ACTA ORTHOPAEDICA et TRAUMATOLOGICA TURCICA
www.aott.org.tr

Systematic Review

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

Andri Maruli Tua Lubis[1], Bernadus Riyan Hartanto[2], Erica Kholinne[3], Romy Deviandri[4,5]

[1]*Department of Orthopedic and Traumatology Cipto Mangunkusumo Hospital, Faculty of Medicine Universitas Indonesia, Jakarta, Indonesia*
[2]*RAA. Soewondo Regional Public Hospital, Pati, Indonesia*
[3]*Department of Orthopedic Surgery, Faculty of Medicine, Universitas Trisakti St. Carolus Hospital, Jakarta, Indonesia*
[4]*Department of Orthopedics, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands*
[5]*Department of Physiology-Faculty of Medicine, Universitas Riau, Division of Orthopedics-Sports Injury, Arifin Achmad Hospital, Pekanbaru, Indonesia*

ARTICLE INFO

Article history:
Submitted November 27,2021
Received in revised form
April 12, 2022
Last revision received
June 14, 2022
Accepted August 28, 2022
Publication Date
October 14, 2022

Keywords:
Shoulder
Adhesive capsulitis
Bursitis
Conservative treatment
Supervised neglect

ORCID iDs of the authors:
A.M.T.L. 0000-0002-0988-6640;
B.R.H. 0000-0002-7236-794X;
E.K. 0000-0002-4326-8205;
R.D. 0000-0003-2515-1959.

Corresponding author:
Andri Maruli Tua Lubis
andrilubisresearch@gmail.com

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

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

Cite this article as: *Maruli Tua Lubis A, Riyan Hartanto B, Kholinne E, Deviandri R. Conservative treatment for idiopathic frozen shoulder: Is supervised neglect the answer? A systematic review. Acta Orthop Traumatol Turc. 2022;56(5):340-346.*

DOI: 10.5152/j.aott.2022.21376

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

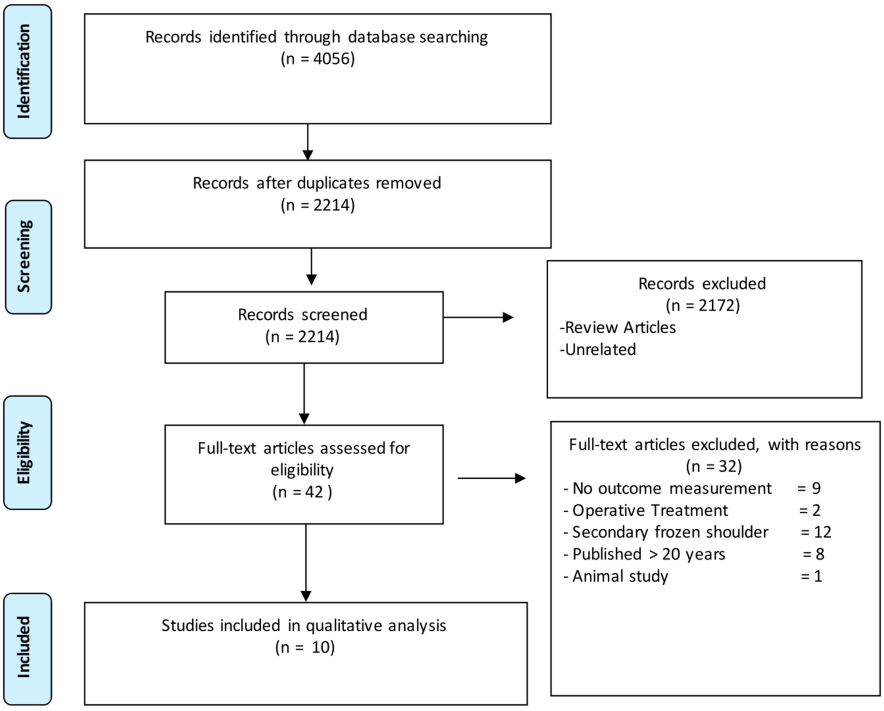

Figure 1. Preferred reporting items for systematic review and meta-analysis flow diagram.

