.8 at rest, 1.1 during activity, and 0.6 at night. Additionally, 94% of the patients had pain scores below 3, with no significant difference compared to the intervention group. However, baseline pain scores and statistical comparisons with the intervention group were not provided, warranting a cautious interpretation. Binder et al. [7] reported that at an average follow-up of 44 months, 6 patients (15%) had mild pain and one (3%) had severe pain; the baseline pain scores and comparisons with other groups were not specified. Tae et al. [34] found that after a mean follow-up of 3.6 years, 2 of 20 patients (10%) reported mild pain, but baseline scores and statistical comparisons with other groups were not provided.

Thus, the clinical parameters in the control groups that received no treatment or unsupervised self-exercise improved over time compared to the baseline. However, some patients did not achieve normal ROM or shoulder function, and residual pain persisted in some cases. These findings suggest that although clinical indicators tend to improve over the long-term, in some patients, complete recovery to normal levels may be difficult, and residual symptoms may persist.

Key question on primary frozen shoulder: diagnosis

1. *Diagnostic validity (O) of ultrasound (I) compared to clinical history and physical examination (C) in frozen shoulder (P)*

Recommendation

Ultrasound alone is not recommended for diagnosing primary frozen shoulders without a clinical history or physical examination. However, this modality may serve as an adjunct tool for ruling out other conditions (Level of evidence: very low, Recommendation grade: C).

Primary frozen shoulder is clinically diagnosed based on a characteristic history of gradual onset of shoulder pain and progressive limitation of shoulder joint ROM, particularly in external rotation and abduction, as identified during physical examination [37,38]. However, distinguishing frozen shoulder from other shoulder conditions, such as rotator cuff tendinopathy, calcific tendinitis, impingement syndrome, and shoulder osteoarthritis, based on symptoms and physical examination alone can be challenging [38]. Ultrasound is a non-invasive imaging tool that allows real-time evaluation of soft tissues, including the rotator cuff, and enables the dynamic assessment and comparison of both shoulders. Given its advantages, ultrasound is frequently used in suspected frozen shoulder cases to facilitate early diagnosis and differentiate it from other conditions [38,39].

Several studies have highlighted three key ultrasound findings in frozen shoulder diagnosis. Coracohumeral ligament (CHL) thickening: The CHL plays a crucial role in shoulder stability, and thickening, which is a common finding in patients with frozen shoulder (sensitivity: 51.3%–94.4%, specificity: 52%–93.1%) [40–51]. Inferior capsule or axillary recess thickening: Thickening of the inferior portion of the joint capsule or axillary recess is a hallmark pathophysiological feature of frozen shoulder (sensitivity: 66.2%–88.6%, specificity: 69%–97.7%) [40,41,52–54]. Rotator interval (RI) abnormality: The RI is a space within the shoulder joint, and abnormalities in this area are frequently observed in patients with frozen shoulder [40,41,45,55,56] (Supplementary Material S3).

Because the standard diagnostic approach for frozen shoulder relies on clinical history and physical examination, most studies have investigated the diagnostic efficiency of ultrasound findings compared with that of clinical diagnoses. Although CHL thickening is commonly reported as a distinguishing feature, some studies have reported inconsistent cutoff values. Cheng et al. [40], Do et al. [41], and Kim et al. [42] suggested a cutoff

value of 2–3 mm, for patients with frozen shoulder presenting a CHL thickness of 3–4 mm and healthy individuals showing 1.4–1.9 mm. In contrast, Park et al. [44], Tandon et al. [45], and Kwon et al. [49] reported a much lower CHL thickness of 1.2–1.3 mm in patients with frozen shoulders and 0.4–0.9 mm in healthy individuals. The high heterogeneity among these studies may be due to their case-control design and significant risk of bias. Inferior capsule or axillary recess thickening is the second most commonly reported ultrasound finding in frozen shoulder, with relatively consistent cutoff values across studies, although its sensitivity and specificity remain moderate. RI abnormalities, unlike previous findings, lack a defined cutoff value, as studies primarily report their presence or absence. The substantial variability in the results suggests that the definition of “RI abnormality” is inconsistent across studies, with a high degree of operator subjectivity influencing the findings. Therefore, while ultrasonography may provide supportive findings in the diagnosis of primary frozen shoulder, it is not recommended to be used as a standalone diagnostic tool, excluding the clinical diagnostic process.

2. Diagnostic validity (O) of MRI (I) compared to clinical history and physical examination (C) in primary frozen shoulder (P)

Recommendation

MRI alone is not recommended for diagnosing primary frozen shoulders in the absence of a clinical history or physical examination. MRI can be used as an adjunct to exclude other conditions (Level of evidence: very low, Recommendation grade: C).

MRI is a useful tool for differentiating frozen shoulders from other shoulder pathologies because of its excellent soft tissue contrast and multiplanar imaging capabilities. Additionally, MRI findings can aid in staging frozen shoulder, providing valuable information for determining the appropriate treatment [57].

Several studies have identified key MRI indicators for diagnosing frozen shoulders. The following 10 findings have been commonly reported: (1) axillary recess capsular thickening [58–72]; (2) axillary recess capsular hyperintensity [73]; (3) axillary recess capsular enhancement [72]; (4) CHL thickening [44,58,62,64–66,71,74–78]; (5) RI capsular thickening [44,59,65,67,69,76,78,79]; (6) RI capsular hyperintensity [62,63,67,68,70,73,76,80]; (7) RI capsular enhancement [61,63,65,67,72,73,75,81,82]; (8) subcoracoid fat obliteration [4,60,61,65,75,78,81,83]; (9) pericapsular hyperintensity or en-

hancement [4,73,75]; and (10) anterior capsular abnormality (abnormal thickening of the anterior capsule or increased T2 signal intensity and enhancement) [62,67,68] (Supplementary Material S3).

Most of these studies evaluated MRI findings against clinical diagnoses and physical examination. Axillary recess thickening was reported as the most characteristic finding, with a cutoff value of 3–5 mm. While patients with frozen shoulders had thicker capsules than controls, the sensitivity ranged from 60% to 100%, and the specificity varied between 54.2% and 100%. Axillary recess hyperintensity was reported without a cutoff value, with a frequency of 40.2%–100% in patients with a frozen shoulder and 5.9%–21.2% in healthy individuals. Axillary recess enhancement was found in 80%–100% of patients with frozen shoulder but only in 0%–36% of healthy individuals. One observational study reported a low frequency of 41.7% [63].

CHL thickening was the second most frequently reported feature. Some studies reported CHL thickness in frozen shoulder as 3.4–4.1 mm compared to 2.5–2.6 mm in controls [74,76], while another study found no difference [64]. Studies using a 3 mm cutoff reported sensitivities ranging from 48.3% to 85% and specificities ranging from 40.7% to 83% [65,77].

RI capsular thickening was reported in 8 studies, with thicknesses ranging from 4.41–12.5 mm in patients with frozen shoulder and 0.6–4.7 mm in controls. Cutoff values of 5- and 6-mm yielded sensitivities ranging between 65.0% and 88% and specificities of 55.1% and 90%. Park et al. [44] reported that the RI thickness differed by phase, measuring 10.0 mm in the freezing phase and 9.0 mm in the frozen phase. RI hyperintensity was observed in 54.6%–100% of patients with frozen shoulder and 9.1%–43% of healthy individuals, with significant variability across studies. However, in a case-control study by Gokalp et al. [67], a signal increase was observed in 100% of the patient group and 77.8% of the control group. RI enhancement was reported in 47%–100% of patients with frozen shoulder and 0%–62% of controls, with considerable inter-study variation.

Subcoracoid fat obliteration was found in 41%–100% of patients with frozen shoulder and 5%–58.3% of controls; some studies reported this in up to 81% of healthy individuals [61]. Pericapsular hyperintensity or enhancement was reported in 35.7%–88.8% of patients with frozen shoulders and 3%–12% of controls. Some studies have found that contrast-enhanced images have higher sensitivity than T2-weighted images [73]. Anterior capsular abnormalities were observed in 53.8%–89.7% of patients with frozen shoulder on T2-weighted images and

89.7%–100% on contrast-enhanced images. One study found no enhancement in shoulder MRI of healthy individuals [67].

While MRI findings provide valuable supplementary information for frozen shoulder diagnosis, a significant variability in sensitivity and specificity exists. Therefore, MRI should not replace clinical history and physical examination but rather be used as an adjunctive tool, especially for ruling out other conditions and staging the disease.

Key question on primary frozen shoulder: treatment

3. Is deep heat therapy (I) effective in improving pain and ROM (O) in patients with frozen shoulder (P) compared to the control treatment (C)?

Recommendation

Deep heat therapy should be performed based on the clinician's judgment in patients with primary frozen shoulder, owing to insufficient evidence regarding its effectiveness (Evidence level: very low, Recommendation grade: I).

Deep heat therapy is a common conservative treatment for frozen shoulder. In this therapy, heat is applied to soft tissues, which reduces tensile stress and alters the viscoelastic properties of connective tissues [84]. There were five RCTs on deep heat therapy in adult patients with a frozen shoulder. Among these, 4 studies were eligible for the meta-analysis [85–88]. One study [89] was excluded because no extractable data from the main text were available.

There were no significant differences in shoulder pain or upper limb function between the deep heat therapy and control groups. The study by Ainsworth et al. [89], which was excluded from the meta-analysis, was a double-blind multicenter clinical trial involving 221 patients with a frozen shoulder. The participants were divided into an ultrasound therapy group and a control group, and differences in upper limb function were analyzed at 2 weeks, 6 weeks, and 6 months. Both groups exhibited improvements over time; however, no significant differences were observed between the groups (Supplementary Material S3).

Based on this analysis, compared to the control group, deep heat therapy in patients with frozen shoulder did not show significant improvement in shoulder pain or upper limb function at the indicated time points. Additionally, the limited number of included studies and small sample sizes of the RCTs made it difficult to determine the strength and direction of recommendations.

4. Is electrical stimulation therapy (I) effective in improving pain and shoulder ROM (O) in patients with frozen shoulder (P) compared to the control group (C)?

Recommendation

Electrical stimulation therapy could be considered for pain relief in patients with primary frozen shoulder (Evidence level: very low, Recommendation grade: B).

Four RCTs were identified for the efficacy of electrical stimulation therapy in adult patients with frozen shoulder [90–93]. Among these, three studies were eligible for meta-analysis, and one study was excluded because of the lack of extractable data [93]. Among the included studies, one study [91] investigated the effects of electrical stimulation therapy alone, while two [90,92] combined electrical stimulation with exercise therapy in the intervention group. Electrical stimulation therapy methods vary across studies and include transcutaneous electrical nerve stimulation (TENS), intramuscular electrical stimulation, and bipolar interferential electrotherapy.

Regarding pain relief, at the immediate time point (0–2 weeks), a significant reduction in pain was noted in the electrical stimulation therapy group compared with the control group (mean difference [MD], -10.14; 95% CI, -15.53 to -4.75; $I^2=28\%$). However, there were no significant differences between the groups in the short-term (2–6 weeks) and mid-term (8–16 weeks) periods. No significant differences were observed in upper limb function between the groups in the short-(2–6 weeks) or long-term (>6 months) periods. Furthermore, in the mid-term period (8–16 weeks), the electrical stimulation therapy group showed a statistically significant improvement compared with the control group (standardized mean difference [SMD], -0.46; 95% CI, -0.91 to -0.01; $I^2=64\%$). Regarding shoulder ROM, one RCT [92] reported significant improvements in the ROM (abduction and external rotation) in the electrical stimulation therapy group compared to the control group at both the short-term (2–6 weeks) and mid-term (8–16 weeks) time points (abduction: MD 8.04, 95% CI 5.05–11.03 vs. MD 3.46, 95% CI 1.63–5.29; external rotation: MD 3.72, 95% CI 1.42–6.02 vs. MD 2.54, 95% CI 0.75–4.33) (Supplementary Material S3).

Based on this analysis, electrical stimulation therapy may provide immediate pain relief and aid in the recovery of shoulder ROM in patients with a frozen shoulder. Therefore, it may be considered a treatment option for pain management in primary

frozen shoulders.

