Efficacy of different types of mobilization techniques in patients with primary adhesive capsulitis of the shoulder : a systematic review

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2015;■:■■■-■■■

REVIEW ARTICLE

Efficacy of Different Types of Mobilization Techniques in Patients With Primary Adhesive Capsulitis of the Shoulder: A Systematic Review

Suzie Noten, MSc,[a,b] Mira Meeus, PhD,[a,b,c] Gaetane Stassijns, MD, PhD,[d] Francis Van Glabbeek, MD, PhD,[e] Olivier Verborgt, MD, PhD,[e,f] Filip Struyf, PhD[a,b]

From the [a]Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, University of Antwerp, Antwerp; [b]Pain in Motion Research Group, Belgium; [c]Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, Ghent University, Ghent; [d]Department of Physical Medicine and Rehabilitation, Antwerp University Hospital, Edegem; [e]Department of Orthopaedic Surgery and Traumatology, Antwerp University Hospital, Edegem; and [f]Department of Orthopaedic Surgery and Traumatology, AZ Monica, Antwerp, Belgium.

Abstract

Objective: To systematically review the literature for efficacy of isolated articular mobilization techniques in patients with primary adhesive capsulitis (AC) of the shoulder.

Data Sources: PubMed and Web of Science were searched for relevant studies published before November 2014. Additional references were identified by manual screening of the reference lists.

Study Selection: All English language randomized controlled trials evaluating the efficacy of mobilization techniques on range of motion (ROM) and pain in adult patients with primary AC of the shoulder were included in this systematic review. Twelve randomized controlled trials involving 810 patients were included.

Data Extraction: Two reviewers independently screened the articles, scored methodologic quality, and extracted data for analysis. The review was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement. All studies were assessed in duplicate for risk of bias using the Physiotherapy Evidence Database Scale for randomized controlled trials.

Data Synthesis: The efficacy of 7 different types of mobilization techniques was evaluated. Angular mobilization (n=2), Cyriax approach (n=1), and Maitland technique (n=6) showed improvement in pain score and ROM. With respect to translational mobilizations (n=1), posterior glides are preferred to restore external rotation. Spine mobilizations combined with glenohumeral stretching and both angular and translational mobilization (n=1) had a superior effect on active ROM compared with sham ultrasound. High-intensity mobilization (n=1) showed less improvement in the Constant Murley Score than a neglect group. Finally, positive long-term effects of the Mulligan technique (n=1) were found on both pain and ROM.

Conclusions: Overall, mobilization techniques have beneficial effects in patients with primary AC of the shoulder. Because of preliminary evidence for many mobilization techniques, the Maitland technique and combined mobilizations seem recommended at the moment.

Archives of Physical Medicine and Rehabilitation 2015;■:■■■-■■■

Adhesive capsulitis (AC) of the shoulder is often defined as a disorder characterized by progressive pain and loss of active and passive mobility of the glenohumeral joint. The annual incidences are 3% to 5% in the general population and even up to 40% in people with diabetes.[1,2] It mainly affects people between the ages of 40 and 60 years, with women more commonly affected than men.[3] AC is mainly divided into 2 types in the literature, the idiopathic or primary form and the acquired or secondary form. Although no specific cause is identified in primary AC, the development of secondary AC is associated with recent surgery, immobilization, or trauma and also with systemic, extrinsic, or intrinsic disorders. Systemic disorders include a history of diabetes mellitus and thyroid disorders.[4] Extrinsic disorders are not

Disclosures: none.

0003-9993/15/$36 - see front matter © 2015 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2015.07.025

directly related to the shoulder and include cardiopulmonary diseases, cervical spine pathology, stroke, Parkinson disease, and humerus fractures. Intrinsic disorders are associated with the glenohumeral joint soft tissues or structures, including rotator cuff pathologies, biceps tendinitis, calcific tendinitis, and AC joint arthritis.[1,5,6] AC lasts approximately 12 to 42 months in total and consists of 3 phases. It starts with a painful phase, which lasts 2 to 9 months. Subsequently, a stiff phase occurs (lasting 3−12mo), defined by stiffening and restriction of shoulder range of motion (ROM). The recovery phase is the final phase of the disease and is characterized by regaining movement and function over approximately 5 to 26 months. Some patients may not recover entirely and remain with some movement restriction.[7] Additionally, after having AC on one side, the individual risk to develop AC in the contralateral shoulder increases by 5% to 34%.[6]

With AC, a decrease of capsular extensibility is seen as one of the most important pathologic mechanisms that results in large mobility deficits. Consequently, the restoration of glenohumeral motion is of great clinical importance to patients with AC because this would largely improve shoulder function.[8,9]

Kelley et al[6] published current evidence-based recommendations and clinical practice guidelines for the treatment of patients with AC. The interventions were comprised of corticosteroid injections in the short term (4−6wk), patient education, physical modalities (ultrasound and electrical stimulation), joint mobilizations, translational mobilizations, manipulations, and stretching exercises. They concluded that some physiotherapeutic interventions show evidence regarding reduced pain or increased mobility in the short and long term.