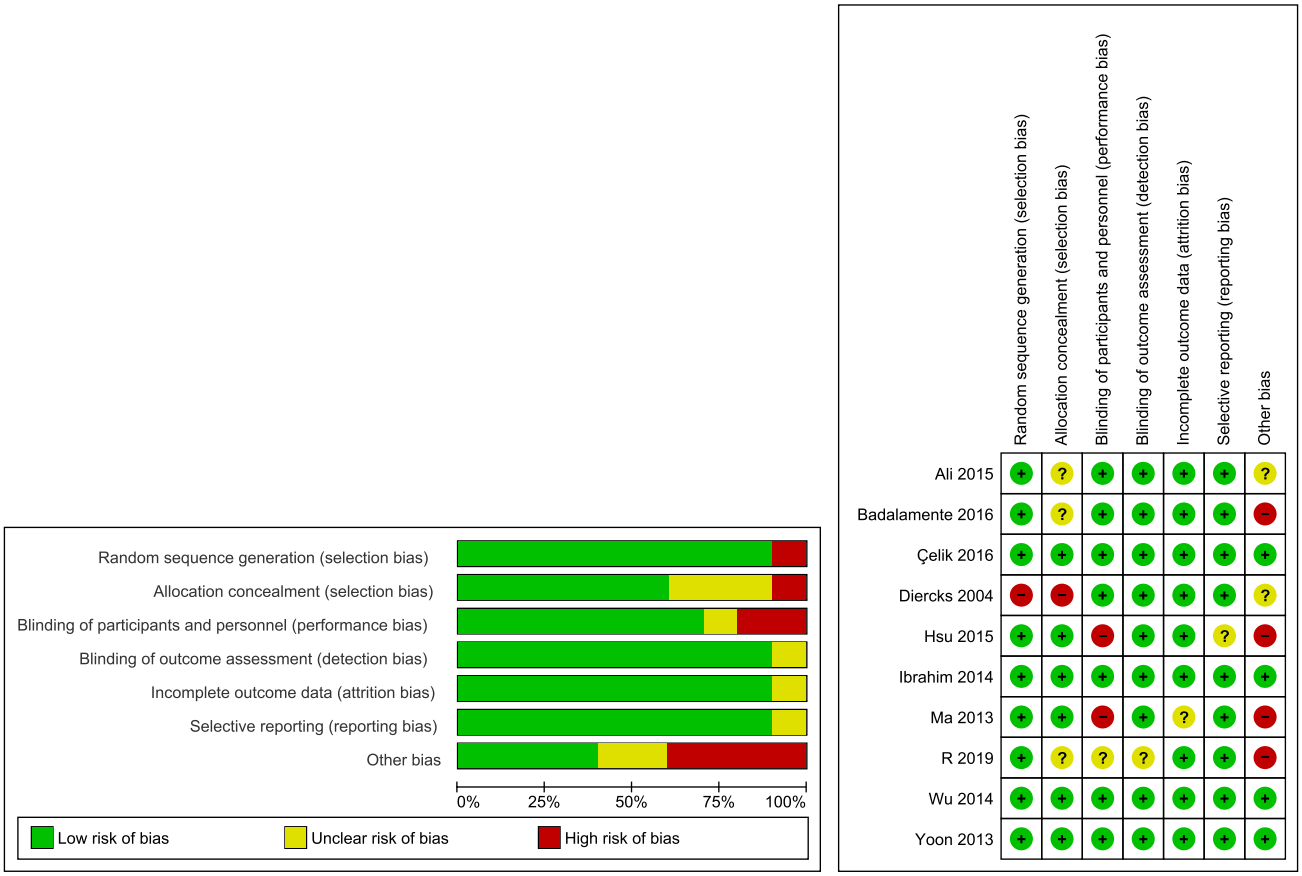

Figure 2. Risk of bias graph: authors' judgments about each risk of bias item presented as percentages and also detailed among all included studies.

