

TREATMENT OF ADHESIVE CAPSULITIS OF THE SHOULDER

A Critical Analysis Review

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Abstract

» Idiopathic adhesive capsulitis of the shoulder is a self-limiting condition with gradual improvement in symptoms over a variable period of time (1 to 3 years), although a small subset of patients can have permanent residual symptoms.

» Nonoperative and operative treatments do not alter the long-term natural history of adhesive capsulitis, but they do provide short-term symptomatic relief of pain and improvement in shoulder range of motion.

» There has been no consensus in scientific literature on a single treatment type, nonoperative, operative, or combined, which is more effective in the treatment of adhesive capsulitis.

» There has been a general consensus that nonoperative management is the initial treatment of choice for adhesive capsulitis. Nonoperative treatments such as physical therapy, oral anti-inflammatory medications, corticosteroid injections, and hydrodilatation allow accelerated pain relief and/or improvement in range of motion compared with untreated controls, but these differences are short-term and there is no difference in final outcomes.

» There has been insufficient evidence to support early operative treatment for adhesive capsulitis. However, there has been a general consensus that operative treatment (arthroscopic capsular release and/or manipulation under anesthesia) is an option if nonoperative treatment fails after a period of 6 months.

» Arthroscopic capsular release with or without manipulation results in early relief of pain and improvement in motion compared with nonoperative treatment, but there is no difference in the final outcomes.

» There has been insufficient evidence to make recommendations with regard to the indication for and timing of operative treatment or to the ideal surgical technique for arthroscopic capsular release.

Adhesive capsulitis, more commonly called frozen shoulder, was first recognized by Duplay in 1896 and termed “peri-arthritis scapulohumerale.” The term “frozen shoulder” was later coined by Codman in 1934, and Neviaser subsequently proposed the term “adhesive capsulitis.”^{1,2} As per the American Shoulder and Elbow Surgeons (ASES) consensus definition, “adhesive capsulitis” refers to a condition of uncertain etiology characterized by considerable

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restriction of both active and passive shoulder motion that occurs in the absence of a known intrinsic shoulder disorder^{1,3}. Primary or idiopathic adhesive capsulitis develops without antecedent trauma or specific shoulder disease⁴. Capsular contracture in secondary adhesive capsulitis occurs secondary to an identifiable cause, which has been further subdivided into intrinsic, extrinsic, and systemic causes^{3,5}.

It is estimated that 2% to 5% of the population is affected with adhesive capsulitis^{1,6-10}. Women between the ages of 40 and 60 years are most commonly affected and are more likely to involve their nondominant shoulder^{1,5}. Various risks factors have been described for adhesive capsulitis, including association with diabetes mellitus, family history, thyroid abnormalities, genetic disposition, and ethnicity^{11,12}. An association between Dupuytren disease and adhesive capsulitis has also been reported, and the rate of palmar contracture has been reported to be as high as 58% in patients with adhesive capsulitis¹³.

Understanding the natural history of adhesive capsulitis is critical for the development of a treatment algorithm and strategies. The clinical course of adhesive capsulitis follows 3 phases (freezing, frozen, and thawing) as originally described by Reeves¹⁴. Reeves noted that the length of the recovery period was associated with the length of the painful period, and the greatest recovery can be seen in patients between 1 and 4 years after the initial onset of symptoms¹⁴. Codman's classic teaching with regard to adhesive capsulitis stated that recovery will and should be expected to occur given appropriate time, which can vary between 2 and 3 years on average^{2,14}. However, multiple studies have shown that complete resolution should not be universally expected^{7,14,15}.

Considerable progress has been made in the understanding of the pathology, natural history, and treatment of adhesive capsulitis. However, there continue to be gaps in our

knowledge with regard to risk factors, etiology, and different aspects of its treatment. The aims of this review were to critically analyze the published literature and to present evidence-based recommendations for the treatment of idiopathic adhesive capsulitis.

Methodology

A search of the literature was performed in English with the help of an information specialist in June 2017. Authors searched for articles published up to June 2017 in MEDLINE through PubMed along with the Cochrane Central Register of Controlled Trials (CENTRAL) and Embase through the Ovid interface. The search was set broadly to identify all studies that discussed the treatment of adhesive capsulitis using the terms "bursitis," "frozen shoulder," or "adhesive capsulitis." The search was limited to adults (≥ 18 years of age) and excluded animal or cadaveric studies. No date limit was applied. The primary focus of this review was the treatment of adhesive capsulitis, and, therefore, all studies that conformed to this topic were aggregated for review. In particular, the studies that were included compared nonoperative treatment modalities or compared surgical and nonoperative treatments. Only studies showing idiopathic adhesive capsulitis were included, which excluded studies showing shoulder stiffness secondary to other shoulder pathology such as post-surgical stiffness, rotator cuff disease, or osteoarthritis of the glenohumeral or acromioclavicular joints. Exclusion criteria for this search included all studies with poorer than Level-III evidence, radiographic studies, biomechanical studies, basic science studies, and meta-analyses.