As previously described, there are reasons to suggest that mobilization techniques may be effective in reducing pain and disability in patients with AC of the shoulder. Mobilization is defined as a low-velocity and small- or large-amplitude movement applied anywhere within a joint ROM[10] to improve the corresponding extensibility of the shoulder capsule and stretch the specific tightened soft tissues to induce beneficial effects.[11] Mobilization techniques are commonly used to improve ROM and include both angular and translational mobilizations. Angular mobilizations are often applied as continuous passive motion or dynamic splinting. An external motorized device provides low-load continuous passive motion to move the joint passively through a specified ROM, creating a prolonged-duration stretch.[9] This is an established method of overcoming joint stiffness and histologically hypothesized for enhancing the healing of connective tissues.[12,13] A shoulder splinting system was developed to apply a low-load prolonged-duration stretch to increase time at end range and achieve permanent elongation of connective tissue.[14] By applying translational mobilizations, the humeral head is shifted in the preferred direction, while the elbow remains fixed.[15] The therapist can either translate in an anterior, posterior, or inferior direction.[16,17] In addition, individual mobilization techniques can be combined, which is implemented in for example Mulligan and Maitland techniques. The Mulligan technique[18] includes a combination of sustained manual application of gliding force to the joint with a simultaneous active movement of the joint by the patient. Studies that have used this technique on the elbow and ankle revealed a beneficial effect on pain and joint ROM.[19,20] The Maitland technique[11] is based on the 5-grade classification system of Maitland and describes the amplitude of the rhythmic oscillating mobilization in the specified range of movement. Furthermore, mobilizations can be performed beyond the pain threshold. These so-called high-intensity techniques do not refer to the frequency that patients are treated, but they include active exercises up to and beyond the pain threshold, passive stretching, and manipulation of the glenohumeral joint and home exercises aimed at stretching and maximal reaching with the intent to restore ROM and reduce pain.[21] Deep friction massage, as used by Cyriax and Russell,[22] is often used before and in conjunction with mobilization techniques. The purpose of friction massage is to reduce abnormal fibrous adhesions and to make scar tissue more mobile in subacute and chronic inflammatory conditions by realigning the normative soft tissue fibers.

Many suggestions for mobilization techniques are available, but it is still a matter of debate what the optimal direction of force and movement application should be to restore joint mobilization in patients with AC of the shoulder.[23] Therefore, it is of importance to compare the treatment effects of different mobilization techniques. The aim of this systematic review is to evaluate the efficacy of isolated articular mobilization techniques in patients with primary AC of the shoulder to identify which technique(s) may be most beneficial in the restoration of joint mobility and reduce pain in patients with AC.

List of abbreviations:

AC	**adhesive capsulitis**
MeSH	**Medical Subjects Heading**
PEDro	**Physiotherapy Evidence Database**
ROM	**range of motion**

Methods

This systematic review is reported following the Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines.[24]

Eligibility criteria

The Population, Intervention, Comparison, Outcome, and Study design method[25] was used to derive keywords. The present systematic review attempted to include articles that described the results of clinical trials (S) evaluating the efficacy of isolated articular mobilization techniques (I) on ROM and pain (O) in patients with primary AC of the shoulder (P). The comparison (C) was undefined to evaluate the efficacy of any isolated mobilization techniques in patients with primary AC of the shoulder.

Information sources and search strategy

Both PubMed and Web of Science databases were searched to retrieve relevant articles. The search was conducted until November 2014. A prefabricated template was used for study selection designed by the Belgian Health Care Knowledge Centre.[26] The following keywords were used *frozen shoulder*, *adhesive capsulitis*, *periarthritis* (Medical Subjects Heading [MeSH]), *periarthritis*, *musculoskeletal manipulations* (MeSH), *musculoskeletal manipulations*, *manual therapy*, *manual techniques*, *manipulation*, *manual translation*, *articular translation*, *manual mobilization*, *manual mobilisation*, *mobilization*, *mobilisation*, *traction* (MeSH), *traction*, *glide*, *gliding*, *treatment outcome* (MeSH), *treatment outcome*, *therapy effect*, *efficacy*, and *effectiveness*.

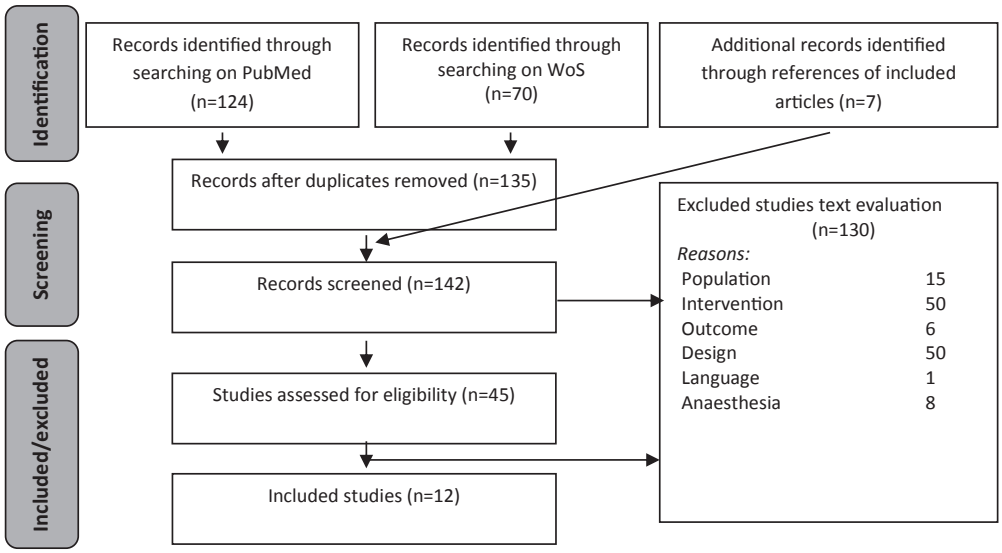

Fig 1 Flowchart of the study selection. Abbreviation: WoS, Web of Science.

Study selection

To be included in the present systematic review, articles had to meet the selection criteria noted in appendix 1.

Data items and collection

The following specific information was extracted from each included trial: (1) characteristics of the trial sample (number of participants, sex, age, stadium of the disease, and the trial's inclusion and exclusion criteria); (2) type of mobilization technique (mobilization modality, intervention frequency, and solely or combined with other treatment techniques); (3) type of control intervention; (4) outcome assessment; and (5) therapy effect (outcome measure, assessment intervals, and results). The included studies were divided between both review authors for data extraction and were checked by the other author. The methods of the included studies are heterogeneous (eg, length of follow-up and treatment period, sample differences); therefore, the approach of a box score or meta-analysis to quantify the results is not appropriate.

