Reliability of specific clinical tests and MRI in the diagnosis of rotator cuff tears in comparison with arthroscopy

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Purpose
Imaging for rotator cuff injury may provide false-positive and false-negative results. Moreover, many studies have questioned both the accuracy and reliability of orthopedic special tests of the shoulder. Herein, this study evaluates the sensitivity, specificity, and accuracy of specific clinical tests and MRI of rotator cuff tears in relation to arthroscopic findings.
Patients and methods
This study was conducted on 45 patients (27 males and 18 females), who were diagnosed clinically to have rotator cuff tears and/or biceps tendon pathology. Mean patients' age was 26.18 years old. The special clinical tests for rotator cuff tears included in this study were Jobe's test for supraspinatus tear, drop arm test for infraspinatus tear, lift-off test for subscapularis tear, and speed test for biceps tendinitis. Thereafter, all patients underwent radiographs, MRI, and shoulder arthroscopy.
Results
Jobe's test showed sensitivity, specificity, and accuracy of 85.7, 75, and 80.4%, respectively, whereas those of MRI were 85.7, 87.5, and 86.6%, respectively. Drop arm test showed sensitivity, specificity, and accuracy of 100, 69.2, and 84.6%, respectively, whereas those of MRI were 100% for each. Lift-off test showed sensitivity, specificity, and accuracy of 50, 76.9, and 63.5%, respectively, whereas those of MRI were 100, 92.3, and 96.2%, respectively. Speed test showed 80% for each of sensitivity, specificity, and accuracy, whereas those of MRI were 80, 100, and 90%, respectively.
Conclusion
We could conclude that Jobe's test and MRI had good correlation with arthroscopy in the diagnosis of supraspinatus tear. Drop arm test had weak correlation whereas MRI had good correlation with arthroscopy in the diagnosis of infraspinatus tear. Lift-off test slightly overestimated the diagnosis of subscapularis tear, whereas MRI findings were close to those of arthroscopy. Speed test and MRI correlated fairly well with arthroscopy in the diagnosis of biceps tendon pathology.

Keywords:
arthroscopy, clinical tests, MRI, rotator cuff tears

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Introduction

Shoulder pain is a significant cause of morbidity, and it is the third most common cause for musculoskeletal consultation in the UK after spinal and knee problems [1]. At least 109 separate shoulder tests have been described, and recently published qualitative articles and reviews have provided important information on the diagnostic accuracy and clinical application of the various clinical tests for shoulder injuries [2].

The rotator cuff tears are considered as one of the most important causes of shoulder pain [3]. They are a group of four tendons that connect the deepest layer of muscles to the humerus. These are subscapularis, supraspinatus, infraspinatus, and teres minor. The rotator cuff tendons together with the long head of biceps share in shoulder motion and stability [4].

Diagnosis of shoulder pain is based on patient history, clinical examination, and radiographs, which are all relatively inexpensive. MRI can confirm many diagnoses with a high degree of reliability [5]. The final and most expensive diagnostic procedure is examination by arthroscopic surgery. MRI is used as a preoperative measure, but if there were good clinical tests for shoulder lesions, it might be possible to avoid the cost of MRI in some cases. Several physical examination maneuvers have been described for evaluating rotator cuff pathology. The specificity and sensitivity of these tests have been reported by some

authors as being excellent [6], but these results may be of limited value in a general clinical population [7].

This study evaluates the sensitivity, specificity, and accuracy of specific clinical tests and MRI of rotator cuff tears in relation to arthroscopic findings.

