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*Systematic Review*

# Conservative treatment for idiopathic frozen shoulder: Is supervised neglect the answer? A systematic review

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ABSTRACT

***Objective:*** The aim of this study was to assess the most beneficial conservative treatment for idiopathic frozen shoulder.

***Methods:*** A total of 498 frozen shoulder cases (mean age 52.4 + 3.8 years) from 10 articles consisting of seven level 1B and three level 2B studies were included after searching electronic databases of Pubmed, Embase, and Scopus from 1st January 2000 up to 30th October 2020. Patients were followed up for 7.9 + 7.7 and 3 (1-24) months on average. The mean duration of symptoms the patient experienced before receiving conservative treatment was 22.5 + 6.8 weeks. This study measured clinical outcomes using the improvement of active range of motion (ROM) and patient-reported outcome measures (PROMs). Numerical data analyses were calculated based on weighted means according to the number of patients involved in each study.

***Results:*** When comparing the ranges of motion of active flexion, abduction, external rotation, and internal rotation it was observed that conservative treatments increased the active ROM of flexion by 57.9o (22.1%), abduction by 62.4o 116 (99.1%), external rotation by 37o (230.4%), and internal rotation by 22.1o 117 (71.2%). From all current included literature on idiopathic frozen shoulder, supervised neglect resulted in the highest percentage of ROM improvement in flexion, abduction, external rotation, and internal rotation. Patients receiving supervised neglected treatment significantly improved their patient-reported outcome measures (PROMs).

***Conclusion:*** Although according to the present literature supervised neglect is the most beneficial conservative therapy, physiotherapy has been proven to provide adequate range of motion and clinical outcome improvement.

***Level of Evidence:*** Level II, Therapeutic Study

## Introduction

As one of the most common diseases in orthopedics, frozen shoulder (FS) is found in 15% of all shoulder pathological conditions, with pain as the predominant complaint.[1] This disease decreases the active and passive global range of motion (ROM) of the shoulder with sudden pain without any obvious cause at the time of examination.[2] The prevalence rate of FS is 2%-5% in the general population and rises to 20% in the diabetic population. It more commonly affects women.[3-4] The incidence of primary or idiopathic FS is more profound compared to the secondary FS.[5] Although the pathophysiology of FS remains unclear, the thickening of the coracohumeral ligament (CHL) is considered as the key morphological feature.[6-8] Several studies have shown that thickening and shortening of the CHL inhibit shoulder external rotation.[8-11] Histological examinations of FS revealed that the restriction of external rotation was caused by fibroblastic proliferation in CHL, a situation comparable to superficial fibromatosis in Dupuytren's disease.[12,13] The CHL involvement in FS is corroborated by the presence of fibrosis of the connective tissue rotator interval, including CHL, in chronic FS patients.[14] Furthermore, a recent study from Mengiardi et al[15] reported that patients with FS had significant thickening of the CHL on magnetic resonance (MR) arthrography.

Despite the high prevalence rate, there is still no consensus regarding the guidelines of treatment.[16] The conservative treatment modalities for FS are heterogeneously reported, ranging from physiotherapy, anesthetic agent injection, and steroid injection up to the latest modalities such as oral corticosteroids, pulse radiofrequency of suprascapular nerve, and cryotherapy.[17-21] Unexpectedly, some studies reported that supervised neglect gives a better clinical outcome than physiotherapy in patients with FS.[22,23] Unfortunately, unlike the secondary FS, the idiopathic FS is less responsive to treatment.[5] Many reports have described the success of conservative treatment.[21,24-27] However, there is still lack of information regarding which treatment results in the most superior outcome when dealing with idiopathic FS.[28-30]

According to the existing literature, this systematic review primarily aims to describe the most beneficial conservative treatment for idiopathic FS. The result

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from this review will be used to define the treatment with the best clinical outcome improvement among idiopathic FS in the results of conservative treatment strategies.

## Materials and Methods

This systematic review has been registered on PROSPERO with ID CRD42020210986 on October 23, 2020.

### Search strategy and study selection

We reported this systematic review according to the preferred reporting items for systematic review and meta-analysis (PRISMA) guidelines.[31] In the first phase, the primary search was performed using electronic databases of PubMed, Embase, and Scopus for the time frame from January 1, 2000, up to October 30, 2020. This study used boolean operation and medical subject headings (MeSH) keywords. We searched articles using simple boolean operation using keywords according to Population, Intervention, Control, Outcome, and Study design (PICOs) analysis (Electronic Supplementary Material 1 and Electronic Supplementary Material 2) to search on the PubMed. Afterward, the following MeSH terms were used for searching also on the PubMed: ("bursitis" [Mesh] OR frozen shoulder* [tiab] OR adhesive capsulitis [tiab] OR bursitis [tiab] OR bursitides [tiab] OR shoulder stiffness [tiab] OR stiff shoulder* [tiab] OR rigid shoulder* [tiab]) AND (conservative*[tiab] OR gentle thawing[tiab] OR "rehabilitation"[Mesh] OR "rehabilitation" [Subheading] OR rehabil*[tiab] OR "Physical Therapy Modalities"[Mesh] OR physiotherap*[tiab] OR physical therap*[tiab]); then this study translated these terms for searching on the Embase database.

