A Proposed Evidence Based Shoulder Special Testing Examination Algorithm: Clinical Utility Based on a Systematic Review of the Literature

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A Proposed Evidence Based Shoulder Special Testing Examination Algorithm: Clinical Utility Based on a Systematic Review of the Literature

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Abstract

PURPOSE: To identify individual orthopedic shoulder physical examination special tests with the best clinical utility statistics in the format of an examination algorithm. Attaining the highest possible level of diagnostic statistical probability assists the practitioner in differential diagnosis between or among common shoulder pathological conditions. METHODS: A computer-assisted literature search of MEDLINE, CINAHL, PubMed and SPORTDiscus databases using keywords related to the statistical clinical utility of common orthopedic shoulder physical examination special tests from 1980 to August 2010 were used for literature review. Articles cited in a reference standard orthopedic shoulder examination algorithm were also included for review.[1] Pre-test probability for each special test was set at 50% based on knowledge inferred about the patient condition during patient examination prior to special testing. A treatment threshold of 80% post-test probability was set to determine whether a specific special test had the statistical utility necessary to be included in the examination algorithm. Quality assessment of the articles used for this study was performed using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) scoring system.[2] RESULTS: Articles deemed to have high-quality based on the QUADAS scoring system were only used for this study. Common shoulder conditions that include subacromial impingement syndrome, rotator cuff tears, anterior capsulolabral instability and/or lesions, posterior capsulolabral instability and/or lesions, SLAP lesions, and acromioclavicular joint lesions were all deemed to be diagnosed with at least 80% post-test probability based on the proposed algorithm data from data in those studies inclusive . Of all common pathological shoulder conditions included in this study, three categories (Articular internal impingement syndrome, long head of the biceps (LHB) tendinopathy, and Bankart lesions) were determined to lack an 80% or greater post-test probability for successful determination of a pathological shoulder lesion.

Introduction

Subjective data, patient history, and physical objective data are of paramount importance in the clinical diagnostic process. Differentially diagnosing between or among various pathological conditions is of great importance in physical medicine for many reasons. Accuracy in diagnosis guides the practitioner toward a proper treatment plan of care. Avoidance of costly diagnostic testing is a great advantage to an accurate diagnosis through physical examination. Diagnostic physical examination accuracy leads to faster treatment thresholds with less reliance placed upon various practitioners. Ruling out certain diagnosis may also make referral markedly less necessary by deeming a patient most appropriate for physical therapy treatment versus other interventions, including surgery.

Orthopedic special tests aim to make the diagnostic process more precise by implicating specific tissue structures that are in a state of pathology. Uses of special tests include confirmation of a tentative diagnosis, making a differential diagnosis, distinguishing between or among various potentially pathological tissues that may be symptomatic, and making sense of atypical objective and subjective patient signs and symptoms.[3]

Special testing is traditionally performed after taking a full subjective examination and a full objective examination that includes but is not limited to patient history and mechanism of injury, clinical observation, bony and soft tissue palpation, assessment of active and passive physiological movements, assessment of passive arthokinematic accessory joint mobility, neurological assessment, manual muscle testing, and functional assessments.

Methods

Special tests using an examination algorithm are proposed to be performed for a specific condition only if indicated based on an individual's subjective data, history, physical presentation, and objective data. Pre-test probability was estimated at 50% for this study; it is estimated that a specific shoulder pathological condition may be ascertained 50% of the time after subjective and objective examination of a patient without the use of special tests. Published specificity and sensitivity values were used to calculate positive and negative likelihood ratios if they were not already given. Post-test probabilities were calculated using these published and/or calculated values with a pre-test probability set at 50%.

Special tests with the best current evidence-based statistical utility profile are only used in this examination algorithm. Testing is proposed to continue until a treatment threshold of 80% post-test probability is achieved (unless otherwise stated due to a lack of current evidence). Procedures for in-depth description of how to perform each special test are outside the scope of this study.