After duplicates were removed, the search resulted in 3,268 citations (Fig. 1). One reviewer assessed the citations on the basis of their titles alone to ascertain the focus of their studies. Those citations that were clearly unrelated to the focus of this review were excluded, leaving 305 citations for abstract review. After abstract review was

completed, the full text of 175 studies was reviewed by 3 authors. Forty-five studies met the inclusion criteria and were analyzed in detail for this critical analysis (Fig. 1). The included studies were evaluated for level of evidence and quality by 2 independent reviewers using the Strength of Recommendation Taxonomy (SORT)¹⁶.

Critical Analysis of the Management of Adhesive Capsulitis

The currently available treatment strategies for adhesive capsulitis provide symptomatic relief of pain and stiffness without affecting the underlying etiology. In this review, we critically analyzed the literature for management of adhesive capsulitis and determined if any of the treatments altered the natural history of adhesive capsulitis and if any treatment type was better than another.

Nonoperative Treatment

Nonoperative management of adhesive capsulitis includes a broad list such as physical therapy, oral anti-inflammatory medications (nonsteroidal anti-inflammatory drugs [NSAIDs] and corticosteroids), shoulder injections (corticosteroids and hyaluronate), alternative medical practices, or any combination of these¹.

Physical Therapy

Physical therapy is the most commonly used nonoperative modality in the treatment of adhesive capsulitis. The term "physical therapy," described in the treatment of adhesive capsulitis, encompasses a broad array of modalities including, but not limited to, stretching, static and dynamic mobilization, and use of other concomitant modalities such as ultrasound, temperature therapy, and massage. Therapy protocols include supervised, group, or home programs.

Lack of uniform treatment protocols and extremely heterogeneous treatment types present a challenge for comparing studies that show the use of physical therapy for the treatment of

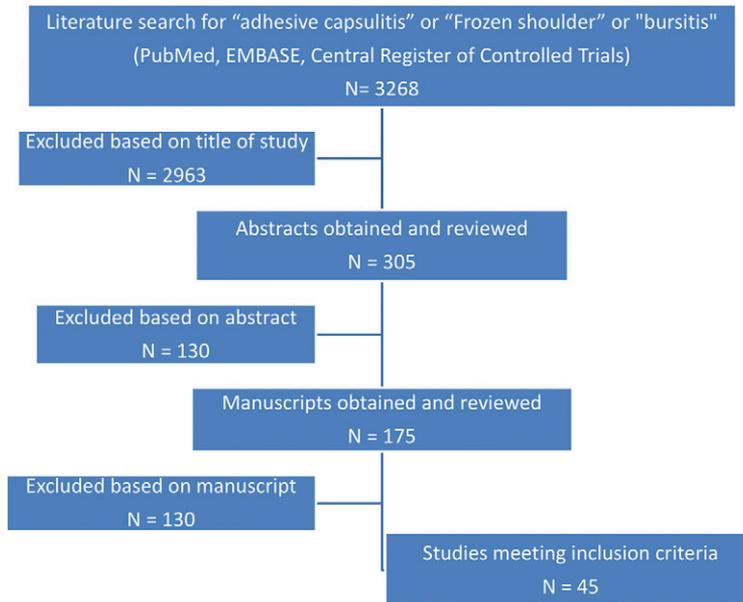


Fig. 1

Flow diagram of the evaluation process for studies included in the literature review for treatment of adhesive capsulitis.

adhesive capsulitis. Diercks and Stevens compared intensive physical therapy (therapist-assisted passive stretching and manual mobilization) and supervised neglect (home exercise program) in a cohort of 77 patients with adhesive capsulitis¹⁷. The intensive physical therapy group had lower mean Constant scores when compared with the supervised neglect group at all time points, including the final follow-up of 2 years. In contrast to the study by Diercks and Stevens, in a blinded, randomized controlled trial (RCT), Russell et al. demonstrated that a group exercise class can produce rapid recovery from adhesive capsulitis compared with individual physical therapy or home exercises alone¹⁸. All 3 groups had improvements in pain score, range of motion, and quality-of-life metrics compared with pretreatment values.