### Inclusion criteria

The inclusion criteria used in this study were (1) published in English (2) idiopathic frozen shoulder (3) no history of prior surgery at the affected shoulder (4) measured clinical outcome scores before and after the intervention (5) reported any incident of complications (6) published in the last 20 years (7) randomized controlled trial or prospective cohort study design.

### Exclusion criteria

The exclusion criteria used in this study were (1) review articles (2) cadaveric or animal studies (3) existence of underlying diseases (i.e. osteoarthritis, rheumatoid arthritis, damage to the glenohumeral cartilage, osteoporosis, history of trauma, rotator cuff disease, malignancy), including diabetes mellitus (4) underwent another procedure in the ipsilateral limb, (5) consumption history of matrix metalloproteinase inhibitor (i.e. Marimastat) (6) The articles unavailable in English.

### Outcome measurement

The primary outcome assessed in this study was the improvement of the active ROM of the shoulder joint in flexion, abduction, internal rotation, and external rotation. In addition to assessing the active ROM before and after conservative treatment, this study also calculates the percentage of improvement in each plane ROM by dividing the difference between the ROM pre- and postconservative management by the ROM before conservative treatment. For studies reporting ROM in terms of functional ability, 3 participating research physicians (AL, RD, and EK) who had extensive shoulder orthopedic experience with the diagnosis and treatment of shoulder disorder (>10 years of practice) converted the scoring from the functional form to the degree of ROM. The secondary outcomes of this study were improvements in clinical outcomes and/or patient-reported outcome measures (PROMs) after conservative therapy compared with preintervention.

**HIGHLIGHTS**

- There is still no consensus for the treatment of idiopathic frozen shoulder. This systematic review aimed to describe the most beneficial conservative treatment for idiopathic frozen shoulder.
- The results showed that physiotherapy is the modality that has the most potential to provide improvement in range of motion and clinical outcome in cases of idiopathic frozen shoulder.
- The authors suggest that these findings should be very carefully interpreted and that there is a need for a study that compares the effect of supervised neglect with other conservative treatment with similar baseline characteristics and follow-up period.

### Data extraction and analysis

Two independent reviewers (AL and BH) selected the first study candidates through the title and abstract and then selected the final articles after a full-text review. Details of study selection are presented in Figure 1. In the first step of literature searching and cross-referencing, this study found 4056 articles, of which 1842 were excluded due to duplication and 2214 articles were reviewed for title and abstract. Two thousand one hundred seventy-two articles were excluded and 42 articles met the eligibility criteria. After a full-text review, 32 articles met the exclusion criteria, and 10 articles were included in this systematic review.

Demographic data from each study such as study design, number of patients, gender, side of the shoulder involved, mean patient age, imaging assessment to exclude other causes of shoulder, duration of symptoms before undergoing conservative treatment, stage of the FS when first received conservative treatment, conservative treatment management, complications, and mean follow-up were extracted independently by 2 authors (AL and BH), and then they were discussed and analyzed by all of the authors. The same procedure was done to extract the outcome data from each of the included studies, such as clinical outcome scores and improvement of active ROM. All numerical data analyses were calculated based on weighted means based on the number of patients involved in each study.

### Level of evidence assessment

Levels of evidence were assessed according to the Oxford Centre for Evidence-Based Medicine document.[32]

### Risk of bias assessment in included studies

The methodological bias in the included studies was assessed by 2 reviewers (AL and BH) independently using the Cochrane collaboration's assessment tool for risk of bias from the Cochrane Handbook for systematic reviews.[33] Any discrepancies between the 2 reviewers were discussed with the third reviewer (RD) until a consensus was reached. The following items were assessed for "low risk," "high risk," or "unclear risk" of bias: (1) random sequence generation, (2) allocation concealment, (3) blinding of participants and personnel, (4) blinding of outcome assessment, (5) incomplete outcome data, and (6) selective reporting addressed. Ninety percent of the included studies had a low risk of random sequence generation bias, while 60% had a low risk of bias in the allocation concealment. Included studies had a 70% low risk of bias in the performance bias and 90% low risk of bias in the detection, attrition, and reporting bias. Details are shown in Figure 2.

