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Systematic review

Natural history of frozen shoulder: fact or fiction? A systematic review

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Abstract

Background In 1940s, it was proposed that frozen shoulder progresses through a self-limiting natural history of painful, stiff and recovery phases, leading to full recovery without treatment. However, clinical evidence of persistent limitations lasting for years contradicts this assumption.

Objectives To assess evidence for the natural history theory of frozen shoulder by examining: (1) progression through recovery phases, and (2) full resolution without treatment.

Data sources MEDLINE, PubMed, EBSCO CINAHL and PEDro database searches augmented by hand searching.

Study selection Cohort or randomised controlled trials with no-treatment comparison groups including adults with frozen shoulder who received no treatment and reporting range of motion, pain or function for ≥6 months.

Data extraction Reviewers assessed study eligibility and quality, and extracted data before reaching consensus. Limited early range-of-motion improvements and greater late improvements defined progression through recovery phases. Restoration of normal range of motion and previous function defined full resolution.

Results Of 508 citations, 13 articles were reviewed and seven were included in this review. Low-quality evidence suggested that no treatment yielded some, but not complete, improvement in range of motion after 1 to 4 years of follow-up. No evidence supported the theory of progression through recovery phases to full resolution without treatment. On the contrary, moderate-quality evidence from three randomised controlled trials with longitudinal data demonstrated that most improvement occurred early, not late.

Limitations Low-quality evidence revealed the weakness of longstanding assumptions about frozen shoulder.

Conclusion Contradictory evidence and a lack of supporting evidence shows that the theory of recovery phases leading to complete resolution without treatment for frozen shoulder is unfounded.

Keywords: Adhesive capsulitis; Prognosis; Outcome; Range of motion; Recovery phase

Introduction

Frozen shoulder, or adhesive capsulitis, is marked by pain and stiffness of unclear origin [1]. While rates attributed to secondary sources are higher [2,3], the 3-year incidence in a large prospective longitudinal population-based study was ∼1%, with incidence associated with female sex, age and diabetes [4]. Diagnosis remains primarily clinical, without formally adopted criteria [5]. In fact, no clinical diagnostic identifiers proposed by expert consensus were validated for early adhesive capsulitis [3]. As clinical presentation can be similar to other conditions such as arthritis and bursitis, and related or unrelated to past trauma, diagnosis can be confusing [1,5,6].

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In addition, confusion may have been increased by reliance on low-level evidence when considering potential pathological causes for frozen shoulder. In the 19th Century, Duplay described stiff and painful shoulders resulting from traumas with subsequent inflammation and fibrous adhesion band formation as 'scapulohumeral periarthritis' [7]. In a 1934 series of shoulder periarthritis and bursitis cases, Codman coined the term 'frozen shoulder' to describe degenerative cuff changes leading to bursal inflammation and adhesions that he hypothesised could re-absorb over time [8,9]. In 1945, after surgically releasing capsular adhesions to restore motion in 10 cases of restricted shoulder motion associated with microscopic capsular degeneration, Neviaser proposed the term 'adhesive capsulitis' [10]. Case–control study findings confirm that capsular fibrosis resulting from hyperplasia leads to the characteristic shoulder stiffness [11] clinically indicative of adhesive capsulitis [6,12]. Recently, capsular thickening independent of adhesions has been identified as a primary restriction to shoulder motion [1].

The early conceptualisation of frozen shoulder as an inflammatory disorder may have led to the theory of a self-limiting condition that progressed through recovery phases paralleling the inflammatory process [13]. Mistakenly combining citation information for Neviaser's 1953 partial rotator cuff tear and 1945 adhesive capsulitis articles, Reeves purported in the 1970s that the frozen shoulder condition followed a natural history, progressing through painful, stiff and recovery phases [14]. In a one-page cohort study without reported methods or objective measures, Grey expanded on the theory, suggesting that frozen shoulder was a self-limiting condition that resolved fully over time [15]. The self-limiting natural history theory suggested in these two papers [14,15] could apply to partial cuff tears, but has less face validity for joint capsule thickening [1] and fibrous adhesions noted in frozen shoulders [10].

