REVIEW

Exercise therapy for the conservative management of full thickness tears of the rotator cuff: a systematic review

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Purpose: To review the evidence for the effectiveness of therapeutic exercise for the treatment of full thickness (including massive and inoperable) tears of the rotator cuff.
Relevance: There is little consensus as to the most effective treatment of full thickness and massive tears of the rotator cuff. There is consensus that the outcome of rotator cuff tendon surgery in the elderly is generally very poor. As such, exercise therapy is usually recommended for this patient group. Although commonly prescribed, the evidence to support this approach is equivocal. The aim of this study was to conduct a systematic review of the literature to determine the efficacy of exercise therapy for the management of full thickness rotator cuff tears.
Methods: A systematic review was conducted to synthesise the available research literature on the effectiveness of exercise therapy for full thickness tears of the rotator cuff.
Data source: Reports up to and including September 2006 were located from MEDLINE, the Cumulative Index to Nursing & Allied Health Literature (CINAHL), AMED, EMBASE, the Cochrane Database of Systematic Reviews and the Physiotherapy Evidence Database (PEDro) using the terms ''rotator cuff'' and ''tear/s'' and ''exercise'' or ''physiotherapy'' or ''physical therapy'' or ''rehabilitation''.
Study selection: Studies were included if they related to full thickness rotator cuff tears and exercise.
Data extraction: Two independent reviewers assessed the methodological quality of the studies. Differences were resolved by consensus.
Analysis/Data synthesis: Ten studies met the inclusion criteria: eight were observational case series and two were single case studies. There were no randomised clinical trials.
Results: Four studies were specific to massive rotator cuff tears. One study had a sub-group with massive cuff tears and five studies were not specific as to the size of the full thickness tear. Due to the heterogeneity of outcome measures used, it was not possible to combine results. In all studies an improvement in outcome scores was reported. Exercise programmes were well documented in five studies.
Conclusions: No randomised controlled trials met the inclusion criteria and the evaluation has been based on observational studies of lower scientific merit. The findings suggest that some evidence exists to support the use of exercise in the management of full thickness rotator cuff tears. There is a definite need for well-planned randomised controlled trials investigating the efficacy of exercise in the management of full thickness and massive rotator cuff tears.

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The first acknowledged description of rotator cuff (RC) tears is attributed to J.G. Smith in the *London Medical Gazette*[1] who described the occurrence of tendon rupture of the shoulder following injury. The four rotator cuff muscles (supraspinatus, infraspinatus, teres minor and subscapularis) fuse to form a tendon that encompasses the humeral head. The rotator cuff contributes to glenohumeral movement and functions as a dynamic stabiliser of the joint, supporting the capsule and preventing excessive anterior and posterior shearing.[2 3]

A commonly held view is that the four rotator cuff tendons are separate entities[4–6] and, as a consequence of this, muscle- and tendon-specific tests have been developed.[7] However, Clark and Harryman[8] have shown that all four tendons fuse, with fibres of subscapularis and infraspinatus combining with those of the supraspinatus. The clear implication of the anatomical structure is that it is not possible clinically to differentiate individual tendon pathology selectively.[9]

Of the range of shoulder pathologies, disorders of the periarticular soft tissue, including the rotator cuff, are considered to be the most common.[10] The incidence of structural rotator cuff tendon pathology, including full thickness RC tendon tears, increases with age.[11–13] In a systematic review of the efficacy of clinical rotator cuff tests, Lewis and Tennent[9] concluded that there does not appear to be a correlation between tears and symptoms as research studies have demonstrated substantial numbers of people with asymptomatic shoulders and full function have partial or full thickness RC tendon tears.[11–15] Additionally, there does not appear to be a significant difference in incidence of tears between groups of people with and without shoulder symptoms.[13] In the 40–49 year age group both groups demonstrated an equal number of tears (58%), while in the 50–59 year age group the incidence of tears in the symptomatic and asymptomatic groups continued to remain equal, increasing to 78%.[13] It appears that the presence of pain may be of more relevance than the size of the tear.[16–18] Lewis and Tennent (2007)[9] concluded that making a diagnosis of rotator cuff disease, including symptomatic full thickness tears of the rotator cuff, and determining the cause of the symptoms are difficult.

The spectrum of hypotheses that have been proposed to explain the aetiology of rotator cuff tendon disease including tears is extensive. It includes: extrinsic mechanisms (acromion, coracoid process, superior aspect of the glenoid fossa), intrinsic degeneration, postural abnormalities, glenohumeral instability,

Abbreviations: RCT, randomised clinical trial

dietary insufficiencies and evolution.[9] It is probable that the cause of tendon pathology is multifactorial, and current diagnostic classifications and aetiological explanations are inadequate.

Treatment for rotator cuff tendon disease ranges from conservative treatment (including exercise, electrotherapy, acupuncture, manual therapy, injection therapy, taping) to surgery. Rotator cuff tendon surgery is thought to be less successful in an elderly population and when the RC tendon tears have retracted past the glenoid rim.[19–21] In this group of patients, treatment options include exercise therapy, attempts at tendon repair and shoulder joint replacement procedures.

