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Diagnostic accuracy of scapular physical examination tests for shoulder disorders: a systematic review

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ABSTRACT

Objective To systematically review and critique the evidence regarding the diagnostic accuracy of physical examination tests for the scapula in patients with shoulder disorders.

Methods A systematic, computerised literature search of PubMED, EMBASE, CINAHL and the Cochrane Library databases (from database inception through January 2012) using keywords related to diagnostic accuracy of physical examination tests of the scapula. The Quality Assessment of Diagnostic Accuracy Studies tool was used to critique the quality of each paper.

Results Eight articles met the inclusion criteria; three were considered to be of high quality. Of the three high-quality studies, two were in reference to a 'diagnosis' of shoulder pain. Only one high-quality article referenced specific shoulder pathology of acromioclavicular dislocation with reported sensitivity of 71% and 41% for the scapular dyskinesis and SICK scapula test, respectively.

Conclusions Overall, no physical examination test of the scapula was found to be useful in differentially diagnosing pathologies of the shoulder.

INTRODUCTION

Orthopedic physical examination tests have become standard practice when evaluating patients with shoulder pain in an effort to confirm or reject suspected diagnoses. Typically, assessment of the patient includes history, systems review, range of motion, accessory motions, strength testing and special tests for assessing the stability and integrity of the rotator cuff, labrum, and other periarticular structures.[1 2] Previous authors have reported on the diagnostic accuracy of a number of individual glenohumeral joint physical examination tests and their association with a wide variety of shoulder pathologies.[3] Testing at the glenohumeral joint only encompasses one of several joints comprising the shoulder joint complex. In prior studies, investigators and clinicians, in an attempt to capture more comprehensively all of the joints of the shoulder complex, have focused on scapulohumeral movement and scapular position and movement tests to assist in the diagnostic process in patients with shoulder pathologies.[4–8]

Given the contribution of the scapula to the normal movement pattern and stability of the shoulder, assessing scapular movement and position is considered an important part of the clinical examination.[9 10] The scapula acts as an area of force transfer and shoulder stability and is a critical component facilitating normal shoulder functional movements.[10–12] Typically, the goal of examination of the scapula is to identify the presence or absence of optimal scapular motion and position in the symptomatic patient, which, in turn, helps to guide specific treatment options.[10] What is lacking, is the ability to identify whether these altered positions or motions are specific to those with shoulder pathology or if these alterations are part of a normal variation. When evaluating the scapula, the examiner typically observes both the resting and dynamic positioning and motion patterns of the scapula to determine if aberrant position or motion is present.[2 9 10 13] This may consist of abnormalities in the form of premature, excessive, or dysrhythmic motions during active elevation and/or lowering of the shoulder relative to the expected motions or upon bilateral comparison.[9 10] Other described tests use the manual positioning of the scapula to assess for symptom alteration during static[14 15] and dynamic conditions.[16]

Prior studies described tests which relay the usefulness of scapular examination for varied shoulder disorders.[15 17–19] The clinical utility of previously reported scapular examination tests to rule in or rule out shoulder pathology remains unclear and to this date, there has been no systematic review of the body of literature pertaining to the use of scapular tests in diagnosis. Therefore, the purpose of this study was to systematically review the evidence regarding scapular physical examination tests for specific shoulder pathology and provide clinicians with information to determine whether these tests are useful in clinical practice.

METHODS

This systematic review was conducted and reported according to the protocol outlined by PRISMA[20] using a research question framed by PICOS methodology. PICOS is a pneumonic representing population (eg, adults), intervention (eg, scapular physical examination tests used to diagnose shoulder disorders), comparison (eg, control group), outcome (eg, diagnostic accuracy) and study design (eg, cohort).

