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The diagnostic value of the combination of clinical tests for the diagnosis of supraspinatus tendon tears

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Abstract:

CONTEXT: A large number of special tests have been described to examine the shoulder. It is unknown which combination of clinical tests might be optimal for the diagnosis of rotator cuff tears.

AIMS OF OUR STUDY: To estimate the diagnostic accuracy of history and clinical tests and to find out which combination of clinical tests is best in diagnosing supraspinatus tendon tears.

SETTINGS AND DESIGN: Diagnostic test accuracy study.

METHODOLOGY: One hundred and thirty-four patients with shoulder pain were evaluated with history-taking and clinical tests and magnetic resonance imaging of the shoulder.

STATISTICAL ANALYSES: Sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratios were calculated with a 2 × 2 table.

RESULTS: The combination of Neer test, painful arc test, and full can test yielded 100% sensitivity and 100% specificity in diagnosing supraspinatus tears of any type.

CONCLUSIONS: Our study shows that individual clinical tests have moderate diagnostic value for the diagnosis of supraspinatus tears. Diagnostic value improves significantly when clinical tests are combined together. Neer test, painful arc test, and full can test form the best combination in diagnosing supraspinatus tears of any type.

Keywords:

Clinical tests, diagnostic accuracy, magnetic resonance imaging, supraspinatus tendon tears

Introduction

Rotator cuff tears are the common cause of shoulder pain and dysfunction.[1,2] The prevalence of rotator cuff tears is 5%–39%.[1] Clinical tests should be used selectively and tailored to the clinical condition suspected.[3,4] Recent meta-analysis showed that data were lacking to support most clinical tests used for diagnosing rotator cuff tears, and there is a need for high-quality studies to test the diagnostic performance of parameters from patient history and physical examinations.[5-7] The study was done to estimate the diagnostic accuracy of clinical tests and to find out which combination of clinical tests is best in diagnosing supraspinatus tendon tears.

Methodology

This prospective study was conducted in the orthopedic department of our hospital from June 2015 to August 2017.

Patient selection

Patients presenting with shoulder pain of age above 18 years of either sex was included in the study. Patients with shoulder fractures, frozen shoulder, arthritis, bilateral shoulder pain, previous dislocation shoulder, and instability were excluded. Ethical clearance has been taken from ethical committee before conducting the study.

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Control
Unaffected opposite shoulder joint was taken as control in our study.

Study design
Diagnostic test acuuracy study design.

Calculating the sample size
The targeted study population consists of all patients who satisfy the criteria for inclusion and are not disqualified by one or more of the exclusion criteria. The included patients were a consecutive series of patients presenting at the study center. No randomization was done. The sample size was calculated assuming a sensitivity and specificity of at least 0.85, the confidence interval of 95% with a width of 0.1 and an effect size of 0.5, leading to sample size of 70 patients with the power of 0.9.[8]

Data collection
The patients of shoulder pain were evaluated by history and clinical examination. The examiner was blinded to the imaging analyses. Subsequently, all patients underwent X-ray of the shoulder and magnetic resonance imaging (MRI) of the involved shoulder as a reference standard for the final diagnosis, which was done on the same day [Figure 1].

Relevant clinical information
Appropriate demographical and historical data were recorded.

Intervention
Routine clinical examination of the shoulder was performed, and then, clinical tests were selected for evaluation in the study [Table 1].[2,3,7] Blood tests and other investigations were done.

Plain X-ray films of the shoulder were useful to rule out other causes of shoulder pain, such as osteoarthritis (of glenohumeral joint and acromioclavicular joint) and calcific tendinitis. Changes seen on plain films that are consistent with rotator cuff disease include acromial spurs, decreased space between the humerus and acromion, and sclerosis and cystic changes in the greater tuberosity.