Patients with symptomatic shoulders that have radiological evidence of full thickness tears of the rotator cuff experience pain and reduced functional ability. The reduction in function may be substantial, including an inability to dress, attend to personal hygiene and use utensils to eat. Pain may be so severe that sleep is affected. However, there is considerable uncertainty as to why the presence of a structural full thickness tear of the rotator cuff may be associated with disabling pain and loss of function in some individuals and be asymptomatic in others.[11–13] Answering this pivotal question will substantially advance our understanding of shoulder pathology and will help to guide appropriate management and care strategies for patients with symptomatic full thickness tears of the rotator cuff.

Conservative treatment, including exercise therapy, is often offered as the first management approach for patients with full thickness rotator cuff tears. It is essential that recommendations and management guidelines are based, in part, upon the available research. As such, a systematic review of the literature was conducted to synthesise the available research on the effectiveness of exercise therapy for full thickness tears of the rotator cuff.

METHOD

Identification and selection of trials

A literature search of the MEDLINE (1950 to 31.7.06), AMED (1985 to 31.7.06), PEDro (to 31.7.06), EMBASE (1974 to 31.7.06), the Cochrane Library (to 31.7.06) and CINAHL (1982 to 31.7.06) databases was conducted using the search terms: shoulder, rotator cuff, rotator cuff tears, subacromial impingement syndrome, exercise, rehabilitation, physiotherapy, physical therapy, clinical trials, case studies, systematic reviews. With the exception of PEDro, OVID was used to search all databases. This was supplemented by manual searches of reference lists of articles identified in the electronic searches.

Criteria for inclusion of trials

To be included in this review, studies had to be randomised clinical trials (RCT) and observational studies in any language. Patients were required to be skeletally mature human adults

Table 1 Description of the studies included in this review

Trial	Type of study	Outcome measure	Sample size	Characteristics of treatment	Shoulder dominance	Follow-up period	Confirmation of tear
Ainsworth (2006)[24]	Case series	OSS SF36	10	Patient education, exercises	Not reported	3 months	Massive full thickness tear confirmed by ultrasonography
Bokor *et al* (1993)[25]	Case series	ASES UCLA SRS	53	NSAIDs, stretching, strengthening, occasional CS injections	Dominant limb involved in 40 cases	Mean 7.6 years	Full thickness tear confirmed arthroscopically
Goldberg *et al* (2001)[26]	Case series	SST SF36	46	Patient education, home stretching and strengthening	Numbers not stated (dominance used in analysis)	Minimum 1 year Mean 2.5 years (SD = 1.6)	Full thickness tear confirmed by ultrasonography, MRI or arthrogram
Hawkins and Dunlop (1995)[27]	Case series	C-M ASES	33	Supervised rotator cuff exercises	26 dominant, 7 non-dominant	3.8 years (range 2.6-4.6 years)	Full thickness tear confirmed by contrast arthrogram
Heers *et al* (2005)[28]	Case series	C-M Night pain ROM	10	Home exercises	Not reported	3 months	3 groups, one group had 10 patients with massive tear confirmed by ultrasonography
Itoi and Tabata (1992)[29]	Case series	MWC	114 (124 shoulders)	Rest, NSAIDs, injection, exercise for range of movement and strength	Not reported	3.4 years (range 1-9 years)	Full thickness tears confirmed by arthrogram
Koubaa *et al* (2005)[30]	Case series	C-M VAS (pain) VAS (impairment)	24	Ultrasound, passive ROM, strengthening, proprioception, education	15 dominant 9 non-dominant	6 months	Full thickness tear confirmed by ultrasonography
Palmer (1998)[31]	Single case study	TRP ROM Power	1	Exercise in water	Not reported	2 years	Full thickness tear confirmed by MRI
Piccoli and Hasson (2004)[32]	Single case study	SPADI SF12	1	Exercise, ultrasound, ice, upper body exerciser	Not reported	7 weeks	Full thickness tear confirmed by MRI
Yamada *et al* (2000)[33]	Case series	JOAS	12	CS, heat, exercise, passive movement	Not reported	4 years	Massive cuff tear confirmed by arthrogram

OSS, Oxford Shoulder Score; SF36, Short Form-36; ASES, American Shoulder and elbow Surgeons; UCLA SRS, University of California at Los Angeles Shoulder Rating Score; SST, Simple Shoulder Test; C-M, Constant–Murley; MWC, Modified Wolfgang's Criteria; TRP, Therapy Report Programme; ROM, range of movement; SPADI, Shoulder Pain and Disability Index; SF12, Short Form-12; JOAS, Japanese Orthopaedic Association Score; CS, corticosteroid.

