An update of systematic reviews examining the effectiveness of conservative physiotherapy interventions for subacromial shoulder pain
Running head: Conservative interventions for shoulder pain

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CONFLICT OF INTEREST

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An update of systematic reviews examining the effectiveness of conservative physiotherapy interventions for subacromial shoulder pain

ABSTRACT

Background: Subacromial shoulder pain (SSP) is a frequently diagnosed shoulder complaint. Management often involves an exercise programme but may include many other interventions. The aim of this review is to update the systematic review published by Littlewood et al. in 2013, which focused on evaluating the effectiveness of interventions within the scope of physiotherapy including exercise, manual therapy, electrotherapy and combined or multimodal approaches.

Study design: Systematic review

Methods: An electronic search of Pubmed, Web of Science and CINAHL was undertaken. Methodological quality was assessed using the AMSTAR-checklist for systematic reviews.

Results: Sixteen systematic reviews were retrieved. Methodological quality was variable. A strong recommendation can be made for exercise therapy as first-line treatment to improve pain, mobility and function in patients with SSP. Manual therapy may be integrated, with strong recommendation, as additional therapy. Moderate evidence of no effect was found for other commonly prescribed interventions, such as laser therapy, extracorporeal shock wave therapy, pulsed electromagnetic and ultrasound.

Conclusions: Evidence for the use of exercise therapy as an intervention for SSP is increasing and strengthening. Ongoing research is required to provide guidance on exercise type, dose, duration and expected outcomes. A strong recommendation may be made regarding the inclusion of manual therapy in the initial treatment phase.

Keywords: shoulder pain, impingement, rotator cuff, tendinopathy, exercise, conservative treatment, non-surgical treatment, rehabilitation, systematic review

INTRODUCTION

Shoulder pain is common, increases with age and is often associated with incomplete resolution of symptoms[17, 28]. Subacromial shoulder pain (SSP)[2] is a term that is used to describe the clinical presentation of pain and impairment of shoulder movement and function usually experienced during shoulder elevation and external rotation. Other terms that are used to describe these symptoms include; subacromial impingement syndrome, rotator cuff tendinopathy[22] and more recently; rotator cuff related shoulder pain (RCRSP)[20]. It is suggested that multiple structures, including the subacromial bursa, the rotator cuff muscles and tendons, the acromion, the coraco-acromial ligament, and capsular and intra-articular tissue, may be involved in the pathogenesis of SSP[18]. Other factors, such as altered shoulder kinematics associated with capsular tightness[37], rotator cuff and scapular muscle dysfunction [7, 19, 23], overuse due to sustained intensive work[6, 13, 25] and poor posture[3, 21], have also been hypothesised as contributing to the pathogenesis of SSP. Although change in load is implicated as the main factor associated with onset, the pathogenesis is possibly multifactorial and this has led to a multitude of suggestions for management[24, 39].

In 2013, Littlewood et al.[22] reviewed the scientific literature regarding the management of rotator cuff tendinopathy. Although the magnitude of the improvement was uncertain, the review reported that exercise and multimodal physiotherapy might be effective in the management of rotator cuff tendinopathy. Consequently, it is recommended that graduated exercise should be prioritised as the primary treatment option, due to its clinical effectiveness (equivalent to surgery), cost effectives (less expensive than surgery), and other associated health benefits.

The aim of the present review was to update the findings reported by Littlewood et al.[22] to determine if more recently published literature provided further understanding in the management of SSP.

METHODS

Data sources and search strategy

An electronic search of three databases (Pubmed, Web of Science, CINAHL) was independently conducted by three researchers. The search terms used are displayed in Table 1. As the search limits of the Littlewood et al.[22] systematic review were set until August 2012, data limits of this review were set from September 2012 up to September 2018.

Search term
(subacromial impingement syndrome OR painful arc syndrome OR shoulder impingement OR subacromial bursitis OR rotator cuff tendonitis OR rotator cuff tendinosis OR supraspinatus tendonitis OR contractile dysfunction) AND (conservative treatment OR exercise OR exercise combined with manual therapy OR multimodal physiotherapy OR corticosteroid injection OR laser OR ultrasound OR extracorporeal shock wave therapy OR pulsed electromagnetic energy) AND (systematic review OR meta-analysis)

