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The Diagnostic Value of Subscapularis Clinical Tests in the Postoperative Diagnosis of Subscapularis Tendon retears after Arthroscopic Repair: An Ultrasound-Comparative Trial

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Abstract

Purpose: To investigate the diagnostic value of the most commonly used clinical tests in the diagnosis of subscapularis tendon re-tears after arthroscopic repair.

Methods: A retrospective (prospectively collected data) case series involving 37 patients suffering from symptomatic complete subscapularis tendon tear was conducted. All patients underwent an all-arthroscopic subscapularis repair with the same operative technique. They were postoperatively evaluated (final end point of follow-up: 12 months) with the use of ultrasound, Constant score, bear hug test, internal rotation lag sign, Napoleon test and lift-off tests. Sensitivity, specificity, accuracy, and positive and negative prognostic values were calculated for each test.

Results: Shoulder function was significantly improved according to the final Constant scores. The internal rotation lag sign was the most sensitive in the diagnosis of postoperative subscapularis retears, while the Napoleon sign had the highest specificity. Although postoperative clinical tests concerning subscapularis retear yielded no false negative findings, they were poorly predictive as for new tendon ruptures. Ten patients (27%), who were found with a positive (for re-rupture), postoperative, clinical test, had a sonographically intact subscapularis tendon repair.

Conclusions: We strongly support the use of the subscapularis-specific clinical tests as a composite, in combination with a specific interpretation of their results. If all tests are found negative for retear, then we could safely assume that the arthroscopic repair remains intact and no further diagnostic examination is necessary. On the contrary, if at least one subscapularis-specific clinical test is positive for retear the patient will likely require an ultrasound or MRI for definite diagnosis.

Level of Evidence: IV; Diagnostic case series.

Keywords: Subscapularis tendon; Bear hug test; Napoleon test; Lift off tests; Internal rotation lag sign; Arthroscopic subscapularis repair; Shoulder ultrasound

Introduction

Rupture of the subscapularis (SSC) tendon, isolated or combined, is not so common as a suparspinatus or an infraspinatus tear, and the treatment modalities are controversial [1,2]. Although pathology of the subscapularis tendon is both infrequently identified and not commonly considered as a major source of shoulder pain and dysfunction [3], tears of the subscapularis tendon are now more frequently recognized [4]. Arthroscopic subscapularis repair appears to be a reasonable option for the treatment of isolated tears of the subscapularis to obtain successful functional and patient-reported clinical outcomes [5].

A combination of physical examination tests can be used to determine both the presence and size of a subscapularis tear [6]. The literature has shown that the Napoleon test as well as the bear hug test, the internal rotation lag sign and the lift-off tests are specific to the subscapularis tendon [7-10].

Hertel et al. reported that the internal rotation lag sign was as specific but more sensitive than the lift-off sign for assessment of the subscapularis [10]. Faruqui et al. were the first who evaluated the sensitivity of three separate clinical tests as a composite [7]. According to them, the sensitivity of the physical examination as a whole in diagnosing primary subscapularis tears was 81% [7]. In comparison with other clinical tests for detecting subscapularis primary tears, Takeda et al. found that the bear hug test had the greatest specificity and positive prognostic value, while the supine Napoleon test had the greatest sensitivity and negative prognostic value [8]. Schiefer et al. illustrated that the bear hug test had the highest sensitivity and negative predictive values in diagnosing primary subscapularis tears, when compared with the Napoleon test, the belly press and lift off tests [9].

On the contrary, no clinical trial has been published yet to assess the diagnostic validity of the aforementioned tests in diagnosing subscapularis retears after arthroscopic subscapularis repair.

Method

We retrospectively studied (prospectively collected data) 37 consecutive patients suffering by symptomatic subscapularis tendon tear who were operated by two senior surgeons (EF, AC) in two medical teaching centers of high caliber.

The overall period of recruitment was 16 months (November 2012-March 2014). We included in our study adult patients treated with an all-arthroscopic anatomic repair of subscapularis tendon tears (regardless of the size). The follow-up for each patient should be at least 12 months.

We planned to exclude from our retrospective analysis patients who were not adults, those who were reoperated on the same shoulder in the past, individuals who did not undergo an arthroscopic treatment of the subscapularis tear or they were treated with a non-anatomic repair (partial or medialized) of subscapularis or had a follow-up less than 12 months, those who did not have a preoperative MRI confirmation of the subscapularis tear, patients suffering from systematic or autoimmune diseases, cancer, psychiatric diseases and uncontrolled hormonal diseases.