Table 2 Methodological Quality Criteria for Assessment of Observational Studies

Trial	1 Relevant subjects	2 Appropriate inclusion criteria	3 Prospective investigation (stated)	4 Adequate follow-up (defined as 1 year after final treatment)	5 Loss to follow-up accounted for	6 Blinded assessment (stated)	7 Appropriate impairment outcomes	8 Appropriate disability outcomes
Ainsworth (2006)[24]	✓	✓	X	X	✓ All present	X	None measured	✓
Bokor *et al* (1993)[25]	✓	✓	X	✓	✓	X	✓	✓
Goldberg *et al* (2001)[26]	✓	✓	X	✓	✓ All present	X	None measured	✓
Hawkins and Dunlop (1995)[27]	✓	✓	✓	✓	✓	X	✓	✓
Heers *et al* (2005)[28]	✓	✓	X	X	✓	X	✓	✓
Itoi and Tabata (1992)[29]	✓	✓	X	✓	✓	X	✓	✓
Koubaa *et al* (2005)[30]	✓	✓	✓	X	✓ All present	X	✓	✓
Palmer (1998)[31]	✓	✓	X	✓	✓ All present	X	✓	None measured
Piccoli and Hasson (2004)[32]	✓	✓	X	X	✓ All present	X	✓	✓
Yamada *et al* (2000)[33]	✓	✓	X	✓	✓	X	✓	✓

who had a clinical diagnosis of full thickness, or massive, or inoperable rotator cuff tears. Studies were required to mention explicitly that at least one treatment group received exercise therapy for the treatment of this condition. Studies were included if the exercise therapy group was administered in isolation or in conjunction with other treatments. In addition, studies were required to report one or more of the following outcome measures: shoulder impairment, shoulder disability, pain, patient-perceived effect/benefit, impact on quality of life.

Assessment of trial quality

Prior to commencing the review it was determined that the quality of any RCTs identified would be assessed using the PEDro scale (http://www.pedro.fhs.usyd.edu.au),[22] and the quality of any observational studies identified would be assessed using guidance from the NHS Centre for Reviews and Dissemination.[23] Each included publication was scored independently by both authors. Any disagreements (n = 2) were resolved by consensus. Consensus was achieved on all publications included in the review without the need to resolve disagreements by a third independent reviewer.

RESULTS

Trials included in the review

The search of the databases identified no appropriate RCTs and 111 observational studies, of which 77 were rejected following review of the abstracts. Full text copies of 34 observational studies were obtained and, following a detailed review of these, 24 were rejected as they did not fulfil the inclusion criteria. The reasons for this were: full thickness rotator cuff tears not specified (15 studies) and exercise therapy not specified (9 studies). Following the literature search, no RCTs and 10 observational studies were reviewed by the authors.

Descriptions of all the observational studies included in this review are detailed in table 1.

Table 2 details the methodological quality of the observational studies included in this review.

Participant information, together with inclusion and exclusion criteria and treatment interventions, are detailed in table 3.

A description of the intervention outcome is detailed in table 4.

RESULTS

The mean age of the patients participating in these investigations ranged from 59 to 78 years (youngest 44, oldest 83). In total, 272 patients were included in the 10 investigations reviewed (116 females, 156 males). Within the investigations, subject numbers ranged from one (2 single case studies[31 32]) to 54 (retrospective case series study[29]).

The mean final outcome measurements were taken from a minimum of 7 weeks to a maximum of 7.6 years. The final measurement in four trials was made less than one year after the final treatment (range 7 weeks to 6 months).

In two studies the time from onset of symptoms to commencement of rehabilitation was not stated. In the eight studies where the duration of symptoms prior to commencement of treatment was stated, the time ranged from 1 week to 30 years. The cause of symptoms (traumatic, non-traumatic) was detailed in five investigations, and in five studies no information was provided regarding the causation of symptoms.

The diagnosis of full thickness rotator cuff tendon tears was made by: ultrasound (3 studies), MRI (2 studies), arthrogram (4 studies) and arthroscope (1 study).

Outcome measures used in the trials

The outcome measures used in these studies included: shoulder impairment (8 trials), shoulder disability (9 trials) and pain (9 trials). Other outcome measurements included: Oxford Shoulder Score (1 trial), Constant–Murley Score (2 trials), Modified Constant–Murley Score (1 trial), Shoulder Pain and Disability Index (1 trial), American Shoulder and Elbow Surgeons Score (1 trial), Simple Shoulder Test (1 trial), UCLA Shoulder Rating Score (1 trial), Japanese Orthopaedic Association Score (1 trial), Modified Wolfgang's Criteria (1 trial), SF 36 (2 trials), SF-12 (1 trial) and patient's perception (3 trials).

Trial quality

No RCTs were identified for inclusion in this review. Of the 10 observational trials included, two involved single case studies and eight were case series investigations. Two specifically stated they were prospective and two were retrospective investigations. It is possible that the remaining six investigations were prospective but this was not stated as part of the methods. No study stated that the investigators were blinded to the initial or follow-up outcome measurements.

Exercise therapy

Four trials involved an exercise only programme,[24 26 27 31] and six involved exercise in combination with other treatments