## Results

### Characteristics and demographics

A total of 498 FS cases were included in this study. The mean age of patients was 52.4 ± 3.8 years. Details of the characteristics and demographics are presented in Table 1. Idiopathic FS patients were

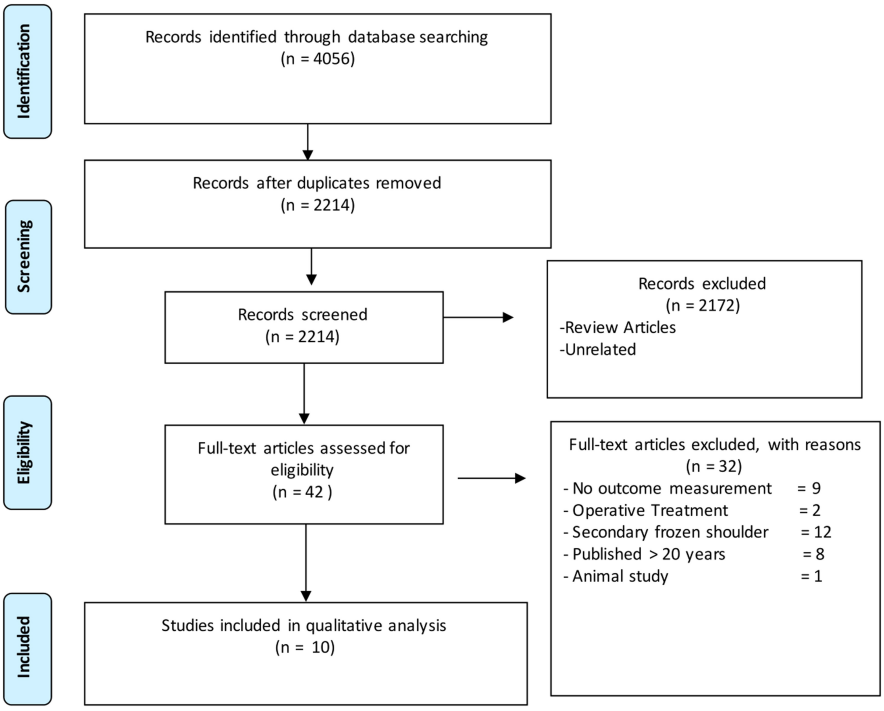


**Figure 1.** Preferred reporting items for systematic review and meta-analysis flow diagram.

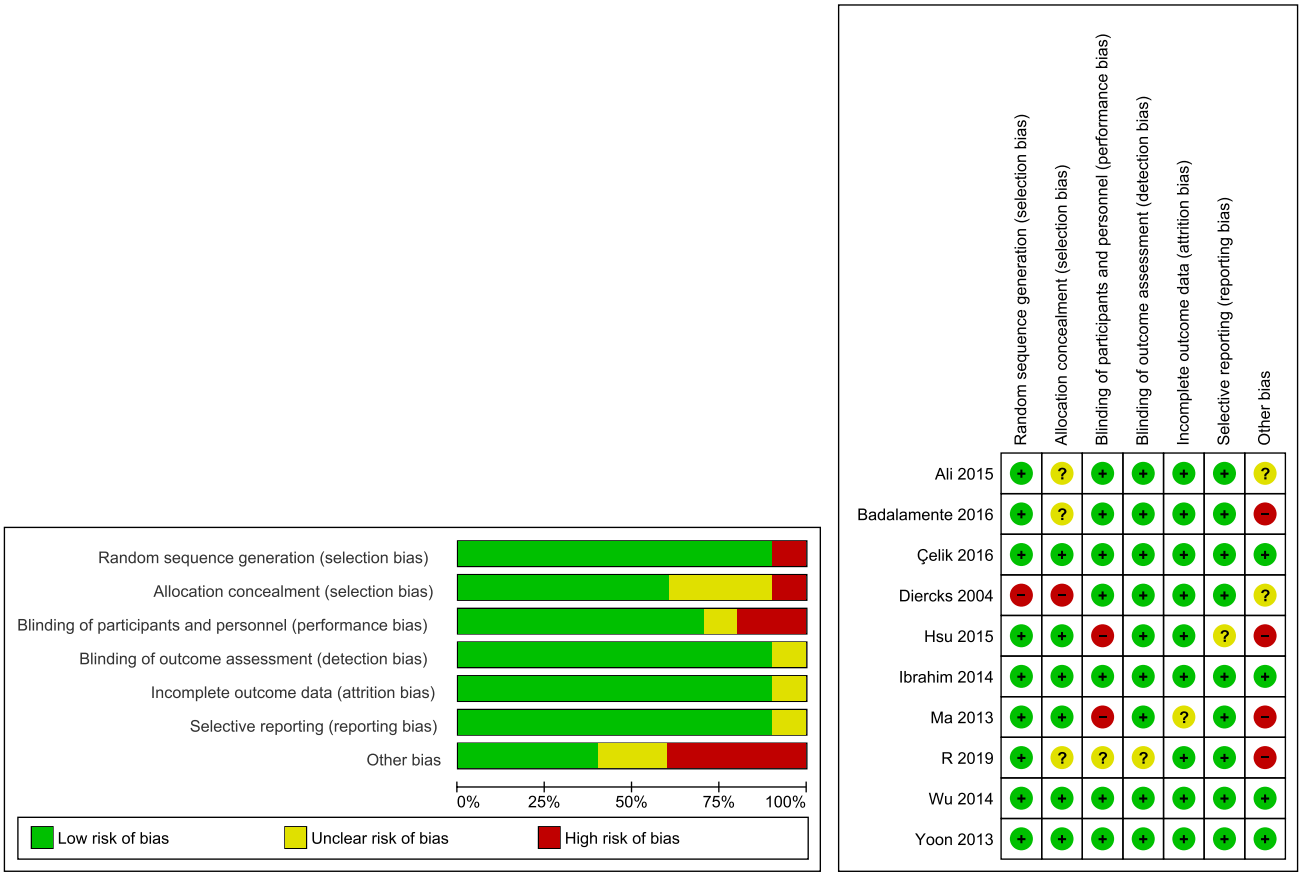


**Figure 2.** Risk of bias graph: authors' judgments about each risk of bias item presented as percentages and also detailed among all included studies.