The technique used for the arthroscopic complete repair of the subscapularis tendon was similar for all patients. A typical shoulder arthroscopy on lateral decubitus position with the use of a 30° scope was performed. The subscapularis tear was assessed with the arthroscopic probe in various degrees of arm rotation after meticulous debridement and posterior humeral head translation in order to have a better visualization. The subscapularis tendon was mobilized and sutured in its anatomic position with the use of one or two suture anchors depending on the extent of the tear. Tenotomy or tenodesis of the long head of biceps was carried out in every patient. The subscapularis repair was also assessed in internal and external rotation with the use of a probe. As next step, bursoscopy was performed and the posterior cuff was also evaluated. Whenever repair was necessary, the cuff was debrided, mobilized and fixed with suture anchors on a single row configuration depending on the tear size. Mild acromioplasty was deployed in most patients.

All patients were evaluated pre- and postoperatively with specific clinical tests for the evaluation of subscapularis integrity. The clinical tests were performed by experienced shoulder surgeons. These tests comprised the internal rotation lag sign, the Napoleon test, the bear-hug and lift-off tests [7-12].

Shoulder function was also evaluated pre- and postoperatively using the Constant score. Postoperative assessments were made at the final follow up appointment (12 months after surgery).

Immobilizer was used in all cases for four weeks. During this period the immobilizer was removed only for hygiene and elbow exercises. From the first postoperative day, active elbow, wrist and hand motions were allowed. At four weeks the immobilizer was removed and assisted active and passive range of motion (RoM) to tolerance were allowed. At eight weeks resistive exercises for scapular stabilizers, biceps, triceps and rotator cuff started. At twelve weeks the goal was to gradually gain active full RoM, while muscle endurance activities might began.

One of the aforementioned two physicians (senior orthopaedic surgeons: EF, AC) carried out all the operations and preoperatively evaluated the patients (clinical tests, Constant score). In addition, two other orthopaedic surgeons assessed the patients in the follow-up period (clinical tests, Constant score). These last two physicians were blinded to the initial preoperative clinical and functional results of the patients as well as their postoperative sonographic results. Furthermore, one of two senior radiologists evaluated the arthroscopic repair of the rotator cuff in the follow-up. These two radiologists were blinded both to the preoperative and postoperative clinical and functional outcomes.

Postoperative imaging

All patients were postoperatively evaluated with the use of ultrasonography by one of two senior radiologists (AP, FL) specialized in musculoskeletal shoulder ultrasound. A linear 12 Mhz probe (Logiq S8; GE Healthcare, Seoul, Korea and iu22; Philips Healthcare, Eindhoven, The Netherlands) was utilized for the sonographic examination, which was undertaken at 6 and 12 months after surgery.

The ultrasound examination was carried out with the examiner sitting on a revolving stool facing the front of the patient who was also sitting on a stool. The same scanning protocol was performed in all patients included in our study. The checklist of the key structures which were under sonographic examination per patient included the long head of the biceps brachii tendon, the subscapularis, supraspinatus, infraspinatus and teres minor tendons and finally the assessment of the supraspinatus and infraspinatus muscles for muscle atrophy.

The postoperative ultrasound image of the repaired subscapularis tendons, along with any differences in structure or echogenicity compared to the normal, contralateral subscapularis tendons, were recorded (Figure 1).

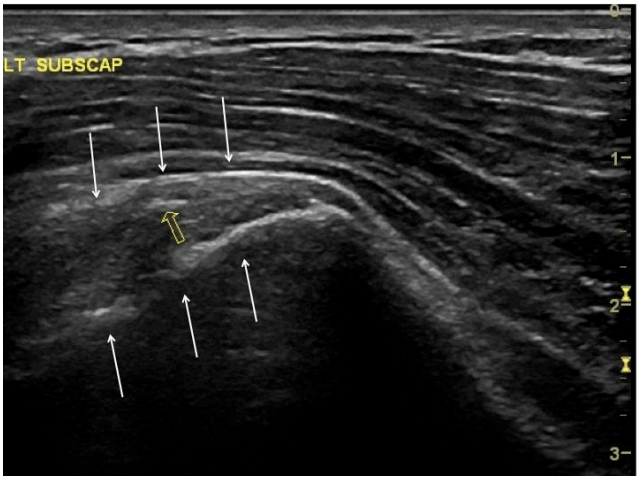

Figure 1: Ultrasound examination 6 months after the repair reveals intact subscapularis tendon with normal fibrillar echostructure (arrows). Brightly echogenic suture material is identified within the tendon substance (void arrow).