Identification and selection of the literature

In order to make the search of articles on diagnostic accuracy as comprehensive as possible, we conducted a systematic, computerised search of the literature based on the combined recommendations of previous authors[21–24] in PUBMED, EMBASE, CINAHL and Cochrane Library databases (from

Table 1 PubMed search strategy

No	Search history	Results
1	(((('Diagnosis'(Mesh) OR 'Sensitivity and Specificity'(Mesh)) OR 'Reference Values'(Mesh)) OR 'False Positive Reactions'(Mesh)) OR 'False Negative Reactions'(Mesh)) OR 'Mass Screening'(Mesh) OR diagnos* OR sensitivity OR specificity OR predictive value* OR reference value* OR ROC* OR likelihood ratio* OR monitoring OR screening OR false positive OR false negative OR accuracy or (predictive AND value*)	8 704 266
2	'Scapula'(Mesh) OR scapul* OR (scapular AND dyskinesis*) OR scapulothoracic OR scapulohumeral OR (scapular AND kinematics*)	10 184
3	'Physical Examination'(Mesh) OR clinical examination*	923 045
4	#1 AND #2 AND #3	1341
5	Limit 4 to humans and English language	1060

database inception through January 2012). This generic search strategy to find studies on diagnostic accuracy was then combined with a subject-specific strategy addressing the scapula and associated pathologies/diagnoses, and physical examination (table 1). To identify relevant articles, titles and abstracts of all database-captured citations were independently screened by two reviewers (AAW and EJH) applying the a priori inclusion/exclusion criteria and agreement was measured using the κ statistic (figure 1). Agreement between the two authors regarding which articles to read in full was determined by consensus. Full-text articles were retrieved if the abstract provided insufficient information to establish eligibility or if the article had passed the first eligibility screening. With the remaining articles, the same two authors (AAW and EJH) read the entire paper and again, a κ value was calculated to measure agreement as to which articles to retain for final analysis (figure 1). The reference lists of all selected publications were screened by both reviewers (AAW and EJH) to retrieve relevant publications that were not identified in the computerised search. A hand search was also conducted which included two authors' (AAW and EJH) private collections and the searching of previous literature reviews.

Selection criteria

An article was eligible for inclusion if it met all of the following criteria: (1) a criterion standard of diagnosed shoulder pathology was reported, (2) the statistical association of at least one physical examination test with the outcome of interest was reported, (3) if one or both of the statistics of sensitivity or specificity was reported or could be calculated from available data, (4) the article was available in full text and (5) the article was written in English language. An article was excluded if: (1) the physical examination test was performed using equipment or devices that are not readily available to most clinicians during physical examination, (2) the special test was performed under anaesthesia or in cadavers, (3) a group of physical examination tests was assigned the status of 'composite physical examination', (4) the study was performed in an asymptomatic population or (5) the article was a review.

All criteria were independently applied by two reviewers (AAW and EJH) to the full text of the articles that passed the first eligibility screening. In case of disagreement, a consensus method was used to discuss and resolve the disagreement.

Quality assessment

The methodological quality of each of the included studies was independently assessed by the same two reviewers (AAW and EJH). Reviewers were not masked to trial identifiers such as author and journal names. The quality of a study was assessed