Table 1 Search strategy

Search term
(("shoulder impingement syndrome"[MeSH Terms] OR ("shoulder"[All Fields] AND "impingement"[All Fields] AND "syndrome"[All Fields]) OR "shoulder impingement syndrome"[All Fields] OR ("subacromial"[All Fields] AND "impingement"[All Fields] AND "syndrome"[All Fields]) OR "subacromial impingement syndrome"[All Fields]) OR (("pain"[MeSH Terms] OR "pain"[All Fields] OR "painful"[All Fields]) AND ("Arthrogryposis renal dysfunction cholestasis syndrome"[All Fields] OR "arc syndrome"[All Fields])) OR (("shoulder"[MeSH Terms] OR "shoulder"[All Fields]) AND impingement[All Fields]) OR (subacromial[All Fields] AND ("bursitis"[MeSH Terms] OR "bursitis"[All Fields])) OR (("rotator cuff"[MeSH Terms] OR ("rotator"[All Fields] AND "cuff"[All Fields]) OR "rotator cuff"[All Fields]) AND ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendonitis"[All Fields])) OR (("rotator cuff"[MeSH Terms] OR ("rotator"[All Fields] AND "cuff"[All Fields]) OR "rotator cuff"[All Fields]) AND ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendinosis"[All Fields])) OR (supraspinatus[All Fields] AND ("tendinopathy"[MeSH Terms] OR "tendinopathy"[All Fields] OR "tendonitis"[All Fields])) OR (("muscle contraction"[MeSH Terms] OR ("muscle"[All Fields] AND "contraction"[All Fields]) OR "muscle contraction"[All Fields] OR "contractile"[All Fields]) AND ("physiopathology"[Subheading] OR "physiopathology"[All Fields] OR "dysfunction"[All Fields]))) AND ((conservative[All Fields] AND ("therapy"[Subheading] OR "therapy"[All Fields] OR "treatment"[All Fields] OR "therapeutics"[MeSH Terms] OR "therapeutics"[All Fields])) OR ("exercise"[MeSH Terms] OR "exercise"[All Fields]) OR (("exercise"[MeSH Terms] OR "exercise"[All Fields]) AND combined[All Fields] AND ("musculoskeletal manipulations"[MeSH Terms] OR ("musculoskeletal"[All Fields] AND "manipulations"[All Fields]) OR "musculoskeletal manipulations"[All Fields] OR ("manual"[All Fields] AND "therapy"[All Fields]) OR "manual therapy"[All Fields])) OR (multimodal[All Fields] AND ("physical therapy modalities"[MeSH Terms] OR ("physical"[All Fields] AND "therapy"[All Fields] AND "modalities"[All Fields]) OR "physical therapy modalities"[All Fields] OR "physiotherapy"[All Fields])) OR (("adrenal cortex hormones"[MeSH Terms] OR ("adrenal"[All Fields] AND "cortex"[All Fields] AND "hormones"[All Fields]) OR "adrenal cortex hormones"[All Fields] OR "corticosteroid"[All Fields]) AND ("injections"[MeSH Terms] OR "injections"[All Fields] OR "injection"[All Fields])) OR ("lasers"[MeSH Terms] OR "lasers"[All Fields] OR "laser"[All Fields]) OR ("ultrasonography"[Subheading] OR "ultrasonography"[All Fields] OR "ultrasound"[All Fields] OR "ultrasonography"[MeSH Terms] OR "ultrasound"[All Fields] OR "ultrasonics"[MeSH Terms] OR "ultrasonics"[All Fields]) OR (extracorporeal[All Fields] AND ("shock"[MeSH Terms] OR "shock"[All Fields]) AND wave[All Fields] AND ("therapy"[Subheading] OR "therapy"[All Fields] OR "therapeutics"[MeSH Terms] OR "therapeutics"[All Fields])) OR (pulsed[All Fields] AND ("electromagnetic radiation"[MeSH Terms] OR ("electromagnetic"[All Fields] AND "radiation"[All Fields]) OR "electromagnetic radiation"[All Fields] OR ("electromagnetic"[All Fields] AND "energy"[All Fields]) OR "electromagnetic energy"[All Fields]))) AND (("review"[Publication Type] OR "review literature as topic"[MeSH Terms] OR "systematic review"[All Fields]) OR ("meta-analysis"[Publication Type] OR "meta-analysis as topic"[MeSH Terms] OR "meta-analysis"[All Fields])) AND ((systematic[sb] OR Meta-Analysis[ptyp]) AND ("2012/09/01"[PDAT] : "2018/10/01"[PDAT]) AND "humans"[MeSH Terms])

Table 1bis Search strategy (detailed version)

Study selection

Study selection was undertaken by three reviewers independently. Systematic reviews that included randomized controlled trials (RCTs) involving people with signs and symptoms suggestive of SSP were included. The following diagnostic categories were considered as being equivalent to the term SSP: rotator cuff tendinopathy, painful arc syndrome, subacromial bursitis, rotator cuff tendinosis, supraspinatus tendonitis, contractile dysfunction. Systematic reviews had to evaluate the effectiveness of the following non-surgical non-pharmacological treatments: exercise, exercise combined with manual therapy, multimodal physiotherapy, corticosteroid injection, laser, ultrasound, extracorporeal shock wave therapy or pulsed electromagnetic energy. Corticosteroid injection is not an intervention within the scope of physiotherapy, but as this intervention was already discussed in the Littlewood et al.[22] systematic review and it is highly related to physiotherapy rehab policies, decision was made to include this intervention in the review.

Data extraction

Three reviewers individually extracted data using a data extraction tool developed for this review regarding methodological quality, design, population, sample size, intervention, outcome and results, a consensus was subsequently reached.

Quality appraisal

Quality appraisal was undertaken by the three reviewers independently. The AMSTAR (assessment of multiple systematic reviews) checklist was used for assessing methodological quality. The AMSTAR checklist consists of 11 items with regard to the quality of the review. Each item can be answered with “yes”, “no”, “can’t answer” or “not applicable”[33]. AMSTAR

characterizes quality at three levels: 8 to 11 is high quality, 4 to 7 is medium quality and 0 to 3 is low quality[32]. The AMSTAR checklist was chosen to provide homogeneity with the review findings reported by Littlewood et al.[22]. Recent guidelines for updating systematic reviews are reporting to replicate the original methods as closely as possible[12].

Cohen's kappa coefficient (κ) was calculated to compare the pre-consensus scoring of the different reviewers. As κ was > 0.81 (κ = 0.92), it can be interpreted as almost perfect.

Appraisal of individual component studies was beyond the scope of this review, as this was the aim of the original systematic reviews, which included an appraisal of studies' quality. With respect to the selected systematic reviews, methods were used to capture essential features of the quality of the evidence, and these are described in detail in the data analysis section.

Data analysis

The level of evidence used in the Tables *(Tables 3-10)* to present the different reviews, is the evidence that was reported in every original review (high / moderate / low).