Patients and methods

Forty-five patients (27 males and 18 females), diagnosed clinically to have rotator cuff tears and/or biceps tendon pathology, form this study, which was conducted at Fayoum University Hospital between January 2013 and November 2015. Ethical approval was obtained for the study, and informed consent was obtained from all patients included in this study. Of these 45 patients; 24 patients sustained supraspinatus tear, 18 patients sustained infraspinatus tear, 12 patients sustained subscapularis tear, and 18 patients sustained biceps tendon pathology, as many patients included in this study had more than one muscle pathology. All patients underwent clinical assessment, radiographs, MRI, and then shoulder arthroscopy. Mean patients' age at shoulder arthroscopy was 26.18 years old (range, 16.84–47.22 years). Pain and weakness were the main symptoms in most of the patients.

The specific clinical tests included in this study for the diagnosis of rotator cuff tears were Jobe's test for supraspinatus muscle tear, drop arm test for infraspinatus muscle tear, lift-off test for subscapularis muscle tear, and speed test for biceps tendon pathology.

Jobe's test [8]: Jobe's described the 'supraspinatus test' in 1983. They reported the supraspinatus test is performed by first assessing the deltoid with the arm at 90° of abduction and neutral rotation. The shoulder is then internally rotated and angled forward 30°; the thumbs should be pointing toward the floor. Muscle testing against resistance will clearly demonstrate a weakness or insufficiency of the supraspinatus secondary to a tear.

Drop arm test [9]: this is the test for the assessment of infraspinatus tendon tears. The patient in supine or sitting posture abducts the arm horizontally. Then, the arm descends actively to the horizontal position; further during the last 90° of descent to the anatomical position, the patient may lean to the affected side, and may lower the whole arm quite suddenly in abduction. The sign is positive if a lag or 'drop' occurs.

Lift-off test [10]: it is used for examination of an isolated rupture of the subscapularis tendon. The test is performed by bringing the arm passively behind the body into maximal internal rotation. The result of this test is considered normal if the patient maintains maximum internal rotation after the examiner releases the patient's hand.

Speed test [11]: the patient's arm is extended in supination at 90° of abduction and 30° of horizontal flexion. The patient attempts to either maintain this position or continue to abduct the arm against the downward pressure of the examiner's hand. The test is positive when pain is localized to the bicipital groove in bicipital tendinitis.

Depending on the fact, shoulder arthroscopy is still the gold standard in the diagnosis and treatment of a variety of shoulder conditions; we evaluated the sensitivity, specificity, and accuracy of these specific clinical tests and MRI of rotator cuff tears in relation to arthroscopic findings.

Technique of arthroscopy

Surgery was performed in a beach chair position and under general anesthesia. Routine diagnostic arthroscopy was performed with a 30° arthroscope, through standard portals and a probe. It was done in a systemic manner throughout glenohumeral joint for examination of glenoid, labrum, rotator interval, glenohumeral ligament, biceps tendon, rotator cuff, humeral head, and capsule. Thereafter, the arthroscope is passed throughout the subacromial space for examination of rotator cuff tears, subacromial bursa, coracoacromial ligament, acromion, and acromioclavicular joint. Finally, positive findings related to rotator cuff tears were included in the study.

Statistical analysis

(1) Data were collected, coded, translated to English to facilitate data manipulation, and entered into Microsoft Access, and data analysis was performed using SPSS Inc., 233 South Wacker Drive, 11th floor, Chicago, Illinois 60606-6307, USA.
(2) Simple descriptive analysis was used, in the form of numbers and percentages for qualitative data, and arithmetic means as central tendency measurement, SDs as measure of dispersion for quantitative parametric data, and inferential statistic test:
    (a) For quantitative parametric data.
    (b) For qualitative data.

(3) χ^2 test to compare two or more than two qualitative groups.
   (a) Sensitivity and specificity test for testing a new test with receiver operating characteristic curve.
(4) The level *P* value less than or equal to 0.05 was considered the cut-off value for significance.

Results

One-third of the study group worked in occupations with overhead activity, whereas one-fourth practiced sports with overhead activity. The frequency of different radiographic findings among the study group is shown in the Table 1.