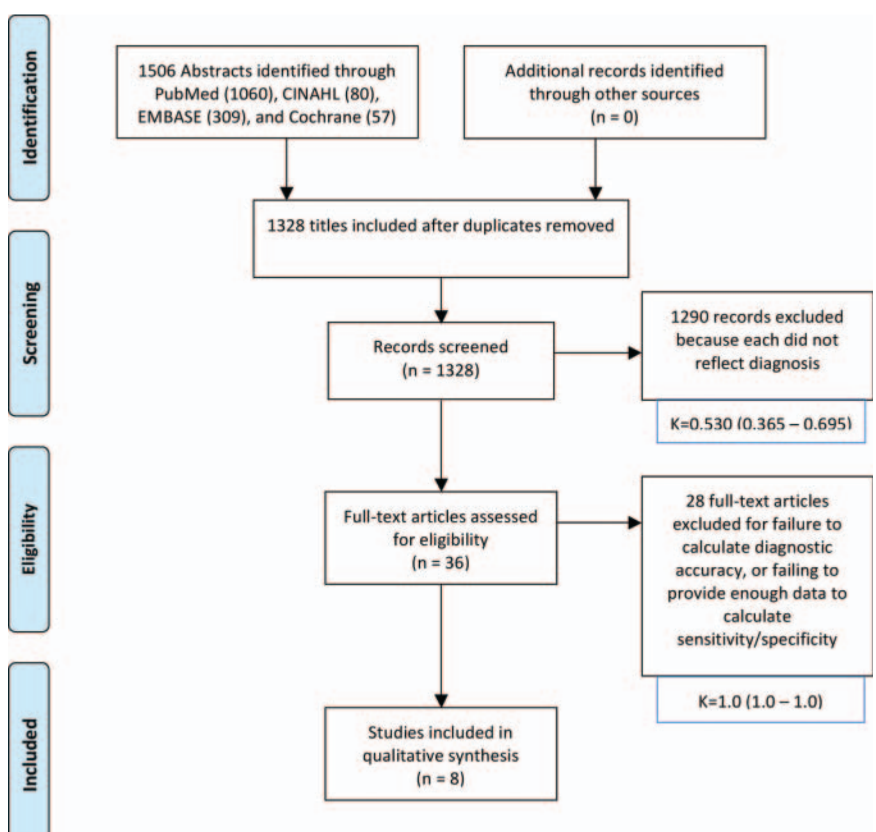

Figure 1 Flow diagram of the literature screening process.

using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool developed by Whiting et al (see online supplementary appendix SA).[25 26] While the authors are aware of the current version of QUADAS, the QUADAS-2, we are unaware of any studies reporting the reliability of the QUADAS-2 and previous attempts by two of the authors (AAW and EJH) in using the tool resulted in a poor weighted κ of 0.31.[27] Therefore, a decision was made to use the original QUADAS tool, which has been adopted for use by the Cochrane Collaboration in a modified version. QUADAS involves individualised scoring of 14 components, with each having a 'yes'/'no'/'unclear' answer option. Individual procedures for scoring each of the 14 items, including operational standards for each question have been published although a cumulative methodological score is not advocated.[28] Disagreements among the reviewers were discussed during a consensus meeting.

The maximum score on the QUADAS tool criteria list was 14. The total score was the count of all of the criteria that scored 'yes'. 'No' and 'unclear' scores carried a zero score value. For each study, a total quality score was given based on the information from all of the available publications. Past studies[29 30] have used a score of 7 of 14 or greater 'yeses' to indicate a high-quality diagnostic accuracy study whereas scores below 7 were indicative of low quality. On the basis of the experience of one of the authors (EJH) in use of the QUADAS tool in his textbook,[31] we established a higher quality score as 10 of 14 or greater unequivocal 'yeses', whereas below 10 was associated with a lower-quality study.

Data extraction

Two reviewers (MF and AAW) independently extracted information and data regarding study population, study design, criterion standard and strength of association statistics associated with the physical examination tests. A third reviewer (EJH) reviewed and confirmed the abstracted results. The third reviewer (EJH) was blinded to the results abstracted by the first two reviewers (MF and AAW).

Statistical analysis

Interobserver agreement of quality assessment was assessed using κ statistics.

The number of true positives, false positives, true negatives and false negatives for each clinical test were extracted from each of the studies, and a 2×2 table was constructed. Discrepancies were resolved by discussion between the two reviewers (AAW and EJH). Sensitivity (SN), specificity (SP), positive likelihood ratio (+LR) and negative likelihood ratio (−LR) estimates were constructed (when possible) based on available data from 2×2 tables. Sensitivity measures the proportion of actual positives which are correctly identified as such (eg, the percentage of sick people who are correctly identified as having the condition). Specificity measures the proportion of negatives which are correctly identified (eg, the percentage of healthy people who are correctly identified as not having the condition). +LR indicates how much the odds of the disease increase when a test is positive.[32] The −LR indicates how much the odds of the disease decrease when a test is negative.[32]

RESULTS

Initially, the search yielded 1506 citations (PubMed 1060, CINAHL 80, EMBASE 309 and Cochrane 57). Of these, 178 duplicates were deleted, leaving 1328 titles with abstracts for review. After the first screening, the full-text articles of 36 potentially eligible citations were retrieved. Following a consensus meeting, a total of eight studies were included in the review (figure 1). Reference checking did not provide any additional studies.