The method to evaluate the strength of recommendation is as follows: a strong recommendation is made when at least 50% of the reviews considering a specific topic are of at least moderate evidence, with at least one review of high evidence. A moderate recommendation is based on the fact that at least 50% of the reviews are of moderate evidence. A weak recommendation is made when less than 50% of the reviews considering a specific topic are of moderate evidence.

RESULTS

Study selection

The study selection progress is detailed in Figure 1. The electronic literature search, (Pubmed, Web of Science and CINAHL), resulted in 107, 109 and 40 articles respectively. Duplicates were identified and removed using Endnote (EndNote X8). Following this, 202 abstracts remained. Screening the title and abstract of the remaining articles resulted in the exclusion of 160 articles on the basis of population and intervention. Following reading the full text of the remaining articles another 26 articles were excluded. 2 articles were excluded because they were already included in the previous review of Littlewood et al.[22]. To reach a consensus on the eligibility of studies, the reviewers had a consensus meeting. Consequently, full agreement was obtained (100%) between all three reviewers, which made arbitration from an external reviewer unnecessary. After the consensus meeting between the three reviewers, 16 relevant studies were deemed appropriate for data extraction.

Quality appraisal

The results of the AMSTAR quality appraisal are shown in Table 2. Nine out of 16 included systematic reviews were of high methodological quality (> 8/11). The remaining seven studies were categorized as having medium quality. The main reason for not meeting an AMSTAR criterion was failure to assess the likelihood of publication bias. This means that the reviewers of these systematic reviews did not assess potential publication bias, by means of graphical aids (e.g. funnel plot) and/or statistical tests (e.g. Egger regression test, Hedges-Olken).

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141 **Figure 1 Study selection process**

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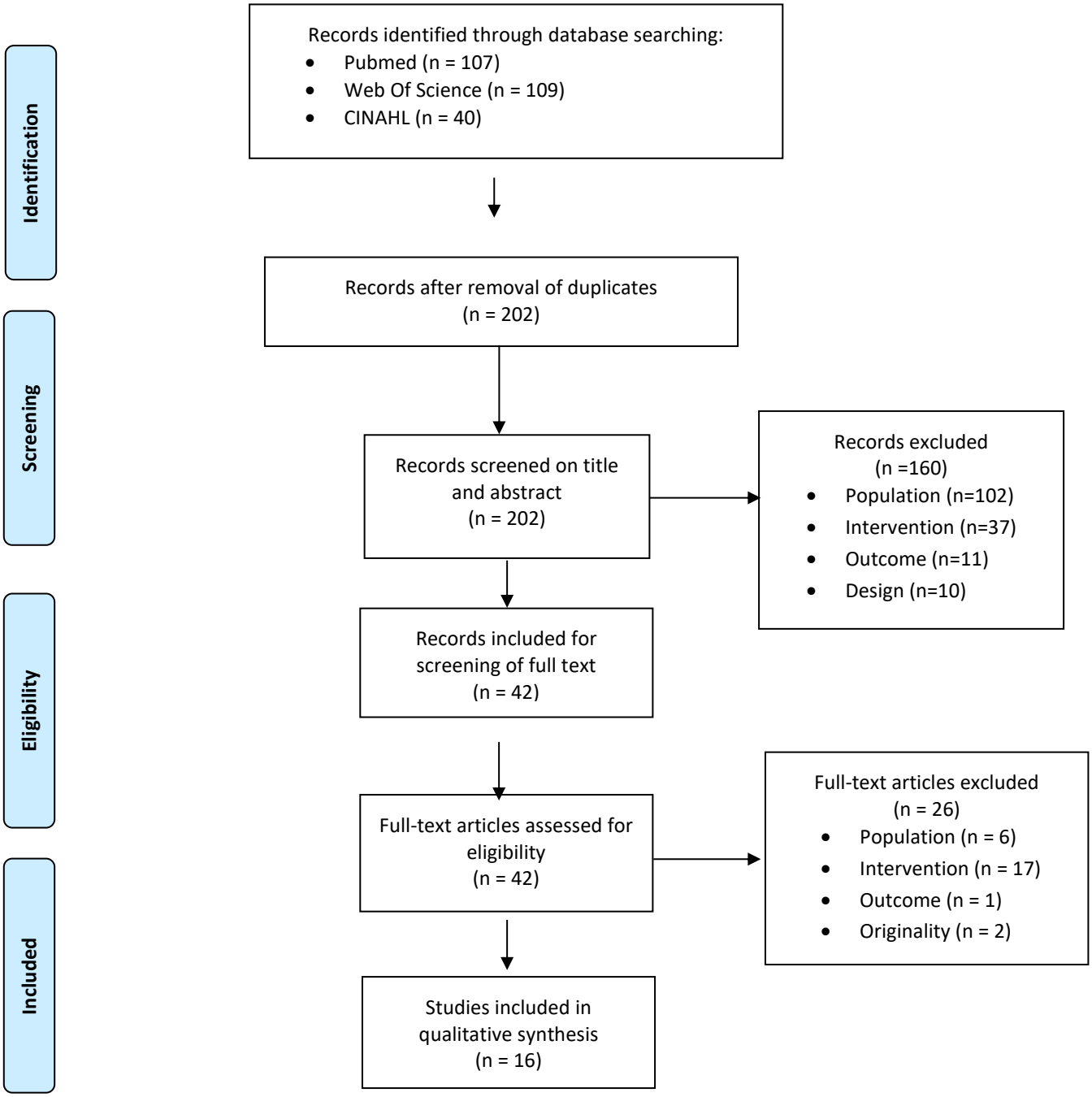

