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Invited Review

The effectiveness of conservative and surgical treatment for shoulder stiffness: a systematic review of current literature

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Abstract

Introduction: Currently, no therapeutic intervention is universally accepted, and the most effective management for restoring motion and diminishing pain in patients with shoulder stiffness has yet to be defined. This systematic review analyses outcomes of conservative and surgical interventions to treat shoulder stiffness.

Source of data: A systematic review of literature according to the PRISMA guidelines was performed. A comprehensive search of PubMed, Medline, CINAHL, Cochrane, Embase, Ovid and Google Scholar databases using various combinations of the keywords 'shoulder', 'shoulder stiffness', 'stiff shoulder', 'conservative', since inception of databases to June 2018 was performed.

Areas of agreement: Shoulder stiffness could be treated with conservative means including nonsteroidal anti-inflammatory medications, corticosteroid injections, or transcutaneous electrical nerve stimulation, manipulation under anaesthesia, and arthroscopic capsular release.

Areas of controversy: No therapeutic intervention is universally accepted, and the most effective management to restore motion and diminish pain in patients with shoulder stiffness has yet to be defined.

Growing points: The rate of failure after treatment for stiff shoulder is higher in the surgical group than in the conservative group.

Areas timely for developing research: There is insufficient evidence to establish whether surgical or conservative management is the best choice to manage shoulder stiffness. Prospective, randomized studies are needed to establish whether surgical or conservative management produce a clinically relevant difference in functional outcome.

Key words: shoulder, shoulder stiffness, stiff shoulder, arthroscopy, conservative treatment, frozen shoulder

Introduction

Shoulder stiffness is a most common problem in general practice, and its incidence is estimated to be 2–5%.[1] Codman stated that shoulder stiffness is condition difficult to define, difficult to treat, and difficult to explain.[2] The members of the Upper Extremity Committee of ISAKOS have recently produced a consensus statement on the definition of this pathology.[3] The term 'stiff shoulder', according to the authors, should be used to describe all patients who present with restricted range of motion (ROM). Frozen shoulder, instead, should be used if no findings on history, examination or imaging can explain the onset of the disease. If the aetiology is known, the term 'Secondary stiff shoulder' should be used. The authors do not support the use of the term 'Adhesive capsulitis', as no real adhesions can be observed. Shoulder stiffness can be classified according to the involved structure: intra-articular (i.e. capsule and synovium), extra-articular (i.e. rotator cuff muscles and tendons), neurological, or arising from other remote causes (e.g. burns, heterotopic ossification, contracture, etc.). Shoulder stiffness has been considered as a self-limiting condition with a natural history lasting 2–3 years, but patients with persistent refractory course, unresponsive to conservative treatment, have also been reported.[4] Affected patients are characterized by spontaneous onset of pain with significant restriction of both active and passive ROM of the shoulder.[5] Severe pain can be expected, especially at night.[5] In shoulder stiffness, the capsule is thickened, and becomes noncompliant and contracted, preventing the normal movement of the shoulder. This causes the scapula to move excessively in upward rotation to compensate for the loss of glenohumeral rotation.[6,7] Active fibroblastic proliferation accompanied by some transformation to myofibroblasts has been reported. The fibroblasts lay down collagen that appears as a thick nodular band or fleshy mass, with no inflammation and no synovial involvement.[8] The contracture acts as a checkrein against external rotation, causing a loss of both active and passive movement.[8] Currently, no therapeutic intervention is universally accepted, and the most effective management to restore motion and diminish pain in patients with shoulder stiffness has yet to be defined. The first objective in the treatment of shoulder stiffness is to relieve pain, allowing the patient to perform the appropriate exercise programme to improve motion and function.[9] Pain-relieving methods include nonsteroidal anti-inflammatory medications, corticosteroid injections or transcutaneous electrical nerve stimulation (TENS).[10–14] It is currently unclear whether there is a difference in the clinical effectiveness of arthroscopic capsular release compared to manipulation under anaesthesia in patients with recalcitrant shoulder stiffness. Arthroscopic capsular release carries the risk of damage to the normal structures, as the adhesions may make it difficult to differentiate between them.[15] Systematic reviews

report the effectiveness of conservative and surgical interventions in patients with shoulder stiffness,[16–19] but a better understanding of the pathology, recent evolution and improvement of surgical management, especially if arthroscopic, may have improved the effectiveness of this type of management for shoulder stiffness.[3,20]

The present systematic analyses the outcomes of conservative and surgical interventions to treat the shoulder stiffness.

Materials and methods

A systematic review of the literature was performed according to the PRISMA guidelines with a PRISMA checklist and algorithm.[21,22] The search algorithm according to the PRISMA guidelines is shown in Figure 1. A comprehensive search of PubMed, Medline, CINAHL, Cochrane, Embase, Ovid and Google Scholar databases using various combinations of the keywords 'shoulder', 'shoulder stiffness', 'stiff shoulder', 'conservative', 'capsular distention', 'brisement', 'manipulation', 'surgery', 'arthroscopic', 'capsular release', 'open', 'lysis', since inception of databases to June 2018 was performed.

Three independent reviewers (U.G.L., J.L. and M.C.) separately conducted the search. All journals were considered, and all relevant studies were analysed. To qualify for the study, an article had to be published in a peer-reviewed journal. All articles

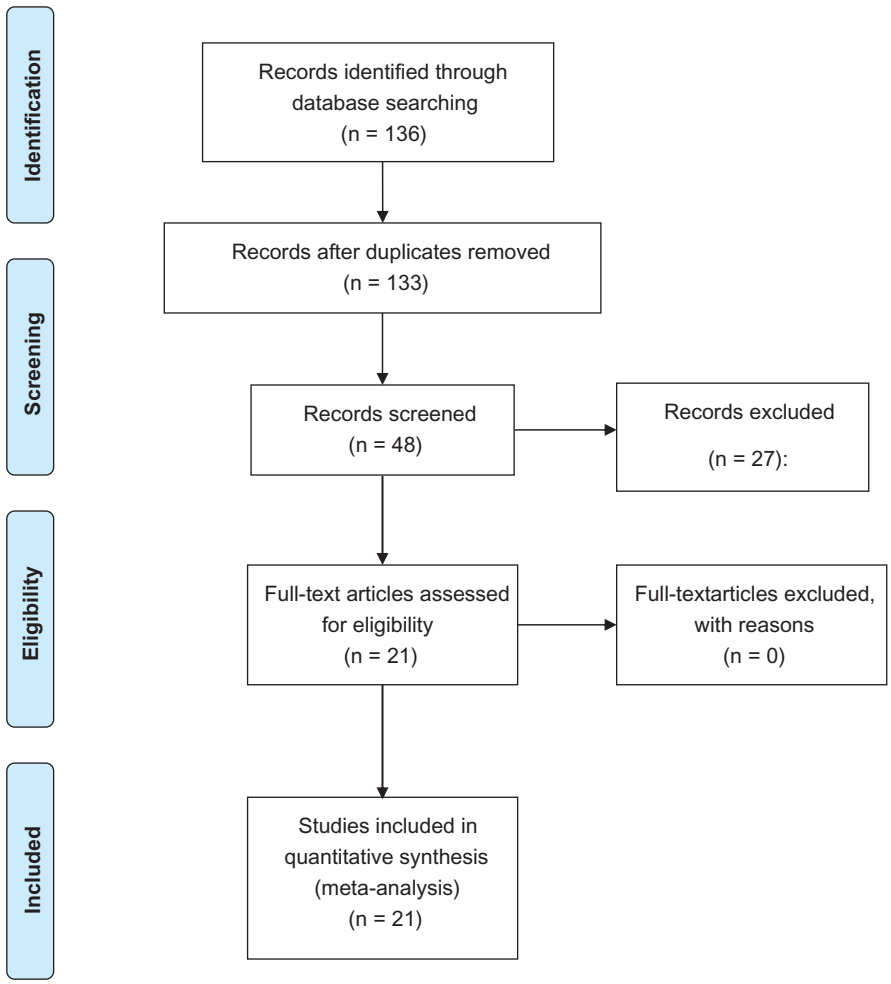

Fig. 1 PRISMA Algorithm: PRISMA 2009 flow diagram.

were initially screened for relevance by title and abstract, excluding articles without an abstract, and obtaining the full-text article if the abstract did not allow the investigators to assess the defined inclusion and exclusion criteria. Three investigators (U.G.L., J.L. and M.C.) separately reviewed the abstract of each publication, and then read all the articles and extracted the relevant data, to minimize selection bias and errors. A cross-reference search of the selected articles was also performed to obtain other relevant articles for the study.

All articles reporting outcomes of conservative and surgical procedures for shoulder stiffness were taken into account.

According to the Oxford centre of EBM, level I to IV articles were found in the literature and included in our study. Given the linguistic capabilities of the authors, articles in English, French, Spanish, German and Italian were included.

We included articles which reported outcomes of conservative and surgical procedures for shoulder stiffness. All the articles had to give an appropriate description of the conservative or surgical procedure and follow-up period, and present at least one of the following clinical outcome scores (ASES, DASH, VAS, Constant) or improvement of ROM, and include a description of the complication rate. The outcome parameters reviewed were failure, need of surgery and clinical scores.

If the study did not respect these parameters, it was excluded from this systematic review. Literature reviews, case reports, studies on animals, cadavers or *in vitro*, biomechanical reports, technical notes, letters to editors and instructional courses were excluded. We also excluded articles with no information on surgical intervention, diagnosis, follow-up, imaging, arthroscopic, or surgical assessment, clinical examination, clinical post-operative outcomes and statistical analysis.

