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DIAGNOSTIC METHODS: Systematic Review

The management of shoulder impingement and related disorders: A systematic review on diagnostic accuracy of physical tests and manual therapy efficacy

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ABSTRACT

Background: Diagnostic accuracy of physical tests and effectiveness of musculoskeletal rehabilitation of shoulder disorders are still debated.
Objectives: To investigate diagnostic accuracy of physical tests, efficacy of physiotherapy and coherence between target of assessment and intervention for shoulder impingement and related disorders like bursitis, rotator cuff and long head biceps tendinopathy and labral lesions.
Methods: A systematic search of four databases was conducted, including RCTs and cross-sectional studies. Cochrane Risk of Bias and QUADAS-2 were adopted for critical appraisal and a narrative synthesis was undertaken.
Results: 6 RCTs and 2 cross-sectional studies were appraised. Studies presented low to moderate risk of bias. There is a lack of evidence to support the mechanical construct guiding the choice of physical tests for diagnosis of impingement. Manual techniques appear to yield better results than placebo and ultrasounds, but not better than exercise therapy alone. Discrepancy between the goal of assessment strategies and the relative proposed treatments were present together with high heterogeneity in terms of selection of patients, type of endpoints and follow-ups.
Conclusions: Musculoskeletal physiotherapy seems to be an effective treatment for patients with shoulder pain although it is still based on weak diagnostic clinical instruments. The adoption of more functional and prognostic assessment strategies is advisable to improve coherence between evaluation and treatment.

1. Background

Shoulder pain is a very common and disabling health condition affecting the general population (Bachasson et al., 2015). The incidence of visits because of shoulder pain in the UK is 9.5 per 1000 healthcare patients (Ostor et al., 2005; Blume et al., 2015; Dilek et al., 2016).

Shoulder problems are a significant societal and economic burden; it has been reported that the prevalence of shoulder pain is between 2.4% and 4.8% in the general population (Greving et al., 2012) and rotator cuff disease is one of the conditions with the highest risks of chronicity (Burbank et al., 2008).

The shoulder impingement syndrome (SIS) is defined as the compression of the rotator cuff and the subacromial bursa caused by structures of the glenohumeral complex (Buss et al., 2009). In literature SIS is reported to be a contributing factor between 48% and 65% of all painful shoulder conditions (Michener et al., 2004; Burbank et al., 2008).

Different kinds of SIS are defined in literature depending on the structures involved: *subacromial impingement syndrome* (SAI) (Neer, 1972), *internal impingement* (IIM) (Behrens et al., 2010) and *Subcoracoid impingement* (SC) (Mulyadi et al., 2009).

Aetiology of SIS is not completely clear; however, there are some structures that could contribute to its onset, such as the shape of the acromion, the coracoacromial ligament, the superior aspect of the glenoid fossa, hypermobility and instability of the glenohumeral joint, capsular retractions and rotator cuff tendinopathy (Lewis et al., 2005).

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Magnetic Resonance Imaging (MRI) and ultrasound (US) have a good diagnostic accuracy in full thickness tear in patients with shoulder pain while accuracy decreases significantly as the extent of the lesion decreases (Lenza et al., 2013; Roy et al., 2015).

Indeed, due to the weak correlation between anatomical lesion and perceived pain, in their guidelines for the diagnosis and treatment of SIS, Diercks et al. (2014) advise against the use of diagnostic imaging before 6 weeks after the onset of symptoms.

Physical examination of patients with shoulder pain has traditionally been a cornerstone of the diagnostic process. Diagnostic manual physical tests can be used at any stage of the patient's care; they are fast performing, non-invasive and are still frequently used in randomized trials on shoulder pain (Schellingerhout et al., 2008). Their capacity to replicate pain or functional deficits give them an implicit relevance to patients' symptoms whereas, by contrast, lesions detected by imaging or in open surgery may actually be asymptomatic (MacDonald et al., 2000). Physical tests have historically been an integral part of the evaluation process, despite the fact that their diagnostic accuracy for shoulder problems is poor (Reid et al., 1995; Deeks, 2001).

Conservative treatment for these disorders is generally based on resting, non-steroidal anti-inflammatory drugs and rehabilitation interventions such as musculoskeletal physiotherapy which includes exercises and manual techniques (Tyler et al., 2010; Diercks et al., 2014). Exercise seems to be a key component in clinical rehabilitation programs (Desmeules et al., 2003; Kromer et al., 2011; Hanratty et al., 2012) even if it is not really clear what type of exercise is needed and its duration (Michener et al., 2004). Moreover, it seems that the treatments and outcome measures adopted in the different studies often do not follow the pathoanatomical results of physical tests (Wright and Baumgarten, 2010).

In our systematic review, we aim to investigate:

- the diagnostic accuracy of physical tests commonly used to diagnose shoulder impingement and related disorders, such as tendinopathies of rotator cuff (RC) and long head biceps tendon (LHBT), Superior Labrum Anterior to Posterior lesions (SLAP) and bursitis.
- the effectiveness of physiotherapy intervention in these disorders
- the consequentiality between target of the assessment and target of the following intervention.

We perform a combined design study in order to enable clinicians to better understand the way of assessment and treatment of shoulder impingement and related disorders (Simopoulos et al., 2015).

2. Methods

This systematic review was performed following the methodological guidance contained in PRISMA Checklist. The Protocol of the review was published in PROSPERO (International Prospective Register of Systematic Reviews) under registration number CRD42016037655.

The PICO strategy was used to formulate the review questions (see appendix 1).

2.1. Scoping search

Firstly, we conducted two scoping searches on Synthesis Database (The Cochrane Library, The Joanna Brigge Institute), Summary Database (Evidence update) and other sources of grey literature (for example Google Scholar and Google search).

We identified recent systematic reviews of good methodological quality and we defined a cut-off as per AMSTAR scale (AMSTAR, 2016) (minimum 8/11), because of a lack of references on cut-off scores in literature. Search strategies regarding both diagnosis and treatment were developed for each database and the year of the last systematic review on the topic identified with the scoping search was set as the starting date (see Table 1).

The review of Hancard et al. (Hanchard et al., 2013) regarding diagnostic question, and Abdulla et al. (2015) and Desjardins-Charbonneau et al. (2015) on the treatment, reflected the inclusion and exclusion criteria identified, except for the absence of SLAP < Grade II between the two treatment revisions. Therefore, treatment of SLAP lesion was investigated without time limits with a dedicated search strategy (see Table 2).

2.2. Eligibility criteria

Studies were eligible for inclusion if they considered an adult population (males and females) with SIS (SAI, IIM or secondary to rotator cuff disease) and local disorders that may accompany impingement like bursitis, RC tendinopathy, labral lesion (Grade I of SLAP lesions) and LHB tendinopathy. We excluded studies on acromion-clavicular pain, shoulder instability, fractures, full-thickness tears of RC, LHB tendinopathy and SLAP > grade 2. We excluded also studies that are limited to a specific population (e.g. Overhead athletes), because they would negatively affect the generalizability of the results and they are not representative of general population.

The specific inclusion criteria for diagnostic review were: cross-sectional studies about diagnostic accuracy of physical tests for SAI, IIM, RC, LHBT and labral lesions. We excluded studies with a physical test under anaesthesia or intra operative setting.

In terms of treatment review, specific inclusion criteria were: Randomized Controlled Trials (RCTs) or quasi-RCT studies focusing on musculoskeletal physiotherapy, which include manual techniques and therapeutic exercise (About IFOMPT). Primary outcomes

Table 1
Scoping search results.

	References included	AMSTAR (Points)	Notes
Diagnostic Search	Hanchard NCA, Lenza M, Handoll HHG et al. Physical tests for shoulder impingements and local lesions of bursa, tendon or labrum that may accompany impingement (Review). *Cochr datab system review 2013*. 1–268.	9/11	Search until 15th of February 2010. Inclusion and exclusion criteria are the same of ours.
Treatment Search	Abdulla SY et al. Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. Man Ther 2015.20 (5):646-656	9/11	Two reviews were selected because one investigates only therapeutic exercise and the other only manual therapy. In the inclusion criteria is not specified SLAP lesion that was object of a dedicated search strategy.
	Charbonneau AD et al. The Efficacy of Manual Therapy for Rotator Cuff Tendinopathy: A Systematic Review and Meta-analysis. *J Orthop Sports Phys Ther* 2015.45 (5):330–350.	8/11	

Table 2
Search strategy for SLAP lesion.

Database	Strategies	Notes
MEDLINE (interfaccia PubMed)	(((((labrum) OR labral) OR slap)) AND ((((("manual therapy") OR exercise) OR "Exercise Therapy"[Mesh]) OR manipulation) OR mobilization)) AND ((("Shoulder Joint"[Mesh]) OR "Shoulder"[Mesh]) OR shoulder)	Search Filters: Language: English and Italian
PEDro	Title and abstract: slap Title and abstract: labral	The results of the two search strategies are combined
Cochrane Database	slap OR labral	
Scopus	((slap OR labral) AND (exercise OR "manual therapy") AND shoulder)	Search Filters: Language: English and Italian Document Type: article

that were considered included pain, active and passive Range of Motion (ROM), function/disability, quality of life, return to work activity and as secondary outcome muscle strength, muscle length, patient (and clinician) satisfaction and perceived quality of treatment, adverse events. We excluded from our treatment review studies focused on the efficacy of modalities or in which musculoskeletal physiotherapy is associated with surgical or pharmacological treatments.

2.3. Search strategy

An electronic bibliographical search was conducted in MEDLINE and Scopus for the part of the review regarding diagnostic value of physical tests, while the part regarding treatment efficacy was conducted in MEDLINE, Scopus, PEDro and The Cochrane Library. A combination of Medical Subject Heading terms and text words was used to identify relevant articles. In addition, a manual search was performed on the reference lists of included articles and previously published reviews (see appendix 1).

Two reviewers independently looked at titles, abstracts and full texts to identify articles of interest. A consensus between the two reviewers was necessary for the studies to be included. A third reviewer was available for a final decision if consensus was not achieved.

2.4. Quality assessment

The internal validity of the studies included was assessed by QUADAS-2 (Whiting et al., 2011) tool for cross-sectional studies and Cochrane Risk Of Bias (Cochrane, 2016) for RCTs, using RevMan software.

3. Results

3.1. Diagnostic studies

The literature search retrieved 473 records. After the removal of duplicates (5 studies), we screened the title and abstract of 468 references and selected 3 papers for full text analysis. Finally, only 2 cross-sectional studies featured the inclusion criteria in diagnostic review (see Table 3).

3.2. Treatment studies

The literature search retrieved 841 records. After removing duplicates (82 studies), we screened the title and abstract of 759 references and selected 10 papers for the full-text analysis. Finally, we selected 6 RCT studies that presented the inclusion criteria in treatment review (see Table 4).

The study selection process is summarized in PRISMA Flowchart (see Figs. 1 and 2).

3.3. Data extraction

Data, characteristics and results were extracted from the studies (see Tables 3 and 4). The quality and risk of bias were assessed by the Cochrane Collaboration tool for assessing risk of bias and QUADAS-2. The assessment of methodological quality of diagnostic studies is summarized in Figs. 3 and 4 while Figs. 5 and 6 feature the assessment of methodological quality for treatment studies.