AMSTAR	ITEM 1	ITEM 2	ITEM 3	ITEM 4	ITEM 5	ITEM 6	ITEM 7	ITEM 8	ITEM 9	ITEM 10	ITEM 11	TOTAL
Abdulla SY et al. (2015)[1]	YES	YES	YES	YES	YES	NO	YES	YES	YES	NO	NO	8/11
Bury J et al. (2016)[5]	YES	NO	YES	YES	NO	YES	YES	YES	YES	NO	YES	8/11
Desjardin-Charbonneau A et al. (2015)[8]	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	YES	9/11
Desmeules F et al. (2016)[9]	YES	NO	YES	YES	NO	YES	YES	YES	NO	NO	YES	7/11
Desmeules F et al. (2015)[10]	YES	NO	YES	YES	NO	NO	YES	YES	YES	NO	YES	7/11
Dong W et al. (2015)[11]	YES	YES	NO	YES	NO	NO	YES	NO	NO	NO	YES	5/11
Goldgrub R et al. (2016)[14]	YES	YES	YES	NO	NO	YES	YES	YES	YES	NO	YES	8/11
Haik NM et al. (2016)[15]	YES	YES	YES	NO	NO	NO	YES	YES	YES	YES	YES	8/11
Haslerud S et al. (2014)[16]	YES	YES	YES	NO	YES	NO	YES	YES	YES	NO	NO	7/11
Page MJ et al. (2016)[26]	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	YES	9/11
Page MJ et al. (2016)[27]	YES	YES	YES	NO	YES	YES	YES	YES	YES	NO	YES	9/11
Saito H et al. (2017)[29]	YES	YES	YES	NO	NO	YES	YES	YES	YES	NO	NO	7/11
Saracoglu I et al. (2017)[30]	YES	YES	YES	NO	NO	YES	YES	YES	YES	NO	YES	8/11
Steuri R et al. (2017)[35]	YES	YES	YES	NO	YES	NO	YES	YES	YES	NO	YES	8/11
Van der Sande R et al. (2013)[38]	YES	YES	NO	YES	NO	NO	YES	YES	NO	NO	NO	5/11
Yu H et al. (2014)[40]	YES	YES	YES	NO	NO	YES	YES	NO	NO	NO	YES	6/11

Table 2 Results of the AMSTAR quality appraisal

1= Was a 'a priori' design developed?, 2= Was there duplicate study selection and data extraction?, 3= Was a comprehensive literature search performed?, 4= Was the status of publication used as an inclusion criteria?, 5= Was a list of studies (included and excluded) provided?, 6= Were the characteristics of the included studies assessed and documented?, 7= Was the scientific quality of the included studies assessed and documented?, 8= Was the scientific quality of the included studies used appropriately in formulating conclusions?, 9= Were the methods used to combine the findings of the studies appropriate?, 10= Was he likelihood of publication bias assessed?, 11= Was the conflict of interest stated?

Study characteristics

A summary of all details and characteristics of all systematic reviews included is detailed in Tables 3-10.

Exercise for subacromial shoulder pain

Seven systematic reviews relating to the effectiveness of exercise for SSP were retrieved (Table 3). According to the AMSTAR quality appraisal, the reviews were of variable quality (range 5 to 8/11). Abdulla et al.[1] suggested with high level evidence that supervised progressive shoulder exercises alone or combined with home-based shoulder exercises were effective in the short term for the management of SSP of variable duration (exercise program of 8 weeks). Also Dong et al.[11] (moderate level of evidence) reported exercise therapy as an ideal treatment in the early stage of SSP. For persistent SSP, supervised and home-based progressive strengthening exercises led to similar outcomes as shoulder decompression surgery in the long term. In addition, supervised strengthening and stretching exercises provided similar short-term benefits to a single corticosteroid injection or a multimodal program for the management of low-grade nonspecific shoulder pain of varied duration[1, 5]. Bury et al.[5] (moderate level of evidence) and Saito et al.[29] (high level of evidence) suggested that a scapula focused approach could offer benefits over generalised approaches in short term follow-up (4-6 weeks), both pain and shoulder function were significantly improved. For construction workers with SSP, only low to moderate level evidence was found that exercise was effective in pain reduction, improvement for return-to-work when compared with a control intervention or placebo[9]. Exercise therapy was effective for improving pain scores, active range of motion and for overall shoulder function in short-term (6-12 weeks) and in long-term follow-up (> 3 months)[15, 35]. Multiple forms of

exercise were reported to be of benefit: scapular stability exercises, strengthening of the rotator cuff and shoulder flexibility exercises[15, 29, 35]. A strong recommendation can be made in favour of exercise therapy for SSP patients.

Table 3 Systematic reviews relating to the effectiveness of exercise therapy for subacromial shoulder pain