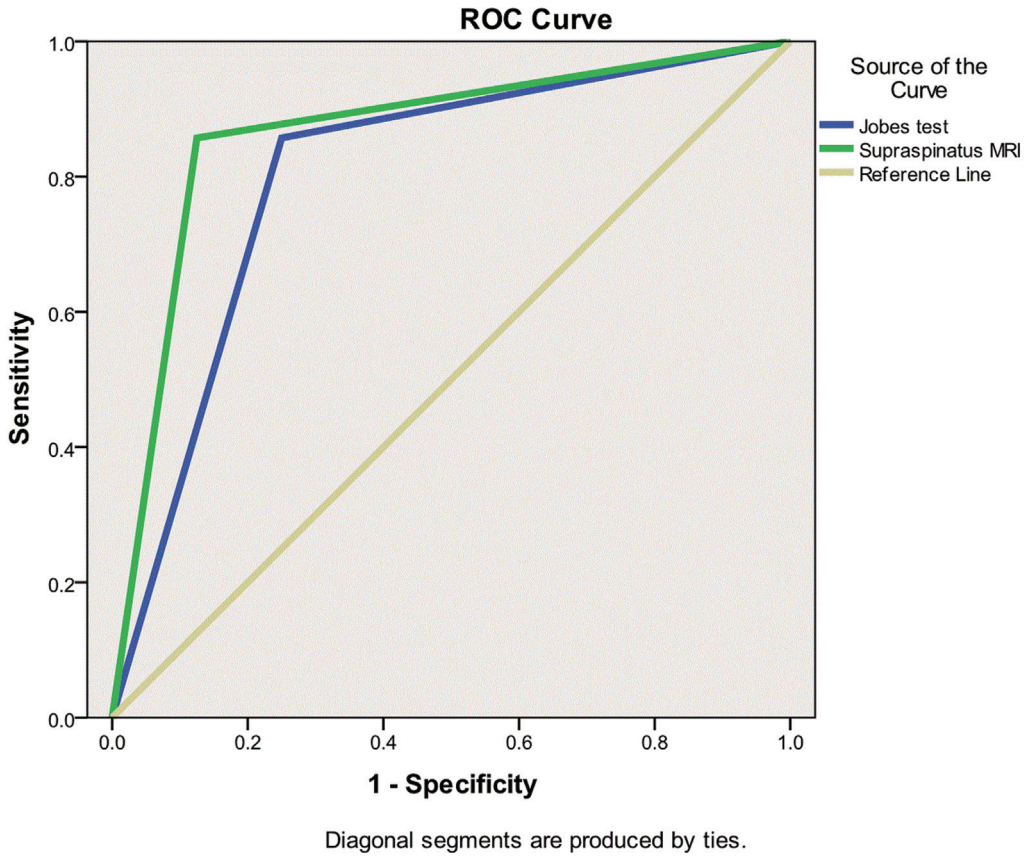
Table 1 Frequency of different radiographic findings among the study group

Radiographic finding	*n* (%) (*N*=15)
Normal	15 (33.3)
Upward migration of humeral head	15 (33.3)
Soft tissue calcification at insertion of rotator cuff	3 (6.7)
Both soft tissue calcification and migration of head humeral	3 (6.7)
Pathological acromion type (curved and hooked)	9 (20)

Shoulder pain was so severe in some cases in a way that affected the assessment of the clinical tests. Accordingly, drop arm test and Jobe's test were difficult to apply in three patients each, whereas lift-off test was difficult to apply in 12 patients.

