Multiple Subscapularis Tendon Sign

A New Risk Factor for Recurrence After Arthroscopic Anterior Shoulder Instability Surgery

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Background: Being able to predict recurrence after the treatment of shoulder instability would be helpful in planning the appropriate treatment.

Purpose: To define the multiple subscapularis tendon sign (MSTS) as a novel anatomic variant and a possible risk factor for the recurrence of shoulder instability after anterior stabilization and to evaluate it, together with the other risk factors as described in the literature.

Study Design: Case-control study; Level of evidence, 3.

Methods: A total of 87 patients met the study criteria and underwent arthroscopic stabilization for anterior shoulder instability. The MSTS was evaluated in this study group. Age, sex, hand dominance, number of preoperative shoulder dislocations, history of overhead or contact sports participation, type of labral lesion, number of anchors used in surgery, presence of the drive-through sign, presence of the MSTS, Oxford Shoulder Score results, and the association of these parameters with recurrence were assessed. The mean follow-up time was 81.0 ± 27.9 months (range, 48-139 months).

Results: Nine (10.3%) patients experienced recurrent instability. The presence of the MSTS ($P = .009$), existence of an anterior labroligamentous periosteal sleeve avulsion (ALPSA) lesion ($P = .04$), and history of overhead or contact sports participation ($P = .04$) were significant risk factors for recurrence. The recurrence rates were as follows: 30.7% with the MSTS; 40% with the MSTS and an ALPSA lesion; and 75% with the MSTS, an ALPSA lesion, and a history of overhead or contact sports participation.

Conclusion: The MSTS is a variation of the anterior shoulder joint capsule. It is a sign of capsular insufficiency or thinning, which may be a risk factor for recurrence after anterior stabilization. Considering the low success rates of anterior capsulolabral repair in patients participating in overhead or contact sports, especially when an ALPSA lesion is present, encountering the MSTS during surgery in this at-risk group may be an indicator for the surgeon to choose the surgical procedure more carefully.

Keywords: anatomic variation; shoulder capsule; labrum; sports; instability

The development of techniques and instrumentation in arthroscopic surgery makes way for finding new anatomic variations and pathological conditions. The intra-articular part of the subscapularis tendon can be easily recognized at the inferior part of the rotator interval. Actually, the subscapularis has 4 to 6 tendon slips within the muscle substance during its course to its insertion on the lesser tubercle.[5,6] Only the most superior subscapularis tendon part can be seen during shoulder arthroscopic surgery. Posterior portions of the other muscle slips are covered by the anterior joint capsule, which hides them from view during surgery. In some cases, we have recognized a variation in which more than 1 slip, usually 2 or 3 slips, of the subscapularis tendon can be seen during arthroscopic surgery. This gives us an impression that the anterior capsule is thin enough to enable visualization of the subscapularis tendon slips when viewing from the posterior portal. We called this finding the "multiple subscapularis tendon sign" (MSTS) (Figure 1).

A thin, weak, or lax anterior shoulder joint capsule may be associated with anterior shoulder instability. In this case, the MSTS may have some role in anterior shoulder instability or some potential negative effect on recurrence after shoulder instability surgery. It is either an anatomic variation or a pathological condition that cannot be fixed with plication, which is performed for capsular abnormalities. It is our opinion that the MSTS is a demonstration of the insufficiency of the anterior joint capsule.

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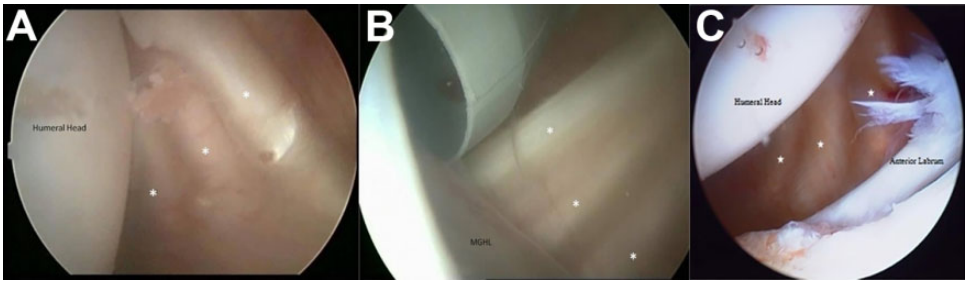

Figure 1. Arthroscopic view of the multiple subscapularis tendon sign (*) through the posterior portal on (A-C) left, right, and left shoulders, respectively.