Risk of bias in individual studies

Methodologic quality was assessed independently by 2 researchers who were blinded from each other's quality assessment. After individually rating the selected articles, the ratings of both researchers were compared, and potential differences were discussed in a consensus meeting. Scorings were checked by a third researcher. Risk of bias in the different studies was assessed with the Physiotherapy Evidence Database (PEDro) Scale.[27] According to the study design and risk of bias, studies could score a level of evidence A2 (randomized controlled trial of good quality, sufficient sample size, and double-blinded) or B (if previous criteria were not fulfilled). Recommendations are graded based on the level of evidence (www.cbo.nl).

Results

Selection of studies

The process of the study selection is presented in figure 1. Most studies were excluded based on the intervention. A total of 12 studies were included in the systematic review.

Risk of bias and level of evidence

As previously stated, all studies were evaluated with the PEDro Scale. There was a 98% (130/133 items) agreement between the 2 researchers when scoring the selected items. After a second review, both researchers agreed on differences in rating. The final score of each study is presented in table 1. The methodologic quality varied between 4 and 10 out of 11 on the PEDro Scale. According to the PEDro classification, most of the studies showed a methodologic quality of level B. Many studies lost points on blinding of patients,[8,9,21,23,28-34] therapist,[8,9,21,23,28-35] and assessor.[9,21,23,28,30,34] Additionally, the concealment of allocation items was often not attained.[8,9,21,28,30,31,34] Most studies scored well on randomization and comparability of groups. Only 1 study was double-blinded and received level of evidence A2.[35]

Study characteristics

To allow deeper interpretation and translation of the results, characteristics regarding the study population, intervention, follow-up period, and main results of the studies are presented in table 2. Level of conclusion of the most important outcome parameters is summarized in table 3.

Participants

This review addressed 810 patients with primary AC with a mean age varying between 47.1[34] and 58.9 years.[28] Adult patients with

Table 1 Results of the methodologic assessment of mobilization techniques in patients with primary AC

Author	Criteria											Quality Score	Level of Evidence
	1	2	3	4	5	6	7	8	9	10	11		
Buchbinder et al[35]	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	10	A2
Diercks and Stevens[21]	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	7	B
Doner et al[28]	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	7	B
Dundar et al[9]	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	7	B
Gaspar and Willis[30]	No	No	No	Yes	No	No	No	No	Yes	Yes	Yes	4	B
Guler-Uysal and Kozanoglu[31]	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	8	B
Johnson et al[23]	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	8	B
Kumar et al[34]	Yes	Yes	No	Yes	No	No	No	Yes	Yes	Yes	Yes	8	B
Paul et al[33]	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	9	B
Vermeulen et al[8]	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	Yes	Yes	8	B
Yang et al[29]	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	8	B
Yang et al[32]	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	9	B

NOTE. Criteria: 1, eligibility criteria were specified; 2, subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received); 3, allocation was concealed; 4, groups were similar at baseline regarding the most important prognostic indicators; 5, there was blinding of all subjects; 6, there was blinding of all therapists who administered the therapy; 7, there was blinding of all assessors who measured at least 1 key outcome; 8, measures of at least 1 key outcome were obtained from >85% of the subjects initially allocated to groups; 9, all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least 1 key outcome were analyzed by intention-to-treat; 10, results of between-group statistical comparisons are reported for at least 1 key outcome; 11, study provides both point measures and measures of variability for at least 1 key outcome.

unilateral restricted shoulder movement[33] or external rotation deficit[23,30] were included mostly if symptoms of pain and stiffness were present for a minimum of 2[31,34] to 3 months.[8,21,28,29,32,35] Most studies included patients in the stiff phase[8,9,28-30,33]; 2 studies included both the painful and stiff phase,[9,33] whereas the rest of the studies did not specifically define the phase.[21,23,31,32,34,35] Glenohumeral restrictions were further defined in a number of studies: 4 studies included patients with 50% loss of passive shoulder movement compared with the unaffected side,[8,21,28,32] 1 study reported a 25% loss of ROM,[29] and 1 study used a restriction of 30° in 2 planes of movement.[35] The aforementioned restrictions had to be present in at least 1[8,28] or 2[32,35] of the 3 movement directions (ie, forward flexion, abduction in the frontal plane, external rotation in 0° or 90° abduction). Corresponding exclusion criterion for patients was secondary AC of the shoulder, including rotator cuff pathologies,[9,29,31,32,35] diabetes mellitus,[21,29,32,34] a history of surgery on the affected shoulder,[21,29,30,32,33] shoulder osteoarthritis,[35] rheumatoid arthritis,[29,32] and neurologic disorders.[8,23,34]

Type of mobilization techniques

The following 7 types of mobilization techniques were evaluated: angular mobilization,[9,30] translational mobilization,[23] spine mobilizations combined with glenohumeral stretching and both angular and translational mobilization,[35] high-intensity techniques beyond the pain threshold,[21] Cyriax approach,[31] Mulligan technique,[28] and Maitland technique.[8,29,30,32-34]

Outcome measures

Most studies reported the effect of mobilization techniques on pain[8,9,23,28,31,33-35] and ROM.[8,9,23,28,30-35] Pain was measured using a visual analog scale[8,9,23,28,31,33,34] or Likert Scale.[35] In addition, the Constant Murley Score[9,21] described pain and ROM after treatment.