The results of the quality assessment are shown in table 2 and online supplementary appendix SB. The two primary reviewers (AAW and EJH) demonstrated a κ of 0.81 (0.71–0.93). This finding represents almost perfect agreement.[33] The overall quality score ranged from 3 to 11 points and three studies were classified as high-quality studies based on our definition of 10/14 or greater on the QUADAS[26] tool.

Most methodological shortcomings concerned the following items: failure to report adequate descriptive statistics on included patients, lack of acceptable reference standard and failure to describe sufficient detail regarding execution of the reference standard.

A summary of the characteristics of each study is presented in table 3. The included studies ranged in size from 30[5] to 144[15] patients. Twelve different clinical tests were conducted to examine the scapular position, movement patterns and symptom alteration tests and its relationship with shoulder pathology. A summary of the evidence for the diagnostic accuracy of the scapular physical examination tests are presented in the following subsections based on pathology (table 2).

Shoulder pain

The two studies that examined the diagnostic accuracy of scapular physical examination tests to assess shoulder pain were of high design/reporting quality by our definition (table 2).[7 8] The scapular dyskinesis test, winging scapula, tilting scapula, kinetic medial rotation test all demonstrated low sensitivity (21–33%) and variable specificity (28–86%) for shoulder pain. Low sensitivity and variable specificity values resulted in very poor +/−LRs suggesting that none of the tests alter post-test probability to confirm or reject shoulder pain.

Shoulder dysfunction (as defined by the original authors)

None of the three articles that addressed the diagnostic accuracy of scapular physical examination tests for generalised shoulder dysfunction/pathology were of high design/reporting quality by our definition (table 2).[5 6 34] Bias in these studies was mostly related to lack of descriptive data with regard to patient representation and lack of a validated reference standard. Most studies used physician referral diagnosis as the reference standard. Two of the studies reported on the diagnostic accuracy of the lateral scapular slide test (LSST) with mixed results. The Odom *et al*[34] study demonstrated poor diagnostic accuracy statistics for the LSST whereas the Shadmehr *et al*[6] study demonstrated high sensitivity (80–100%), low specificity (4–26%). The LSST for shoulder dysfunction demonstrated no evidence for the ability to rule in or out, change post-test probability or have overall diagnostic discriminative performance. The Kibler *et al*[5] study reported increased muscle force with resisted scapular plane abduction during the scapular retraction test as compared with when the scapula was not retracted in both the control and patient groups, independent of injury.

Shoulder impingement

The scapular reposition test, examined for its ability to identify scapular dysfunction in patients with shoulder impingement symptoms, was of lower design/reporting quality by our definition.[15] A positive test was defined in two ways; increased shoulder strength or decreased pain. The authors did not examine the diagnostic accuracy of the scapular reposition test since it was not the primary purpose of their study, but the