3.4. Quality assessment

3.4.1. Diagnostic studies

In Lasbleiz et al. (2014) there is a possible risk of bias in patient selection because it included only patients who were over 40 years old and with previous diagnosis of degenerative tendinopathy. They used US for the diagnosis, representing a possible risk of bias for the reference standard. There is also an unclear risk for flow and timing because the reference standard (US) was given before the index test, even if the blindness of the assessors was guaranteed.

In Gillooly et al. (2010) there is high risk of bias in patient selection and unclear concern of applicability because inclusion and exclusion criteria were not made explicit. Furthermore, a comparison between a new test (lateral Jobe test) and 3 tests that the author claimed to be reliable in patients over 60 years old (in the study are selected patients between 17 and 83 years, with an average age of 53,3) was made. In addition, an unclear risk to the item of the Index test was stated because it is not known which test for impingement was carried out and in what sequence the index tests were administered.

3.4.2. Treatment studies

Three studies (Al Dajah, 2014; Moezy et al., 2014; Granviken and Vasseljen, 2015) do not specify well the allocation process, thus presenting selection bias; moreover, four of the studies included (Al Dajah, 2014; Camargo et al., 2015; Granviken and Vasseljen, 2015; Littlewood et al., 2016) show a high risk of performance and detection bias because they did not provide the blindness of patients, clinicians and assessors. The remaining studies report a low risk of these biases, since the blindness of the patients guaranteed the blindness of the evaluators and outcome measures were self-administered.

Moezy et al. (2014) did not perform an intention-to-treat analysis (ITT) for the drop-out.

In Al Dajah (2014) there is high risk of attrition bias because they did not specify the number of patients the analysis was carried out on; the study also provided treatment and evaluation in one session, which is not representative of the type of patient disorder.

In Camargo et al. (2015) there is high risk of reporting bias because they did not pre-specify all the outcome measures used in the study protocol.

In two of the studies (Al Dajah, 2014; Littlewood et al., 2016), there is an unclear risk of reporting bias.

Table 3
Characteristics of diagnostic included studies.

Author/year	Partecipants (n)	Target Condition(s) and index test(s)	Reference Standard	Sensibility/ Specificity % (CI 95%)	LR+/LR-(CI 95%)	PPV/NPV % (CI 95%)	Notes
Gillooly et al. (2010)	n = 175 97 males 78 females Age (mean): 53 years *Exclusions criteria:* Fractures or previous shoulder surgery	***Target condition:*** Rotator cuff disorders (tears) ***Index test:*** Lateral Jobe Test compare to a test combination (weakness and/or pain to the resisted ER, impingement tests and Jobe sopraspinatus test)	Arthroscopy	**LJ:** SN = 81 (72, 88) SP = 89 (79, 55) ***Combination tests:*** SN = 57 (48, 67) SP = 88 (77, 94)	–	**LJ:** PPV = 91 NPV = 77 ***Combination tests:*** PPV = 87 NPV = 60	8 false positive and 19 false negative No known which tests for impingement was used and how it have been combined
Lasbleiz et al. (2014)	n = 35 (39 shoulders) 8 males 31 females Age (mean): 59 anni *Inclusion criteria*: • Age > 40 • Shoulder pain for at least a month • Diagnosis of degenerative RC pathology *Exclusion criteria:* • Passive ROM limited • Positive X-rays scan for Calcific tendinitis • Previous surgery • Shoulder instability • Fractures • Corticosteroid injection in the previous 30 days • Inflammatory articular pathology • Neoplasm • Neck and neurological disorders	***Target condition:*** Degenerative RC disorders ***Index test:*** **Supraspinatus** • Jobe test • Full can test **Infraspinatus** • Hornblower • Dropping • Gate • Resisted ER • Patte **Subscapularis** • Belly press • Lift-off **Biceps Brachii** • Palm-up • Yergason	US	***Tendinopathy:*** • **Jobe test** *Pain:* SN = 100 (54.1; 100) SP = 12.1 (3.4; 28.2) *Weakness:* SN = 33.3 (4.3; 77.7) SP = 33.3 (17; 51.8) • **Full can** *Pain* SN = 50 (11.8; 88.2) SP = 27.3 (13.3; 45.5) *Weakness:* SN = 33.3 (4.3; 77.7) SP = 45.4 (28.1; 63.6) • **Hornblower** *Weakness:* SN = 0 (0; 52.2) SP = 94.1 (80.3; 99.3) • **Dropping test** *Weakness:* SN = 0 (0; 52.2) SP = 100 (89.7; 100) • **Gate test** *Weakness:* SN = 0 (0; 52.2) SP = 91.2 (76.3; 98.1) • **Resisted ER** *Pain* SN = 80 (28.4; 99.49) SP = 41.2 (24.6; 59.3) *Weakness:* SN = 0 (0; 52.2) SP = 61.8 (43.6; 77.8) • **Patte**	***Tendinopathy:*** • **Jobe test** *Pain:* LR+ = 1.14 (0.61; 1.3) LR- = 0 (0; 3.95) *Weakness:* LR+ = 0.5 (0.14; 1.13) LR- = 2 (0.81; 3.86) • **Full can** *Pain:* LR+ = 0.69 (0.25; 1.22) LR- = 1.83 (0.61; 4.21) *Weakness:* LR+ = 0.61 (0.17; 1.44) LR- = 1.47 (0.62; 2.58) • **Hornblower** *Weakness:* LR+ = 0 (0; 10.31) LR- = 1.06 (0.52; 1.16) • **Dropping test** *Weakness:* LR+= (0, infinity) LR- = 1 (0, infinity) • **Gate test** *Weakness:* LR+ = 0 (0; 6.48) LR- = 1.1 (0.54; 1.22) • **Resisted ER** *Pain* LR+ = 1.36 (0.61; 2.06) LR- = 0.49 (0.08; 1.73) *Weakness:* LR+ = 0 (0; 1.23) LR- = 1.62 (0.77; 2.09) • **Patte**	***Tendinopathy:*** • **Jobe test** *Pain* PPV = 17.1 (6.6; 33.6) NPV = 100 (39.8; 100) *Weakness:* PPV = 8.3 (1; 27) NPV = 73.3 (44.9; 92.2) • **Full can** *Pain:* PPV = 11.1 (2.3; 29.2) NPV = 75 (42.8; 94.5) *Weakness:* PPV = 10 (1.2; 31.7) NPV = 78.9 (54.4; 93.9) • **Hornblower** *Weakness:* PPV = 0 (0; 84.2) NPV = 86.5 (71.2; 95.5) • **Dropping test** *Weakness:* PPV= (0; 100) NPV = 87.2 (72.6; 95.7) • **Gate test** *Weakness:* PPV = 0 (0; 70.8) NPV = 86.1 (70.5; 95.3) • **Resisted ER** *Pain* PPV = 16.7 (4.7; 37.4) NPV = 93.3 (68; 99.8) *Weakness:* PPV = 0 (0; 24.7) NPV = 80.7 (60.6; 93.4) • **Patte**	The diagnostic accuracy was evaluated in terms of painful response and loss of strength, where possible. This study evaluates also the diagnostic accuracy in the total cuff injuries (which constitute an exclusion criterion of this review)

(*continued on next page*)

Table 3 (*continued*)

Author/year	Partecipants (n)	Target Condition(s) and index test(s)	Reference Standard	Sensibility/ Specificity % (CI 95%)	LR+/LR-(CI 95%)	PPV/NPV % (CI 95%)	Notes
				Pain SN = 100 (47.8; 100) SP = 21.2 (9; 38.9) *Weakness:* SN = 40 (5.3; 85.3) SP = 66.7 (48.2; 82)	*Pain:* LR+ = 1.27 (0.61; 1.51) LR- = 0 (0; 2.38) *Weakness:* LR+ = 1.2 (0.33; 2.97) LR- = 0.9 (0.34; 1.51)	*Pain* PPV = 16.1 (5.4; 33.7) NPV = 100 (59; 100) *Weakness:* PPV = 15.4 (1.9; 45.4) NPV = 88 (68.8; 97.4)	
				• **Belly press** *Pain:* SN = 50 (6.8; 93.2) SP = 74.3 (56.7; 87.5) *Weakness:* SN = 0 (0; 60.2) SP = 91.4 (76.9; 98.2)	• **Belly press** *Pain:* LR+ = 1.94 (0.53; 4.71) LR- = 0.67 (0.2; 1.23) *Weakness:* LR+ = 0 (0; 7.83) LR- = 1.09 (0.47; 1.19)	• **Belly press** *Pain:* PPV = 18.2 (2.2; 51.8) NPV = 92.9 (76.5; 99.1) *Weakness:* PPV = 0 (0; 70.8) NPV = 88.9 (73.9; 96.9)	
				• **Lift-off** *Weakness:* SN = 0 (0; 60.2) SP = 94.1 (80.3; 99.3) *Lag sign:* SN = 0 (0; 60.2) SP = 82.3 (65.5; 93.2)	• **Lift-off** *Weakness:* LR+ = 0 (0; 12.24) LR- = 1.06 (0.46; 1.14) *Lag sign:* LR+ = 0 (0; 3.37) LR- = 1.21 (0.52; 1.4)	• **Lift-off** *Weakness:* PPV = 0 (0; 84.2) NPV = 88.9 (73.9; 96.9) *Lag sign:* PPV = 0 (0; 45.9) NPV = 87.5 (71; 96.5)	
				• **Palm-up** *Pain:* SN = 83.3 (35.9; 99.6) SP = 36.4 (20.4; 54.9)	• **Palm-up** *Pain:* LR+ = 1.3 (0.7; 1.9) LR- = 0.46 (0.08; 1.79)	• **Palm-up** *Pain:* PPV = 19.2 (6.5; 39.3) NPV = 92.3 (64; 99.8)	
				• **Yergason** *Pain:* SN = 66.7 (22.3; 95.7) SP = 81.8 (64.5; 93)	• **Yergason** *Pain:* LR+ = 3.7 (1.3; 8.7) LR- = 0.41 (0.12; 0.89)	• **Yergason** *Pain:* PPV = 40 (12.2; 73.8) NPV = 93.1 (77.2; 99.1)	

Legend: CI=Confidence Interval; ER = External Rotation; LJ = Lateral jobe test; LR = Likelihood Ratio; MRI = magnetic resonance; NPV = negative predictive value; PPV = positive predictive value; RC = rotator cuff; SN = sensibility; SP = specificity; US= Ultrasound.

3.5. Synopses of the results

3.5.1. Diagnostic studies

Gillooly et al. (2010) enrolled 175 patients with an average age of 53 and who were administered four tests: the Index Test consists of Lateral Jobe test (LJ) and a combination of tests (weakness and/or pain in resisted ER, impingement tests and Jobe sopraspinatus test). The target condition was rotator cuff disorders. Arthroscopy was the reference standard; surgeons were blinded to the results of the Index Test. LJ reported Sensitivity (SN) = 81 Confidence Interval (CI): (72, 88) Specificity (SP) = 89 CI: (79, 55), while the combination of the other tests SN = 57 CI: (48, 67) SP = 88 (77, 94).