In this study, the prevalence of the MSTS was evaluated in a group of patients and also in an age- and sex-matched control group consisting of patients without shoulder instability. We also investigated the association of the MSTS with other known risk factors for recurrence. These risk factors are patient related (younger age, ligamentous hyperlaxity, dominant side, sex, number of previous dislocations, overhead or contact sports), technical (number of anchors used, type of anchors, insufficient soft tissue tensioning, technical errors, rehabilitation program), and pathoanatomic (capsular lesions/laxity, bone loss on glenoid or humeral side, anterior labroligamentous periosteal sleeve avulsion [ALPSA] lesions, associated intra-articular abnormalities [including superior labral from anterior to posterior (SLAP) lesions and rotator cuff tears]).[1-4,12-17,25]

Recognizing the risk factors associated with the recurrence of anterior traumatic shoulder instability after arthroscopic anatomic repair helps the surgeon in deciding whether the planned repair type will be sufficient and whether additional procedures will be required to address the increased risk of recurrence. The purpose of this study was to evaluate the risk factors for the recurrence of anterior shoulder instability after arthroscopic anatomic repair and to define the MSTS as a novel anatomic variant and a possible risk factor.

METHODS

Patients

Clinical and digital video data from our institutional archive between January 2006 and July 2011 were retrospectively evaluated. Patients who underwent anatomic repair for anterior shoulder instability and who had no additional shoulder abnormalities were included in the study. Exclusion criteria for shoulder instability cases were posterior instability, multidirectional instability, atraumatic instability, humeral avulsions of the glenohumeral ligament, ligamentous hyperlaxity as described by Wynne-Davies,[26] engaging Hill-Sachs lesions, medially localized (off-track) Hill-Sachs lesions, glenoid bony defects over 20% of the anterior-posterior diameter of the glenoid, capsulolabral repair without suture anchors, rotator cuff tears, and subacromial abnormalities. The reason for excluding patients with large bony defects was that they already required nonanatomic surgical procedures such as the Bristow-Latarjet procedure and mostly underwent additional procedures such as remplissage. Institutional review board approval was obtained for this study.

Other risk factors for recurrence after arthroscopic surgery were also recorded. These were age, sex, hand dominance, number of previous dislocations, participation in overhead or contact sports, labral lesion type (Bankart vs ALPSA), number of anchors used, SLAP 2 lesions, presence of the drive-through sign, and presence of the MSTS.[15-18]

The Oxford Shoulder Score (OSS) was used in clinical assessments. The recurrence of instability was deemed positive if the patient had a frank dislocation or experienced a subluxation during shoulder abduction and external rotation.

There were 169 arthroscopic anatomic repair procedures performed for anterior shoulder instability between January 2006 and July 2011. Of these, 96 met the inclusion criteria. Nine patients (9.3%) were lost to follow-up, and the study was conducted on 87 patients (Figure 2). Determining the prevalence of the MSTS in patients without shoulder instability was made by a comparison with a control group, which included 87 age- and sex-matched patients chosen randomly from the shoulder arthroscopic surgery archive.

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Ethical approval for this study was obtained from the Erzincan University Ethical Committee (approval No. 33216249-604.01.02-E29396).

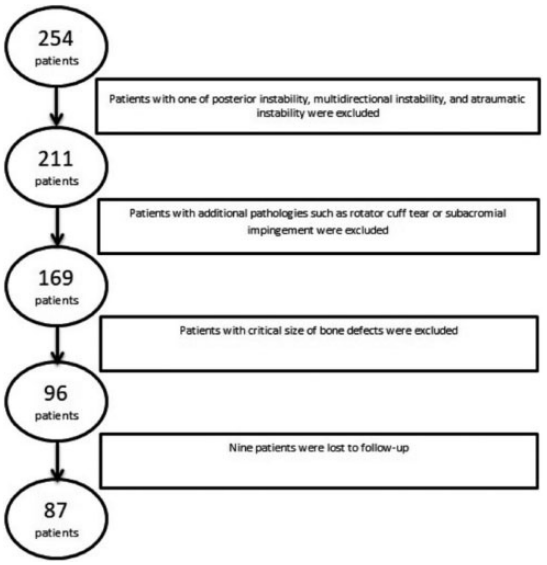

Figure 2. Flowchart of study participants.