5. Is oral steroid treatment (I) effective in improving pain and ROM (O) in patients with frozen shoulder (P) compared to the control group (C)?

Recommendation

Insufficient evidence is available to determine the strength and direction of the recommendation for oral steroid treatment in patients with primary frozen shoulders (Evidence level: very low, Recommendation grade: I).

Three RCTs examined the effects of oral steroids in adult patients with frozen shoulders [7,94,95]. Among these, two studies used a placebo group as the control [94,95], whereas one used a no-treatment control group [7]. A meta-analysis was not performed, and the evidence level was assessed through a narrative review.

The type, dosage, and duration of the oral steroid treatment varied among the selected studies. In a study involving 32 participants [95], the treatment group received 200 mg of cortisone for the first 3 days, and then the dosage was gradually tapered, amounting to a total of 2.5 g over 4 weeks. The control group received a placebo with a similar dosage regimen. No significant differences were observed between the groups in terms of pain relief or improvement in shoulder ROM. However, in the oral steroid group, a major reduction in pain was noted during the first week, whereas the control group showed little change in pain during the first week, with a sustained pattern throughout the observation period. Shoulder ROM also increased more significantly during the first 4 weeks in the steroid group than in weeks 4–18, although this was not statistically significant.

In a study involving 40 participants [7], the treatment group received 10 mg of prednisolone daily for four weeks, followed by 5 mg daily for two weeks (total of six weeks). Compared to the no treatment control group, the steroid-treated group showed a significant improvement in nighttime pain ($p < 0.05$). However, after 5 months, the differences between the groups were not significant. No significant differences were observed in shoulder ROM between the groups.

Buchbinder et al. [94] administered 30 mg of oral prednisolone daily for 3 weeks to 49 participants. At the 3-week mark, the oral steroid group showed significantly greater improvements in overall pain, function, and ROM than the placebo group. However, at 6 and 12 weeks, the differences between the groups were no longer evident. The effects of treatment varied

over time, with the steroid group showing maximum improvement at 3 weeks but no further gains thereafter, whereas the placebo group exhibited gradual improvement, reaching the maximum benefit at 12 weeks.

However, oral steroids may have potential adverse effects. The known side effects include osteoporosis, avascular necrosis, hypertension, hyperglycemia, hyperlipidemia, obesity, increased risk of atherosclerosis, and withdrawal symptoms due to hypothalamic-pituitary-adrenal axis suppression, which may cause loss of appetite, lethargy, fatigue, nausea, weight loss, skin thinning, and headache. In a study by Binder et al. [7], among 20 patients taking oral steroids, two reported mild dyspepsia that improved when the steroid dosage was reduced. Given these potential adverse effects, the use of oral steroids as a first-line treatment option for frozen shoulders requires careful clinical consideration.

6. Is oral non-steroidal anti-inflammatory drug treatment (I) effective in improving pain and ROM (O) in patients with frozen shoulder (P) compared to the control group (C)?

Recommendation

Oral non-steroidal anti-inflammatory drug (NSAID) should be performed based on the clinician's judgment in patients with primary frozen shoulder, owing to insufficient evidence regarding its effectiveness (Evidence level: very low, Recommendation grade: I).

NSAIDs are commonly used as first-line pharmacological treatment for frozen shoulders. A meta-analysis was not conducted, and the evidence level was assessed through a narrative review.

A study comparing celecoxib (100 mg twice daily) and loxoprofen (60 mg thrice daily) in patients with frozen shoulder [96] found significant pain reduction in both groups. Over 1–2 weeks, the VAS score for the celecoxib group decreased from 3.41 ± 0.86 to 2.30 ± 1.02 , while in the loxoprofen group, it decreased from 3.73 ± 0.67 to 2.76 ± 0.96 ($p < 0.0001$). Regarding nocturnal pain, 21 patients in the celecoxib group initially reported nocturnal pain, of whom 15 (71.4%) experienced improvement after treatment. In the loxoprofen group, 19 patients initially had nocturnal pain, with improvement observed in only 7 (36.8%), suggesting that celecoxib was more effective ($p = 0.0281$). However, no differences were observed between the two groups in terms of resting or movement-induced pain. Regarding shoulder ROM, the celecoxib group improved from $128.4^\circ \pm 46.2^\circ$ pre-treatment to $143.7^\circ \pm 31.9^\circ$ post-treatment,

while the loxoprofen group improved from $121.5^{\circ} \pm 46.0^{\circ}$ to $137.4^{\circ} \pm 35.0^{\circ}$ ($p < 0.0001$). External rotation also significantly improved in both groups ($p < 0.05$ and $p < 0.001$, respectively).

In another study comparing oxaprozin (1,200 mg once daily, $n=49$) and diclofenac (50 mg thrice daily, $n=47$) [97], pain scores at day 15 decreased significantly in both groups (-5.85 ± 4.62 vs. -5.54 ± 4.41), with no significant difference between them. Shoulder function (measured by ROM) improved in the oxaprozin-treated group ($p=0.028$). Quality of life, as evaluated using the SF-36 total score, also showed greater improvement in the oxaprozin group.

A third study compared a group receiving oral diclofenac (100 mg/day) plus physical therapy with another group that received diclofenac/physical therapy along with intravenous prednisolone for three consecutive days [98]. In the diclofenac plus physical therapy group, the mean pain score decreased from 7.16 to 4.9 ($p < 0.001$). In the group that also received prednisolone, the mean pain score decreased from 7.1 to 2.96 ($p < 0.001$).

A single-group study evaluated the long-term outcomes of patients with adhesive capsulitis who received conservative treatment, including physical therapy and NSAIDs [35]. Among the 54 patients, the follow-up period ranged from 5.5 to 16.0 years, with a mean of 9.2 years. Statistically significant improvements were observed in all measured motion directions (elevation, external rotation, and internal rotation) ($p < 0.0001$). However, no data on pain outcomes were reported.

Based on these findings, oral NSAIDs may be effective in reducing shoulder pain and improving the ROM in patients with frozen shoulder. However, owing to insufficient evidence comparing NSAIDs with other treatments, their superiority and relative effectiveness remain uncertain. Therefore, the use of NSAIDs in frozen shoulder management should be determined based on the clinical judgment of healthcare professionals.

7. Does manual therapy, including ROM exercises (I), improve pain, ROM, and upper limb function (O) in patients with frozen shoulder (P) compared to the control group (C)?

Recommendation

Manual therapy including ROM exercises may be considered for improving upper limb function and shoulder ROM in patients with primary frozen shoulder (Level of evidence: low, Recommendation grade: B).

Thirteen RCTs investigated manual therapy, including ROM

exercises, in adult patients with frozen shoulder [32,99-110]. All these studies were included in the meta-analysis.

Among the 13 included studies, only 2 [103,105] applied manual therapy with ROM exercises alone, while the other 11 included additional physical therapy or self-exercise interventions in the experimental group [32,99-102,104,106-110]. Compared to the control group, manual therapy, including ROM exercises, significantly improved upper limb function in the short-term (2-6 weeks; SMD, -1.09 ; 95% CI, -1.71 to -0.47 ; $I^2=87\%$). Shoulder ROM also showed statistically significant improvements in all directions, except for internal rotation (Supplementary Material S3).

Based on these findings, manual therapy, including ROM exercises, was associated with significant improvements in upper limb function and shoulder ROM in patients with frozen shoulder. Therefore, manual therapy with ROM exercises is recommended in the treatment plan for a frozen shoulder.

8. Does self-stretching of the shoulder (I) improve pain, ROM, and upper limb function (O) in patients with frozen shoulder (P) compared to the control group (C)?

Recommendation

Self-stretching may be considered as an adjunctive management for primary frozen shoulder, if appropriate exercise prescription and patient adherence are ensured (Recommendation grade: expert consensus).

Seven RCTs that investigated the effects of stretching exercises in patients with frozen shoulder were identified. Among them, 6 studies [111-116] used proprioceptive neuromuscular facilitation techniques, and one [117] used continuous passive motion devices as an intervention tool. As all 7 studies required either an interventionist or a device, they did not focus solely on self-stretching exercises. Therefore, no study met the inclusion criteria for the meta-analysis of self-stretching alone.

However, a study by Russell et al. [32] in 2014 compared two groups of patients with frozen shoulders who either received booklet-based self-exercise education twice a week for 6 weeks or performed self-stretching exercises alongside exercise education. The exercise education group showed better recovery of upper limb function and ROM than self-exercise group. Additionally, Tanaka et al. [109] studied 475 patients with frozen shoulder and found that while the frequency of hospital-based physical therapy did not affect recovery outcomes, patients who performed daily self-stretching exercises had significantly im-

proved ROM and shorter recovery times.

Based on these findings, no direct evidence has confirmed that self-stretching alone is superior to control interventions in terms of pain relief, upper limb function, or shoulder ROM improvement. However, if self-stretching is implemented, proper exercise education should be provided to patients, and adherence must be ensured to achieve the desired clinical benefits.

9. Does strength exercise (I) in patients with frozen shoulder (P) show differences in pain, shoulder ROM, and upper limb function (O) compared to the control group (C)?

Recommendation

Shoulder strengthening exercises may improve pain and functional recovery in patients with primary frozen shoulder. However, owing to the insufficient number of studies, the decision to implement strengthening exercises should be based on the clinical judgment of healthcare professionals (Evidence level: very low, Recommendation grade: I).

Two RCTs on the effectiveness of shoulder strengthening exercises in adult patients with frozen shoulders were selected [116,118]. The first study compared a group that performed rotator cuff strengthening exercises, joint exercises, and TENS with a group that performed only joint exercises and TENS. The results showed differences in pain, upper limb function, and shoulder ROM after four weeks [118]. The second study compared a group performing isometric exercises with elastic resistance bands and isotonic exercises using dumbbells with another group performing neuromuscular exercises using exercise equipment. This study assessed the differences in pain and shoulder ROM after 8 weeks [116]. A meta-analysis showed that the MD in pain levels (VAS) for shoulder strengthening exercises was -1.02 (MD, -1.02; 95% CI, -1.58 to -0.46; $I^2=97\%$), indicating a statistically significant improvement. However, a high heterogeneity was observed. Only one study reported results regarding function, making the meta-analysis infeasible. The study, assessed by SPADI, showed a significant difference in pre- and post-intervention scores: control group (pre, 84.33±19.72; post, 54.29±12.17), and shoulder strengthening group (pre, 87.67±10.23; post, 34.67±6.69) [118]. The meta-analysis did not reveal any significant differences in shoulder ROM between the two groups (Supplementary Material S3).

These findings suggest that shoulder strengthening exercises may significantly improve pain and upper limb function in

patients with a frozen shoulder. However, owing to the limited number of studies, it was difficult to determine the strengths and directions of the recommendations. Thus, the decision to implement these exercises should be based on the preferences and clinical judgment of the treating healthcare professional.

10. Does intra-articular steroid injection (I) in patients with frozen shoulder (P) show differences in pain, shoulder ROM, and upper limb function (O) compared to other non-invasive treatments (C)?

Recommendations

1. Intra-articular steroid injections should be considered to improve shoulder pain and upper limb function in patients with primary frozen shoulders (Evidence level: low, Recommendation grade: B).
2. A combination of intra-articular steroid injection and physical therapy should be considered to improve shoulder pain and upper limb function in patients with a primary frozen shoulder (Evidence level: low, Recommendation grade: B).

A total of 21 RCTs on intra-articular steroid injections in adult patients with frozen shoulder were identified [119-139]. Seventeen of these studies were eligible for meta-analysis, while 4 were excluded owing to a lack of extractable data [122,132,135,138].

Among the included studies: Eleven studies evaluated the effects of intra-articular steroid injections alone [122-127,129,131,134,136,139]. Nine studies assessed the combination of intra-articular steroid injections and physical therapy [119-121,123,124,130,133,134,137]. Three studies used intra-articular steroid injections alone and in combination with physical therapy [123,124,134].

