ORIGINAL ARTICLE

Reliability and Diagnostic Accuracy of 5 Physical Examination Tests and Combination of Tests for Subacromial Impingement

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ABSTRACT. Michener LA, Walsworth MK, Doukas WC, Murphy KP. Reliability and diagnostic accuracy of 5 physical examination tests and combination of tests for subacromial impingement. Arch Phys Med Rehabil 2009;90:1898-903.

Objective: To investigate the reliability and diagnostic accuracy of individual tests and combination of tests for subacromial impingement syndrome (SAIS).

Design: A prospective, blinded study design.

Setting: Orthopedic surgeon shoulder clinic.

Participants: Patients with shoulder pain (n=55, mean age=40.6y).

Interventions: Patients were evaluated with 5 physical examination tests for SAIS: Neer, Hawkins-Kennedy, painful arc, empty can (Jobe), and external rotation resistance tests. Surgical diagnosis was the reference standard.

Main Outcome Measures: Diagnostic accuracy calculated with a receiver operating characteristic (ROC) curve and sensitivity, specificity, positive likelihood ratio (+LR), and negative likelihood ratio (−LR). A forward stepwise binary logistic regression analysis was used to determine the best test combination for SAIS. An ROC curve analysis was also used to determine the cut point of the number of tests discriminating between the presence and absence of SAIS. Kappa coefficients and percent agreement assessed interrater reliability.

Results: The ROC analyses revealed a significant area under the curve (AUC) (AUC=.67–.72, $P<.05$) for all tests, except for the Hawkins-Kennedy. The tests with a +LR greater than or equal to 2.0 were the painful arc (+LR=2.25; 95% CI, 1.33–3.81), empty can (+LR=3.90; 95% CI, 1.5–10.12), and the external rotation resistance tests (+LR=4.39; 95% CI, 1.74–11.07). Tests with −LR less than or equal to 0.50 were the painful arc (−LR=.38; 95% CI, .16–.90), external rotation resistance (−LR=.50; 95% CI, .28–.89), and Neer tests (−LR=.35; 95% CI, .12–.97). The regression analysis had no specific test combinations for confirming or ruling out SAIS. The ROC analysis was significant (AUC=.79, $P=.001$), with a cut point of 3 positive tests out of 5 tests. Reliability was moderate to substantial agreement ($\kappa=.45–.67$) for the painful arc, empty can, and external rotation resistance tests and fair strength of agreement ($\kappa=.39–.40$) for the Neer and Hawkins-Kennedy tests.

Conclusions: The single tests of painful arc, external rotation resistance, and Neer are useful screening tests to rule out SAIS. The single tests of painful arc, external rotation resistance, and empty can are helpful to confirm SAIS. The reliability of all tests was acceptable for clinical use. Based on reliability and diagnostic accuracy, the single tests of the painful arc, external rotation resistance, and empty can have the best overall clinical utility. The cut point of 3 or more positive of 5 tests can confirm the diagnosis of SAIS, while less than 3 positive of 5 rules out SAIS.

Key Words: Diagnosis; Rehabilitation; Rotator cuff; Sensitivity and specificity; Shoulder; Shoulder impingement syndrome; Tendonitis.

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SHOULDER PAIN ACCOUNTS for 33.2% of physician office visits for musculoskeletal pain in the United States.[1] The prevalence of shoulder pain is 7% to 27% for adults and is increasing for women and older individuals.[1-3] The most frequent cause of shoulder pain is SAIS[3-5]; however, there is no consensus as to the diagnostic criteria for SAIS. The physical examination tests used to diagnose SAIS vary widely in clinical trials.[6,7] This lack of consensus for diagnosing SAIS is an obstacle to investigating treatment interventions and prognosis for this disorder. There are several reasons for the lack of diagnostic consensus, including the multifactorial nature of this disorder along with the limited and conflicting evidence as to the diagnostic capability of physical tests for SAIS.

The spectrum of SAIS involves injury of the subacromial space structures to include rotator cuff tendinosis, rotator cuff partial thickness tear, and bursitis. Injury to the rotator cuff most frequently involves the supraspinatus tendon caused by direct compression to the tendon within the subacromial space and by tension overload applied to the tendon leading to intrinsic tendon degeneration during repetitive activities. The tests used to differentially diagnose SAIS via compression of the tendon in the subacromial space include the Neer,[8] Hawkins-Kennedy,[9] and the painful arc[10] tests. Tests used to

List of Abbreviations

AUC	area under the curve
CI	confidence interval
−LR	negative likelihood ratio
+LR	positive likelihood ratio
ROC	receiver operating characteristic
SAIS	subacromial impingement syndrome

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apply tension to the supraspinatus tendon via supraspinatus muscle contraction include resisted shoulder elevation with the empty can (Jobe Test)[11] and resisted shoulder external rotation, which is also known as the external rotation resistance test.[12] The diagnostic ability of these tests has been examined,[12-16] but these studies have provided inconsistent results and have major methodologic limitations that include a retrospective design, nonblinding of the examiner who determined the reference standard, and use of a reference standard that has its own error. Previous studies[16-20] investigating reliability of SAIS tests have also shown inconsistent results, with Kappa values ranging from .18 to 1.0, indicating poor to almost perfect agreement.