The mean age at surgery was 28.4 ± 10.8 years (range, 16-62 years), and 75 (86.2%) of the patients were male. The involved shoulder was the dominant side in 50 (57.5%) patients. The mean follow-up was 81.0 ± 27.9 months (range, 48-139 months). Nine patients suffered from recurrence after a mean time of 25.1 ± 26.3 months (range, 10-84 months). Seven patients described a frank dislocation reduced at an emergency unit, and 2 patients described only symptoms of a subluxation. All dislocations were caused by trauma during athletic activities. Preoperative demographic details of the patients are summarized in Table 1. Arthroscopic findings and details of the procedures are presented in Table 2.

TABLE 1
Demographics of All Patients (N = 87)[a]

Age at surgery, y	28.4 ± 10.8 (16-62)
Sex, n (%)	
Male	75 (86.2)
Female	12 (13.8)
Involvement of dominant side, n (%)	50 (57.5)
No. of dislocations, n (%)	
1	19 (21.8)
2-5	32 (36.8)
6-10	17 (19.5)
>10	19 (21.8)
Follow-up, mo	81.0 ± 27.9 (48-139)
Participation in overhead or contact sports, n (%)	31 (35.6)
Recurrence, n (%)	9 (10.3) (7 dislocations, 2 subluxations)
Time to recurrence, mo	25.1 ± 26.3 (10-84)

[a]Data are shown as mean ± SD (range) unless otherwise indicated.

TABLE 2
Arthroscopic Findings and Treatment Details[a]

	n (%)
Labral lesion type	
Bankart	56 (64.4)
ALPSA	31 (35.6)
No. of anchors	
2	41 (47.1)
3	46 (52.9)
SLAP 2 lesion	30 (34.5)
Drive-through sign	70 (80.5)
Multiple subscapularis tendon sign	13 (14.9)

[a]ALPSA, anterior labroligamentous periosteal sleeve avulsion; SLAP, superior labrum anterior to posterior.

Surgical Technique

All operative procedures were performed by the senior author (U.K.) with the patient in the semi–lateral decubitus position, in which the patient was tilted 20° to 30° posteriorly and the affected arm at 15° of flexion and 45° of abduction under 10 lb of longitudinal traction. Three standard portals were used: the posterior portal as a viewing portal and the anterior-superior and anterior-inferior portals as working portals. The procedures were performed with 0.9% NaCl solution under 40 mm Hg of pressure. During diagnostic arthroscopic surgery, the labral lesion type was identified by examining with a probe. Additional arthroscopic findings, including SLAP lesions, humeral and glenoid bone defects, the MSTS, capsular tears, rotator cuff tears, long head of the biceps tendon defects, and the drive-through sign were identified. Capsulolabral abnormalities were classified as the Bankart group or ALPSA group.

In all capsulolabral lesion types, the medially retracted anterior labrum was first elevated with an arthroscopic elevator from the anterior aspect of the glenoid rim up to the articular cartilage level to facilitate reduction of the anterior capsulolabral complex to the anatomic attachment site, especially in ALPSA lesions. Then, the anterior surface of the glenoid was rasped to eliminate scar tissue from the glenoid edge. If a SLAP lesion was detected, it was addressed before the repair of Bankart lesions by using a suture anchor, thus providing a reference point to reduce the remaining detached labrum. In anterior stabilization, a double-loaded suture anchor was placed at 5 o'clock initially (for right shoulders). A shuttle relay was used to pass a suture from the inferior glenohumeral ligament and labrum and to secure them to the edge of the articular surface of the glenoid, which provided a bumper effect at the anterior aspect of the glenoid face. Then, a second anchor loaded with 2 sutures was placed at the 3-o'clock position. If needed, a third suture anchor loaded with 1 suture was placed at the 1-o'clock position.