Lasbleiz et al. (2014) included 35 patients who were over 40, with 39 cases of shoulder pain (4 subjects had bilateral shoulder pain) for at least 1 month and diagnosis of rotator cuff degeneration, confirmed by ultrasound. The assessor administered some tests for supraspinatus: Jobe test, Full can test; Infraspinatus: Hornblower, Dropping, Gate, resisted ER, Patte; Subscapularis: Belly press, Lift-off; Biceps: Palm-up, Yergason.

Diagnostic accuracy was evaluated in terms of pain and weakness, where possible; it was also assessed in relation to full-thickness cuff tear.

3.5.2. Treatment studies

3.5.2.1. ENDPOINT. Outcome measures used in the studies included are summarized in Table 5.

3.5.2.2. Therapeutic exercise versus conventional physiotherapy. Moezy et al. (2014) included 72 patients with ages between 18 and 75 who had been experiencing shoulder pain for more than a month. They were positive to the painful arc, Neer test, Hawkins and Empty can. Then, they were randomized into 2 groups: 36 in a scapular stabilization (ET) group while 36 were treated with conventional physical therapy (PT) that included exercises for ROM, laser therapy, ultrasound, TENS. They attended 18 sessions (3/week for 6 weeks). Assessment was performed at baseline and at the end

Table 4
Characteristics of treatment included studies.

Author, year and study design	Partecipants (n), inclusion/exclusion criteria	Groups, Interventions and number of treatment (NT)	Endpoint(s)	Assessment and Follow-up	Results (m = mean; SD = standard deviation) [CI 95%]
Al Dajah (2014) RCT	n = 25 *Inclusion Criteria:* • Age 40–60 years • Capsule stretch test (-) • VAS ≥ 5 • ER = 35°±5° • OR = 155 ± 10 cm • No NSAID and drugs 24 h before the enrollment • Neer Test (+) *Exclusion criteria:* • Open wounds, recent trauma and surgery, RA, edema, reflex symphatetic Syndrome, Adhesive Capsulitis	• *Group STM n = 15:* subscapularis STM + PNF • *Group US n = 10:* Ultrasound therapy • NT = 1	*Pain:* • Vas *ROM:* • RE *Overhead Reach (OR):* • Centimeter measured by distance from floor and third finger	• Before and after treatment	• PAIN: significative improvement (***p* < 0.05**) in group STM pre (m = 6,2 SD = 0.79) and post (m = 3.8 SD 0.79) treatment • ROM(°): significative improvement (***p* < 0.05**) in group STM (m pre = 36.6; m post = 52.4 SD = 4.9) than group US (m pre = 36.47; mpost = 40.33 SD = 5.6) • OR: significative improvement (***p* < 0.028**) in group STM (m pre = 162.5 cm; mpost = 173.1 cm SD = 9.07) than group US (m pre = 163.6 cm; m post = 165.3 cm SD = 8.4)
Camargo et al. (2015) RCT	n = 46 *Inclusion SIS criteria:* • Pain due to non-traumatic onset • Painful arc during active elevation of the arm, • 1 or more positive SIS tests (Hawkins-Kennedy, Jobe, Neer) or pain during passive or isometric re- sisted external rotation of the arm at 90° of abduction and pain with palpation of the rotator cuff tendons. *Exclusion criteria:* • history of clavicle, scapula, or humerus fractures; a history of rotator cuff surgery; numbness or tingling of the upper limb reproduced by the cervical compression test; sulcus or apprehension test (+); drop arm test (+), a systemic illness; a corticosteroid injection within 3 months prior to the intervention; or physical therapy within 6 months prior to the intervention. Individuals with a Beck Depression Inventory score higher than 9 were excluded from pain and mechanical sensitivity assessments.	• *Exercise + MT group (n = 23)*: 3 stretching exercises (Upper trapezius, pictoralis minor, posterior region of the shoulder) and 3 strenghtening exercises (ER, lower trapezius, Serratus) performed in each upper limbs. Grade III-IV mobilizations (glenoumeral, scap-ulothoracic, acromio-clavicular, sternoclavicular and cervical spine), PNF, SCS. • *EX group (n = 23)*: The same 3 stretching and strenghtening exercises NT = 4 weeks	***Primary:*** *Scapular kinematics:* • RI, RE • UR, DR • AT, PT ***Secondary:*** *Disability:* • DASH score *Pain:* • VAS	• baseline • At the end of treatment (4th week)	• SCAPULAR KINEMATICS: there is not any significative differences (***p* > 0.05**) between groups and anything big effect size (Cohen d < 0.8) except for AT (group ex + MT shown significative improvement (***p* = 0.01**) without important effect size (Cohen d = 0.4) • DISABILITY: Both groups shown a significative improvement (***p* < 0.001**) with big effect size in groups (ex + MT: Cohen d = 0.9; ex: Cohen d = 0.91) but moderate effect size between groups (Cohen d = 0.34) • PAIN: Both groups showed a significative improvement post-intervention (***p* < 0.01**) in pain variables (pain at rest, pain with movement, worst pain in the last week). Only "minimum pain in the last week" showed bigger improve-ment in group ex + MT (m = 0.9 [−5.5, 7.2]; Cohen d = 0.72) compare to only exercise (m = −0.7 [−7.8, 6.5]; Cohen d = 0.09) *NOTE:* 2 individuals in group ex + MT and 3 in EX group was excluded from analysis due to BDI >9
Delgado-Gil et al. (2015) RCT	n = 42 *Inclusion Criteria:* • History of shoulder pain of more than 3 months duration • pain localized at the proximal anterolateral shoulder region • medical diagnosis of SIS with at least 2 positive impingement tests including Neer, Hawkins, or Jobe test *Exclusion Criteria:* • diagnosis of fibromyal- gia, pregnancy, a history of traumatic onset of shoulder pain, other histories of shoulder injury, torn tendons, ligamentous laxity based on a positive Sulcus and apprehension tests, numbness or tingling in the upper extremity, previous shoulder or cervical spine surgery, systemic illness, corticosteroid injection on the shoulder within 1	• *MWM group (n = 21)*: glenohumeral postero-lateral accessory glide combined with active anterior flexion • *placebo group (n = 21)*: Active flexion without external pressure NT: 2 sessions/week x 2 weeks = 4 sessions	***Primary:*** *Pain:* • NPRS ***Secondary:*** *ROM:* • Active ROM in FLS, ER, IR, EXT, ABD, ADD	• Baseline (NPRS) • 24 h afte reach session for every 4 sessions	• PAIN: Significative improvement (***p* = 0.011**) in FLS in MWM group (m = −1.1 [− 1.7, − 0.3]) compare to placebo group (m = 0.3 [−0.4, 0.9]) with big effect size for MWM (SMD = 0.9) • ROM(°): significative improvement in **flexion pain-free ROM** (**p = 0.001,** MWM m = 31 [22.4, 39.5]; placebo m = − 3.2 [− 11.8, 5.3] SMD between group = 1,8), **in max ER** (**p = 0.001,** MWM m = 6.8 [2.7, 11.0]; palcebo m = − 1.4 [− 5.5. 2.8] SMD between gruoups= 0,9) e in **max FLS** (**p = 0.001,** MWM m = 20.1 [13.8, 26.5] placebo m = 0.9 [−5.5, 7.2)] SMD between groups = 1,4)

(*continued on next page*)

Table 4 (*continued*)

Author, year and study design	Partecipants (n), inclusion/exclusion criteria	Groups, Interventions and number of treatment (NT)	Endpoint(s)	Assessment and Follow-up	Results (m = mean; SD = standard deviation) [CI 95%]
	year of the study, and physical therapy 6 months before the study				
Granviken et al. (2015) RCT	n = 46 *Inclusion Criteria:* • Age between 18 and 65 years • unilateral shoulder pain lasting more than 12 weeks • Positive to: painful arc, infraspinatus test (resisted ER with adducted arm and 90° of elbow FLX), Kennedy-Hawkins test *Exclusion criteria:* glenohumeral instability, acromioclavicular joint pathology, labrum pathology on imaging, proven full thickness ruptures/total ruptures of the RC, or signs of glenohumeral osteoarthritis. Shoulder surgery, insufficient language capability, cervical spine problems, rheumatoid arthritis, or other physical or serious mental illness.	• *Home exercise group (ED.) (n = 23)*: Home exercises (scapular repositiong, RC strenghtening exercises, pain free exercises) • *Supervised exercise group (ES.) (n = 23)*: Home exercises (as above) + supervised exercises NT = 6 weeks. home exercises 2 times/day supervised exercises: 10 sessions *ED group*: 1 supervised session + home ex. *ES group:* 10 supervised sessions + home ex.	***Primary:*** *Pain/Disability:* • SPADI scale (at baseline and 6th week) ***Secondary:*** *Pain:* • NPRS (last week) *Clinical tests:* • Painful arc • Infraspinatus test • Kennedy-Hawkins test *ROM:* • Active in FLS, ABD, ER, IR Disability: • FABQ physical activity e FABQ Work • Work status *Patient satisfaction* • Survey	• baseline • 6 weeks • 26 weeks: only SPADI and Work Status	• SPADI: No difference between groups neither at 6th week (difference m = 0 points [-14, 14]) nor at 26th week (diff. m =- 2 punti [-21, 17]. • PAIN: No difference between groups at 6th week (diff m = −0.1 [− 1.8 to 1.6]) • CLINICAL TESTS: 18/21 (ED group) and 11/23 (ES group) had at leats 2 positive tests (at 6th week) • ROM(°): No difference between groups at 6th week in IR (diff. m = 0 [− 10 to 11]), ER (diff. m = 2 [− 14 to 18]), ABD (diff m = −14 [− 43 to 15]) and FLX (diff m = 0 [− 16 to 16]). • DISABILITY: No difference between groups at 6th week in FABQ physical activity (diff m = 2.8 [− 1.0 to 6.5]), and FABQ Work (diff m = 0.0 [− 7.0 to 6.9]). • PATIENT SATISFACTION: 52% (ED group) and 83% (ES group) are satisfied, 29% (ED) and 4% (ES) partially satisfied, 19% (ED) and 9% (ES) neither satisfied nor unsatisfied *NOTE:* At 6th week n = 2 drop-out in ED group, at 26th week n = 3 drop out in ED group, and n = 2 in ES group. No ITT analysis
Moezy et al. (2014) RCT	n = 72 *Inclusion criteria:* • age = 18–75 years • Unilateral shoulder pain of more than one month localized (anterior and/or anterolateral) to the acromion • tenderness to palpation of the rotator cuff tendons; • Positive impingement tests, or a painful arc of movement (60°–120°) • Pain produced or increased during flexion and/or abduction of the symptomatic shoulder. *Exclusion criteria:* • cervical or shoulder symptoms reproduced by a cervical screening exam; • abnormal results with reflex or thoracic outlet tests; • symptoms of numbness or tingling in the upper extremity; • pregnancy, or a history of the followings: onset of symptoms due to traumatic injury,	• *Scapular exercise group (ET) (n = 36)*: warm-up, strenghtening exercises (RC, external rotator, serratus) mobility exercises (clock exercise and PNF) and stretching (sleeper's stretch, crossed arm stretch, corner stretch, stretching for minor and major pectoralis, posterior capsule stretch) • *Usual care group (PT) (n = 36)*: various modalities: ROM exercises, lasertherapy, ultrasounds, TENS, NT: 3 sessions/week for 6 weeks = 18 sessions	***Primary***: *Pain:* • VAS ***Secondary:*** *ROM:* • Active in ABD and ER	• baseline • 6 week	• PAIN: significative post-test improvement (***p*** < ***0,05***) in each groups; there is not any significative difference (***p*** = ***0,576***) between groups • ROM: significative post-test improvement (***p*** < ***0,05***) in each group. Significative improvement (***p*** < ***0,001***) of ET group compared to PT group as regards ABD (PT: m±SD = 19.14 ± 14.42; ET: m±SD = 28.78 ± 19.8) and ER (PT: m±SD = 7.00 ± 8.06; ET: m±SD = 15.75 ± 12.99)

