J Shoulder Elbow Surg (2016) 25, 1069–1075

ELSEVIER

Journal of Shoulder and Elbow Surgery

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Tendon retraction with rotator cuff tear causes a decrease in cross-sectional area of the supraspinatus muscle on magnetic resonance imaging

Shoji Fukuta, MD, PhD[a,*], Takahiko Tsutsui, MD[a], Rui Amari, MD[a], Keizo Wada, MD[b], Koichi Sairyo, MD, PhD[b]

[a]*Department of Orthopaedic Surgery, Kochi Health Sciences Center, Kochi, Japan*
[b]*Department of Orthopedics, Tokushima University, Tokushima, Japan*

Background: Muscle atrophy and fatty degeneration of the rotator cuff muscles have been reported as negative prognostic indicators after rotator cuff repair. Although the Y-shaped view is widely used for measuring the cross-sectional area of the supraspinatus muscle, the contribution of retraction of the torn tendon as well as muscle atrophy must be considered. The purpose of this study was to clarify the relationship between cross-sectional area and tendon retraction or size of the tear.

Methods: This study included 76 shoulders that were evaluated arthroscopically for the presence and size of tears. Cross-sectional areas of rotator cuff muscles were measured from the Y-shaped view to 3 more medial slices. The occupation ratio and tangent sign were evaluated on the Y-shaped view. The retraction of torn tendon was also measured on the oblique coronal images.

Results: On the Y-shaped view, the cross-sectional area of the supraspinatus and the occupation ratio decreased in conjunction with the increase in tear size. A significant decrease in cross-sectional area was noted only in large and massive tears on more medial slices from the Y-shaped view. Significant decreases in the cross-sectional area of the infraspinatus were observed in large and massive tears on all images. A negative correlation was found between tendon retraction and cross-sectional area, which was strongest on the Y-shaped view.

Conclusions: To avoid the influence of retraction of the supraspinatus tendon, sufficient medial slices from the musculotendinous junction should be used for evaluation of muscle atrophy.

Level of evidence: Basic Science Study; Anatomy; Imaging

Keywords: Rotator cuff tear; muscle atrophy; magnetic resonance imaging; tendon retraction; cross-sectional area

This study was approved as a retrospective clinical study by the Institutional Review Board of Kochi Hills Health Sciences Center. All patients were informed that their medical data, excluding personally identifiable information, might be used for the purpose of retrospective clinical study, and they gave their consent. Because it is a retrospective study, patients were not given details of the study design in advance.

*Reprint requests: Shoji Fukuta, MD, PhD, Department of Orthopaedic Surgery, Kochi Health Sciences Center, 2125-1 Ike, Kochi 781-8555, Japan.
E-mail address: shojifc001@yahoo.co.jp (S. Fukuta).

1058-2746/$ - see front matter © 2016 Journal of Shoulder and Elbow Surgery Board of Trustees. All rights reserved.
http://dx.doi.org/10.1016/j.jse.2015.11.008

Arthroscopic rotator cuff repair has become the first line of treatment for rotator cuff tears.[9,11] Good clinical results have been reported; however, the high rate of structural failure remains one of the complications of arthroscopic cuff repair.[3,11] Atrophy of rotator cuff muscles is considered one of the factors influencing clinical outcomes and the structural integrity of the repair.[8,15] Therefore, preoperative assessment of the condition of the rotator cuff muscles is essential in surgical decision-making.

Preoperative muscle atrophy has been evaluated by measuring the cross-sectional areas of the rotator cuff muscles on the Y-shaped view of magnetic resonance imaging (MRI).[12,13,15] The Y-shaped view is the most lateral image where the scapular spine is in contact with the scapular body. The cross-sectional area on the Y-shaped view might not be representative of muscle volume because it may be highly influenced by retraction of the musculotendinous junction in patients with rotator tears.

The purpose of this study was to determine whether the decrease in the cross-sectional area of the supraspinatus was due to muscle atrophy or to retraction of the torn supraspinatus tendon. We hypothesized that more medial slices from the Y-shaped view would be appropriate to remove the influence of retraction of the musculotendinous junction.