The natural history theory that frozen shoulders progress from stiff to recovery phases, leading to full resolution without treatment [14,15] was already questionable given long-lasting and unresolved deficits documented previously, even within Reeves' study [13,14]. Although numerous authors have challenged the theory, documenting long-term residual deficits years later [6,16,17], review articles [18,19], orthopaedic texts [20,21] and internet health websites [22,23] perpetuate the long-running theory of frozen shoulder as a self-limiting condition that resolves over time. Common assumption of a self-limiting resolution can affect clinical decisions of practitioners and patients, who may opt not to have any treatment rather than face the cost, discomfort and inconvenience of treatment, but then be left with chronic residual deficits that can restrict functional activities [24].

This systematic review evaluated the evidence for the 1970s theory of a self-limiting natural history of frozen shoulder, specifically assessing evidence of: (1) progression through stiff to recovery phases, and (2) full resolution without supervised treatment.

Methods

This systematic review adhered to a predetermined protocol following current Cochrane Collaboration guidelines [25]. This review had no external funding source.

Data sources and study selection

An electronic search of MEDLINE, PubMed, EBSCO CINAHL and PEDro databases was conducted through September 2015 without time limits using Boolean combinations of the search terms: frozen shoulder, adhesive capsulitis, natural history, non-operative treatment, supervised neglect, prognosis and general symptoms. The search was augmented by bibliographic hand searches of reviews, popular health websites, and board review textbooks recommended by the American Academy of Physical Medicine and Rehabilitation, American College of Rheumatology, American Academy of Orthopaedic Surgery, and Federation of State Boards of Physical Therapy.

Search results were compiled and duplicates were removed. Five reviewers screened all titles and abstracts independently. Two reviewers examined the full text of each potentially eligible study using a standard eligibility form. Inclusion criteria included: (1) cohort studies or randomised controlled trials with no-treatment comparison groups; (2) adult participants diagnosed with primary or idiopathic frozen shoulder without previous treatment; (3) no supervised study treatment other than benign neglect, sparing the use of pain medication, patient education or unsupervised home exercise; and (4) objective outcome measures including range of motion and function. Exclusion criteria included: (1) reviews and expert opinions; (2) samples with >20% diabetic patients; and (3) follow-up <6 months to assess for recovery phases. Consensus was reached on all studies.

Data extraction and quality assessment

Two reviewers completed standardised data extraction forms independently for each included study, recording design, participant number and description, study conditions, and range-of-motion and functional recovery outcomes. Indicators of evidence for the natural history theory were defined as: (1) progression through stiff to recovery phases marked by slower early range-of-motion restoration when the capsule is thought to be stiffest [14] compared with late; and (2) full resolution without supervised treatment to normal range of motion and prior functional level. The standard error of measurement for shoulder range of motion has been reported to be 2° to 6° with minimal clinical differences of 7° to 16° depending on the motion [26].

Data synthesis and analysis

Two reviewers used a standardised bias risk tool to assess the following domains independently: participant

Table 1
Description of included studies.

Study	Category	*n*	'No supervised treatment' group description
Binder *et al.* 1984 [30]	Prospective cohort	8	Home exercise programme consisting of pendulum exercises, non-salicylate analgesics and diazepam 5 mg at night 'available as required'
Diercks *et al.* 2007 [31]	Randomised controlled trial	45	Home exercise programme consisting of pendulum and active exercises within painless range
Grey 1978 [15]	Retrospective cohort	21 (25 shoulders)	'. . .treatment limited to reassurances as well as occasional simple analgesics and hypnotics'
Kivimäki *et al.* 2007 [2]	Randomised controlled trial	60 at baseline, 42 at final follow-up	Physiotherapy advice in two sessions, written instructions for a home exercise programme including pendulum exercises and stretching techniques
Reeves 1975 [14]	Prospective cohort	49 at baseline, 41 at final follow-up	In early stage, resting arm in a sling, analgesics; in late stage, general exercise
Russell *et al.* 2014 [29]	Randomised controlled trial	26	Home exercise programme consisting of an information booklet with suggested shoulder exercises, information about frozen shoulder, advice on sleep, posture and pain relief
Vastamäki *et al.* 2011 [28]	Retrospective cohort	51 (52 shoulders)	Observation and benign neglect

n, only the participants included in the control or non-treatment group.