Table 3 Description of studies included in the systematic review

Trial	Participants	Inclusion	Exclusion	Intervention
Ainsworth (2006)[24]	10 patients	Clinical inclusion:	Neurological abnormality affecting the shoulder complex	Defined programme involving:
	Mean age 76 years	all or some of	Potentially operable RC tears	Active anterior deltoid strengthening, scapular exercises, patient education, adaptation, proprioception, home programme
	(range 70-83 years)	positive humeral thrust on elevation,	Patients involved in industrial claim or litigation	1 x 30 minute treatment each week for 4 weeks
	6 female	gross weakness and wasting of the supraspinatus and infraspinatus, infraspinatus lag, rupture of long head biceps		Then at 2–3 weekly intervals
	4 male	Ultrasound confirmation of massive rotator cuff tear (defined as leading edge of tear retracted past glenoid margin)		Duration and number of treatments not stated
	Onset: Not stated Duration of symptoms prior to treatment: Not stated			
Bokor *et al* (1993)[25]	53 patients from initial group of 80 patients.	Clinical inclusion:	Previous or subsequent surgery on the involved shoulder	NSAIDs
	Mean age at onset 62.2 years (range 45–83 years)	Pain and / weakness Nonoperative course of treatment chosen by patient and clinician		Strengthening and stretching Corticosteroid injections (16 shoulders)
	13 female	Arthrogram confirmation of rotator cuff tear		15 of these continued to have pain at final review
	40 male Onset: Trauma 40 patients Duration of symptoms prior to treatment: 39 no history of symptoms prior to onset. < 3 months – 28 patients 3–6 months – 9 patients > 6 months – 16 patients			
Goldberg *et al* (2001)[26]	46 patients	Clinical inclusion:	Workers compensation claim	Education
	Mean age 65 years	None stated	Previous surgery	Home strengthening and stretching programme
	(SD+11 years)	Elective nonoperative management.		Strengthening involving: rotator cuff specific exercises,
	24 female	Ultrasound, MRI or arthrogram confirmation of non-acute full thickness rotator cuff tear		Progressive supine press
	22 male			Stretching involving:
	Onset: Not stated Duration of symptoms prior to treatment: No acute tears (time not specified)			flexion, external and internal rotation and cross-body adduction
Hawkins and Dunlop (1995)[27]	33 patients available for follow-up (from initial group of 50)	Clinical inclusion:		Supervised exercises over a 4-month period, and home programme, including:
	Mean age 59.6 years	Not stated		Internal and external rotation (with rubber tubing), short and long arc active flexion-extension exercises,
	6 female	Clinical assessment:		Scapular retraction, supraspinatus drill, diagonal proprioneuromuscular facilitation patterns with weights
	27 male	Muscle wasting		Strengthening exercises and proprioceptive patterning
	Onset: Traumatic 21 Non-traumatic 12 Duration of symptoms prior to treatment: 1 month to 30 years	'Pop-eye' deformity Active and passive movement Drop arm sign Strength tests Double contrast arthrogram confirmation of rotator cuff tear		
Heers *et al* (2005)[28]	34 patients recruited	Clinical inclusion:	X-ray or MRI finding of subacromial spur	Home-based graduated exercise programme involving: 3 warm-up exercises, 4 stretching exercises, 5 strengthening exercises

Table 3 Continued

Trial	Participants	Inclusion	Exclusion	Intervention
	23 female	Neer Impingement Sign	Younger than 40 years	The home programme required 40 minutes per day for 12 weeks
	13 male	and / or	Older than 70 years	
	Mean age 60.4 years (range 44–69)	Hawkins and Kennedy Test	Previous surgery	
	Onset:	Clinical assessment	No analgesia permitted during 12-week programme	
	Not stated	Range of movement: external rotation, flexion, abduction		
	Duration of symptoms prior to treatment:			
	Group I: 30.4 (SD = 34.5) months	Ultrasound		
	Group II: 28.8 (SD = 23.9) months			
	Group III: 71.0 (SD = 48.3) months			
Itoi and Tabata (1992)[29]	114 patients (124 shoulders) recruited	Clinical inclusion:	Fracture or fracture dislocation of shoulder	Various combinations of: rest, NSAIDs, steroid injection (repeated to a maximum of 4 times)
	55 Female	None stated		After the symptoms had subsided: active and passive range of motion, and muscle strengthening exercises started
	59 Male	Clinical assessment:		Mean treatment period: 26 months (range 1–83 months)
	Onset:	Impingement test		
	Not stated	Palpation tenderness		
	Duration of symptoms prior to treatment:	Muscle atrophy		
	Acute tears (<3 weeks) [15 shoulders]	Night pain		
	3 weeks to 3 months [19 shoulders]	Motion pain		
	3 months to 12 months [19 shoulders]	Arthrogram confirmation of rotator cuff tear		
	> 12 months [9 shoulders]	6 patients with traumatic anterior dislocation of the shoulder were also included		
Koubaa *et al* (2005)[30]	Case series of 24 patients	Clinical inclusion:		Analgesics for mild pain, analgesics and NSAID (Piroxicam 20 mg/day for 14 days) for stronger pain
	15 female	None stated		Corticosteroid injection if medications did not reduce pain
	9 male	Clinical assessment		When pain was controlled rehabilitation programme commenced (3 times per week for 2 months)
	Mean age 59 years (range 44–83 years)	Pain at rest		This included:
	Onset:	Pain with activity		Pulsed ultrasound for 10 minutes and cervical massage prior to each treatment
	Chronic degenerative changes	Pain at night		Passive range of movement exercises.
	Duration of symptoms prior to treatment:	Range of movement		Humeral head depressor exercises (pectoralis major and latissimus dorsi).
	Mean 9.1 (SD = 12.3) months (range 3–32 months)	Impairment (VAS)		Abduction exercises
		Subjective benefit rated as: effective or very effective, little effect, not effective		Proprioceptive exercises
		Returned to work on other functional activities		Education (avoid shoulder flexion and sustained or repetitive overhead activities).
		All patients had refused surgical repair		Biofeedback exercises
		Ultrasound		
Palmer (1998)[31]	Single case study	Clinical inclusion:	None stated	Active water-based exercises including stretching and strengthening and swimming for 3.5 months, divided into two phases
	1 female	None stated		Phase I: Water-based progressive resistance exercises, range of movement exercises, breast-stroke
	78 years	(Recommendation for surgery following medical examination)		Phase II: Overhead curl
	Onset:	MRI confirmation of FTT supraspinatus		Commenced at week 8
	Head-on motor vehicle collision			Patient seen on 10 occasions in clinic and continued programme at home in own therapeutic pool
	Duration of symptoms prior to treatment: 6.5 months			
Piccoli and Hasson (2004)[32]	Single case study	Clinical inclusion:		Physical therapy 3 times per week for 7 weeks (19 visits)
	1 female	Full can test		Phase I