When comparing studies that evaluated intra-articular steroid injections against other intervention methods, significant short- and mid-term improvements in pain scores were observed compared to the control group after injection (2-6 weeks: SMD -0.49, 95% CI -0.95 to -0.04, $I^2=86\%$; 8-16 weeks: SMD -0.55, 95% CI -1.03 to -0.07, $I^2=86\%$). Additionally, intra-articular steroid injections showed significant short- and mid-term improvements in upper limb function compared with the control group (2-6 weeks: SMD -0.51, 95% CI -0.91 to -0.11, $I^2=83\%$; 8-16 weeks: SMD -0.62, 95% CI -1.09 to -0.15, $I^2=86\%$). For ROM, intra-articular steroid injections showed statistically significant improvements compared with other interventions, except for external and internal rotations in the long-term (Supplementary Material S3).

Considering the diversity of the interventions in the included

studies, an additional subgroup meta-analysis was conducted. This additional meta-analysis utilized studies comparing intra-articular steroid injections combined with simple physiotherapy versus simple physiotherapy alone, incorporating a total of 9 studies [119-121,123,124,130,133,134,137]. In the subgroup analysis, patients who received both intra-articular steroid injections and simple physiotherapy showed statistically significant improvements in pain and upper limb function compared to those who underwent simple physiotherapy alone at short- and mid-term follow-ups (pain: 2–6 weeks, SMD -0.54, 95% CI -0.87 to -0.21, $I^2=0\%$; pain: 8–16 weeks, SMD -0.54, 95% CI -0.82 to -0.27, $I^2=0\%$; upper limb function: 2–6 weeks, SMD -0.53, 95% CI -0.82 to -0.24, $I^2=0\%$; upper limb function: 8–16 weeks, SMD -0.83, 95% CI -1.36 to -0.30, $I^2=0\%$). With regard to ROM, significant improvements were observed in forward flexion and abduction in the group that received intra-articular steroid injections combined with simple physiotherapy. However, no significant differences were found between the two groups in terms of external and internal shoulder rotation (Supplementary Material S3).

Intra-articular steroid injections provide significant improvements in pain and upper limb function in patients with frozen shoulders compared with other treatments. Additionally, when combined with physical therapy, they showed greater benefits than those with physical therapy alone. Therefore, intraarticular steroid injections should be considered in the treatment plan for frozen shoulder.

11. Does image-guided intra-articular steroid injection (P) show differences in pain, shoulder ROM, and upper limb function (O) compared to landmark-guided intra-articular steroid injection (C) in patients with frozen shoulder (P)?

Recommendation

There is insufficient evidence to support the clinical superiority of ultrasound-guided intra-articular steroid injections in patients with primary frozen shoulders. However, ultrasound-guided intra-articular steroid injections should be considered based on the clinician's level of expertise (Recommendation grade: expert consensus).

Four RCTs [140-143] compared image-guided and landmark-guided intra-articular steroid injections in adults with frozen shoulder. All 4 studies used ultrasound as the imaging guidance method. In the case of landmark-guided intra-articular steroid injections, all studies reported that the procedures were per-

formed by physicians with 5, 7, 15, and 15 years of experience, respectively.

When comparing ultrasound-guided and landmark-guided intra-articular steroid injections, no significant differences were observed in terms of pain relief or upper limb function. However, in terms of shoulder ROM, ultrasound-guided intra-articular steroid injection led to a statistically significant improvement in external rotation at short-term follow-up (4–8 weeks), with an average increase of 2.63° compared to the landmark-guided approach (MD, 2.63; 95% CI, 0.49–4.76; $I^2=0\%$) (Supplementary Material S3).

Cho et al. [140] reported a 100% success rate for the ultrasound-guided approach compared with a 71.1% success rate for the landmark-guided approach. Similarly, Raeissadat et al. [143] reported success rates of 90% and 76.19% for the ultrasound-guided and landmark-guided methods, respectively, suggesting that ultrasound guidance may offer advantages in terms of accuracy. The success rate of landmark-guided intra-articular steroid injections has been reported to range from 42% to 93.3% [144,145].

Although the difference in success rates did not appear to have a significant impact on the clinical outcomes in this analysis, the effect of these differences on clinical outcomes when the procedure is performed by less-experienced clinicians remains unclear. Based on these findings, ultrasound-guided intra-articular steroid injection did not show a significant difference from landmark-guided injections in terms of pain relief and upper limb function recovery in patients with a frozen shoulder. However, given that all the studies included in this analysis were conducted by experienced physicians, determining the strength and direction of the recommendation for ultrasound guidance is difficult. Ultimately, the decision to use ultrasound guidance should be based on the clinician's level of expertise and judgment.

12. Does high-dose intra-articular steroid injection (I) show differences in pain, shoulder ROM, and upper limb function (O) compared to low-dose intra-articular steroid injection (C) in patients with frozen shoulder (P)?

Recommendation

There is insufficient evidence regarding the effects of different intraarticular steroid doses in patients with primary frozen shoulder. Therefore, the steroid dosage should be determined based on the clinician's clinical judgment (Evidence level: low, Recommendation grade: I).

Among the RCTs comparing different doses of intra-articular steroids, 5 studies [139,146-149] were included in the present analysis, 4 of which were used for the meta-analysis. The study by de Jong et al. [146], which compared 40 and 10 mg triamcinolone acetonide, was excluded from the meta-analysis because of the absence of extractable data.

The remaining 4 studies compared 40 and 20 mg of triamcinolone acetonide; thus, this analysis was limited to discussing these two dosages. The meta-analysis failed to detect a significant difference in pain relief between the two triamcinolone acetonide doses. However, 40 mg of triamcinolone acetonide resulted in significant improvement in shoulder function at short-term follow-up (2–6 weeks) (SMD, 0.52; 95% CI, 0.05–0.99; $I^2=16\%$) and also showed statistically significant improvement in abduction and external rotation ROM at short-term follow-up (2–6 weeks) compared to 20 mg (abduction: MD -11.39, 95% CI -19.10 to -3.67, $I^2=0\%$; external rotation: MD -6.75, 95% CI -10.43 to -3.06, $I^2=0\%$). No significant differences were observed at the other time points (Supplementary Material S3).

Regarding adverse effects, Yoon et al. [139] reported facial flushing in 3 patients receiving 40 mg of triamcinolone and in one receiving 20 mg. In the study by Kim et al. [148], there was no significant increase in blood glucose or glycated hemoglobin levels after injection; however, at the 6-week follow-up, blood glucose levels were significantly higher in the high-dose steroid group than in the low-dose group. Lee et al. [149] reported no adverse effects in either group.

Although not included in the meta-analysis, de Jong et al. [146] found that 40 mg of triamcinolone was significantly more effective than 10 mg in terms of pain relief and shoulder ROM, with 42% of patients in the 40 mg group reporting no functional limitations at 6 weeks, compared to only 4% in the 10 mg group.

Based on these findings, 40 mg of triamcinolone may provide greater clinical improvement than 20 mg in patients with frozen shoulders. However, clinicians should carefully consider the potential adverse effects, their severity and frequency, and the patient's medical history when prescribing the appropriate steroid dose.

13. In patients with frozen shoulder (P), does performing hydrodilatation during intra-articular steroid injection (I) lead to differences in pain relief, ROM, and function (O) compared to intra-articular steroid injection alone (C)?

Recommendation

Hydrodilatation could be considered in conjunction with intra-articular steroid injections to improve shoulder pain and upper limb function in patients with primary frozen shoulder (Evidence level: low, Recommendation grade: B).

Nine studies comparing the therapeutic effects of intra-articular steroid injection combined with hydrodilatation versus intra-articular steroid injection alone in adult patients with frozen shoulder were included in the final selection [136,150-157]. Among them, the study by Swaroop et al. [154] was excluded from the meta-analysis because of the lack of standard deviation data.

The meta-analysis results showed that hydrodilatation led to significantly greater improvements in pain relief at the short- and mid-term follow-ups compared to the control group (2–6 weeks: MD -0.46, 95% CI -0.87 to -0.06, $I^2=15\%$; 8–16 weeks: MD -0.50, 95% CI -0.81 to -0.19, $I^2=1\%$). Additionally, improvements in upper limb function were observed in both the short- and mid-term (SMD, -0.32; 95% CI, -0.57 to -0.06; $I^2=24\%$ vs. SMD, -0.48; 95% CI, -0.81 to -0.15; $I^2=39\%$). Significant improvements were also observed in flexion at mid- and long-term follow-ups and in external rotation at short- and mid-term follow-ups (Supplementary Material S3).

Both the hydrodilatation and control groups reported mild adverse effects, such as pain, facial flushing, and transient blood glucose elevation in patients with diabetes; however, no significant differences in adverse events were noted between the groups. No study has specifically addressed the additional side effects related to increased fluid volume or the drugs used in hydrodilatation.

Despite differences in hydrodilatation protocols and limited sample sizes across studies, the overall analysis confirmed that hydrodilatation combined with intra-articular steroid injection leads to significant improvements in pain relief and upper limb function compared to intra-articular steroid injection alone in patients with frozen shoulder. Therefore, hydrodilatation may be considered an adjunctive treatment when administering intra-articular steroid injections in patients with a frozen shoulder.

14. In patients with frozen shoulder (P), does intra-articular hyaluronic acid injection (I) lead to differences in pain relief, ROM, and function (O) compared to other treatments (C)?

Recommendation

Intra-articular steroid injections should be considered before intra-articular hyaluronic acid injections to improve shoulder pain and upper limb function in patients with primary frozen shoulders. However, if intra-articular steroid injection is not feasible, hyaluronic acid injection may be considered, based on the judgment of the clinician (Recommendation grade: expert consensus).

Nine RCTs investigated intra-articular hyaluronic acid injection in adult patients with frozen shoulder [122,129,158-164]. Among these, six studies were included in the meta-analysis [122,129,159,162-164], while three were excluded because of the lack of extractable data [158,160,161]. Six of the included studies compared hyaluronic acid injections with intra-articular steroid injections. The results showed that, in terms of pain relief, intra-articular steroid injections were significantly more effective than hyaluronic acid injections in the short-term (2–6 weeks; MD, +1.67; 95% CI, 0.16–3.19; $p=0.03$; $I^2=94\%$). However, in the mid-term (8–16 weeks), there was no significant difference in pain relief between the two treatments (MD, +0.33; 95% CI -0.61 to 1.27; $p=0.50$; $I^2=0\%$). Regarding upper limb function, intra-articular steroid injection was superior in the short-term (2–6 weeks; SMD, -0.75; 95% CI, -1.27 to -0.24; $p=0.004$; $I^2=73\%$), whereas there was no significant difference between the two treatments in the mid-term (MD, -2.11; 95% CI, -6.33 to 2.12; $p=0.33$; $I^2=0\%$). Additionally, there were no significant differences between hyaluronic acid and steroid injections in terms of short- and mid-term ROM improvements in shoulder flexion, abduction, external rotation, and internal rotation (Supplementary Material S3).

Among the studies excluded from the meta-analysis, one compared intra-articular hyaluronic acid injection with intra-articular NSAID injection (ketorolac) [158], whereas the other compared hyaluronic acid injection combined with physiotherapy versus physiotherapy alone [161]. An RCT of 160 patients with frozen shoulder comparing intra-articular hyaluronic acid injection with NSAID injection found that both treatments led to significant improvements in pain and function at 4 weeks. Although the score changes were greater in the NSAID group, the differences were not statistically significant. Another study comparing intra-articular hyaluronic acid injection plus physiother-

apy with physiotherapy alone found that both groups showed improvements in pain, function, ROM, and quality of life, with no significant differences between them.

Overall, while intra-articular hyaluronic acid injection was less effective than intra-articular steroid injection for short-term pain relief and functional improvement, it still provided significant improvements in pain, function, and ROM compared to baseline. Therefore, in cases where intra-articular steroid injection is not feasible, hyaluronic acid injection may be considered as an alternative treatment option for frozen shoulder.

15. In patients with frozen shoulder (P), does a suprascapular nerve block (I) improve pain, upper limb function, and ROM (O) compared to other treatments (C)?

Recommendation

Suprascapular nerve block could be considered for pain relief in patients with primary frozen shoulders (Level of evidence: very low, Recommendation grade: B).

The analysis included only RCTs that directly compared the suprascapular nerve block with conservative treatment. Seven studies were included in the meta-analysis: 6 assessed pain [130, 165-169], and 6 evaluated upper limb function [130,165,167-170].