recruitment; participant group allocation; allocated condition maintenance; patient, researcher and evaluator blinding; objective outcomes assessment and interpretation; researchers' baseline assumptions about frozen shoulder; researchers' profession; and funding. Ratings were determined by reviewer consensus, although third-reader adjudication was available. Reviewers only analysed originally reported data. Levels of evidence were assigned [25], downgrading studies with medium risk of bias and double-downgrading studies with high risk of bias. The body of evidence was graded considering inclusion of extracted trial data that were not intended to study the natural history of frozen shoulder [25].

Results

From 508 unique citations, 13 full-text articles were reviewed; of these, seven studies published between 1952 and 2014 were included in this review (Fig. A, see online supplementary material). Studies were excluded for inadequate follow-up time or supervised treatment. The seven studies included in this review (four cohort studies and three randomised controlled trials with no-treatment comparison groups) investigated 234 subjects with 239 shoulders (Table 1). Two studies included subjects with diabetes [2,28], two studies included subjects with minor shoulder trauma [28,30], and two studies omitted specific mention of comorbidities [14,15], although some subjects required hospitalisation [14]. Study heterogeneity precluded meta-analysis.

Natural history – progression through recovery phases

None of the studies demonstrated a recovery pattern consistent with the theoretical pain, stiff and thawing recovery phases suggested by Reeves, defined as slow early range-of-motion improvement compared with later gains. Reeves characterised shoulders with overlapping symptom durations of 10 to 36 weeks for the painful phase, 4 to 12 months for the stiff phase, and 5 to 26 months for the recovery phase [14]. The contrary progression of faster early improvement and slower late improvement was evident in three randomised controlled trials reporting longitudinal data for no-treatment control groups (Figs 1 and 2) [2,29,31].

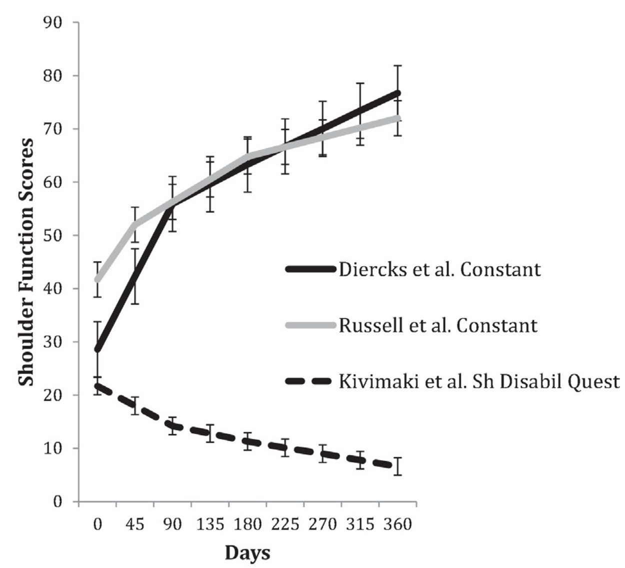

Fig. 1. Functional improvement without treatment in studies reporting longitudinal data, presented with standard error bars. Constant, Constant–Murley score (0 to 100), high scores represent better function; Sh Disabil Quest, Shoulder Disability Questionnaire (0 to 28), low scores represent less dysfunction.

Full resolution without supervised treatment

While range-of-motion and functional improvements occurred, objectively measured evidence for full recovery was not apparent (Table 2).