followed up for 7.9 ± 7.7 and 3 (1-24) months in median. The mean duration of symptoms the patient experienced before receiving conservative treatment was 22.5 ± 6.8 weeks. Details of the diagnostic and treatment are described in Table 2.

**Outcome measurement and results**

Comparing the ROMs of active flexion, abduction, external rotation, and internal rotation, conservative treatments increased the active ROM of flexion by 57.9° (22.1%), abduction by 62.4° (99.1%), external

**Table 1.** Characteristic and demographic of the studies

| Authors | Study design (level of evidence) | Number of patients | Gender (female/male) | Affected arm (dominant/nondominant) | Mean age (years) |
|---|---|---|---|---|---|
| Diercks et al, 2004[22] | Prospective cohort (2b) | Intervention group (45); control group (32) | Intervention group (26/19); control group (21/11) | NA | Intervention group 50 ± 6; control group 51 ± 7 |
| Celik et al, 2014[25] | Randomized controlled trial (1b) | Intervention group (12); control group (14) | Intervention group (9/3); control group (9/5) | Intervention group (8/4); control group (9/5) | Intervention group 54.2 ± 7.9; control group 54.8 ± 6.4 |
| Hsu et al, 2015[34] | Randomized controlled trial (1b) | Intervention group (33); control group (33) | Intervention group (26/7); control group (25/8) | NA | Intervention group 54.88 ± 7.06; control group 56.41 ± 9.44 |
| Ma et al, 2013[20] | Randomized controlled trial (1b) | Intervention group (15); control group (15) | Intervention group (13/2); control group (11/4) | Intervention group (12/3); control group (11/4) | 57.2 ± 6.6 |
| Ibrahim et al, 2014[35] | Randomized controlled trial (1b) | Intervention group (30); control group (30) | Overall (31/29) | Overall (32/28) | Intervention group 51.9; control group 51.2 |
| Anjum et al, 2019[36] | Prospective cohort (2b) | Intervention group (26); control group (26) | Intervention group (17/9); control group (15/11) | Intervention group (10/13); control group (10/14) | Intervention group 44.46; control group 41.2 |
| Ali et al, 2015[21] | Randomized controlled trial (1b) | Intervention group (22); control group (22) | Intervention group (15/7); control group (15/7) | NA | Intervention group 51.3; control group 51.7 |
| Wu et al, 2014[26] | Randomized controlled trial (1b) | Intervention group (21); control group (21) | Intervention group (16/5); control group (17/4) | Intervention group (7/14); control group (9/12) | Intervention group 55.0 ± 9.2; control group 57.1 ± 10.9 |
| Yoon et al, 2015[27] | Randomized controlled trial (1b) | Intervention group 1 (20); intervention group 2 (20); control group (11) | Intervention group 1 (10/10); intervention group 2 (8/12); control group (6/5) | Intervention group 1 (10/10); intervention group 2 (11/9); control group (5/6) | Intervention group 1 54.2 ± 5.1; intervention group 2 52.2 ± 3.8; control group 55.9 ± 3.1 |
| Badalamente et al, 2015[24] | Prospective cohort (2b) | Four intervention group (40); control group (10) | NA | NA | 54 ± 8 |

NA, not applicable.