Finally, to avoid bias, the selected articles, the relative list of references, and the articles excluded from the study were reviewed, assessed, and discussed by all the authors. If there was disagreement among investigators regarding the inclusion and exclusion criteria, the senior investigators (N.M. and V.D.) made the final decision.

Demographics, previous surgery, imaging assessment, diagnosis, surgical or conservative management, complications, failure and outcome measurements were extracted independently by all the investigators.

Quality assessment

To assess the quality of the studies, the modified Coleman Methodology Score (CMS) was used.[23] The CMS assesses methodology using ten criteria, giving a total score between 0 and 100. A score of 100 indicates that the study largely avoids chance, various biases, and confounding factors. The subsections that compose the Coleman Methodology Score are based on the subsections of the CONSORT statement (for randomized controlled trials), and are modified to allow for other trial designs.

The Coleman criteria were modified to make them reproducible and relevant for the systematic review of shoulder stiffness. Each study was scored by two reviewers (U.G.L and J.L) independently and in duplicate for each of the criteria adopted (listed in Table 1) to give a total Coleman methodology score between 0 and 100. Disagreements were resolved by discussion.

Evaluation of the strength of recommendation and quality of evidence of this systematic review was conducted using GRADE (Grading of Recommendations Assessment, Development and Evaluation) assessment.[24,25] We used GRADE to establish the quality of evidence through four factors: study design, study quality, consistency and directness. The combinations of these determine the quality of strength of recommendation which is given through a qualitative assessment of the evidence: high quality, moderate quality, low quality and very low quality.

Statistical analysis

We used Fisher's Exact test to establish whether the difference of percentage in terms of post-treatment failure was statistical relevant. A P value <0.05 was considered significant. A meta-analysis of clinical outcomes of the included studies could not be performed since most of the included studies did not report the standard deviation.

Table 1 Modified Coleman Methodology Score

Part A: Only one score to be given for each of the seven sections		
Study size – number of patients	<30	0
	30–50	4
	51–100	7
	>100	10
Mean follow-up	<12 months	0
	12–36 months	4
	37–60 months	7
	>61 months	10
Surgical approach	Different approach used and outcome not reported separately	0
	Different approaches used and outcome reported separately	7
	Single approach used	10
Type of study	Retrospective cohort study	0
	Prospective cohort study	10
	Randomized control trial	15
Description of diagnosis	Described without % specified	0
	Described with % specified	5
Descriptions of surgical technique	Inadequate (not stated, unclear)	0
	Fair (technique only stated)	5
	Adequate (technique stated, details of surgical procedure given)	10
Description of postoperative rehabilitation	Described	5
	Not described	0
Part B: Scores may be given for each option in each of the three sections if applicable		
Outcome criteria	Outcome measures clearly defined	2
	Timing of outcome assessment clearly stated	2
	Use of outcome criteria that has reported reliability	3
	General health measure included	3
Procedure of assessing outcomes	Subjects recruited	5
	Investigator independent of surgeon	4
	Written assessment	3
	Completion of assessment by patients themselves with minimal investigator assistance	3
Description of subject selection process	Selection criteria reported and unbiased	5
	Recruitment rate reported	
	>90%	5
	<90%	0

Results

The literature search and cross-referencing resulted in a total of 136 references, of which 67 were rejected because of failure to fulfil the inclusion criteria (Fig. 1).

After reading the remaining full-text articles, other 24 articles were excluded because of insufficient details of clinical test and image used for the diagnosis, the type of treatment and outcome measures used.

Finally, 43[11–14,26–64] articles were included (Fig. 1).

Quality assessment

The mean value of the CMS score was 48.2 points, showing that the mean quality of included studies was fair. Detailed values of the Coleman score are reported in Table 2. Interobserver agreement was found between mean values of CMS calculated by the three examiners.

Demographics

A total of 4578 patients and 4599 shoulders were included,[11–14,26–64] with a median age of 54.3 years, ranging from 22[57] to 87[49] years. The dominant side was involved in 422 (48%) of 880 shoulders while the nondominant side in 458 (52%)[11,12,26–28,30,44,50,51,60–62]. In the remaining 3719 shoulders this data was not reported (Table 2). Patients were assessed at a median follow-up period of 1.44 years (ranging from 2 weeks[39] to 20.6 years[37]).

Imaging assessment

Fifteen studies,[11–14,26,32,42,52,54,58,60–64] describing 823 of 4578 (18%) patients, provided a detailed description of the imaging exams performed for diagnosis. The cost common imaging modality performed were radiographies, magnetic resonance and ultrasound scanning. The remaining 28 studies,[27–31,33–41,43–51,53,55–57,59] describing 3755 (82%) patients, did not provide further specifications of imaging assessment (Table 3).

Diabetes, disease phase, compliance and previous treatment

Twenty studies[28,29,31,32,37,40,41,44,48,50,52,54–59,61,63,64] reported data about incidence of diabetes among the included patients. 204 (18%) of 1129 patients were affected. A surgical treatment was the treatment of choice for 116 (57%) patients,[28,32,40,44,52,54,57–59,63,64] while a conservative modality was chosen for 77 (38%) patients[29,31,37,48,50,55,56,61]; for the remaining 11 (5%) patients, treatment was not specified.[11–14,26,27,30,33–36,38,39,41–43,45–47,49,51,53,60,62]

No data was reported for disease phase, compliance and previous treatment.

Conservative management

In 26 studies,[11–14,26,29–31,33,34,36–39,41,42,45–47,51,53,55,56,60,61] evaluating 3710 (81%) patients, conservative management for shoulder stiffness was reported. The conservative treatment varied among the included studies (Table 3). Physiotherapy alone was chosen in 3309 (89%) patients. Oral glucocorticoids were administrated in 121 (3.3%) patients.[11,29,46,51,56] A total of 248 (6.7%) injections were performed: intra-articular and sub-acromial injections of low molecular-weight hyaluronic acid were administered to 52 (21%) patients[12]; intra-articular corticosteroids to 159 (64%) patients[26,30,31,33,38,47,48,51,65]; 37 (15%) patients underwent an intra-articular injections with lidocaine.[26,30,31,33,38,48,51] NSAIDs were also administered in 54 (1.5%) patients undergoing a conservative treatment,[36] a suprascapular nerve block was performed in 53 (1.4%) patients,[47] 19 (0.5%) patients also received shock wave therapy[13]; 21 (0.6%) patients received ultrasound-guided pulsed radiofrequency stimulation of the suprascapular nerve.[66]

Complications for conservative management were reported: a vaso-vagal collapse following an intra-articular injection (0.4% of all intra-articular injections) and mild pain in 11 patients (4.4% of all intra-articular injections).[14,41]

Surgical management

In 19[27,28,32,35,40,41,43,44,48–50,52,54,57–59,62–64] studies evaluating 894 (19%) patients, a surgical procedures for shoulder stiffness was reported. 789 (88.3%) patients underwent an arthroscopic capsular release or an arthroscopic capsulotomy (Table 3). Complications for arthroscopic capsular release were reported: 3 (0.4%) patients had a post-operative infection; post-operative osteoarthritic changes requiring replacement prosthesis were reported in 2 (0.3%) patients; a delayed healing of the posterior portal, a diffuse brachial plexopathy and a post-operative haematoma were also reported in 1 (0.1%) patient, respectively.[27,35,44,58,63,64]

Manipulation under general anaesthesia was performed in 80 (8.9%) patients.[41,48,50]

In one study, including 30 patients undergoing manipulation under general anaesthesia, local synovitis was observed in 22 (73%) patients, an acute rupture of the capsule in 29 (97%), a localized detachment of the anterior labrum in 4 (13%), a rupture of the long head of the biceps tendon in 3 (10%), a partial rupture of the superior or medial glenohumeral ligament, a partial tear of the subscapularis tendon and a SLAP I lesion, respectively, in

Table 2 Details of the included studies

Authors	Study design (level of evidence)	No. of patients (shoulders)	Mean age (range) (years)	Side (dominant/ not dominant)	Diabetes mellitus diagnosis	Coleman Methodology Score
Canbulat *et al.*[11]	Case series (IV)	33	52 (43–71)	18/15	None	41
Russo *et al.*[12]	Case series (IV)	52	44 (36–52)	35/17		34
Hsu *et al.*[42]	Prospective randomized controlled trial (I)	Control physiotherapy only group (PT group) (33); Lidocaine injection plus physiotherapy group (INJPT group) (33)	PT group: 56.4 (47–65.8); INJPT group: 54.9 (47.9–61.9)			65
Vahdatpour *et al.*[13]	Prospective randomized clinical trial (I)	Intervention group (IT) (19); Control group (CT) (17)	IT group: 56.1 (45.5–66.7); CT group: 60.3 (55.5–65.1)			62
Wu *et al.*[14]	Prospective randomized clinical trial (I)	Intervention group (IT) (21); Control group (CT) (21)	IT group: 55 (45.8–64.2); CT group: 57.1 (46,2–68)			66
Waszczykowski *et al.*[62]	Case series (IV)	27	51.6 (24–76)	15/12	None	47
Arslan and Çeliker[26]	Prospective randomized clinical trial (I)	20	55.6 (43.4–67.8) (group A); 56.4 (49.3–63.5) (group B)	8/12		34
Berghs *et al.*[28]	Case series (IV)	25	50.8 (41–61)	12/13	6	35
Buchbinder *et al.*[29]	Double blind, randomized, placebo controlled trial (I)	50 (24 oral prednisolone group; 26 placebo group)	53.5 (oral prednisolone group); 55.0 (placebo group)		13	44
Carette *et al.*[31]	Randomized controlled trial (I)	93 (21 group 1; 23 group 2; 26 group 3; 23 group 4)	54.9 (44.4–65.4) (group 1); 55.4 (45.4–65.4) (group 2); 54.2 (45.9–62.5) (group 3); 56.5 (47.1–65.9) (group 4)		6	51