	glenohumeral joint dislocation, acromioclavicular joint separation, shoulder fracture, surgery on the shoulder, fibromyalgia, use of any treatment within three months.				
Littlewood et al. (2016) Multicenter RCT	n = 86 *Inclusion Criteria:* • Age > 18 years • willing and able to partici- pate • primary complaint of shoulder pain with or without referral into the upper limb for greater than 3 months • no/minimal resting shoulder pain • ROM largely preserved (>50% ER) • shoulder pain provoked consistently with resisted muscle tests, usually ABD or ER. *Exclusion criteria:* shoulder surgery within last 6 months, systemic pathology including inflammatory disorders, cervical repeated movement testing affects shoulder pain and/or ROM.	• *Single exercise self-adminsiteredgroup (SE) (n = 42)*: single exercise against gravity, a resistive therapeutic band or hand weight over three sets of 10–15 repetitions twice per day. Exercise prescription is guided by symptomatic response requiring that pain is produced during exercise that remains no worse upon cessation of that exercise. Participants were offered follow-up appointments as required to facilitate self-management and discuss exercise progression. • *Conventional physiotherapy group (CP) (n = 44)*: advice, stretching, exercise, manual techniques, massage, strapping, acupuncture, electrotherapy, corticosteroid injection at the discretion of the treating physiotherapist NT: Home exercise: 2 session/day SE group at the discretion of the treating physiotherapist for CP group for 12 weeks. Supervised session (mean): 3.1 SE group versus 3.4 Cp group	***Primary:*** *Pain-Disability:* • SPADI scale (at 3 months) ***Secondary:*** *Pain-Disability:* • SPADI scale (at 6–12 months) *Partecipation:* • SF-36 (at 6 and 12 months) *Function:* • PSFS (at 6 and 12 months)	• baseline • 3 months • 6 months • 12 months	• SPADI SCALE: significative improvement in each group at 3 months: change of 12.4 (95% CI 5.4 to 19.5; $\boldsymbol{p < 0.01}$) in SE group and 16.7 (95% CI 9.6 to 23.7; $\boldsymbol{p < 0.01}$) in CP group; 29.1 points of change (95% CI 21.0 to 37.1; $\boldsymbol{p < 0.01}$) in SE group and 23.5 points (95% CI 15.1 to 31.9; $\boldsymbol{p < 0.01}$) in CP group at 6 months; 31.0 points of change (95% CI 20.8 to 41.3; $\boldsymbol{p < 0.01}$) in SE group and 25.2 (95% CI 14.3 to 36.1; $\boldsymbol{p < 0.01}$) in CP group at 12 months. There is not any significative difference between groups ($\boldsymbol{p > 0,05}$) • SF-36: There is not any significative difference between groups ($\boldsymbol{p > 0,05}$) • PSFS: Not analyzed due to etherogenity

Legend: ABD = abduction; ADD = adduction; AT = anterior tilt; BDI= Back Depression Inventory; CI = confidence interval; DASH: Disability of Arm Shoulder and Hand; DR = downward rotation; ER = External Rotation; EST = estension; FABQ = fear avoidance belief questionnaire; FLS = flexion; IR = internal rotation; ITT=Intention to treat; MT = Manual Therapy; MWM = mobilization with movement; NPRS = numeric pain rating scale; OR = overhead reach; PNF:Proprioceptive Neuromuscular Facilitation; PPT=Pressure Pain Threshold; PSFS: Patient Specific Functional Scale; PT = posterior tilt; RA = Reumatoid Arthritis; RC = rotator cuff; RCT = Randomized controlled trial; ROM = range of motion; SCS = strain counterstrain; SF-36:Short Form 36 scale; SIS=Sub-acromial impingement syndrome; SMD=Standardized mean score differences; SPADI=Shoulder Pain and Disability Index; STM = soft tissue mobilization; UR = upward rotation; VAS=Visuo analogic scale.

of the treatment. In terms of pain (VAS scale) there was significant post-test improvement ($p < 0.05$) within the two groups with no significant difference ($p = 0.576$) between groups.

In terms of ROM (degrees) there was significant post-test improvement ($p < 0.05$) within the two groups and significant improvement ($p < 0.001$) in the ET group both as regards both the abduction (ABD) and external rotation (ER).

Littlewood et al. (2016) recruited 86 patients over 18 years, with more than 3 months of shoulder pain caused by isometric tests in ABD and ER. They were randomized into two groups: in one of them patients did a single exercise against gravity or elastic resistance on their own. A provocation of mild pain is tolerated during exercise, but it should not worsen after exercise (SE group n = 42). The other group did conventional physiotherapy (CP group n = 46) that included counselling, exercises, stretching, manual techniques, massage, acupuncture, electrotherapy, corticosteroid injections, at the discretion of the physical therapist. Home exercise were performed twice a day in the SE group, while in the other group the sessions were administered at the discretion of the physiotherapist for 12 weeks. The mean total number of supervised sessions in the self-managed exercise group was marginally less than the usual physiotherapy treatment group (3.1 versus 3.4 respectively) but this difference was not statistically significant ($p = 0.40$). Significant ($p < 0.01$) improvement at 3, 6 and 12 months in the SPADI Scale was registered in both groups.

3.5.2.3. Home exercises versus supervised exercise. Granviken and Vasseljen (2015) included 46 patients between 18 and 65 with shoulder pain for more than three months, painful arc and positive test for the infraspinatus (resisted ER) and Hawkins-Kennedy. They were randomized into two groups: 23 (ED group) performed tailored home exercises (mobility and strength oriented) and 23 performed the same protocol exercises with the difference that in 10 sessions the patients were followed by a physiotherapist (ES group) twice a day for 6 weeks.

Both groups improved from 30 to 40% (as regards SPADI score) but there was no significant difference between groups in the 6th and 26th week. In addition, no significant difference was noticed between groups in the 6th week in terms of pain.

In 18 out of 21 patients (Group ED) there were 2 or more positive physical tests during the 6th week, while 11/23 tests were positive in the other group. There was no difference between groups in terms of IR, ER, ABD, FLS. The trend was the same for disability: no difference in the sixth week in FABQ physical activity and FABQ Work.

3.5.2.4. Mobilization with movement (MWM) versus placebo. Delgado-Gil et al. (2015) enrolled 42 patients with shoulder pain persisting for more than 3 months that resulted positive in two or more of Neer, Hawkins and Jobe tests and then randomized them into two groups, one (MWM group; n = 21) in which they did MWM (humerus postero-lateral accessory glide combined with active forward flexion) and the other (placebo group; n = 21), in which they provided the same procedure, but without manual pressure.

Pain decreased significantly more ($p = 0.011$) during the FLS in the MWM group compared to the placebo group after 24 h with large effect size in favour of MWM. As regards mobility, there was an improvement of the ROM (degrees) without pain in FLS ($p = 0.001$), in ER ($p = 0.001$) and FLS.

3.5.2.5. Therapeutic exercise versus therapeutic exercise plus manual techniques. Camargo et al. (2015) enrolled 46 patients with non-traumatic shoulder pain, presence of painful arc and positivity to one or more of these tests: Hawkins-Kennedy, Jobe, Neer, pain in passive ER or pain due to active isometric resistance at 90° of ABD

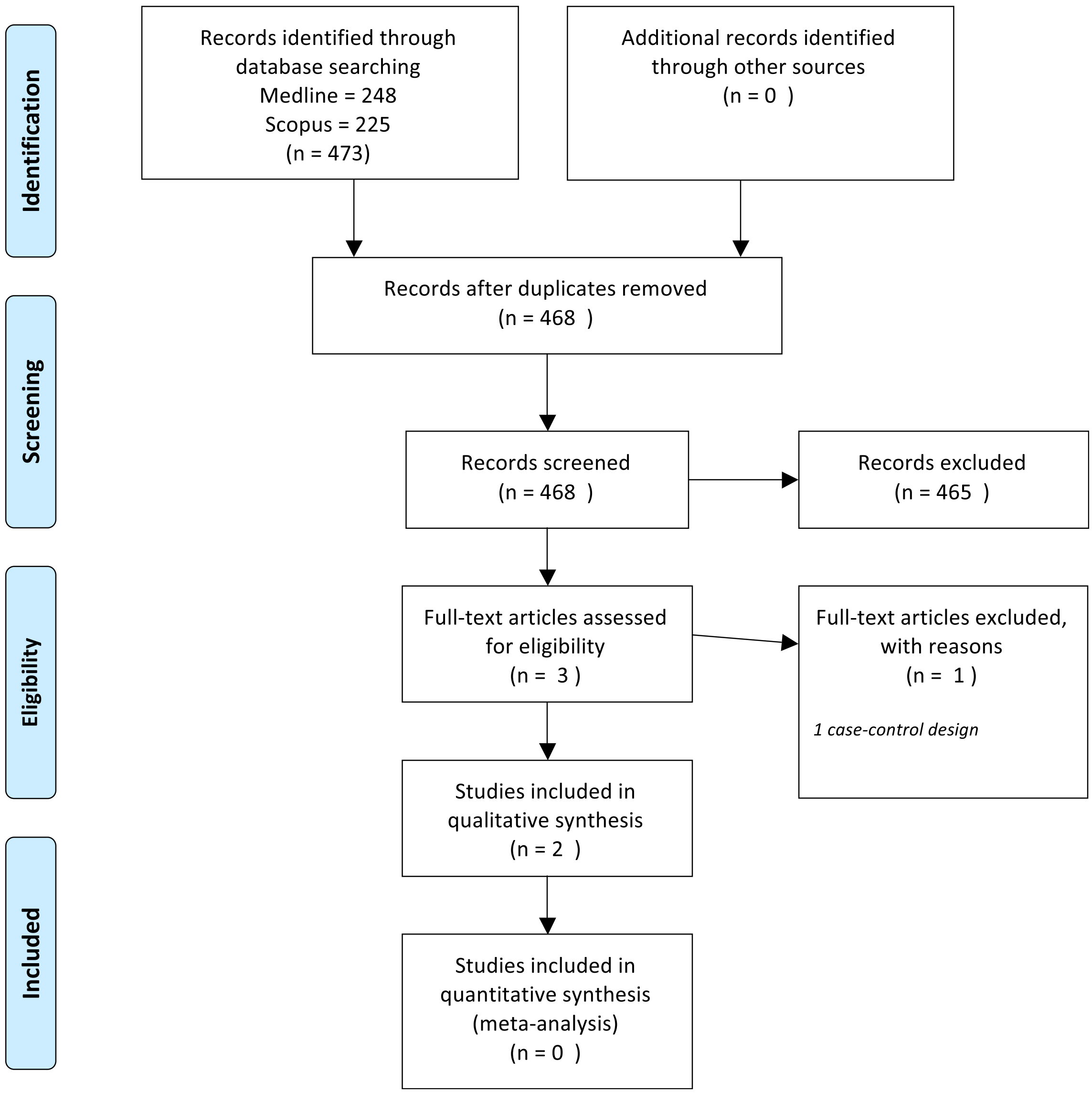

Fig. 1. PRISMA flow-chart (Diagnosis).

and pain on palpation of the RC tendons. Patients were randomized into two groups. A first group in which the subjects performed 3 stretching exercises, 3 strengthening exercises of scapular muscles and, according to the individual clinical presentation of each s, received manual therapy (glenohumeral, cervical, thoracic, acromion-clavicular mobilizations and soft tissue techniques) (ES + TM group; n = 23). A second group in which patients only performed the same 3 stretching and strength exercises (ES group; n = 23).