Statistical analysis

Data were expressed as mean ± standard deviation (S.D.) for quantitative variables and as percentages for qualitative variables. The diagnostic results of the clinical tests were compared to the ultrasound findings in order to determine the sensitivity, specificity, positive and negative prognostic values, and accuracy of clinical tests. The comparison of preoperative and postoperative evaluation of Constant score was performed using the paired samples t-test. All tests were two-sided, a p-value of <0.05 was used to denote statistical significance. All analyses were carried out using the statistical package SPSS vr 17.00 (Statistical Package for the Social Science, SPSS Inc., Chicago, Ill., USA).

Results

The average age of the patients at surgery was 62.3 years (31-74), the male to female ratio 22/15, and the right to left arm ratio 29/8. According to the intra-operative arthroscopic findings, ten patients were diagnosed with an isolated subscapularis tear, while 27 patients had a subscapularis tear combined with other rotator cuff tears (supraspinatus, or both supraspinatus and infraspinatus).

During the postoperative ultrasound examination all tendons of the rotator cuff were examined and retears of supraspinatus and infraspinatus tendons were reported. As a result, seven out of 23 patients with postero-superior cuff repairs (30.4%) had postoperative sonographic supraspinatus and/or infraspinatus retears, while there was no clinical indication of subscapularis retear in this category of patients.

A disruption of the subscapularis tendon with complete failure to visualize the tendon was diagnosed in eight patients (21.6% of all patients) (Figure 2).

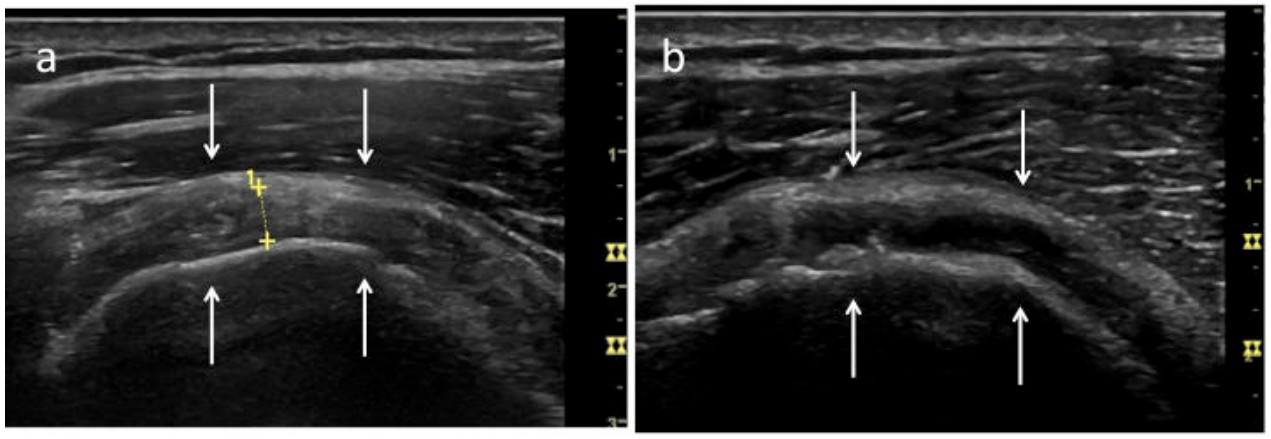

Figure 2: A 55-year old male with traumatic, type III Romeo right subscapularis tendon tear. Non-intact subscapularis tendon post-operatively. (a) normal left subscapularis tendon (b) absent, retorn right subscapularis tendon arrows: subscapularis tendon.

Nineteen out of 37 patients (51.4% of all patients) who were postoperatively found with all four clinical tests being negative for retear, had also sonographically intact subscapularis tendons (true negative). So, we did not find any false negative patient in our sample (a patient with clinical tests as a composite documented negative for retear, whereas the ultrasound would be positive). On the contrary, from the 18 patients (48.6% of all patients) who had at least one clinical test positive for subscapularis tendon retear, more than half (10 out of 18 patients: 55.6%) had intact tendons at the follow-up ultrasound (false positive). The combination of these clinical and sonographic findings resulted in three subgroups of patients: a true negative subgroup (19 patients), a true positive subgroup (8 patients) and a false positive subgroup (10 patients) (Table 1).