Jobe's test was positive (i.e. supraspinatus tear) in 24 (53.3%) cases, negative in 18 (40%) cases, and could not be applied in three (6.7%) cases. MRI showed partial supraspinatus tear in 12 (26.7%) cases and full-thickness tear in nine (20%) cases, and was normal in 24 (53.3%) cases. Arthroscopy showed partial supraspinatus tear in three (6.7%) cases, and full-thickness tear in 18 (40%) cases, and was normal in 24 (53.3%) cases. Jobe's test showed sensitivity, specificity, and accuracy of 85.7, 75, and 80.4%, respectively, whereas those of MRI were 85.7, 87.5, and 86.6%, respectively (Figs 1–3). Of the 24 cases diagnosed by Jobe's test to have supraspinatus muscle tear, diagnosis of 21 (87.5%) cases was confirmed by arthroscopy. Thereby, clinical diagnosis of supraspinatus muscle tear by Jobe's test correlated fairly well with the arthroscopic findings. Clinical examination mildly overestimated supraspinatus muscle tear.

Figure 1

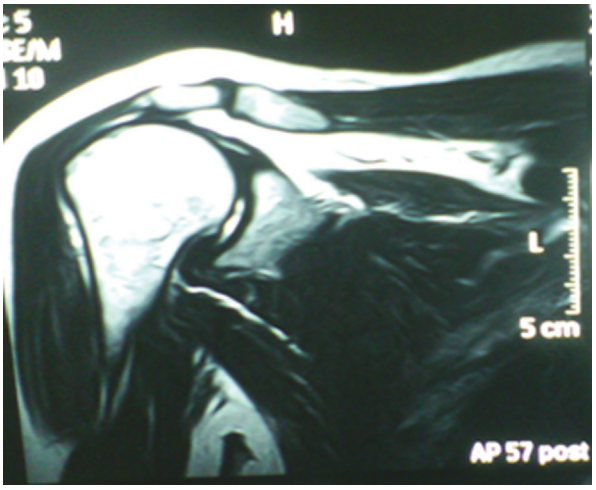


ROC curve of sensitivity and specificity of Jobe's test and MRI in relation to arthroscopy (reference line) in the diagnosis of supraspinatus tear. ROC, receiver operating characteristic.

Drop arm test was positive (i.e. infraspinatus tear) in 18 (40%) cases, negative in 24 (53.3%) cases, and could not be applied in three (6.7%) cases. MRI showed full-thickness tear in six (13.3%) cases, and was normal in 39 (86.7%) cases. Arthroscopy showed full-thickness tear in six (13.3%) cases, and was normal in 39 (86.7%) cases. Drop arm test showed sensitivity, specificity, and accuracy of 100, 69.2, and 84.6%, respectively, whereas those of MRI were 100% for each (Fig. 4). Of the 18 cases diagnosed by drop arm test to have infraspinatus muscle tear, diagnosis of six cases was confirmed by arthroscopy (33.3%). Thereby, clinical diagnosis of infraspinatus muscle tear by drop arm test correlated fairly weak with the arthroscopic findings.

Lift-off test was positive (i.e. subscapularis tear) in 12 (26.7%) cases, negative in 21 (46.6%) cases, and could not be applied in 12 (26.7%) cases. MRI showed full-thickness tear in three (6.7%) cases and was normal in 42 (93.3%) cases. Arthroscopy showed full-thickness tear in six (13.3%) cases and was normal in 39 (86.7%)

