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Subscapularis Tendon Integrity: An Examination of Shoulder Index Tests

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Clinical Question: The systematic review focused on various index tests for the shoulder. We concentrated on the subscapularis tendon results to determine the accuracy of reported index tests for clinically diagnosing subscapularis integrity.

Data Sources: Studies were identified by an OVID search using MEDLINE, SPORTDiscus, and CINHAL databases (1966–2006) and a hand search by 2 authors (E.J.H. and S.C.). Primary search terms were *shoulder*, *examination*, and *diagnosis*. In addition to the database searches, personal files were hand searched by one of the authors (E.J.H.) for publications, posters, and abstracts. The reference lists in review articles were cross-checked, and all individual names of each special test were queried using MEDLINE and PubMed.

Study Selection: The search was limited to English-language journals. Studies were eligible for inclusion if the criterion standard was surgery, magnetic resonance imaging, or injection (subacromial or acromioclavicular joint); at least 1 physical examination test or special test was studied; and one of the paired statistics of sensitivity and specificity was reported or could be determined. Excluded were studies in which the index test was performed under anesthesia or in cadavers, studies in which the index test was assigned the status of composite physical examination, and review articles. Studies were grouped according to the subscapularis index test assessed: lift off, internal-rotation lag sign, Napoleon sign, bear hug, belly off, and belly press.

Data Extraction: Studies were selected in a 2-stage process. First, all abstracts and articles found through the search process were independently reviewed by 2 authors (E.J.H. and S.C.). Disagreement on inclusion of an article was resolved by consensus. Second, each selected study was assessed by each reviewer independently. A third reviewer made the final decision on any disagreements for the selected studies. The primary outcome measures were sensitivity and specificity and positive and negative likelihood ratios. The quality of a study was determined by assessing its internal and external validity. Validity was determined by the primary author (E.J.H.) using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) statement. Our work required data extraction from the original articles, which we used to generate 2×2 contingency tables for each index test. Pooled indices of clinical usefulness were then determined for each index test.

Main Results: The specific search criteria identified 922 articles for review. Of these, 4 met the inclusion and exclusion criteria for subscapularis tendon tears, resulting in the number of studies assessing each index test as follows: 4 for lift off, 2 for internal-rotation lag sign, 2 for Napoleon sign, 1 for bear hug, 1 for belly off, and 1 for belly press. Subscapularis tears were identified by the criterion standard of surgery to visually assess the torn fibers. Across all 4 studies, a total of 304 shoulders were examined, 95 of which had a subscapularis tear (45 full thickness, 50 partial thickness), and 106 were injury free. Indices of clinical usefulness for full-thickness and partial-thickness subscapularis tears are reported in Tables 1 and 2, respectively.

Key Words: upper extremity, diagnosis, assessment

COMMENTARY

The rotator cuff accounts for approximately 30% of all shoulder disorders,[1] with supraspinatus tendon tears being the most common injury.[2] Approximately 24% of supraspinatus tears also involve a tear of the subscapularis tendon,[2] which is uncommon in isolation.[3] Comorbidity of supraspinatus and subscapularis tears is attributed to their congruent attachment at the anterosuperior edge of the humerus.[4,5] Subscapularis tears, either in isolation or in conjunction with other tendinous or labral injuries, are often overlooked, resulting in suboptimal treatment outcomes, especially when one considers that the subscapularis is the largest rotator cuff muscle.[4]

Sensitivity and specificity provide information about an index test's diagnostic use for ruling a particular condition in or out. *Test sensitivity* represents the proportion of patients with a positive test who have the condition, as indicated by a reference standard. Clinical index tests with proven high sensitivity that yield negative findings strongly indicate that the investigated condition does not exist. For full-thickness tears of the subscapularis tendon, the internal-rotation lag sign (98%), Napoleon sign (98%), and lift-off (94%) index tests had the highest pooled sensitivities. Conversely, for partial-thickness subscapularis tears, the pooled sensitivities for all the index tests were low to moderate, with the belly-off test demonstrating the highest sensitivity (69%). *Test specificity* represents the proportion of patients without the condition who exhibit a negative test, as verified by a reference standard. Clinical index tests with high specificity are valuable as a screening tool to rule out an investigated condition. For both full-

Table 1. Pooled Indices of Clinical Usefulness for Full-Thickness Subscapularis Tendon Tears

Index Test	Sensitivity	Specificity	Positive Likelihood Ratio	Negative Likelihood Ratio
Lift off	0.94	0.99	132.0	0.06
Internal-rotation lag sign	0.98	0.94	16.0	0.02
Napoleon sign	0.98	0.97	32.0	0.02
Bear hug (90°)	0.88	0.91	9.6	0.14
Belly off	0.90	NA	1.8	0.20
Belly press	0.88	0.97	29.0	0.13

Abbreviation: NA, not available.

thickness and partial-thickness subscapularis tears, all the index tests (excluding the belly off, for which specificity information was not provided) had pooled specificities of 91% and higher. The hierarchal order (highest to lowest) was lift off, Napoleon sign and belly press (which tied in the order), internal-rotation lag sign, and bear hug.