Comprehensive retrieval of as many articles as possible on the statistical utility of shoulder special tests was attempted by employing a search strategy previously reported.[4] Though this strategy was reported for use with MEDLINE, it was used to retrieve additional articles in the CINAHL, PubMed, and SPORTDiscus databases if not already retrieved. Articles cited in a reference standard orthopedic shoulder examination algorithm were included for review if not already retrieved.[1]

After article retrieval, quality assessment of those articles containing special test data was performed. Internal and external validity were evaluated by the author using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) tool. A scoring system for quality assessment includes 14 questions regarding methodology of a chosen article.[2] Scores indicating a high-quality diagnostic study of statistical utility have been previously graded at 7 or higher by other authors in the review of other diagnostic testing statistics.[5,6] After quality assessment was completed, those articles that included adequate statistical utility that was calculated to meet a treatment threshold of 80% post-test probability were reviewed. In the event that a singular special test had two or more articles that had statistical utility data reports, the lesser statistical utility data set was used.

Special Testing Examination Algorithm

I. Initial Hypothesis Based on Subjective and Objective Data

Indication for algorithm-based special testing begins with a quality subjective and objective examination. This will provide the practitioner with a working hypothesis as to the nature of the pathology. Clusters of common signs and symptoms may be indicative of the potential nature of a patient's shoulder condition.[1,7]

Patient reports of anterior/lateral pain, pain with overhead motion, demonstration of a painful arc with active shoulder elevation, and night pain may be indicative of rotator cuff tendinopathy and/or subacromial impingement syndrome.[1,7]

Patient reports of anterior/lateral pain, compensatory shoulder shrugging with overhead motion, gross functional disabilities, constant achiness in the shoulder, night pain, pain that wakes that patient during sleep, and patient age of 40-60 or greater may be indicative of a rotator cuff tear.[1,7]

Patient reports of anterior pain, apprehension and/or pain in positions of abduction and external rotation, a history of anterior/inferior trauma, recurrent or volitional anterior/inferior subluxations and/or dislocations, complaints of joint clicking/clunking, complaints of joint locking, and a history of "dead arm syndrome" may be indicative of anterior capsulolabral instability or labral lesions or a Bankart lesion.[1,7]

Patient reports of deep posterior pain, apprehension and/or pain in positions of horizontal adduction, apprehension or pain during activities that involve pushing (especially coupled with horizontal adduction), apprehension or pain during closed kinetic chain (CKC) positions, a history of posterior/inferior trauma, recurrent or volitional posterior/inferior subluxations and/or dislocations, and complaints of joint clicking/clunking may be indicative of posterior capsulolabral instability or labral lesions.[1,7]

Patient reports of deep shoulder pain, complaints of clicking/clunking, complaints of joint locking, pain with activities that require eccentric deceleration of the upper extremity (such as throwing or swinging), and pain with muscular loading of the biceps (especially during shoulder flexion and arm supination) may be indicative of a SLAP lesion.[1,7]

Patient reports of very specific posterior/superior pain during shoulder abduction and external rotation as well as possible pain with activities that require eccentric

deceleration of the upper extremity (such as throwing or swinging) may be indicative of an articular-sided internal impingement syndrome of the rotator cuff.[1,7]

Patient reports of anterior pain, painful palpation to the proximal aspect of the long head of the biceps (LHB), pain with activities that require eccentric deceleration of the upper extremity (such as throwing or swinging), and pain with muscular loading of the biceps (especially during shoulder flexion and arm supination) may be indicative of LHB tendinopathy.[1,7]

Patient reports of superior joint pain, pain with end-range elevation activities, pain with horizontal adduction activities, painful palpation to the acromioclavicular (AC) joint, a notable AC joint "step-off" on observation, and an injurious mechanism that involves a fall on the shoulder may be indicative of an AC joint lesion.[1,7]

II. Screening into Testing Sub-Categories

Screening Test: Screening tests are indicated to be performed on all patients to rule in or rule out both intra-articular pathology and rotator cuff pathology.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Internal Rotation Resisted Strength Test(IRRST)[8]	In 90° ABD and 80° ER, if IR MMT<< ER MMT the test is positive for intra-articular pathology. If IR MMT>>ER MMT the test is positive for rotator cuff pathology.	.96	.86	22.0	.13

