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ORIGINAL ARTICLE

The prevalence and morphometric analysis of ossified superior transverse scapular ligaments in patients with rotator cuff tears

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Background: The prevalence of ossified superior transverse scapular ligaments (OSTSLs) in rotator cuff tears (RCTs) has not yet been determined. The purposes of this study were to evaluate the prevalence of OSTSLs in RCTs and to investigate the correlation between OSTSL morphology and supraspinatus muscle atrophy.

Methods: We analyzed a total of 213 patients with RCTs for whom 3-dimensional (3D) computed tomography (CT) and magnetic resonance imaging were performed prior to arthroscopic procedures. The mean age of the patients was 59.73 ± 8.43 years, and 103 patients were men. OSTSLs were identified based on 3D CT findings. The correlations between OSTSLs and age, sex, and RCT size were analyzed. The horizontal and vertical diameters, area, and circumference of the suprascapular foramen were measured. By use of the occupation ratio calculated from magnetic resonance imaging results, supraspinatus muscle atrophy was evaluated.

Results: Of 213 patients with RCTs, 22 (10.3%) had OSTSLs. OSTSLs were found at a rate of 15.5% (16 of 103) in men, higher than that in women ($P = .016$). The rate of OSTSLs increased with age ($P = .003$). RCT size was not correlated with the prevalence of OSTSLs. As the horizontal diameter and circumference of the suprascapular foramen increased, muscle atrophy progressed ($P = .001$ and $P = .046$, respectively).

Conclusion: One of ten patients with RCTs had OSTSLs; the rate of OSTSLs was higher among men and increased with age. For patients with RCTs preparing to undergo arthroscopic superior transverse ligament resection, preoperatively identifying OSTSLs through 3D CT would be useful for the resection.

Level of evidence: Level III; Case-Control Design; Prognosis Study

Keywords: Shoulder; scapular; suprascapular notch; suprascapular foramen; ossification; superior transverse scapular ligament

The Kyung Hee University Hospital Institutional Review Board approved an exemption for this study because of its retrospective design (KHUH 2016-12-017).

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The suprascapular nerve (SSN) crosses the floor of the suprascapular fossa and obliquely passes beneath the suprascapular notch. If the suprascapular notch is narrow for congenital reasons or is converted into a bony suprascapular foramen (BSF) owing to a completely ossified superior

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transverse scapular ligament (OSTSL), the suprascapular notch directly compresses the SSN, constraining SSN mobilization.[27] This constraint leads to SSN entrapment, which may induce shoulder pain and muscle weakness of the supraspinatus or infraspinatus.[14]

In addition to direct pathologic compression injury, there is indirect traction injury of the SSN. Rotator cuff tears (RCTs) associated with SSN injury are being increasingly recognized.[25] A cadaveric study reported an indirect tethering injury of the SSN at the suprascapular notch on medial retraction of supraspinatus tears, which decreases the angle between the SSN and its first motor branch, effecting increased tension of the SSN.[2] Controversy exists about whether a release of the superior transverse scapular ligament (STSL) is necessary once stretch and traction on the nerve have been relieved by repairing the RCT. However, Lafosse et al[13] argued that once compression is suspected, a nerve release is required regardless of the electromyography (EMG) findings, given that SSN pathology is a dynamic phenomenon that cannot always be demonstrated on EMG.

The SSN has traditionally been decompressed at the suprascapular notch through an open technique.[3,10] Since Bhatia et al[5] reported treating SSN decompression with an all-arthroscopic approach for release of the STSL, arthroscopic SSN decompression has been performed more frequently.[6,15] In most cases, the STSL is easily transected via the superior-medial portal using arthroscopic scissors.[28] Rarely, when a BSF is observed during surgery, osteotomy is required for release of the OSTSL, which could cause the OSTSL to be a risk factor for surgical exploration during SSN decompression.[23]

However, there has been no report on the rate of OSTSLs in a population with RCTs in which there is a possibility of both direct compression and indirect traction injury of the SSN. This study aimed to investigate the prevalence of OSTSLs in RCTs and the correlation between BSF morphology and muscle atrophy. We hypothesized that OSTSLs would rarely be identified and that smaller BSFs would be associated with more severe suprascapular muscle atrophy in patients with RCTs.