Study duration

Frequency, total duration, and follow-up of all of the therapies are diverse. Frequency of therapies varied from 1[35] to 5[9,28,33,34] times a week. Total duration lasted 1 week[31] up until 90 days.[30] Follow-up fluctuated between 2 weeks[31] and 2 years.[21]

Effect of mobilization techniques

It can be seen from the data in table 3 that 4 of 8 studies (all level B) reported reduced pain after a mobilization program. In addition, 8 of 10 (7 with level B, 1 with level A2) studies reported a beneficial effect of mobilization techniques on ROM.

Effect of angular mobilization

The utilized techniques regarding angular mobilizations were continuous passive motion[9] and dynamic splinting.[30] Dundar et al[9] compared continuous passive motion with traditional therapy, consisting of pendulum exercises and stretching, and found a reduction in pain after continuous passive motion. No improvement in the Constant Murley Score (including pain and ROM evaluations) was found. Gaspar and Willis[30] compared a cortical steroid injections with dynamic splinting, provided by the Dynasplint Shoulder System, the Maitland technique,[11] and a combination of both. Dynamic splinting[30] had a superior effect on ROM compared with the cortical steroid injections, but no significant difference between intervention groups was found.

Effect of translational mobilization

Johnson et al[23] compared the effect of posterior and anterior glide mobilizations on ROM and pain. A reduction in pain was reported in both experimental groups, whereas the progression in ROM was favorable for posterior glide mobilizations.

Table 2 Population characteristics, intervention, and results

Author	Subjects	EI	CI	Assessment	Outcome	Results
Buchbinder et al[35]	N=156 F:99; M:57 55.0±9.3y 55.3±7.7y DO: 12	2 times per wk, 2wk to 1 time per wk, 4wk Stretch muscles glenohumeral joint Cervicothoracic spine mobilization Glenohumeral/p/accessory glide and angular mobilization Coordination and strength Rc and scapular stabilizers	2 times per wk, 2wk to 1 time per wk, 4wk Sham ultrasound	Baseline, 6wk, 12wk, 26wk	Pain (Likert Scale) ROM$_{/a/,\ FL,\ AB,\ ER,\ HBB}$	EI=CI ↑EI >↑CI
Diercks and Stevens[21]	N=77 F:47; M:30 50±6y 51±7y	Physical therapy group>pain threshold Active exercises Manipulation glenohumeral joint Stretching and maximal reaching	Supervised neglect group<pain threshold Pendulum exercises Active exercises	1 time per 3mo, up to 24mo	Constant score	↑EI<↑CI (3–18mo)
Doner et al[28]	N=40 F:31; M:9 58.9±8.77y	5 times per wk, 3wk Hot pack TENS (20min, 100Hz, .05-.07ms) Mulligan technique (flexion, elevation, internal rotation)	5 times per wk, 3wk Hot pack TENS (20min, 100Hz, 0.05–0.07ms) Conventional passive stretching	Baseline, 3wk, 3mo	Pain (VAS) ROM$_{/a/,\ /p/,\ FL,\ AB,\ ER,\ HBB}$	↑EI >↑CI ↑EI >↑CI
Dundar et al[9]	N=57 F:39; M:18 56.3±7.8y 57.1±8.3y	1h/d, 5 times per wk, 4wk Continuous passive motion gradual increase in motion Home: Passive ROM, pendulum exercises 1 time a d, 12wk	1h/d, 5 times per wk, 4wk Conventional physiotherapy treatment: active stretching, pendulum exercises Home: same	Baseline, 4wk, 12wk	Pain (VAS) ROM Constant score	↑EI >↑CI ↑EI =↑CI ↑EI =↑CI
Gaspar and Willis[30]	N=62 55.6±7.9y	Standard (EI1): 2 times per wk Physical therapy Therapeutic exercise Moist heat Education Maitland $_{\text{end range}}$ ROM$_{/p/a/}$ PNF; Shoulder Dynasplint Systems (EI2): 2 times per d, 7d/wk Combined (EI3): 2 times per wk EI1 + EI2	Cortical steroid injections	Baseline, 90d	ROM$_{/a/,\ ER90}$	↑EI1=EI2=EI3 >↑CI

(*continued on next page*)

Table 2 (*continued*)

Author	Subjects	EI	CI	Assessment	Outcome	Results
Guler-Uysal and Kozanoglu[31]	N=40 F:28; M:12 56.0±8.6y	CYR: 1h, 3 times per wk, 1–2 w (>80% normative ROM) CYR consisting of deep friction massage and manipulation Active stretching and pendulum exercises Home: passive ROM, pendulum exercises 1 time a d	PT: 1h, 5 times per wk, 1–2wk (>80% normative ROM) PT: Hot pack (20min), Short-wave diathermy (220V/50Hz, 20min) Active stretching and pendulum exercises Home: same	Baseline, 1wk, 2wk	Pain (VAS) $ROM_{FL,\ AB,\ IR,\ ER}$	↑CYR > ↑PT (NS) ↑CYR > ↑PT (2wk) NOT ROM_{AB}
Johnson et al[23]	N=18 F:14; M:4 54.7±8.0y 50.4±6.9y DO: 2	AM 2–3wk, 6 sessions total AM Ultrasound (1–3MHz, 1.5W/cm^2, 10 min, anterior) Grade III mobilization End-stretch position>1min, 15min total, 6 times	PM 2–3wk, 6 sessions total PM Ultrasound (1–3MHz, 1.5W/cm^2, 10min, posterior) Grade III mobilization End-stretch position>1min, 15min total, 6 times	Baseline, after each session	Pain (VAS) ROM_{ER}	↑AM = ↑PM ↑AM < ↑PM (session 3–session 6)
Kumar et al[34]	N=40 F:14; M:26 47.9y 47.1y	2–3 glides/s, 30s, 5 sets, 3 times per wk, 4wk CI plus Maitland mobilization Glenohumeral caudal glides Glenohumeral caudal glides progression Glenohumeral posteroanterior glides Passive oscillatory movements	10×10s per exercise, 5 times per wk, 4wk Supervised exercise program Codman exercises Shoulder wheel exercises Wall-ladder exercises Self-stretching exercises (AB, FL, ER, IR, AD)	Baseline, 4wk	Pain (VAS) $ROM_{ER,\ AB}$	↑EI>↑CI ↑EI>↑CI
Paul et al[33]	N=100 F:35; M:65 49.16±6.09y 53.22±6.74y	20min, 5 times per wk, 2wk CI plus weighted shoulder countertraction during mobilization, 2–3kg Glides in Maitland grades I–IV	20min, 5 times per wk, 2wk Moist heat Mobilization (4 sets, 8–12 times) Home program ROM, function exercises (10×3/d)	Baseline, 2wk	Pain (VAS) ROM	↑EI = ↑CI ↑EI = ↑CI