Materials and methods

Between January 2007 and December 2010, 132 patients underwent arthroscopic shoulder surgery for rotator cuff disease at our institution. The criteria for inclusion in this study were full-thickness rotator cuff tear confirmed during arthroscopy and no associated pathologic process, such as glenohumeral arthritis or shoulder instability. All the patients had undergone preoperative MRI within the 2 months before arthroscopy at our institution and following the same protocol, which included the Y-shaped view and 3 consecutive medial slices from the Y-shaped view on sagittal oblique images. Patients with a partial-thickness rotator cuff tear, an isolated subscapularis tear, or previous shoulder surgery were excluded. Sixty-one full-thickness rotator cuff tears met these criteria. Fifteen patients with impingement syndrome with an intact rotator cuff who were treated by arthroscopic subacromial decompression were also included as the control group.

The mean age of the patients was 66.7 years (range, 41-83 years), and there were 41 men and 35 women. On the basis of the sagittal extent of the tear measured at arthroscopy, the patients with rotator cuff tears were divided into 4 groups according to the classification published by Cofield et al.[1] There were 14 small tears (<1 cm), 17 medium tears (1-3 cm), 16 large tears (3-5 cm), and 14 massive tears (>5 cm). All patients' demographic data are reported in Table I.

All MRI scans were performed with a 1.5T unit (Vantage 1.5T [Toshiba, Tokyo, Japan] or Signa HDx 1.5T [GE Healthcare Japan, Tokyo, Japan]). The affected arm was placed at the side of the body in a neutral rotation. The examination was performed using spin-echo T1-weighted (repetition time, 450-600 msec; echo time, 10-15 msec) and T2-weighted (repetition time, 3600-4000 msec; echo time, 80-90 msec) sequences in axial, oblique coronal, and oblique sagittal planes. All images were obtained on a 256 × 192 matrix. The field of view was 18 cm, and slice thickness was 5 mm with no interslice gap. Oblique sagittal views covered the supraspinatus muscle from the greater tuberosity to the middle of the scapula.

The retraction of the supraspinatus tendon was measured as the maximum distance from the most lateral portion of the footprint on the greater tuberosity to the torn tendon edge on T2-weighted oblique coronal images. Quantitative analysis of muscle atrophy was performed on the spin-echo T1-weighted oblique sagittal images. The outline of the rotator cuff muscles was drawn by hand, and cross-sectional area was calculated by image processing software attached to the electronic medical system (HOPE EGMAIN-LX; Fujitsu Ltd, Tokyo, Japan). Because the border between the infraspinatus and teres minor may not always be determined, these 2 muscles were combined into a single measurement. Measurement of the areas was performed on the Y-shaped view, which is the most lateral image in which the scapular spine is in contact with the rest of the scapula,[11] together with the next 3 consecutive medial images from the Y-shaped view (Fig. 1). To compensate for individual body composition, the cross-sectional area of the supraspinatus muscle was standardized by dividing it by the area of the supraspinatus fossa on the Y-shaped view as previously described.[15]

The occupation ratio[13] and tangent sign,[15] both of which are established methods in the evaluation of supraspinatus muscle atrophy, were also assessed on the Y-shaped view. The occupation ratio is the ratio of the cross-sectional area of the supraspinatus to the supraspinatus fossa (Fig. 2). This ratio can be determined only on the Y-shaped view because the coracoid process is not visible on more medial images, resulting in a low ratio between the osseous and muscular limits. Occupation ratio values of <0.5 indicate

Table I Demographic data of each group

	Impingement (n = 15)	Small tear (n = 14)	Medium tear (n = 17)	Large tear (n = 16)	Massive tear (n = 14)
Mean age (years)	64.1 ± 6.9	67.3 ± 8.3	64.8 ± 10.2	65.7 ± 9.1	70.6 ± 10.3
Sex M:F	7:8	5:9	9:8	9:7	11:3
Dominant/nondominant	7/8	7/7	12/5	11/5	11/3
Symptom duration (months)	9.1 ± 11.8	8.1 ± 8.6	11.2 ± 28.1	6.7 ± 7.5	10.6 ± 18.8
Trauma history	2	5	9	10	5

Data are reported as means ± standard deviation.