Table 3 Continued

Trial	Participants	Inclusion	Exclusion	Intervention
	Age 76 years	Drop arm test		Pulsed ultrasound, isometric shoulder exercises, active assisted movements, isokinetic exercises, scapular exercises, home programme and ice
	Onset: Fall	Neer sign Clinical assessment:		Phase II Isokinetic exercises, scapular exercises, active assisted exercises against gravity, active exercises, free weights, resistance tubing exercises
	Duration of symptoms prior to treatment: 1 week	Forward head posture Scapular symmetry Range of movement VAS (pain) Shoulder muscle strength MRI confirmation of FTT supraspinatus (5.0 cm)		Phase III Functional exercises, proprioceptive neuromuscular facilitation.
Yamada *et al* (2000)[33]	Case series of 13 patients choosing conservative treatment 5 female 9 male Mean age 70 years (range 55–81 years) Onset: Not stated Duration of symptoms prior to treatment: Mean 44 months (range 12 months to 11 years)	Clinical inclusion: Not stated Arthrography		Weeks 1–3 sling for comfort CS injection (1–2/week; up to 15 injections in total) Hotpacks Passive range of movement for flexion and external rotation Rotator cuff strengthening exercises Injection, heat, exercise, passive movement

(slings, analgesics, NSAIDs, corticosteroid injections, therapeutic modalities such as ultrasound, and education). Nine studies involved land-based exercises and one study involved a water-based programme (hydrotherapy). The quality of information relating to the type of exercise, duration, intensity, repetitions and progression varied substantially in the included studies. On the basis of the information provided, it would be possible to repeat the exercise programme from only five of the included investigations.[24 28 30–32] One study[24] advocated exercises for shoulder flexion (aiming to recruit anterior deltoid) and another[30] recommended avoiding this movement entirely, preferring to exercise the humeral head depressors and rehabilitate shoulder elevation in the direction of shoulder abduction only. The rationale for both approaches appeared to be hypothetical and not supported by definitive evidence.

DISCUSSION

Appropriately designed and analysed randomised placebo controlled trials are considered to be the most rigorous study design to assess the effectiveness of a clinical investigation.[34] Observational studies provide some limited evidence to guide clinical practice. However, in view of the existence of selection bias and other confounding factors, there is concern relating to the validity of observational studies and the ability to generalise the findings of such studies to inform clinical practice. Although a number of assessment tools have been proposed to score the quality of observational studies, they have not been adequately developed or fully validated.[35] Additionally, there is no validated scoring system for observational studies.

The literature review for this investigation failed to identify any randomised clinical trials which had investigated the effectiveness of exercise in the management of full thickness tears of the rotator cuff. Ten observational studies that included exercise as part of the therapeutic intervention for full thickness tears of the rotator cuff (8 English, 1 French and 1 German language) were identified. Of these, eight were case series investigations (ranging from 10 to 54 participants) and two were single case studies.

Due to the diversity of study designs, inclusion criteria, interventions, types of exercise, outcome measurements, follow-up times, and home versus clinic-based programmes, it was considered inappropriate to attempt to pool the results.

Overall, the results suggest that exercise therapy (defined as strengthening and stretching), when included as part of a treatment programme, has a beneficial effect for patients who have symptomatic shoulders and radiological or arthroscopic evidence of full thickness rotator cuff tears. It is not possible at present to determine the potential size of that effect with any certainty and although there appears to be a definite benefit of including exercise, it is arguable that, on the basis of the findings, the effect at present should only be considered as modest. It is also not possible to determine if it is exercise alone or exercise in combination with other interventions that offers the greatest benefit. In addition, guidance as to the most appropriate exercise therapy, including duration, intensity and number of repetitions, remains speculative. There is also uncertainty as to when to start and how to progress the exercise programme. There is also no guidance to follow to inform clinicians whether the exercise needs to be specific or general in nature. Additionally, it is unclear why the exercise may be having a beneficial effect. A non-exhaustive list of possibilities includes: pain modulation, teaching other muscles to perform and co-ordinate movement, an unspecified therapeutic effect on the structurally damaged rotator cuff muscles and tendons, placebo, and reducing kinesiophobia and the patient's uncertainty if the arm should be moved. In addition, the relationship between outcome and upper limb dominance, as well as outcome and onset (traumatic or non-traumatic event), requires further investigation to determine if differences