Continued

Table 2 *Continued*

Authors	Study design (level of evidence)	No. of patients (shoulders)	Mean age (range) (years)	Side (dominant/ not dominant)	Diabetes mellitus diagnosis	Coleman Methodology Score
Dudkiewicz *et al.*[36]	Case series (IV)	54	51,8			39
Farrell *et al.*[37]	Retrospective case series (IV)	25 (26)	50		8	35
Gam *et al.*[38]	Randomized Controlled Trial (I)	22	53 (40–65)		None	36
Hsu *et al.*[41]	Prospective case series (IV)	75	52 (38–73)		11	30
Jones[47]	Randomized trial (II)	30	Group 1: 53 (43–63); group 2: 60 (44–76).			35
Segmüller *et al.*[57]	Case series (IV)	24 (26)	50 (22–73)		3	35
Guler-Uysal and Kozanoglu[39]	Randomized comparative prospective clinical trial (II)	40	Group 1: 53.6 (43–70); group 2: 58.4 (44–82)			44
Baums *et al.*[27]	Prospective unrandomized case series (V)	30	50 (36–61)	18/12	0	56
Bulgen *et al.*[30]	Randomized, placebo controlled trial (II)	42	55.8 (44–74)	22 (20)	0	31
Diercks and Stevens[34]	Prospective unrandomized case series (V)	Supervised neglect group (45); Physical therapy group (32)	Supervised neglect group (50); Physical therapy group (51)		0	48
Diwan and Murrell[35]	Case-controlled cohort study (IV)	Standard anteroinferior arthroscopic capsule release group, ACR-S group (18); capsular release extended an additional 65° posteriorly, a portion of the intra-articular part of the subscapularis tendon was divided, and the patients had a modified earlier, supervised postoperative physical therapy program, ACR-M group (22)	ACR-S (33–71); ACR-M (45–69)		0	58
Hettrich[40]	Basic Science Study; Histology (V)	20	51.2 (42–65)		2	29

Continued

Table 2 *Continued*

Authors	Study design (level of evidence)	No. of patients (shoulders)	Mean age (range) (years)	Side (dominant/ not dominant)	Diabetes mellitus diagnosis	Coleman Methodology Score
Jerosch[43]	Retrospective case series (IV)	28	49 (33–67)		0	43
Jerosch *et al.*[44]	Therapeutic retrospective case series study, Level (IV)	167 (173)	48 (25–80)	102 (71)	25	46
Jewell *et al.*[45]	Retrospective cohort study (IV)	2370	55.3			29
Johnson *et al.*[46]	Randomized clinical trial (II)	20	Not stated (37–66)		0	31
Kivimäki and Pohjolainen[48]	Randomized trial (II)	24	51 (35–68)		1	41
Le Lievre and Murrell[49]	Therapeutic Level IV	43 (49)	61 (37–87)		0	49
Loew *et al.*[50]	Prospective trial (IV)	30	52.9 years (38–62)	13 (17)	3	47
Lorbach *et al.*[51]	Level 1, Randomized Clinical Trial	40	50 (42–58)	20 (20)	0	66
Mehta *et al.*[52]	Prospective Case Series (IV)	21 with diabetes, 21 without diabetes	54.5 (48–65);		21	57
Melzer *et al.*[53]	Retrospective Case Series (IV)	Mixture of drug therapy and physical rehabilitation (97). Mobilization under anaesthesia (21)	(34–78)			45
Mubark *et al.*[54]	Prsopective case series (IV)	40	48.2 (38–62)		4	62
Çinar *et al.*[32]	Prospective case series (IV)	26 (28)	50 (40–65)		14	60
Placzek *et al.*[55]	Prospective case series (IV)	31 (32)	49.1 (41.2–57)		4	46
Ryans *et al.*[56]	Randomized controlled trial (II)	80	Group A 56.3; Group B 52.3; Group C 52.6; Group D 55.2.		Group A 5; Group B 5; Group C 5; Group D 11.	65

Continued

Table 2 *Continued*

Authors	Study design (level of evidence)	No. of patients (shoulders)	Mean age (range) (years)	Side (dominant/ not dominant)	Diabetes mellitus diagnosis	Coleman Methodology Score
Smith *et al.*[58]	Prospective case series (IV)	136	52 (34–72)	45 (91)	23	55
Snow[59]	Therapeutic, retrospective comparative study (III)	48	51 (28–65)		7	52
Tanaka *et al.*[60]	Randomized controlled study (II)	110	63.7 (54.6–72.8)	60 (50)	0	61
Van der Windt *et al.*[33]	Randomized trial (II)	Corticosteroid injections group (53); physiotherapy group (56)	Corticosteroid injections group (57.3); physiotherapy group (60.2)		0	66
Vermeulen *et al.*[61]	Randomized Controlled Trial	100	High-grade mobilization techniques (HGMT): 49; low-grade mobilization techniques (LGMT): 51	HGMT: 23 (47); LGMT 31 (61)	HGMT 8; LGMT 8	86
Watson *et al.*[63]	Prospective case series (IV)	73	52 (37–70)		3	62
Yamaguchi *et al.*[64]	Retrospective case series (IV)	20 (23)	48 (37–64)		**8**	**50**

Table 3 Adhesive capsulitis management

Authors	Imaging assessment	Duration of disorder	Treatment	Complications
Canbulat *et al.*[11]	Anterior–posterior, oblique, axillary, and outlet radiographs (RX) and MRI		Conservative: oral glucocorticoids (0.5 mg/kg/day methylprednisolone halved each week for 4 weeks); Pregabalin (2 × 75 mg of pregabalin for an average of 6 weeks), paracetamol (max. 2 g/day) and proton pump inhibitor (Esomeprazole or Pantoprazole) also administered); home exercise program (for 10 min every 2 h during daytime)	None
Russo *et al.*[12]	Standard plain radiographs (RX) and MRI		Locoregional injections (three per week) of 10 ml of ropivacaine (2 mg/ml); intra-articular and subacromial injections of 2 ml of low molecular-weight hyaluronic acid (Hyalgan; Fidia Farmaceutici, Abano Terme, Italy) three times a week; anaesthetic block of the suprascapular nerve and/or low doses of triamcinolone acetonide (7 patients only); physiotherapy program (three per week) and home exercise program	None
Hsu *et al.*[42]	RX and ultrasound scanning		Lidocaine injection plus physiotherapy group (INJPT group): injection of 3 ml of 1% lidocaine before each physiotherapy (three times per week for 3 months). Control group (PT group): physiotherapy (three times per week for 3 months).	
Vahdatpour *et al.*[13]	RX		Meloxicam 15 mg daily, activity modification to reduce pain, pendulum exercises (for 5–10 times) and stretching 30 s (twice a day); if tolerated, also wall walking and Jackins exercise. Intervention group received shock wave therapy once a week for 4 weeks	
Wu *et al.*[14]	Ultrasound scanning		IT group: 12 weeks of physical therapy after one treatment of ultrasound-guided pulsed	

Continued

Table 3 *Continued*

Authors	Imaging assessment	Duration of disorder	Treatment	Complications
			radiofrequency stimulation of the suprascapular nerve; CT group: 12 weeks of physical therapy alone	IT group: mild tingling or pain at the puncture site, disappeared 1 h later (4).
Waszczykowski *et al.*[62]	Arthroscopy		Arthroscopic capsular release	
Arslan et Çeliker[26]	RX		40 mg methylprednisolone acetate injection with local anaesthetic (group A); physical therapy measures plus acemethazine 120 mg/day (group B)	
Berghs *et al.*[28]			Arthroscopic capsular release and physiotherapy	
Buchbinder *et al.*[29]			30 mg oral prednisolone/day for three weeks or placebo.	
Carette *et al.*[31]			Group 1: corticosteroid injection (triamcinolone hexacetonide 40 mg) performed under fluoroscopic guidance followed by 12 sessions of supervised physiotherapy; group 2, corticosteroid injection alone; group 3, saline injection followed by supervised physiotherapy; or group 4, saline injection alone (placebo group)	
Dudkiewicz *et al.*[36]			Physical therapy and NSAIDs	
Farrell *et al.*[37]			Physical therapy for a mean of 6.2 months.	
Gam *et al.*[38]			Group 1: steroid alone (8); group 2: distension combined with steroid (12)	
Hsu *et al.*[41]			Group M: manipulation under an anaesthesia and physiotherapy (25). Group D: arthroscopic distension and physiotherapy (25). Group P: physiotherapy alone (25)	
Jones[47]			Group 1: suprascapular nerve block (20 mg Triamcinolone acetonide and 9.5 ml 0.5% Bupivacaine Hydrochloride) (15). Group 2: intra-articular injections (20 mg Triamcinolone	Vaso-vagal collapse following an intra-articular injection (1); mild pain (11)

Continued

Table 3 *Continued*

Authors	Imaging assessment	Duration of disorder	Treatment	Complications
			acetonide and 4.5 ml 2% Lidocaine Hydrochloride) (15).	
Segmüller *et al.*[57]			Arthroscopic capsular release	
Guler-Uysal and Kozanoglu[39]			Group 1: deep friction massage and mobilization exercises three times weekly. Group 2: daily physical therapy including hot pack and short wave diathermy application. Stretching exercises and a daily home exercise program for both.	
Baums *et al.*[27]		12 months (range 6–16)	Arthroscopic capsular release	Delayed healing of the posterior portal (1); Haematoma (1)
Bulgen *et al.*[30]		4.8 months (1–12 months)	Intra-articular steroids (11), mobilizations, (11), ice therapy (12), no treatment (8).	
Diercks and Stevens[34]		Supervised neglect group: 5 months (3–12); Physical therapy group 5 months (3–10)	Supervised neglect group (45); Physical therapy group (32)	
Diwan and Murrell[35]			Standard anteroinferior arthroscopic capsule release (18); capsular release extended an additional 65° posteriorly, a portion of the intra-articular part of the subscapularis tendon was divided, and the patients had a modified earlier, supervised postoperative physical therapy program (22)	The shoulders of the patients in the ACR-S cohort refroze and needed revision capsular release 8 and 10 months after index procedure
Hettrich[40]			Arthroscopic capsular release	
Jerosch[43]		24 months	360° arthroscopic capsular release	None
Jerosch *et al.*[44]		12 months (1–156)	Arthroscopic capsular release	Postoperative infection (1); recurrence and revision due pain (8); osteoarthritic changes, requiring replacement prosthesis (2)
Jewell *et al.*[45]				