**Table 2.** Idiopathic frozen shoulder diagnostic and treatment

| Authors | Imaging assessment | Duration of disorder (Weeks) | Stage of frozen shoulder | Treatment | Complications | Mean follow-up (months) |
|---|---|---|---|---|---|---|
| Diercks et al, 2004[22] | | Group A: 20 (12-48); group B: 20 (12-40) | NA | Group A: supervised neglect; group B: passive mobilization and stretching | NA | 24 |
| Celik et al, 2014[21] | Plain x-ray and MRI | 15.7 (14-21) | NA | Group A: joint mobilization and stretching; group B: stretching alone | NA | 12 |
| Hsu et al, 2015[34] | Plain x-ray, ultrasonography | Group A: 24.5 ± 20; group B: 18.16 ± 13 | NA | Group A: lidocaine injection plus physiotherapy; group B: physiotherapy only | NA | 6 |
| Ma et al, 2013[20] | Plain x-ray | 4.3 | NA | Group A: whole-body cryotherapy, physical therapy, passive joint mobilization; group B: physical therapy and passive joint mobilization | NA | 1 |
| Ibrahim et al, 2014[35] | Plain x-ray | NA | Thawing | Group A: intervention group, traditional therapy+static progressive stretch device; group B: control group, traditional therapy alone (3 times/weeks for 4 weeks; pulley, wand, and pendulum exercises at 20 repetitions of each, 3 times daily) | NA | 12 |
| Anjum et al, 2019[36] | Plain x-ray, MRI | 24 | NA | Group A: physiotherapy; group B: physiotherapy and intra-articular steroid (80 mg methylprednisolone mixed with 0.5% bupivacaine to make a 10 mL solution) | NA | 3 |
| Ali et al, 2015[21] | NA | >12 weeks | NA | Group A: general exercise therapy+manual mobilization using Maitland techniques 3 days/week for 5 weeks; group B: general exercise therapy only 3 days/week for 5 weeks | NA | 1.25 |
| Wu et al, 2014[26] | Ultrasonography | Group A: 27.2 ± 25.2; group B: 29.2 ± 25 | NA | Group A: pulse radiofrequency stimulation of suprascapular nerve plus physiotherapy, group B: physiotherapy | NA | 3 |
| Yoon et al, 2015[27] | Plain x-ray, ultrasonography | Group A: 22 ± 10; group B: 18.8 ± 8.4; group C: 20.4 ± 12.4 | Frozen | Group A: intervention group 1, USG-guided 4 mL of 10 mg/mL triamcinolone acetonide injection with 1 mL of 1% lidocaine; group B, intervention group 2, USG-guided 2 mL of 10 mg/mL triamcinolone acetonide injection with 3 mL of 1% lidocaine; group 3, placebo group, 5 mL of 1% lidocaine | Facial flushing in 3 participants in high-dose group, 1 in low-dose group) | 3 |
| Badalamente et al, 2015[24] | Plain x-ray, MRI | 33.2 | Frozen | Group 1-4: collagenase *Clostridium histolyticum* (CCH) various doses plus standardized home exercise Group 1: 0.29 mg CCH/1.0 mL; group 2: 0.58 mg CCH/2.0 mL; group 3: 0.58 mg CCH/1.0 mL; group 4: 0.58 mg CCH/0.5 mL; group 5: control: home shoulder exercise only, 3 times daily | Injection-site pain (40%-60% ), bruising (30%-60%), swelling (20%-50%), and ecchymosis (0%-20%) in group 1-4 | 3 |

MRI, magnetic resonance imaging; NA, not applicable.

rotation by 37° (230.4%), and internal rotation by 22.1° (71.2%). The most significant percentage of ROM improvement after conservative treatment was found on external rotation.

From all the current included literature on idiopathic FS, supervised neglect resulted in the highest percentage of ROM improvement in flexion, abduction, external rotation, and internal rotation. Diercks et al.[22] reported a specific degree of active range prior to the supervised neglect protocol. However, at follow up, the authors did not report the specific degree of active ROM, but instead reported in the form of Constant-Murley Shoulder (CMS) functional score. Therefore, the scoring was converted from the functional form to the degree of ROM, and the details are presented in Electronic Supplementary Material 3.

The second-biggest percentage of ROM improvement varies in different studies. For flexion, lidocaine injection combined with physiotherapy gave the second-best result, followed by whole-body cryotherapy combined with physiotherapy.[20,34] For both abduction and external rotation, the second-best ROM improvement is gained by the combination of physiotherapy and static progressive device, followed by joint mobilization with stretching.[25,35] Lastly, for internal rotation, the second-biggest percentage improvement is achieved by giving bupivacaine injection with physiotherapy, followed by joint mobilization with stretching.[25,36]

The clinical outcome was measured by the CMS outcome score. Two studies (Diercks et al[22] and Çelik et al[25]) reported the outcome using the CMS score. Çelik et al showed that the combination of joint mobilization and physiotherapy improved the clinical score compared to physiotherapy significantly. In line with those results, Diercks et al[22] described that the supervised neglected group significantly improved the CMS outcome score in comparison to those who received passive mobilization and stretching.[25]

Several types of PROMs were used in the included studies. Two studies (Çelik et al[25] and Ibrahim et al[35]) that used disabilities of the arm, shoulder, and hand score (DASH) reported improvement scores of 36.3 points and 71.8 points, respectively, which were over the 15 points DASH minimum important change (MIC).[37] All five studies that reported outcomes using Shoulder Pain and Disability Index (SPADI) had findings that surpassed the MIC of 18 points.[20,22,24-26] From 2 studies that reported outcomes using American shoulder and elbow surgeons score (ASES), Badalamente et al showed a 27-point increase in ASES, which was over MIC (17 points).[38,39] However, Ma et al[20] reported 12-point ASES improvement, which was below the MIC. Details of the outcome measurements are presented in Table 3.