The primary outcome was scapular kinematics and both groups did not have significant improvement. As regards DASH score ($p < 0.001$), the effect size was large within each group but moderate between the two groups; the pain (VAS) improved significantly ($p < 0.01$) post-intervention in the analyzed variables (current pain at rest, pain with movement, worst pain in the last week). Only in the “less pain experienced in the last week” variable there was a greater improvement in ES + TM group.

3.5.2.6. Therapeutic exercise plus manual techniques versus ultrasound. Al Dajah (2014) enrolled 30 patients with ages from 40 to 60 with shoulder pain produced by the Neer test and with no restriction of ROM (ER = 35°±5°) or capsular dysfunction (capsular stretch test negative). The patients were randomized into 2 groups: group STM (n = 15) that performed soft tissue mobilization (STM) of the subscapularis plus PNF techniques and group US (n = 10) that received ultrasound treatment.

There was significant pain improvement ($p < 0.05$) in group STM pre- and post-treatment; as regards mobility, there was significant improvement ($p < 0.05$) in group STM.

4. Discussion

The purpose of this review was to investigate the diagnostic accuracy of manual tests and the effectiveness of musculoskeletal physiotherapy in the diagnosis and management of SIS and related disorders. Furthermore, we tried to understand if there is agreement between the target of evaluation and the target of treatment.

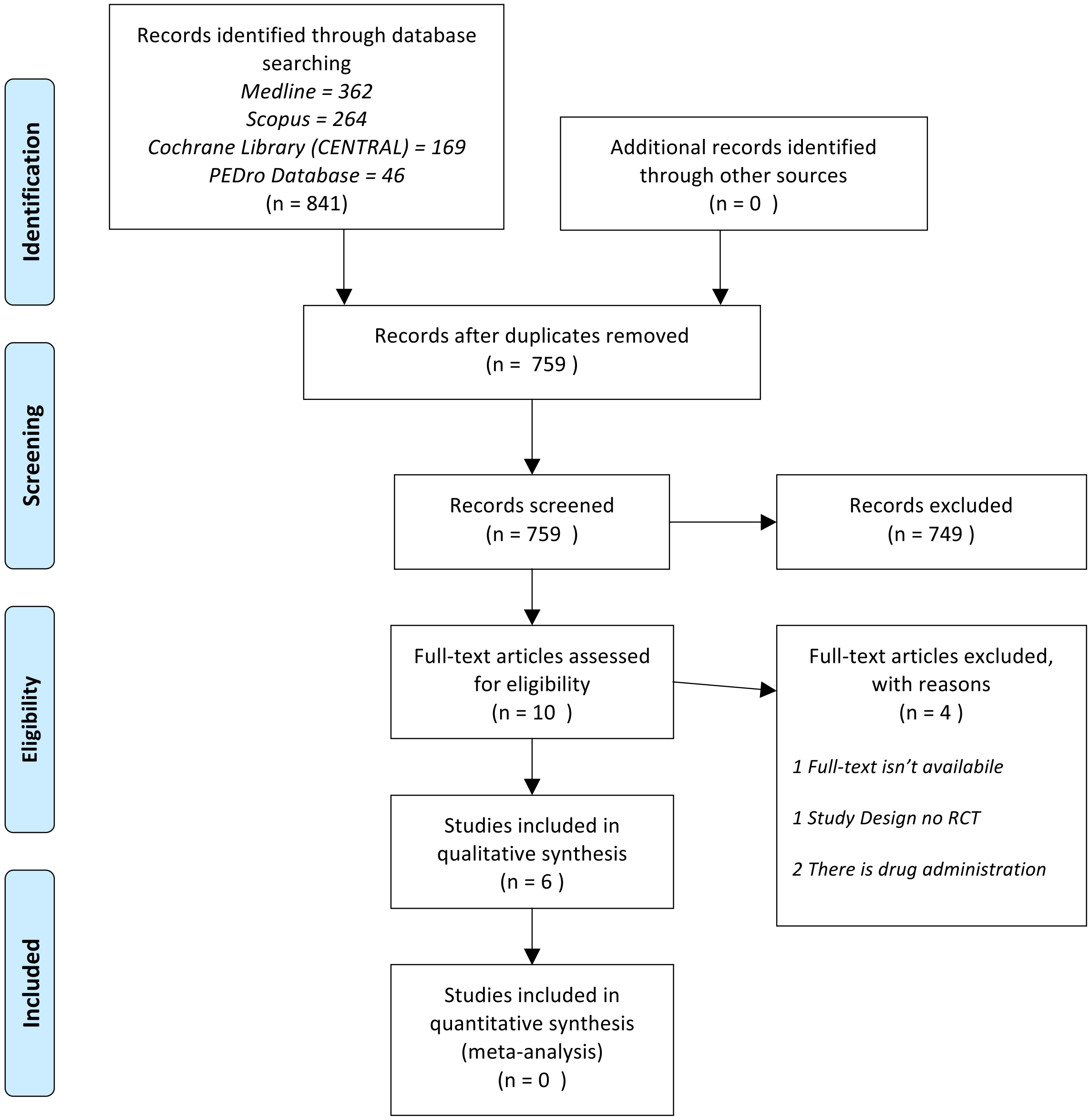

Fig. 2. PRISMA flow-chart (Treatment).

4.1. Diagnostic accuracy of physical tests

Only 2 studies about tests accuracy were retrieved after Hanchard's review (Hanchard et al., 2013) that we considered as our starting point. Lasbleiz et al. (2014) investigated the diagnostic accuracy of 11 manual tests about RC tendinopathy and full-thickness tear. All the tests analyzsed presented some weakness in detecting the target condition. The Yergason test was the only one with acceptable values of LR in the diagnosis of LHB tendinopathy.

This may be due to the fact that many other tests activate and stress multiple other structures/muscles in the shoulder complex and this does not allow to detect a single structure responsible for patient's symptoms. In fact, also widely used test for the diagnosis of SIS as the Jobe's or an "empty can" test did not show significant accuracy if pain is taken as a positivity criterion, while it increases if weakness is used as a positive response and tendon/muscle lesion as evaluation target.

This heterogeneity in terms of interpretation may also explain the poor reliability of the physical test (both intra-rater and inter-rater) (Lange et al., 2017).

Gillooly et al. (2010) proposed a new test for the identification of RC disorders (Lateral Jobe test). It was compared to a combination of other clinical tests and also with the reference standard. Unfortunately, there are several methodological biases that could affect the results of this study in terms of clinical applicability.

Therefore, our results confirm that there is a lack of evidence in the choice of test for SIS and related disorders to be employed. According to Hancard et al. (2013) this problem originates from the heterogeneity of diagnostic studies, in terms of standard reference and target condition reference, and their poor methodological quality.

4.2. Effectiveness of musculoskeletal physiotherapy

Musculoskeletal physiotherapy (Al Dajah, 2014; Moezy et al., 2014; Delgado-Gil et al., 2015; Granviken and Vasseljen, 2015; Littlewood et al., 2016) seems to be effective in patients with SIS

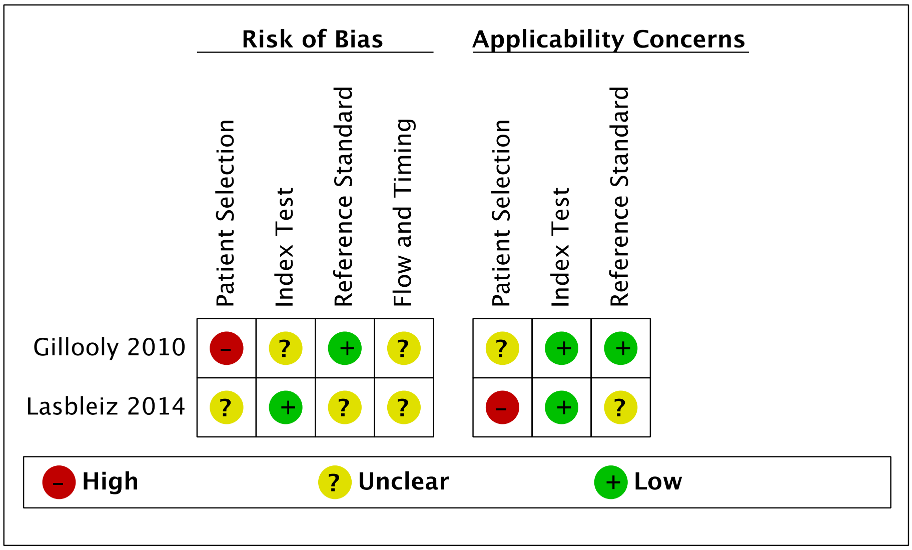

Fig. 3. Risk of bias summary (Diagnosis).

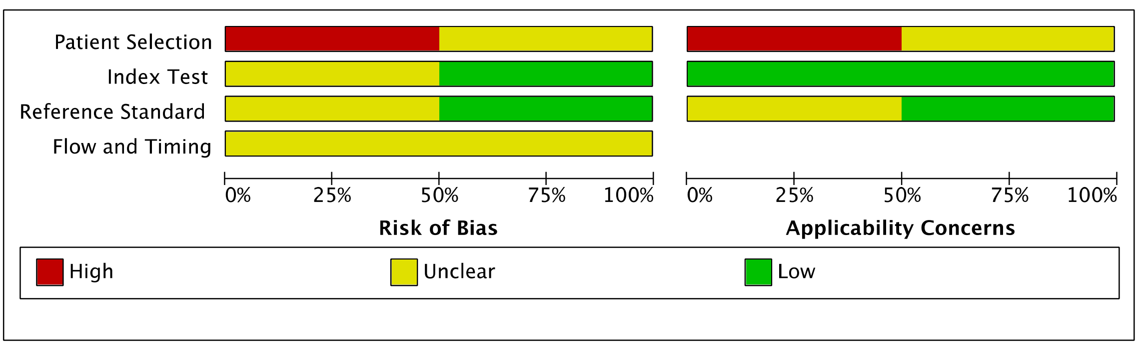

Fig. 4. Risk of bias graph (Diagnosis).

and related disorders, and these results are in line with the findings of Abdulla et al. (2015) and Desjardins-Charbonneau et al. (2015). The inclusion of specific manual joint techniques (Delgado-Gil et al., 2015) appears to lead to significant pain and mobility improvement compared to placebo (Delgado-Gil et al., 2015) or ultrasound (Al Dajah, 2014). However, they do not seem to increase the effectiveness of scapular kinematics, functionality and pain, compared to exercise alone (Camargo et al., 2015).