Continued

Table 3 *Continued*

Authors	Imaging assessment	Duration of disorder	Treatment	Complications
			Physiotherapie, iontophoresis, phonophoresis, ultrasound or massage	
Johnson *et al.*[46]		9.5 months	Six therapy sessions consisting of application of therapeutic ultrasound, joint mobilization, and upper-body ergometer exercise	
Kivimäki and Pohjolainen[48]		7 months (3–18)	Manipulation under anaesthesia with steroid injection (13), and without steroid injection (11)	
Le Lievre and Murrell[49]			Arthroscopic capsular release	0
Loew *et al.*[50]		14.6	Manipulation under general anaesthesia	Local synovitis (22); acute rupture of the capsule (29); acute intra-articular lesions (12); localized detachment of the anterior labrum (4); SLAP I lesion (2); SLAP II (1); anterior labral detachment with osteochondral fragment (1); partial rupture of the superior or medial glenohumeral Ligament (2); partial tear of the subscapularis tendon (2); rupture of the long head of the biceps tendon (3)
Lorbach *et al.*[51]		11 months	Oral corticoid treatment regimen or three intra-articular injections of corticosteroids.	0
Mehta *et al.*[52]	RX	8.3 months (6–13)	Arthroscopic release	0
Melzer *et al.*[53]		1.7 (0.6–4.6)	Mixture of drug therapy and physical rehabilitation (97). Mobilization under anaesthesia (21)	
Mubark *et al.*[54]	RX	at least six months and at least 3 months of physical therapy and anti-inflammatory treatment	Arthroscopic capsular release	0
Çinar *et al.*[32]	RX	8.4 months	Arthroscopic capsular release	0

Continued

Table 3 *Continued*

Authors	Imaging assessment	Duration of disorder	Treatment	Complications
Placzek *et al.*[55]		7.8 months	Moist heat, ultrasound, joint mobilization and therapeutic exercise program	0
Ryans *et al.*[56]		Group A 14.2 months; Group B 12.2; Group C 14.4; Group D 14.9.	Group A, injection of triamcinolone 20 mg and eight sessions of standardized physiotherapy; Group B, injection of triamcinolone 20 mg alone; Group C, placebo injection and eight sessions of standardized physiotherapy; Group D, placebo injection alone.	
Smith *et al.*[58]	Radiography	11 months (minimum of 2)	Arthroscopic capsular release	One infection
Snow[59]		at least 3 months	Arthroscopic capsular release with anterior and inferior release (27) only or also with a posterior release (21)	0
Tanaka *et al.*[60]	Radiography	4.6 (3.4–5.8) months	Joint mobilization of the shoulder joint by physical therapists for 40 min per day and instruction on self-exercises to be performed in the home setting	
Van der Windt *et al.*[33]		Corticosteroid injections group (18 months); physiotherapy group (25 months)	6 weeks of treatment either with corticosteroid injections (53) or physiotherapy (56)	Croticosteroid injections group: facial flushing was reported by nine women, irregular menstrual bleeding by 6, 2 of whom were postmenopausal.
Vermeulen *et al.*[61]	Arthrography	HGMT 8 months (5–14.5); LGMT 8 months (6–14)	HGMT group: intensive passive mobilization techniques in end-range positions of the glenohumeral joint (49); LGMT group: passive mobilization techniques within the pain-free zone (51)	
Watson *et al.*[63]	Radiography	19.7 months (1.5–180),	Arthroscopic capsulotomy	Eight (11%) patients were seen with a recurrence of their pain and some minor stiffness limitations after they had been discharged from supervised treatment at a mean of 3.5 months (range 2–4.5 months). The ache at the time of representation was 5.6 out of

Continued

Table 3 *Continued*

Authors	Imaging assessment	Duration of disorder	Treatment	Complications
				10. Most of these patients had pain localized to the region of their long head of biceps tendon. In all cases the pain appeared to have been reaggravated by unaccustomed loading of the shoulder such as heavy gardening or cleaning. One of the patients also had a bilateral degenerative full-thickness tear of the supraspinatus tendon. Four patients underwent injection to the paratenon surrounding biceps tendon, whereas the other four settled with further physiotherapy (average two treatments). The average time to settle was 2.5 weeks.
Yamaguchi *et al.*[64]	Radiographs		Arthroscopic capsular release	One diffuse brachial plexopathy. By eight weeks postoperatively, the neurologic symptoms were completely resolved.

2 (6.7%) patients, a SLAP II lesion and an anterior labral detachment with osteochondral fragment in 1 (3.3%) patient, respectively.[50]

The remaining 25 patients (2.8%) underwent an arthroscopic distension. Rupture of the contracted tissues that did not require treatment was reported in 5 (20%) of these patients.[41]

Outcome measurements

Several outcome measures were reported in the included studies (Table 4).[11–14,26–64] The Constant Score was used in 10 studies[11,28,32,34,43,44,51,52,54,59]; the Disabilities of the Arm, Shoulder and Hand (DASH) score was used in one study[11]; the American Shoulder and Elbow Surgeons (ASES) score was used in three studies[11,27,62]; the visual analogue scale (VAS) was reported in 12 studies.[11,14,26–28,38,44,46,51,56,58,64] Other outcome measures reported were the Shoulder Disability Questionnaire, the Shoulder Pain and Disability Index (SPADI), the 36-item Short-Form Health Survey, the University of California at Los Angeles Shoulder Score, the Wolfgang's functional assessment score, the Oxford shoulder score.[13,14,27–32,35,36,42,55,56,58,61,64] 34 studies measured ROM.[11,12,14,27–29,31–39,41,42,44,46–49,51,52,54–56,58,59,61–64]

Failures

Failure was reported as either resistance to conservative treatment, with limitations in ROM, and need of surgical management or regression to pre-operative levels of ROM after treatment. A recurrence of shoulder stiffness was reported in 29 (3.6%) of 789 patients undergoing arthroscopic capsular release or arthroscopic capsulotomy.[13,26,34,43,56,62] Failure after conservative treatment was reported in 28 (0.8%) of 3710 patients.[11,12,31,37,53] Two patients considered failures occurred for conservative treatment group with oral glucocorticoids,[11] both patients were resistant to treatment, with a limitation of 45° of external rotation and a limitation of 130° of forward elevation each in one patient. Other two patients required arthroscopic capsular release.[12] Other two patients, treated with intra-articular injection of corticosteroids, showed a regression to pre-treatment ROM.[31]

A quantitative synthesis of the including studies that compared surgical and conservative management for stiff shoulder was performed. The results showed that the rate of failure was higher after arthroscopic capsular release (3.6%) than after a conservative treatment (0.8%), odds ratio 5.02; 95% confidence interval [CI], 2.97–8.48; $P = <0.005$).

The quality of the evidence of studies which reported the rate of failure between surgical and conservative treatment group was low according to GRADE (Fig. 2).

Discussion

This systematic review showed that the rate of failure after treatment for stiff shoulder was higher in the surgical group than in the conservative group (3.6% vs 0.8%, odds ratio 5.02; 95% confidence interval [CI], 2.97–8.48; $P = <0.005$). No clear or common definition for failure was provided by the included studies.[11–14,26–64] Failure was reported as either resistance to conservative treatment, with limitations in ROM, and need for surgical management or regression to pre-operative ROM after treatment.

The definitive treatment for shoulder stiffness remains unclear, and different interventions have been studied, including oral medications, corticosteroid or hyaluronic injections, exercises, joint mobilization, distension, acupuncture, manipulation under anaesthesia, nerve blocks and surgery.[67] Comparison between these techniques is difficult, as varied inclusion criteria, different treatment protocols and various outcome assessment were used.[11–14,26,29–31,33,34,36–39,41,42,45–47,51,53,55,56,60,61] One of the major difficulties in assessing efficacy is the definition of success.[67] The ideal approach to shoulder stiffness should be prevention, but identifying patients at early stage in the course of the condition is often difficult, as patients may complain only of vague pain with terminal stretch.[68] A second important point is to avoid misdiagnosis of other shoulder disorders, such as pseudoparalytic