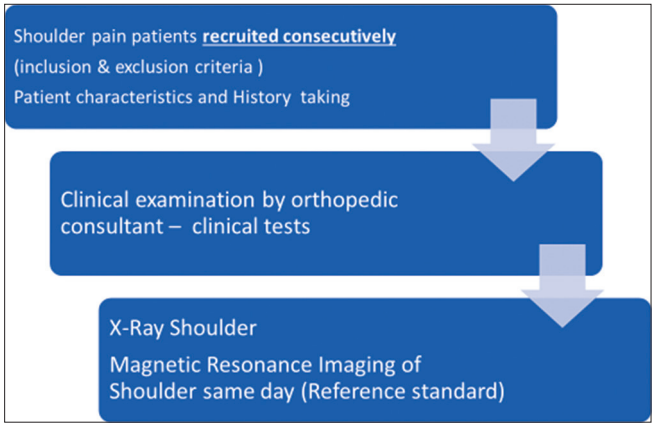

Figure 1: Methodology-data collection

Reference standard–magnetic resonance imaging
Experienced radiologist who was blinded from clinical test results reported the MRI. MRI gives a great deal of anatomic information and usually is considered the gold standard for imaging cuff disease. The normal rotator cuff tendon is of low signal on T1- and T2-weighted images. Partial-thickness rotator cuff tears most commonly appear as interruption of the normal cuff contour, resulting in a cuff defect filled with fluid signal. Full-thickness tears were seen as defect has fluid-like signal and might also see tendon retraction.[9-11]

Data analyses/statistical analyses
Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio, and negative likelihood ratios were calculated with a 2 × 2 table.

Results

One hundred and thirty-four (134) patients were collected. Thirty-four patients were excluded as per inclusion and exclusion criteria. Effective sample size was (134–34) 100. Table 2 shows patient's demographic characteristics. Sixty-seven patients were diagnosed with supraspinatus tendon tears. Males were affected more commonly. Right shoulder has higher incidence of supraspinatus tendon tears. Table 3 shows different types of rotator cuff tears and their frequency. Incidence of supraspinatus tears was higher as compared to other tendons and partial tears were more common. Tables 4 and 5 show various MRI diagnoses and their frequencies. Partial tear of supraspinatus tendon was the most common diagnosis. Twenty-four patients had other diagnosis [Table 5] and nine patients had normal shoulder on MRI.

History
The highest incidence of supraspinatus tendon tears was seen in the age group above 50–60 years, which was clinically significant ($P = 0.009$). Night pain has showed the highest sensitivity. Weakness and smoking have highest specificities [Table 6].

Clinical tests
Painful arc test has highest sensitivity of 96%. Palpation test, external rotation at 0°, and drop arm test have highest specificity of 100%, 100%, and 97%, respectively.