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 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) 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) Control Group 34.6 (30.8-38.5) → 75.2 (69.7-80.9); (p=0.006) DASH : Intervention Group 50.7 (37.5 – 63.4) → 5.1 (3.1 – 7.5) (p=0.66) Control Group 54.3 (43.8-63.5) → 11.5 (7.5-15.3) (p=0.66) VAS : Intervention group 5.3 (3.6 – 6.8) → 0.2 (0.0-0.5) (p=0.2) 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 : Intervention Group 54.91 ± 20.5 → 16.7 ± 14.8 (p<0.001); 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) Control Group 6.0 ± 0.8 → 3.7 ± 0.6 (p<0.01) ASES : Intervention Group 12 ± 1.4 → 24 ± 1.4 (p<0.01) 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; Control Group from 72.9 ± 4.8 → 55.3 ± 30.3 (p<0.001) VAS : Intervention Group 4.1 ± 1.6 → 1.1 ± 1.0; 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; Control group : 5.69 ± 1.2 → 1.77 ± 0.7 (p=0.000) SPADI score : Intervention group 62.49 ± 8.7 → 18.91 ± 3.9, 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); Control group 7.6 ± 1.5 → 5.2 ± 1.5 (p<0.01), intergroup difference p=0.808 SPADI Score : Intervention group 78.4 ± 8.9 → 56.4 ± 11.2; (p<0.01) 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) Control Group 6.3 ± 1.5 → 3.3 ± 2.5 (p<0.001) SPADI Intervention Group 55.6 ± 11.9 → 15.6 ±12.3 (p<0.001); 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) Low-dose group 4.9 ± 1.3 → 2.4 ± 1.3 (p<0.05); (p=0.001 compared to control) Control group 5.5 ± 1.3 → 4.6 ± 1.6 (p<0.05). High dose and low dose group p=0.999 SPADI: High-dose group 37.9 ± 14.2 → 14.1 ± 12.4 (p<0.05). (p<0.001 compared to control) Low-dose group 37.6 ± 13.7 → 18.3 ± 14.0; (p<0.05); (p=0.001 compared to control) Control group 44.2 ± 12.2 → 37.1 ± 10.4 (p<0.05). 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) 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.

Author Contributions: Concept - A.M.T.L., R.D.; Design - A.M.T.L., B.R.H.; Supervision - A.M.T.L., E.K.; Materials - B.R.H.; Data Collection and/or Processing - A.M.T.L., B.R.H., E.K., R.D.; Analysis and/or Interpretation - A.M.T.L., E.K., R.D.; Literature Review - B.R.H.; Writing - A.M.T.L., B.R.H., E.K., R.D.; Critical Review - A.M.T.L., E.K., R.D.

Declaration of Interests: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study has received no financial support.