Table 4 Trial outcomes

Trial	Outcome	
Ainsworth (2006)[24]	Oxford Shoulder Score	SF36
Outcome measured at 12 weeks after the start of the programme and compared to baseline measurements	Mean improvement 10 points	Pain:
	(range 3–16)	Mean improvement 22 points
	Mean at baseline: 34.2	Role limitation due to physical health:
	Mean at 3 months: 23.6	Mean 10-point improvement
		Role limitation due to emotional health:
		Mean 23-point decline
		General health:
		Mean 9-point decline
Bokor *et al* (1993)[25]	Pain	Range of movement:
Final evaluation (mean 7.6 years after onset, range 3.7–12 years)	39 patients (74%) none or slight pain	Mean elevation at initial consultation 121°
80 patients initially evaluated	[2 patients at initial presentation]	Mean elevation at follow up: 149°
53 included in final analysis	Little or no pain at follow-up	Mean external rotation range increased by 8°
34 patients reviewed by questionnaire and physical examination	24/28 (86%) patients experiencing pain <3 months	UCLA Shoulder Score:
19 patients by telephone interview only	6/9 (67%) patients experiencing pain 3–6 months	(34 patients assessed)
	9/16 (51%) patients experiencing pain >6 months	Initial mean score 14.6
	Subjective weakness	Final mean score 28.1
	42/53 (79%) at initial consultation	19 patients (56%) had a satisfactory result
	experienced moderate or severe weakness.	Greatest improvement in group treated within 3 months of onset. Least in group treated after 6 months of onset
	18/53 (34%) at follow-up	
	Activities of daily living	
	At initial consultation 25% could perform ADL	
	with little or no compromise.	
	At final consultation 77%.	
Goldberg *et al* (2001)[26]	Simple Shoulder Test	14/45 (30%) experienced worsening
	Initial consultation 5.6 (SD = 3.2)	5/47 (11%) remained unchanged
	Final consultation 7.0 (SD = 3.8)	Predicating outcome
	Mean efficacy 1.4 (SD = 3.6)	Dominance
	Responsiveness to nonoperative treatment	Patients with symptoms in dominant shoulder were more likely to improve (p = 0.02)
	determined to be low.	Tucking shirt behind back
	Only two factors of the SST had significantly	Patients who initially had difficulty performing this movement were more likely to improve (p = 0.04)
	improved (p<0.01):	
	– ability to sleep on affected side	
	– ability to place hand behind head	
	SF36	
	Significant improvement (p = 0.01) in comfort score	
	Vitality, physical function, general health,	
	physical component summary decreased significantly.	
	27/46 (59%) experienced improvement	
Hawkins and Dunlop (1995)[27]	Constant–Murley Scores	Of the 6 components of the C-M Score (pain, function, positioning, strength, range of movement, total score) there were no significant differences between Groups 1 and 2 on the initial measurement. At follow-up there were no significant differences for pain, function, positioning, range of movement scores. There were significant differences in favour of Group 1 for strength (p = 0.008) and total score (p = 0.038)
21 patients continued with conservative treatment (Group 1)	Group 1	Patient satisfaction
12 ''dissatisfied patients'' eventually elected to have surgery (at a mean 13 months after commencing conservative programme, range 2 months–3.5 years); an additional 2 patients who elected not to have surgery were also dissatisfied with conservative treatment (group 2)	Initial	(using ASES)
	14 good to excellent (75–100 points)	Impairment measures (strength, muscle wasting, range of movement) did not correlate with patient satisfaction. Pain reduction, reduced analgesia, improved sleep, improved recreation, most strongly correlated with improved patient satisfaction
	5 fair (50–74 points)	Patients reporting loss of sleep and, to a lesser extent, compensation claim issues, at the initial assessment were predictors of an unsatisfactory outcome
	0 poor (<50 points)	
	Final	
	18 good to excellent	
	1 fair	