Table 1: Clinical tests

Clinical tests	Method to perform	Inference
Neer test	The impingement sign is elicited with the patient seated and the examiner standing. Scapular rotation is prevented with one hand while the other hand raises the arm in forced forward elevation, causing the greater tuberosity to impinge against the acromion	A positive test is if the maneuver produces pain over the anterolateral shoulder
Hawkins-Kennedy test	The examiner forward flexes the humerus to 90° and forcibly internally rotates the shoulder. This maneuver drives the greater tuberosity farther under the coracoacromial ligament	Pain over the anterolateral shoulder with this maneuver is considered positive for impingement
Drop arm test (Codman's sign)	It and is performed by passively abducting the patient's shoulder to 180° and then observing as the patient slowly lowers the arm to the waist. The patient may be able to lower the arm slowly to 90° (because this is a function mostly of the deltoid muscle as opposed to the supraspinatus) but will be unable to continue the maneuver as far as the waist	This test is positive when the arm drops to the side
Full can test	The full can test is performed with patient's arms abducted in 90° in the scapular plane and rotated 45° externally, with the thumb pointing upward	The sign is positive when there is pain over the anterolateral shoulder or weakness at the downward pressure applied by the examiner
Painful arc test	The painful arc test was performed with the patient standing. The patient was asked to elevate the arm actively in the scapular plane, until the arm was fully elevated and then to let the arm down in the same arc	The test was considered positive when the patient demonstrated pain over the anterolateral shoulder or reported a painful catching between 60° and 120° elevation
Empty can test (Jobe test)	Test was performed with the patient standing, the shoulder in 90° abduction in the scapular plane and with full internal rotation. The thumbs were pointing toward the floor. The patient maintained this position against downward resistance applied by the examiner	The test was considered positive when the patient demonstrated weakness or pain over the anterolateral shoulder during the applied resistance
Palpation of tendon defect	Codman first described the palpation of full thickness rotator cuff tears. He described the ability to palpate a "sulcus" produced by a rent in the supraspinatus tendon. The elbow on the affected side is flexed to 90° and held in that position. The top of the humeral head is palpated with the arm rotated into internal and external rotation and then hyper extended. In external rotation, an anterior supraspinatus tear can be felt	The test was considered positive when the defect is felt
External rotation lag sign at 0°	The patient is seated with his or her back to the physician. The elbow is passively flexed to 90°, and the shoulder is held at 20° elevation (in the scapular plane) and near-maximum external rotation (i.e., maximum external rotation–5° to avoid elastic recoil in the shoulder) by the physician. The patient is then asked to actively maintain the position of external rotation as the physician releases the wrist while maintaining support of the limb at the elbow	The sign is positive when a lag, or angular drop, occurs. The magnitude of the lag is recorded to the nearest 5°. A positive test indicates posterosuperior cuff (supraspinatus and infraspinatus) deficiency
Supraspinatus strength test	It is tested with the arm in internal rotation and elevated to 90° in the plane of the scapula	It is graded from 0-5 Grade 0: No contraction or muscle movement Grade 2: Movement at the joint with gravity eliminated Grade 3: Movement against gravity, but not against added resistance Grade 4: Movement against external resistance with less strength than usual Grade 5: Normal
Infraspinatus strength test	It is measured by testing external rotation with the elbow flexed to 90° and the arm held to the side	It is graded from 0-5 Grade 0: No contraction or muscle movement Grade 2: Movement at the joint with gravity eliminated Grade 3: Movement against gravity, but not against added resistance Grade 4: Movement against external resistance with less strength than usual Grade 5: Normal

Table 2: Demography of patients

Parameters	Number (*N*)
Total patients enrolled	116, 16 cases excluded based on inclusion and exclusion criteria
Effective sample size	100
Full-thickness supraspinatus tear	18
Age (years)	32-77
Mean age (years)	61
Sex (%)	
Males	10 (55)
Females	8 (45)
Side (%)	
Right	13 (72)
Left	5 (18)
Dominant arm (%)	
Right	18 (100)
Left	00
Mean BMI (range)	26.8 (18-31)
Occupation	
Homemaker	8
Office work/desk	6
Job	
Heavy work	4

BMI: Body mass index

Table 3: Types of rotator cuff tears and their frequency

Tendon	Types of tear	*n*
Supraspinatus	Partial	49
	Complete	18
	Total	67 patients
Infraspinatus	Partial	3[a]
	Complete	00
Subscapularis	Partial	1[b]
	Complete	00

[a]1 case was associated with partial supraspinatus tear, 2nd case was associated with complete supraspinatus tear and 3rd case was associated with complete supraspinatus tear and partial subscapularis tear, [b]1 case was associated with complete supraspinatus tear and partial infraspinatus tear

Drop arm test has positive likelihood ratio of 11, suggesting that it is very useful test in ruling in the disease. Diagnostic values of individual tests and combination of tests are presented in Tables 7 and 8.