Table 2
Recovery parameters.

Study	Evidence of recovery phases	Recovery time Mean (range)	Shoulder range of motion Mean (range)	Pain Mean (range)	Return to function Mean (range)
Binder *et al.* 1984 [30]	–	Symptom duration prior to study: 4.8 months Follow-up: 44 months	Final FLX: 163 (160 to 170) Final ABD: 151 (140 to 165) Final ER: 57 (40 to 80) Total final rotation: 154 (125 to 180)	–	–
Diercks *et al.* 2007 [31]	–	Symptom duration prior to study: 5 months Symptom duration: 15 months	Change in FLX: 33 (151 to 180) Change in ER: back of head/elbow forward to top of head/elbow back Change in IR: dorsum of hand from buttock to 12th vertebrae	–	Constant–Murley score (≥80 indicates 'a normally functioning shoulder') At baseline: 28.6 (SD 8.6) At 24 months = 89% reached 80
Grey 1978 [15]	–	Follow-up: 2 years	Initial ABD: 85 to 120 Final ABD: 1 shoulder lost 20[a]	1 shoulder 'slightly painful'	–
Kivimäki *et al.* 2007 [2]	–	Symptom duration prior to study: 7 months (3 to 22)[a] Follow-up: 1 year	Change in FLX: 109 to 154 Change in ABD: 80 to 154 Change in IR: 12 to 10 cm (distance from fingertip to contralateral scapula) Change in ER: 18 to 61	Pain change on 0 to 10 scale: 7 to 2.2 Pain change on SDQ: 21.7 to 6.6	Working ability measured on a scale of 0 to 10: 0 = total disability and 10 = best work ability At baseline: 5.9 (SD 0.4) At 1 year: 8.2
Reeves 1975 [14]	Proposed stages: painful (10 to 36 weeks); stiffness (4 to 12 months); recovery (5 to 26 months) No data	Symptom duration: 30.1 months	–	–	22 patients left with 'clinical limitation' of movement defined as 'no impairment of any of their normal functional activities including work or hobbies, though the affected joint had a detectable movement loss compared to the opposite side'. 16 patients had 'full recovery' at follow-up. Three patients had 'functional limitations' that '. . .interfered with either work or hobbies' at follow-up.
Russell *et al.* 2014 [29]	–	Symptom duration prior to study: 5.8 months (4 to 10) Follow-up: 1 year	Change in FLX: 95 (85 to 120) to 146 (100 to 180) Change in ER: 16 (10 to 25) to 49 (35 to 60)	Pain change on Constant–Murley score: 18.7 to 34	Change in Constant–Murley score: 39.8 (18 to 64) to 72 (49 to 91)
Vastamäki *et al.* 2011 [28]	–	Symptom duration: 15 months (4 to 36)	Change in FLX: 101 (40 to 135) to 157 Change in ABD: 89 (10 to 125) to 175 Change in ER: 26 (0 to 50) to 52 Change in IR: dorsum of hand to buttock to dorsum of hand to L1/T12	Final pain on 10-cm VAS: 0.8 (0 to 3) at rest 1.1 (0 to 8) with activity 0.6 (0 to 7) at night 63% report no pain on Constant–Murley scale	Constant–Murley score at follow-up: 83 (35 to 97) Simple shoulder test (maximum is 12 indicates least affected functionally) at follow-up: 11 (6 to 12)

ABD, abduction; ER, external rotation; FLX, flexion; IR, internal rotation; VAS, visual analogue scale; SDQ, Shoulder Disability Questionnaire; SD, standard deviation.
[a] No specific data reported.

