Review

Contribution of clinical tests to the diagnosis of rotator cuff disease:
A systematic literature review

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Abstract

Objective: To evaluate the diagnostic performance of clinical tests for degenerative rotator cuff disease, based on a systematic literature review.

Methods: We searched Medline, Embase, and Pascal Biomed until the first half of 2006 inclusive for articles that reported at least the sensitivity and specificity of clinical tests for rotator cuff disease. Predictive values and accuracy were recorded where available. The results were discussed and validated.

Results: We selected nine studies, of which three investigated tests for subacromial impingement syndrome and seven tests for rotator cuff tendinopathy. The Neer and Hawkins tests had good sensitivity but low specificity for subacromial impingement syndrome. For diagnosing tears of the supraspinatus or infraspinatus, the Jobe sign and the full can test showed similar performance characteristics to the Patte test and resisted external rotation with the elbow at the side flexed at 90°. For diagnosing tendinopathies with or without tears, active unresisted external rotation for the infraspinatus and the lift off test for the subscapularis were specific but lacked sensitivity. In one study, limitation of the range of active resisted internal rotation was sensitive and specific for subscapularis tendon disease. The palm up test performed poorly for diagnosing long head of biceps disease.

Conclusions: Data on the diagnostic performance of clinical tests for rotator cuff tendon disease are fragmentary. However objective data exist to support the usefulness of some of these tests. Further studies are needed.

Keywords: Clinical tests; Rotator cuff disease; Diagnostic value; Systematic review

1. Introduction

Degenerative rotator cuff disease is the leading cause of shoulder pain [1]. Clinical testing is the recommended first-line investigation for diagnosing degenerative rotator cuff disease [2]. Some clinical tests are designed to detect subacromial impingement, whereas others are intended for
identifying tendon and muscle dysfunction. Subacromial impingement is a cause of rotator cuff disease, whereas tendon and muscle dysfunction are consequences. The diagnostic performance of clinical tests can be assessed based on sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and ability to classify patients accurately according to the type of tendinopathy. Knowledge of these performance characteristics is crucial to the practice and interpretation of clinical tests conducted in patients with shoulder pain.

The goal of this study was to review objective data on the diagnostic performance of clinical tests for rotator cuff disease. To this end, we conducted a systematic literature review.

2. Methods

We searched Medline, Embase, and Pascal Biomed using the following keywords: rotator cuff, shoulder pain, diagnostic value, sensitivity, specificity, predictive value, and diagnostic accuracy; and their French translations coiffe des rotateurs, épaule douloureuse, valeur diagnostique, sensibilité, spécificité, valeur prédictive, and exactitude diagnostique. We used the literature search performed by the French High Health Authority in April 2005 for developing recommendations on the management of chronic shoulder pain without instability in adults [2]. We updated the findings to the first half of 2006 inclusive. Studies were selected based on the following criteria: patients with rotator cuff disease, number of patients known to be greater than 30, known reference criterion (subacromial impingement or tendon disease), well-described diagnostic method, knowledge of the prevalence of the abnormality in the overall study population, well-described clinical tests with clear definitions of positive and negative test results, and availability of sensitivity and specificity data.

For each selected article, one of us recorded the sensitivity and specificity of each clinical test and, where available, the PPV, NPV, and accuracy. Data on subacromial impingement and data on rotator cuff lesions were presented separately. We grouped clinical tests that were similar in terms of intended use and performance characteristics and that were often evaluated in the same studies. The data from the literature review were discussed and validated by the other authors, who were experts in the fields of clinical rheumatology and scientific literature analysis.

3. Results

3.1. Selected studies

We selected nine studies (Table 1). Three studies evaluated the detection of subacromial impingement [3—5]; the number of patients ranged from 85 to 448, mean age ranged from 40 to 57 years, and recruitment occurred chiefly in surgery departments. Sample size, age, and recruitment were comparable in the seven studies on rotator cuff lesions [4,6—11].

3.2. Clinical tests for subacromial impingement

3.2.1. Painful arc test

The painful arc during lateral arm elevation was evaluated in two studies comparatively to a positive subacromial injection test [3] or arthrographic evidence of a tendon tear [4]. These reference standards [12,13] are open to criticism. Subacromial injection of several milliliters of anesthetic may be followed by diffusion of the drug to the tendons and, in the event of tendon rupture, to the joints, limiting the specificity of the test results. Furthermore, subacromial impingement is only one of the many causative factors of tendon tears [14]. Therefore, tendon tears do not constitute a valid marker for subacromial impingement.