Six high-quality studies that compared special techniques of physical therapy with those of conventional physical therapy were analyzed to determine if a particular physical therapy technique was superior in the treatment of adhesive capsulitis (Table I)¹⁹⁻²⁴. Each of these 6 RCTs compared a particular adjunctive therapy technique with conventional physical therapy and, because of the heterogeneous nature of

these studies, group comparisons were not made. Nonetheless, most of the adjunctive therapy techniques augment improvements in pain and range of motion for the treatment of adhesive capsulitis compared with conventional physical therapy.

Physical therapy results in early gain in range of motion, but there has been insufficient evidence to conclude that a particular type of physical therapy (home, hospital, or group) or a particular adjunctive technique is more effective in adhesive capsulitis. Furthermore, there has been insufficient evidence to suggest that physical therapy alters the long-term natural history of adhesive capsulitis.

Oral Medications

In addition to physical therapy, oral anti-inflammatory medications account for the mainstay of initial conservative care for adhesive capsulitis^{1,9}. Both steroidal and nonsteroidal medications are commonly used. However, to our knowledge, there have been no RCTs evaluating NSAIDs compared with placebo. Other RCTs have evaluated the use of oral corticosteroids in the treatment of adhesive capsulitis, but only 2 studies matched our inclusion criterion^{25,26}. In 1 RCT, Buchbinder

et al. randomized 50 patients with adhesive capsulitis into a corticosteroid group (daily oral corticosteroids [30 mg] for 3 weeks) or a control group (placebo tablets), with both groups having access to a home exercise program. The corticosteroid group had significantly greater improvement ($p < 0.05$) in pain relief and range of motion at the early time point (3 weeks), but there were no significant differences between the 2 groups for any outcome measures at later time points (6 and 12 weeks)²⁶. No serious adverse effects were reported in the study except for stress fracture in the foot in the placebo group. The corticosteroid group did notice a rebound effect or flare-up, which is worsening of shoulder pain due to the sudden withdrawal of corticosteroids. In another study, Binder et al. randomized 40 patients with adhesive capsulitis to the corticosteroid treatment group (daily oral, enteric-coated prednisolone [10 mg for the first 4 weeks and 5 mg for next 2 weeks]) or the control group (no oral corticosteroids). The corticosteroid group had significantly better pain relief ($p < 0.05$) early on, and there were no significant differences between the 2 groups at the time of the final follow-up in terms of pain scores or range of motion²⁵. Two patients in the

TABLE I Studies with Treatment of Adhesive Capsulitis Comparing Conventional Physical Therapy with Special Physical Therapy Techniques*

Study	Study Design	LOE	No. of Patients	Follow-up	Intervention Groups	Outcome Measures	Conclusions
Donez ²¹ (2013)	RCT	I	40	3 mo	Mulligan's technique compared with conventional physical therapy	VAS, range of motion, Constant score, SDQ, satisfaction	Outcome improvements greater in Mulligan's technique at final follow-up ($p < 0.05$)
Ibrahim ²³ (2014)	RCT	I	60	12 mo	Static stretch device with physical therapy compared with physical therapy alone	Range of motion, DASH, VAS	Better scores and range of motion with static stretch device group ($p < 0.05$)
Paul ²⁴ (2014)	RCT	I	100	2 wk	Sustained stretching compared with conventional physical therapy	Range of motion, VAS, OSS	Significantly higher number of patients achieving satisfactory shoulder function with sustained stretching ($p < 0.001$)
Gutiérrez Espinoza ²² (2015)	RCT	I	57	10 wk	Posterior mobilization compared with conventional physical therapy	Range of motion, VAS, Constant score	Greater improvements in range of motion and scores for mobilization group ($p < 0.0001$)
Ali ¹⁹ (2015)	RCT	I	44	5 wk	Physical therapy with Maitland mobilization compared with conventional physical therapy	SPADI, VAS, range of motion	No significant difference in any outcomes at final follow-up ($p > 0.05$)
Chung ²⁰ (2015)	RCT	I	30	6 mo	Physical therapy with continuous passive motion compared with conventional physical therapy	Constant score, VAS, range of motion	No significant difference between groups in outcome scores or range of motion; significantly better VAS scores for continuous passive motion group at final follow-up ($p < 0.001$)

*LOE = Level of Evidence, SDQ = Shoulder Disability Questionnaire, DASH = Disabilities of the Arm, Shoulder and Hand questionnaire, OSS = Oxford Shoulder Score, and SPADI = Shoulder Pain and Disability Index.

corticosteroid group had mild indigestion, which improved with reduction of the corticosteroid dose.

The available evidence demonstrates that oral anti-inflammatory medications provide early pain relief, but the overall duration of symptoms and final improvements in range of motion are not significantly different compared with control or placebo.