Postoperative Care

All patients received the same postoperative care and followed a standard rehabilitation program directed by the same physical therapist. The arm was immobilized in a

TABLE 3
Recurrence Rates Based on Specific Risk Factors[a]

	n (%)
Recurrence	9/87 (10.3)
ALPSA lesion	6/31 (19.3)
Overhead or contact sports	6/31 (19.3)
MSTS	4/13 (30.7)
ALPSA lesion and overhead or contact sports	5/15 (33.3)
MSTS and ALPSA lesion	4/10 (40.0)
MSTS and overhead or contact sports	3/5 (60.0)
MSTS, ALPSA lesion, and overhead or contact sports	3/4 (75.0)

[a]ALPSA, anterior labroligamentous periosteal sleeve avulsion; MSTS, multiple subscapularis tendon sign.

shoulder sling for 3 weeks with the allowance of only isometric exercises. The sling was continued for an additional 3 weeks with passive range of motion (ROM) and pendulum exercises. Active assistive ROM exercises were begun at the end of 5 weeks. The sling was discontinued at the end of 6 weeks, and active ROM exercises were initiated. Activities of daily living were permitted after 8 weeks, and general fitness training and light training activities were initiated after 3 months, along with strengthening exercises with a rubber band. Return to sports was allowed after 6 months postoperatively.

Clinical Follow-up

Follow-up evaluations were performed at 3 and 6 weeks after surgery before discontinuing the sling. Subsequently, the patients were examined at 3, 6, 12, 24, and 36 months after surgery. The last evaluation was performed by an orthopaedic surgeon (M.G.) who was not involved in the surgical procedure or rehabilitation management of the patients. Shoulder function was assessed at the last follow-up with the OSS.

Statistical Analysis

Frequencies, means, and standard deviations were calculated by descriptive statistical methods. Continuous variables were assessed with the Mann-Whitney U test. Dichotomous variables were assessed by crosstab and the Pearson chi-square test or Fisher exact test. Linear multiple regression analysis was used to evaluate the effects of an ALPSA lesion, participation in overhead or contact sports, and the MSTS on recurrence. For all comparisons, statistical significance was reported as $P < .05$ (2-tailed). Statistical analyses were performed with SPSS software (version 21.0; IBM Corp).

RESULTS

Multiple Subscapularis Tendon Sign

The MSTS was present in 44.4% (4/9) of the patients with recurrence. Of 13 patients with the MSTS, 4 (30.7%) had recurrence, and of 10 patients with both the MSTS and an ALPSA lesion, 4 (40.0%) had recurrence. The recurrence rate in patients with the MSTS, an ALPSA lesion, and participation in overhead or contact sports was 75.0% (3/4) (Table 3). There was a statistically significant relationship between the MSTS and recurrence ($P = .009$), chi-square test.

The MSTS was positive in 13 (14.9%) patients in the study group, while it was positive only in 2 (2.3%) patients in the control group. Details of the MSTS-positive and MSTS-negative groups are summarized in Table 4.

TABLE 4
Demographics of MSTS-Positive and MSTS-Negative Groups[a]

	Positive (n = 13)	Negative (n = 74)
Age, mean ± SD, y	24.33 ± 5.26	33.54 ± 11.36
Side		
Right	8 (61.5)	45 (60.8)
Left	5 (38.5)	29 (39.2)
Sex		
Male	13 (100.0)	62 (83.8)
Female	0 (0.0)	12 (16.2)
Involvement of dominant side	8 (61.5)	42 (56.8)
Participation in overhead or contact sports	5 (38.5)	26 (35.1)
No. of dislocations		
1	2 (15.4)	17 (23.1)
2-5	5 (38.5)	27 (36.5)
6-10	6 (46.1)	11 (14.8)
>10	0 (0.0)	19 (25.6)
Labral lesion type		
ALPSA	10 (76.9)	21 (28.4)
Bankart	3 (23.1)	53 (71.4)
No. of anchors		
2	5 (38.5)	36 (48.6)
3	8 (61.5)	38 (51.4)
SLAP 2 lesion	4 (30.8)	26 (35.1)
Drive-through sign	12 (92.3)	58 (78.4)
Recurrence	4 (30.7)	5 (6.8)

[a]Data are shown as n (%) unless otherwise indicated. ALPSA, anterior labroligamentous periosteal sleeve avulsion; MSTS, multiple subscapularis tendon sign; SLAP, superior labral from anterior to posterior.