Table 2 Alphabetical list of common scapular physical examination tests

Test name(s)	Pathology	Lead author	Sensitivity	Specificity	+LR	−LR	QUADAS score
Scapular dyskinesis test	Shoulder pain	Tate[8]					10
	>3/10 shoulder pain		24	71	0.83	1.07	
	>6/10 shoulder pain		21	72	0.75	1.10	
Winging scapula	Shoulder pain	Struyf[7]	11	86	0.79	1.03	10
Tilting scapula	Shoulder pain	Struyf[7]	33	78	1.5	0.86	10
Kinetic medial rotation test	Shoulder pain	Struyf[7]	28	28	0.39	2.57	10
Lateral Scapular Slide test	Shoulder dysfunction	Odom[34]					8
1cm threshold							
0° Abduction			35	48	0.67	1.35	
45° Abduction			41	54	0.89	1.09	
90° Abduction			43	56	0.98	1.02	
1.5 cm threshold							
0° Abduction			28	53	0.60	1.36	
45° Abduction			50	58	1.19	0.86	
90° Abduction			34	52	0.71	1.27	
Lateral Scapular Slide Test	Shoulder pathology	Shadmehr[6]					7
1 cm threshold							
0° Abduction			93–100	8–23	1.01–1.30	0.875–0	
45° Abduction			90–93	4–23	0.94–1.21	2.5–0.30	
90° Abduction			86–96	4–15	0.90–1.13	0.27–3.5	
1.5 cm threshold							
0° Abduction			90–96	12–26	1.02–1.3	0.15–0.83	
45°			83–93	15–26	0.98–1.26	0.27–1.13	
90°			80–90	4–19	0.83–1.11	0.52–5.0	
Scapular Retraction Test (increased strength)	Scapular dyskinesis and decreased supraspinatus strength and one of the following: labral injury, glenohumeral instability or impingement	Kibler[5]	100	33	1.49	0	3
Scapular Reposition test	Shoulder impingement	Tate[15]					9
Increased strength	symptoms		26	70	0.87	1.06	
Decreased pain			47		–	–	
Scapular dyskinesis (Kibler pattern)	Acromioclavicular dislocation	Gumina[4]	71	NT	–	–	11
SICK scapula (Scapular malposition, Inferior medial border prominence, Coracoid pain and malposition and dysKinesis of scapular movement)	Acromioclavicular dislocation	Gumina[4]	41	NT	–	–	11
Winging scapula during rest	Trapezius myalgia	Juul[36]	13	83	0.76	1.05	9
Winging scapula during arm elevation			13	78	0.59	1.12	
Winging scapula during arm elevation with a dumbbell			13	91	1.44	0.96	

*Bias: high=score of <10/14; low=score of ≥10/14.
*95% CI were not reported.
1 cm and 1.5 thresholds are defined as a bilateral difference of greater than 1.0 or 1.5 cm in scapular distance measurements (inferior angle of scapula to the spinous process of the thoracic vertebra in the same horizontal plane) to define abnormal scapular asymmetry.
Degrees of abduction are in reference to the three test positions of the lateral scapular slide test whereby the patient is asked to position the shoulder in 0, 45 and 90 degrees of abduction.
AC, acromioclavicular; ER, external rotation; FTT, full thickness tear; OA, osteoarthritis; QUADAS, Quality Assessment of Diagnostic Accuracy Studies; RC, rotator cuff; SLAP, superior labrum anterior to posterior.

values reported allowed for our calculation of these values. When defined as increased shoulder strength, the scapular reposition test demonstrated a sensitivity of 26%, a specificity of 70%, with no ability to change post-test probability for ruling in or out shoulder impingement. When defined as a decrease in pain, the reported sensitivity was 47% suggesting the use of this test to diagnose shoulder impingement is no better than chance.

Acromioclavicular dislocation

Two tests, scapular dyskinesis and SICK scapula, for diagnosis of scapular dysfunction in the presence of acromioclavicular dislocation were reported in a single article of high design/reporting quality by our definition.[4] Reported sensitivities of the scapular dyskinesis test and SICK scapula were 71% and 41%, respectively. Specificity values were not reported and could not be calculated from the data as all patients included in the study were positive for previous diagnoses of acromioclavicular dislocation. Given the fact that the test was performed after the diagnosis of a type III acromioclavicular dislocation, it is of no surprise that such tests would be abnormal or considered positive following such injury. Our finding is consistent with previous authors[35] who have suggested that signs of scapular dyskinesis may be the result of shoulder pathologies versus the cause.