Figure 2

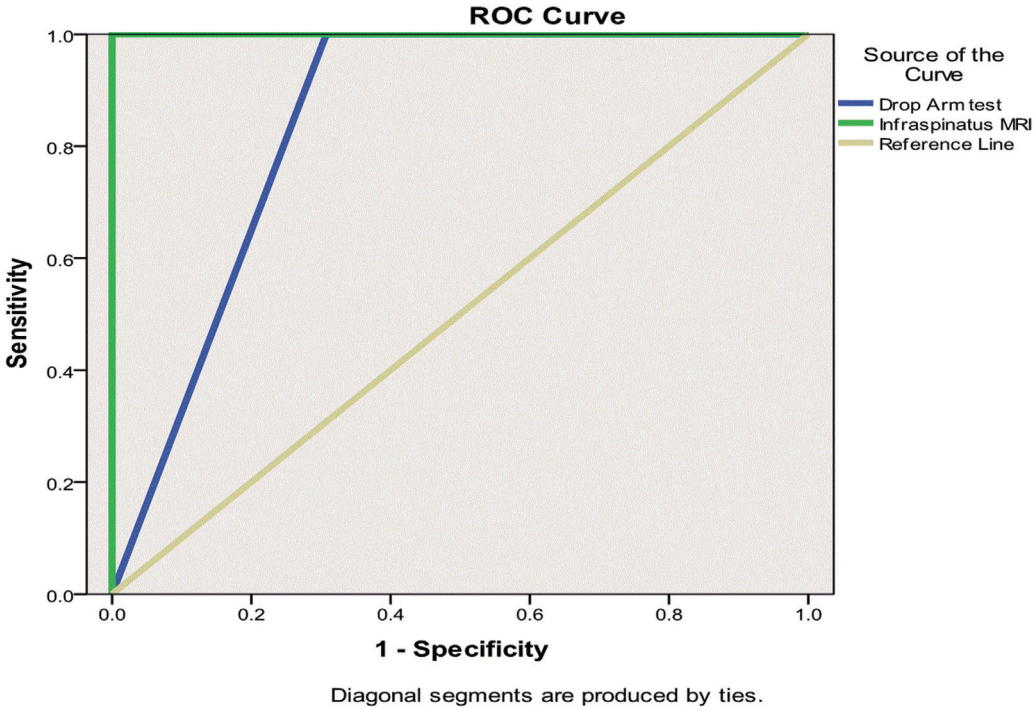


MRI showing supraspinatus and infraspinatus muscles tears.

Figure 3

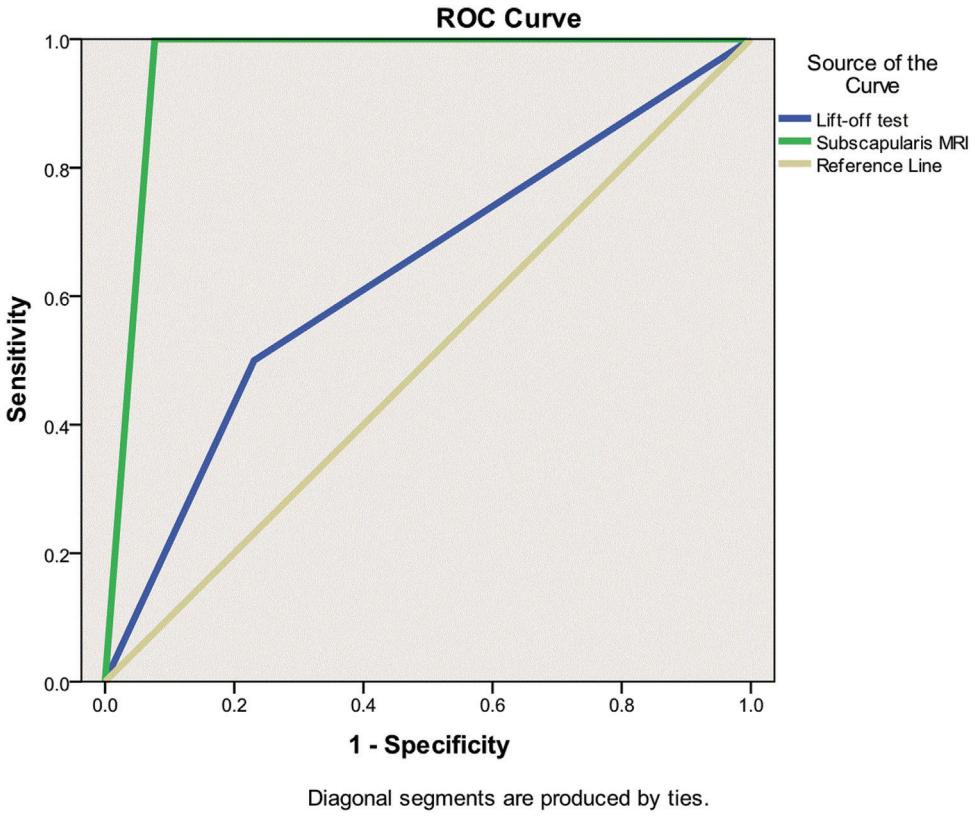
Supraspinatus muscle tear as a positive arthroscopic finding.