STUDY	SAMPLE SIZE	PATIENTS INCLUDED	OUTCOME	RISK OF BIAS*	LEVEL OF EVIDENCE*
Abdulla SY et al.[1] (2015)	N = 11	N = 466	Evidence suggests that supervised and home-based progressive shoulder strengthening and stretching exercises for the RC and scapular muscles are effective options for the management of SSP in both short term and long term. (No effect sizes reported)	Low (Scottish Intercollegiate Guidelines Network criteria)	High
Bury J et al.[5] (2016)	N = 7	N = 190	Evidence that a scapula focused approach (exercise therapy and stretching) benefits patients with SSP over generalized approaches up to six weeks post commencement of treatment. (Effect size on short term pain: 0.714 [0.402 to 1.026]) (Effect size on short term function: 14.008 [11.159, 16.857])	Unclear (PEDro quality appraisal)	Moderate
Desmeules F et al.[9] (2015)	N = 10	N = 788	Low to moderate-grade evidence that therapeutic exercises provided in a clinical setting are an effective modality to treat workers suffering from RC tendinopathy and to promote return-to-work. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Moderate
Dong W et al.[11] (2015)	N = 33	N = 2300	Evidence that exercise and other exercise-based therapies are ideal treatments for patients at an early stage of SSP. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Moderate
Haik NM et al.[15] (2016)	N = 64	N = 6319	High evidence that exercise therapy should be the first-line treatment to improve pain, function and range of motion. (No effect sizes reported)	Low (PEDro quality appraisal)	High
Saito H et al.[29] (2017)	N = 6	N = 250	High evidence that scapular focused interventions can improve shoulder pain and function in the short term (4 weeks post commencement of treatment). (Effect size on pain: −0.88 [−1.19 to −0.58]) (Effect size on shoulder function: −11.31 [−17.20 to −5.41])	Low (Cochrane risk of bias tool)	High
Steuri R et al.[35] (2017)	N = 200	N = 10529	Evidence that, for pain and shoulder function, exercise was superior to non-exercise control interventions. Specific exercises were superior to generic exercises. (Effect size on pain: −0.94 [−1.69 to −0.19]) (Effect size on shoulder function: 0.57 [−0.85 to −0.29])	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)

* reported in the original review

Exercise combined with manual therapy for subacromial shoulder pain

Six systematic reviews evaluated the effect of manual therapy combined with exercises (Table 4). According to the AMSTAR quality appraisal, the systematic reviews were of variable quality (range 5 to 9/11). Four reviews[8, 15, 26, 35] reported moderate and high level of evidence that in addition to exercises, manual therapy offered a short-term decrease in pain. Desmeules et al.[9] (low level of evidence) reported no significant improvement in outcome when exercise was combined with manual therapy when compared to exercise alone. Dong et al.[11] concluded with low level of evidence that exercise resulted in a better effect on pain reduction when combined with manual therapy, but this review scored the lowest quality for the studies concerning manual therapy combined with exercise. Based on the results, a strong recommendation may be made in favor of exercises combined with manual therapy.

Multimodal physiotherapy for subacromial shoulder pain

Three included reviews reported the effect of multimodal physiotherapy (Table 5). According to the AMSTAR quality appraisal, the systematic reviews were of variable quality (5 and 8/11). Multimodal therapy was defined as combined non-surgical treatment including; passive physical modalities, exercise, manual therapy, taping, corticosteroids or electrotherapy. One study[11] concluded with low level evidence that exercise combined with other therapies (kinesio taping, specific exercises and acupuncture) was a beneficial treatment effect. For taping as adjunct therapy, the effectiveness was weak for improvement of pain, disability, range of motion and strength[30] (low level of evidence). Pulsed electromagnetic field therapy, localized corticosteroid injection and ultrasound therapy were supposed as potential additional second-line treatments. In contrast, Goldgrub et al.[14] reported low level of evidence supporting the effectiveness of multimodal care over

isolated interventions in the management of SSP. The findings of the current review suggest that the clinical significance of multimodal physiotherapy remains unclear, possibly due to the variety of different treatment modalities, so currently only a weak recommendation for including multimodal therapy in the management of SSP can be made.

Corticosteroid injection for subacromial shoulder pain

Four systematic reviews relating to the effectiveness of corticosteroid injection for SSP were retrieved (Table 6). The systematic reviews were of variable quality (range 5 to 8/11). Steuri et al.[35] (moderate level of evidence) reported the short term benefit (i.e. immediately after the intervention) of corticosteroid injection as being superior to the negative control (i.e. no therapy) and also superior to physical therapy modalities. Ultrasound guided corticosteroid injections provided better outcome results than blind injections for both pain and overall shoulder function. Dong et al.[11] (low level of evidence) recommended corticosteroid injection as a second-level treatment, in addition to exercise-based therapies. In another review, moderate level of evidence was found regarding the usefulness of corticosteroid injections compared to placebo in the short- or the long term[38]. Goldgrub et al.[14] stated with low level of evidence that corticosteroid injection and exercise both led to similar outcomes as multimodal physiotherapy for the treatment of non-specific shoulder pain. Overall, a moderate recommendation can be made regarding the clinical significance of corticosteroid injection as solitary treatment or in addition to exercise-based therapy.

Table 4 Systematic reviews relating to the effectiveness of exercise combined with manual therapy for subacromial shoulder pain

STUDY	*SAMPLE SIZE*	*PATIENTS INCLUDED*	*OUTCOME*	*RISK OF BIAS**	*LEVEL OF EVIDENCE**
Desjardin-Charbonneau A et al.[8] (2015)	N = 21	N = 554	Moderate evidence that manual therapy intervention added to an exercise program significantly reduces pain in individuals with SSP. Unclear if manual therapy can improve function. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Moderate
Desmeules F et al.[9] (2015)	N = 10	N = 788	No significant difference between exercise therapy or exercise combined with manual therapy. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Dong W et al.[11] (2015)	N = 33	N = 2300	Low level of evidence that exercise results in a better effect on pain reduction when combined with manual therapy. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Haik NM et al.[15] (2016)	N = 64	N = 6319	High evidence regarding the effectiveness of exercises associated with mobilizations to optimize improvements in pain and function in the short term. (No effect sizes reported)	Low (PEDro quality appraisal)	High
Page MJ et al.[26] (2016)	N = 60	N = 3620	High evidence that no clinically important differences are measured between manual therapy combined with exercise and placebo with respect to overall pain, function, pain on motion, global treatment success, quality of life and strength in the short term. (No effect sizes reported)	High (Cochrane risk of bias tool)	High (GRADE approach)
Steuri R et al.[35] (2017)	N = 200	N = 10529	Evidence that manual therapy plus exercise is superior to placebo or exercise alone, for pain and shoulder function, but only at short term follow-up (= immediately after the intervention). (Effect size on shoulder function compared to placebo: -0.35 [−0.69 to −0.01]) (Effect size on shoulder function compared to exercise alone: -0.32 [−0.62 to −0.01])	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)