(*continued on next page*)

Table 2 (*continued*)

Author	Subjects	EI	CI	Assessment	Outcome	Results
Vermeulen et al[8]	N=100 F:66; M:34 51.6±7.6y 51.7±8.6y DO: 4	HGMT: 30min, 2 times per wk, up to 12wk (>6wk+ROM=normal→0–1 time per wk) High-grade mobilization (Maitland mobilization grades III and IV) Inferior glides Posterior and lateral glides Anterior and medial glides Oscillatory movements (caudal, lateral and anterior)	LGMT: 30min, 2 times per wk, up to 12wk (>6wk+ROM=normal→0–1 time per wk) Low-grade mobilization (Maitland mobilization grade II) Same glides and oscillatory movements 3min proprioceptive neuromuscular facilitation$_{/p/}$ 2min Codman pendular exercises Without causing pain	Baseline, 3mo, 6mo, 12mo	Pain (VAS); ROM$_{ER,}$ $_{/a/, /p/}$	↑HGMT =↑LGMT; ↑HGMT>↑LGMT$_{/a/ER (12m0), /p/, ER, /p/, AB (3 and 12mo)}$
Yang et al[29]	N=28 F:24; M:4 53.3±6.5y 58±10.1y DO: 7	A-B-A-C (EI1): 2 times per wk 30min mobilization and simple exercises, 12wk A=MRM, Maitland B=ERM C=MWM 10–15 repetitions	A-C-A-B (EI2)	Every 3wk up to 12wk	FLEX-SF; FASTRAK motion analysis	↑EI1 =↑EI2 for ERM and MWM; ↑ERM =↑MWM SHR: ↑MWM >↑ERM
Yang et al[32]	N=32 F:22; M:10 54.3±7.6y 56.8±7.2y 54.9±10.3y DO: 2	CrI: 2 times per wk, 3mo CC plus end-range mobilization (Maitland grade IV) Scapular mobilization CC: 2 times per wk, 3mo Midrange mobilization,/p/, stretch, physical modalities (ultrasound; short-wave diathermy; electrotherapy) Active exercises	Control: 2 times per wk, 3mo (larger shoulder kinematics compared with CrI and CC) CC	4wk, 8wk	FLEX-SF; FASTRAK motion analysis ROM$_{/p/}$(hand behind back; external rotation; internal rotation)	↑CI >↑CC (8wk) ↑CrI >↑CC (8wk); ↑CI >↑CC (4–8wk) ↑CrI >↑CC (8wk) ↑CrI >↑CC (4wk, 8wk); ↑CrI >↑CC (4wk, 8wk); ↑CI=↑CC=↑CrI

Abbreviations: /a/, active; AB, abduction; AD, adduction; AM, anterior glide mobilization; CC, criteria control; CI, control intervention; CrI, criteria intervention; CYR, Cyriax; DO, dropouts; EI, experimental intervention; ER, external rotation; ERM, end-range mobilization; ER90, external rotation with the arm in 90° of abduction; F, female; FL, flexion; FLEX-SF, flexion level scale of the shoulder function; HBB, hand behind back; HGMT, high-grade mobilization technique; IR, internal rotation; LGMT, low-grade mobilization technique; M, male; MRM, midrange mobilization; MWM, mobilization with movement; NS, not significant; /p/, passive; PM, posterior glide mobilization; PNF, proprioceptive neuromuscular facilitation; PT, physical therapy; RC, rotator cuff; SHR, scapulohumeral rhythm; TENS, transcutaneous electrical nerve stimulation; VAS, visual analog scale.

Table 3 Level of conclusion of the most important results

Outcome Variables	Studies	Type of Mobilization Techniques	Level of Evidence	Level of Conclusion
Pain	+ Dundar et al[9]	Angular mobilization	B	Moderate +
	+ Guler-Uysal and Kozanoglu[31]	Cyriax approach	B	
	+ Doner et al[28]	Mulligan technique	B	
	+ Kumar et al[34]	Maitland technique	B	
	= Johnson et al[23]	Translational mobilization	B	
	= Paul et al[33]	Maitland technique	B	
	= Vermeulen et al[8]	Maitland technique	B	
	= Buchbinder et al[35]	Combined technique	A2	
ROM	+ Johnson et al[23]	Translational mobilization	B	Moderate +
	+ Buchbinder et al[35]	Combined techniques	A2	
	+ Guler-Uysal and Kozanoglu[31]	Cyriax approach	B	
	+ Doner et al[28]	Mulligan technique	B	
	+ Gaspar and Willis[30]	Angular and Maitland technique	B	
	+ Kumar et al[34]	Maitland technique	B	
	+ Vermeulen et al[8]	Maitland technique	B	
	+ Yang et al[32]	Maitland technique	B	
	= Dundar et al[9]	Angular mobilization	B	
	= Paul et al[33]	Maitland technique	B	
Constant Murley Score	= Dundar et al[9]	Angular mobilization	B	Weak −
	− Diercks and Stevens[21]	High-intensity mobilization	B	
FLEX-SF	+ Yang et al[29]	Maitland technique	B	Moderate +
	+ Yang et al[32]	Maitland technique	B	
FASTRAK	+ Yang et al[29]	Maitland technique	B	Moderate +
	+ Yang et al[32]	Maitland technique	B	

Abbreviations: FLEX-SF, flexion level scale of the shoulder function; +, positive result; −, negative result; =, equal result of mobilization techniques compared with conventional therapy.