## Discussion

This systematic review aimed to define the most beneficial conservative treatment strategies with the best clinical outcome improvement among idiopathic FS. From the currently available literature in the last 20 years, a study by Diercks et al[22] performing supervised neglect showed the highest active ROM improvement for the treatment of idiopathic FS compared to other conservative management. This result was similar to a study by Vastamäki et al.[23] who compared 3 interventions, namely supervised neglect, conservative treatment, and manipulation under anesthesia. In contrast to Diercks et al[22], Vastamäki et al included both patients with either primary or secondary FS. Similarly, they found no significant differences in active or passive ROM, CMS outcome score, or disease duration between the 3 groups over a 9-year mean follow-up period. Diercks et al[22] explained in the study that intervention in the FS can produce side effects on the natural course of the disease, especially in the inflammatory or proliferative phase, and possibly in the early fibrosis phase by activating an inflammatory reaction. In our opinion, the results of this study must be very carefully interpreted in order to get good clinical implications. In the study by Diercks et al[22], the allocation of patient interventions between supervised neglect and physiotherapy was based on different time periods of patient arrival (supervised neglect group in the first 2 years and physical therapy group in the following 2 years). The time difference in patient allocation could create a potential bias in the assessment of active ROM and clinical outcome. In addition, this study was also assessed by an unblinded single assessor. It should be noted that the good results of supervised neglect in this review cannot be separated from the fact that the study by Diercks et al had the longest follow-up duration of 24 months, compared to other studies (1-12 months).[4,12,16,23] With all our belief that all studies included here are of high quality, the same caution should be implemented when interpreting the study of Vastamäki et al[23] which reported similar results to Diercks et al, where 29% of patients treated with conservative treatment had a disease duration of more than 2 years, whereas only 14% of supervised neglect patients had FS disease duration over 2 years.

Following supervised neglect, the second-best outcome of improved ROM in all planes (flexion, abduction, internal rotation, and external rotation) was achieved by a variety of conservative treatment modalities, but the one modality used by all of these studies was physiotherapy. Despite the effectiveness shown by physiotherapy as a treatment modality, frequently, many patients were unable to cope with an adequate and proper rehabilitation program due to the pain.[34] This argument is reinforced by the findings of Ibrahim et al.[35] who used a special progressive static system to conduct physiotherapy specifically on FS patients who were already in the thawing phase; according to the course of their natural course, the pain was already subsided when they underwent physiotherapy. For abduction and external rotation, this modality yielded the most improvement following supervised neglect.[35] Similarly, among all studies with short-term follow-up (<6 months), Anjum et al[36] confirmed that bupivacaine injection followed by physiotherapy resulted in the most superior ROM gain. Conversely, the least ROM gain was found in patients who underwent manual mobilization with general exercise.[21] For this reason, most of the conservative management of FS in this systematic review targeted pain relief (i.e., lidocaine injection,[34] whole-body cryotherapy,[20] and pulsed radiofrequency of the suprascapular nerve[26] to motivate adequate physiotherapy). Ma et al[20] explained in their study that whole-body cryotherapy at -110°C for 2.5 minutes had been shown to provide a local analgesic effect by slowing down the majority of nerve transmission in the body and increased the concentration of endorphins, thereby reducing pain perception.[20]

Most of the included articles used utilized patient-reported outcome measurement with MIC as the basis for comparison.[10] Ma et al reported that whole-body cryotherapy and physiotherapy showed improvement in ASES scores despite being below MIC. However, the improvement was found to be significant when compared to preoperative measures. The possible explanation is because of the short period of follow-up and a limited number of included subjects (type II errors).