The operational definition of rotator cuff pathology is as follows: Findings that include a thickened or inflamed subacromial bursa, erosions on the CA ligament and undersurface of the acromion, and bursal side partial or full thickness rotator cuff tears.[8]

The operational definition of intra-articular pathology is as follows: Findings that included glenoid erosion or labral tears, middle GH ligament tearing, articular-sided rotator cuff partial tears, posterior labral lesions, and SLAP lesions.[8]

The post-test probability that the patient will exhibit either intra-articular pathology or rotator cuff pathology is 91.7% when the test implicates such. The post-test probability that the patient will exhibit either intra-articular pathology or rotator cuff pathology when the test does not indicate such is 6.1%. Inconclusive testing (normative values for IR and ER manual muscle testing), therefore, can be used to rule out both intra-articular pathology and rotator cuff pathology. One can deduce that an extra-articular pathology or pain referred from a different area of the body may be present with an inconclusive test. QUADAS score is 7 for the article in which statistical data was attained and calculated for these post-test probability statistics.

The examiner may now place the patient into an appropriate diagnostic test sub-category with a high level of confidence based on this screening test (Figure 1).

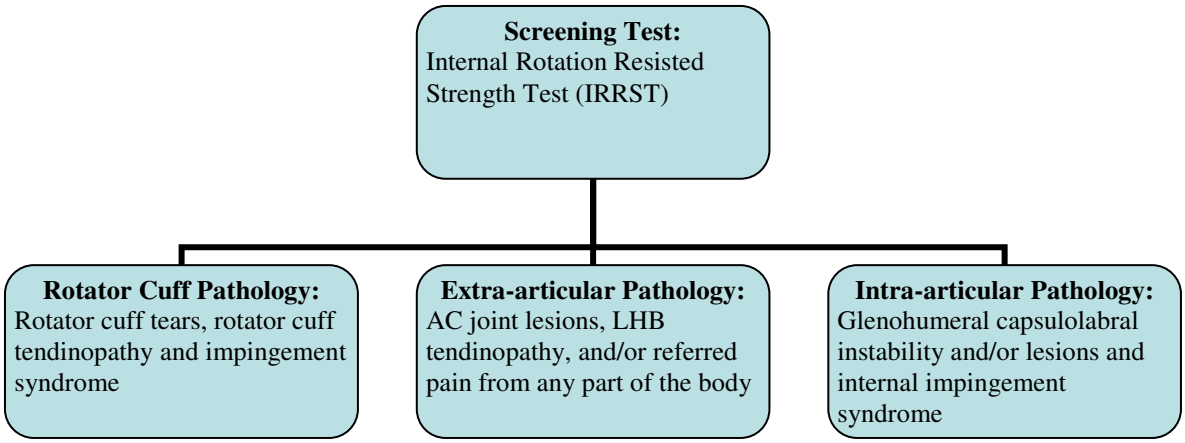

Figure 1. The Internal Rotation Resisted Strength Test (IRRST) allows the practitioner to categorize a shoulder condition into one of three categories: rotator cuff pathology, extra-articular pathology, or intra-articular pathology.

III. Rotator Cuff (RTC) Pathology

A. Rotator Cuff Tendinopathy/Impingement Syndrome: Testing is indicated with a positive IRRST (IR MMT>>ER MMT) and other appropriate signs and symptoms suggesting rotator cuff impingement syndrome.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Test Item Cluster[9]	Hawkins-Kennedy, Infraspinatus Muscle Test, and Painful Arc Sign are all positive.	NR	NR	10.56	NR
Test Item Cluster[9]	Two of three tests are positive: Hawkins-Kennedy, Infraspinatus Muscle Test, and Painful Arc Sign.	NR	NR	5.03	NR

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

Post-Test probability for the Test Item Cluster (TIC) of the three above tests is 95.5% if all 3 are positive, and 91.0% if 2 of 3 are positive as reported by Park and colleagues[8]. The post-test probability that the patient will exhibit rotator cuff tendinopathy and/or impingement syndrome when the TIC doesn't indicate such is unknown, as the –LR data was not reported.[8] QUADAS score is 10 for the article in which statistical data was attained and calculated for these post-test probability statistics.