Injections

We analyzed 15 RCTs (Level I or II) to answer 3 important questions related to injection therapies in adhesive capsulitis: (1) Is the injection therapy superior to placebo or to oral medications or physical therapy? (2) Does the site (subacromial compared with intra-articular) or location (anterior compared with posterior approach) of the injection or the dosage of corticosteroid injections influence treatment response? (3) Is there a difference in outcomes between different injected medications (corticosteroid compared with hyaluronic acid)?

We analyzed 4 studies that compared the efficacy of intra-articular corticosteroid injection with that of control or placebo in adhesive capsulitis (Table II)²⁷⁻³⁰. Bal et al. randomized 80 patients to receive a single intra-articular corticosteroid (methylprednisolone acetate; 40 mg) or placebo injection (1 mL of 0.9% sodium chloride)²⁷. One physician did all injections without image guidance via the posterior approach, and all patients participated in a home exercise program. There was significant improvement in shoulder pain and outcome scores in the corticosteroid group at 2 weeks ($p = 0.002$), but there were no differences between the 2 groups at later time points. Similar results were reported by Roh et al. in an RCT on a diabetic population²⁹. In a triple-blinded, placebo-controlled RCT, Yoon et al. randomized 53 patients with adhesive capsulitis to ultrasound-guided intra-articular corticosteroid injection (triamcinolone acetonide, high dose [40 mg] and low dose [20 mg], posterior approach) or placebo

treatment, with all groups allowed concurrent home exercise program³⁰. Both corticosteroid groups had significant improvements ($p < 0.05$) in the visual analog scale (VAS) pain scores, outcome measures, and range of motion (flexion, abduction, and internal rotation) compared with placebo, but there were no significant differences between the high-dose and low-dose corticosteroid groups. In an RCT, Prestgaard et al. compared ultrasound-guided intra-articular corticosteroid and combined intra-articular and rotator interval corticosteroid (20-mg triamcinolone hexacetonide) injection²⁸. The sham injection group (control) received lidocaine but no corticosteroids. There were significant improvements ($p < 0.05$) in pain relief and outcome measures in both of the corticosteroid groups at 6 and 12 weeks compared with the sham group, but no significant differences were present between the 3 groups at a later time point (26 weeks). All 4 high-level studies and 2 additional studies discussed later in this article (Carette

TABLE II Studies Comparing the Use of Corticosteroid Injections with Controls or Placebo for the Treatment of Adhesive Capsulitis*

Study	Study Design	LOE	No. of Patients	Follow-up	Intervention Groups	Outcome Measures	Conclusions
Bal ²⁷ (2008)	RCT	I	80	12 wk	Single intra-articular corticosteroid injection (methylprednisolone 40 mg) compared with saline solution injection	SPADI, UCLA, range of motion	Greater pain relief ($p = 0.002$) with intra-articular corticosteroid at 2 wk, but no significant difference at final follow-up
Roh ²⁹ (2012)	RCT	II	45	24 wk	Intra-articular corticosteroid injection compared with no-injection control†	VAS, range of motion, ASES	Greater improvement in pain at 4 wk ($p = 0.02$) and range of motion at 12 wk with intra-articular corticosteroid ($p = 0.04$), but no significant difference in outcomes at 24 wk
Yoon ³⁰ (2013)	RCT	II	53	12 wk	High-dose intra-articular corticosteroid (triamcinolone 40 mg) compared with low-dose intra-articular corticosteroid (triamcinolone 20 mg) compared with placebo	SPADI, VAS, range of motion	Significant improvements in outcomes scores in the corticosteroid groups compared with placebo ($p < 0.05$)
Prestgaard ²⁸ (2015)	RCT	I	122	26 wk	Intra-articular corticosteroid injection compared with intra-articular and rotator interval injection compared with sham injection‡	Pain score, range of motion, SPADI, EQ-5D	Significant improvements in both corticosteroid groups compared with sham group up to 12 wk ($p < 0.002$), but no significant difference at final follow-up

*LOE = Level of Evidence, SPADI = Shoulder Pain and Disability Index, UCLA = University of California at Los Angeles score, and EQ-5D = EuroQol 5-Dimensions. †This group has a single 40-mg triamcinolone injection for each corticosteroid group. ‡This group had a single 20-mg triamcinolone injection for each corticosteroid group.

et al.³¹ and Ryans et al.³²) provided good-quality evidence that intra-articular corticosteroids result in short-term pain relief and improvements in range of motion compared with placebo, but this treatment does not shorten the duration or final outcome of adhesive capsulitis.