Discussion

This study evaluates diagnostic values of individual patient's characteristics, symptoms, and clinical tests in supraspinatus tendon tears. The prevalence of supraspinatus tendon tears in our study is 67%; in other studies, it is 40%.[6,12]

According to Murrell and Walton[12] and van Kampen *et al*.,[13] rotator cuff tear prediction increases with increasing age. Our study also showed increased incidence of cuff tear in 51–60 years of age group. In our study, age above 50.5 years has very significant correlation ($P = 0.009$) with

Table 4: Various magnetic resonance imaging diagnosis

MRI diagnosis	Frequency
Normal	9
Partial tear of supraspinatus tendon	49
Complete tear of supraspinatus tendon	18
Others diagnosis	24
Total	100

MRI: Magnetic resonance imaging

Table 5: Other diagnosis on magnetic resonance imaging

Diagnosis	Number of patients
Acromioclavicular joint arthritis	7[a]
SLAP tear	6[b]
Subacromial bursitis	3
Biceps tendinitis	2[c]
Supraspinatus and infraspinatus tear	2
Supraspinatus, infraspinatus, and subscapularis tear	1
Calcific tendinitis	1
Type 2 acromion	1[d]
Bankart's lesion	1[e]
Total	24

[a]4 cases were associated with partial supraspinatus tear, 1 case was associated with complete supraspinatus tear, 1 case was associated with biceps tendinitis, [b]1 case was associated with partial supraspinatus tear, [c]1 case was associated with complete supraspinatus tear, [d]1 case was associated with complete supraspinatus tear, [e]1 case was associated with partial supraspinatus tear. SLAP: Superior labral tear from anterior to posterior

supraspinatus tendon tears. Night pain has sensitivity of 89% in the study by van Kampen *et al*., while our study showed similar result (89%). Further, radiation of pain and patients taking analgesics showed high sensitivities of 73% and 78%, respectively. Weakness has 34% sensitivity and 55% specificity in the study by van Kampen *et al*., while our study had sensitivity of 40% and specificity of 88% for weakness.

Sensitivity of clinical tests ranged from 6% to 96%. Painful arc test showed highest sensitivity of 96%, which was also reported in study by Park *et al*.[14] Hawkins test had highest sensitivity of 95.2%.

Specificity of clinical tests ranged from 21% to 100%. Palpation test and external rotation test at 0° showed highest specificity and PPV of 100%. Drop arm test had specificity of 97%. Park *et al*. showed that infraspinatus muscle test had highest specificity of 75% and highest PPV of 90.6% for rotator cuff disease of any type. Drop arm test had highest specificity of 100%. In the study by Wolf and Agrawal,[15] the transdeltoid palpation test was found to have a sensitivity of 95.7%, a specificity of 96.8%, a PPV of 95.7%, a NPV of 96.8%, and an overall accuracy of 96.3%.

The present study (2018), Ardic *et al*.,[16] Kim *et al*.,[17] Caliş *et al*.,[18] and Itoi *et al*.[19] have MRI as reference

Table 6: Diagnostic values of various symptoms

Symptoms	Sensitivity	Specificity	PPV	NPV	+LR	–LR
Weakness	40	88	87	42	3.3	0.7
Radiation	73	52	75	49	1.5	0.5
Night pain	89	49	78	70	1.7	0.2
Are you able to lift weight without bending elbow?	51	27	59	21	0.7	1.8
History of trauma?	28	76	70	34	1.1	0.9
History of smoking?	24	88	80	36	2	0.9
Are you taking analgesics?	78	55	78	55	1.7	0.4
Is ADL limited?	45	61	70	35	1.1	0.9
Comorbidities	57	58	73	40	1.4	0.7

All values are in percentages. ADL: Activities of daily living, PPV: Positive predictive value, NPV: Negative predictive value, +LR: Positive likelihood ratio, –LR: Negative likelihood ratio

Table 7: Diagnostic values of various clinical test

Clinical tests	Sensitivity	Specificity	PPV	NPV	+LR	–LR
Neer test	90	18	69	46	1.1	0.5
Hawkins-Kennedy test	75	30	69	37	1	0.8
Drop arm test	34	97	96	42	11	0.7
Full can test	93	64	84	81	2.6	0.1
Painful arc test	96	21	72	88	1.2	0.2
Empty can test	78	73	85	62	3	0.3
Palpation test	30	100	100	41	∞	0.7
External rotation at 0°	06	100	100	34	∞	0.9
Supraspinatus strength test	84	39	74	54	1.4	0.4
Infraspinatus strength test	31	91	88	40	3	0.8