Age, Sex, and Hand Dominance

Of the patients who suffered a recurrence 66% were younger than 23 years. Of the 37 patients younger than 23 years, 6 (16.2%) had postoperative recurrence, while of 50 patients aged ≥24 years, 3 (6.0%) had recurrence. However, these results were not statistically significant. The relationship of the recurrence rate with hand dominance and sex was also not significant statistically.

Number of Preoperative Dislocations

With the data available, we found no statistically significant relationship between the number of dislocations before surgery and the recurrence rate. The rate was 5.8% (3/51)

in patients with 1 to 5 dislocations before surgery, while it was 16.6% (6/36) in patients with more than 5 dislocations. Moreover, it was 5.2% (1/19) in patients with 1 dislocation and 11.7% (8/68) in patients with more than 1 dislocation.

History of Participation in Overhead or Contact Sports

A total of 31 patients (35.6%) participated in overhead or contact sports. The recurrence rate in this group was 19.3% (with frank dislocations in 6 patients), while it was 5.3% in the remaining 56 patients ($P = .04$).

Labral Lesion Type

Of the 87 patients, 56 (64.4%) had an underlying Bankart lesion, and 31 (35.6%) had an ALPSA lesion. There was a statistically significant relationship between the recurrence rate and ALPSA lesions ($P = .04$). The recurrence rate was 19.3% in the ALPSA group and 5.3% in the Bankart group.

When multiple regression analysis was conducted to evaluate the effects of an ALPSA lesion, overhead or contact sports participation, and presence of the MSTS on recurrence, it was found to be statistically significant ($P = .008$). However, among these 3 parameters, only presence of the MSTS was significantly associated with an increased risk of recurrence ($P = .03$). The equation can be formulated as follows: recurrence = $1.749 + 0.124\times$(overhead or contact sports) + $0.06\times$(ALPSA) + $0.207\times$(MSTS).

OSS, Number of Anchors, SLAP 2 Lesion, and Drive-through Sign

The follow-up OSS in patients with and without recurrence was 16.3 ± 5.7 (range, 12-34) and 24.2 ± 9.6 (range, 12-46), respectively. The number of anchors was 2 in 41 (47.1%) patients and 3 in 46 (52.9%) patients ($P = .819$). There were 30 (34.5%) patients with an accompanying SLAP lesion and 70 (80.5%) patients with a drive-through sign. The presence of SLAP lesions and the drive-through sign were not related to recurrence.

DISCUSSION

The superior portion of the subscapularis tendon is localized intra-articularly and can be viewed arthroscopically. However, the tendon slips of the subscapularis cannot be viewed arthroscopically because they are covered by the joint capsule. For arthroscopic visualization, the joint capsule must be either attenuated or very thin and transparent, a condition that we termed the MSTS in the current study. Besides being a novel anatomic variant of the anterior capsule, the MSTS may contribute to an increase in the risk of recurrence when it accompanies other risk factors. The MSTS was positive in 2.3% of the control group, while it was positive in 14.9% of the study group. Although it is not possible to take the MSTS into account in preoperative decision making on the appropriate surgical option (because its existence in patients with traumatic anterior shoulder instability cannot be evaluated by a clinical examination and radiology), it may subsequently be visualized during arthroscopic surgery. Thus, a patient with anterior instability with an accompanying MSTS should prompt the surgeon to be more careful in choosing the appropriate procedure because it suggests an increased risk of the recurrence of instability. One of the other remarkable findings of this study was the high rate of SLAP lesions; 30 patients (34.5%) had a SLAP lesion in this study. There are studies in the literature that have similar rates of patients with SLAP lesions, even though this rate is lower in most studies.[8,17,18]

Recurrence is one of the most devastating complications after arthroscopic anatomic repair for anterior shoulder instability. The rates of recurrence documented in the literature are between 3.4% and 35%.[7,17,18,22-25] The recurrence rate of 10.3% in the current study is comparable with the literature. Preoperative and intraoperative assessments of the risk factors for recurrence could help the surgeon in deciding the surgical repair procedure.