Suprascapular nerve block showed significant pain reduction in both the short-term (2–6 weeks) and midterm (8–16 weeks) compared to conservative treatments (MD, -0.87; 95% CI, -1.47 to -0.26; $I^2=77\%$ vs. MD, -0.66; 95% CI, -1.23 to -0.09; $I^2=94\%$). While there was no significant improvement in upper limb function in the short-term, a significant improvement was observed in the midterm (MD, -7.05; 95% CI, -11.41 to -2.69; $I^2=91\%$). Regarding shoulder ROM, the suprascapular nerve block showed significant improvement in flexion and internal rotation in the short-term, but did not show significant differences in abduction, external rotation in the short-term, or any ROM parameters in the midterm (Supplementary Material S3).

Based on these findings, the suprascapular nerve block provides pain relief in the short- and midterm compared to conservative treatments in patients with frozen shoulder. Additionally, a significant improvement in upper limb function was observed in the mid-term, with partial improvements in the ROM in the short-term. However, comparisons with intra-articular steroid injections, the most commonly used treatment for frozen shoul-

der, were not included in this analysis. Since the suprascapular nerve block was compared with conservative treatments such as physiotherapy or saline injections, it should be considered as a treatment option for pain relief rather than a substitute for intra-articular steroid injections.

16. In patients with frozen shoulder (P), does MUA (I) improve pain, ROM, and function (O) compared to other treatments (C)?

Recommendation

MUA for primary frozen shoulder has insufficient clinical evidence to support its efficacy and carries the risk of complications (e.g., fractures and rotator cuff tears). Therefore, intra-articular steroid injections should be considered before MUA (Recommendation grade: expert consensus).

MUA is widely used as a treatment option for frozen shoulder, either alone or in combination with other treatments, such as intraarticular steroid injections. The 5 included studies varied in intervention and control groups [31,171-174]. The interventions included MUA combined with self-exercise [31,171,172], MUA with intra-articular steroid injection [174], and MUA with intra-articular steroid injection and physiotherapy [173]. The control groups also varied and included self-exercise [31], intra-articular steroid injection [174], intra-articular steroid injection with hydrostatic distension, self-exercise or physiotherapy [171,172], and physiotherapy alone [173].

All 5 studies assessed pain after the intervention. Three studies reported no significant differences in postprocedural pain between the groups [31,171,173]. Kivimäki et al. [31] found no significant differences in pain at the 3-, 6-, and 12-month follow-ups between the MUA and self-exercise groups, although both groups showed pain reduction over time. Jacobs et al. [171] compared MUA with intraarticular steroid injection and hydrostatic distension and reported no significant differences at 16 weeks. Rangan et al. [173] compared MUA with intra-articular steroid injection and physiotherapy and found no significant pain differences at 3-, 6-, and 12 months follow-ups. However, Thomas et al. [174] reported that at 3 months, 80% (n=12) of patients with MUA had daytime pain improvement compared to 47% (n=7) in the control group. There was no significant difference in nighttime pain improvement between the groups. Quraishi et al. [172] found that at 6 months, the hydrostatic distension group showed significantly better pain improvement than the MUA group.

Three studies reported no significant differences in upper limb function between the MUA and control groups [31,171,173]. Kivimäki et al. [31] assessed Shoulder Disability Questionnaire scores at 6 weeks, 3 months, 6 months, and 12 months and found no significant differences between the groups. Jacobs et al. [171] measured the Constant-Murley Shoulder Function Assessment Score (CMS) and found no significant differences at 16 weeks. Rangan et al. [173] assessed the Oxford Shoulder Score and Quick Disability of the Arm, Shoulder, and Hand and reported no significant differences between the groups at 3, 6, and 12 months. However, Thomas et al. [174] reported that at 1 month, 2 patients with MUA had full functional recovery, and at 3 months, 47% (n=7) had full recovery compared to 13% (n=2) in the control group. Quraishi et al. [172] reported that at 6 months, the hydrostatic distension group showed significantly greater CMS score improvement than the MUA group.

Three studies reported the shoulder ROM. Thomas et al. [174] found that at 3 months, 40% (n=6) of patients with MUA showed >90° improvement in shoulder flexion compared with 13.3% (n=2) in the control group. Kivimäki et al. [31] reported a significantly greater improvement in shoulder flexion at 3 months in the MUA group than in the self-exercise group. However, Quraishi et al. [172] found no significant differences between the groups in abduction, flexion, external rotation, or internal rotation at 6 months.

Rangan et al. [173] reported two cases (1%) of serious complications in the MUA group, whereas no serious complications were observed in the control group. Jacobs et al. [171] reported no significant adverse events in either group. However, previous studies have reported severe complications associated with MUA, including humeral fractures, shoulder dislocation, hemarthrosis, and rotator cuff tears [175]. Therefore, clinicians should be aware of these risks, and patient consent is essential.

DISCUSSION

This CPG systematically reviewed the literature and summarized the evidence to provide 2 background questions with answers, and 16 key questions with recommendations for the diagnosis and treatment of primary frozen shoulder. Two background questions identified comorbidities, such as diabetes, thyroid disorders, and hyperlipidemia, as risk factors for frozen shoulder. Additionally, although primary frozen shoulder is typically a self-limiting condition, some patients do not fully recover, which should be considered in clinical practice. The

guidelines present 16 recommendations based on key questions that can be practically applied in clinical settings.

Primary frozen shoulder can be diagnosed based on the clinical history and physical examination. However, imaging modalities such as ultrasound or MRI may be used in cases with non-specific symptoms or when differentiation from other shoulder pathologies, such as rotator cuff tears, impingement syndrome, or calcific tendinitis, is required. Although several imaging findings are characteristic of primary frozen shoulder, their sensitivity and specificity do not surpass those of clinical diagnosis, making them more suitable as supplementary diagnostic tools than stand-alone diagnostic tools.

For noninvasive treatments, electrical stimulation therapy can be used for pain relief, and manual therapy, including ROM exercises, may be performed to improve upper limb function and shoulder mobility. However, due to the lack of supporting literature and small effect sizes, deep heat therapy, oral corticosteroids, NSAIDs, self-administered shoulder stretching exercises, and shoulder strengthening exercises should be implemented at the discretion of the clinician.

In terms of minimally invasive treatments, intra-articular steroid injections have demonstrated significant improvements in pain, upper limb function, and shoulder ROM compared to control groups. Combining intra-articular steroid injections with physical therapy or hydrodilatation has shown even greater clinical benefits, consistent with existing international clinical guidelines [1,10,11]. Although previous studies have not shown a clear advantage of image-guided injections over landmark-guided injections, this may depend on the expertise of the operator. The dose of triamcinolone (20 mg vs. 40 mg) should be determined based on clinical judgment. For patients who cannot undergo intra-articular steroid injections, a suprascapular nerve block may be considered for pain relief, and intra-articular hyaluronic acid injection may be an option for improving both pain and upper limb function.

However, this CPG has some limitations. First, a multidisciplinary approach is lacking. Although rehabilitation specialists, orthopedic surgeons, radiologists, and methodology experts contributed to the development of this guideline, non-physician healthcare professionals, such as physical therapists and nurses, were not involved. Therefore, the guidelines specifically target physicians who manage frozen shoulders. Second, frozen shoulder progresses through three phases (painful, frozen, and thawed), warranting phase-specific recommendations. However, owing to the scarcity of clinical studies stratifying patients

by disease stage, phase-specific recommendations cannot be provided. Instead, each recommendation is categorized based on its primary goal, such as pain relief or functional improvement, allowing clinicians to tailor treatment decisions according to the individual patient conditions. Additionally, for some key questions, inconsistent study results or low-quality evidence precluded a meta-analysis, necessitating a narrative review of the literature.

CONCLUSION

This is the first CPG for primary frozen shoulder that reflects the level of evidence from the relevant literature and expert consensus, adhering to a rigorous guideline development methodology. The guideline is expected to be widely used by physicians and other healthcare professionals in primary and tertiary care settings and provide valuable information for patients and caregivers.

ADDITIONAL INFORMATION

¹Department of Physical and Rehabilitation Medicine, Chung-Ang University College of Medicine, Seoul, Korea

²Department of Rehabilitation Medicine, Pusan National University Hospital, Pusan National University School of Medicine, Busan, Korea

³Department of Rehabilitation Medicine, Chungnam National University College of Medicine, Daejeon, Korea

⁴Department of Physical and Rehabilitation Medicine, Samsung Kangbuk Hospital, Sungkyunkwan University School of Medicine, Seoul, Korea

⁵Department of Rehabilitation Medicine, Kyung Hee University Gangdong Hospital, College of Medicine, Kyung Hee University, Seoul, Korea

⁶Department of Physical Medicine and Rehabilitation, College of Medicine, Kyung Hee University, Seoul, Korea

⁷Seoul Spine Rehabilitation Clinic, Ulsan, Korea

⁸Department of Rehabilitation Medicine, International St. Mary's Hospital, Catholic Kwandong University College of Medicine, Incheon, Korea

⁹Department of Physical Medicine and Rehabilitation, Jeonbuk National University Medical School, Jeonju, Korea

¹⁰Department of Physical Medicine and Rehabilitation, Soonchunhyang University Bucheon Hospital, Soonchunhyang University College of Medicine, Bucheon, Korea

¹¹Department of Physical Medicine and Rehabilitation, Wooridul Spine Hospital, Seoul, Korea

¹²Howareyou Rehabilitation Clinic, Seoul, Korea

¹³Department of Rehabilitation Medicine, Hanyang University College of Medicine, Seoul, Korea

¹⁴Department of Physical Medicine and Rehabilitation, Inje University Sanggye Paik Hospital, Seoul, Korea

¹⁵Department of Rehabilitation Medicine, Seoul National University Bundang Hospital, Seoul National University College of Medicine, Seongnam, Korea

¹⁶Department of Physical Medicine and Rehabilitation, Dong-A University College of Medicine, Busan, Korea

¹⁷Department of Rehabilitation Medicine, Happy Rehabilitation Medicine Clinic, Daegu, Korea

¹⁸Department of Rehabilitation Medicine, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, Korea

¹⁹Department of Rehabilitation Medicine, Konkuk University Medical Center, Seoul, Korea

²⁰Department of Rehabilitation Medicine, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea

²¹Department of Physical Medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

²²Department of Rehabilitation Medicine, CHA Bundang Medical Center, CHA University School of Medicine, Seongnam, Korea

²³Department of Physical Medicine and Rehabilitation, College of Medicine, Yeungnam University, Daegu, Korea

²⁴Department of Rehabilitation Medicine, SMG-SNU Boramae Medical Center, Seoul National University College of Medicine, Seoul, Korea

²⁵Department of Physical Medicine and Rehabilitation, Korea University Guro Hospital, Seoul, Korea

²⁶Department of Physical and Rehabilitation Medicine, Chonnam National University Medical School and Hospital, Gwangju, Korea

²⁷National Health Insurance Service Ilsan Hospital, Ilsan, Korea

²⁸Department of Rehabilitation Medicine, Ewha Womans University Seoul Hospital, Seoul, Korea

²⁹Department of Rehabilitation Medicine, Yeouido St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

³⁰Department of Radiology, Konkuk University Medical Center, Konkuk University School of Medicine, Seoul, Korea

³¹Department of Rehabilitation Medicine, Daejeon Wellness Hospital, Daejeon, Korea

³²Department of Orthopaedic Surgery, Soonchunhyang University Bucheon Hospital, Soonchunhyang University School of Medicine, Bucheon, Korea

³³Department of Physical Medicine and Rehabilitation, Ajou University School of Medicine, Suwon, Korea

³⁴Department of Physical and Rehabilitation Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea

³⁵Department of Radiology, Kyungpook National University Hospital, School of Medicine, Kyungpook National University, Daegu, Korea

³⁶Department of Physical Medicine and Rehabilitation, Myongji Hospital, Goyang, Korea

CONFLICTS OF INTEREST

The members who were involved in this guideline had no other conflicts of interest (COI). The COI was required to determine whether or not these persons should be involved in the development of similar guidelines, employment, financial interests, and other potential interests. No potential conflicts of interest

relevant to this article were reported.