	Intact subscapularis (ultrasound)	Non-intact subscapularis (ultrasound)
Negative clinical tests for subscapularis re-tear	True negative = 19	False negative=0
Positive clinical tests for subscapularis re-tear	False positive = 10	True positive = 8

Table 1: Correlation of clinical tests for subscapularis tendon re-tear with ultrasound findings.

The bear hug test had 87.5% sensitivity, 82.8% specificity, 83.8% accuracy, 58.3% positive predictive value and 96% negative predictive value in the diagnosis of subscapularis retears after complete arthroscopic repair. The Napoleon test had 62.5% sensitivity, with 89.6% specificity, 83.8% accuracy, 62.5% Positive Predictive Value (PPV) and 89.6% Negative Predictive Value (NPV) in the diagnosis of subscapularis retears after complete arthroscopic repair (Table 2).

Test-sign	Sensitivity%	Specificity%	Accuracy%	PPV%	NPV%
Napoleon	62.5(25.9-89.8)	89.6(71.5-97.3)	83.8(68.0-93.8)	62.5(25.9-89.8)	89.6(71.5-97.3)
Lift off	62.5(25.9-89.8)	68.9(49.1-84.1)	67.6(50.2-82.0)	35.7(14.0-64.4)	86.9(65.3-96.6)
Bear Hug	87.5(46.7-99.4)	82.8(63.5-93.5)	83.8(68.0-93.8)	58.3(28.6-83.5)	96.0(77.7-99.8)
Internal rotation lag sign	100(39.8-100)	50.0(30.6-69.4)	56.3(37.7-73.6)	22.2(16.5-30.0)	100(100.0-100.0)

Table 2: Sensitivity , specificity , PPV an NPV of clinical tests using the ultrasound findings as gold standard method of diagnosis.

In addition, the lift-off test was found with 62.5% sensitivity, 68.9% specificity, 67.6% accuracy, 35.7% PPV and 86.9% NPV. Finally, the sensitivity of the internal rotation lag sign was estimated 100%, while the specificity was 50%, the accuracy 56.3%, and the positive and negative predictive values 22.2% and 100%, respectively.

Regarding the functional outcomes, all 37 patients (100%) had significantly improved final postoperative values. The final mean postoperative Constant From a mean preoperative Constant Score: 31.5 ± 9.8, we reached to a final mean postoperative value of 68.0 ± 12.7 ($p<0.0005$). In addition, the Constant Score was significantly improved in all patient subgroups.

Particularly, the p-value was <0.0005 in the true negative subgroup, <0.0016 in the false positive subgroup and <0.0005 in the true positive subgroup. Moreover, all those patients who were clinically found with a subscapularis tendon retear (18 patients: true positive and false positive patients) illustrated significant improvement in their final Constant score ($p<0.005$).

Discussion

The most important finding of our study was that the diagnostic value of the clinical tests for diagnosing subscapularis retear was high when they were found negative. On the contrary, a high percentage of false positive results was reported, which jeopardizes the diagnostic value of the subscapularis-specific clinical tests after arthroscopic subscapularis repair in the case that they are found positive.

According to a relative systematic review, special tests for the diagnosis of subscapularis tears include the lift-off, belly-press, and bear-hug tests [11]. In a Level I diagnostic study, Barth et al. showed that the bear-hug test represents the most sensitive test [12]. We utilized four different clinical tests in our study: the bear hug, the Napoleon, the lift off and the internal rotation lag sign.

The knowledge regarding the sensitivity of the subscapularis-specific physical examination as a composite can lead practitioners to implement all clinical tests, even when one test has a negative finding, thus promoting a more thorough physical examination [7]. Performing all subscapularis-specific clinical tests has been proven more efficient in predicting the size of the tear than selecting only one specific clinical test [12].

Concerning our clinical trial, we investigated the diagnostic validity of the subscapularis clinical tests in the diagnosis of subscapularis retears. The assessment of each clinical test separately illustrated that the Napoleon sign was found with the highest specificity amongst all tests in diagnosing subscapularis retears, while the internal rotation lag sign had the highest sensitivity. In addition, the bear hug test and the Napoleon test were found with the highest accuracy (both with 83.8%). On the other hand, the lift off test was the one with the lower performance (Table 2).