References

1. Ostör AJ, Richards CA, Prevost AT, Speed CA, Hazleman BL. Diagnosis and relation to general health of shoulder disorders presenting to primary care. *Rheumatology (Oxford)*. 2005;44(6):800-805. [CrossRef]
2. Cho CH, Song KS, Kim BS, Kim DH, Lho YM. Biological aspect of pathophysiology for frozen shoulder. *BioMed Res Int*. 2018;2018:7274517. [CrossRef]
3. Cho CH, Lee YH, Kim DH, Lim YJ, Baek CS, Kim DH. Definition, diagnosis, treatment, and prognosis of frozen shoulder: a consensus survey of shoulder specialists. *Clin Orthop Surg*. 2020;12(1):60-67. [CrossRef]
4. Uppal HS, Evans JP, Smith C. Frozen shoulder: a systematic review of therapeutic options. *World J Orthop*. 2015;6(2):263-268. [CrossRef]
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(1):340. [CrossRef]
6. Li JQ, Tang KL, Wang J, et al. MRI findings for frozen shoulder evaluation: is the thickness of the coracohumeral ligament a valuable diagnostic tool? *PLoS One*. 2011;6(12):e28704. [CrossRef]
7. Koide M, Hamada J, Hagiwara Y, Kanazawa K, Suzuki K. A thickened coracohumeral ligament and superomedial capsule limit internal rotation of the shoulder joint: report of three cases. *Case Rep Orthop*. 2016;2016:9384974. [CrossRef]
8. Homsi C, Bordalo-Rodrigues M, da Silva JJ, Stump XMGRG. Ultrasound in adhesive capsulitis of the shoulder: is assessment of the coracohumeral ligament a valuable diagnostic tool? *Skelet Radiol*. 2006;35(9):673-678. [CrossRef]
9. Kanazawa K, Hagiwara Y, Sekiguchi T, et al. Correlations between capsular changes and ROM restriction in frozen shoulder evaluated by Plain MRI and MR arthrography. *Open Orthop J*. 2018;12(1):396-404. [CrossRef]
10. Neer Csii SCC, Dalsey RM, Flatow EL. The anatomy and potential effects of contracture of the coracohumeral ligament. *Clin Orthop Relat Res*. 1992. Available at: https://journals.lww.com/clinorthop/Fulltext/1992/07000/The_Anatomy_and_Potential_Effects_of_Contracture.23.aspx.
11. Ferrari DA. Capsular ligaments of the shoulder: anatomical and functional study of the anterior superior capsule. *Am J Sports Med*. 1990;18(1):20-24. [CrossRef]
12. Bunker TD, Anthony PP. The pathology of frozen shoulder. A Dupuytren-like disease. *J Bone Joint Surg Br*. 1995;77(5):677-683. [CrossRef]
13. Smith SP, Devaraj VS, Bunker TD. The association between frozen shoulder and Dupuytren's disease. *J Shoulder Elbow Surg*. 2001;10(2):149-151. [CrossRef]
14. Ozaki J, Nakagawa Y, Sakurai G, Tamai S. Recalcitrant chronic adhesive capsulitis of the shoulder. Role of contracture of the coracohumeral ligament and rotator interval in pathogenesis and treatment. *J Bone Joint Surg Am*. 1989;71(10):1511-1515. [CrossRef]
15. Mengiardi B, Pfirrmann CWA, Gerber C, Hodler J, Zanetti M. Frozen shoulder: MR arthrographic findings. *Radiology*. 2004;233(2):486-492. [CrossRef]
16. Dias R, Cutts S, Massoud S. Frozen shoulder. *Br Med J*. 2005;331(7530):1453-1456. [CrossRef]
17. Çınar BM, Battal VE, Bal N, Güler ÜÖ, Beyaz S. Comparison of efficacy of Oral versus intra-articular corticosteroid Application in the treatment of Frozen Shoulder: an experimental study in rats. *Acta Orthop Traumatol Turc*. 2022;56(1):64-70. [CrossRef]
18. Gencer Atalay K, Kurt S, Kaplan E, Yağcı İ. Clinical effects of suprascapular nerve block in addition to intra-articular corticosteroid injection in the early stages of adhesive capsulitis: a single-blind, randomized controlled trial. *Acta Orthop Traumatol Turc*. 2021;55(6):459-465. [CrossRef]
19. 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. *Skelet Radiol*. 2020;49(5):795-803. [CrossRef]
20. Ma SY, Je HD, Jeong JH, Kim HY, Kim HD. Effects of whole-body cryotherapy in the management of adhesive capsulitis of the shoulder. *Arch Phys Med Rehabil*. 2013;94(1):9-16. [CrossRef]