FUNDING INFORMATION

This guideline was developed with financial support from the Korean Academy of Rehabilitation Medicine and the Korean Association of Pain Medicine. The development of this CPG was not influenced by the supporting academies and was not supported by other groups.

AUTHOR CONTRIBUTION

Conceptualization: Jae-Young Han, Doo Young Kim, Du Hwan Kim, Dong Hwan Kim, Kyunghoon Min, Donghwi Park, Chul-Hyun Park, Jae-Hyun Lee, Jong Hwa Lee, Byung Chan Lee, Jong-Moon Hwang. Methodology: Jae-Young Han, Doo Young Kim, Du Hwan Kim, Dong Hwan Kim, Kyunghoon Min, Donghwi Park, Chul-Hyun Park, Jae-Hyun Lee, Jong Hwa Lee, Byung Chan Lee, Jong-Moon Hwang. Data curation: all authors. Formal analysis: all authors. Funding acquisition: Jae-Young Han. Supervision: Jaeki Ahn, Jae-Young Lim, Kyoung Hyo Choi. Writing – original draft: Byung Chan Lee, Jae-Young Han. Writing – review and editing: all authors. Approval of final manuscript: all authors.

ACKNOWLEDGEMENTS

We sincerely thank Kyu Cheol Noh (Hallym University College of Medicine) and Miyoung Choi (National Evidence-based Healthcare Collaborating Agency) for their expert advice and contributions as advisory committee members throughout the development of this guideline.

We also extend our appreciation to the external reviewers—Min-Hyung Rhee (Pusan National University Hospital), Jongwoo Kim (Nazareth Hospital Rehabilitation Center), Kyung-Ho Shin (Bornotop Rehabilitation Clinic), Hyun Seok Lee (One Physical Medicine and Rehabilitation Clinic), Jung Ho Park (Korea University College of Medicine), Joon Sung Kim (The Catholic University of Korea College of Medicine), and Yong-Taek Lee (Sungkyunkwan University School of Medicine)—for their constructive feedback and valuable insights that contributed to the refinement of this work.

This guideline was developed with financial support from the Korean Academy of Rehabilitation Medicine and the Korean Association of Pain Medicine. We gratefully acknowledge their

support.

SUPPLEMENTARY MATERIALS

Supplementary materials can be found via <https://doi.org/10.5535/arm.250057>.

ORCID

Byung Chan Lee, <https://orcid.org/0000-0001-8824-0639>
 Beom Suk Kim, <https://orcid.org/0000-0003-4972-9508>
 Byeong-Ju Lee, <https://orcid.org/0000-0002-7250-8909>
 Chang-Won Moon, <https://orcid.org/0000-0003-4096-7470>
 Chul-Hyun Park, <https://orcid.org/0000-0002-9897-6612>
 Dong Hwan Kim, <https://orcid.org/0000-0002-3812-5509>
 Dong Hwan Yun, <https://orcid.org/0000-0003-1800-319X>
 Donghwi Park, <https://orcid.org/0000-0002-7724-4682>
 Doo Young Kim, <https://orcid.org/0000-0003-1327-5348>
 Du Hwan Kim, <https://orcid.org/0000-0002-9980-8549>
 Gi-Wook Kim, <https://orcid.org/0000-0002-1628-8382>
 Hyun Jung Kim, <https://orcid.org/0000-0002-3802-7829>
 Il-Young Jung, <https://orcid.org/0000-0001-8204-8195>
 In Jong Kim, <https://orcid.org/0000-0002-7143-6114>
 Jae Hyeon Park, <https://orcid.org/0000-0001-5619-4818>
 Jae-Hyun Lee, <https://orcid.org/0000-0002-4927-9722>
 Jaeki Ahn, <https://orcid.org/0000-0002-1728-181X>
 Jae-Young Lim, <https://orcid.org/0000-0002-9454-0344>
 Jin A Yoon, <https://orcid.org/0000-0001-5762-0559>
 Jong Hwa Lee, <https://orcid.org/0000-0003-2489-358X>
 Jong-Moon Hwang, <https://orcid.org/0000-0002-9807-8783>
 Keewon Kim, <https://orcid.org/0000-0001-6597-578X>
 Kyeong Eun Uhm, <https://orcid.org/0000-0003-2714-1092>
 Kyoung Hyo Choi, <https://orcid.org/0000-0001-9137-3889>
 Kyung Eun Nam, <https://orcid.org/0000-0001-5195-4320>
 Kyunghoon Min, <https://orcid.org/0000-0003-3357-9795>
 Min Cheol Chang, <https://orcid.org/0000-0002-7629-7213>
 Myung Woo Park, <https://orcid.org/0000-0001-7531-8433>
 Nackhwan Kim, <https://orcid.org/0000-0002-9650-2755>
 Hyeng-Kyu Park, <https://orcid.org/0000-0003-3769-6227>
 Seong Hun Kim, <https://orcid.org/0000-0003-1831-7930>
 Seoyon Yang, <https://orcid.org/0000-0002-7522-1655>
 Sun Jae Won, <https://orcid.org/0000-0002-9057-3747>
 Sung Gyu Moon, <https://orcid.org/0000-0003-4953-4102>
 Sung Joon Chung, <https://orcid.org/0000-0002-6277-3637>
 Sungju Jee, <https://orcid.org/0000-0002-9400-9609>

Woo Hyung Lee, <https://orcid.org/0000-0003-3413-5950>
 Yong Bok Park, <https://orcid.org/0000-0002-0753-1328>
 Yoonju Na, <https://orcid.org/0000-0001-5460-8810>
 Yu Hui Won, <https://orcid.org/0000-0003-2007-9652>
 Yu Jin Im, <https://orcid.org/0000-0002-3284-3024>
 Yu Sung Yoon, <https://orcid.org/0000-0003-2349-5256>
 Yun Jung Lee, <https://orcid.org/0000-0001-5415-5735>
 Yunsoo Soh, <https://orcid.org/0000-0001-8368-4900>
 Jae-Young Han, <https://orcid.org/0000-0003-1672-8875>

REFERENCES

1. Kelley MJ, Shaffer MA, Kuhn JE, Michener LA, Seitz AL, Uhl TL, et al. Shoulder pain and mobility deficits: adhesive capsulitis. *J Orthop Sports Phys Ther* 2013;43:A1-31.
2. Dias R, Cutts S, Massoud S. Frozen shoulder. *BMJ* 2005;331:1453-6.
3. Zappia M, Di Pietto F, Aliprandi A, Pozza S, De Petro P, Muda A, et al. Multi-modal imaging of adhesive capsulitis of the shoulder. *Insights Imaging* 2016;7:365-71.
4. Mohammed MH, Fahmi FM, Shehata KA, Elia RZ. Shoulder adhesive capsulitis: can clinical data correlate with fat-suppressed T2 weighted MRI findings? *Egypt J Radiol Nucl Med* 2022;53:76.
5. Ryan V, Brown H, Minns Lowe CJ, Lewis JS. The pathophysiology associated with primary (idiopathic) frozen shoulder: a systematic review. *BMC Musculoskelet Disord* 2016;17:340.
6. Tao MA, Karas V, Riboh JC, Laver L, Garrigues GE. Management of the stiff shoulder with arthroscopic circumferential capsulotomy and axillary nerve release. *Arthrosc Tech* 2017;6:e319-24.
7. Binder AI, Bulgen DY, Hazleman BL, Roberts S. Frozen shoulder: a long-term prospective study. *Ann Rheum Dis* 1984;43:361-4.
8. Vastamäki H, Kettunen J, Vastamäki M. The natural history of idiopathic frozen shoulder: a 2- to 27-year followup study. *Clin Orthop Relat Res* 2012;470:1133-43.
9. Itoi E, Arce G, Bain GI, Diercks RL, Guttman D, Imhoff AB, et al. Shoulder stiffness: current concepts and concerns. *Arthroscopy* 2016;32:1402-14.
10. Robb G, Arroll B, Reid D, Goodyear-Smith F. Summary of an evidence-based guideline on soft tissue shoulder injuries and related disorders--Part 2: Management. *J Prim Health Care* 2009;1:42-9.
11. Hanchard NC, Goodchild L, Thompson J, O'Brien T, Davison D, Richardson C. Evidence-based clinical guidelines for the diagnosis, assessment and physiotherapy management of contracted (frozen) shoulder: quick reference summary. *Physiotherapy* 2012;98:117-20.
12. Philadelphia Panel. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for shoulder

- pain. *Phys Ther* 2001;81:1719-30.
13. Whiting PF, Rutjes AW, Westwood ME, Mallett S, Deeks JJ, Reitsma JB, et al.; QUADAS-2 Group. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. *Ann Intern Med* 2011;155:529-36.
 14. Goldet G, Howick J. Understanding GRADE: an introduction. *J Evid Based Med* 2013;6:50-4.
 15. Huang YP, Fann CY, Chiu YH, Yen MF, Chen LS, Chen HH, et al. Association of diabetes mellitus with the risk of developing adhesive capsulitis of the shoulder: a longitudinal population-based followup study. *Arthritis Care Res (Hoboken)* 2013;65:1197-202.
 16. Lo SF, Chu SW, Muo CH, Meng NH, Chou LW, Huang WC, et al. Diabetes mellitus and accompanying hyperlipidemia are independent risk factors for adhesive capsulitis: a nationwide population-based cohort study (version 2). *Rheumatol Int* 2014;34:67-74.
 17. Kim JH, Kim BS, Han KD, Kwon HS. The risk of shoulder adhesive capsulitis in individuals with prediabetes and type 2 diabetes mellitus: a longitudinal nationwide population-based study. *Diabetes Metab J* 2023;47:869-78.
 18. Chan JH, Ho BS, Alvi HM, Saltzman MD, Marra G. The relationship between the incidence of adhesive capsulitis and hemoglobin A1c. *J Shoulder Elbow Surg* 2017;26:1834-7.
 19. Tzeng CY, Chiang HY, Huang CC, Lin WS, Hsiao TH, Lin CH. The impact of pre-existing shoulder diseases and traumatic injuries of the shoulder on adhesive capsulitis in adult population: A population-based nested case-control study. *Medicine (Baltimore)* 2019;98:e17204.
 20. Park HB, Gwark JY, Jung J, Jeong ST. Involvement of inflammatory lipoproteinemia with idiopathic adhesive capsulitis accompanying subclinical hypothyroidism. *J Shoulder Elbow Surg* 2022;31:2121-7.
 21. Park HB, Gwark JY, Kam M, Jung J. Association between fasting glucose levels and adhesive capsulitis in a normoglycemic population: a case-control study. *J Shoulder Elbow Surg* 2020;29:2240-7.
 22. Li W, Lu N, Xu H, Wang H, Huang J. Case control study of risk factors for frozen shoulder in China. *Int J Rheum Dis* 2015;18:508-13.
 23. Sarasua SM, Floyd S, Bridges WC, Pill SG. The epidemiology and etiology of adhesive capsulitis in the U.S. Medicare population. *BMC Musculoskelet Disord* 2021;22:828.
 24. Wang K, Ho V, Hunter-Smith DJ, Beh PS, Smith KM, Weber AB. Risk factors in idiopathic adhesive capsulitis: a case control study. *J Shoulder Elbow Surg* 2013;22:e24-9.
 25. Austin DC, Gans I, Park MJ, Carey JL, Kelly JD 4th. The association of metabolic syndrome markers with adhesive capsulitis. *J Shoulder Elbow Surg* 2014;23:1043-51.
 26. Huang SW, Lin JW, Wang WT, Wu CW, Liou TH, Lin HW. Hyperthyroidism is a risk factor for developing adhesive capsulitis of the shoulder: a nationwide longitudinal population-based study. *Sci Rep* 2014;4:4183.
 27. Jacob L, Gyasi RM, Koyanagi A, Haro JM, Smith L, Kostev K. Prevalence of and risk factors for adhesive capsulitis of the shoulder in older adults from germany. *J Clin Med* 2023;12:669.
 28. Wang JY, Liaw CK, Huang CC, Liou TH, Lin HW, Huang SW. Hyperlipidemia is a risk factor of adhesive capsulitis: real-world evidence using the Taiwanese national health insurance research database. *Orthop J Sports Med* 2021;9:2325967120986808.
 29. Sung CM, Jung TS, Park HB. Are serum lipids involved in primary frozen shoulder? A case-control study. *J Bone Joint Surg Am* 2014;96:1828-33.
 30. Park HB, Gwark JY, Jung J. What serum lipid abnormalities are associated with adhesive capsulitis accompanied by diabetes? *Clin Orthop Relat Res* 2018;476:2231-7.
 31. Kivimäki J, Pohjolainen T, Malmivaara A, Kannisto M, Guillaume J, Seitsalo S, et al. Manipulation under anesthesia with home exercises versus home exercises alone in the treatment of frozen shoulder: a randomized, controlled trial with 125 patients. *J Shoulder Elbow Surg* 2007;16:722-6.
 32. Russell S, Jariwala A, Conlon R, Selfe J, Richards J, Walton M. A blinded, randomized, controlled trial assessing conservative management strategies for frozen shoulder. *J Shoulder Elbow Surg* 2014;23:500-7.
 33. Diercks RL, Stevens M. Gentle thawing of the frozen shoulder: a prospective study of supervised neglect versus intensive physical therapy in seventy-seven patients with frozen shoulder syndrome followed up for two years. *J Shoulder Elbow Surg* 2004;13:499-502.
 34. Tae SK, Jung YB, Lim JI, Ryu TY, Han JN. A comparative study about the natural course of idiopathic frozen shoulder and the effectiveness of conservative treatment. *J Korean Orthop Assoc* 2000;35:431-6.
 35. Dudkiewicz I, Oran A, Salai M, Palti R, Pritsch M. Idiopathic adhesive capsulitis: long-term results of conservative treatment. *Isr Med Assoc J* 2004;6:524-6.
 36. Reeves B. The natural history of the frozen shoulder syndrome. *Scand J Rheumatol* 1975;4:193-6.
 37. Karbowiak M, Holme T, Mirza M, Siddiqui N. Frozen shoulder. *BMJ* 2022;377:e068547.
 38. Mezan K, Coffey R, Chang KV. Frozen shoulder(archived). StatPearls Publishing; 2023.
 39. Fields BKK, Skalski MR, Patel DB, White EA, Tomasian A, Gross JS, et al. Adhesive capsulitis: review of imaging findings, pathophysiology, clinical presentation, and treatment options. *Skeletal Radiol*