Figure 4



ROC curve of sensitivity and specificity of drop arm test and MRI in relation to arthroscopy (reference line) in the diagnosis of infraspinatus tear. ROC, receiver operating characteristic.

Figure 5

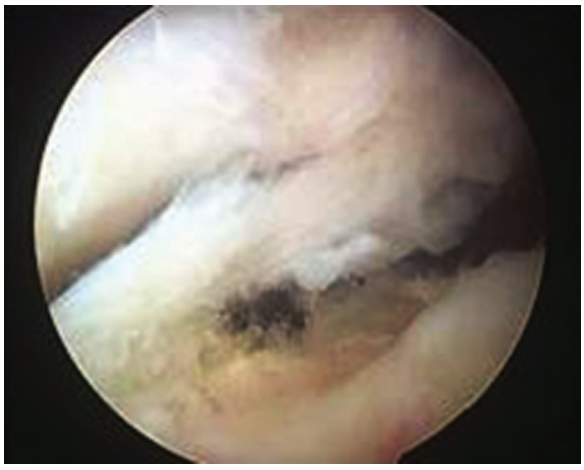


ROC curve of sensitivity and specificity of lift-off test and MRI in relation to arthroscopy (reference line) in the diagnosis of subscapularis tear. ROC, receiver operating characteristic.

cases. Lift-off test showed sensitivity, specificity, and accuracy of 50, 76.9, and 63.5, respectively, whereas those of MRI were 100, 92.3, and 96.2%, respectively (Figs 5, 6). Of the 12 cases diagnosed by lift-off test to have subscapularis tear, diagnosis of six (50%) cases was confirmed by arthroscopy. Thereby, clinical diagnosis of subscapularis tear by lift-off test correlated fairly weak with the arthroscopic findings.

Speed test was positive (i.e. bicipital tendinitis) in 18 (40%) cases, negative in 24 (53.3%) cases, and could not be applied in three (6.7%) patients. MRI showed tenosynovitis in nine (20%) cases and tendon displacement in three (6.7%) cases, and was normal in 33 (73.3%) cases. Arthroscopy showed tenosynovitis in 12 (26.7%) cases and tendon displacement in three (6.7%) cases and was normal in 30 (66.7%) cases. Speed test showed 80% for each of sensitivity, specificity, and accuracy, whereas those of MRI were 80, 100, and 90%, respectively (Figs 7, 8). Of the 18 cases diagnosed by speed test to have biceps tendon pathology in this series, diagnosis of 15 (83.5%) cases was confirmed by arthroscopy. Each of speed test and MRI was correlated fairly well with arthroscopic findings in the diagnosis of biceps tendon pathology.