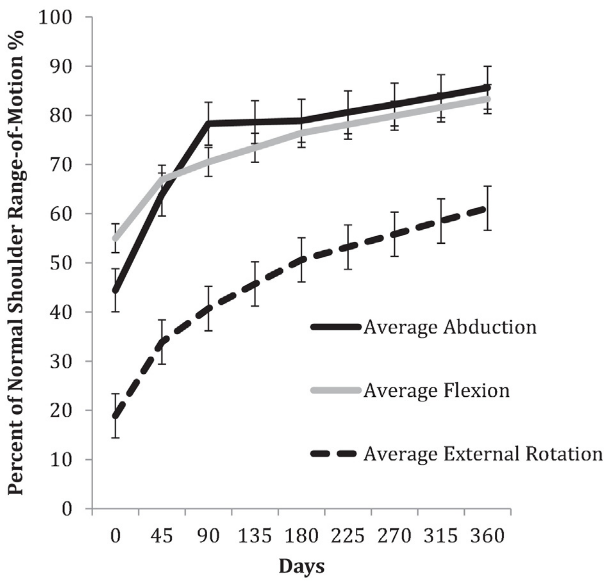

Fig. 2. Improvement in shoulder range of motion without treatment in studies reporting objective longitudinal data. Average values extracted from Kivimäki *et al*. J Shoulder Elbow Surg 2007;16:722–6 and Russell *et al*. J Shoulder Elbow Surg 2014;23:500–7, and presented with standard error bars.

Range of motion

All studies reported improvement in range of movement, although not within the normal range [27] when accounting for standard error of measurement and minimal clinical difference [26]. Of studies reporting objective baseline and follow-up measures, average improvement in range of motion, measured actively in standing, was 45° to 56° to 154° to 157° flexion, 74° to 86° to 154° to 175° abduction [2,28], and 16° to 43° to 49° to 61° external rotation [2,29]. Most studies did not report reliability or blinding of range-of-motion assessments [2,28,30,31]. Two single-author cohort studies reported a return ‘to normal’ in 24 of 25 shoulders from 21 patients [15] and full recovery in 16 of 41 patients [14] without providing range-of-motion data or describing objective assessment methods (Table 2). Only one study documented a return to normal without supervised treatment and just for one motion [28] when considering standard error of measurement and minimal clinical difference of shoulder motion [26].

Function

Three studies assessed functional improvement using the Constant–Murley score [28,29,31], a 100-point shoulder function scale incorporating self-report, active range of motion, and strength data with higher scores representing better function [32]. The control group in one randomised controlled trial increased in function from 39.8 to 72 [29], another reported an average score of 83 at follow-up [28], and another reported that 89% of patients had a Constant–Murley score ≥80, suggesting a ‘normally functioning shoulder’ at follow-up [31]. Another study rated ‘working ability’ on a patient-reported numeric rating scale that demonstrated improvement at follow-up [2]. One author reported that most patients returned to normal daily activities despite limitations in shoulder motion compared with the opposite shoulder despite contralateral shoulder involvement, without offering quantifiable functional assessment [14] (Table 2). Full recovery of objectively measured function was not consistently apparent.

Grade of evidence

Both aspects of the natural history theory for frozen shoulder – (1) progress through stiff to thawing recovery phases resulting in (2) complete recovery without treatment – had very-low-quality evidence, signifying inconsistent and inconclusive data to support the theory. As cohorts of interest within randomised controlled trials were no-treatment control groups, randomised controlled trials were rated as Level II evidence. Four studies with high risk of bias were double-downgraded (Table A, see online supplementary material). Given the low level of evidence of the included studies and the inclusion of extracted data from randomised controlled trials, an overall assessment of low-quality evidence supported some improvement in frozen shoulder without treatment. Moderate-quality evidence from three randomised controlled trials with longitudinal data demonstrated the contrary finding that most improvement occurred early, not late.

Discussion

The results of this systematic review did not support the two main tenets of the natural history theory of frozen shoulder: (1) progression through painful, stiff and recovery phases to (2) full resolution without supervised treatment. Low-quality evidence documented some improvement without treatment. However, rather than range of motion increasing late in the frozen shoulder condition, moderate-quality evidence from three randomised controlled trials with prospective longitudinal data demonstrated that most improvement occurred early. It should be noted that low-quality evidence for the natural history theory strengthens the null hypothesis that the theory is unsupported. No studies documented an objectively measured return to normal range of motion of the shoulder.