* reported in the original review

Table 5 Systematic reviews relating to the effectiveness of multimodal physiotherapy for subacromial shoulder pain

STUDY	*SAMPLE SIZE*	*PATIENTS INCLUDED*	*OUTCOME*	*RISK OF BIAS**	*LEVEL OF EVIDENCE**
Dong W et al.[11] (2015)	N = 33	N = 2300	Evidence suggests that most combined treatments based on exercise demonstrated better effects than exercise alone. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Goldgrub R et al.[14] (2016)	N = 19	N = 1217	Little evidence to support that multimodal care provides superior effectiveness compared with individual interventions for the management of SSP or nonspecific shoulder pain. For SSP, multimodal care may be associated with small and non-clinically important improvement in pain and function compared with corticosteroid injections. (No effect sizes reported)	Low (Scottish Intercollegiate Guidelines Network criteria)	Low
Saracoglu I et al.[30] (2017)	N = 4	N = 135	Low evidence that clinical taping in addition to other physiotherapy interventions (exercise, manual therapy, electrotherapy) provides superior effectiveness for the initial stage of the treatment. (No effect sizes reported)	High (PEDro quality appraisal)	Low

* reported in the original review

Table 6 Systematic reviews relating to the effectiveness of corticosteroid injection for subacromial shoulder pain

STUDY	*SAMPLE SIZE*	*PATIENTS INCLUDED*	*OUTCOME*	*RISK OF BIAS**	*LEVEL OF EVIDENCE**
Dong W et al.[11] (2015)	N = 33	N = 2300	Localized corticosteroid injection may be considered as second-line treatment. Exercise and exercise-based therapies are the first line choices. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Goldgrub R et al.[14] (2016)	N = 19	N = 1217	Evidence that corticosteroid injection leads to a similar outcome as multimodal physiotherapy in case of non-specific shoulder pain. (No effect sizes reported)	Low (Scottish Intercollegiate Guidelines Network criteria)	Low
Steuri R et al.[35] (2017)	N = 200	N = 10529	Evidence that corticosteroid injection is superior to active physical therapy modalities for improvement on pain and overall shoulder function, but only at short follow-up. (Effect size on pain: −0.25 [−0.46 to −0.05]) (Effect size on shoulder function: −0.43 [−0.71 to −0.15])	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)
Van der Sande R et al.[38] (2013)	N = 8	N = 852	Conflicting evidence was found in favor of the effectiveness of corticosteroid injection versus placebo in the short-term and long-term treatment of SSP. (No effect sizes reported)	Low (Furlan's 12 criteria)	Moderate

Laser for subacromial shoulder pain

Six systematic reviews discussed the effect of laser therapy for SSP (Table 7). According to the AMSTAR quality appraisal, these systematic reviews were of variable quality (range 5 to 9/11). Dong et al.[11] (low level of evidence) and Haik et al.[15] (high level of evidence) did not provide any evidence of the benefit of low laser therapy in the treatment of SSP. Haslerud et al.[16] concluded with moderate level of evidence that laser could reduce pain and improve function when used as adjunct therapy to exercise or in a physiotherapy treatment program, but no evidence was found when laser was applied as a monotherapy. Other reviews[35, 40] (moderate level of evidence) reported laser in combination with other therapies superior to placebo, but no benefits of laser as monotherapy were supplied. Only Page et al.[27] suggested low quality evidence for the effect of laser on pain, shoulder function, active mobility and strength. Overall, a strong recommendation can be made to not use laser therapy in the treatment of SSP, since there was no evidence supporting the effectiveness of laser therapy as monotherapy compared to other interventions.

Ultrasound for subacromial shoulder pain

Five systematic reviews evaluating the effectiveness of ultrasound for SSP were reviewed (Table 8). The systematic reviews were of variable quality (range 5 to 9). Although there is only a weak recommendation, the reviews consistently concluded that there was no evidence for the effectiveness of therapeutic ultrasound[10, 11, 27, 35, 40].

Table 7 Systematic reviews relating to the effectiveness of laser for subacromial shoulder pain

STUDY	*SAMPLE SIZE*	*PATIENTS INCLUDED*	*OUTCOME*	*RISK OF BIAS**	*LEVEL OF EVIDENCE**
Dong W et al.[11] (2015)	N = 33	N = 2300	Low-level laser therapy is not recommended for patients with shoulder pain syndrome. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Haik NM et al.[15] (2016)	N = 64	N = 6319	Low-level laser therapy is ineffective in reducing pain and improving function in individuals with SSP. (No effect sizes reported)	Low (PEDro quality appraisal)	High
Haslerud S et al.[16] (2014)	N = 17	N = 801	Evidence that for reducing pain low-level laser therapy is significantly better than placebo or no therapy. Laser reduces pain and accelerates improvement when used as add-on therapy to exercise or in a physiotherapy treatment regimen. No strong evidence is found for laser therapy alone regarding shoulder function. (Effect size on pain compared to placebo: 23.54 [15.72 to 31.36]) (Effect size on pain as adjunct therapy: 10.00 [−19.74 to 39.74])	Unclear (PEDro quality appraisal)	Moderate
Page MJ et al.[27] (2016)	N = 47	N = 2388	Little evidence with respect to pain, function, active mobility and strength. Low quality evidence for benefits of laser combined with physical therapy interventions. (No effect sizes reported)	High (Cochrane risk of bias tool)	Low (GRADE approach)
Steuri R et al.[35] (2017)	N = 200	N = 10529	Evidence that laser is superior to placebo. Evidence that laser in combination with exercise is superior to placebo in combination with exercise. (Effect size on pain compared to placebo: -0.88 [−1.48 to -0.27]) (Effect size on pain in combination with exercise: -0.65 [−0.99 to -0.31])	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)
Yu H et al.[40] (2014)	N = 22	N = 1195	Low-level laser is more effective than placebo or ultrasound in providing short-term pain reduction for patients with SSP. The effect is of variable duration. (No effect sizes reported)	Low (Scottish Intercollegiate Guidelines Network criteria)	Moderate