Figure 6



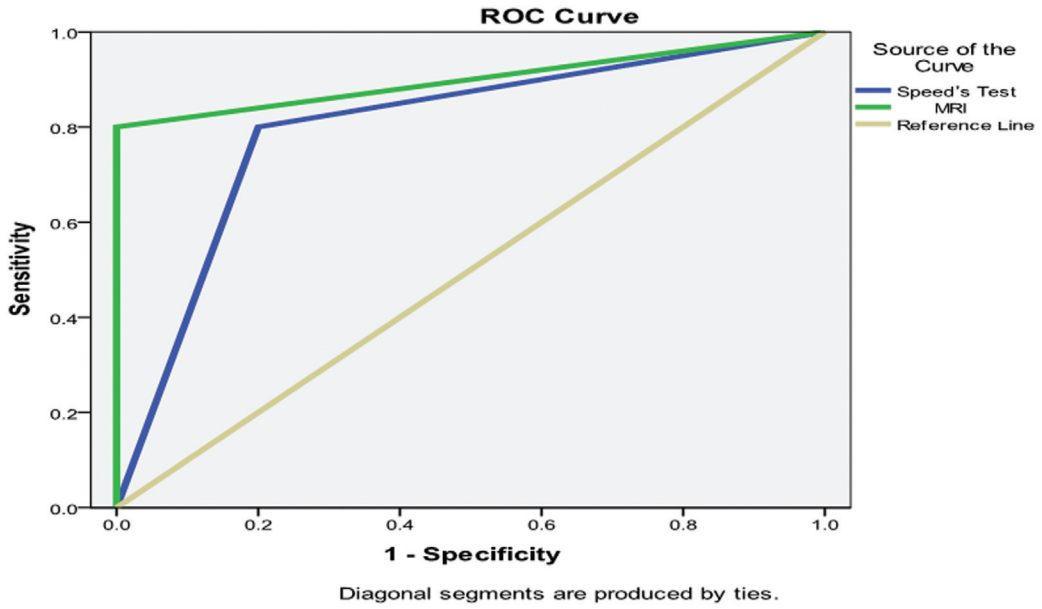
Subscapularis with a partial tear in the superior border as shown by arthroscopy.

Diagnostic shoulder arthroscopy was relatively safe and valuable in this series, with low postoperative complications.

Discussion

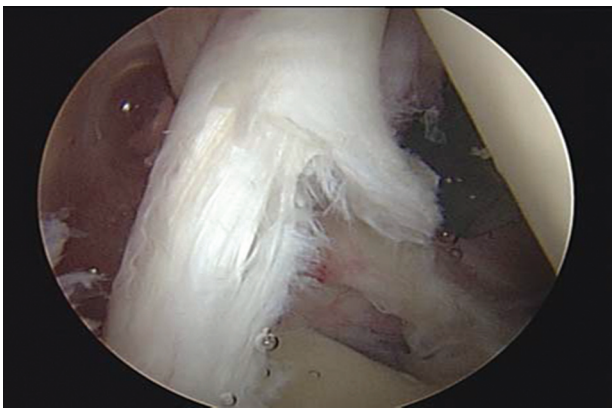
The shoulder is often considered a difficult joint to examine, and this is partly owing to the large number of

Figure 7



ROC curves of sensitivity and specificity of speed's test and MRI in relation to arthroscopy (reference line) in the diagnosis of long head of biceps tendon pathology. ROC, receiver operating characteristic.

Figure 8



Arthroscopy showing partial tear of biceps tendon.

different clinical tests of shoulder function [12]. Although it can be hard to choose the right clinical test from all the available possibilities, the chosen tests were selected from those recommended by Hegedus *et al.* [13]. One test was chosen for each condition to make the advice as practical as possible for daily use, and to decrease the variables in this study especially with the small number of the patients included.

Imaging for rotator cuff injury may provide false-positive and false-negative results, and it has therefore been proposed that traditional clinical examination of the shoulder should remain the cornerstone for diagnosis [14]. However, Malhi and Khan [15] found that clinical diagnosis of rotator cuff tears had a weak correlation with the arthroscopic findings. In contrast, Ure *et al.* [16] reported that clinical diagnosis of rotator cuff tears had good correlation with the arthroscopic findings. The poor accuracy of clinical tests for rotator cuff pathology could be related to a lack of anatomical validity of the tests or it may be that the close relationships of structures in the shoulder may make it difficult to identify specific pathologies with clinical tests [15]. Herein, this study evaluates the sensitivity, specificity, and accuracy of different clinical tests and MRI of rotator cuff tears in relation to arthroscopic findings.