Table 4 Results of adhesive capsulitis management

Authors	Outcome scores					Results (Measured range of motions)			Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others					
Canbulat *et al.*[11]	Before treatment: 28.31 ± 12.3; after treatment: 94.81 ± 3.99	Before treatment: 50.97 ± 18.34; after treatment: 1.36 ± 1.77	Before treatment: 25.92 ± 14.2; after treatment: 98.73 ± 2.75	Before treatment: 6.32 ± 2.64 at rest; 8.23 ± 1.63 with motion.after treatment: 0.78 ± 0.95 at rest; 1.43 ± 1.7 with motion (p = 0.102)		Active Flex Abd ER IR Passive Flex Abd ER IR	Before 87.42 ± 22.1 77.06 ± 29.5 22.42 ± 13.1 22.12 ± 12.1 Before 97.52 ± 22.1 88.03 ± 27.3 29.24 ± 15.5 27.36 ± 15.6	After 176.54 ± 5.6 176.15 ± 6.3 85.38 ± 7.61 86.15 ± 6.37 After 177.31 ± 5.3 176.92 ± 6.1 86.15 ± 6.97 86.54 ± 6.29	resistant to treatment (1), with 45° of external rotation and 130° of forward elevation (1)	1.75 (1–3.1)
Russo *et al.*[12]						Mean pre-treatment ROM: 85° forward elevation, 75° abduction, 25° external rotation, 15° internal rotation. Mean post-treatment ROM: 175° forward elevation, 175° abduction; 87.5° external rotation, 75° internal rotation.			resistant to treatment (2). required arthroscopic capsular release	2.2 (1.5–2.9)
Hsu *et al.*[42]					Shoulder Disability Questionnaire (SDQ): before treatment, PT group: 48.20 ± 19.03; INJPT group: 39.06 ± 7.99 (p < 0.001). After treatment, PT group 22.61 ± 17.94; INJPT group: 10.58 ± 15.72 (p < 0.001) Shoulder Disability Questionnaire; Shoulder Pain and Disability Index (SPADI) Before treatment: Total PT group: 41.31 ± 19.68; INJPT group: 54.91 ± 20.48.	Active ROM in flexion and in external rotation after treatment, passive ROM in flexion after treatment and in external rotation after treatment, showed significant higher values for the INJPT group. No significant group effect was observed for internal rotation in either the active or passive ROM.			0	0.5

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)		Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others				
					After treatment, PT group: 19.32 ± 14.75 ($P < 0.001$); INJPT group: 16.73 ± 14.81 ($P < 0.001$). 36-item Short-Form Health Survey (SF-36) Before treatment: no group difference				
Vahdatpour *et al.*[13]					Shoulder Pain and Disability Index (SPADI) flexion, extension, and abduction, internal, and external rotation: improvement was more satisfactory in the intervention group ($P < 0.05$); mean internal rotation in both groups was similar and no significant difference was observed ($P > 0.05$)			0	0.5
Wu *et al.*[14]				Before treatment IT group: 6.5 ± 1.3; CT group: 6.3 ± 1.5 After treatment IT group: 1.7 ± 1.5; CT group: 3.3 ± 2.5 ($P < 0.001$)	Shoulder Pain and Disability Index (SPADI) total before treatment IT group: 55.6 ± 11.9; CT group: 52.17 ± 12.7 after treatment IT group: 15.6 ± 12.3; CT group: 36.3 ± 19.0 ($P < 0.001$)	Before treatment IT group Passive flexion 124.8 ± 19.9; Passive EX 32.4 ± 10.3; Passive Abd 82.2 ± 23.3; Passive Med. Rot 43.3 ± 15.4 CT group Passive FL: 128.5 ± 13.6; Passive EX: 36.4 ± 12.8; Passive Abd: 87.6 ± 20.9; Passive Med. Rot	After treatment IT group Passive FL: 160.2 ± 13.7; Passive EX: 54.1 ± 10.6; Passive Abd: 131.2 ± 27.1; Passive Med. Rot 75.2 ± 10.5;	0	1

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)			Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others					
						45.5 ± 5.6; Passive Lat. Rot: 34.6 ± 13.2		Passive Lat. Rot: 62.7 ± 12.4 CT group Passive FL: 150.2 ± 10.5; Passive EX: 45.3 ± 12.3; Passive Abd: 117.6 ± 16.9; Passive Med. Rot: 66.0 ± 6.3; Passive Lat. Rot: 59.8 ± 16.0		
Waszczykowski *et al.*[62]			Mean pre-operative: 25.6; mean post-operative:91.2 ($P < 0.05$)			Range of motion FFLX ABD ER	Pre-operative 81.9° 60.8° 6.1°	Post-operative 166.3° 147.5° 57.8°	0	2
Arslan et Çeliker[26]				Group A, before treatment: 8.4 ± 1.4; after treatment 2.3 ± 0.8 Group B, before treatment 8.6 ± 0.8; after treatment 2.7 ± 0.8					0	0.25
Berghs *et al.*[28]	preoperative: 25.3; postoperative: 75.5			Preoperative: 3.1; postoperative: 12.6 (scale 0–15).	Postoperative SF36: 48.7	Preoperatively mean passive elevation: 73.7°; postoperatively: 163°; preoperatively mean passive external Rotation: 10.6°; postoperatively 46.8°, passive internal rotation improving by a mean of 9 levels.			0	1.23 (0.25–3.3)

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
Buchbinder *et al.*[29]					Shoulder Pain and Disability Index (SPADI): overall pain in the prednisolone group than in the placebo group (mean (SD) change from baseline, 4.1 (2.3) v 1.4 (2.3); adjusted difference in mean change between the two groups, 2.4 (95% CI, 1.1 to 3.8)	marked or moderate overallimprovement in 22/23 v 11/23; RR = 2 (1.3 to 3.1), p = 0.001	0	0.25
Carette *et al.*[31]					Shoulder Pain and Disability Index: At 6 weeks, the total scores improved significantly more in groups 1 and 2 compared with groups 3 and 4 (P = 0.0004). At 3 months, groups 1 and 2 still showed significantly greater improvement in SPADI scores than group 4. At 12 months, all groups had improved to a similar degree	The total range of active and passive motion increased in all groups, with group 1 having significantly greater improvement than the other 3 groups. At 12 months, all groups had improved to a similar degree.	Group 1: regression to preoperative levels of ROM and need of re-release (2)	1
Dudkiewicz *et al.*[36]					Mean Simple Shoulder Test score 9.5	Increase in elevation, external and internal rotation ($P < 0.00001$)	0	0.77 (0.46–1.33)
Farrell *et al.*[37]						Forward elevation: mean pre treatment: 104°(70°-140°); mean post treatment 168°(90°-180°). External rotation: mean pre treatment: 23°(5°-70°); post treatment 67°(0°-90°).	Necessity of surgical treatment for a symptomatic rotator cuff tear 3 years later (1)	15 (8.1–20.6)

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)			Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others					
Gam *et al.*[38]				Group 1: Pre-treatment 4; post treatment 1. Group 2: pre-treatment 3.5; post treatment: 2 (P > 0.05)		Group 2 ROM showed significant improvement in all directions except extension (external P = 0.0007; P = flexion; P = 0.03; extension P = 0.01).			0	0.25
Hsu *et al.*[41]						Group M: range of motion	Pre-treatment	Post-treatment	0	0.25
						FFLX	80	130		
						ABD	80	120		
						Group D: range of motion	Pre-treatment	Post-treatment		
						FFLX	80	125		
						ABD	80	115		
						Group P: range of motion	pre-treatment	post-treatment		
						FFLX	80	110		
						ABD	80	90		
Jones[47]						Group 1: range of motion	Pre-treatment	Post-treatment	0	0.25
						ABD	90	170		
						ER	20	80		
						Group 2: range of motion	Pre-treatment	Post-treatment		
						ABD	100	170		
						ER	30	70		
Segmüller *et al.*[57]	Preoperative:10; postoperative: 18					Return to normal/near normal shoulder function in 76% of patients.				0.25
Guler-Uysal and Kozanoglu[39]						19 patients in group 1 (95%) and 13 patients in group 2 (65%) reached sufficient ROM at the end of the second week (p < 0.05).			0	0.04
Baums *et al.*[27]			Preoperative 35 (10–71); postoperativ 91	preoperative 7 (3–8); postoperativ 2 (0–5) (p < 0.05).	SF-36 scores there was a significant improvement (*P* < 0.05)	A from a mean of 70° preoperatively to 150° at latest follow-up. Mean FE from 85° to 160°. ER in adduction from 10° preoperatively			0	3 (2–6)

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
			(62–96) ($p < 0.05$)			to 65°. IR in adduction from 15° preoperatively to 60°.		
Bulgen *et al.*[30]					Average improvement in degrees: Component analysis to compute a principal component, C, which accounted for 59% of the Total variation between the patients initially. C = (0.536 x total flexion) + (0.201 x glenohumeral flexion) + (0.679 x total abduction) + (0.263 glenohumeral abduction) + (0.079 x External rotation) + (0.369 x total rotation) - 137–7. Initial improvement in movement was most marked in the steroid group, but by the end of the study the groups were similar.		0	0.5
Diercks and Stevens[34]	Supervised neglect group: 89% of participants reached a score of 80 or higher; physical therapy group: 63% of patients reached a score of 80 or higher					Supervised neglect group (at inclusion): Forward elevation 33°(6°); Lateral elevation 40°(6°); External rotation 9° (10°); Internal rotation Dorsum of hand to buttock. Physical therapy group (at inclusion): Forward elevation 33°(6°); Lateral elevation 38°(7°); External rotation 10°(9°); Internal rotation Dorsum of hand to buttock	0	2
Diwan and Murrell[35]					Patient-reported pain Relief, The pattern of		2 shoulders of in the ACR-S cohort	2.2.