All values are in percentages. PPV: Positive predictive value, NPV: Negative predictive value, +LR: Positive likelihood ratio, –LR: Negative likelihood ratio

Table 8: Diagnostic accuracy of combination of tests

Combination of clinical tests	Sensitivity	Specificity	PPV	NPV	+LR	–LR
Neer test + Painful arc test	100	53	81	100	2.1	–1.9
Neer test + full can test	100	97	99	100	33	0
Full can test + painful arc test	100	82	92	34	5.6	–1.2
Neer test + painful arc test + full can test	100	100	100	100	∞	0

All values are in percentages, PPV: Positive predictive value, NPV: Negative predictive value, +LR: Positive likelihood ratio, –LR: Negative likelihood ratio

standard. Barth *et al*.,[20] Itoi *et al*.,[21] Park *et al*., and MacDonald *et al*.[22] have arthroscopy as reference standard. Holtby and Razmjou,[23] Murrell and Walton, and Leroux *et al*.[24] have operation as reference standard. Study designs with operation and arthroscopy as reference standard are invasive and can induce verification bias because only patients who require surgery were tested with reference standard.

According to Murrell and Walton, when all three tests are positive (supraspinatus weakness, weakness in external rotation, and impingement) or if two tests were positive and patient's age is >60 years, there is 98% chance of having the rotator cuff tear. Combined absence of these features excludes the diagnosis. According to Park *et al*., Hawkins test, painful arc test, and weakness in external rotation form the best combination in diagnosing overall impingement syndrome. According to Ardic *et al*. and McDonald *et al*., combination of Hawkins test and/or Neer test was diagnostically inaccurate. According to our study (2018), Neer test, painful arc test, and full can test form the best combination in diagnosing supraspinatus tears of any type. Individual clinical tests do not have higher sensitivity, specificity, PPV, NPV, positive likelihood ratio, and negative likelihood ratio all together, hence requiring combination of clinical tests and/or prediction model. The present study confirms that combination of clinical tests improves the diagnostic value for supraspinatus tears.

Limitation of our study

(1) Small sample size of 100 patients, but we have ensured all patients have undergone rigid protocol. (2) Examiner was not blinded about history information of the patient, which might influence the test results. Bias was tried to be avoided by performing rigid fixed order of clinical tests. (3) We did not assess every clinical test for supraspinatus tear that was published. (4) Intra- and inter-observer reliability in conducting clinical tests and in interpreting of MRI results was not studied. (5) Fatigue component leading to positive result was not studied.

Conclusions

Our study shows that individual clinical tests were less accurate in diagnosing supraspinatus tendon tears as compared to combination tests. Diagnostic value improves significantly when clinical tests are combined together. Neer test, painful arc test, and full can test form the best combination in diagnosing supraspinatus tears of any type. This study is useful in low-income countries with limited access to MRI and to limit the number of MRI ordered.

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Nil.

Conflicts of interest
There are no conflicts of interest.