Special tests with reported data that fail to consistently meet the treatment threshold for use in this study included the Hawkins-Kennedy test[9-15], the Neer test[9-14,16], the Yocum test[12,14], the horizontal adduction test[9,11], the painful arc sign[9,11], the empty can test[9,11,14], the drop arm test[9,11], the Yergason test[9,11], the Speed test[9-11], the Pattes test[14], the Gerber lift-off test[14], the hourglass test[17], the anterior apprehension test[18], the fulcrum test[19], the forced shoulder abduction test[19], and Ellman's test[19].

B. Rotator Cuff Tears: Testing is indicated with a positive IRRST (IR MMT>>ER MMT) and other appropriate signs and symptoms suggesting rotator cuff tearing.

Test	Applicable Findings	Sp	Sn	+LR	-LR
External Rotation	Shoulder is held in 20^0 of	.98	.69-	15.5-	.02-.32

Lag Sign (ERLS) for Supraspinatus and/or Infraspinatus[20,21]	scaption, nearly full ER, and 90^0 of elbow flexion. Inability to keep the shoulder in near maximal ER indicates a positive test.		.98	34.50	
Dropping Sign @ 90^0 ABD and 45^0 ER for Infraspinatus[21]	Inability to hold shoulder in ER in described position.	1.00	1.00	0.00	0.00
Hornblower's Sign for Teres Minor[21]	Inability to externally rotate to "Hornblower" position.	.93	1.00	14.29	0.00
Internal Rotation Lag Sign (IRLS) for Subscapularis[20]	Patient is placed in 20^0 of shoulder extension in near maximal IR with the forearm behind the back. Inability to hold shoulder IR indicates a positive test.	.96	.97	24.3	.03

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

The post-test probabilities that the patient will exhibit rotator cuff tears are 88.75% (at minimum) for the ERLS, approximately 100% for the Dropping Sign, 87.7% for the Hornblower's Sign, and 92.4% for the IRLS. The post-test probabilities that the patient will exhibit rotator cuff tears are 13.8% (at maximum) for the ERLS, approximately 0.0% for the Dropping Sign, approximately 0.0% for the Hornblower's Sign, and 1.48% for the IRLS. QUADAS scores are 7 for both articles in which statistical data was attained and calculated for these post-test probability statistics.

Special tests with reported data that fail to consistently meet the treatment threshold for use in this study included the full can test[22], the empty can test[9,12,17,20,22], the Neer test[9,13], the Hawkins-Kennedy test[9,13], the Speed test[9,12,17], the Rent test[25,26], the Gilcrest palm-up test[9,12,17], the drop sign (90^0 abduction and 90^0 external rotation) [9,20,30], the lift-off test[12,20,27,28,29], the belly-off test[29], the Napolean test[27,29], the bear-hug test[27], the supine impingement sign[22], the infraspinatus muscle test[9], the painful arc sign[9,22], the cross-body adduction test[9], manual muscle testing of the supraspinatus combined with palpation[26], manual muscle testing of the infraspinatus combined with palpation[26], passive elevation of less than 170 degrees[22], passive external rotation of less than 70[22], supraspinatus atrophy[22], and infraspinatus atrophy[22].

IV. Intra-Articular Pathology

A. Anterior/Anterior-Inferior Glenohumeral Instability: Testing is indicated with a positive IRRST (IR MMT<<ER MMT) and other appropriate signs and symptoms suggesting anterior glenohumeral instability.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Apprehension Test[31,32]	Apprehension to test position of 90^0 abduction, 90^0 of elbow flexion, and maximal external rotation.	.96-.99	.53-.72	20.2-53	.29-.47

Anterior Release Test (also known as Surprise Test)[31,33]	Apprehension or pain when posterior relocation is removed in test position of 90^0 abduction, 90^0 of elbow flexion, and maximal external rotation..	.89-.99	.64-.92	8.36-58.6	.09-.37

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

Post-test probabilities for the above tests are respectively 91.0% and 80.7% at minimum. The post-test probabilities that the patient will exhibit anterior/anterior-inferior glenohumeral instability when the above tests do not indicate such are respectively 19.0% and 15.6% at maximum. QUADAS scores are respectively 10, 11, and 9 for the articles in which statistical data was attained and calculated for these post-test probability statistics.