Nevertheless, these results must be read critically. In the studies we included, a great variety of disability/participation indexes were used, none of which are present in more than two studies. For example, in terms of *mobility*, some studies assess only the movement of ABD and ER (Moezy et al., 2014), others only FLS and IR (Granviken and Vasseljen, 2015) and others include EXT and ADD (Delgado-Gil et al., 2015). Also the choice of follow-up times is not the same: some authors settled for follow ups at a very short time, while others (Granviken and Vasseljen, 2015; Littlewood et al., 2016) included follow-ups after over 6 weeks and no one used the same timeframe (Al Dajah, 2014; Camargo et al., 2015; Delgado-Gil et al., 2015).

In terms of inclusion criteria and clinical tests, the characteristics of the diagnostic categories applied to the patients included in the studies appears to be heterogeneous (Al Dajah, 2014; Camargo et al., 2015; Delgado-Gil et al., 2015; Granviken and Vasseljen, 2015).

4.3. Agreement between target of evaluation and target of treatment

The therapeutic strategies proposed are rarely correlated to the specific assessment outcomes.

Al Dajah et al. (2014) enrolled patients with positive Neer test and ROM limitation in ER and F. However, when they opted for the intervention their goal was to treat the trigger points in subscapularis muscle by Soft Tissue Mobilization and Proprioceptive Neuromuscular Facilitation.

Camargo et al. (2015) and Granviken et al. (2015) proposed stretching and strength exercises to restore the normal motion pattern (Granviken and Vasseljen, 2015) and eliminate pain and tightness (Camargo et al., 2015). However, to include patients in the trial, they considered some orthopaedic tests (Camargo et al., 2015; Granviken and Vasseljen, 2015), active and passive painful movement and palpation of muscles (Camargo et al., 2015) as positive criteria.

Moezy et al. (2014), adopted strengthening (RC, external rotator, serratus) and stretching exercises (sleeper's stretch, crossed arm stretch, corner stretch, stretching for minor and major pectoralis, posterior capsule stretch) on the basis of positive impingement tests, tenderness of rotator cuff palpation and painful movement of flexion/abduction.

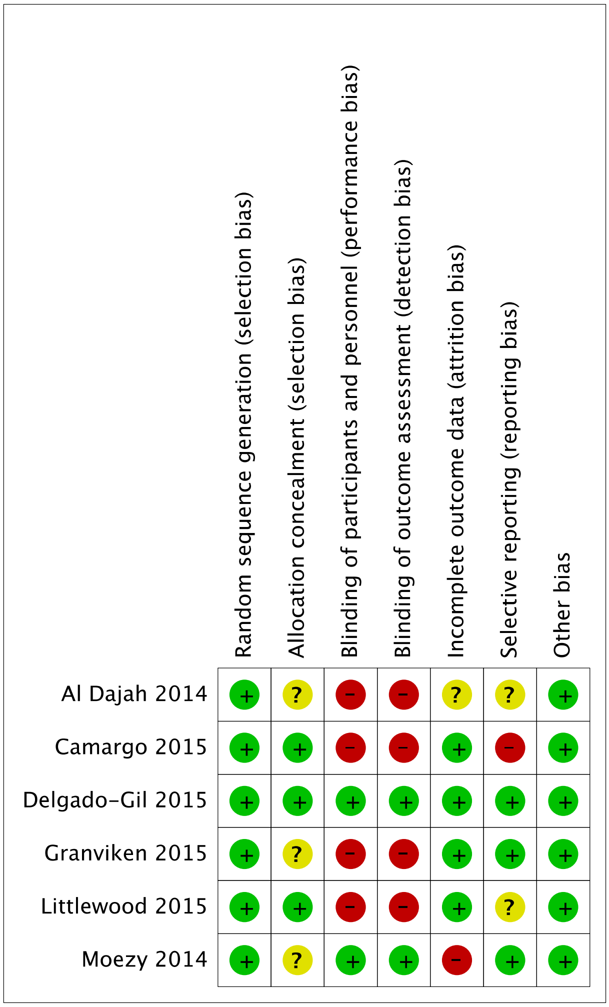

Fig. 5. Risk of bias summary (Treatment).

An additional evaluation of the studies included in the revisions that were identified as starting point of our investigation (Abdulla et al., 2015; Desjardins-Charbonneau et al., 2015) highlighted the same lack of consequentiality between assessment and treatment.

In many cases, orthopaedic tests were used as a positive criterion to include patients in the trial (Bang and Deyle, 2000; Ludewig and Borstad, 2003; Munday SL et al., 2007; Atkinson M et al., 2008; Barbosa RI, 2008; Kachingwe et al., 2008; Lombardi et al., 2008; Ketola et al., 2009; Bansal K 2011; Senbursa et al., 2011; Djordjevic et al., 2012; Ketola et al., 2013; Kromer et al., 2013; Maenhout et al., 2013) but the choice of treatment did not derive directly from the test results. Some authors based the treatment on strength and stretch exercises targeted toward rotator cuff muscles (Ludewig and Borstad, 2003; Lombardi et al., 2008; Ketola et al. 2009, 2013; Maenhout et al., 2013), while others used manual therapy of the GH (Munday SL et al., 2007; Atkinson M et al., 2008; Barbosa RI et al., 2008; Kachingwe et al., 2008), of the AC joint (Munday SL et al., 2007; Atkinson M et al., 2008), of the ribs (Munday SL et al., 2007), of the scapula (Munday SL et al., 2007; Surenkok et al., 2009) and of cervicals (McClatchie et al., 2009; Kromer et al., 2013) and thoracic joints (Kromer et al., 2013). Finally, Senbursa et al. (2011) used soft tissue mobilization and massage together with articular manual techniques (GH, scapula, cervical, thoracic).

It seems clear that the choice of treatment strategy goals proposed in the different studies was almost never directly and consequentially linked with the goals and results of the physical tests (Al Dajah, 2014; Delgado-Gil et al., 2015); nevertheless, the treatments resulted effective.

Moreover, aside from the limitations of clinical test and relative diagnostic classification (Schellingerhout et al., 2008), literature shows that pain and functional disability in symptomatic subjects are not primarily related to structural factors such as the size of tissue damage, the presence of adipose infiltration, tendon retraction or muscular atrophy (Curry EJ et al., 2015; Chester et al., 2016).

To overcome these problems, we need to change our category of diagnostic classification moving from a disease-based approach to a more functional and prognostic one (Chester et al. 2013, 2016; Croft et al., 2015).

These discrepancies between pathoanatomical diagnosis and functional symptom-based therapeutic intervention could be overcome with the adoption of more functional diagnostic procedures. In this way we could integrate and complete the structural, orthopaedic diagnostic description of the condition with social and psychological features that may give us more cues to target the treatment toward the multifaceted aspect of pain experience (Williams, 2013). Such evaluation procedure may provide more coherent bases for the therapeutic choices of specific exercise or manual therapy techniques and better correlate to the construct of functional outcome measures commonly used in rehabilitative clinical practice (Hudak et al., 1996; Breckenridge and McAuley,

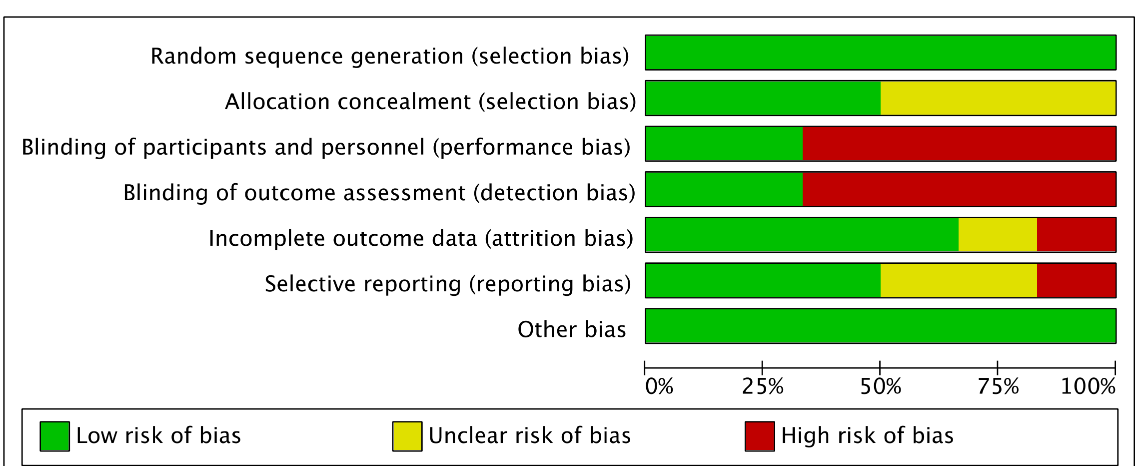

Fig. 6. Risk of bias graph (Treatment).

Table 5
Primary and secondary endpoints.

Category	Pimary Endpoint	Secondary Endpoint
Pain	NPRS	VAS PPT NPRS
Pain/Disability Disability	SPADI scale	SPADI Scale DASH scale FABQ physical activity FABQ work PSFS
Partecipation		SF-36
Other	Scapular kinematics	Manual physical tests Patient satisfaction ROM FHS Mid-thoracic curve Scapular retraction and protraction Pectoralis minor lenght

NPRS=Numeric Pain Rating Scale; VAS=Visuo Analog Scale; PPT=Pressure Pain Threshold; SPADI=Shoulder Pain Disability Index; DASH = Disability of Harm Shoulder and Hand; FABQ=Fear-Avoidance Belief Questionnaire; PSFS=Patient-Specific Functional Scale; SF-36 = Short Form 36; ROM = Range of Motion; FHS=Forward Head Posture.

2011). This pragmatic approach would foster tailoring treatment to the single individual patient (Wijma et al., 2016).

This is what happened, for example, in the evaluation approach of the lumbar spine: starting from the inability of physical tests to identifying a structure responsible of patient's symptoms, the pathological model underlying the disease was progressively abandoned (Chorti et al., 2009; Hartvigsen et al., 2015).

Some authors proposed to develop diagnostic criteria better linked to treatment that became a common clinical practice in the management of back pain (O'Sullivan, 2005).

In presence of aspecific back pain, patients can be subgrouped on the basis of movement abnormalities and symptom processing mechanisms, identifying the dominance of a peripheral/nociceptive or central sensitization pain condition (Nijs et al., 2015) and, after such a triage, an adequate therapy can be chosen.

This allows to pragmatically target the treatment to the dysfunctional pattern and overcome the limits that results from a diagnostic classification following the positivity of tests based on patho-anatomical models that are often inaccurate and not reproducible (Dankaerts et al., 2006).

We consider that this could be a valuable approach also for the painful shoulder and hope that future studies will support the adoption of a more pragmatic evaluation of shoulder disorders.

5. Limit and conclusion

The present review confirms the satisfactory effectiveness of musculoskeletal physiotherapy in patients with shoulder problems despite the weak diagnostic power of clinical tests the interventions were based on.