Materials and methods

Materials

Three-dimensional (3D) computed tomography (CT) (Lightspeed Ultra 16 CT; Siemens, Berlin, Germany) was performed on 213 consecutive patients who had received arthroscopic rotator cuff repair between November 2015 and August 2016 and had undergone magnetic resonance imaging of the shoulder within 6 months before surgery. RCT sizes were measured intraoperatively according to the classification of DeOrio and Cofield[8] by assessing the anteroposterior dimension using a calibrated probe introduced through the posterior portal with a view from the lateral portal. The tear sizes were categorized into small (<1 cm), medium (1-3 cm), large (3-5 cm), and massive (>5 cm). A total of 76 small tears (35.7%), 100 medium tears (46.9%), 21 large tears (9.9%), and 16 massive tears (7.5%) were enrolled in this study. Of the patients, 103 were men and 110 were women. The mean patient age was 59.73 years, and 146 patients and 67 patients had right-sided and left-sided RCTs, respectively. Patients undergoing prior rotator cuff repair or revision shoulder procedures were included. However, patients with a history of trauma, pathology, or bony metastasis around the shoulder were excluded.

Radiologic measurements

Supraspinatus muscle atrophy was measured on the scapular Y view using oblique sagittal magnetic resonance imaging at the location where the body of the scapula, scapular spine, and medial border of the coracoid process form a Y shape. We quantified atrophy by calculating the occupation ratio according to the method of Thomazeau et al[22]; the occupation ratio is the ratio between the cross-sectional area of the supraspinatus muscle and the supraspinatus fossa on the scapular Y view.

The presence of OSTSLs was evaluated by obtaining a 3D image in which the suprascapular notch was clearly shown on 3D CT. In cases in which the suprascapular transverse ligament was completely ossified, we classified the BSF as type VI based on the classification of Rengachary et al,[21] and we measured the following using a picture archiving and communication system: horizontal diameter, vertical diameter, foramen area, and foramen circumference of the suprascapular foramen; distance from the glenoid to the medial border and lateral border of the suprascapular foramen; and distance to the medial border and superior border of the suprascapular foramen from the superior border of the coracoid process (Figs. 1-3). The measurements were conducted by 2 study authors. Each author independently measured the same image twice, and the average value was used.

A 1.5-T imaging unit (Signa; GE Healthcare, Milwaukee, WI, USA) equipped with a dedicated shoulder coil (sensitivity encoding shoulder 4-channel coil for the 3.0-T system and a large shoulder array coil [receiver only] for the 1.5-T system) was used to obtain magnetic resonance images. The following sequences were obtained with the 1.5-T system: axial turbo spin echo T2 weighted (field of view, 140 × 140 mm; repetition time [TR], 3600-4000 milliseconds; echo time [TE], 100-110 milliseconds; matrix, 256 × 255; section thickness, 3.0 mm; and intersection gap, 0.5 mm); oblique coronal turbo spin echo T2 weighted (field of view, 140 × 140 mm; TR, 3600-4000 milliseconds; TE, 100-110 milliseconds; matrix, 256 × 255; section thickness, 3.0 mm; and intersection gap, 0.5 mm); and oblique sagittal turbo spin echo T2 weighted (field of view, 140 × 140 mm; TR, 3600-4000 milliseconds; TE, 100-110 milliseconds; matrix, 256 × 255; section thickness, 3.0 mm; and intersection gap, 0.5 mm).

Statistical analyses

The correlations between the presence of OSTSLs and sex, hand dominance, or age were determined by the χ^2 test. Pearson coefficient-of-correlation tests were used to evaluate the correlation between each variable parameter including age, horizontal diameter, vertical diameter, area, circumference, distance to the lateral border of the suprascapular foramen from the glenoid articular surface, and occupation ratio. IBM SPSS Statistics for Windows (version 22.0;