Special tests with reported data that fail to consistently meet the treatment threshold for use in this study included the sulcus sign[19,37,40], the Feagin test[19], the apprehension test (for a labral tear or for pain as opposed to apprehension)[31,32,40], the Jobe relocation test[31,32,34,40], the anterior slide test[35,36], the anterior load and shift test[32,37,38,39,40].

B. Bankart Lesion and/or Anterior Labral Tear: Testing is indicated with a positive IRRST (IR MMT<<ER MMT) and other appropriate signs and symptoms suggesting anterior-inferior glenohumeral capsulolabral pathology.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Test Item Cluster (Crank Test, Apprehension Test, Jobe Relocation Test, and Anterior Load and Shift Test*[40]	Positive findings for all four tests are necessary: apprehension or an audible click for the Crank test, apprehension for the Apprehension test, elimination of apprehension for the Jobe Relocation test, and excessive translation for the anterior load and shift test.	.85	.90	6.0	.12

*This test item cluster has been studied in the detection for any anterior glenoid capsulolabral tear, including but not limited to a Bankart Lesion. This data is not specific to the Bankart lesion alone.
Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

Post-test probability for the Test Item Cluster is 75.0%. The post-test probability that the patient will exhibit a Bankart lesion (or anterior SLAP lesion) when the Test Item Cluster does not indicate such is 7.0%. Treatment threshold at this time is proposed as a positive Test Item Cluster as described in spite of the lack of statistical evidence. QUADAS score is 11 for the article in which statistical data was attained and calculated for these post-test probability statistics.

Special tests that have reported data that fail to consistently meet the treatment threshold for use in this study include the clunk tests (clunk test and clunk test II)[1,19] and the crank test[41-46].

C. Posterior/Posterior-Inferior Glenohumeral Capsulolabral Instability/Labral Lesions: Testing is indicated with a positive IRRST (IR MMT<<ER MMT) and other appropriate signs and symptoms suggesting posterior glenohumeral pathology.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Jerk Test[48]	Sharp pain and/or click/clunk with described test procedure.	.98	.73	36.5	.28
Kim Test[48]	Sharp pain and/or click/clunk with described test procedure.	.94	.80	13.3	.21

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

Post-test probabilities for the above tests are respectively 94.8% and 86.9%. The post-test probabilities that the patient will exhibit posterior/posterior-inferior glenohumeral instability and/or a labral lesion when the above tests do not indicate such are respectively 12.3% and 9.5%. The QUADAS score is 11 for the article in which statistical data was attained and calculated for these post-test probability statistics.

Special tests that have reported data that fail to consistently meet the treatment threshold for use in this study include the posterior slide test and the posterior load and shift test.[1,37]

D. SLAP Lesions: Testing is indicated with a positive IRRST (IR MMT<<ER MMT) and other appropriate signs and symptoms suggesting a SLAP lesion.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Biceps Load Test I[49]	Apprehension in ER or pain with resisted bicep contraction during described test procedure.	.97	.90	30	.10
Biceps Load Test II[50]	Pain with resisted bicep contraction during described test procedure.	.97	.90	30	.10

Post-test probabilities are respectively 93.75% for each test. The post-test probabilities that the patient will exhibit a SLAP lesion when the above tests do not indicate such are 5.25% for each test. QUADAS scores are respectively 9 and 11 for the articles in which statistical data was attained and calculated for these post-test probability statistics.

Special tests with reported data that fail to consistently meet the treatment threshold for use in this study included the compression rotation test[19,36], the O'Brien test[19,36,43-44,51,52], the Jobe relocation test[19,44,46,52,53], the Speed test[19,44,46,52,55-58], the Yergason test[19,43,46,58],the pain provocation test[42,46], the anterior slide test[19,44,46,52,53], the biceps tenderness test[19,44,52], the resisted supination external rotation test[45], the Neer test[19,46], the Hawkins-Kennedy test[19,46], and the SLAPrehension test[54].