21. Ali SA, Khan M. Comparison for efficacy of general exercises with and without mobilization therapy for the management of adhesive capsulitis of shoulder - an interventional study. *Pak J Med Sci*. 2015;31(6):1372-1376. [CrossRef]
22. 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(5):499-502. [CrossRef]
23. Vastamäki H, Kettunen J, Vastamäki M. The natural history of idiopathic frozen shoulder: A 2- to 27-year follow-up study. *Clin Orthop Relat Res*. 2012;470(4):1133-1143. [CrossRef]
24. Badalamente MA, Wang ED, CORR® ORS Richard A. Brand award: clinical trials of a new treatment method for adhesive capsulitis. *Clin Orthop Relat Res*. 2016;474(11):2327-2336. [CrossRef]
25. 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(8):786-794. [CrossRef]
26. Wu YT, Ho CW, Chen YL, Li TY, Lee KC, Chen LC. Ultrasound-guided pulsed radiofrequency stimulation of the suprascapular nerve for adhesive capsulitis: a prospective, randomized, controlled trial. *Anesth Analg*. 2014;119(3):686-692. [CrossRef]
27. 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(5):1133-1139. [CrossRef]
28. Itoi E, Arce G, Bain GI, et al. Shoulder stiffness: current concepts and concerns. *Arthroscopy*. 2016;32(7):1402-1414. [CrossRef]
29. Lamplot JD, Lillegraven O, Brophy RH. Outcomes From conservative treatment of shoulder idiopathic adhesive capsulitis and factors associated with developing contralateral disease. *Orthop J Sports Med*. 2018;6(7):2325967118785169. [CrossRef]
30. Rookmoneea M, Dennis L, Brealey S, et al. The effectiveness of interventions in the management of patients with primary frozen shoulder. *J Bone Jt Surg - Ser B. J Bone Joint Surg Br*. 2010;92(9):1267-1272. [CrossRef]
31. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement. *PLOS Med*. 2009;6(7). [CrossRef]
32. Howick J, Chalmers I, Glasziou P, et al. The Oxford 2011 levels of evidence. Oxford Centre evidence-based medicine. *Group*. 2011;1(March):5653. Available at: https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocebm-levels-of-evidence.
33. Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JAC. Assessing risk of bias in a randomized trial. In: *Cochrane Handbook for Systematic Reviews of Interventions*. Chichester: John Wiley & Sons, Ltd; 2019:205-228.
34. Hsu WC, Wang TL, Lin YJ, Hsieh LF, Tsai CM, Huang KH. Addition of lidocaine injection immediately before physiotherapy for frozen Shoulder: a randomized controlled trial. *PLoS One*. 2015;10(2):e0118217. [CrossRef]
35. Ibrahim M, Donatelli R, Hellman M, Echternach J. Efficacy of a static progressive stretch device as an adjunct to physical therapy in treating adhesive capsulitis of the shoulder: a prospective, randomised study. *Physiotherapy*. 2014;100(3):228-234. [CrossRef]
36. Anjum J, Aggrawal R, Gautam S, Pathak AS. Evaluating outcome of two different regimes in adhesive capsulitis- A prospective clinical Study.pdf. *Med Princ Pract*. 2019. [CrossRef]
37. Franchignoni F, Vercelli S, Giordano A, Sartorio F, Bravini E, Ferriero G. Minimal clinically important difference of the disabilities of the arm, shoulder and hand outcome measure (DASH) and its shortened version (quickDASH). *J Orthop Sports Phys Ther*. 2014;44(1):30-39. [CrossRef]
38. Badalamente MA, Hurst LC. Efficacy and safety of injectable mixed collagenase subtypes in the treatment of Dupuytren's contracture. *J Hand Surg Am*. 2007;32(6):767-774. [CrossRef]
39. Tashjian RZ, Deloach J, Green A, Porucznik CA, Powell AP. Minimal clinically important differences in ASES and simple shoulder test scores after nonoperative treatment of rotator cuff disease. *J Bone Jt Surg - Ser A. J Bone Joint Surg Am*. 2010;92(2):296-303. [CrossRef]
40. Vermeulen HM, Rozing PM, Obermann WR, Cessie S le, Vliet Vlieland TP. Grade mobilization techniques in the management of adhesive capsulitis of the shoulder : randomized. *Phys Ther*. 2006;86(3):355-368. [CrossRef]

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