Table 3 Summary of studies

Author (year)	Sample size	Age	Symptom duration	Study design	Criterion standard	Test	Conclusions
Kibler *et al* (2006)[5]	20 Patients Control group: 10	42.75 (SD 16.0) 30.8 (SD 6.0)	Unclear	Controlled laboratory study	Clinical and MRI diagnosis of labral injury, glenohumeral instability or impingement; AND decreased supraspinatus strength; AND scapular dyskinesis on clinical examination (% presence of scapular dyskinesis was not reported)	Scapular retraction test	– Manual muscle testing of the supraspinatus muscle (Jobe/empty can test) in the scapular retraction position improves muscle force generation in both symptomatic and asymptomatic patients – The magnitude of increase in supraspinatus muscle force was less in this control group. This finding may reflect the lack of clinically detectable scapular dyskinesis and abnormal scapular protraction so that retraction would have less effect on strength – Scapular positioning exerts its effects on increased strength independent of specific injury
Gumna *et al* (2009)[4]	34 Patients	47.0 Range: 24–69	Unclear	–	Radiograph	Scapular dyskinesis; SICK scapula	– Chronic type III AC dislocation causes scapular dyskinesis
Juul-Kristensen *et al* (2011)[36]	TM: 38 Control: 23	TM: 44.0 (SD 11.1) Control: 41.5 (SD 8.7)	More than 30 days within the previous year	Reproducibility study; case–control study	Questionnaire and clinical criteria	1. Winging scapula during rest 2. Winging scapula during arm elevation 3. Winging scapula during arm elevation with a dumbbell	– Weakness or dysfunction of the scapula stabilising muscles in the trapezius myalgia group compared to the healthy controls was not present in the clinical variables: winging; delayed movement start; weakness of scapula stabilising muscles; and active proprioception/reposition
Odom *et al* (2001)[34]	Shoulder dysfunction: 20 Control: 26	30.0 (SD 11.1)	–	Case control	Physician diagnosis including: impingement or glenohumeral instability (8); rotator cuff tear (4); rotator cuff strain/tendinitis (3); glenohumeral dislocation or subluxation (4); labral tears (1)	Lateral Scapular Slide Test (LSST)	– LSST does not appear to be useful for identifying the injured side based on the value of the derived difference in scapular distance measurements- Sn and Sp of the LSST are poor and the LSST cannot be used to identify people with and without shoulder dysfunction
Shadmehr *et al* (2010)[6]	27 Patients 30 control	Symptomatic: 47.7 (SD 11.6) Asymptomatic: 33.5 (SD 11.7)	–	Cross-sectional, prospective, repeated-measure study	Orthopedic Surgeon Referral including: recurrent dislocation (4); supra spinatus tendonitis (10); biceps tendonitis (3); rotator cuff tear (4); scapular dyskinesis (1); rotator cuff strain (2); impingement syndrome (30)	LSST	– Diagnostic accuracy of the LSST was low, which questions the clinical importance of the test outcomes- Asymmetry is not necessarily an indicator of dysfunction
Struyf *et al* (2011)[7]	36 Patients 36 control	Symptomatic: 33.4 (SD 11.3) Range 18–60 Asymptomatic: 33.1 (SD 10.9) Range 18–56	–	Case–control study	Self-reported shoulder pain (Shoulder disability questionnaire)	1. Winging 2. Tilting 3. Kinetic Medial Rotation Test	– No scapular positioning or motor control differences were found in athletes with or without shoulder pain in winging, tilting, or kinematic medial rotation test
Tate *et al* (2009)[8]	104 Shoulder pain	–	–	Validation study	Self-reported shoulder pain (Penn Shoulder Scale)	Scapular Dyskinesis Test	– Validity of this test has been demonstrated by differences in scapular kinematics found between participants with and without obvious dyskinesis- There is no relationship between the presence of pain and scapular dyskinesis in the athletes included in the study
Tate *et al* (2008)[15]	98 Shoulder impingement 46 non-impingement	20.8 (SD 2.8)		Repeated measures; case control	Shoulder impingement by clinical exam including 1 positive impingement test (Neer, Hawkins-Kennedy, Jobe)	Scapular Reposition Test	– The presence of impingement did not affect strength gains with the SRT- Strength gains with scapular repositioning are not exclusive to those with symptoms or pathology- In athletes with shoulder impingement symptoms, nearly half demonstrate reduced pain with the SRT- The SRT is a simple clinical test that may potentially be useful to identify impairments related to shoulder pathology