Effect of spine mobilizations combined with glenohumeral stretching and both angular and translational mobilization

Buchbinder et al[35] included spine mobilization, glenohumeral stretching, gliding, and angular mobilization in the experimental intervention and compared it with sham ultrasound. For active ROM, the combined technique proved to be superior, but no beneficial effects were found in terms of pain.

Effect of high-intensity techniques beyond the pain threshold

Diercks and Stevens[21] included intensive mobilizations up to and beyond the pain threshold in addition to stretching and compared the results with a supervised neglect group receiving traditional therapy below the pain threshold. The Constant Murley Score was reported as an outcome variable, which showed less improvement with high-intensity techniques beyond the pain threshold.

Effect of Cyriax approach

Guler-Uysal and Kozanoglu[31] compared a Cyriax approach of deep friction massage and mobilization exercises with a traditional therapy supplemented with a hot pack and short-wave diathermy. A positive effect of Cyriax on pain and ROM was reported.

Effect of the Mulligan technique

Doner et al[28] compared the effect of the Mulligan technique with conventional stretching exercises. Both strategies were found to be effective in reducing pain and restoring ROM, but the immediate and long-term effects were in favor of the Mulligan technique.

Effect of the Maitland technique

Six studies made use of the Maitland technique as an intervention.[8,29,30,32-34] As previously stated, Gaspar and Willis[30] included this technique in their experiment; the effect on ROM was in favor of the intervention groups compared with cortical steroid injections. Paul et al[33] found no superior effect of the Maitland technique on pain and ROM compared with mobilization in flexion and abduction stance. The Maitland technique had a beneficial effect on pain and ROM when compared with a supervised exercises program as used in the study of Kumar et al.[34] A study by Vermeulen et al[8] tried to unravel if there would be a difference between high-grade versus low-grade mobilization techniques, which resulted in a favorable effect of using high-grade mobilization on improving ROM. Two independent studies by Yang et al[29,32] implemented the Maitland technique, which showed significant progression on the flexion level scale of shoulder function in favor of end-range mobilization and mobilization with movement. In addition, both mobilizations showed improvement of the FASTRAK motion analysis outcomes. Hand behind back and external rotation ROM increased in the end range mobilization group compared with the midrange mobilization group.

Discussion

Summary of evidence

Overall, mobilization techniques have beneficial effects in patients with primary AC of the shoulder, with strength of conclusions varying between moderate and preliminary evidence. Particularly, the Maitland technique and spine mobilizations combined with glenohumeral stretching and both angular and translational mobilization seem to be recommended at the moment. Because of the preliminary evidence, more studies are needed on assessing the effect of angular, translational, and high-intensity mobilization techniques; Cyriax approach; and Mulligan technique on pain and ROM.

The use of angular mobilization showed very limited preliminary evidence to reduce pain and improve ROM in primary AC (weak evidence) compared with corticosteroid injections or usual therapy. Angular mobilizations are preferable to corticosteroid injections, but no differences were found between intervention groups consisting of angular mobilization techniques, Maitland mobilizations, or a combination of both,[30] which could be explained by a lack of power.

Preliminary evidence was found for the use of translational mobilization in primary AC. Only 1 study was found on the use of translational mobilization; therefore, the results must be interpreted with caution. Posterior glides proved to be superior to anterior glides to restore external rotation ROM, but optimal glide direction and duration of stretch mobilizations to restore ROM needs to be evaluated in further research. Care should be taken in generalizing the results of this study because of the small sample size and inclusion of only 1 therapist.[23]

Preliminary evidence was also found for the effect of high-intensity techniques beyond the pain threshold in patients with AC. According to their beliefs, Diercks and Stevens[21] found an adverse effect of the high-intensity technique compared with the supervised neglect group on the Constant Murley Score. They suggested that intensive passive stretching may affect the natural course of the disease by activating the inflammatory reaction, when applied during the inflammation and proliferation stage and perhaps also during the early fibrotic stage. This indicates the importance of timing and therapy adjustments according to the different stages of AC. This study does not present detailed information about the composition of the techniques used.

Buchbinder[35] observed additional effects of spine mobilizations combined with glenohumeral stretching and both angular and translational mobilization on ROM for at least 6 months, which may be clinically important. The lack of pain reduction could be explained by the fact that there was less potential for additional effect of the device on this outcome. Further trials are needed to confirm the beneficial effects of the studied interventions and to determine whether other sequential treatments or a combination of treatments may result in better outcomes.

The Cyriax approach of deep friction massage and mobilization exercises showed very limited preliminary evidence on pain and ROM in the early phase of treatment. This technique is easily applicable because it does not require special equipment and anesthesia. However, long-term follow-up results are unknown and should be provided in future research. The exact mobilization exercises that were used in this study were not described properly.