**Table 3.** Results of frozen shoulder conservative management

| Authors | Outcome scores<br>Constant-Murley Shoulder (CMS) score / DASH / VAS / ASES/ SPADI / Others | | Results (Measured range of motions) | | |
|---|---|---|---|---|---|
| Diercks et al, 2004[20] | Constant Murley Shoulder (CMS) : No significant difference was detected at inclusion (p>0.05)<br>In the 2 years follow up, Supervised neglect group showed that 89% of participants reached a score of 80 or higher; while only 63% in the physical therapy group reached a score of 80 or higher (p=0.004) | | Before | After | ROM gain (%) |
| | | Flex | 33 | 165.5 | 132 (401.5%) |
| | | Abd | 40 | 135 | 95 (237.5%) |
| | | ER | 9 | 90 | 81 (900%) |
| | | IR | 23 | 58 | 35 (152.8) |
| Celik et al, 2014[19] | CMS : Intervention Group 39.1 (35.3-42.6) → 92.4 (88.2-96.6) (p=0.006)<br>Control Group 34.6 (30.8-38.5) → 75.2 (69.7-80.9); (p=0.006)<br>DASH : Intervention Group 50.7 (37.5 – 63.4) → 5.1 (3.1 – 7.5) (p=0.66)<br>Control Group 54.3 (43.8-63.5) → 11.5 (7.5-15.3) (p=0.66)<br>VAS : Intervention group 5.3 (3.6 – 6.8) → 0.2 (0.0-0.5) (p=0.2)<br>Control Group 5.3 (4.3-6.2) → 0.4 (0.1-0.6) (p=0.2) | | Before | After | ROM gain (%) |
| | | Flex | 126.6 (107.7–141.1) | 172.0 (167.8–175.4) | 46 (36.5%) |
| | | Abd | 91.9 (86.1–96.7) | 154.1 (141.6–164.2) | 62 (67%) |
| | | ER | 28.1 (22.2–34.2) | 70.5 (61.8–76.9) | 42.5 (151%) |
| | | IR | 35.1 (29.2–41.2) | 71.1 (65.4–76.9) | 36 (102.8%) |
| Hsu et al, 2015[19] | SPADI Score :<br>Intervention Group 54.91 ± 20.5 → 16.7 ± 14.8 (p<0.001);<br>Control Group 41.3 ± 19.7 → 19.3 ± 14.8 (p<0.001) | | Before | After | ROM gain (%) |
| | | Flex | 120 (110-148) | 168 (150-180) | 48 (40%) |
| | | Abd | 90 (75-110) | 150 (130-170) | 60 (66.6%) |
| | | ER | 35 (15-50) | 59 (48-70) | 24 (68.5%) |
| | | IR | 57 (43-65) | 63 (57-70) | 6 (10.5%) |
| Ma et al, 2013[18] | VAS : Intervention Group 6.0 ± 0.7 → 2.5 ± 0.5 (p<0.01)<br>Control Group 6.0 ± 0.8 → 3.7 ± 0.6 (p<0.01)<br>ASES : Intervention Group 12 ± 1.4 → 24 ± 1.4 (p<0.01)<br>Control Group 13 ± 1.6 → 20 ± 1.2 (p<0.01) | | Before | After | ROM gain (%) |
| | | Flex | 116 ± 6.7 | 162 ± 5.3 | 46 (36.5%) |
| | | Abd | 117 ± 6.4 | 158 ± 5.3 | 62 (67%) |
| | | ER | 34 ± 2.1 | 54 ± 2.7 | 42.5 (151%) |
| | | IR | 69 ± 2.9 | 80 ± 2.6 | 36 (102.8) |
| Ibrahim et al, 2014[33] | DASH : Intervention group from 73.3 ± 3.4 → 1.5 ± 2.6;<br>Control Group from 72.9 ± 4.8 → 55.3 ± 30.3 (p<0.001)<br>VAS : Intervention Group 4.1 ± 1.6 → 1.1 ± 1.0;<br>Control group 4.6 ± 1.4 → 3.1 ± 2.0 (p<0.001) | | Before | After | ROM gain (%) |
| | | Abd | 66 ± 10 | 178 ± 2 | 112 (169.7%) |
| | | ER | 20 ± 4 | 87± 3 | 67 (335%) |
| Anjum et al, 2019[34] | VAS : Intervention group 5.92 ± 1.2 → 1.15 ± 0.4;<br>Control group : 5.69 ± 1.2 → 1.77 ± 0.7 (p=0.000)<br>SPADI score : Intervention group 62.49 ± 8.7 → 18.91 ± 3.9,<br>Control group 62.2 ± 8.2 → 24.4 ± 5.7 (p=0.000) | | Before | After | ROM gain (%) |
| | | Flex | 123.6 | 169.6 | 46 (37.2%) |
| | | Abd | 80.7 | 134.8 | 54.1 (67%) |
| | | ER | 34.8 | 66.9 | 32.1 (92.2%) |
| | | IR | 23 | 58 | 35 (152.2%) |
| Ali et al, 2015[19] | VAS : Intervention group 7.68 ± 1.8 → 5.5 ± 1.5 (p<0.01);<br>Control group 7.6 ± 1.5 → 5.2 ± 1.5 (p<0.01), intergroup difference p=0.808<br>SPADI Score : Intervention group 78.4 ± 8.9 → 56.4 ± 11.2; (p<0.01)<br>Control group 71.1 → 49.4 (p<0.01), intergroup difference p=0.790 | | Before | After | ROM gain (%) |
| | | Abd | 73.4 ± 1.8 | 87.2 ± 21.3 | 13.8 (18.8%) |
| | | ER | 41.9 ± 16.9 | 49.2 ± 18.1 | 7.3 (17.5%) |
| | | IR | 53.8 ± 15.9 | 62.5 ± 15.9 | 8.7 (16.2%) |
| Wu et al, 2014[24] | VAS: Intervention Group 6.5 ± 1.3 → 1.7±1.5 (p<0.001)<br>Control Group 6.3 ± 1.5 → 3.3 ± 2.5 (p<0.001)<br>SPADI<br>Intervention Group 55.6 ± 11.9 → 15.6 ±12.3 (p<0.001);<br>Control Group 52.2 ± 16.1→ 36.3 ± 19.0 (p<0.001) | | Before | After | ROM gain (%) |
| | | Flex | 124.8 ± 19.9 | 160.2 ± 13.7 | 36 (29%) |
| | | Abd | 92.0 ± 26.9 | 131.2 ± 27.1 | 39 (42.4%) |
| | | ER | 32.4 ± 10.3 | 54.1 ± 10.6 | 21.6 (66.6%) |
| | | IR | 43.3 ± 15.4 | 75.2 ± 10.5 | 31.7 (73.2%) |
| Yoon et al, 2015[25] | VAS : High dose group 5.2 ± 1.7 → 2.4 ± 1.7 (p=<0.05). (p<0.001 compared to control)<br>Low-dose group 4.9 ± 1.3 → 2.4 ± 1.3 (p<0.05); (p=0.001 compared to control)<br>Control group 5.5 ± 1.3 → 4.6 ± 1.6 (p<0.05).<br>High dose and low dose group p=0.999<br>SPADI: High-dose group 37.9 ± 14.2 → 14.1 ± 12.4 (p<0.05). (p<0.001 compared to control)<br>Low-dose group 37.6 ± 13.7 → 18.3 ± 14.0; (p<0.05); (p=0.001 compared to control)<br>Control group 44.2 ± 12.2 → 37.1 ± 10.4 (p<0.05).<br>High dose and low dose group p=0.826 | | Before | After | ROM gain (%) |
| | | Flex | 141.0 ± 16.8 | 160.0± 13.1 | 19 (13.5%) |
| | | Abd | 92.6 ± 14.3 | 140.3 ± 18.4 | 47.7 (51.5%) |
| | | ER | 41.4 ± 18.8 | 68.0 ± 21.7 | 26.6 (64.3%) |
| | | IR | 45.5 ± 13.2 | 71.0 ± 20.5 | 25.5 (56%) |
| Badalamente et al, 2015[22] | VAS : 0.5 mg CCH/2 ml group and 0.58 CCH/1ml group score showed significant improvement than the Control Group (p<0.05)<br>ASES : 0.5 mg CCH/2 ml group and 0.58 CCH/1ml group showed significant improvement than the Control Group (p<0.05) | | Before | After | ROM gain (%) |
| | | Flex | 124.8 ± 19.9 | 160.2 ± 13.7 | 36 (29%) |
| | | ER | 32.4 ± 10.3 | 54.1 ± 10.6 | 21.6 (66.6%) |
| | | IR | 43.3 ± 15.4 | 75.2 ± 10.5 | 31.7 (73.2%) |