We analyzed 3 studies that directly compared intra-articular corticosteroids with either NSAIDs or oral corticosteroids³³⁻³⁵. Ranalletta et al. randomized 74 patients with adhesive capsulitis to receive either a single intra-articular corticosteroid injection (12-mg betamethasone) or oral NSAIDs (75-mg diclofenac, 2 times a day)³⁵. The corticosteroid group had significant improvement ($p < 0.001$) in pain and function compared with the NSAID group up to 8 weeks, but there was no significant difference at 12 weeks. Dehghan et al. reported results similar to those in the study by Ranalletta et al. in an RCT in which 57 patients with adhesive capsulitis were randomized to receive either a single ultrasound guided intra-articular

corticosteroid injection (40-mg triamcinolone) or oral NSAIDs (500-mg naproxen, twice a day) and found no significant difference between the 2 groups at the time of the final follow-up (24 months)³³. Lorbach et al. compared oral and intra-articular corticosteroids in an RCT with 40 patients³⁴. The intra-articular corticosteroid group received a series of 3 fluoroscopically controlled corticosteroid injections (40-mg triamcinolone at 0, 4, and 8 weeks) and the oral corticosteroid group received a tapering dose of oral corticosteroid spread over 25 days. Both the oral and intra-articular corticosteroid groups reported pain relief and improvements in range of motion compared with pretreatment values, but the injection group had significant improvements ($p < 0.05$) in the Constant score, patient satisfaction, and range of motion (abduction) compared with the oral corticosteroid group at 1 year.

Very few studies have compared intra-articular injections with physical therapy for adhesive capsulitis. Carrette

et al.³¹ and Ryans et al.³² compared corticosteroid injection with and without physical therapy against sham injection with and without physical therapy. The corticosteroid treatment groups had early improvement compared with the sham injection group, but at later time points (≥ 3 months), all groups had a similar degree of improvement of all measured outcomes. The aforementioned studies demonstrate that there is no long-term difference among corticosteroid injections, oral corticosteroids, NSAIDs, and physical therapy.

Five studies compared the influence of the site of injection (anterior approach compared with posterior approach and subacromial compared with intra-articular) (Table III) on the efficacy of corticosteroid treatment in adhesive capsulitis^{28,36-39}. Oh et al.³⁷ and Shin and Lee³⁸ prospectively compared subacromial and intra-articular routes of corticosteroid injection and did not find any significant difference in outcomes at ≥ 3 months. On the contrary, an RCT by

TABLE III Studies Comparing the Location of Injections for the Treatment of Adhesive Capsulitis*

Study	Study Design	LOE	No. of Patients	Follow-up	Intervention Groups	Outcome Measures	Conclusions
Oh ³⁷ (2011)	RCT	I	71	12 wk	Intra-articular corticosteroid injection compared with subacromial corticosteroid injection†	VAS, Constant, range of motion	Significant improvement in VAS scores for intra-articular group at 3 wk (p = 0.02), but no significant difference in outcomes at any other time point
Shin ³⁸ (2013)	RCT	II	191	24 wk	Intra-articular corticosteroid injection compared with subacromial corticosteroid injection compared with combined (intra-articular and subacromial) compared with oral medication†	VAS, ASES	Significant improvement in pain in all injection groups compared with oral group up to 16 wk (p < 0.05), but no significant difference at final follow-up
Prestgaard ²⁸ (2015)	RCT	I	122	26 wk	Intra-articular corticosteroid injection compared with intra-articular and rotator interval injection compared with sham injection‡	Pain scores, range of motion, SPADI, EQ-5D	Significant improvements in both injection groups over sham up to 12 wk (p < 0.002), but no significant difference at final follow-up
Yoon ³⁹ (2016)	RCT	I	86	6 mo	Intra-articular corticosteroid injection compared with subacromial corticosteroid injection compared with hydrodilatation (corticosteroid)†	VAS, SST, Constant	Hydrodilatation had improved VAS and SST at 1 and 3 mo (p < 0.05), but no significant difference between groups at final follow-up
Cho ³⁶ (2016)	RCT	II	126	12 wk	Intra-articular corticosteroid injection compared with subacromial corticosteroid injection compared with combined (intra-articular and subacromial) injection†	VAS, ASES, SSV, range of motion	Intra-articular and combined groups had significantly better outcomes compared with subacromial alone (p < 0.03)

*LOE = Level of Evidence, SPADI = Shoulder Pain and Disability Index, and SST = Simple Shoulder Test. †This group had a single 40-mg triamcinolone injection for each corticosteroid group. ‡This group had a single 20-mg triamcinolone injection for each corticosteroid group.