Table 4 Continued

Trial	Outcome	
	0 poor Group 2 Initial 8 good to excellent 2 fair 4 poor Final 8 good to excellent 2 fair 4 poor	
Heers *et al* (2005)[28]	Modified Constant–Murley Score (maximum score 95 points) Group I Mean increase 13.0 (SD = 7.9) p = 0.001 Group II Mean increase 13.2 (SD = 11.4) p-0.002 Group III Mean increase 17.5 (SD = 6.6) p = 0.005 Night pain [0 (no pain) – 15 (maximal pain)] Group I (initial) 9.0 (SD = 3.5) (12 weeks) 3.8 (SD = 2.6) (p = 0.002) Group II (initial) 8.6 (SD = 3.7) (12 weeks) 3.9 (SD = 3.5) (p = 0.003) Group III (initial) 6.9 (SD = 6.9) (12 weeks) 3.6 (SD = 4.8) (p<0.03)	Range of movement: External rotation Group I Mean increase 7.5˚ (SD = 8.7˚) p<0.02 Group II Mean increase 6.1˚ (SD = 7.8˚) p<0.03 Group III Mean increase 10.0˚ (SD = 13.3˚) p<0.05 Flexion Group I Mean increase 6.5˚ (SD = 14.9˚) p<0.2 Group II Mean increase 15.0˚ (SD = 26.2˚) p<0.03 Group III Mean increase 24.0˚ (SD = 38.1˚) p<0.05 Abduction Group I Mean increase 22.5˚ (SD = 38.6˚) p<0.03 Group II Mean increase 26.4˚ (SD = 40.1˚) p<0.03 Group III Mean increase 36.0˚ (SD = 38.1˚) p<0.02 Neer Sign and / or Hawkins and Kennedy Test Group I: Initially 12 positive (86%) 12 weeks 4 positive (29%) Group II: Initially 13 positive (93%) 12 weeks 7 positive (50%) Group III: Initially 9 positive (90%) 12 weeks 7 positive (70%)
Itoi and Tabata (1992)[29]	Modified Wolfgang's Criteria Pain (0–4) 0 = severe, constant disabling 4 = absent regardless of activity Motion [abduction] (0-4) 0 = <10˚, 4 = >150˚ Strength (0-4) 0 = absent, 4 = normal Function (0–4) 0 = no functional value, 4 = no impairment Total score Poor outcome (0–7), fair (8–10), 11–14 (good), 15–16 (excellent) Overall final assessment: Improved (72.6%), 38 patients (45 shoulders) Unchanged (12.9%) 7 patients (8 shoulders) Worse (14.5%) 9 patients (9 shoulders) Overall: Excellent (53%), 27 patients (33 shoulders) Good (29%), 18 patients (18 shoulders) Fair (16%), 8 patients (10 shoulders) Poor (2%), 1 patient (1 shoulder)	Overall within the individual categories of the Modified Wolfgang's Criteria, significant improvements in pain (p<0.001), range of movement (p<0.05) and function (p<0.001) were reported; no significant change was reported for strength Follow-up scores significantly improved in all groups (p< 0.05) except for those who had experienced symptoms for more than 12 months In addition, 32 patients (not available for clinical follow-up and contacted by telephone) Excellent (31.25%): 10 patients Good (56.25%): 18 patients Fair (6.25%) 2 patients Poor (6.25%): 2 patients Of the 3 patients with FTT and traumatic dislocations, 2 were evaluated as good and 1 fair. No recurrence was reported
Koubaa *et al* (2005)[30] Evaluation before, at end and 6 months after end of last treatment. Treatment deemed successful if C-M score >80 achieved, a VAS (handicap) score of <20/100 mm and VAS (pain) <20/100 mm.	18 patients (75%) had a C-M score higher than 80, a VAS (pain) <20 mm, and a VAS (handicap) <20 mm at 6 months. At the end of treatment 19/24 (79.1%)	VAS (pain at rest): Initial: 30.0 mm (SD = 21.6) End treatment: 6.3 mm (SD = 11.1) 6 months: 4.3 mm (SD = 6.0) (p = .001)

Table 4 Continued

Trial	Outcome	
	reported treatment to be effective or very effective. At 6 months 18/24 (75%) reported treatment to be effective or very effective. Constant–Murley Score Constant score improved from 44.7 (SD = 15.4) to 71.8 (SD = 14.1) at the end of treatment and to 74.7 (SD = 15.2) at 6 months ($p<0.0001$)	VAS (pain during movement): Initial: 74.1 mm (SD = 19.5) End treatment: 21.1 mm (SD = 14.1) 6 months: 17.1 mm (SD = 15.2) ($p<0.0001$) VAS (impairment): Initial: 56.4 mm (SD = 15.5) End treatment: 14.7 mm (SD = 11.8) 6 months: 13.7 mm (SD = 15.4) ($p<0.0001$)
Palmer (1998)[31]	Baseline versus (12 weeks) [change] Flexion ROM 90° (160°) [+70°] External rotation ROM Not measured (77°) [?] Internal rotation ROM Not measured (60°) [?] Extension ROM 36° (51°) [+15°] Strength (in lbs) Supraspinatus 0 (7lbs) [+7lbs]	Middle deltoid 7lbs (7lbs) [no change] External rotation 8lbs (17lbs) [+9lbs] Internal rotation Not measured (20lbs) [?] Triceps 10lbs (25lbs) [+15lbs] At 2 years: 2 continuous lengths of a 40-foot indoor pool
Piccoli and Hasson (2004)[32]	SPADI (range 0–100, 100 maximal disability) At 7 weeks SPADI decreased 78% (initial score 76, final score 17) SF-12 Initially >2.5 standard deviation from the norm At 7 weeks within 1 standard deviation of the norm. VAS (Pain) Worse pain Initial 10/10, 7 weeks 3/10 Shoulder elevation pain Initial 8/10, 7 weeks 3/10	Washing hair Initial 10/10, 7 weeks 3/10 Range of active movement Flexion Initial 90°, 7 weeks 150° Abduction Initial 80°, 7 weeks 139° External rotation Initial 45°, 7 weeks 89° All patients' goals achieved (with minimal pain and difficulty) Comb and wash hair, housework, gardening
Yamada *et al* (2000)[33] Mean follow-up period 48 months (range 12 months–19 years) JOAS Based on pain (30 points), function (20 points), range of movement (30 points), radiographic evaluation (5 points), joint stability (15 points). Maximum score 100 points.	Group I-Exercise Group Mean JOAS increased from 53.2 to 71.1 ($p = 0.002$) Pain decreased by 58% Function improved by 22% ROM improved by 18% 8/13 (62%) satisfied Group II-Surgery Group (n = 26, 3 female, mean age 62 years (range 47–82) Mean JOAS increased from 58.8 to 85.9 ($p<0.0001$) Pain decreased by 71% Function improved by 26% ROM improved by 18% 22/26 (85%) satisfied	