Trapezius myalgia

A single article examined three scapular physical examination tests for scapular winging in subjects with and without trapezius myalgia. Perhaps because this article was designed to examine reliability and not validity per se, the article was of lower design/reporting quality by our definition.[36] All three tests, winging scapula during rest, winging scapula during arm elevation and winging scapula during weighted arm elevation with a dumbbell demonstrated low sensitivity (13%) with high specificity (78–91%). These three tests in this study demonstrated +/− LRs near zero, indicating none of the tests demonstrate an ability to rule in or out scapular winging in subjects with or without trapezius myalgia, nor do they effect changes in post-test probability.

DISCUSSION

The overall results of this systematic review indicate that physical examination tests for scapular position or motion alterations, and scapular symptom alteration tests do not enable the diagnosis of a shoulder pathology or general shoulder pain. These results are based on 8 studies of 12 scapular physical examination tests; several additional articles were not included because diagnostic accuracy values were not presented or able to be calculated[16 37 38]; the study was performed in an asymptomatic population[13 39]; or the study was not diagnostic of shoulder pathology.[19 40 41] Findings across studies for the scapular physical examination tests could not be combined for meta-analysis because of the low number of studies that used the same reference standard, methodology or diagnosis. Some tests had moderate-to-high specificity and others moderate-to-high sensitivity, but overall, no scapular position, motion, or symptom alteration physical examination test appeared to be of value in terms of modifying post-test probability. In other words, the use of any of these scapular physical examination tests would not result in any meaningful shift in pretest to post-test probability of a diagnosis of shoulder pain or pathology.

Only three of the included eight studies were considered of high quality, a QUADAS score ≥ 10/14. Scapular position and motion via the scapular dyskinesis test[8 42] performed during active arm elevation was examined in two[4 8 42] of these three studies. The scapular dyskinesis test was found by Tate *et al*[8] to have moderate specificity (72%) but not sensitive for diagnosing general shoulder. Conversely, Gumina *et al*[4] found moderate sensitivity (71%) in acromioclavicular dislocation; specificity was not calculated. Struyf *et al*[7] used a similar scapular examination in a cohort of overhead athletes with shoulder pain. They assessed scapular position and motion of winging and tilting during both static arm positions and during active arm abduction, and found moderate-to-high specificity but very poor sensitivity. The diagnoses in these three high-quality studies were general shoulder pain[8 18] and a specific shoulder pathology of acromioclavicular dislocation.[4] The diagnostic values reported in these prior three studies for the scapular dyskinesis test or a variant thereof indicate that this test likely is not helpful in the diagnostic process.