Positive and negative likelihood ratios reflect the shift in probability that an index test results favor the presence or absence of the condition once the index test results are obtained. A positive likelihood ratio ranges from 1 to infinity, with ratios closer to 1 being no better than chance that a positive test will predict a certain condition. Full-thickness tears had pooled positive likelihood ratios of 132 for the lift off, 32 for the Napoleon sign, and 29 for the belly press. The same hierarchal order existed for partial-thickness tears, with the pooled positive likelihood ratios reduced by a factor of 4 to 1 for the lift off and by a factor of 2 to 1 for both the Napoleon sign and belly press. Positive likelihood ratios of this magnitude (for both full-thickness and partial-thickness tears) indicate a large shift in the probability that subscapularis injury is present when the test is positive. Negative likelihood ratios range from 0 to 1, with values closer to 0 indicating the absence of a condition with a negative test. Full-thickness tears had pooled negative likelihood ratios of 0.02 for the internal-rotation lag sign and Napoleon sign and a ratio of 0.06 for the lift off. Negative likelihood ratios of this magnitude indicate a large shift in the probability that a complete tear of the subscapularis does not exist. This was not the case for partial-thickness tears, in which pooled negative likelihood ratios for all 6 index tests ranged from 0.49 to 0.79, indicating a small, questionable shift in the probability that supports the absence of a partial-thickness subscapularis tear.

In their systematic review, Hegedus et al[6] concluded that the bear-hug and belly-press tests may be valuable for ruling in a subscapularis muscle tear. This finding was supported by Chao et al[7] and Tokish et al,[8] who in separate electromyographic studies showed that the belly press resulted in greater activation of the upper portion of the subscapularis than did the lift off, whereas the lift off activated the lower portion of the subscapularis more than did the belly press. Chao et al[7] also reported that the bear hug at 90° and 45° of shoulder flexion resulted in the greatest activation of the lower and upper subscapularis, respectively. Ostensibly, test position affects fiber alignment and the relationship between neuromuscular activation and test sensitivity. Subscapularis tendon tears appear to initiate proximally and extend distally, so one would expect that the bear hug at 90° should have the highest sensitivity for clinically detecting full-thickness subscapularis tears, because this position seems to enhance detection of lower tendon violation. Surprisingly, this was not the case in our review (sensitivity = 88%). Because this finding is based on a single study with a sample of only 3 participants, additional research is needed to determine its clinical value. Unfortunately, no sensitivity or specificity information has been reported for the bear hug at 45° of shoulder flexion for partial-thickness subscapularis tears. Chao et al[7] reported that this position demonstrated the highest upper subscapularis activity; thus, it holds promise for sensitive detection of early (and proximal) subscapularis tendon injury.

Table 2. Pooled Indices of Clinical Usefulness for Partial-Thickness Subscapularis Tendon Tears

Index Test	Sensitivity	Specificity	Positive Likelihood Ratio	Negative Likelihood Ratio
Lift off	0.22	0.99	30.0	0.79
Internal-rotation lag sign	0.54	0.96	12.0	0.49
Napoleon sign	0.33	0.98	16.0	0.69
Bear hug (90°)	0.53	0.92	6.3	0.51
Belly off	0.69	NA	1.4	0.63
Belly press	0.29	0.98	14.0	0.72

Abbreviation: NA, not available.

Although the lift-off and internal-rotation lag sign tests had high clinical value for determining subscapularis integrity, 9% of patients were unable to be placed in the required test position as a result of pain or restricted range of internal rotation (or both). This limitation markedly reduces the sensitivity and specificity of both tests. Because the inability to be placed in this test position is not exclusive to subscapularis tears, follow-up testing with the Napoleon sign or belly-press index tests, which have high pooled specificities and achievable test positions, is warranted to identify a subscapularis tear. In addition, it is important to consider the clinical presentation, which can include anterior shoulder pain, increased shoulder external rotation with the arm at the side, weakness in shoulder internal rotation, and inability to tuck a shirt in.

The quality of the articles under review was interpreted using the QUADAS,[9] which is based on a range of 0 to 14, with the latter interpreted as the highest quality. Scores of 7 and higher are traditionally considered high quality, although Hegedus et al[6] used a score of 10 for this purpose. The QUADAS scores (references are provided in Hegedus et al[6]) were as follows: 11 for Barth et al,[10] 9 for Gerber and Krushell,[11] 7 for Hertel et al,[12] and 6 for Scheibel et al.[13] Limitations of the latter 2 studies included bias in that the outcome was known before clinical testing and arthroscopic evaluation and failure to include uninjured control participants.

CONCLUSIONS

Based on our analysis, the Napoleon sign, internal-rotation lag sign, and lift-off index tests all demonstrated good clinical usefulness for ruling a full-thickness subscapularis tear in or out. Although 5 of the 6 index tests (belly-off test specificity could not be determined) can be used effectively for screening for partial-thickness subscapularis

tears, no single test has yet demonstrated high value for clinically determining its presence (as based on sensitivity). The bear-hug test holds promise for partial-thickness tears. It remains to be determined if increased sample size, combinations of index tests, or a combination of index test and clinical symptoms yield improvement in the clinical assessment of this often-overlooked shoulder injury.

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