The relationship between labral lesion type and the recurrence rate should also be considered. The overall risk for recurrence was reported as 12.6% for all types of anterior instability, while it was reported as 6.5% for Bankart lesions.[17,18] In the current study, the recurrence rate was 19.3% in the ALPSA group and 5.3% in the Bankart group. The presence of an ALPSA lesion in which the capsule and labrum are coinjured is significantly related to recurrence.[16] The recurrence rate is reported to be 15.2% in contact sports and 11.8% in other athletes and nonathletes.[2] In this study, it was 19.3% in contact sports and 5.3% in other athletes and nonathletes.

Previous studies have demonstrated that recurrence is rare in patients who experienced a shoulder dislocation only once before surgery.[9,11] While it does result in a significantly reduced recurrent dislocation rate over those who are treated nonoperatively, recurrence is not "rare." In a recently published review, the recurrence rate was reported to be 18.5% in patients who experienced fewer than 10 dislocation episodes and 31.4% in those who experienced $\geq$10.[18] In this study, although the difference did not achieve statistical significance, the recurrence rate in patients who experienced more than 1 dislocation episode was approximately 2 times more than those who had just 1 instability episode (11.7% and 5.2%, respectively), and it was approximately 3 times lower in those who experienced 1 to 5 episodes compared with more than 5 dislocation episodes (5.8% and 16.6%, respectively). This result has been attributed to cumulative injuries in the capsulolabral complex over the course of time with recurrent dislocation episodes.[2] In the literature, 60% of recurrence is reported after the first dislocation episode.[10] In light of these reports, we believe that a surgical intervention should be planned after the initial episode, considering the other risk factors for recurrent dislocations.[10]

With the lack of a consensus, 20, 23, and 25 years of age are generally accepted as the critical thresholds for recurrence in the literature.[14,17,19,21] In a systematic review, the recurrence rate was reported as 33.6% for patients younger than 20 years and 11.8% for those $\geq$20 years of age.[18] The cutoff age was set as 23 years in the current study; the recurrence rate in patients aged under 23 years was 2.5 times higher than for those aged $\geq$24 years. There are

studies in the literature reporting male sex as a risk factor for recurrent dislocations.[14,19,20] A review reported the recurrence rate as 15% in male patients and 8.7% in female patients.[9] However, we could demonstrate no relationship between sex and recurrence in this study. The recurrence rates have been reported as 10% to 35% with 2 anchors and 5% to 30% with ≥3 anchors.[9,18] In the current study, they were 10.8% and 9.7%, respectively.

In cases in which an ALPSA lesion and the MSTS were both present, the recurrence rate was 40%. In cases in which a history of overhead or contact sports participation accompanied an ALPSA lesion and the MSTS, the recurrence rate went up to 75%. This is a potential indicator of capsular insufficiency after arthroscopic shoulder stabilization. The presence of the MSTS along with other major risk factors should alert surgeons about an increased risk of recurrence and may prompt them to perform additional procedures (ie, extracapsular plication, rotator interval closure, or soft tissue/bone transfer).

There are several limitations to this study. Because this was a retrospective study, preoperative standard assessment criteria could not be fulfilled. The patient groups were also heterogeneous; there were patients with variable activity levels, such as participation in overhead or contact sports. Another shortcoming of the study was the relatively small patient cohort. Further investigations with more patients distributed in homogeneous groups may help in eliciting the role of the MSTS in recurrent shoulder instability.

CONCLUSION

The MSTS is a variation of the anterior shoulder joint capsule. It is a sign of capsular insufficiency or thinning, which may be a risk factor for recurrence after anterior stabilization. Considering the low success rates of anterior capsulolabral repair in patients participating in overhead or contact sports, especially when an ALPSA lesion is present, encountering the MSTS during surgery in this "at-risk" group may be an indicator for surgeons to choose the surgical procedure more carefully.

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