Scapular asymmetry in motion or position is likely not an indicator of shoulder dysfunction, and is not limited to those with shoulder pathology. The percentage of those with altered scapular motion and position has been reported to be quite similar in cohorts of subjects with and without shoulder pain.[18 19] Moreover, the presence of scapular motion alterations and shoulder pain has not shown to be significantly related.[8] None of the studies included in this systematic review reported an ability to discriminate between those with and those without shoulder pain or a specific pathology based on findings from scapular physical examination tests. These findings suggest that scapular asymmetry or motion alterations do not provide any additional clinical examination benefit with regard to diagnosing shoulder pain or pathology. There are two explanations for this finding: (1) clinical tests of scapular dyskinesis are incapable of diagnosing shoulder pathology because they are poor tests lacking validity, reliability or both and (2) scapular dyskinesis is a clinically understood yet nebulous concept that makes dyskinesis a poor reference test. From the results of this review, the correct explanation is left to conjecture. Clearly, none of the tests displayed sensitivity or specificity numbers of note. However, scapular dyskinesis is a coupled motion of both the scapula and humerus occurring simultaneously in three different planes. Therefore, although dyskinesis is often presented as a singular noun, dyskinesis is most likely a collective noun composed of multiple movement impairments. Much like a syndrome, the collection of impairments makes a reference test, a test designed to capture the concept of dyskinesis, difficult. Not only, then, are the reference tests compromised, but also almost none of the studies in this review used an acceptable reference standard for the pathologies the reference tests were attempting to detect. Further, some of the pathologies reported (eg, impingement or shoulder dysfunction) are syndromes with a lack of a defined criterion standard. Others (eg, rotator cuff and biceps tear) have an established criterion standard (surgery) but the study authors failed to incorporate subjects who had been diagnosed by the criterion standard. The end result, then, should be a healthy skepticism on the part of the reader for the numbers gleaned from the studies in this review and therefore, caution against relying too heavily on these clinical tests is encouraged.

Scapular motion and position physical examination tests were not formally defined as diagnostic tests for shoulder pathology or pain in the majority of included studies; however, a majority of the studies attempted to relate scapular examination test findings back to a specific shoulder diagnosis.[4 5 15 36] Worth noting is the lack of acceptable reference standards in the majority of studies included. Scapular alteration tests are likely most appropriately used to classify impairments, which facilitates decision-making for the development of specific rehabilitation programmes. Specifically, if altered scapular position or motion impairments are observed, further clinical measures of scapular muscle strength and length of soft tissues attached to the scapula may be required in order to determine the selection of specific treatment interventions, however we cannot confirm this based on current findings. In reality, further research is needed to determine the clinical utility of tests of scapular dyskinesis as they relate to shoulder pain and dysfunction. There is a great need for large, prospective, well-designed studies that examine the ability of the many aspects of the clinical examination and what combinations of these aspects are useful in differentially diagnosing pathologies of the shoulder and facilitate selection of interventions and treatment planning.

Limitations

Any review is limited by the quality of studies contained therein. Diagnostic accuracy statistics were not reported in the majority of studies included requiring calculations by the authors from the results reported. Many of the studies in this review had issues with the reference standard and subject flow and timing. Again, there was a clear trend in the use of physician referral based on clinical examination as a criterion standard. Further, we limited our articles to those in the English language that may make this review more prone to dissemination bias.

CONCLUSIONS

On the basis of the findings of this systematic review, the use of any physical examination tests for the scapula position, scapular motion (dyskinesis) or symptom alteration test cannot be recommended for clinical use to diagnose shoulder pain or shoulder pathology. No single scapular physical examination test demonstrated the ability to alter post-test probability to enable the diagnostic process. Scapular physical examination tests are best used as measures of impairments to select suitable treatment interventions and develop treatment programmes. They may be helpful in prognosticating future shoulder injury risk or development of chronic shoulder pain; however, further studies are needed to establish such a relationship. Future studies are needed to investigate the full utility of these scapular tests.

What this study adds

- This is the first systematic review regarding the diagnostic accuracy of physical examination tests for the scapula in patients with shoulder disorders.
- Overall, no physical examination test of the scapula was found to be useful in differentially diagnosing pathologies of the shoulder.
- No scapular position, motion or symptom alteration physical examination test appeared to be of value in terms of modifying post-test probability of a diagnosis of shoulder pain or pathology.
- None of the studies included in this systematic review reported an ability to discriminate between those with and those without shoulder pain or a specific pathology based on findings from scapular physical examination tests.

Recommendations

- The use of any singular scapular physical examination test to make a pathognomonic diagnosis cannot be recommended.

Contributors Conception and design: AAW and EJH; analysis and interpretation of data: AAW, MF and EJH; manuscript preparation: AAW, LAM, CAW; revising critically: AAW, LAM, CAW, EJH; final approval: AAW, LAM, CAW, EJH, MF.

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Notes