E. Articular-Sided Rotator Cuff Internal Impingement Syndrome: Testing is indicated with a positive IRRST (ER MMT>>IR MMT) and other appropriate signs and symptoms suggesting internal impingement syndrome.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Posterior Impingement Sign[59]	Pain is elicited with testing procedure as described.	.85	.76	5.0	.29

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

This article presents the only known research with data on the statistical profile for identification of internal impingement of the articular side of the rotator cuff at this time. Post-test probability with a positive test is 71.4%. The post-test probability that the patient will exhibit symptoms of internal impingement syndrome when the above test does not indicate such is 12.7%. It is also hypothesized that positive traditional rotator cuff impingement syndrome testing and a positive IRRST for an intra-articular lesion may combine to suggest internal impingement syndrome.[8] Due to a lack of evidence, treatment threshold at this time is proposed as a positive test as described as well as positive traditional rotator cuff impingement testing. The QUADAS score is 7 for the article in which statistical data was attained and calculated for these post-test probability statistics.

V. Extra-Articular Pathology

A. LHB Tendinopathy: Testing is indicated with appropriate signs and symptoms suggesting LHB tendinopathy/tendinosis. LHB tendinopathy may be an isolated pathology, in which case the IRRST screening test would be inconclusive. If LHB tendinopathy is coupled with subacromial impingement or a SLAP lesion, a positive IRRST screening test may be possible. LHB tendinopathy may include a positive IRRST for rotator cuff pathology (IR MMT>>ER MMT) along with all other appropriate signs and symptoms suggesting LHB tendinopathy. LHB tendinopathy may also include a positive IRRST (IR MMT<<ER MMT) if associated with a SLAP lesion, along with all other appropriate signs and symptoms suggesting LHB tendinopathy.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Yergason's Test[14,58]	Pain is produced in the bicipital groove.	.58-.79	.43-.74	1.76-2.05	.45-.72
Speed Test[57,58]	Pain is elicited with testing in the proximal shoulder.	.14-.75	.32-.90	1.0-1.28	.71-.91
Gilcrest Palm-Up Test[12,14]	Pain is elicited with testing in the proximal shoulder.	.35-.58	.63-.74	.97-1.76	.45-1.06

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)

-LR: Negative likelihood ratio=(1-sensitivity)/specificity

Post-Test probabilities with a positive Yergason's test range from 46.8% to 50.6%, from 33.3% to 39.0% with a positive Speed test, and from 32.7% to 46.8% with a positive Gilcrest Palm-Up Test. The post-test probabilities that the patient will exhibit an LHB lesion when the above tests do not indicate such range from 18.4% to 26.5% with the Yergason's test, from 26.2% to 31.27% with the Speed test, and from 18.4% to 34.6% with the Gilcrest Palm-Up Test. Because the statistical profile for the above tests are fairly similar, treatment threshold for the exception of lack of current evidence is proposed to be positive results for two of the three tests. QUADAS scores range from 7-11 for the articles in which statistical data was attained and calculated for these post-test probability statistics. These four articles are the only known to have statistical data for the presence of isolated LHB lesions (lesions that are found in the LHB as well as those in the presence of subacromial impingement syndrome and/or SLAP lesions).

B. AC Joint Pathology: Testing is indicated with appropriate signs and symptoms suggesting an AC joint lesion as well as an inconclusive IRRST.

Test	Applicable Findings	Sp	Sn	+LR	-LR
Test Item Cluster[60]	All three of the following tests are positive: Cross-Body Adduction test, AC Resisted Extension Test, and the O'Brien's Test.	.97	.25	8.3	.77

Sp: Specificity=true negatives/(true negatives+false positives)
Sn: Sensitivity=true positives/(true positives+false negatives)
+LR: Positive likelihood ratio=sensitivity/(1-specificity)
-LR: Negative likelihood ratio=(1-sensitivity)/specificity

Post-Test probability when all three tests are positive per the Test Item Cluster (TIC) is 80.5%. The post-test probability that the patient will exhibit an AC joint lesion when the TIC does not indicate such is 27.8%. The QUADAS score is 10 for the article in which statistical data was attained and calculated for these post-test probability statistics.