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
					reduction in pain in both groups was similar	ACR-S group: preoperativ (Intraoperativ): forward flexion 78°(121°), Abduction 74°(114°), External rotation 9° (51°), internal rotation (vertebral level) L3 (T9). ACR-M group: forward flexion 97°(150°), abidctopm 86° (146°), 13°(66°) internal rotation L4 (T10).	refroze and needed revision capsular release 8 and 10 months after index operation	
Hettrich[40]					Immunohistochemical analysis			
Jerosch[43]	Mean preoperative score: 44; postoperative 85					Abduction improved from 75° preoperatively to 167° at last follow up; external rotation in adduction improved from 3° to 76°; external rotation in abduction from 4° to 85°; internal rotation in abduction from 17° to 63.	0	1.8 (0.5–4)
Jerosch *et al.*[44]	Preoperative: 3.5 (0–5); postoperative: 14 (5–15)			7 (6–10)		Abduction, adduction, flexion and extension were significantly improved.	recurrence and revision due pain (8); painful restriction movement (1)	3 (1.2–4.7)
Jewell *et al.*[45]					odds of meaningful improvement			
Johnson *et al.*[46]				significant (P =0.01) decrease of pain by the end of treatment		significant (P =0.01) improvement		
Kivimäki and Pohjolainen[48]						Manipulation with steroid injection: Flexion (°) before manipulation 101; 4 months after manipulation 156; Abduction 83, after 147; Outer rotation before 27 after 49; inner rotation (rating 1–15) before 2.5 after 5.9. Manipulation without steroid injection Flexion before 109, day 159; Abduction before 85, after 150; outer rotation before 28, after 47; inner rotation (rating 1–15) before 1.6, after 8.4		0.33
Le Lievre and Murrell[49]					standardized questionnaire with scales for evaluating both pain and function (based on the Shoulder Rating	Significant improvement in shoulder motion at seven years compared with the initial presentation ($p < 0.001$)		0.58 (5–13)

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
					Questionnaire; patient-reported pain scores			
Loew *et al.*[50]					flexion improved from 70° to 180°; abduction from 50° to 170°; external rotation from −5° to 40°			
Lorbach *et al.*[51]	Pre-treatment: 18.9, at final follow up: 62.7			Significant improvements	Simple shoulder test, pre-treatment: 1.5, at final follow up: 7.9	Flexion increased from 102° to 158°; Abduction from 72° to 158°; External rotation from 15° to 54°; internal rotation from 54° to 68°.		1
Mehta *et al.*[52]	Significant improvement ($P < 0.01$). The results in diabetic were significantly worse					Preoperative for Patients with diabetes (Non-diabetes): Forward flexion 78.1°(80.2°); Abduction 63.9°(75.5°); External rotation 15.8°(15.6°); Internal rotation 15.6° (16.7°) Postoperative for Patients with diabetes (Non-diabetes): Forward flexion 165.2°(173.2°); Abduction 156° (170.2°); external rotation 58°(68°); Internal rotation 56.7°(64.2°)		2
Melzer *et al.*[53]					subjective personal score: 49% of the patients was satisfied or very pleased by the result; for 34.4% a reasonable outcome was achieved; in 16.6% results were unsatisfactory.		21 patients were not considered healed	3.8
Mubark *et al.*[54]	Preoperatively 36.35 (21–51). At the end of FUP 85.8 (62–98)					Mean forward flexion improved from 95° to 160°; abduction from 85° to 155°; external rotation with arm in abduction from 10° to 80°; external rotation with arm in adduction from 8° to 74°; internal rotation in abduction from 5° to 55°.		0.5

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
Çinar *et al.*[32]	Diabetic patients: increased from 30.4 to 82.0; idiopatic patients: increased from 29.6 to 93.6				UCLA Score: diabetic patients, increased from 10.1 to 29.0; idiopatic patients, increased from 10.0 to 32.7	Range of joint motion was significantly improved in all directions in both groups (P\0.05),		4.5 (1.1–8.3)
Placzek *et al.*[55]					Wolfgang's functional assessment score (0 = completely disabled, 16 = normal function) increased significantly ($F_{2,89} = 176.4$; $P < 0.001$)	Mean ROM for flexion, abduction, internal and external rotation increased significantly after manipulation and remained significantly increased ($F_{3,120} = 82.6$, 99.0, 77.5, and 91.2, respectively. $P < 0.001$)		1.2
Ryans *et al.*[56]				Group A 57.2; Group B 65.0; Group C 63.9; Group D 62.7.	Shoulder Disability Questionnaire: mean change from baseline: 7.8; 6.1; 3.5; 3.1. Others: Short form 36 general health assessment; hospital anxiety and depression scale	Range of external rotation improved at 6 weeks in those having physiotherapy treatment.		0.3
Smith *et al.*[58]				Preoperative score 6.6; postoperative 1.0	Oxford shoulder score	In the diabetic group, 48% had regained forward flexion greater than 160°, 30% had regained internal rotation to L1 or greater and 17% had regained external rotation greater than 70°. This compared with 79%, 73% and 55% respectively in the non-diabetic group ($P < 0.01$).	Failed to get pain relief (10)	0.4
Snow[59]	significant improvement postoperatively ($P < 0.0.001$)					Significant improvement postoperatively ($P < 0.001$). There was no significant difference between the two groups.		0.42 (0.4–2)

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
Tanaka *et al.*[60]					Linear regression analysis for functional results showed a weak correlation between IA and age; no significant differences in IA between male and female; IA of the dominant-handed group was significantly higher than that of the non-dominant-handed group; the frequency of joint mobilization by physical therapists in the hospital setting showed no relationship with IA			0.49 (0,3–0.6)
Van der Windt *et al.*[33]					Improvement score on a six point Likert scale: statistically significant difference between the groups which favored treatment with corticosteroid injections.	Nonparametric testing (MannWhitney U test) indicated that there was a significantly greater improvement in degree of restriction of ROM among those treated with corticosteroids		1.08
Vermeulen *et al.*[61]					Short-Form Health Survey (SF-36)	Active ROM, improvement of active external rotation was significantly greater in the HGMT group at final follow up. Passive ROM abduction was significantly greater in the HGMT group at final follow up.		1

Continued

Table 4 *Continued*

Authors	Outcome scores					Results (Measured range of motions)	Failures	Mean follow-up (range) (years)
	Constant score	DASH	ASES	VAS	Others			
Watson *et al.*[63]					Shoulder pain settled after surgery at a mean of 2.24 weeks (range 4 days to 8 weeks). When the preoperative and postoperative pain scores at the time of discharge were compared, a large, statistically significant effect (P <0.0001) was found.	Preoperative (mean values) Abduction 84°; Flexion 103°, Extension 32°, Horizontal flexion 11°, Horizontal extension 5°, External rotation at 0° 19°, Hand behind back S1/L4, External rotation at 90° 14°, Internal rotation at 90° 9°	8 (11%) patients had recurrence of pain and some minor stiffness limitations a mean of 3.5 months after demission. 1 of the patients also had a bilateral degenerative full-thickness tear of the supraspinatus tendon. 4 patients underwent injection to the paratenon surrounding biceps tendon, whereas the other 4 settled with further physiotherapy.	1
Yamaguchi *et al.*[64]				Preoperative average score 8.1, postoperative 1.2 (P < 0.001)	The Shoulder Score Index increased from an average of 37.1 out of 100 to 90.9 (P <0.001).	Near complete restoration of range of motion without pain was achieved in 95% of the patients		1.9 (1–3.1)

Participants (studies)	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Overall certainty of evidence	Study event rates (%)		Relative effect (95% CI)	Anticipated absolute effects	
							Risk with conservative treatment	Risk with Surgical		Risk with conservative treatment	Risk difference with Surgical
Rate of Failure											
(11 observational studies)	not serious	not serious	not serious	not serious	none	⨁⨁◯◯ LOW	4449 cases	4449 controls	**OR 5.02** (2.97 to 8.48)	**Low**	
										8 per 1.000	**31 more per 1.000** (from 15 more to 56 more)

Fig. 2 GRADE summary of findings.

shoulder, chronic anterior shoulder luxation, neurological disorders. In fact, apparent stiffness arising from muscle weakness or because of pain inhibition can mislead the clinician. Therefore, it is important to recognize the two principal characteristics of shoulder stiffness: normal plain radiographs, and pain and physical restriction of movements of the glenohumeral joint.[10] Once diagnosed, treatment for patients with shoulder stiffness must be individualized and based on the severity and chronicity of the patient's symptoms, as well as previous therapeutic efforts.[3,69]

Reves *et al.* identified three phases in the natural history of shoulder stiffness: pain, stiffness and recovery.[5] Patients in different phases exhibit different symptoms, and may benefit from individualized treatment. In the freezing phase, pain is most prominent. Intra-articular corticosteroids provide rapid short-term pain relief. At 6 weeks to 9 months after onset, restricted ROM is predominant. In this phase, therapy should concentrate on increasing ROM, and mobilization techniques or distension are recommended. In the thawing phase, there is a minimum of pain and progressive improvement in ROM. As pain and muscular inhibition result in compensatory movements of the scapula, the role of adaptation of scapular motion could be important in managing rehabilitation in shoulder stiffness. Continued use of compensatory movements of the scapula to minimize pain and muscular inhibition may produce pain and dysfunction elsewhere, for example development of a kissing coracoid.[70] Therefore, after normalization of ROM and after the pain has ceased, an important goal should be to restore physiological scapular movement.[16]

Traditionally, initially conservative treatment for shoulder stiffness is warranted, and most patients will experience resolution without the need of surgery.[71] In our systematic review, the most common non-operative treatment was physiotherapy alone. Suprascapular nerve block, oral glucocorticoids, NSAIDs, shock wave therapy, intra-articular and sub-acromial injections of glucocorticoids, low molecular weight hyaluronic acid, lidocaine were also were also reported.[11–14,26,29–31,33,34,36–39,41,42,45–47,51,53,55,56,60,61]

Treatment may have to be modified based on the patient's clinical response and perceived disability. Some patients tolerate a protracted conservative treatment plan with range-of-motion exercises, while others necessitate a more aggressive approach.[72] Given the protracted course of the condition, the routine use of narcotics should be avoided. Nonsteroidal anti-inflammatory medications can be effective,[73] including oral or intra-articular injections of corticosteroids.[11,74] Adequate injections of the joint are important to prevent limited effectiveness of the treatment.[75] Patients with a stiff shoulder should be placed on an exercise program to regain ROM. The exercise program should be active assisted and ROM should be obtained complying with gentle, passive, stretching exercises.[76] These exercises should be performed four to five times per day, and should include forward elevation, internal and external rotation, and cross-body adduction.[12,13,42] The failure or the success of the therapy largely depends on the patient's compliance. Griggs *et al.* found 90% (64/75 patients) satisfaction with non-operative treatment, with only 7% requiring manipulation under anaesthesia or capsular release.[77] In our systematic review, conservative treatment failed in 0.8% of all included patients. Arthroscopic capsular release allows a controlled release of the contracted tissue

without the risk of injury to normal structures or fractures and also provides diagnostic information on concomitant disorders such as labral tears, chondromalacia, biceps pathologies, rotator cuff tears, large anterolateral acromial spurs or calcium deposits.