- 2019;48:1171-84.
40. Cheng X, Zhang Z, Xuanyan G, Li T, Li J, Yin L, et al. Adhesive capsulitis of the shoulder: evaluation with US-arthrography using a sonographic contrast agent. *Sci Rep* 2017;7:5551.
 41. Do JG, Hwang JT, Yoon KJ, Lee YT. Correlation of ultrasound findings with clinical stages and impairment in adhesive capsulitis of the shoulder. *Orthop J Sports Med* 2021;9:23259671211003675.
 42. Kim DH, Choi YH, Oh S, Kim HJ, Chai JW. Ultrasound microflow imaging technology for diagnosis of adhesive capsulitis of the shoulder. *J Ultrasound Med* 2020;39:967-76.
 43. McKean D, Chung SL, Naudé RTW, McElroy B, Baxter J, Pendse A, et al. Elasticity of the coracohumeral ligament in patients with frozen shoulder following rotator interval injection: a case series. *J Ultrason* 2021;20:e300-6.
 44. Park GY, Park JH, Kwon DR, Kwon DG, Park J. Do the findings of magnetic resonance imaging, arthrography, and ultrasonography reflect clinical impairment in patients with idiopathic adhesive capsulitis of the shoulder? *Arch Phys Med Rehabil* 2017;98:1995-2001.
 45. Tandon A, Dewan S, Bhatt S, Jain AK, Kumari R. Sonography in diagnosis of adhesive capsulitis of the shoulder: a case-control study. *J Ultrasound* 2017;20:227-36.
 46. Wada T, Itoigawa Y, Yoshida K, Kawasaki T, Maruyama Y, Kaneko K. Increased stiffness of rotator cuff tendons in frozen shoulder on shear wave elastography. *J Ultrasound Med* 2020;39:89-97.
 47. Wu CH, Chen WS, Wang TG. Elasticity of the coracohumeral ligament in patients with adhesive capsulitis of the shoulder. *Radiology* 2016;278:458-64.
 48. Wu PY, Hsu PC, Chen TN, Huang JR, Chou CL, Wang JC. Evaluating correlations of coracohumeral ligament thickness with restricted shoulder range of motion and clinical duration of adhesive capsulitis with ultrasound measurements. *PM R* 2021;13:461-9.
 49. Kwon DR, Kim MY, Chae YJ, Park JS, Kim JS, Yi TI. Comparison of coracohumeral ligament thickness between asymptomatic shoulders and adhesive capsulitis in Korean. *J Korean Acad Rehabil Med* 2009;33:392-5.
 50. Ozbalci AB, Piskin A. Clinical significance of shear wave ultrasound elastography in patients with idiopathic adhesive capsulitis: can it be used instead of magnetic resonance imaging as an early indicator? *Ultrasound Q* 2022;38:250-6.
 51. Stella SM, Gualtierotti R, Ciampi B, Trentanni C, Sconfienza LM, Del Chiaro A, et al. Ultrasound features of adhesive capsulitis. *Rheumatol Ther* 2022;9:481-95.
 52. Kim DH, Cho CH, Sung DH. Ultrasound measurements of axillary recess capsule thickness in unilateral frozen shoulder: study of correlation with MRI measurements. *Skeletal Radiol* 2018;47:1491-7.
 53. Lee JG, Peo H, Cho JH, Cho CH, Kim DK, Kim DH. Dynamic ultrasonographic measurement of inferior joint capsule thickness in patients with unilateral frozen shoulder. *Diagnostics (Basel)* 2021;11:898.
 54. Park EW, Cho JH, Cho CH, Sung DH, Kim DH. Comparison of shoulder ultrasonographic assessments between polymyalgia rheumatica and frozen shoulder in patients with bilateral shoulder pain: a comparative retrospective study. *J Pers Med* 2021;11:372.
 55. Lee JC, Sykes C, Saifuddin A, Connell D. Adhesive capsulitis: sonographic changes in the rotator cuff interval with arthroscopic correlation. *Skeletal Radiol* 2005;34:522-7.
 56. Walmsley S, Osmotherly PG, Walker CJ, Rivett DA. Power Doppler ultrasonography in the early diagnosis of primary/idiopathic adhesive capsulitis: an exploratory study. *J Manipulative Physiol Ther* 2013;36:428-35.
 57. Pimenta M, Vassalou EE, Cardoso-Marinho B, Klontzas ME, Dimitri-Pinheiro S, Karantanas AH. The role of MRI and ultrasonography in diagnosis and treatment of glenohumeral joint adhesive capsulitis. *Mediterr J Rheumatol* 2023;34:7-15.
 58. Kim HJ, Han TI, Lee KW, Kwon ST, Choi YS, Kim DH, et al. Adhesive capsulitis of the shoulder: MR arthrography. *J Korean Radiol Soc* 2001;45:55-9.
 59. Lee YT, Yoon KJ, Lee JY, Lee JS, Park HJ. Feasibility of contrast-enhanced magnetic resonance imaging for representing decreased joint volume in adhesive capsulitis of shoulder. *Clinical Pain* 2015;14:87-92.
 60. Choo HJ, Lee SJ. Adhesive capsulitis of the shoulder: indirect magnetic resonance arthrography. *Choeisimihak* 2009;52:26-30.
 61. Ahn KS, Kang CH, Kim Y, Jeong WK. Diagnosis of adhesive capsulitis: comparison of contrast-enhanced MRI with noncontrast-enhanced MRI. *Clin Imaging* 2015;39:1061-7.
 62. Choi YH, Kim DH. Correlations between clinical features and MRI findings in early adhesive capsulitis of the shoulder: a retrospective observational study. *BMC Musculoskelet Disord* 2020;21:542.
 63. Connell D, Padmanabhan R, Buchbinder R. Adhesive capsulitis: role of MR imaging in differential diagnosis. *Eur Radiol* 2002;12:2100-6.
 64. Emig EW, Schweitzer ME, Karasick D, Lubowitz J. Adhesive capsulitis of the shoulder: MR diagnosis. *AJR Am J Roentgenol* 1995;164:1457-9.
 65. Erber B, Hesse N, Goller S, Gilbert F, Ricke J, Glaser C, et al. Diagnostic performance and interreader agreement of individual and combined non-enhanced and contrast-enhanced MR imaging parameters in adhesive capsulitis of the shoulder. *Skeletal Radiol* 2024;53:263-73.
 66. Gillet R, Zhu F, Padoin P, Rauch A, Hossu G, Teixeira PAG, et al. MR