* reported in the original review

Table 8 Systematic reviews relating to the effectiveness of ultrasound for subacromial shoulder pain

STUDY	*SAMPLE SIZE*	*PATIENTS INCLUDED*	*OUTCOME*	*RISK OF BIAS**	*LEVEL OF EVIDENCE**
Desmeules F et al.[10] (2016)	N = 11	N = 792	Low level evidence that ultrasound is not superior to a placebo and does not have an additional benefit when used in conjunction with exercise, in terms of pain reduction and self-reported function. (Effect size: -0.26 [−3.84 to 3.32])	Unclear (Cochrane risk of bias tool)	Low
Dong W et al.[11] (2015)	N = 33	N = 2300	Ultrasound can be considered as second-line treatment. Exercise and exercise-based therapies are the first line choices. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Page MJ et al.[27] (2016)	N = 47	N = 2388	Low level evidence that ultrasound is not more effective than placebo with respect to pain, global treatment success or shoulder function. (No effect sizes reported)	High (Cochrane risk of bias tool)	Low (GRADE approach)
Steuri R et al.[35] (2017)	N = 200	N = 10529	Non-significant results of ultrasound on pain, overall shoulder function or active range of motion. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)
Yu H et al.[40] (2014)	N = 22	N = 1195	Ultrasound is not more effective than a placebo for the treatment of non-specific shoulder treatment. (No effect sizes reported)	Low (Scottish Intercollegiate Guidelines Network criteria)	Moderate

Extracorporeal shock wave therapy for subacromial shoulder pain

Three systematic reviews relating to the effectiveness of extracorporeal shock wave therapy for SSP were reviewed (Table 9). According to the quality appraisal based upon AMSTAR, these systematic reviews were of variable quality (range 5 to 8/11). Although there is only a moderate recommendation, all three reviews consistently concluded that the evidence did not support the effectiveness of extracorporeal shock wave therapy[11, 35, 40].

Pulsed electromagnetic energy for subacromial shoulder pain

Four systematic reviews evaluated the effectiveness of pulsed electromagnetic energy for SSP were included (Table 10). The systematic reviews were of variable quality (range 5 to 9/11). None of the reviews found a greater effect of pulsed electromagnetic energy on pain reduction or improvement of shoulder function than a placebo treatment. With strong recommendation, conclusion can be made that there is no evidence supporting the effectiveness of pulsed electromagnetic energy for SSP[11, 15, 27, 35].

Table 9 Systematic reviews relating to the effectiveness of extracorporeal shock wave therapy for subacromial shoulder pain

STUDY	SAMPLE SIZE	PATIENTS INCLUDED	OUTCOME	RISK OF BIAS*	LEVEL OF EVIDENCE*
Dong W et al.[9] (2015)	N = 33	N = 2300	Low level evidence that extracorporeal shock wave therapy does not have an additional benefit when used in conjunction with exercise, in terms of pain reduction and self-reported function. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Steuri R et al.[26] (2017)	N = 200	N = 10529	Non-significant results of extracorporeal shock wave therapy on pain, overall shoulder function or active range of motion. (Effect size on pain compared to a placebo: -0.39 [−0.78 to -0.01])	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)
Yu H et al.[38] (2014)	N = 22	N = 1195	Extracorporeal shock wave therapy is not more effective than placebo for the management of SSP. (No effect sizes reported)	Low (Scottish Intercollegiate Guidelines Network criteria)	Moderate

* reported in the original review

Table 10 Systematic reviews relating to the effectiveness of pulsed electromagnetic energy for subacromial shoulder pain

STUDY	SAMPLE SIZE	PATIENTS INCLUDED	OUTCOME	RISK OF BIAS*	LEVEL OF EVIDENCE*
Dong W et al.[9] (2015)	N = 33	N = 2300	Pulsed electromagnetic energy can be considered as second-line treatment. Exercise and exercise-based therapies are the first line choices. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Low
Haik NM et al.[15] (2016)	N = 64	N = 6319	Pulsed electromagnetic energy is not effective to reduce pain and improve function in individuals with SSP. (No effect sizes reported)	Low (PEDro quality appraisal)	High
Page MJ et al.[27] (2016)	N = 47	N = 2388	Pulsed electromagnetic energy has no clinically important benefits compared to placebo. (No effect sizes reported)	High (Cochrane risk of bias tool)	Low (GRADE approach)
Steuri R et al.[26] (2017)	N = 200	N = 10529	Non-significant results of pulsed electromagnetic energy on pain, overall shoulder function or active range of motion. (No effect sizes reported)	Low (Cochrane risk of bias tool)	Moderate (GRADE approach)

DISCUSSION

The aim of this review was to perform an updated review of systematic reviews to investigate the effectiveness of conservative physiotherapy treatment for SSP. Littlewood et al.[22] suggested that exercise and multimodal physiotherapy were promising interventions for SSP but the extent of their effectiveness remains unclear. The conclusions of the current update were able to support and strengthen the recommendation regarding exercise therapy. Evidence for exercise as intervention for SSP is increasing and strengthening, although the optimal type, dose and load still remains unclear.