Arthroscopic capsular release is safe and effective to treat shoulder stiffness, even though recurrence rate can be as high as 11% at 1 year after index operation.[63] The best timing for a surgical procedure is still debated, but most surgeons agree to wait for failure of conservative measures for 6–12 months.[3] Discharge in a sling and a non rigorous post-operative rehabilitation program should also be avoided, as early post-operative regression of ROM has been reported.[35] Post-operative rehabilitation should be individualized and include four phases: early motion, active motion, strengthening and advanced strengthening.[3] Improvement in pain and function is faster after an arthroscopic treatment than any other treatment modality.[32,49] In this systematic review, no bony or soft tissue abnormality was reported in patients treated with an arthroscopic capsular release.[58,78] Complications for arthroscopic capsular release were post-operative infection (0.4%), post-operative osteoarthritic changes requiring replacement prosthesis (0.3%), delayed healing of the posterior portal (0.1%), diffuse brachial plexopathy (0.1%) and post-operative haematoma (0.1%).[27,35,44,58,63,64]

The relationship between diabetes mellitus and shoulder stiffness has been recognized in different epidemiological studies.[79–83] In this systematic review, 204 (18%) were affected. A surgical treatment modality was the option of choice for 57% of these patients.[28,32,40,44,52,54,57–59,63,64] No statistical analysis of risk of failure of stiff shoulder management or complications in patients with diabetes could be performed, given the poor quality of data of the included studies. Patients with established diabetes have a greater likelihood of developing a stiff shoulder. Frequently, these patients cannot receive adequate non-surgical treatment, as corticosteroid treatment might be contraindicated. Therefore, these patients often require a surgical procedure.

Most of the included studies concentrated on short-term results, with a mean follow up of 1.44 years (ranging from 2 weeks[39] to 20.6 years[37]).

The main limitation of the present study was that only low quality of evidence for the management of shoulder stiffness had been reported in the peer reviewed literature. Studies were at risk of bias, since they exhibited weaknesses such as deficient sample size and no randomization. Therefore, available data must be interpreted with caution. Future studies should accomplish blinding of interventions, perform concealed allocation and use blinded outcome measurements because these would improve the quality and validity of their results.

A further limitation of the included studies was that no clear or common definition for failure was provided by the included studies. Therefore, the definition of success should be standardized to provide easier comparison between different techniques.

Conclusion

Any strong clinical recommendation based on the existing published literature is difficult, as the quality of the published studies is low.

Treatment for shoulder stiffness should be individualized and based on the severity and chronicity of the patient's symptoms. Conservative treatment should always be warranted at the beginning of the pathology, and most patients will experience resolution without the need of surgery. Arthroscopic capsular release is a valid treatment options for patients who failed conservative treatment.

Further high quality randomized controlled trials are needed to support the use of either treatment modality.

Conflict of interest statement

The authors have no potential conflicts of interest.

References

1. Hand C, Clipsham K, Rees JL, et al. Long-term outcome of frozen shoulder. *J Shoulder Elbow Surg* 2008; 17:231–6.

2. Del Buono A, Oliva F, Longo UG, et al. Metalloproteases and rotator cuff disease. *J Shoulder Elbow Surg*. 2012; 21:200–8.
3. Itoi E, Arce G, Bain GI, et al. Shoulder stiffness: current concepts and concerns. *Arthroscopy* 2016;32:1402–14.
4. Grey RG. The natural history of 'idiopathic' frozen shoulder. *J Bone Joint Surg Am* 1978;60:564.
5. Reeves B. The natural history of the frozen shoulder syndrome. *Scand J Rheumatol* 1975;4:193–6.
6. Neviaser AS, Hannafin JA. Adhesive capsulitis: a review of current treatment. *Am J Sports Med* 2010;38:2346–56.
7. Denaro V, Ruzzini L, Longo UG, et al. Effect of dihydrotestosterone on cultured human tenocytes from intact supraspinatus tendon. *Knee Surg Sports Traumatol Arthrosc* 2010;18:971–6.
8. Bunker T, Anthony P. The pathology of frozen shoulder. A Dupuytren-like disease. *J Bone Joint Surg Br* 1995;77:677–83.
9. Schultheis A, Reichwein F, Nebelung W. [Frozen shoulder. Diagnosis and therapy]. *Orthopade* 2008;37:1065-6–1068-72.
10. Guyver PM, Bruce DJ, Rees JL. Frozen shoulder – a stiff problem that requires a flexible approach. *Maturitas* 2014;78:11–6.
11. Canbulat N, Eren I, Atalar AC, et al. Nonoperative treatment of frozen shoulder: oral glucocorticoids. *Int Orthop* 2015;39:249–54.
12. Russo A, Arrighi A, Vignale L, et al. Conservative integrated treatment of adhesive capsulitis of the shoulder. *Joints* 2014;2:15–9.
13. Vahdatpour B, Taheri P, Zade AZ, et al. Efficacy of extracorporeal shockwave therapy in frozen shoulder. *Int J Prev Med* 2014;5:875–81.
14. Wu YT, Ho CW, Chen YL, et al. Ultrasound-guided pulsed radiofrequency stimulation of the suprascapular nerve for adhesive capsulitis: a prospective, randomized, controlled trial. *Anesth Analg* 2014;119:686–92.
15. Grant JA, Schroeder N, Miller BS, et al. Comparison of manipulation and arthroscopic capsular release for adhesive capsulitis: a systematic review. *J Shoulder Elbow Surg* 2013;22:1135–45.
16. Favejee MM, Huisstede BM, Koes BW. Frozen shoulder: the effectiveness of conservative and surgical interventions–systematic review. *Br J Sports Med* 2011;45: 49–56.
17. Alvado A, Pelissier J, Benaim C, et al. [Physical therapy of frozen shoulder: literature review]. *Ann Readapt Med Phys* 2001;44:59–71.
18. Shah N, Lewis M. Shoulder adhesive capsulitis: systematic review of randomised trials using multiple corticosteroid injections. *Br J Gen Pract* 2007;57:662–7.
19. Maund E, Craig D, Suekarran S, et al. Management of frozen shoulder: a systematic review and cost-effectiveness analysis. *Health Technol Assess* 2012; 16:1–264.
20. Le HV, Lee SJ, Nazarian A, et al. Adhesive capsulitis of the shoulder: review of pathophysiology and current clinical treatments. *Shoulder Elbow* 2017;9:75–84.
21. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. *BMJ* 2009;339: b2700.
22. Moher D, Liberati A, Tetzlaff J, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009;339:b2535.
23. Coleman BD, Khan KM, Maffulli N, et al. Studies of surgical outcome after patellar tendinopathy: clinical significance of methodological deficiencies and guidelines for future studies. Victorian Institute of Sport Tendon Study Group. *Scand J Med Sci Sports* 2000;10:2–11.
24. Dijkers M Introducing GRADE: a systematic approach to rating evidence in systematic reviews and to guideline development. KT Update 2013; 1
25. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: 1. Introduction—GRADE evidence profiles and summary of findings tables. *J Clin Epidemiol* 2011; 64:383–94.
26. Arslan S, Çeliker R. Comparison of the efficacy of local corticosteroid injection and physical therapy for the treatment of adhesive capsulitis. *Rheumatol Int* 2001; 21:20–3.
27. Baums M, Spahn G, Nozaki M, et al. Functional outcome and general health status in patients after arthroscopic release in adhesive capsulitis. *Knee Surg Sports Traumatol Arthrosc* 2007;15:638–44.
28. Berghs BM, Sole-Molins X, Bunker TD. Arthroscopic release of adhesive capsulitis. *J Shoulder Elbow Surg* 2004;13:180–5.
29. Buchbinder R, Hoving J, Green S, et al. Short course prednisolone for adhesive capsulitis (frozen shoulder or stiff painful shoulder): a randomised, double blind, placebo controlled trial. *Ann Rheum Dis* 2004;63:1460–9.
30. Bulgen D, Binder A, Hazleman B, et al. Frozen shoulder: prospective clinical study with an evaluation of three treatment regimens. *Ann Rheum Dis* 1984;43: 353.
31. Carette S, Moffet H, Tardif J, et al. Intraarticular corticosteroids, supervised physiotherapy, or a combination of the two in the treatment of adhesive capsulitis of the shoulder: a placebo-controlled trial. *Arthritis Rheum* 2003;48:829–38.