Special tests with reported data that fail to consistently meet the treatment threshold for use in this study included the O'Brien test[51,60,61], the Paxino test[61], AC joint palpation[61], the cross-body adduction test[60], the AC resisted extension test[60], the Neer test[60], the Hawkins-Kennedy test[60], the painful arc sign[60], the drop arm sign[60], and the speed test[60].

Summary of Proposed Shoulder Examination Algorithm Special Test Classifications

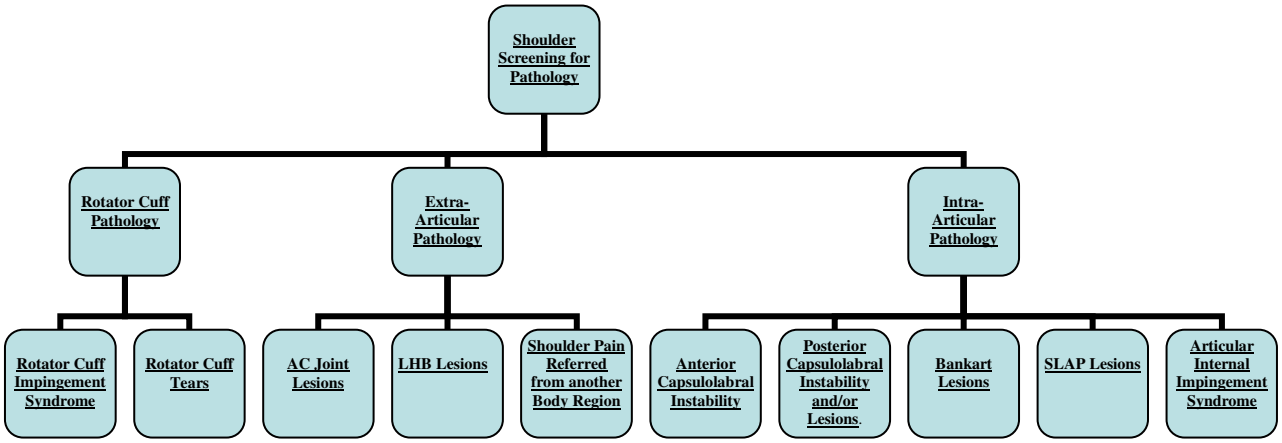

Figure 2. Flow chart of algorithm based examination process. Rotator cuff pathology, extra-articular pathology, and intra-articular pathology are further subdivided into common shoulder conditions that may be differentially diagnosed.

Conclusion

Statistical data quality, accuracy, and precision were all necessary for inclusion of the special tests in the proposed shoulder examination algorithm. Due to the fact that many special tests had numerous data citations with wide variance, both accuracy and precision were necessary for appropriate data selection. For this reason, the minimal data set for each special test was used in the selection process. Wide variance in data for a number of special tests and a wide range in the number of data sets per each special test made this a necessity. Other means for reporting statistical data such as the mean, median, mode, or use of the best data set for each test was deemed inappropriately cautionary for clinical utility by the author.

A widely used and highly popular shoulder examination algorithm was used as a reference standard for this study.[1] 54 articles were critiqued to evaluate the 58 tests named in the reference standard algorithm examination and the version proposed in this study (41 tests from the reference standard algorithm and 13 of 25 tests in the version proposed in this study that were not included in the reference standard algorithm). In the reference standard shoulder examination algorithm, 5 of 41 tests achieved a post-test probability statistic of at least 80%. In the proposed shoulder examination algorithm, 17 of 25 tests achieved a post-test probability statistic of at least 80%. 10 tests were included in 3 different Test Item Cluster data sets. Two TIC data sets that include 6 special tests met a post-test probability statistic of at least 80% when they otherwise would not have in isolation. Special testing data has not shown to be consistently sufficient to date for detection of articular internal impingement syndrome, tendinopathy of the LHB, and Bankart lesions with the parameters set in this study. A summary of the data sources for selected special tests used in this examination algorithm is given in table 1.

Table 1. Data Summary of the 17 articles yielding statistics for the 25 special tests included in the proposed shoulder examination algorithm. The minimal reported data sets achieve the set treatment threshold for every test category with the exception of Bankart lesions, articular internal impingement syndrome, and LHB tendinopathy.