These two studies [3,4] produced conflicting results in terms of sensitivity, specificity, PPV, and NPV (Table 2). Accuracy was poor in the study that evaluated this parameter [3]. Thus, the results fail to clarify the value of the painful arc test for diagnosing subacromial impingement syndrome. The discrepancies in the results may be ascribable to the differences between the two studies regarding both the reference standard and patient recruitment (medical and surgical in one study [3] and surgical only in the other [4]).

Table 1

<table>
<thead>
<tr>
<th>Authors and tests</th>
<th>n of Patients</th>
<th>Age (years)</th>
<th>Recruitment</th>
</tr>
</thead>
</table>
| | McDonald et al., 2000 [5] | 85 | 40 | S
| | Leroux et al., 1995 [8] | 55 | 51 | S
| | Hertel et al., 1996 [9] | 100 | 51 | S
| | Ito et al., 1999 [10] | 136 | 43 | S

S, surgical; M, medical; MS, medical and surgical.

Table 2

<table>
<thead>
<tr>
<th>Authors and tests</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Painful arc test</td>
<td>Calis et al., 2000 [3]</td>
<td>32</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Neer test</td>
<td>Calis et al. 2000 [3]</td>
<td>89</td>
<td>30</td>
<td>76</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>McDonald et al., 2000 [5]</td>
<td>75</td>
<td>47</td>
<td>56</td>
<td>83</td>
</tr>
<tr>
<td>Hawkins test</td>
<td>Calis et al., 2000 [3]</td>
<td>91</td>
<td>25</td>
<td>75</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>McDonald et al., 2000 [5]</td>
<td>92</td>
<td>44</td>
<td>39</td>
<td>93</td>
</tr>
</tbody>
</table>

Calis et al., 2000 [3]: reference, subacromial injection; prevalence, 70%. Litaker et al., 2000 [4]: reference, rotator cuff tear/arthrography; prevalence, 67%.
McDonald et al., 2000 [5]: reference, bursitis/arthroscopy; prevalence, 28%.
3.2. Neer and Hawkins tests

Two studies evaluated the Neer and Hawkins tests (Table 2) [3,5]. For the Neer test, only anterolateral elevation was considered; the effects of subacromial injection were not assessed. The reference standard was the effect of subacromial injection [3] or findings by shoulder arthroscopy [5]. In the study that used arthroscopy as the reference [5], subacromial bursitis and rotator cuff tearing were evaluated separately and no difference was found. Therefore, we will discuss only the findings pertaining to subacromial bursitis, which is a more specific marker for subacromial impingement.

Both tests were sensitive (Neer, 75–89%; and Hawkins, 91–92%). Specificity, in contrast, was low (Neer, 30–40%; and Hawkins, 25–44%) [3,5]. PPV and NPV differed between the two studies. Diagnostic accuracy was determined in one study [3] and showed that 72–75% of cases were correctly classified by either test. Combining the two tests produced similar performance characteristics [5].

3.2.3. Yocum test

Few data are available on the Yocum test. Sensitivity was estimated at 78% versus arthroscopic evidence of tendinopathy with or without tearing [8].

3.3. Tests evaluating the rotator cuff tendons

3.3.1. Tests evaluating the supraspinatus tendon

3.3.1.1. Jobe test and full can test. The Jobe test is used for diagnosing tears in the supraspinatus tendon [15]. Two studies evaluated the Jobe test performed for this reason [6,10] (Table 3). When weakness was used to define a positive test, both studies indicated good sensitivity (77–95%), NPV (85–90%), and accuracy (70–85%), with somewhat lower specificity (65–68%). Using pain exacerbation to define a positive test yielded less satisfactory performance characteristics [10]. PPV varied across studies [6]. When the reference standard was tendon damage with or without tearing, sensitivity was usually greater than specificity [4,8,9]. In two studies, a positive Jobe test correlated weakly with the extent of tendon tearing [7,8].

The full can test consists in evaluating the patient’s ability to resist downward pressure on the arms held at 90° elevation in the scapular plane and 45° external rotation. It was developed as an alternative to the Jobe test (or empty can test), as external rotation usually causes less pain than internal rotation [10]. A single study assessed the full can test (Table 3) [10]. The reference standard was supraspinatus tendon tearing by magnetic resonance imaging. Weakness was better than pain as a criterion for a positive test. The Jobe test and full can test assessed based on weakness showed comparable performance characteristics, although no head-to-head comparison was performed.

3.3.2. Tests evaluating the infraspinatus tendon

3.3.2.1. Patte test and resisted external rotation with the elbow at the side flexed at 90°. Several clinical tests involving external rotation of the arm are used to assess the infraspinatus tendon [4,7,9] (Table 3). The Patte test and resisted external rotation with the elbow at the side flexed at 90° were evaluated comparatively to presence of a partial or complete tear by arthrography [4,7]. Both tests proved useful. Sensitivity was 79% for the Patte test and 76% for external rotation. Specificity was somewhat lower (67 and 57%, respectively).