Several methodological biases affect the studies available and further diagnostic and therapeutic primary studies with higher level of methodological standards are needed. Although we found only few articles from the review that we choose as start point for our work, the combined design study allow us to have a more realistic and clinical point of view about the management of these patients. Thus it seems advisable adopt a more pragmatic assessment strategy together with the usual orthopaedic diagnostic procedures in order to improve coherence between the evaluation results and the following therapeutic intervention.

Declaration of interests

The author(s) report no conflicts of interest.

Appendix 1. Search strategies

PICO (Diagnosis)

Patient: impingement or impingement and tendinopathy (RC and LHBT, bursitis, SLAP).

Intervention: test and cluster of manual tests.

Control: reference standard (Arthroscopy, US, Magnetic Resonance imaging).

Outcome: sensibility, specificity, Likelihood Ratio.

PICO (Treatment)

Patient: impingement or impingement and tendinopathy (RC and LHBT, bursitis, SLAP).

Intervention: manual therapy.

Control: -

Outcome: all.

Diagnosis search strategies

Database	Strategies	Notes
MEDLINE (interfaccia PubMed)	((((Diagnosis OR diagnosis[mesh] OR sign OR examin* OR test OR “physical examination”[mesh] OR “physical examination”)) AND (“active compression" OR release OR jerk OR “modified dynamic labral shear" OR “load and shift” OR "biceps load" OR "bicipital groove" OR "compression rotation" OR crank OR "empty can" OR "full can" OR gerber OR hawkins OR kennedy OR "hawkins kennedy" OR jobe OR neer OR O'brien OR relocation OR speed OR yergason OR “posterior impingement sign” OR sulcus)) AND (impingement OR "shoulder impingement syndrome”[mesh] OR “chronic pain”[mesh] OR “chronic pain” OR “chronic shoulder pain” OR tendinitis OR tendinopathy OR tendinopathy[mesh] OR bursitis OR bursitis[mesh] OR slap)) AND (biceps OR bicipital OR glenoid OR "glenoid cavity"[mesh] OR infraspinatus OR intraarticular OR internal OR labr* OR "rotator cuff" OR "rotator cuff"[mesh] OR shoulder OR “shoulder joint"[mesh] OR subacromial OR subdeltoid OR subscapular* OR subcoracoid OR "teres minor”)	Search filters: • Publication date: from 15th february 2010 until 10th April 2016 • Language: English and Italian
Scopus	((((diagnosis OR sign OR examin* OR test OR "physical examination")) AND (“active compression" OR release OR jerk OR "modified dynamic labral shear" OR "load and shift" OR "biceps load" OR "bicipital groove" OR "compression rotation" OR crank OR "empty can" OR "full can" OR "belly press" OR gerber OR hawkins OR kennedy OR "hawkins kennedy" OR jobe OR "lift off" OR neer OR o'brien OR relocation OR speed OR yergason OR "posterior impingement sign" OR sulcus)) AND (impingement OR "chronic pain" OR "chronic shoulder pain" OR tendinitis OR tendinopathy OR bursitis OR slap)) AND (biceps OR bicipital OR glenoid OR infraspinatus OR intraarticular OR internal OR labr* OR "rotator cuff" OR shoulder OR subacromial OR subdeltoid OR subscapular* OR subcoracoid OR "teres minor")	

Treatment search strategies

Database	Strategies	Notes
MEDLINE (interfaccia PubMed)	(((impingement OR "shoulder impingement syndrome"[mesh] OR "chronic pain"[mesh] OR "chronic pain" OR "chronic shoulder pain" OR tendinitis OR tendinopathy OR tendinopathy[mesh] OR bursitis OR bursitis[mesh] OR slap)) AND (biceps OR bicipital OR glenoid OR "glenoid cavity"[mesh] OR infraspinatus OR intraarticular OR labr* OR "rotator cuff" OR "rotator cuff"[mesh] OR shoulder OR "shoulder joint"[mesh] OR subacromial OR subdeltoid OR subscapular* OR subcoracoid OR "teres minor")) AND ("musculoskeletal manipulations"[Mesh] OR "manual therapy" OR exercise OR exercise[mesh] OR "therapeutic exercise" OR rehabilitation OR "physical therapy modalities"[mesh] OR "physical therapy" OR rehabilitation[mesh])	Search Filters: • Publication date: from June 2014 until 10th April 2016 • Language: English and Italian
PEDro	Title and abstract: impingement Title and abstract: tendinopathy	The results of the two search strategies are combined
Cochrane Database	("manual therapy" OR physiotherapy OR conservative) AND impingement AND shoulder	
Scopus	(((impingement OR "chronic pain" OR "chronic shoulder pain" OR tendinitis OR tendinopathy OR bursitis OR slap)) AND (biceps OR bicipital OR glenoid OR infraspinatus OR intraarticular OR labr* OR "rotator cuff" OR shoulder OR subacromial OR subdeltoid OR subscapular* OR subcoracoid OR "teres minor")) AND ("manual therapy" OR exercise OR "therapeutic exercise" OR rehabilitation OR "physical therapy")	Search filters: • Publication date: from June 2014 until 10th April 2016 • Language: English and Italian

References

Abdulla, S.Y., Southerst, D., Cote, P., Shearer, H.M., Sutton, D., Randhawa, K., Varatharajan, S., Wong, J.J., Yu, H., Marchand, A.A., et al., 2015. Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. Man. Ther. 20 (5), 646–656.

About IFOMPT. [accessed 20/03/16]. http://www.ifompt.org/About+IFOMPT.html.

Al Dajah, S.B., 2014. Soft tissue mobilization and PNF improve range of motion and minimize pain level in shoulder impingement. J. Phys. Ther. Sci. 26 (11), 1803–1805.

AMSTAR, 2016. What Is AMSTAR. http://amstar.ca/About_Amstar.php. (Accessed 4 April 2016).

Atkinson M, M.R., Brantingham, J.W., et al., 2008. A randomized controlled trial to assess the efficacy of shoulder manipulation vs placebo in the treatment of shoulder pain due to rotator cuff tendinopathy. J. Am. Chiropr. Assoc. 45, 11–26.

Bachasson, D., Singh, A., Shah, S.B., Lane, J.G., Ward, S.R., 2015. The role of the peripheral and central nervous systems in rotator cuff disease. J. Shoulder Elbow Surg. 24 (8), 1322–1335.

Bang, M.D., Deyle, G.D., 2000. Comparison of supervised exercise with and without manual physical therapy for patients with shoulder impingement syndrome. J. Orthop. Sports Phys. Ther. 30 (3), 126–137.

Bansal K, P.S., 2011. A comparative study between the e cacy of therapeutic ultrasound and soft tissue massage (deep friction massage) in supraspinatus tendinitis. Indian J. Physiother Occup. Ther. 5, 80–84.

Barbosa RI, G.R., Mazzer, N., Fonseca, M.C.R., 2008. The influence of joint mobilization on tendinopathy of the biceps brachii and supraspinatus muscles. Rev. Brasileira Fisioterapia 12, 298–303.

Behrens, S.B., Compas, J., Deren, M.E., Drakos, M., 2010. Internal impingement: a review on a common cause of shoulder pain in throwers. Physician Sportsmed. 38 (2), 11–18.

Blume, C., Wang-Price, S., Trudelle-Jackson, E., Ortiz, A., 2015. Comparison of eccentric and concentric exercise interventions in adults with subacromial impingement syndrome. Int. J. Sports. Phys. Ther. 10 (4), 441–455.

Breckenridge, J.D., McAuley, J.H., 2011. Shoulder pain and disability index (SPADI). J. Physiother. 57 (3), 197.

Burbank, K.M., Stevenson, J.H., Czarnecki, G.R., Dorfman, J., 2008. Chronic shoulder pain: part I. Evaluation and diagnosis. Am. Fam. Physician 77 (4), 453–460.

Buss, D.D., Freehill, M.Q., Marra, G., 2009. Typical and atypical shoulder impingement syndrome: diagnosis, treatment, and pitfalls. Instr. Course Lect. 58, 447–457.

Camargo, P.R., Alburquerque-Sendín, F., Avila, M.A., Haik, M.N., Vieira, A., Salvini, T.F., 2015. Effects of stretching and strengthening exercises, with and without manual therapy, on scapular kinematics, function, and pain in individuals with shoulder impingement: a randomized controlled trial. J. Orthop. Sports Phys. Ther. 45 (12), 984–997.

Chester, R., Jerosch-Herold, C., Lewis, J., Shepstone, L., 2016. Psychological factors are associated with the outcome of physiotherapy for people with shoulder pain: a multicentre longitudinal cohort study. Br. J. Sports Med. 0, 1–8.

Chester, R., Shepstone, L., Lewis, J.S., Jerosch-Herold, C., 2013. Predicting response to physiotherapy treatment for musculoskeletal shoulder pain: protocol for a longitudinal cohort study. BMC Muscoskel. Disord. 14, 192.

Chorti, A.G., Chortis, A.G., Strimpakos, N., McCarthy, C.J., Lamb, S.E., 2009. The prognostic value of symptom responses in the conservative management of spinal pain: a systematic review. Spine 34 (24), 2686–2699.

Cochrane, 2016. Cochrane handbook for systematic reviews of interventions. In: Chapter 8: Assessing Risk of Bias in Included Studies. Cochrane Group. http://handbook.cochrane.org/. (Accessed 20 March 2016).

Croft, P., Altman, D.G., Deeks, J.J., Dunn, K.M., Hay, A.D., Hemingway, H., LeResche, L., Peat, G., Perel, P., Petersen, S.E., et al., 2015. The science of clinical practice: disease diagnosis or patient prognosis? Evidence about "what is likely to happen" should shape clinical practice. BMC Med. 13, 20.

Curry EJ, M.E., Dong, Y., Higgins, L.D., Katz, J.N., Jain, N.B., 2015. Structural characteristics are not associated with pain and function in rotator cuff tears: the row cohort study. Orthopaedic J. Sports. Med. 3 (5).

Dankaerts, W., O'Sullivan, P.B., Straker, L.M., Burnett, A.F., Skouen, J.S., 2006. The inter-examiner reliability of a classification method for non-specific chronic low back pain patients with motor control impairment. Man. Ther. 11 (1), 28–39.

Deeks, J.J., 2001. Systematic reviews in health care: systematic reviews of evaluations of diagnostic and screening tests. BMJ 323 (7305), 157–162.

Delgado-Gil, J.A., Prado-Robles, E., Rodrigues-de-Souza, D.P., Cleland, J.A., Fernandez-de-las-Penas, C., Alburquerque-Sendin, F., 2015. Effects of mobilization with movement on pain and range of motion in patients with unilateral shoulder impingement syndrome: a randomized controlled trial. J. Manipulat. Physiol. Therapeut. 38 (4), 245–252.

Desjardins-Charbonneau, A., Roy, J.S., Dionne, C.E., Fremont, P., MacDermid, J.C., Desmeules, F., 2015. The efficacy of manual therapy for rotator cuff tendinopathy: a systematic review and meta-analysis. J. Orthop. Sports Phys. Ther. 45 (5), 330–350.

Desmeules, F., Cote, C.H., Fremont, P., 2003. Therapeutic exercise and orthopedic manual therapy for impingement syndrome: a systematic review. Clin. J. Sport Med. Official Can. Acad. Sport Med. 13 (3), 176–182.