Cho et al. comparing intra-articular, subacromial, and combined intra-articular and subacromial corticosteroid injection demonstrated conflicting results³⁶. All patients received an ultrasound-guided injection of 40-mg triamcinolone. At the 3-month follow-up, the intra-articular group and the subacromial plus intra-articular corticosteroid group had significant improvements (p < 0.001) in the VAS scores, ASES, Subjective Shoulder Value (SSV), and internal rotation compared with the subacromial group. There is conflicting evidence in the literature to demonstrate superiority of any particular injection site (intra-articular, subacromial, or combined) for corticosteroids in the shoulder.

Three studies evaluated the influence of corticosteroid dose on treatment of adhesive capsulitis^{28,30,40}. In an RCT, Kim et al. compared 40 mg (high dose) with 20 mg (low dose) of triamcinolone acetate, which was administered via anterior approach using ultrasound guidance⁴⁰. Both groups improved significantly compared with the baseline outcomes (p < 0.05), but there were no significant differences between the 2 groups with respect to pain scores and other outcome measures. Results similar to those in the study by Kim et al. were reported by Prestgaard et al.²⁸ and Yoon et al.³⁰. In addition to corticosteroid injections, intra-articular sodium hyaluronate has been shown to be safe and has been used for the treatment of

adhesive capsulitis, but there is limited evidence in the literature comparing hyaluronic acid with other treatments for adhesive capsulitis⁴¹⁻⁴⁴.

Hydrodilatation

Hydrodilatation of the capsule was originally described by Andren and Lundberg in the treatment of the stiff shoulder, and this technique involves intra-articular injection and progressive dilatation of the shoulder capsule until eventual rupture⁴⁵. We reviewed 4 RCTs that compare hydrodilatation with other treatments (Table IV)^{39,46-48}. Tveitå et al. compared hydrodilatation using intra-articular corticosteroid (20-mg triamcinolone) with injection of an intra-articular corticosteroid

TABLE IV Studies Comparing Hydrodilatation and Other Treatment Modalities for Adhesive Capsulitis*

Study	Study Design	LOE	No. of Patients	Follow-up	Intervention Groups	Outcome Measures	Conclusions
Tveit ⁴⁸ (2008)	RCT	II	76	3 mo	Intra-articular corticosteroid and hydrodilatation compared with intra-articular corticosteroid alone†	SPADI, range of motion	No significant difference in outcomes between groups at final follow-up
Park ⁴⁷ (2013)	RCT	I	100	6 wk	Intra-articular corticosteroid compared with hydrodilatation with hyaluronic acid (series of 3 injections for all patients)‡	Pain scores, working ability, SPADI	No significant difference between groups at final follow-up for functional scores or pain, but improved external rotation ($p < 0.05$) with hydrodilatation
Yoon ³⁹ (2016)	RCT	I	86	6 mo	Intra-articular corticosteroid injection compared with subacromial corticosteroid injection compared with hydrodilatation (corticosteroid)‡	VAS, SST, Constant score, range of motion	Hydrodilatation with significantly better VAS and range of motion at 1 and 3 mo ($p < 0.05$), but no significant difference in groups at final follow-up
Lee ⁴⁶ (2017)	RCT	I	64	3 mo	Intra-articular corticosteroid and hydrodilatation compared with intra-articular corticosteroid injection alone‡	Range of motion, SPADI, VAS	No significant difference in outcomes between groups at any time points

*LOE = Level of Evidence, SPADI = Shoulder Pain and Disability Index, and SST = Simple Shoulder Test. †This group had a single 20-mg triamcinolone injection for each corticosteroid group. ‡This group had a single 40-mg triamcinolone injection for each corticosteroid group.

alone for the treatment of adhesive capsulitis. Patients were given a total of 4 injections at 2-week intervals under radiographic control, and, at each time point, the injection group received a mean volume of 7 mL and the hydrodilatation group received a mean volume of 21 mL⁴⁸. Capsule rupture was demonstrated by dye leakage on radiographs in 3 patients in the injection group and in all patients in the hydrodilatation group. The addition of capsular distention to intra-articular corticosteroid did not significantly change the functional scores or range of motion. Lee et al.⁴⁶ and Park et al.⁴⁷ also demonstrated no considerable short or long-term differences with the addition of hydrodilatation to an intra-articular injection of a corticosteroid or hyaluronic acid (Table IV). In contrast to the aforementioned studies, Yoon et al. found that hydrodilatation with an intra-articular corticosteroid results in significantly better motion, pain improvement, and functional scores at 1 and 3 months, although, at 6 months, there were no significant differences compared with an intra-articular or subacromial corticosteroid injection³⁹. Critical evaluation of available studies assessing hydrodilatation as a

treatment modality for adhesive capsulitis demonstrates conflicting evidence on the additive effect of hydrodilatation combined with intra-articular corticosteroid or hyaluronic acid injection.