It is established that the gold standard for the diagnosis of a rotator cuff retear is the second-look arthroscopy [13]. In our study we avoided to perform a second operation due to the significant clinical improvement of the patients who were suspicious for retear. On the contrary, we used ultrasound as the preferred imaging modality for the diagnosis of subscapularis retears after the primary arthroscopic repair.

Although an accurate physical examination is of paramount importance, imaging modalities such as magnetic resonance imaging (MRI), and ultrasound offer advanced knowledge of the spectrum of abnormalities involving the subscapularis tendon. Tung et al. have shown that subscapularis tears are frequently missed on MRI [3]. Compared with poster superior rotator cuff tears, MRI detection of subscapularis is less reliable and therefore requires a high index of suspicion [6].

On the other hand, shoulder ultrasound is nowadays extensively used for the accurate evaluation of the rotator cuff pathology [14-16]. Furthermore, several studies have proven the efficacy of the ultrasound imaging modality in the postoperative assessment of the rotator cuff repair after arthroscopic surgery [17-19]. High-resolution ultrasonography may not only assess the operated tendon's integrity, but also evaluate the postoperative tendon's position and echostructure. Our study confirmed that most repaired subscapularis tendons had fibrillar echotexture postoperatively and similar sonographic qualitative characterictics to the contralateral normal tendons. The holes which were drilled by the treated surgeon on the lesser tubercle were sonographically identified as bone depression. Furthermore, the sutures were sonographically visible on the initial examination (6 months postoperatively) as echogenic foci within the tendon substance. Those subscapularis tendons which were sonographically intact at 6 months after surgery, were also maintained intact after 12 months.

Shoulder ultrasound has been used in several studies as the reference examination for the estimation of the diagnostic values of the various clinical tests [20-22]. Taking into consideration the correlation that we found in our study between the clinical findings as a composite and the ultrasound findings, we divided our patients into three subgroups (true negative, true positive, false positive subgroups). Especially regarding the false positive subgroup, although postoperative ultrasound demonstrated an intact subscapularis tendon, the follow-up clinical evaluation implied that there was retear. If all the subscapularis specific clinical tests are negative for retear, then we could safely base on them for the patient's postoperative assessment (no false negative findings in our study). On the contrary, when a subscapularis specific clinical test is positive for retear, then we should

proceed to further examinations for the accurate evaluation of the patient (due to high rate of false positive results).

A significant improvement in shoulder's function was also illustrated, when we compared the preoperative and follow-up values of the Constant score, regardless of the individual's outcome as assessed by the clinical tests or the ultrasound. The functional improvement in these patients who had a clinically successful repair was something to be expected. Contrariwise, an interesting point of our study was the significant functional improvement that was documented in the mean postoperative Constant score of the false positive subgroup (patients who had a sonographically intact subscapularis repair but at least one positive postoperative clinical test). We might assume that this result could be due to the unique role which the subscapularis plays as an anterior restraint of the humerus. It has been proven that subscapularis assists in the provision of a fulcrum of motion even in the absence of contractile elements [23,24].

Secondarily, we assessed the sonographic status of the other rotator cuff tendons. Almost one third of the patients who were submitted to a posterosuperior tendons' repair, were sonographically found to have rotator cuff retears. Surprisingly, there was no clinical indication of subscapularis tendon retear in this category of patients. So, we deduced that the presence of tears elsewhere in the rotator cuff and their postoperative failed repair did not influence the outcome of the subscapularis repair.

We recognize also some limitations in our study. Weak points were the relatively small number of patients included, the retrospective design of the trial and the absence of any control group. Furthermore, ultrasound has been used as the sole imaging modality for postoperative assessment. However, postoperative shoulder ultrasonography has the advantage of being less susceptible to postoperative artifacts that may be seen on MRI, while it is nowadays established as an accurate diagnostic tool for the follow-up assessment of patients who have undergone an arthroscopic rotator cuff repair [25-27].

Conclusion

The internal rotation lag sign was the most sensitive in the diagnosis of postoperative subscapularis retears, while the Napoleon sign had the highest specificity and the bear hug test the highest accuracy. We strongly support the use of the subscapularis-specific clinical tests as a composite, in combination with a specific interpretation of their results. If all tests are found negative for retear, then we could safely assume that the arthroscopic repair remains intact and no further diagnostic examination is necessary. On the contrary, if at least one subscapularis-specific clinical test is positive for retear the patient will likely require an ultrasound or MRI for definite diagnosis.

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