Very limited preliminary evidence is found for the effect of the Mulligan technique on pain and ROM. The positive result of the Mulligan technique on pain and ROM should be interpreted with caution because it was only investigated in 1 study. This technique was chosen for the advantage of increasing ROM in addition to providing analgesia, but because it is a hands-on treatment, it is not possible to perform the study in a blinded manner.[28]

The Maitland technique showed a beneficial effect on ROM, flexion level scale of the shoulder function, and FASTRAK motion analysis outcomes. The study by Kumar[34] showed that adding the Maitland technique to the supervised exercise program gives advantages in terms of pain and ROM. Mobilization techniques performed in the specific plane close to the end range improve the corresponding extensibility of the shoulder capsule and stretch the specific tightened soft tissues to induce beneficial effects. The neurophysiological effect could result from the rhythmic oscillatory movement of the Maitland technique that stimulates the peripheral mechanoreceptors and inhibits the nociceptive receptors.[11] However, Paul[33] did not find these superior effects on pain and ROM, which could be explained by the used measurement tool that may have been less reliable. Therefore, further studies, which establish the biomechanical rationale behind the effect of countertraction with appropriate tools, will need to be undertaken.

High-grade and low-grade mobilization in patients with primary AC yielded results according to expectations. Although the effect of the high-grade mobilization was superior, the low-grade group also achieved a considerable clinical improvement. Therefore, low-grade mobilization could be the preferred treatment mode for those who are anxious about experiencing pain. The largest improvement was attained during the treatment itself, but ongoing progression of shoulder function was seen and can be explained by the initial improvement.[8] Furthermore, because a control group was not included in this study, the findings may be the result of natural improvement. In addition, 2 other studies used this technique and found a beneficial effect of end-range mobilization and mobilization with movement in favor of the midrange mobilization techniques.[29] This could be explained by the fact that the latter may only extend the adhesive capsule, whereas the end-range mobilization and mobilization with movement techniques can stretch the adhesive capsule and associated contracted periarticular structures. The appropriate treatment for each individual with primary AC of the shoulder may be dependent on the course and duration of symptoms. The multitreatment design limits the generalizability of the finding to normative clinical practice. Yang[32] concluded that end-range mobilization and scapular mobilization are important techniques for primary AC of the shoulder. Subjects with larger shoulder kinematics were included in the control group. This homogenous subgroup was unlikely to improve with treatment, which could have biased the results.

Study limitations

This review has certain limitations that should be taken into account when interpreting its results. First, the main weakness of this review is the risk of bias; most studies failed to achieve blinding of the patients,[8,9,21,23,28-34] therapist,[8,9,21,23,28-35] and assessor,[9,21,23,28,30,34] and concealment of allocation items[8,9,21,28,30,31,34] were often not attained. Therefore, a note of caution is due here. However, only 1 of the 12 studies was not randomized,[30] and in 1 study randomization was completed after patients had been allocated on the basis of shoulder kinematics.[32]

Second, characteristics of the included studies were heterogeneous. Inclusion criteria varied among most studies (eg, duration and classification of injury, magnitude of loss of ROM). Most of the

mobilization techniques included patients in the stiff phase, whereas some studies did not specifically report the phase. It would seem reasonable that mobilization techniques would be most effective in the stiff phase to improve mobility, but not all studies took this into consideration. Therefore, the timing of the therapy at specific times in the disease's progress is an important issue for future research. In some studies the sample size was small, which may have resulted in a lack of statistical significance because of type II error (not enough power).[8,9,23,28-32] Multiple treatment techniques and outcome measures were used, and the description of some utilized mobilization techniques was insufficient. For example, ROM was measured differently by most included studies, either active or passive ROM, total, or only glenohumeral ROM,[36] and different positions were used (flexion, abduction, internal or external rotation, hand behind back). Therefore, the results must be interpreted with caution because marked heterogeneity was apparent for ROM. The use of ROM investigations should be normalized in further studies to generalize the results. It would not be ethical to use a sham group; therefore, the control group in most studies was also treated with therapy. In some studies hot packs were used to deliver superficial heating to increase the extensibility of collagen.[28,31,33] The application of heat has potentiated the effect of stretching on improving ROM in healthy people and may have influenced the results.[37]

Follow-up, total duration, and frequency of the therapy also varied among studies. Additionally, patient activity between posttest and follow-up were not always controlled. The benefits of the particular treatment over a longer follow-up period were unknown in most studies. As Struyf and Meeus[36] previously mentioned, it is difficult to take the self-limiting aspect of AC into account. In most studies the follow-up period is limited to only 3 months,[9,23,28-32,35] which seems to be insufficient knowing that AC can last up to several years. Although mobilization techniques seemed beneficial to reduce pain and increase ROM, there is little evidence to suggest that these techniques and physical therapy or other therapy modalities can alter disease prognosis and duration.[6] Therefore, further research with a longer follow-up period is warranted to establish long-term effects.

Conclusions

Based on the present systematic literature review, overall mobilization techniques have beneficial effects in patients with primary AC of the shoulder. The Maitland technique and spine mobilizations combined with glenohumeral stretching and both angular and translational mobilizations seem to be recommended for the moment. Because of limited homogeneity and a limited number of studies with appropriate levels of evidence, more studies are needed on assessing the effect of angular, translational, and high-intensity mobilization techniques; Cyriax approach; and Mulligan technique on pain and ROM.

Keywords

Bursitis; Rehabilitation; Review [publication type]

Corresponding author

Filip Struyf, PhD, Universiteit Antwerpen, Department of Rehabilitation Sciences and Physiotherapy, Universiteitsplein 1, 2610 Antwerpen. *E-mail address:* filip.struyf@uantwerpen.be.