Operative Treatment

Operative treatment for adhesive capsulitis includes manipulation under anesthesia and surgical capsular release. Despite treatment with nonoperative modalities, there is a subset of patients with adhesive capsulitis who continue to have persistent, disabling shoulder symptoms that can affect their sleep, activities of daily living, and other desired activities, and there is general consensus that these patients will benefit from operative intervention^{1,2,7}.

Is Operative Treatment Superior to Nonoperative Care?

There are inherent limitations in designing high-quality randomized studies comparing nonoperative and operative treatment for adhesive capsulitis. Issues related to patient selection, defining the indication and optimal timing for surgical intervention, and optimizing the surgical treatment (manipulation under anesthesia, limited

capsular release, or circumferential capsular release) are some of the challenges that prohibit conducting an ideal research study. Furthermore, having a control group with supervised neglect has ethical implications. The ideal timing of the surgical procedure continues to be arbitrary (3 to 6 months of nonoperative care), but there has been a suggestion that operative treatment may alter the natural history and may shorten a prolonged course of pain and disability^{1,49,50}.

We analyzed 5 studies that compared operative and nonoperative treatment of adhesive capsulitis (Table V)⁵¹⁻⁵⁵. De Carli et al. prospectively evaluated 44 patients with adhesive capsulitis who were randomized to treatment with manipulation under anesthesia and arthroscopic capsular release ($n = 23$) or to intra-articular corticosteroid injection ($n = 21$)⁵¹. At a final follow-up of 1 year, both treatments resulted in substantial improvements compared with baseline with respect to range of motion, pain, and outcome scores. However, significant improvements in pain, outcome scores, and range of motion ($p < 0.03$) were seen in the operative treatment group at the 6-week follow-up compared with the

TABLE V Studies Comparing Operative and Nonoperative Treatments for Adhesive Capsulitis*

Study	Study Design	LOE	No. of Patients	Follow-up	Intervention Groups	Outcome Measures	Conclusions
De Carli ⁵¹ (2012)	RCT	I	44	12 mo	Manipulation under anesthesia and arthroscopic capsular release compared with intra-articular corticosteroid injection	ASES, UCLA, Constant score, SST, range of motion	Operative group achieved significant improvements from baseline 6 wk faster (p < 0.03)
Jacobs ⁵² (2009)	RCT	I	53	24 mo	Manipulation under anesthesia compared with intra-articular corticosteroid and hydrodilatation	Constant score, VAS, SF-36	No significant difference between 2 groups at final follow-up
Kivimäki ⁵³ (2007)	RCT	I	125	12 mo	Manipulation under anesthesia with home physical therapy compared with home physical therapy alone	Pain, working ability, SDQ	No significant difference between groups at final follow-up
Quraishi ⁵⁵ (2007)	RCT	I	36	6 mo	Manipulation under anesthesia compared with hydrodilatation	Range of motion, Constant score, VAS, satisfaction	Significantly better pain (p < 0.0001) and Constant score (p = 0.02) for hydrodilatation at final follow-up
Mun ⁵⁴ (2016)	RCT	II	121	12 mo	Manipulation under anesthesia plus hydrodistention compared with intra-articular corticosteroid injection	Constant score, VAS, range of motion	No significant difference at final follow-up

*LOE = Level of Evidence, UCLA = University of California at Los Angeles score, SST = Simple Shoulder Test, SDQ = Shoulder Disability Questionnaire, and SF-36 = Short-Form 36.

injection treatment group at the 12-week follow-up. Jacobs et al. randomized 53 patients with adhesive capsulitis into treatment with either hydrodilatation with corticosteroid (n = 25) or manipulation under anesthesia (n = 28). There were no significant differences in the Constant scores, VAS, or Short Form-36 (SF-36) scores between the treatment groups over a 2-year follow-up⁵². Similarly, manipulation under anesthesia, combined with a home exercise program, did not show any additive effect, with respect to improvement in pain, outcome scores, or working ability, compared with the home exercise program alone⁵³. Contrary to the results of the study by Jacobs et al., Mun and Baek demonstrated early improvements with manipulation under anesthesia plus hydrodilatation compared with intra-articular corticosteroid injection, although the final follow-up (12 months) results were not different

in the 2 groups⁵⁴. In contrast to the aforementioned studies, Quraishi et al. reported significantly better Constant scores and VAS scores with hydrodilatation compared with manipulation under anesthesia in an RCT⁵⁵. At the 6-month final follow-up, the hydrodilatation group had better Constant scores (p = 0.02) and VAS scores (p < 0.0001) and a higher percentage of patient satisfaction, but the range of motion was similar in both groups.