Diercks, R., Bron, C., Dorrestijn, O., Meskers, C., Naber, R., de Ruiter, T., Willems, J., Winters, J., van der Woude, H.J., 2014. Guideline for diagnosis and treatment of subacromial pain syndrome. Acta Orthop. 85 (3), 314–322, 2014 Jun.

Dilek, B., Gulbahar, S., Gundogdu, M., Ergin, B., Manisali, M., Ozkan, M., Akalin, E., 2016. Efficacy of proprioceptive exercises in patients with subacromial impingement syndrome: a single-blinded randomized controlled study. Am. J. Phys. Med. Rehabil. 95 (3), 169–182.

Djordjevic, O.C., Vukicevic, D., Katunac, L., Jovic, S., 2012. Mobilization with movement and kinesiotaping compared with a supervised exercise program for painful shoulder: results of a clinical trial. J. Manipulat. Physiol. Therapeut. 35 (6), 454–463.

Gillooly, J.J., Chidambaram, R., Mok, D., 2010. The lateral Jobe test: a more reliable method of diagnosing rotator cuff tears. Int. J. Shoulder Surg. 4 (2), 41–43.

Granviken, F., Vasseljen, O., 2015. Home exercises and supervised exercises are similarly effective for people with subacromial impingement: a randomised trial [with consumer summary]. J. Physiother. 61 (3), 135–141.

Greving, K., Dorrestijn, O., Winters, J.C., Groenhof, F., van der Meer, K., Stevens, M., Diercks, R.L., 2012. Incidence, prevalence, and consultation rates of shoulder complaints in general practice. Scand. J. Rheumatol. 41 (2), 150–155.

Hanchard, N.C., Lenza, M., Handoll, H.H., Takwoingi, Y., 2013. Physical tests for shoulder impingements and local lesions of bursa, tendon or labrum that may accompany impingement. Cochrane Database Syst. Rev. 4, CD007427.

Hanratty, C.E., McVeigh, J.G., Kerr, D.P., Basford, J.R., Finch, M.B., Pendleton, A., Sim, J., 2012. The effectiveness of physiotherapy exercises in subacromial impingement syndrome: a systematic review and meta-analysis. Semin. Arthritis Rheum. 42 (3), 297–316.

Hartvigsen, L., Kongsted, A., Hestbaek, L., 2015. Clinical examination findings as prognostic factors in low back pain: a systematic review of the literature. Chiropr. Man. Ther. 23, 13.

Hudak, P.L., Amadio, P.C., Bombardier, C., 1996. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand) [corrected]. The Upper Extremity Collaborative Group (UECG). Am. J. Ind. Med. 29 (6), 602–608.

Kachingwe, A.F., Phillips, B., Sletten, E., Plunkett, S.W., 2008. Comparison of manual therapy techniques with therapeutic exercise in the treatment of shoulder impingement: a randomized controlled pilot clinical trial. J. Man. Manip. Ther. 16 (4), 238–247.

Ketola, S., Lehtinen, J., Arnala, I., Nissinen, M., Westenius, H., Sintonen, H., Aronen, P., Konttinen, Y.T., Malmivaara, A., Rousi, T., 2009. Does arthroscopic acromioplasty provide any additional value in the treatment of shoulder impingement syndrome?: a two-year randomised controlled trial. J. Bone Joint Surg. 91 (10), 1326–1334.

Ketola, S., Lehtinen, J., Rousi, T., Nissinen, M., Huhtala, H., Konttinen, Y.T., Arnala, I., 2013. No evidence of long-term benefits of arthroscopicacromioplasty in the treatment of shoulder impingement syndrome: five-year results of a randomised controlled trial. Bone Joint Res. 2 (7), 132–139.

Kromer, T.O., Bie, R.A., Bastiaenen, C.H., 2013. Physiotherapy in patients with clinical signs of shoulder impingement syndrome: a randomized controlled trial. J. Rehabil. Med. 45 (5), 488–497.

Kromer, T.O., Tautenhahn, U.G., Bie, R.A., Staal, J.B., Bastiaenen, C.H.G., 2011. Effectiveness of physiotherapy interventions for patients with shoulder impingement syndrome: a systematic review. Physiotherapy eS638–eS639.

Lange, T., Matthijs, O., Jain, N.B., Schmitt, J., Lutzner, J., Kopkow, C., 2017. Reliability of specific physical examination tests for the diagnosis of shoulder pathologies: a systematic review and meta-analysis. Br. J. Sports Med. 51 (6), 511–518.

Lasbleiz, S., Quintero, N., Ea, K., Petrover, D., Aout, M., Laredo, J.D., Vicaut, E., Bardin, T., Orcel, P., Beaudreuil, J., 2014. Diagnostic value of clinical tests for degenerative rotator cuff disease in medical practice. Ann. Phys. Rehabil. Med. 57 (4), 228–243.

Lenza, M., Buchbinder, R., Takwoingi, Y., Johnston, R.V., Hanchard, N.C., Faloppa, F., 2013. Magnetic resonance imaging, magnetic resonance arthrography and ultrasonography for assessing rotator cuff tears in people with shoulder pain for whom surgery is being considered. Cochrane Database Syst. Rev. 9, CD009020.

Lewis, J.S., Green, A., Wright, C., 2005. Subacromial impingement syndrome: the role of posture and muscle imbalance. J. Shoulder Elbow Surg. 14 (4), 385–392.

Littlewood, C., Bateman, M., Brown, K., Bury, J., Mawson, S., May, S., Walters, S.J., 2016. A self-managed single exercise programme versus usual physiotherapy treatment for rotator cuff tendinopathy: a randomised controlled trial (the SELF study). Clin. Rehabil. 30 (7), 686–696.

Lombardi Jr., I., Magri, A.G., Fleury, A.M., Da Silva, A.C., Natour, J., 2008. Progressive resistance training in patients with shoulder impingement syndrome: a randomized controlled trial. Arthritis Rheum. 59 (5), 615–622.

Ludewig, P.M., Borstad, J.D., 2003. Effects of a home exercise programme on shoulder pain and functional status in construction workers. Occup. Environ. Med. 60 (11), 841–849.

MacDonald, P.B., Clark, P., Sutherland, K., 2000. An analysis of the diagnostic accuracy of the Hawkins and Neer subacromial impingement signs. J. Shoulder Elbow Surg. 9 (4), 299–301.

Maenhout, A.G., Mahieu, N.N., De Muynck, M., De Wilde, L.F., Cools, A.M., 2013. Does adding heavy load eccentric training to rehabilitation of patients with unilateral subacromial impingement result in better outcome? A randomized, clinical trial. Knee Surg. Sports Traumatol. Arthrosc. Official J. ESSKA 21 (5), 1158–1167.

McClatchie, L., Laprade, J., Martin, S., Jaglal, S.B., Richardson, D., Agur, A., 2009. Mobilizations of the asymptomatic cervical spine can reduce signs of shoulder dysfunction in adults. Man. Ther. 14 (4), 369–374.

Michener, L.A., Walsworth, M.K., Burnet, E.N., 2004. Effectiveness of rehabilitation for patients with subacromial impingement syndrome: a systematic review. J. Hand Ther. 17 (2), 152–164.

Moezy, A., Sepehrifar, S., Solaymani Dodaran, M., 2014. The effects of scapular stabilization based exercise therapy on pain, posture, flexibility and shoulder mobility in patients with shoulder impingement syndrome: a controlled randomized clinical trial. Med. J. Islam. Repub. Iran 28 (87), 1–15.

Mulyadi, E., Harish, S., O'Neill, J., Rebello, R., 2009. MRI of impingement syndromes of the shoulder. Clin. Radiol. 64 (3), 307–318.

Munday SL, J.A., Brantingham, J.W., Globe, G., Jensen, M., Price, J.L., 2007. A randomized, single- blinded, placebo-controlled clinical trial to evaluate the efficacy of chiropractic shoulder girdle adjustment in the treatment of shoulder impingement syndrome. J. Am. Chiropr. Assoc. 44, 6–15.

Neer 2nd, C.S., 1972. Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report. J. Bone Jt. Surg. Am. 54 (1), 41–50.

Nijs, J., Apeldoorn, A., Hallegraeff, H., Clark, J., Smeets, R., Malfliet, A., Girbes, E.L., De Kooning, M., Ickmans, K., 2015. Low back pain: guidelines for the clinical classification of predominant neuropathic, nociceptive, or central sensitization pain. Pain Physician 18 (3), E333–E346.

O'Sullivan, P., 2005. Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. Man. Ther. 10 (4), 242–255.

Ostor, A.J., Richards, C.A., Prevost, A.T., Speed, C.A., Hazleman, B.L., 2005. Diagnosis and relation to general health of shoulder disorders presenting to primary care. Rheumatology 44 (6), 800–805.

Reid, M.C., Lachs, M.S., Feinstein, A.R., 1995. Use of methodological standards in diagnostic test research. Getting better but still not good. Jama 274 (8), 645–651.

Roy, J.S., Braen, C., Leblond, J., Desmeules, F., Dionne, C.E., MacDermid, J.C., Bureau, N.J., Fremont, P., 2015. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. Br. J. Sports Med. 49 (20), 1316–1328.

Schellingerhout, J.M., Verhagen, A.P., Thomas, S., Koes, B.W., 2008. Lack of uniformity in diagnostic labeling of shoulder pain: time for a different approach. Man. Ther. 13 (6), 478–483.

Senbursa, G., Baltaci, G., Atay, O.A., 2011. The effectiveness of manual therapy in supraspinatus tendinopathy. Acta Orthop. Traumatol. Turcica 45 (3), 162–167.

Simopoulos, T.T., Manchikanti, L., Gupta, S., Aydin, S.M., Kim, C.H., Solanki, D., Nampiaparampil, D.E., Singh, V., Staats, P.S., Hirsch, J.A., 2015. Systematic review of the diagnostic accuracy and therapeutic effectiveness of sacroiliac joint interventions. Pain Physician 18 (5), E713–E756.

Surenkok, O., Aytar, A., Baltaci, G., 2009. Acute effects of scapular mobilization in shoulder dysfunction: a double-blind randomized placebo-controlled trial. J. Sport Rehabil. 18 (4), 493–501.

Tyler, T.F., Nicholas, S.J., Lee, S.J., Mullaney, M., McHugh, M.P., 2010. Correction of posterior shoulder tightness is associated with symptom resolution in patients with internal impingement. Am. J. Sports Med. 38 (1), 114–119.

Whiting, P.F., Rutjes, A.W., Westwood, M.E., Mallett, S., Deeks, J.J., Reitsma, J.B., Leeflang, M.M., Sterne, J.A., Bossuyt, P.M., Group, Q., 2011. QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann. Intern. Med. 155 (8), 529–536.

Wijma, A.J., van Wilgen, C.P., Meeus, M., Nijs, J., 2016. Clinical biopsychosocial physiotherapy assessment of patients with chronic pain: the first step in pain neuroscience education. Physiother. Theory Pract. 32 (5), 368–384.

Williams, D.A., 2013. The importance of psychological assessment in chronic pain. Curr. Opin. Urol. 23 (6), 554–559.

Wright, R.W., Baumgarten, K.M., 2010. Shoulder outcomes measures. J. Am. Acad. Orthop. Surg. 18 (7), 436–444.