3.3.2.2. Lag signs in external rotation. Limited active external rotation with the arm abducted at 20° or at 90° (called the external rotation lag sign and drop sign, respectively) was evaluated in one study for detecting tendinopathy with or without tearing [9] (Table 4). Both tests showed high

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Performance characteristics of tests for rotator cuff disease.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors and tests</td>
<td>Response criterion</td>
</tr>
<tr>
<td>Supraspinatus tests</td>
<td></td>
</tr>
<tr>
<td>Jobe test</td>
<td>Weakness 95</td>
</tr>
<tr>
<td>Itoi et al., 1999 [10]</td>
<td>Pain 63</td>
</tr>
<tr>
<td>Noël et al., 1989 [6]</td>
<td>Weakness 77</td>
</tr>
<tr>
<td>Full can test</td>
<td></td>
</tr>
<tr>
<td>Itoi et al., 1999 [10]</td>
<td>Pain 66</td>
</tr>
<tr>
<td>Noël et al., 1989 [6]</td>
<td>Weakness 77</td>
</tr>
<tr>
<td>Infraspinatus tests</td>
<td></td>
</tr>
<tr>
<td>Resisted external rotation with the elbow at the side flexed at 90°</td>
<td>Weakness 76</td>
</tr>
<tr>
<td>Patte test</td>
<td>Weakness 79</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Performance characteristics of tests for detecting rotator cuff disease with or without tearing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors and tests</td>
<td>Sensitivity</td>
</tr>
<tr>
<td>Infra spinatus tests</td>
<td></td>
</tr>
<tr>
<td>Weakness in active external rotation arm in 20° of abduction</td>
<td>Hertel et al., 1996 [9]</td>
</tr>
<tr>
<td>Weakness in active external rotation arm in 90° of abduction</td>
<td>Hertel et al., 1996 [9]</td>
</tr>
<tr>
<td>Subscapularis tests</td>
<td></td>
</tr>
<tr>
<td>Weakness in active internal rotation</td>
<td>Hertel et al., 1996 [9]</td>
</tr>
</tbody>
</table>

Noël et al., 1989 [6]: reference, tear/arthrography; prevalence, 67%.
Itoi et al., 1999 [10]: reference, full-thickness tear/MRI; prevalence, 24%.
Litaker et al. [4]: reference, tear/arthrography; prevalence, 67%.
Walch, 1993 [7]: reference, tear seen during surgery; prevalence, 40%.
However, we found that uncertainties remain regarding the validity of clinical tests. Of the many clinical tests for degenerative rotator cuff disease [2,16,17], some have not been evaluated and others have been investigated in only small numbers of studies [3–11] (Table 2).

Among the most widely used tests for subacromial impingement, the Neer test seems particularly well-suited to the detection of anterolateral impingement involving the supraspinatus and infraspinatus tendons; and the Hawkins and Yocum tests to the detection of anteromedial impingement involving the supraspinatus, long head of biceps, and subscapularis tendons [18]. The Neer and Hawkins tests are sensitive for subacromial bursitis, which can be viewed as a marker for subacromial impingement, whether primary or secondary to tendon damage. However, both tests lack specificity. The Yocum test, which is sensitive, was usually evaluated as a tool for detecting tendinopathy of any cause rather than subacromial impingement. The reference standards used to evaluate the painful arc test are of doubtful relevance, and the performance data are conflicting. Thus, the use of tests for subacromial impingement rests on assumptions that have not been entirely validated. Their poor specificity may be related in part to the need for internally rotating the shoulder, which consistently causes pain in patients with shoulder disease [12,17,19,20]. Furthermore, the passive movements used for these tests may load the acromioclavicular joint, which may be the source of the symptoms. The Yocum test requires elevation and adduction of the shoulder, which also occur with the cross arm test used to detect symptomatic acromioclavicular disease [20]. Correlations between the results of tests for subacromial impingement and those of tests for acromioclavicular disease have not been investigated.