As a large group of the included reviews (7 out of 16) included exercise therapy as treatment for SSP, and all of them with high or moderate evidence, a strong recommendation may be made for including exercise for those diagnosed with SSP. But as many randomised controlled trials and systematic reviews do not describe the exercise program in detail, it remains uncertain as to what constitutes the most appropriate exercise regime. For example, whether or not treatment for patients with SSP should be designed around loading that can temporarily reproduce and aggravate patients' pain and symptoms is still a matter of debate[34]. Based on surveys concerning the instructions physiotherapists give during the rehabilitation of a musculoskeletal shoulder problem, it is known that the following foundations are the most common used[4, 36]: exercises may be performed both at home and / or at a clinic, patients are permitted to perceive some discomfort (<5/10 on a visual analogue scale), the exercises should be with resistance, and an expected therapy duration of 12 weeks is proposed.

A strong recommendation may be made as well regarding the effectiveness of manual therapy when combined with exercise. In 2012, Littlewood et al.[22] reported no clear

evidence regarding any benefits of manual therapy. Manual therapy was mainly described as: joint mobilizations, specific soft tissue techniques, manipulations, neurodynamic mobilizations, and mobilizations with movement of the shoulder girdle or spine[9], but other reviews defined manual therapy as 'movement of the joints and other structures by a healthcare professional'[8]. The absence of a well described definition and the variety of included interventions makes it difficult to draw a conclusion which “type” of manual therapy favours patients with SSP. As the evidence for exercise as an intervention for SSP is strengthening, and the findings of this review suggest manual therapy in addition to exercise may, in the short-term, further reduce pain and improve function, that following a shared decision-making discussion, this additional intervention may support patient management. There is a clear need for research to investigate different types of both exercise and manual therapy in the management of this condition to provide clear instructions and recommendations.

With respect to the effectiveness of multimodal therapy, no clear conclusions may be provided, and only a weak recommendation can be made. Multimodal physiotherapy appeared to confer superior outcomes over placebo or no treatment, although the clinical significance of any positive effect remained unclear. The heterogeneity of the different components defining multimodal therapy could explain the variety of conclusions. Multimodal therapy can include many different interventions, which makes it difficult to draw a conclusion on the effectiveness.

Regarding the effectiveness of corticosteroid injection, a moderate recommendation can be made regarding the clinical significance of corticosteroid injection as isolated treatment or in

addition to exercise-based therapy. More research is needed to draw definite conclusions on the effectiveness of corticosteroids for the management of SSP.

Other commonly prescribed interventions, including therapeutic ultrasound, low level laser, extracorporeal shock wave therapy and pulsed electromagnetic energy, lack evidence of effectiveness and should not be advised as part of the management of SSP.

The methodological quality of the studies included in the current review were judged to be of medium quality using the AMSTAR quality appraisal scoring system. Littlewood et al.[22] reported scores ranging from 3 to 9/11, with a mean value of 5.96/11. The range of scores in the current review between 5 and 9/11, with a mean value of 7.44/11.

Future reviews and research should focus on the modalities of exercise therapy (e.g. types, repetitions). Also, there is a clear lack of high quality RCTs and reviews testing the potential added value of manual therapy including if, when and how it should be applied. As multimodal physiotherapy is covering a wide range of different treatment modalities, a clear and well-considered selection should be made which kind of treatment modalities should be used in addition to exercise therapy.

As this review is a review of systematic reviews, only data (e.g. comparison groups, follow-up assessments) provided in the original reviews could be used. There were no specific requirements or inclusion / exclusion criteria considering comparators. As in every review, different comparison groups are used, and as this review is using 16 different reviews, the variability of the comparison groups is too wide and disordered to present a clear overview.

Potential limitations of this review

A possible limitation of writing a review of systematic reviews is the risk of multiple counting of primary studies that are included in multiple systematic reviews. Hence, those interventions that have been studied the most are over-represented in reviews of this nature. Another limitation can be that, despite this review is focusing on non-surgical interventions, certain interventions may have been missed using this search strategy.

Due to the fact that different terms are used to describe the problem SSP[31], it might be that reviews missed certain RCT studies, using other terms to describe this shoulder problem.

- Exercise and multimodal physiotherapy might be effective in the management of rotator cuff tendinopathy
- Exercise therapy should be prioritised as the primary treatment option, due to its clinical effectiveness, cost effectives, and other associated health benefits

Box 1 What is known about this subject

- The evidence for the use of exercise therapy in the management of SSP is consistent, and should be considered as a principal intervention in the management of those with SSP
- Manual therapy may provide further benefit if used in addition to exercise therapy
- Conflicting evidence surrounds the effectiveness of multimodal therapy and corticosteroid injection
- Ultrasound, low level laser and extracorporeal shock wave therapy lack evidence of effectiveness

Box 2 What this study adds to existing knowledge

CONCLUSION

Evidence for exercise as most important management for SSP is increasing and strengthening. On-going research is necessary to identify if there is an optimal dose and type of exercise. Currently it is not possible to state that one exercise program is more appropriate than another. As an addition to exercise therapy, a strong recommendation may be made to include manual therapy as additional intervention. Conflicting evidence surrounds the effectiveness of multimodal therapy and corticosteroid injection. Other commonly prescribed non-surgical interventions, such as ultrasound, low level laser and extracorporeal shock wave therapy lack evidence of effectiveness.

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