- imaging biomarkers for clinical impairment and disease progression in patients with shoulder adhesive capsulitis: a prospective study. *J Clin Med* 2021;10:3882.
67. Gokalp G, Algin O, Yildirim N, Yazici Z. Adhesive capsulitis: contrast-enhanced shoulder MRI findings. *J Med Imaging Radiat Oncol* 2011;55:119-25.
 68. Gürbüz AF, Keven A, Emir Yetim E, Elasan S, Karaali K. Evaluation of the differences in the MRI findings related to primary and secondary adhesive capsulitis. *Can Assoc Radiol J* 2023;74:78-86.
 69. Jung JH, Kim DH, Yi J, Kim DH, Cho CH. Determination of magnetic resonance imaging criteria for diagnosis of adhesive capsulitis. *Rheumatol Int* 2019;39:453-60.
 70. Jung JY, Jee WH, Chun HJ, Kim YS, Chung YG, Kim JM. Adhesive capsulitis of the shoulder: evaluation with MR arthrography. *Eur Radiol* 2006;16:791-6.
 71. Kanazawa K, Hagiwara Y, Sekiguchi T, Suzuki K, Koide M, Ando A, et al. Correlations between capsular changes and ROM restriction in frozen shoulder evaluated by plain MRI and MR arthrography. *Open Orthop J* 2018;12:396-404.
 72. Yoon JB, Chung SW, Lee BJ, Kim HS, Yi JH, Lee HJ, et al. Correlations of magnetic resonance imaging findings with clinical symptom severity and prognosis of frozen shoulder. *Knee Surg Sports Traumatol Arthrosc* 2017;25:3242-50.
 73. Pessis E, Mihoubi F, Feydy A, Campagna R, Guerini H, Roren A, et al. Usefulness of intravenous contrast-enhanced MRI for diagnosis of adhesive capsulitis. *Eur Radiol* 2020;30:5981-91.
 74. Chi AS, Kim J, Long SS, Morrison WB, Zoga AC. Non-contrast MRI diagnosis of adhesive capsulitis of the shoulder. *Clin Imaging* 2017;44:46-50.
 75. Gondim Teixeira PA, Balaj C, Chanson A, Lecocq S, Louis M, Blum A. Adhesive capsulitis of the shoulder: value of inferior glenohumeral ligament signal changes on T2-weighted fat-saturated images. *AJR Am J Roentgenol* 2012;198:W589-96.
 76. Lee SY, Park J, Song SW. Correlation of MR arthrographic findings and range of shoulder motions in patients with frozen shoulder. *AJR Am J Roentgenol* 2012;198:173-9.
 77. Li JQ, Tang KL, Wang J, Li QY, Xu HT, Yang HF, et al. MRI findings for frozen shoulder evaluation: is the thickness of the coracohumeral ligament a valuable diagnostic tool? *PLoS One* 2011;6:e28704.
 78. Zhao W, Zheng X, Liu Y, Yang W, Amirbekian V, Diaz LE, et al. An MRI study of symptomatic adhesive capsulitis. *PLoS One* 2012;7:e47277.
 79. Lefevre-Colau MM, Drapé JL, Fayad F, Rannou F, Diche T, Minvielle F, et al. Magnetic resonance imaging of shoulders with idiopathic adhesive capsulitis: reliability of measures. *Eur Radiol* 2005;15:2415-22.
 80. Sofka CM, Ciavarra GA, Hannafin JA, Cordasco FA, Potter HG. Magnetic resonance imaging of adhesive capsulitis: correlation with clinical staging. *HSS J* 2008;4:164-9.
 81. Sasanuma H, Sugimoto H, Fujita A, Kanaya Y, Iijima Y, Saito T, et al. Characteristics of dynamic magnetic resonance imaging of idiopathic severe frozen shoulder. *J Shoulder Elbow Surg* 2017;26:e52-7.
 82. Song KD, Kwon JW, Yoon YC, Choi SH. Indirect MR arthrographic findings of adhesive capsulitis. *AJR Am J Roentgenol* 2011;197:W1105-9.
 83. Carbone S, Napoli A, Gumina S. MRI of adhesive capsulitis of the shoulder: distension of the bursa in the superior subscapularis recess is a suggestive sign of the pathology. *Eur J Radiol* 2014;83:345-8.
 84. Hardy M, Woodall W. Therapeutic effects of heat, cold, and stretch on connective tissue. *J Hand Ther* 1998;11:148-56.
 85. Balci TO, Turk AC, Sahin F, Kotevoglou N, Kuran B. Efficacy of therapeutic ultrasound in treatment of adhesive capsulitis: a prospective double blind placebo-controlled randomized trial. *J Back Musculoskelet Rehabil* 2018;31:955-61.
 86. Uysal B, Özkuk K, Şahin N, Ökmen BM, Sezer R, Ateş Z. Comparison of the effectiveness of high-intensity laser and ultrasound therapies in adhesive capsulitis: a randomized controlled study. *J Back Musculoskelet Rehabil* 2023;36:227-36.
 87. Dogru H, Basaran S, Sarpel T. Effectiveness of therapeutic ultrasound in adhesive capsulitis. *Joint Bone Spine* 2008;75:445-50.
 88. Leung MS, Cheing GL. Effects of deep and superficial heating in the management of frozen shoulder. *J Rehabil Med* 2008;40:145-50.
 89. Ainsworth R, Dziedzic K, Hiller L, Daniels J, Bruton A, Broadfield J. A prospective double blind placebo-controlled randomized trial of ultrasound in the physiotherapy treatment of shoulder pain. *Rheumatology (Oxford)* 2007;46:815-20.
 90. Van Der Heijden GJ, Leffers P, Wolters PJ, Verheijden JJ, van Marmeren H, Houben JP, et al. No effect of bipolar interferential electrotherapy and pulsed ultrasound for soft tissue shoulder disorders: a randomised controlled trial. *Ann Rheum Dis* 1999;58:530-40.
 91. Morgan B, Jones AR, Mulcahy KA, Finlay DB, Collett B. Transcutaneous electric nerve stimulation (TENS) during distension shoulder arthrography: a controlled trial. *Pain* 1996;64:265-7.
 92. Shanmugam S, Mathias L, Manickaraj N, Kumar KUD, Kandakurti PK, Dorairaj SK, et al. Intramuscular electrical stimulation combined with therapeutic exercises in patients with shoulder adhesive capsulitis: a randomised controlled trial. *Int J Surg Protoc* 2021;25:71-83.
 93. Herrera-Lasso I, Mobarak L, Fernández-Dominguez L, Cardiel MH, Alarcón-Segovia D. Comparative effectiveness of packages of treatment including ultrasound or transcutaneous electrical nerve stimu-

- lation in painful shoulder syndrome. *Physiotherapy* 1993;79:251-3.
94. Buchbinder R, Hoving JL, Green S, Hall S, Forbes A, Nash P. Short course prednisolone for adhesive capsulitis (frozen shoulder or stiff painful shoulder): a randomised, double blind, placebo controlled trial. *Ann Rheum Dis* 2004;63:1460-9.
 95. Blockey NJ, Wright JK, Kellgren JH. Oral cortisone therapy in peri-arthritis of the shoulder; a controlled trial. *Br Med J* 1954;1:1455-7.
 96. Ohta S, Komai O, Hanakawa H. Comparative study of the clinical efficacy of the selective cyclooxygenase-2 inhibitor celecoxib compared with loxoprofen in patients with frozen shoulder. *Mod Rheumatol* 2014;24:144-9.
 97. Heller B, Tarricone R. Oxaprozin versus diclofenac in NSAID-refractory peri-arthritis pain of the shoulder. *Curr Med Res Opin* 2004;20:1279-90.
 98. Saeidian SR, Hemmati AA, Haghighi MH. Pain relieving effect of short-course, pulse prednisolone in managing frozen shoulder. *J Pain Palliat Care Pharmacother* 2007;21:27-30.
 99. Aggarwal A, Saxena K, Palekar TJ, Rath M. Instrument assisted soft tissue mobilization in adhesive capsulitis: a randomized clinical trial. *J Bodyw Mov Ther* 2021;26:435-42.
 100. Anitha A, Sridevi J, Anusuya S, Avinash VN. Effectiveness of end range mobilization along with conventional therapy in patients with peri-arthritis shoulder. *Res J Pharm Technol* 2020;13:1271-6.
 101. Bilal U, Khalid M, Anwar K, Arshad H, Ahmed U. Additional effects of Thoracic manipulation on pain, shoulder disability and range of motion in patients with Adhesive Capsulitis. *Pakistan J Med Health Sci* 2021;15:3333-6.
 102. Buchbinder R, Youd JM, Green S, Stein A, Forbes A, Harris A, et al. Efficacy and cost-effectiveness of physiotherapy following glenohumeral joint distension for adhesive capsulitis: a randomized trial. *Arthritis Rheum* 2007;57:1027-37.
 103. Bulgen DY, Binder AI, Hazleman BL, Dutton J, Roberts S. Frozen shoulder: prospective clinical study with an evaluation of three treatment regimens. *Ann Rheum Dis* 1984;43:353-60.
 104. Çelik D, Kaya Mutlu E. Does adding mobilization to stretching improve outcomes for people with frozen shoulder? A randomized controlled clinical trial. *Clin Rehabil* 2016;30:786-94.
 105. Gutiérrez Espinoza HJ, Pavez F, Guajardo C, Acosta M. Glenohumeral posterior mobilization versus conventional physiotherapy for primary adhesive capsulitis: a randomized clinical trial. *Medwave* 2015;15:e6267.
 106. Nicholson GG. The effects of passive joint mobilization on pain and hypomobility associated with adhesive capsulitis of the shoulder. *J Orthop Sports Phys Ther* 1985;6:238-46.
 107. Arul Pragassame S, Mohandas Kurup VK, Kifayathunnisa A. Effectiveness of scapular mobilisation in the management of patients with frozen shoulder- a randomised control trial. *J Clin Diagn Res* 2019;13:YC05-9.
 108. Rahbar M, Ranjbar Kiyakalayeh S, Mirzajani R, Eftekharsadat B, Dolatkhan N. Effectiveness of acromioclavicular joint mobilization and physical therapy vs physical therapy alone in patients with frozen shoulder: a randomized clinical trial. *Clin Rehabil* 2022;36:669-82.
 109. Tanaka K, Saura R, Takahashi N, Hiura Y, Hashimoto R. Joint mobilization versus self-exercises for limited glenohumeral joint mobility: randomized controlled study of management of rehabilitation. *Clin Rheumatol* 2010;29:1439-44.
 110. Yang JL, Jan MH, Chang CW, Lin JJ. Effectiveness of the end-range mobilization and scapular mobilization approach in a subgroup of subjects with frozen shoulder syndrome: a randomized control trial. *Man Ther* 2012;17:47-52.
 111. AKBAŞ E, GÜNERİ S, TAŞ S, ERDEM EU, YÜKSEL İ. The effects of additional proprioceptive neuromuscular facilitation over conventional therapy in patients with adhesive capsulitis. *Turk J Physiother Rehabil* 2015;26:12.
 112. Balcı NC, Yuruk ZO, Zeybek A, Gulsen M, Tekindal MA. Acute effect of scapular proprioceptive neuromuscular facilitation (PNF) techniques and classic exercises in adhesive capsulitis: a randomized controlled trial. *J Phys Ther Sci* 2016;28:1219-27.
 113. Yuvarani G, Paul J, Abraham MM, Harikrishnan N. Impact of PNE, active release technique and conventional physiotherapy on the physical ability of subjects with peri-arthritis shoulder. *J Popul Ther Clin Pharmacol* 2023;30:291-7.
 114. Lin P, Yang M, Huang D, Lin H, Wang J, Zhong C, et al. Effect of proprioceptive neuromuscular facilitation technique on the treatment of frozen shoulder: a pilot randomized controlled trial. *BMC Musculoskelet Disord* 2022;23:367.
 115. Saleem R, Bashir MS, Noor R. Effects of sequential approach of positional release for subscapularis and OLA Grimsby technique on shoulder external rotation in adhesive. *J Pak Med Assoc* 2022;72:1831-3.
 116. Wang L, Yu G, Zhang R, Wu G, He L, Chen Y. Positive effects of neuromuscular exercises on pain and active range of motion in idiopathic frozen shoulder: a randomized controlled trial. *BMC Musculoskelet Disord* 2023;24:50.
 117. Dundar U, Toktas H, Cakir T, Evcik D, Kavuncu V. Continuous passive motion provides good pain control in patients with adhesive capsulitis. *Int J Rehabil Res* 2009;32:193-8.
 118. Rawat P, Eapen C, Seema KP. Effect of rotator cuff strengthening as an adjunct to standard care in subjects with adhesive capsulitis: a