32. Çınar M, Akpınar S, Derincek A, et al. Comparison of arthroscopic capsular release in diabetic and idiopathic frozen shoulder patients. *Arch Orthop Trauma Surg* 2010;130:401–6.
33. der van Windt D, Koes B, Deville W, et al. Effectiveness of corticosteroid injections versus physiotherapy for treatment of painful stiff shoulder in primary care: randomised trial. *BMJ* 1998;317:1292–6.
34. Diercks RL, Stevens M. Gentle thawing of the frozen shoulder: a prospective study of supervised neglect versus intensive physical therapy in seventy-seven patients with frozen shoulder syndrome followed up for two years. *J Shoulder Elbow Surg* 2004;13:499–502.
35. Diwan DB, Murrell GA. An evaluation of the effects of the extent of capsular release and of postoperative therapy on the temporal outcomes of adhesive capsulitis. *Arthroscopy* 2005;21:1105–13.
36. Dudkiewicz I, Oran A, Salai M, et al. Idiopathic adhesive capsulitis: long-term results of conservative treatment. *IMAJ* 2004;6:524–6.
37. Farrell CM, Sperling JW, Cofield RH. Manipulation for frozen shoulder: long-term results. *J Shoulder Elbow Surg* 2005;14:480–4.
38. Gam AN, Schydlowsky P, Rossel I, et al. Treatment of 'frozen shoulder'with distension and glucorticoid compared with glucorticoid alone: a randomised controlled trial. *Scand J Rheumatol* 1998;27:425–30.
39. Guler-Uysal F, Kozanoglu E. Comparison of the early response to two methods of rehabilitation in adhesive capsulitis. *Swiss Med Wkly* 2004;134:353–8.
40. Hettrich CM, DiCarlo EF, Faryniarz D, et al. The effect of myofibroblasts and corticosteroid injections in adhesive capsulitis. *J Shoulder Elbow Surg* 2016;25:1274–9.
41. Hsu S, Chan K. Arthroscopic distension in the management of frozen shoulder. *Int Orthop* 1991;15:79–83.
42. Hsu W-C, Wang T-L, Lin Y-J, et al. Addition of lidocaine injection immediately before physiotherapy for frozen shoulder: a randomized controlled trial. *PLoS One* 2015;10:e0118217.
43. Jerosch J. 360 arthroscopic capsular release in patients with adhesive capsulitis of the glenohumeral joint–indication, surgical technique, results. *Knee Surg Sports Traumatol Arthrosc* 2001;9:178–86.
44. Jerosch J, Nasef NM, Peters O, et al. Mid-term results following arthroscopic capsular release in patients with primary and secondary adhesive shoulder capsulitis. *Knee Surg Sports Traumatol Arthrosc* 2013;21:1195–1202.
45. Jewell DV, Riddle DL, Thacker LR. Interventions associated with an increased or decreased likelihood of pain reduction and improved function in patients with adhesive capsulitis: a retrospective cohort study. *Phys Ther* 2009;89:419–29.
46. Johnson AJ, Godges JJ, Zimmerman GJ, et al. The effect of anterior versus posterior glide joint mobilization on external rotation range of motion in patients with shoulder adhesive capsulitis. *J Orthop Sports Phys Ther* 2007;37:88–99.
47. Jones DS, Chattopadhyay C. Suprascapular nerve block for the treatment of frozen shoulder in primary care: a randomized trial. *Br J Gen Pract* 1999;49:39–41.
48. Kivimäki J, Pohjolainen T. Manipulation under anesthesia for frozen shoulder with and without steroid injection. *Arch Phys Med Rehabil* 2001;82:1188–90.
49. Le Lievre HM, Murrell GA. Long-term outcomes after arthroscopic capsular release for idiopathic adhesive capsulitis. *JBJS* 2012;94:1208–16.
50. Loew M, Heichel TO, Lehner B. Intraarticular lesions in primary frozen shoulder after manipulation under general anesthesia. *J Shoulder Elbow Surg* 2005;14:16–21.
51. Lorbach O, Anagnostakos K, Scherf C, et al. Nonoperative management of adhesive capsulitis of the shoulder: oral cortisone application versus intra-articular cortisone injections. *J Shoulder Elbow Surg* 2010;19:172–9.
52. Mehta S, Singh H, Pandey R. Comparative outcome of arthroscopic release for frozen shoulder in patients with and without diabetes. *Bone Joint J* 2014;96:1355–8.
53. Melzer C, Hoffmann S, Wallny T, et al. Frozen shoulder—treatment and results. *Arch Orthop Trauma Surg* 1995;114:87–91.
54. Mubark IM, Ragab AH, Nagi AA, et al. Evaluation of the results of management of frozen shoulder using the arthroscopic capsular release. *Ortop Traumatol Rehabil* 2015;17:21–8.
55. Placzek JD, Roubal PJ, Freeman DC, et al. Long term effectiveness of translational manipulation for adhesive capsulitis. *Clin Orthop Relat Res* 1998;356:181–91.
56. Ryans I, Montgomery A, Galway R, et al. A randomized controlled trial of intra-articular triamcinolone and/or physiotherapy in shoulder capsulitis. *Rheumatology* 2005;44:529–35.
57. Segmüller HE, Taylor DE, Hogan CS, et al. Arthroscopic treatment of adhesive capsulitis. *J Shoulder Elbow Surg* 1995;4:403–8.
58. Smith CD, Hamer P, Bunker T. Arthroscopic capsular release for idiopathic frozen shoulder with intra-articular injection and a controlled manipulation. *Ann R Coll Surg Engl* 2014;96:55–60.
59. Snow M, Boutros I, Funk L. Posterior arthroscopic capsular release in frozen shoulder. *Arthroscopy* 2009;25:19–23.

60. Tanaka K, Saura R, Takahashi N, et al. Joint mobilization versus self-exercises for limited glenohumeral joint mobility: randomized controlled study of management of rehabilitation. *Clin Rheumatol* 2010;29:1439–44.
61. Vermeulen HM, Rozing PM, Obermann WR, et al. Comparison of high-grade and low-grade mobilization techniques in the management of adhesive capsulitis of the shoulder: randomized controlled trial. *Phys Ther* 2006;86:355–68.
62. Waszczykowski M, Polguj M, Fabiś J. The impact of arthroscopic capsular release in patients with primary frozen shoulder on shoulder muscular strength. *Biomed Res Int* 2014;2014:834283.
63. Watson L, Dalziel R, Story I. Frozen shoulder: a 12-month clinical outcome trial. *J Shoulder Elbow Surg* 2000;9:16–22.
64. Yamaguchi K, Sethi N, Bauer GS. Postoperative pain control following arthroscopic release of adhesive capsulitis: a short-term retrospective review study of the use of an intra-articular pain catheter. *Arthroscopy* 2002;18:359–65.
65. Gam A, Schydlowsky P, Rossel I, et al. Treatment of'f-rozen shoulder'with distension and glucorticoid compared with glucorticoid alone: a randomised controlled trial. *Cand J Rheumatol* 1998;27:425–30.
66. Hsu JE, Anakwenze OA, Warrender WJ, et al. Current review of adhesive capsulitis. *J Shoulder Elbow Surg* 2011;20:502–14.
67. Kelley MJ, Mcclure PW, Leggin BG. Frozen shoulder: evidence and a proposed model guiding rehabilitation. *J Orthop Sports Phys Ther* 2009;39:135–48.
68. Paul A, Rajkumar JS, Peter S, et al. Effectiveness of sustained stretching of the inferior capsule in the management of a frozen shoulder. *Clin Orthop Relat Res* 2014; 472:2262–8.
69. Russell S, Jariwala A, Conlon R, et al. A blinded, randomized, controlled trial assessing conservative management strategies for frozen shoulder. *J Shoulder Elbow Surg* 2014;23:500–7.
70. Stenvers JD. *De primaire frozen shoulder: een retrospectief onderzoek naar de behandeling door middel van fysiotherapie*. Proefschrift Rijksuniversiteit Groningen, 1994.
71. Levine WN, Kashyap CP, Bak SF, et al. Nonoperative management of idiopathic adhesive capsulitis. *J Shoulder Elbow Surg* 2007;16:569–73.
72. Kwaees TA, Charalambous CP. Surgical and non-surgical treatment of frozen shoulder. Survey on surgeons treatment preferences. *Muscles Ligaments Tendons J* 2014;4:420.
73. Huskisson EC, Bryans R. Diclofenac sodium in the treatment of painful stiff shoulder. *Curr Med Res Opin* 1983;8:350–3.
74. Hollingworth GR, Ellis RM, Hattersley TS. Comparison of injection techniques for shoulder pain: results of a double blind, randomised study. *BMJ* 1983;287: 1339–41.
75. Richardson A. Ernest Fletcher Lecture. The painful shoulder. *Proc R Soc Med* 1975;68:731.
76. Page MJ, Green S, Kramer S, et al. Manual therapy and exercise for adhesive capsulitis (frozen shoulder). *Cochrane Database Syst Rev* 2014;26:CD011275.
77. Longo UG, Berton A, Khan WS, et al. Histopathology of rotator cuff tears. *Sports Med Arthrosc Rev* 2011;19: 227–36.
78. Waszczykowski M, Polguj M, Fabis J. The impact of arthroscopic capsular release in patients with primary frozen shoulder on shoulder muscular strength. *Biomed Res Int* 2014;2014:834283.
79. Balci N, Balci MK, Tüzüner S. Shoulder adhesive capsulitis and shoulder range of motion in type II diabetes mellitus: association with diabetic complications. *J Diabetes Complications* 1999;13:135–40.
80. Bannwarth B. Drug-induced musculoskeletal disorders. *Drug Saf* 2007;30:27–46.
81. Bridgman J. Periarthritis of the shoulder and diabetes mellitus. *Ann Rheum Dis* 1972;31:69.
82. Huang YP, Fann CY, Chiu YH, et al. Association of diabetes mellitus with the risk of developing adhesive capsulitis of the shoulder: a longitudinal population-based followup study. *Arthritis Care Res* 2013;65: 1197–1202.
83. Tighe CB, Oakley WS Jr. The prevalence of a diabetic condition and adhesive capsulitis of the shoulder. *South Med J* 2008;101:591–5.