Weakness during the Jobe test and full can test is sensitive for detecting supraspinatus tendon tears. Both tests are less specific than sensitive. Their performance characteristics are similar when weakness is used to evaluate the result. That pain without weakness indicates tendinopathy without tearing has been suggested but not validated. The Patte test and resisted external rotation with the elbow at the side flexed at 90° are sensitive for infraspinatus tendon tears; their specificity is lower than their sensitivity. In contrast, weakness during resisted active external rotation is a specific sign that has good PPV for infraspinatus tendon damage. The lift off test is highly specific for subscapularis tendon lesions; sensitivity is lower. However, restricting the use of resisted external rotation tests and of the lift off test only to the detection of infraspinatus and subscapularis tendon tearing or avulsion might improve sensitivity. Weakness of active internal rotation may be the most reliable marker for subscapularis tendinopathy, according to a single study. Tests for subscapularis tendinopathy often cause pain, in common with subacromial impingement tests, because they require marked internal rotation [2]. This factor limits their feasibility. The belly press test was recently suggested for evaluating the subscapularis tendon [21]. Although this test seems less painful, it needs to be evaluated [2]. No test performs well for detecting lesions to the long head of biceps. Inspection and palpation may show

### Table 5
Performance characteristics of tests for detecting disease of the long head of biceps tendon.

<table>
<thead>
<tr>
<th>Authors and tests</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>PPV %</th>
<th>NPV %</th>
<th>Accuracy %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palm up test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leroux et al., 1995 [8]</td>
<td>63</td>
<td>35</td>
<td>43</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Ardic et al., 2006 [11]</td>
<td>69</td>
<td>60</td>
<td>82</td>
<td>43</td>
<td>41</td>
</tr>
</tbody>
</table>

Leroux et al., 1995 [8]: reference, tendinopathy/arthroscopy; prevalence, 29%. Ardic et al., 2006 [11]: reference, tendinopathy/ultrasonography; prevalence, 61%.

specificity (100%), PPV (100%) and accuracy. However, sensitivity and NPV were low.

#### 3.3.3. Tests for the subscapularis tendon

Two tests involving internal rotation have been evaluated for detecting subscapularis tendon damage with or without tearing, namely, the lift off test and the internal rotation lag sign (Table 4) [7,9]. The lift off test showed high specificity (85–100%) and lower sensitivity (59–62%). The internal rotation lag sign was highly sensitive and specific in a single study [9], whose results need to be confirmed.

#### 3.3.4. Tests for the long head of biceps

Only the palm up test (also known as the Speed test or Gilcreest test) has been evaluated [8,11]. Its diagnostic performance was limited (Table 5).

### 4. Discussion

Clinical testing for subacromial impingement and rotator cuff disease is a key step in the clinical assessment of the painful shoulder, together with history taking, inspection, palpation, and determination of active and passive motion ranges [2]. Clinical tests are most useful in patients without passive motion range limitation due to capsular or glenohumeral abnormalities. Passive motion range limitation may be associated with pain upon motion and with decreased resistance to loading, independently from tendon disease. Therefore, pain or weakness is difficult to ascribe to tendinopathy in patients with restricted passive motion. The tests discussed in this review were evaluated in patients with normal passive motion. Passive range of motion must be examined before using clinical tests for subacromial impingement or rotator cuff damage.

In patients with suspected degenerative rotator cuff disease, clinical testing is performed as the first-line investigation for tendon damage, as well as to look for underlying subacromial impingement. The results may affect treatment decisions. Evidence of subacromial impingement may prompt a glucocorticoid injection into the subacromial bursa, together with rehabilitation aimed at dynamic centering of the humeral head. Weakness suggests tendon tearing, which requires close monitoring during medical treatment followed, in nonresponders, by surgical repair. Therefore, the diagnostic performance of clinical tests is of crucial importance.
evidence of tearing or dislocation out of the bicipital groove, with a decrease in muscle tone and a change, subtle at times, in the bulge produced by resisted contraction.

5. Conclusions

In sum, the most extensively studied tests for subacromial impingement — Neer and Hawkins — are sensitive but lack specificity. Among tests for rotator cuff disease, when weakness is used to assess the test result, the Jobe test and the full can test show good sensitivity with somewhat lower specificity for the supraspinatus, and the same is true of the Patte test and external rotation lag test for the infraspinatus. Performance characteristics are poorer when pain is the response criterion. A number of tests can be used to detect tendinopathies with or without tearing: weakness of unresisted active external rotation for the infraspinatus and the lift off test and internal rotation lag test for the subscapularis. This last test was both sensitive and specific, in a single study. The other tests may lack sensitivity.

Knowledge of these data is crucial, as clinical tests for the rotator cuff provide information on the nature of the lesions and therefore help to guide treatment decisions. Nevertheless, studies of the performance of clinical tests are few. Further evaluations are needed, as well as efforts to standardize the manner in which these tests are used, performed, and interpreted. This systematic review and the recommendations issued by the French High Health Authority in April 2005 [2] should help to achieve these goals.

References