Appendix 1 Study selection criteria

Inclusion Criteria	Exclusion Criteria
• Adult patients with primary AC of the shoulder, in any stadium • The study assessed the efficacy of all kinds of articular mobilization techniques • The outcome measure is pain or ROM to assess the efficacy of the treatment • Clinical trials published in full text • Studies in English or Dutch • Full-text available	• Secondary AC of the shoulder • Manipulations under anesthesia of the affected shoulder • Case reports, reviews, letters to the editor, clinical trials, trial of an intervention, and retrospective studies

References

1. Tasto JP, Elias DW. Adhesive capsulitis. Sports Med Arthrosc 2007;15:216-21.
2. 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 (Hoboken) 2013;65:1197-202.
3. Hand C, Clipsham K, Rees JL, Carr AJ. Long-term outcome of frozen shoulder. J Shoulder Elbow Surg 2008;17:231-6.
4. Cakir M, Samanci N, Balci N, Balci MK. Musculoskeletal manifestations in patients with thyroid disease. Clin Endocrinol (Oxf) 2003;59:162-7.
5. Zuckerman JD, Rokito A. Frozen shoulder: a consensus definition. J Shoulder Elbow Surg 2011;20:322-5.
6. Kelley MJ, Shaffer MA, Kuhn JE, et al. Shoulder pain and mobility deficits: adhesive capsulitis. J Orthop Sports Phys Ther 2013;43:A1-31.
7. Lubiecki M, Carr A. Frozen shoulder: past, present, and future. J Orthop Surg (Hong Kong) 2007;15:1-3.
8. Vermeulen HM, Rozing PM, Obermann WR, le Cessie S, Vliet Vlieland TP. 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.
9. Dundar U, Toktas H, Cakir T, Evcik D, Kavuncu V. Continuous passive motion provides good pain control in patients with adhesive capsulitis. Int J Rehabil Res 2009;32:193-8.
10. Maitland G, Hengeveld E. Maitland's vertebral manipulation. 7th ed. London: Elsevier; 2005.
11. Maitland G. Peripheral Manipulation. 2nd ed. London: Butterworths; 1977.
12. Laupattarakasem W. Short term continuous passive motion. A feasibility study. J Hand Surg [Br] 1988;70:802-6.
13. Ada L, Goddard E, McCully J, Stavrinos T, Bampton J. Thirty minutes of positioning reduces the development of shoulder external rotation contracture after stroke: a randomized controlled trial. Arch Phys Med Rehabil 2005;86:230-4.
14. Hepburn G. Contracture and stiff joint management with Dynasplint. J Orthop Sports Phys Ther 1987;8:498-504.
15. Edmond S. Manipulation and mobilization: extremities and spinal techniques. St Louis: Mosby; 1993.
16. Kaltenborn F. Manual therapy of the extremity joints. Oslo: Olaf Norlis, Bokhandel; 1973.
17. Roubal PJ, Dobritt D, Placzek JD. Glenohumeral gliding manipulation following interscalene brachial plexus block in patients with adhesive capsulitis. J Orthop Sports Phys Ther 1996;24:66-77.
18. Mulligan B. "Manual Therapy ""NAGS", SNAGS", "MWMS" etc." Wellington: Pl view Serv. Ltd; 1999.

19. O'Brien T, Vicenzino B. A study of the effects of Mulligan's mobilization with movement treatment of lateral ankle pain using a case study design. Man Ther 1998;3:78-84.
20. Abbott JH. Mobilization with movement applied to the elbow affects shoulder range of movement in subjects with lateral epicondylalgia. Man Ther 2001;6:170-7.
21. 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.
22. Cyriax J, Russell G. Textbook of Orthopaedic Medicine. 10th ed. London: Bailliere, Tindall & Cassell Ltd; 1980.
23. Johnson AJ, Godges JJ, Zimmerman GJ, Ounanian LL. 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.
24. Moher D, Liberati A, Tetzlaff J, Altman DG. PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int J Surg 2010;8:336-41.
25. Stone PW. Popping the (PICO) question in research and evidence-based practice. Appl Nurs Res 2002;15:197-8.
26. Thiry. KCE - Belgian Health Care Knowledge Centre. Template Study Sel., 2010.
27. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. Phys Ther 2003;83:713-21.
28. Doner G, Guven Z, Atalay A, Celiker R. Evalution of Mulligan's technique for adhesive capsulitis of the shoulder. J Rehabil Med 2013; 45:87-91.
29. Yang JL, Chang CW, Chen SY, Wang SF, Lin JJ. Mobilization techniques in subjects with frozen shoulder syndrome: randomized multiple-treatment trial. Phys Ther 2007;87:1307-15.
30. Gaspar PD, Willis FB. Adhesive capsulitis and dynamic splinting: a controlled, cohort study. BMC Musculoskelet Disord 2009; 10:111.
31. 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.
32. Yang JL, Jan MH, Chang CW, Lin JJ. Effectiveness of the end-range mobilization and scapular mobilization approach in a subgroup of subjects with frozen shoulder syndrome: a randomized control trial. Man Ther 2012;17:47-52.
33. Paul A, Rajkumar JS, Peter S, Lambert L. Effectiveness of sustained stretching of the inferior capsule in the management of a frozen shoulder. Clin Orthop Relat Res 2014;472:2262-8.
34. Kumar A, Kumar S, Aggarwal A, Kumar R, Das PR. Effectiveness of Maitland techniques in idiopathic shoulder adhesive capsulitis. ISRN Rehabil 2012;2012:1-8.
35. Buchbinder R, Youd JM, Green S, et al. Efficacy and cost-effectiveness of physiotherapy following glenohumeral joint distension for adhesive capsulitis: a randomized trial. Arthritis Rheum 2007; 57:1027-37.
36. Struyf F, Meeus M. Current evidence on physical therapy in patients with adhesive capsulitis: what are we missing? Clin Rheumatol 2014; 33:593-600.
37. Nakano J, Yamabayashi C, Scott A, Reid WD. The effect of heat applied with stretch to increase range of motion: a systematic review. Phys Ther Sport 2012;13:180-8.