The rotator cuff is commonly injured because of trauma, degeneration with aging, or inflammation owing to tendonitis, bursitis, or arthritis of the shoulder. Rotator cuff injury is particularly common in people who perform repetitive overhead motions that can stress the rotator cuff [3]. One-third of the study group in this series worked in occupations with overhead activity, whereas one-fourth practiced sports with overhead activity. The supraspinatus was the most commonly affected tendon in this series (53.3%) which could be attributed to overuse and trauma, going in line with what was reported by some authors [17].

In the current study, Jobe's test for supraspinatus tear had higher sensitivity (85.7%) than that in the study by Gillooly *et al.* (81%) [18]. Gillooly *et al.* [18] showed that Jobe's test alone had a higher sensitivity of 81% than the combined tests (empty can, strength in ER, and subacromial impingement tests). However, Chew *et al.* [19] found that diagnosis of supraspinatus

pathology may be accomplished with a cluster of three tests (Neer, Hawkins-Kennedy, cross-body adduction, drop arm, full can, empty can, and painful arc), age more than 39 years, positive painful arc, and self-reported clicking or popping. In this study, MRI and Jobe's test used in the diagnosis of supraspinatus muscle tear, had same sensitivity, but MRI had a specificity and an accuracy slightly higher than those of drop arm test.

In this series, drop arm test had higher sensitivity (100%) than that in the study by Miller *et al*. [20] (73%), but in Miller's study, drop arm test had higher specificity (77%) than that in this series (69.2%). In the study by Miller *et al*. [20], a positive sign (external rotation lag sign and drop sign) would appear to suggest the moderate likelihood of the presence of a full-thickness tear. In this study, MRI and drop arm test used in the diagnosis of infraspinatus muscle tear, had same sensitivity, but MRI had a specificity and an accuracy higher than those of drop arm test.

In this study, lift-off test had a higher sensitivity (50%), and a lower specificity (76.9%) than that in the study by Bartsch *et al*. [21], with a sensitivity of 40% and specificity of 79%. The findings of Barth *et al*. [22] indicated the lift-off test to be an accurate test for diagnosing subscapularis pathology, using weakness as a criterion, with a sensitivity of 100%; however, these results were not found by Itoi *et al*. [23]. MRI which we used in the diagnosis of subscapularis muscle tear had a sensitivity, a specificity, and an accuracy higher than that of lift-off test.

In the study by Goyal *et al*. [24], speed test had lower sensitivity and higher specificity than that in our study. In this study, MRI and speed test used in the diagnosis of biceps tendon pathology had same sensitivity, but MRI had a specificity and an accuracy higher than those of speed test. In this series, speed test had good accuracy in the diagnosis of long head of biceps tendon pathology, and addition of MRI further increased its accuracy.

The limitations of this study are the small number of patients, no control group, no MRI arthrography, and many patients sustained more than one rotator cuff tear. Moreover, there is a great need for large, prospective, well-designed studies that examine the diagnostic accuracy of many aspects of the clinical examination and what combinations of these examination are useful in differentially diagnosing pathologies of the shoulder, especially among patients with more than one shoulder pathology.

Conclusion

Finally, we could conclude that Jobe's test and MRI had good correlation with arthroscopic findings in the diagnosis of supraspinatus tear. Drop arm test had weak correlation, whereas MRI had excellent correlation to arthroscopic findings in the diagnosis of infraspinatus tear. Lift-off test slightly overestimated the diagnosis of subscapularis tear, whereas MRI findings were close to those of arthroscopy. Speed test and MRI correlated fairly well with arthroscopic findings in the diagnosis of biceps tendon pathology. We believe that traditional clinical examination of the shoulder should remain the cornerstone for making the most probable diagnosis for rotator cuff tears, and the addition of noninvasive diagnostic procedure such as MRI further increases the likelihood of an accurate diagnosis.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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