The modern evidence-based clinician may be surprised that low-quality evidence with high likelihood of bias could have given rise to such a long-running theory despite contrary evidence. It appears that the natural history theory of frozen shoulder has been perpetuated by continued citation of secondary sources in research article introductions [5,29], reviews [18,19,34], textbooks [20,21] and health websites that provide information to the public [22,23]. The lack of primary research beyond the lowest level of evidence to support the natural history theory of frozen shoulder, especially combined with stronger evidence to the contrary, leads to a recommendation that reference to the theory that frozen shoulders progress through stiff to recovery phases leading to full resolution without supervised treatment should be discontinued. Correcting professional and public misconceptions about frozen shoulder may reduce delays in people seeking treatments that demonstrate moderate to strong evidence for improvements in pain, range of motion and function [24,34].

No longitudinal evidence supports the notion that frozen shoulders progress through painful, stiff and recovery or thawing phases [13,14]. The only study that attempted to characterise clinical progression through recovery phases, based on overlapping symptom durations, was Reeves' initial single-author study that proposed the theoretical phases [14]. The study had high risk of bias due to methods that could be anticipated to result in the proposed clinical recovery phases [14]. After placing the painful shoulders in slings for up to 9 months, the shoulders were unsurprisingly found to be in a phase of stiffness. When movement was subsequently allowed, stiffness began to subside in what was dubbed the 'recovery' phase [14]. In contrast, the weight of evidence from multiple controlled studies with longitudinal periodic follow-up data shows that the greatest recovery in range of motion and function occurs in the first few months, followed by diminishing returns [2,29,31] (Figs 1 and 2). The reported time to greatest improvement ranged from 12 to 48 months [2,29,30], not including pre-study symptom durations from 1 to 12 months [2,29–31] and any poststudy symptom duration. Reduced gains observed as more time passed may be consistent with the formation of patho-anatomic capsular thickening [1] or fibrotic adhesions [6].

The suggestion that frozen shoulder resolves fully with time [15] was not supported. The only report of complete return to full range of motion and function was Grey's single-author one-page observational study that did not report controlled methods, objective data or statistical analysis [15]. At 5-to-10-year follow-up, fewer than 40% of Reeves' subjects had 'full recovery' of shoulder motion compared with the contralateral side, despite bilateral involvement in some patients [14]. Low-quality evidence does support the finding that some improvement occurs in frozen shoulders without supervised treatment, based on extracted data from randomised trial control groups and data from studies with high risk of bias and an overall low quality of evidence (Fig. 2). Improvements in no-treatment control groups cannot strictly be considered as the natural progression of the condition because the prospective controlled trials provided patient education and unsupervised home care programmes at study initiation that could have influenced the outcomes.

One retrospective study with no longitudinal interim data reported that of a subset of subjects, nearly 94% who received benign neglect without a home exercise programme returned to full function after 36 months [28]. However, this study did not include intent-to-treat analysis; the majority of the subjects chose to receive various treatments, presumably because they had not recovered without treatment or did not participate primarily due to poor physical condition [28]. Including patients who chose to have treatment or not participate, a conservative estimate of subjects returning to full function without treatment would have been a more modest 26% [28]. While most studies demonstrated increased range of motion without supervised treatment, the risk of measurement bias was high. For instance, range of motion was assessed seated [30], standing [2,28] and actively [28] through comparison with the other arm – some that also had frozen shoulder [14] – or with unspecified [31] or undescribed [15] methods that allow compensatory movements or overstatements of range of motion. Complete resolution of range-of-motion deficits, however, may not be required for a return to full function [30].