Flex : Flexion; Abd : Abduction; ER : External Rotation; IR : Internal Rotation; ROM : Range of Movement.

We acknowledged that the current systematic review had several limitations. First, there was a lack of information regarding which phase of the FS was being treated. Secondly, no follow-up duration criteria were applied in this study, and also non-uniform outcome measurements made it difficult to compare the outcomes. Third, the majority of the included studies concentrated on short-term outcomes, with a mean follow-up of 7.9 months (1-24 months). However, despite the mentioned limitations, this systematic review included only randomized controlled trials and prospective cohort studies, which provides the highest level of evidence and inferences. Therefore, a study that discusses long-term effectiveness, has an equal baseline and follow-up period, and has uniform outcome measurements is needed to be conducted in the future. We believe that an outcome comparison with an equal baseline (follow-up duration) is needed to have a fair comparison in conservative treatment modalities.

## Conclusion

Although according to the current literature, supervised neglect is the most beneficial conservative treatment in improving ROM and clinical outcome, prospective studies with an equal baseline testing the effectiveness of supervised neglect are strongly recommended to be conducted in the future to verify this finding. Physiotherapy is a treatment modality that has been proven to provide improved ROM and superior clinical outcomes in cases of idiopathic FS.

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**Electronic Supplementary Material 1.** PICO(s) Analysis

| PICO(S) | Definition |
|---|---|
| Population / Problem | Idiopathic Frozen Shoulder |
| Intervention | Conservative Treatment |
| Control | Supervised Neglect |
| Outcome | Range of Motion Improvement |
| Study Design | Randomized Controlled Trial, Prospective Cohort |

**Electronic Supplementary Material 2.** Search Strategy applied in Scopus (Up to 30th October 2020)

| Number | Search Terms |
|---|---|
| 1 | Frozen Shoulder |
| 2 | Adhesive capsulitis |
| 3 | OR/ 1-2 |
| 4 | Conservative Therapy |
| 5 | Conservative Treatment |
| 6 | Gentle Thawing |
| 7 | OR/ 4-6 |
| 8 | 3 AND 7 |

**Electronic Supplementary Material 3.** Conversion of Supervised neglect (Diercks et al[11]) range of motion improvement

| | Baseline (at inclusion) | Conversion of baseline ROM (at inclusion) | Constant score at final follow up | Interpretation of constant score at final follow up | Conversion of final ROM at final follow up | Improvement of ROM |
|---|---|---|---|---|---|---|
| Flex | 33° | 33° | 10 | (151°-180°) | 165.5° | 132.5°(401.5%) |
| Abd | 40° | 40° | 8 | (121°-150°) | 135.5° | 95.5°(238.8%) |
| ER | 9° | 9° | 10 | Full elevation | 90° | 81°(900%) |
| IR | Dorsum hand to buttock | 23 | 8 | Dorsum hand to dorsal vertebral T12 | 58° | 35°(152.2%) |

Flex: Flexion; Abd: Abduction; ER: External Rotation; IR: Internal Rotation; ROM: Range of Movement