There is insufficient evidence to recommend surgical intervention as the first-line treatment in adhesive capsulitis. Furthermore, there is insufficient and inconsistent evidence to demonstrate superiority of surgical treatment over nonoperative treatment. Nevertheless, the current literature does support operative treatment as an option if adhesive capsulitis is refractory to nonoperative care, although the quality of evidence is poor.

Is One Operative Technique More Effective (Manipulation Compared with Arthroscopic Capsular Release)?

To our knowledge, there have been no RCTs comparing arthroscopic capsular release and manipulation under anesthesia. This may be attributed to the concurrent nature in which both of these techniques are performed clinically. Some surgeons perform manipulation under anesthesia routinely prior to or after the arthroscopic capsular release. Both manipulation under anesthesia and arthroscopic capsular release have been widely reported to be effective in achieving early pain relief, improved shoulder range of motion, and higher patient satisfaction, but there is concern that manipulation under anesthesia does not allow complete capsular release and may not be as effective as arthroscopic capsular release^{1,5,56}. The indications for the extent of capsular release (limited compared with pancapsular) are not well

TABLE VI Recommendations for Care for Adhesive Capsulitis

Recommendation	Grade*
1. Nonoperative treatment is the initial recommended treatment of choice for patients with idiopathic adhesive capsulitis.	C
2. Physical therapy, corticosteroids (oral or injection), hydrodilatation, or a combination of these is recommended for short-term relief of pain and improvement in range of motion, but these modalities do not alter the long-term outcome of adhesive capsulitis.	B
3. Arthroscopic capsular release is an option for patients who have undergone failed nonoperative treatment for >6 months.	C
4. Early surgical intervention is not recommended for adhesive capsulitis because there is insufficient evidence to demonstrate its long-term superiority over nonoperative treatment (either corticosteroids or physical therapy or both).	I
5. There is insufficient evidence to recommend a gold-standard nonoperative or operative treatment strategy that can alter the long-term natural history of adhesive capsulitis.	I

*Grade of recommendations: A = Good evidence (Level-I studies with consistent findings) for or against recommending intervention, B = Fair evidence (Level-II or III studies with consistent findings) for or against recommending intervention, C = Conflicting or poor-quality evidence (Level-IV or V studies) not allowing a recommendation for or against intervention, and I = There is insufficient evidence to make a recommendation.

defined. We analyzed 3 studies that compared limited and pancapsular arthroscopic capsular release for adhesive capsulitis. Chen et al. compared limited anterior with pancapsular arthroscopic capsular release in 74 patients in an RCT⁵⁷. All patients, regardless of treatment arm, underwent manipulation under anesthesia immediately following arthroscopic capsular release. The pancapsular group had a better early recovery of shoulder range of motion at 2, 4, 6, and 12 weeks compared with the limited release group. However, by 6 months, the 2 groups had similar Constant scores, VAS pain scores, and range of motion. In this study, a reasonable argument can be made that manipulation under anesthesia has the potential to convert limited release to nearly complete capsular release, resulting in no long-term difference between the 2 groups. Moon compared the results of pancapsular release with those of selective anterior release in patients with adhesive capsulitis who underwent at least 6 months of failed nonoperative treatment⁵⁸. The first 16 patients in the cohort

underwent pancapsular release, and the subsequent 19 patients underwent limited release. The 2 groups had similar outcomes, including VAS, Constant scores, and range of motion, except for better internal rotation ($p < 0.05$) immediately postoperatively in the pancapsular group. Walther et al. retrospectively evaluated 54 patients treated with arthroscopic capsular release plus subacromial decompression, with subacromial decompression plus manipulation under anesthesia, or with selective arthroscopic release alone⁵⁹. At a mean follow-up of 37 weeks, there were no significant differences in range of motion between any groups. There is insufficient evidence to recommend one particular surgical technique (manipulation under anesthesia or arthroscopic capsular release) for the treatment of adhesive capsulitis.

Conclusion

Our understanding of the pathophysiology and natural history of adhesive capsulitis continues to improve. The ideal treatment strategy for treating

idiopathic adhesive capsulitis is not known, and there is no agreement on one particular nonoperative or operative treatment strategy being more effective. Operative and nonoperative treatments result in relatively faster pain relief and improvements in range of motion, but final outcomes are not different. There is a general consensus on initial nonoperative treatment of adhesive capsulitis. Operative treatment is recommended for cases that have undergone failed nonoperative care for >3 to 6 months. However, the timing of surgical treatment, ideal surgical technique, and indications for surgical details including pancapsular compared with limited capsular release are not well defined (Table VI).

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