References

1. Barr KP. Rotator cuff disease. Phys Med Rehabil Clin N Am 2004;15:475-91.
2. Jain NB, Wilcox RB 3rd, Katz JN, Higgins LD. Clinical examination of the rotator cuff. PM R 2013;5:45-56.
3. Longo UG, Berton A, Ahrens PM, Maffulli N, Denaro V. Clinical tests for the diagnosis of rotator cuff disease. Sports Med Arthrosc Rev 2011;19:266-78.
4. McFarland EG, Garzon-Muvdi J, Affonso J, Petersen SA. Examination of the shoulder for rotator cuff disease. In: Maffulli N, Furia J, editors. Rotator cuff disorders: Basic Science and Clinical Medicine. London: Jaypee Medical Publishers; 2012. p. 41-54.
5. Hermans J, Luime JJ, Meuffels DE, Reijman M, Simel DL, Bierma-Zeinstra SM, *et al.* Does this patient with shoulder pain have rotator cuff disease? The rational clinical examination systematic review. JAMA 2013;310:837-47.
6. Hegedus EJ, Goode A, Campbell S, Morin A, Tamaddoni M, Moorman CT 3rd, *et al.* Physical examination tests of the shoulder: A systematic review with meta-analysis of individual tests. Br J Sports Med 2008;42:80-92.
7. Hegedus EJ, Goode AP, Cook CE, Michener L, Myer CA, Myer DM, *et al.* Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. Br J Sports Med 2012;46:964-78.
8. Guyatt GH, Mills EJ, Elbourne D. In the era of systematic reviews, does the size of an individual trial still matter. PLoS Med 2008;5:e4.
9. Lenza M, Buchbinder R, Takwoingi Y, Johnston RV, Hanchard NC, Faloppa F. 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 of systemic reviews 2013.
10. Ellenbogen PH, Tashjian JH. RadiologyInfo: Reaching out to touch patients. J Am Coll Radiol 2007;4:809-15.
11. Awh MH, Stadnick ME. MRI challenge. Sports health- multidisciplinary approach. J Sports Health - A Multidisciplinary Approach 2009;1:180-3.
12. Murrell GA, Walton JR. Diagnosis of rotator cuff tears. Lancet 2001;357:769-70.
13. van Kampen DA, van den Berg T, van der Woude HJ, Castelein RM, Scholtes VA, Terwee CB, *et al.* The diagnostic value of the combination of patient characteristics, history, and clinical shoulder tests for the diagnosis of rotator cuff tear. J Orthop Surg Res 2014;9:70.
14. Park HB, Yokota A, Gill HS, El Rassi G, McFarland EG. Diagnostic accuracy of clinical tests for the different degrees of subacromial impingement syndrome. J Bone Joint Surg Am 2005;87:1446-55.
15. Wolf EM, Agrawal V. Transdeltoid palpation (the rent test) in the diagnosis of rotator cuff tears. J Shoulder Elbow Surg 2001;10:470-3.
16. Ardic F, Kahraman Y, Kacar M, Kahraman MC, Findikoglu G, Yorgancioglu ZR, *et al.* Shoulder impingement syndrome: Relationships between clinical, functional, and radiologic findings. Am J Phys Med Rehabil 2006;85:53-60.
17. Kim E, Jeong HJ, Lee KW, Song JS. Interpreting positive signs of the supraspinatus test in screening for torn rotator cuff. Acta Med Okayama 2006;60:223-8.
18. Caliş M, Akgün K, Birtane M, Karacan I, Caliş H, Tüzün F, *et al.* Diagnostic values of clinical diagnostic tests in subacromial impingement syndrome. Ann Rheum Dis 2000;59:44-7.
19. Itoi E, Kido T, Sano A, Urayama M, Sato K. Which is more useful, the "full can test" or the "empty can test," in detecting the torn supraspinatus tendon? Am J Sports Med 1999;27:65-8.
20. Barth JR, Burkhart SS, De Beer JF. The bear-hug test: A new and sensitive test for diagnosing a subscapularis tear. Arthroscopy 2006;22:1076-84.
21. Itoi E, Minagawa H, Yamamoto N, Seki N, Abe H. Are pain location and physical examinations useful in locating a tear site of the rotator cuff? Am J Sports Med 2006;34:256-64.
22. MacDonald PB, Clark P, Sutherland K. An analysis of the diagnostic accuracy of the Hawkins and Neer Subacromial impingement signs. J Shoulder Elbow Surg 2000;9:299-301.
23. Holtby R, Razmjou H. Validity of the supraspinatus test as a single clinical test in diagnosing patients with rotator cuff pathology. J Orthop Sports Phys Ther 2004;34:194-200.
24. Leroux JL, Thomas E, Bonnel F, Blotman F. Diagnostic value of clinical tests for shoulder impingement syndrome. Rev Rhum Engl Ed 1995;62:423-8.