Despite incomplete resolution of range-of-motion deficits, four studies reported functional improvements [31] without treatment or improvement in both pain and function [2,28,29]. Without a gold standard for shoulder function assessment, several studies used the Constant–Murley score [28,29,31], the validity of which has been questioned due to the subjective interpretation of functionality and unstandardised range-of-motion and strength subscales, particularly for people with limited range of motion [35]. Perhaps for this reason, the Constant–Murley score has not been validated for use with frozen shoulder [35]. Some studies only provided a qualitative assessment of function [14,15,30] or patient satisfaction score [28]. Self-reported shoulder injury scales include a psychological dimension [36] that may account for the lack of concordance in subjective and objective reports of patients with idiopathic frozen shoulder [28,30]. Patients appear to adapt to their condition through physical and behavioural compensations despite incomplete and delayed recovery [28].

However, the assumption that frozen shoulders will resolve without supervised treatment may affect the attitudes of patients and practitioners, and provide an unrealistic prognosis [24]. Expectations of eventual 'thawing' leading to complete recovery without treatment may lead patients to delay or forego treatment, which can be arduous and uncomfortable. Delayed treatment may lead to worse outcomes, as evidence suggests that the greatest gain, regardless of treatment approach, occurred early before a plateau in improvement, potentially indicative of chronic fibrosis [31,32]. An assumption of recovery phases may also distract from other diagnostic processes. While numerous clinical signs have been proposed for early adhesive capsulitis, none were found to be valid diagnostic signs [3]. This may explain the frequent disagreements about diagnoses [6,29], and why patients present for treatment later when fibrosis has already limited their mobility severely. Diagnostic processes including biochemical or histological methods may identify the changes in connective tissue in frozen shoulder found similar to Dupuytren's contractures [37] or those affected by diabetes mellitus [38]. Uncertainty with regard to consistent diagnosis of frozen shoulder that could affect subject selection further weakens the evidence for the natural history theory of stiff and recovery phases leading to full recovery, strengthening the recommendation to discontinue reference to the theory in professional and public health information sites.

Limitations

This systematic review was limited by the inclusion of cohort and controlled trial studies that allowed unsupervised pendulum and active movement in the defined no-treatment conditions, which reflects the paucity of evidence related to the natural history of frozen shoulder. Without inclusion of these studies, no longitudinal evidence exists from the past 125 years to describe the theory of stiff and recovery phases for the frozen shoulder condition. Control groups providing patient education and unsupervised home exercise were included as no-treatment conditions because the subjects lacked professional supervision. Although patient education and home exercise could have affected the outcomes, all subjects in prospective cohort studies were considered to have received some education about their condition, if no more than a diagnosis, by virtue of their involvement in the studies. The inclusion of extracted data from randomised trial controls, which provided the most consistent follow-up data, was accounted for in the final recommendations [2,29,31]. Other limitations included: (1) follow-up times as short as 1 year; (2) subject heterogeneity, such as the inclusion of up to 20% of subjects with diabetes or the inclusion of patients with recent unspecified minor trauma [28,30]; and (3) varying objective measures and methods of range-of-motion assessment among studies. Finally, reviewers were not blinded to the authors and journal of the articles. A well-controlled longitudinal cohort study to assess the natural history of the painful stiff shoulder, without assumption of recovery phases, would clarify the expected outcomes of a no-treatment approach. However, moderate evidence documenting early improvements in range of motion that contradicts the natural history theory for frozen shoulder directs future research towards diagnostic processes that can more clearly identify the inflammatory [6], fibrotic [5], systemic [4,38] or genetic [39] conditions underlying the stiffness and disability of people with frozen shoulder, and help clinicians establish best practice treatment.

Conclusion

This systematic review found that the often-repeated natural history theory of frozen shoulder as a self-limiting condition with stiff and recovery phases progressing to full recovery was not supported in the literature. Although limited range-of-motion and function gains occur over many months, moderate-quality evidence from longitudinal studies supports the contrary progression of early improvement that slows with time, and results in prolonged limitations that can last for multiple years.

Conflict of interest: None declared.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.physio.2016.05.009.

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