exist between these important variables. There is also uncertainty over how long to offer conservative care before seeking a surgical opinion. Recommendations have ranged from 3 months to 18 months.[29 36–38]

Uncertainty exists regarding the advice a clinician should offer patients concerning the benefit of exercise therapy and the size of the full thickness tear. Hawkins and Dunlop (1995)[27] reported that a greater number of patients with large (3–5 cm) and massive (>5 cm) full thickness rotator cuff tears eventually choose surgical management than those with small (<1 m) and moderate (1–3 cm) size tears. However, the presence of a massive tear does not imply that surgery is mandatory, as Picolli and Hasson (2004)[32] reported substantial improvement in function and pain after 7 weeks in an individual with a 5 cm tear identified on MRI following a traumatic fall down steps.

Other investigations have reported equivocal results relating to the size of the tear and function. McCabe *et al* (2005)[39] reported that patients with massive rotator cuff tears (identified during arthroscopic surgery) had a significant reduction in strength in comparison to the contralateral asymptomatic side when strength was tested at 10° of shoulder abduction. However, no reduction in strength was reported when the shoulder was tested at 90° of shoulder abduction in the plane of the scapula, external rotation at 90° abduction, or during the 'full can test'. It is possible that weakness identified during clinical tests may be more attributable to pain inhibition than true weakness.[16–18] Ben-Yishay *et al* (1994)[16] reported significant increases in range of movement and strength in 14 patients (9 with full thickness RC tears) following a subacromial injection. This finding suggests that the presence and size of a tear may be less important than the presence of pain. This may also help to explain why individuals with full thickness tears but without shoulder pain are able to function normally.[11–13]

There is uncertainty as to what constitutes best management and treatment for a patient with a symptomatic shoulder with a structural diagnosis of a full thickness rotator cuff tear. Following a retrospective analysis of 50 patients with rotator cuff tears who had undergone surgical repair, Ellman *et al* (1986)[36] proposed that tears (including massive tears) are best treated surgically and that earlier surgery will result in a better outcome than if the operation is delayed, especially with massive recent tears. Others[38] have suggested that conservative management, including exercise therapy, for full thickness rotator cuff tears may also be associated with substantial improvement. Bartolozzi *et al* (1994)[38] reported good to excellent improvement in 76% (n = 68) of patients following non-surgical care for rotator cuff tears. Of note, improvement was found to increase significantly as post-treatment follow-up duration increased. This suggests that there may be an element of natural resolution in some patients with rotator cuff tears, which may or may not be associated with the initial treatment.

What is already known on this topic

- Both conservative procedures and surgical techniques have been proposed for the management of rotator cuff tears.
- There is little consensus as to the optimum management of such tears.
- No previous systematic reviews specifically focus on the use of exercise in the management of rotator cuff tears.

What this study adds

- The study highlights the paucity of published evidence concerning the use of specific exercises in the management of rotator cuff tears.
- Given that no randomised controlled trials were identified for inclusion in this study, the need is emphasised for quality trials to develop the evidence base as to the optimum exercise programme.

However, these studies,[36 38] as with the studies included in this systematic review, lack the robustness of a prospective, randomised placebo controlled trial with attention to power, allocation concealment and other features that would strengthen the utility of the conclusions that have been reached.

Appropriately designed randomised clinical investigations that address the areas identified as deficiencies in our knowledge base as a result of this review would help to address this lack of understanding and provide clinicians with better and more appropriate information to present to patients to help inform discussions and decisions regarding management and care pathways. For these studies to provide meaningful information, it is imperative that appropriate and validated impairment and disability outcome measures are incorporated into the design. To be able to pool the results from future randomised controlled trials, these studies should endeavour to use the same validated outcome measures.

CONCLUSION

The findings of this review suggest that the inclusion of exercise therapy, either in isolation or as part of a nonoperative package of care for full thickness tears of the rotator cuff, has some benefit. In addition, the findings suggest that it would be appropriate to recommend exercise therapy as a therapeutic option to patients with a symptomatic shoulder with an imaging diagnosis of a full thickness rotator cuff tear of either traumatic or non-traumatic origin. However, there is no definitive guidance as to when to start the programme, what to include in the programme and when to refer for a surgical opinion. This review draws attention to the fact that many diverse exercise approaches with different levels of supervision have been investigated, but that no definitive clinical guidance is possible. As such, it is essential that appropriately designed randomised clinical investigations, using appropriate validated outcome measurements, are conducted to begin to address the considerable deficiencies in our knowledge base regarding best management practice for this common and disabling condition.

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