Clinicians make a diagnosis from a combination of findings from the history and physical examination. Three studies[12-14] have examined the combination of tests for diagnosing SAIS. The combination of the external rotation resistance test (weakness or pain), Hawkins-Kennedy, and painful arc tests showed moderate to large shifts in probability to confirm the diagnosis and screen for SAIS.[12] Conversely, another study[14] found the combination of positive findings for 5 tests of 7 tests (Hawkins-Kennedy, Neer, Horizontal Adduction, Speeds, Yeargason, Painful Arc, Drop Arm) was only minimally helpful to diagnose SAIS with a small shifts in posttest probability. In a third study[13] investigating the combination of the Neer and Hawkins-Kennedy tests, the diagnostic capability was not improved when compared with either test individually.

To examine the effectiveness of treatment for SAIS, further evidence is needed to determine those tests with the strongest ability to screen for and diagnose SAIS. Moreover, further examination of the usefulness of the combination of tests for SAIS is needed. The purposes of this study were to determine (1) interrater reliability of SAIS physical examination tests, (2) diagnostic accuracy of the SAIS physical examination tests, and (3) a specific cluster of tests that are optimal to confirm or rule out SAIS. These results will aid clinicians in diagnosing SAIS. Optimizing the diagnosis of SAIS will improve the ability to guide treatment decision making and ultimately lead to improved medical management.

METHODS

This was a prospective blinded cohort study approved by the Medical Center Investigational Review Board. Consecutive patients presenting with shoulder pain to an orthopedic surgeon's office were invited to participate in this study. To be included in this study, patients had to report shoulder pain for at least 1 week, and shoulder pain had to be their primary complaint. A total of 65 patients were invited to participate; 3 refused to participate, and 7 did not undergo the reference standard (surgery), leaving a total of 55 subjects for the sample. The sample (n=55) consisted of 47 men and 8 women with an average age of 40.6±15.1 years (range 18–83y) and an average symptom duration of 33.8±48.9 months (range 2–230mo).

The rights of the subjects were protected by an informed consent, which was read and signed by all participants. All patients then underwent a standardized history and physical examination by 2 clinicians: 1 orthopedic surgeon board certified in orthopedic surgery and a physical therapist board certified in orthopedics, with 17 and 8 years experience in musculoskeletal examinations, respectively. Each clinician independently performed a standardized history and physical examination and was blinded to each other's findings and without knowledge of any imaging studies. Before the start of the study, the clinicians underwent training to standardize technique and interpretation of the tests.

The Neer test[8] was performed with the examiner stabilizing the scapula with a downward force while fully flexing the humerus overhead maximally while applying overpressure. A positive test was reproduction of pain of the superior shoulder.

The Hawkins-Kennedy test[9] was performed by the examiner flexing the humerus and elbow to 90° and then maximally internally rotating the shoulder and applying overpressure. A positive test was reproduction of pain of the superior shoulder.

The painful arc[10] was performed by asking the patient to actively abduct his/her shoulder and report any pain during abduction. If pain of the superior shoulder was noted between 60° and 120° of abduction, the test was considered positive.

The empty can test,[11] also known as the Jobe test, was performed by the examiner elevating the shoulder to 90° in the scapular plane (30°–40° anterior to the coronal plane) and then placing the shoulder in internal rotation by asking the patient to rotate the shoulder so that his/her thumb was pointing toward the floor. The examiner then applied a downward directed forced at the wrist while the patient attempted to resist. A positive test was considered if weakness was detected of the involved shoulder as compared bilaterally.

The external rotation resistance test[12] was performed by placing the arm at the patient's side and flexing their elbow to 90°. A medially directed force was exerted on the distal forearm to resist shoulder external rotation. A positive test was considered if weakness was detected of the involved shoulder as compared bilaterally.

There were 5 tests for SAIS; results were recorded as "positive" or "negative" for each test as described. After completion of the history and physical examination, the patients underwent an arthroscopic examination within an average of 2.6 months (±2.7mo, range: 1d–8mo) after the clinical examination. The reference standard was determined via operative findings reported by an operative surgeon blinded to the clinical examination findings. This method was used to ensure blinding of the reference standard to the clinical examination to eliminate the risk for review bias. The intraoperative reference standard criteria for SAIS were the presence of any of the following: visually enlarged bursa, fibrotic appearing bursa, or degeneration of the supraspinatus tendon at the superficial aspect. Patients with additional shoulder pathologies such as partial or full-thickness rotator cuff tears, labral tears, or fraying and instability were not excluded.

Data Analysis

The first aim was to determine the intertester reliability for the 5 impingement tests between 2 clinicians. Reliability was

Table 1: Diagnoses of Subjects by the Gold Standard of Surgical Findings

Diagnosis	Number of Subjects (%)
Negative for SAIS	39/55 (71)
Positive for SAIS	16/55 (29)
SAIS only	1 (1.8)
SAIS and	
PT-RCT	4 (7.3)
FT-RCT	3 (5.5)
Labral tear (any type)	11 (20)
Instability	1 (1.8)
Acromio-clavicular joint	
Degenerative joint disease	3 (5.5)
Biceps tendon tear	3 (5.5)

NOTE. n=55. Some patients had more than 1 additional diagnosis beyond SAIS.
Abbreviations: PT-RCT, partial-thickness rotator cuff tear; FT-RCT, full-thickness rotator cuff tear.

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