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Lengthening of the subscapularis tendon as a sign of partial tearing in continuity

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Background: The quantification of a subscapularis tendon lesion may be difficult on magnetic resonance imaging, as well as during arthroscopic inspection. Consequently, the surgical decision of whether to only debride a degenerated tendon or to lateralize the more intact tendon portion may be arbitrary. This study aims to quantify the length of the subscapularis tendon as a sign of partial tendon tearing.
Methods: We retrospectively identified 92 magnetic resonance arthrography studies of suspected rotator cuff lesions obtained 3 months before shoulder arthroscopy. The myotendinous junction was identified, and the subscapularis tendon and muscle lengths were measured. Findings on arthroscopy performed later were used as the diagnostic gold standard for tendon integrity and compared with the magnetic resonance data.
Results: Arthroscopy showed an intact subscapularis tendon in 43 patients, tendinopathy in 21 patients, and a partial rupture in 28 patients. The mean subscapularis tendon lengths were 40 mm in cases of intact subscapularis musculotendinous units, 45 mm in cases of tendinopathy, and 53 mm in cases of partial tears, whereas the mean subscapularis muscle lengths were 105 mm, 94 mm, and 95 mm, respectively, in these groups.
Conclusion: Partial tears of the subscapularis tendon lead to muscle shortening by approximately 10% and elongation of the tendon by approximately 32%, which may be interpreted as muscle retraction and a tendon rupture in continuity. If the subscapularis tendon has an apparent length of greater than 60 mm, the probability of a tear is 98%. Determination of the tendon length may therefore be a useful additional tool to quantify the integrity of the subscapularis tendon and degree of myotendinous retraction.
Level of evidence: Level III, Diagnostic Study.

Keywords: Rotator cuff tear; partial subscapularis lesion; tendon lengthening; muscle shortening; myotendinous retraction; arthroscopy; MR arthrography

General written consent was obtained from all patients allowing analysis of patient data for retrospective analysis. Our institutional review board (Ethikkommission Zürich) allowed retrospective analysis of patient data relating to standard diagnostic or therapeutic procedures without individual informed consent.

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Complete rotator cuff tendon tears lead to retraction of the corresponding musculotendinous unit.[4] Retraction is an important predictor of the outcome of surgical repair.[9,14] The changes result from shortening of the muscle, as well as—in later stages—shortening of the tendon.[10] Partial supraspinatus ruptures lead to tendon lengthening representing failure in continuity.[4,8]

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Although less frequent than lesions of the posterosuperior rotator cuff, subscapularis tears are a known cause of shoulder pain and dysfunction.[6] Subscapularis lesions can be either traumatic or degenerative. Most subscapularis tears start as disinsertion of the superior border of the tendon and extend inferiorly over time. Partial tears of the subscapularis tendon seem not only to diminish the width of the insertion at the lesser tuberosity but also to increase the tendon length, analogous to partial supraspinatus tears.[4,8]

To gain a better understanding of the pathophysiology of partial subscapularis lesions and to improve clinical decision making, we conducted this investigation to quantitatively assess potential tendon lengthening and retraction of the corresponding muscle after partial subscapularis tendon tears on magnetic resonance (MR) arthrography. We hypothesized that tears of the subscapularis tendon may be associated with retraction of the muscle and lengthening of the tendon despite radiologic muscle-tendon-bone continuity.

Materials and methods

For the purpose of this study, we identified 191 consecutive patients who had undergone shoulder arthroscopy in our department between 2010 and 2012 and in whom MR arthrography had been performed less than 3 months preoperatively. We excluded 89 shoulders because the intended measurements were not possible either because of poor imaging quality or because the medial border of the scapula was not visible on MR arthrography.

All surgical reports and intraoperative pictures of the remaining 102 patients were retrospectively reviewed and regarded as the gold standard to determine the integrity of the subscapularis tendon. All medical histories were reviewed for demographic data (sex, body weight, patient height).