- randomized controlled trial. *J Hand Ther* 2017;30:235-41.e8.
119. Afzal T, Chaudhry AA, Gillani SFUHS, Rafiq A, Dar UZ, Sultan N. Intra-articular corticosteroid with physiotherapy versus physiotherapy alone for the treatment of frozen shoulder: a randomized controlled trial. *J Pak Orthop Assoc* 2019;31:85-9.
 120. Anjum R, Aggarwal J, Gautam R, Pathak S, Sharma A. Evaluating the outcome of two different regimes in adhesive capsulitis: a prospective clinical study. *Med Princ Pract* 2020;29:225-30.
 121. Bal A, Eksioglu E, Gulec B, Aydog E, Gurcay E, Cakci A. Effectiveness of corticosteroid injection in adhesive capsulitis. *Clin Rehabil* 2008;22:503-12.
 122. Calis M, Demir H, Ulker S, Kirnap M, Duygulu F, Calis HT. Is intraarticular sodium hyaluronate injection an alternative treatment in patients with adhesive capsulitis? *Rheumatol Int* 2006;26:536-40.
 123. Carette S, Moffet H, Tardif J, Besette L, Morin F, Frémont P, et al. Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: a placebo-controlled trial. *Arthritis Rheum* 2003;48:829-38.
 124. Dacre JE, Beeney N, Scott DL. Injections and physiotherapy for the painful stiff shoulder. *Ann Rheum Dis* 1989;48:322-5.
 125. El Nagggar TEDM, Maaty AIE, Mohamed AE. Effectiveness of radial extracorporeal shock-wave therapy versus ultrasound-guided low-dose intra-articular steroid injection in improving shoulder pain, function, and range of motion in diabetic patients with shoulder adhesive capsulitis. *J Shoulder Elbow Surg* 2020;29:1300-9.
 126. Gupta N, Thakur A, Gautam D. Prospective clinical study on intraarticular corticosteroids injection, medical management, and hydraulic capsular distension with supervised physical therapy for frozen shoulder management. *Int J Pharm Clin Res* 2023;15:130-3.
 127. Kothari SY, Srikumar V, Singh N. Comparative efficacy of platelet rich plasma injection, corticosteroid injection and ultrasonic therapy in the treatment of periarthritis shoulder. *J Clin Diagn Res* 2017;11:RC15-8.
 128. Lee M, Haq AM, Wright V, Longton EB. Periarthritis of the shoulder: a controlled trial of physiotherapy. *Physiotherapy* 1973;59:312-5.
 129. Oh SH, Sung WS, Oh SH, Jo CH. Comparative analysis of intra-articular injection of steroid and/or sodium hyaluronate in adhesive capsulitis: prospective, double-blind, randomized, placebo-controlled study. *JSES Int* 2021;5:1091-104.
 130. Parashar A, Goni V, Neradi D, Guled U, Rangasamy K, Batra YK. Comparing three modalities of treatment for frozen shoulder: a prospective, double-blinded, randomized control trial. *Indian J Orthop* 2020;55:449-56.
 131. Prestgaard T, Wormgoor MEA, Haugen S, Harstad H, Mowinckel P, Brox JI. Ultrasound-guided intra-articular and rotator interval corticosteroid injections in adhesive capsulitis of the shoulder: a double-blind, sham-controlled randomized study. *Pain* 2015;156:1683-91.
 132. Rizk TE, Pinals RS, Talaiver AS. Corticosteroid injections in adhesive capsulitis: investigation of their value and site. *Arch Phys Med Rehabil* 1991;72:20-2.
 133. Roh YH, Yi SR, Noh JH, Lee SY, Oh JH, Gong HS, et al. Intra-articular corticosteroid injection in diabetic patients with adhesive capsulitis: a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc* 2012;20:1947-52.
 134. Ryans I, Montgomery A, Galway R, Kernohan WG, McKane R. A randomized controlled trial of intra-articular triamcinolone and/or physiotherapy in shoulder capsulitis. *Rheumatology (Oxford)* 2005;44:529-35.
 135. Sahoo BS, Sahoo KB, Naik LK, Sahoo TP. Role of intraarticular steroid injection with physiotherapy and physiotherapy alone in idiopathic adhesive capsulitis of shoulder (frozen shoulder). *Int J Pharm Clin Res* 2023;15:1050-6.
 136. Sharma SP, Bærheim A, Moe-Nilssen R, Kvåle A. Adhesive capsulitis of the shoulder, treatment with corticosteroid, corticosteroid with distension or treatment-as-usual; a randomised controlled trial in primary care. *BMC Musculoskelet Disord* 2016;17:232.
 137. Tas-Cebe G, Cummings C. A single-blinded controlled trial comparing corticosteroid injection, acupuncture and home-based exercises for the treatment of primary contracted (frozen) shoulder. *J Acupunct Assoc Chart Physiother* 2013;2013:25-38.
 138. van der Windt DA, Koes BW, Devillé W, Boeke AJ, de Jong BA, Bouter LM. Effectiveness of corticosteroid injections versus physiotherapy for treatment of painful stiff shoulder in primary care: randomised trial. *BMJ* 1998;317:1292-6.
 139. Yoon SH, Lee HY, Lee HJ, Kwack KS. Optimal dose of intra-articular corticosteroids for adhesive capsulitis: a randomized, triple-blind, placebo-controlled trial. *Am J Sports Med* 2013;41:1133-9.
 140. Cho CH, Min BW, Bae KC, Lee KJ, Kim DH. A prospective double-blind randomized trial on ultrasound-guided versus blind intra-articular corticosteroid injections for primary frozen shoulder. *Bone Joint J* 2021;103-B:353-9.
 141. Lee HJ, Lim KB, Kim DY, Lee KT. Randomized controlled trial for efficacy of intra-articular injection for adhesive capsulitis: ultrasonography-guided versus blind technique. *Arch Phys Med Rehabil* 2009;90:1997-2002.
 142. Lee HJ, Ok JH, Park I, Bae SH, Kim SE, Shin DJ, et al. A random-

- ized comparative study of blind versus ultrasound guided glenohumeral joint injection of corticosteroids for treatment of shoulder stiffness. *Clin Shoulder Elb* 2015;18:120-7.
143. Raeissadat SA, Rayegani SM, Langroudi TF, Khoiniha M. Comparing the accuracy and efficacy of ultrasound-guided versus blind injections of steroid in the glenohumeral joint in patients with shoulder adhesive capsulitis. *Clin Rheumatol* 2017;36:933-40.
 144. Eustace JA, Brophy DP, Gibney RP, Bresnihan B, FitzGerald O. Comparison of the accuracy of steroid placement with clinical outcome in patients with shoulder symptoms. *Ann Rheum Dis* 1997;56:59-63.
 145. Kraeutler MJ, Cohen SB, Ciccotti MG, Dodson CC. Accuracy of intra-articular injections of the glenohumeral joint through an anterior approach: arthroscopic correlation. *J Shoulder Elbow Surg* 2012;21:380-3.
 146. de Jong BA, Dahmen R, Hogeweg JA, Marti RK. Intra-articular triamcinolone acetonide injection in patients with capsulitis of the shoulder: a comparative study of two dose regimens. *Clin Rehabil* 1998;12:211-5.
 147. Kim KH, Park JW, Kim SJ. High- vs low-dose corticosteroid injection in the treatment of adhesive capsulitis with severe pain: a randomized controlled double-blind study. *Pain Med* 2018;19:735-41.
 148. Kim YS, Lee HJ, Lee DH, Choi KY. Comparison of high- and low-dose intra-articular triamcinolone acetonide injection for treatment of primary shoulder stiffness: a prospective randomized trial. *J Shoulder Elbow Surg* 2017;26:209-15.
 149. Lee JH, Choi EJ, Han SC, Chung HS, Kwon MJ, Jayaram P, et al. Therapeutic efficacy of low-dose steroid combined with hyaluronidase in ultrasonography-guided intra-articular injections into the shoulder for adhesive capsulitis. *Ultrasonography* 2021;40:555-64.
 150. CHOUDHARY N, GUPTA S. Frozen shoulder: does hydrodilatation with steroid has added advantage over intra-articular steroid injection. *Asian J Pharm Clin Res* 2022;15:147-9.
 151. Paruthikunnan SM, Shastry PN, Kadavigere R, Pandey V, Karegowda LH. Intra-articular steroid for adhesive capsulitis: does hydrodilatation give any additional benefit? A randomized control trial. *Skeletal Radiol* 2020;49:795-803.
 152. Reza SS, Bijan F, Asghar HA, Morteza T. Treatment of frozen shoulder: a double blind study comparing the impact of triamcinolone injection alone or in association with joint distention. *Res J Pharm Biol Chem Sci* 2013;4:226-34.
 153. Sharma SP, Kvåle A, Bærheim A. Outcome in shoulder capsulitis (frozen shoulder) treated with corticosteroid and corticosteroid with distension: a randomised pilot study. *Int Musculoskelet Med* 2009;31:75-80.
 154. Swaroop S, Gupta P, Patnaik S, Reddy SS. Intra-articular steroid alone vs hydrodilatation with intra-articular steroid in frozen shoulder - a randomised control trial. *Malays Orthop J* 2023;17:34-9.
 155. Tveitå EK, Tariq R, Sesseng S, Juel NG, Bautz-Holter E. Hydrodilatation, corticosteroids and adhesive capsulitis: a randomized controlled trial. *BMC Musculoskelet Disord* 2008;9:53.
 156. Yoon JP, Chung SW, Kim JE, Kim HS, Lee HJ, Jeong WJ, et al. Intra-articular injection, subacromial injection, and hydrodilatation for primary frozen shoulder: a randomized clinical trial. *J Shoulder Elbow Surg* 2016;25:376-83.
 157. Park GY, Hwnag SE. Comparison of intraarticular steroid injection with and without capsular distension in adhesive capsulitis of the shoulder. *J Korean Acad Rehabil Med* 2000;24:1174-9.
 158. Akhtar M, Nadeem RDA, Shah Gillani SE, Cheema OI, Nadeem MR. Comparison of intra articular NSAID (ketorolac) injection versus hyaluronic acid injection for the mean decrease of pain score (according to UCLA shoulder rating scale) in the management of adhesive capsulitis. *Pak J Pharm Sci* 2019;32:953-6.
 159. Kim C, An JK, Park YB, Park YK, Rue HW, Kim DY. The effect of sono-guided intraarticular injection of hyaluronate in shoulder adhesive capsulitis. *Clin Pain* 2007;6:82-8.
 160. Elwan Sayed M, Mohammed Hussein E, Moslaem Ebrahim A, Moshrif A. Ultrasonographic guided intra articular steroid versus hyaluronic acid in adhesive capsulitis with and without suprascapular nerve block: a randomized controlled trial. *Muscle Ligaments Tendons J* 2022;12:216-23.
 161. Hsieh LF, Hsu WC, Lin YJ, Chang HL, Chen CC, Huang V. Addition of intra-articular hyaluronate injection to physical therapy program produces no extra benefits in patients with adhesive capsulitis of the shoulder: a randomized controlled trial. *Arch Phys Med Rehabil* 2012;93:957-64.
 162. Lim TK, Koh KH, Shon MS, Lee SW, Park YE, Yoo JC. Intra-articular injection of hyaluronate versus corticosteroid in adhesive capsulitis. *Orthopedics* 2014;37:e860-5.
 163. Park KD, Nam HS, Lee JK, Kim YJ, Park Y. Treatment effects of ultrasound-guided capsular distension with hyaluronic acid in adhesive capsulitis of the shoulder. *Arch Phys Med Rehabil* 2013;94:264-70.
 164. Kim HW, Kim HS, Ahn KH. The effect of intraarticular injection of hyaluronic acid and steroid in adhesive capsulitis of shoulder. *J Korean Acad Rehab Med* 1999;23:117-23.
 165. Abodonya AM, Alrawaili SM, Abdelbasset WK. Evaluation of shoulder pain, disability, mobility, and quality of life in patients with adhesive capsulitis following suprascapular nerve block combined with low-intensity laser therapy. *Eur Rev Med Pharmacol Sci*

- 2023;27:845-51.
166. Dahan TH, Fortin L, Pelletier M, Petit M, Vadeboncoeur R, Suissa S. Double blind randomized clinical trial examining the efficacy of bupivacaine suprascapular nerve blocks in frozen shoulder. *J Rheumatol* 2000;27:1464-9.
 167. Jadon A, Sanyal S, Pavan S, Bakshi A, Bharadwaj A, Singh AP. Suprascapular Nerve Block (SSNB) improves the outcome in exercise based management of Primary Adhesive Capsulitis (PAC): a prospective randomized comparative study. *J Anaesthesiol Clin Pharmacol* 2023;39:195-200.
 168. Mardani-Kivi M, Nabi BN, Mousavi MH, Shirangi A, Leili EK, Ghadim-Limudahi ZH. Role of suprascapular nerve block in idiopathic frozen shoulder treatment: a clinical trial survey. *Clin Shoulder Elb* 2022;25:129-39.
 169. Schiltz M, Beeckmans N, Gillard B, DE Baere T, Hatem SM. Randomized controlled trial of suprascapular nerve blocks for subacute adhesive capsulitis. *Eur J Phys Rehabil Med* 2022;58:630-7.
 170. Kılç Z, Filiz MB, Çakır T, Toraman NF. Addition of suprascapular nerve block to a physical therapy program produces an extra benefit to adhesive capsulitis: a randomized controlled trial. *Am J Phys Med Rehabil* 2015;94(10 Suppl 1): 912-20.
 171. Jacobs LG, Smith MG, Khan SA, Smith K, Joshi M. Manipulation or intra-articular steroids in the management of adhesive capsulitis of the shoulder? A prospective randomized trial. *J Shoulder Elbow Surg* 2009;18:348-53.
 172. Quraishi NA, Johnston P, Bayer J, Crowe M, Chakrabarti AJ. Thawing the frozen shoulder. A randomised trial comparing manipulation under anaesthesia with hydrodilatation. *J Bone Joint Surg Br* 2007;89:1197-200.
 173. Rangan A, Brealey SD, Keding A, Corbacho B, Northgraves M, Kottam L, et al.; UK FROST Study Group. Management of adults with primary frozen shoulder in secondary care (UK FROST): a multicentre, pragmatic, three-arm, superiority randomised clinical trial. *Lancet* 2020;396:977-89.
 174. Thomas D, Williams RA, Smith DS. The frozen shoulder: a review of manipulative treatment. *Rheumatol Rehabil* 1980;19:173-9.
 175. Salomon M, Pastore C, Maselli F, Di Bari M, Pellegrino R, Brindisino F. Manipulation under anesthesia versus non-surgical treatment for patients with frozen shoulder contracture syndrome: a systematic review. *Int J Environ Res Public Health* 2022;19:9715.