Special Test	Citation	Test Category	Sample Size	Reference Standard	Sp	Sn	LR+	LR-	Post-Test Probability
IRRST	Zaslav (8)	Screening Test	110	Surgical Observation	0.96	0.86	0.86	0.13	91.7%
Rotator Cuff Impingement TIC (3/3)	Park et al (9)	RTC Impingement	552	Surgical Observation	NR	NR	10.56	NR	95.5%*
Rotator Cuff Impingement TIC (2/3)	Park et al (9)	RTC Impingement	552	Surgical Observation	NR	NR	5.03	NR	91.0%*
ERLS	Hertel et al (20)	RTC (Supraspinatus and/or Infraspinatus) Tear	87	Surgical Observation	0.69	0.98	15.50	0.32	88.8%
ERLS	Walch et al (21)	RTC (Supraspinatus and/or Infraspinatus) Tear	87	Surgical Observation	0.98	0.98	34.50	0.02	94.5%
Dropping-Sign	Walch et al (21)	RTC (Infraspinatus) Tear	87	Surgical Observation	1.00	1.00	0.00	0.00	100.0%
Hornblower's Sign	Walch et al (21)	RTC (Teres Minor) Tear	87	Surgical Observation	0.93	1.00	14.29	0.00	87.7%
IRLS	Hertel et al (20)	RTC (Subscapularis) Tear	54	Surgical Observation	0.96	0.97	24.30	0.03	92.4%
Apprehension Test	Lo et al (31)	Anterior Instability	46	Radiograph	0.99	0.53	20.20	0.47	91.0%
Apprehension Test	Farber et al (32)	Anterior Instability	363	Surgical Observation	0.96	0.72	53.00	0.47	96.4%
Anterior Release (Surprise) Test	Lo et al (31)	Anterior Instability	46	Radiograph	0.99	0.64	8.36	0.37	80.7%
Anterior Release (Surprise) Test	Gross et al (33)	Anterior Instability	100	Surgical Observation	0.89	0.92	58.60	0.09	96.7%
Anterior Labral Tear TIC	Liu et al (40)	Bankart Lesion/Anterior Labral Tear	62	MRI	0.85	0.90	6.00	0.12	75.0%
Jerk Test	Kim et al (48)	Posterior Instability/Labral Tear	172	Surgical Observation	0.98	0.73	36.50	0.28	94.8%
Kim Test	Kim et al (48)	Posterior Instability/Labral Tear	172	Surgical Observation	0.94	0.80	13.30	0.21	86.9%
Biceps Load Test I	Kim et al (49)	SLAP Lesion	75	Surgical Observation	0.97	0.90	30.00	0.10	93.8%
Biceps Load Test II	Kim et al (50)	SLAP Lesion	127	Surgical Observation	0.97	0.90	30.00	0.10	93.8%
Posterior Impingement Sign	Meister et al (59)	Articular Internal Impingement Syndrome	69	Surgical Observation	0.85	0.76	5.00	0.29	71.4%
Yergason's Test	Naredo et al (14)	LHB Tendinopathy	31	Ultrasonography	0.58	0.74	1.76	0.45	46.8%
Yergason's Test	Holtby et al (58)	LHB Tendinopathy	50	Surgical Observation	0.79	0.43	2.05	0.72	50.6%
Speed Test	Bennett (57)	LHB Tendinopathy	46	Surgical Observation	0.14	0.90	1.00	0.71	33.3%
Speed Test	Holtby et al (58)	LHB Tendinopathy	50	Surgical Observation	0.75	0.90	1.28	0.91	39.0%
Gilcrest Palm-Up Test	Leroux (12)	LHB Tendinopathy	55	Surgical Observation	0.35	0.63	0.97	1.06	32.7%
Gilcrest Palm-Up Test	Naredo et al (14)	LHB Tendinopathy	31	Ultrasonography	0.58	0.74	1.76	0.45	46.8%
AC Joint TIC (3/3)	Chronopoulos et al (60)	AC Joint Lesion	325	AC Joint Injection	0.97	0.25	8.30	0.77	80.5%

*Post-test probabilities for the RTC impingement TIC were reported by Park et al[9] under parameters in their study.

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