Ten patients with complete subscapularis tendon tears were excluded. The remaining 92 patients were included in our study and classified according to the intraoperative findings as having an intact subscapularis tendon (control group), subscapularis tendinopathy without disinsertion (tendinopathic group), or partial disinsertion of the tendon (partial tear group).

At our institution, all patients underwent MR arthrography on a 1.5-T magnetic resonance imaging (MRI) unit (Symphony; Siemens, Erlangen, Germany) after injection of approximately 12 mL (range, 10-14 mL) of gadopentetate dimeglumine (Magnevist solution at a concentration of 2 mmol/L; Schering). The shoulder was placed in a dedicated receive-only shoulder coil with the arm in a neutral position and the thumb pointing vertically. MR arthrography protocols included T1-weighted spin-echo images in the coronal-oblique plane with fat saturation (repetition time [TR]/echo time [TE], 792 milliseconds/20 milliseconds; section thickness, 3 mm; field of view [FOV], 160 × 160 mm; matrix size, 265 × 512), in the transverse plane (TR/TE, 500 milliseconds/30 milliseconds; section thickness, 3 mm; FOV, 160 × 160 mm; matrix size, 256 × 512), and in the sagittal-oblique plane (TR/TE, 500 milliseconds/30 milliseconds; section thickness, 4 mm; FOV, 160 × 160 mm; matrix size, 256 × 512). T2-weighted fast spin-echo images (TR/TE, 3,000 milliseconds/20 milliseconds; section thickness, 4 mm; FOV, 160 × 160 mm; matrix size, 256 × 512) and intermediate-weighted fast spin-echo images (TR/TE, 2,350 milliseconds/20 milliseconds; section thickness, 4 mm; FOV, 160 × 160 mm; matrix size, 256 × 512) were obtained in the coronal-oblique plane with fat saturation. Patients with technically comparable MR arthrography studies performed at other institutions were included in the study group.

Analysis of subscapularis tendon integrity on MR arthrography

A musculoskeletal fellowship–trained radiologist (S.B.) reviewed all MR arthrography studies and graded the subscapularis tendon integrity as follows by means of widely accepted radiologic signs[12]: intact tendon, lesion of the superior border, partial rupture of one-third, partial rupture of two-thirds, or total rupture. The radiologist was blinded to the results of arthroscopy.

Analysis of subscapularis tendon and muscle length on MR arthrography

Independent readout was performed by 2 readers (M.G. and S.M.Z.) who were blinded to the results of shoulder arthroscopy. For statistics, mean values of these 2 measurements were used.

To exclude a significant influence (error) of humeral rotation, the angle from the center of rotation to the midpoint of the glenoid and the bicipital grove was determined on the median axial slice (MAS) (Fig. 1). All measurements were performed on the MAS. However, because the muscle was usually best identifiable on the most cranial axial slice, on which the tendon was still depicted, the position of the articular-sided myotendinous junction of the subscapularis was identified on this cranial slice and projected to the MAS (Fig. 2). The length of the tendon was defined as the distance from the myotendinous junction to the tendon insertion at the lesser tuberosity.[4] The length of the muscle was measured from the myotendinous junction to the medial border of the scapula (Fig. 2).

To define the position of the myotendinous junction in relation to the glenoid, a line was drawn through the anterior and posterior borders of the glenoid. The distance between the myotendinous junction and the glenoid plane was defined as the myotendinous junction–glenoid plane distance. Negative values indicate that the myotendinous junction is medial to the glenoid plane, whereas positive values indicate that the myotendinous junction is lateral to the glenoid plane.

Statistical methods

Statistical analysis was performed using GraphPad Prism software, version 6.0 for Mac (GraphPad Software, La Jolla, CA, USA). Values were reported as means and standard deviations. One-way analysis of variance, followed by the Mann-Whitney *U* test, was used for comparisons between groups, once the D'Agostino-Pearson omnibus normality test was passed. The level of significance was set at $P < .05$. Receiver operating characteristics and the sensitivity, specificity, and likelihood ratio were calculated for different cutoff values. The Pearson correlation coefficient was calculated to determine interobserver variability and correlations between demographic data (patient height) and tendon or muscle length.