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Visualization of rotator cuff tear morphology by radial magnetic resonance imaging

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ABSTRACT

The objective of this study was to investigate whether rotator cuff tear morphology could be visualized using radial MRI. We retrospectively investigated 52 shoulders that underwent preoperative MRI and arthroscopy for a complete rotator cuff tear. The tear length and width were measured using oblique coronal, axial, and radial MRI. Arthroscopic findings were compared with the tear morphology. Tear morphology was visualized using oblique coronal and axial MRI for 24 of the 52 shoulders (46%), and radial MRI for all 52 shoulders. Radial MRI data for 49 of 52 shoulders (94%) were concordant with the arthroscopic findings.

1. Introduction

Rotator cuff tear, which is a common cause of shoulder pain and dysfunction, occurs in 20% of the population [1]. Conservative therapy can relieve pain and restore function [2], but the size of the tear has been shown to increase over time [3,4]. Therefore, surgical treatment is performed in patients with worsening pain or dysfunction. Currently, arthroscopic rotator cuff repair is widely performed as a surgical treatment, and favorable results have been reported for small-sized and medium-sized tears [5]. Large or massive tears, however, have been associated with a high postoperative healing failure (18–94%), which leads to poor functional outcome or revision surgery [5–11].

Before rotator cuff repair is performed, it is important to ascertain the tear morphology and predict both the direction of traction on the torn rotator cuff and the optimal anchor insertion site [11–13]. Magnetic resonance imaging (MRI) is one method of diagnosing a rotator cuff tear. The location and size of a tear in the anteroposterior direction perpendicular to the rotator cuff tendons are visualized on oblique sagittal MRI. Oblique coronal MRI in the plane parallel to the rotator cuff tendons is commonly used to assess the supraspinatus tendon and the part of the infraspinatus tendon, while axial MRI is mainly used for the major part of the subscapularis and infraspinatus tendons. However, no plane of oblique coronal or axial MRI provides a proper cross-sectional view of the tendons in their anterosuperior and posterosuperior regions because of the circumferential attachment of the rotator cuff tendons to the humeral head, which results in poor visualization of the tendons due to partial volume effect artifact [14]. Although MRI has a high sensitivity for diagnosing rotator cuff tears (> 90%) [15–18], it is not clear whether it can be used to accurately visualize tear size and morphology. We recently described the use of radial MRI to visualize the rotator cuff attachment on the lesser and greater tuberosities [14,19]. We found that radial MRI provided significantly greater visualization of supraspinatus and infraspinatus tendon tears in the posterosuperior region of the rotator cuff compared to oblique coronal or axial MRI.

We hypothesized that radial MRI could also be used to ascertain tear morphology before surgery. Therefore, the present study's objective was to compare visualization of the rotator cuff tear morphology and size between radial MRI and arthroscopy.

2. Materials and methods

2.1. Subjects

The institutional review board of our institution approved this retrospective comparative study, and informed consent was obtained from all patients.

63 patients underwent preoperative MRI and arthroscopy for a rotator cuff tear between April 2011 and December 2013. Exclusion criteria were a partial-thickness tear and concomitant surgery for glenohumeral joint instability. 11 patients were excluded (10 for a partial-thickness tear, and one for concomitant surgery for glenohumeral joint instability).

Therefore a total of 52 patients (52 shoulders) were included in the study. The study population included 27 men and 25 women, and the

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mean age was 64.0 years (range, 46–78 years). The mean period between MRI and surgery was 8 weeks (range, 3 days–16 weeks).

2.2. MRI protocol

A 3.0-T MRI system with a dedicated 4-channel shoulder coil (Achieva 3.0 T X-series; Philips Healthcare, Best, the Netherlands) was used. Subjects were asked to lay in the supine position with their arms at their sides. Their elbows were fully extended with the palms facing upward. Fat-suppressed T2-weighted imaging (echo time [TE] = 9428 ms, repetition time [TR] = 59 ms, and echo train length [ETL] = 17) was used for the radial cross-sections with a slice thickness of 3.0 mm, field of view (FOV) of 150 mm × 150 mm, and a resolution of 304 × 224. Planning of the radial axis scan was defined using sagittal and coronal scans to correct for the complex anatomic angulations of the glenoid and humeral head and to provide geometric offsets and angulations for the sequence. We used the axial and coronal magnetic resonance (MR) images that best demonstrated the midpoint of the glenoid and humeral head when we planned the radial axis slices.

A total of 24 radial slice MR images were acquired at 7.5° intervals using the line connecting the midpoints of the glenoid fossa and humeral head as the rotational axis [14,19]. The image acquisition time was approximately 4 min (Fig. 1).

The oblique coronal and axial images were acquired using fat-suppressed T2-weighted imaging (TR = 4000 ms, TE = 56 ms, and ETL = 17), with a slice thickness of 3.0 mm, slice gap of 0.3 mm, FOV of 130 mm × 130 mm, and resolution of 304 × 221. Contiguous slices encompassing the entire width of the humeral head were selected on the oblique coronal plane parallel to the scapula and on the axial plane perpendicular to the body axis. The oblique sagittal images were acquired using T2-weighted imaging (TR = 5800 ms; TE = 100 ms; and ETL = 16), with a slice thickness of 3.0 mm, slice gap of 0.3 mm, FOV of 150 mm × 150 mm, and resolution of 368 × 256. Contiguous slices encompassing the area from the lateral side of the humeral head to the scapular spine were selected on the plane perpendicular to the scapula. The image acquisition time was approximately 4 min in all cases.

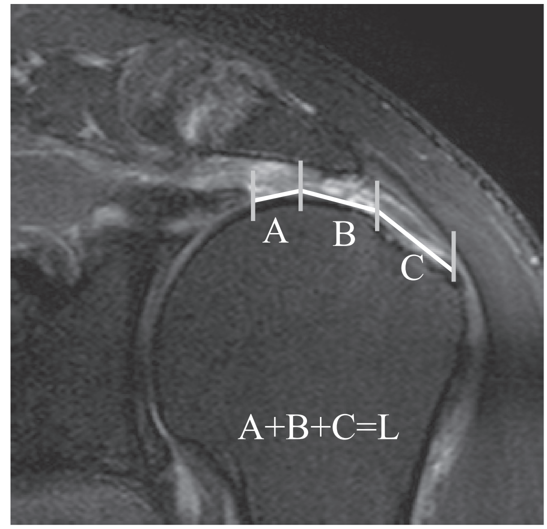

Fig. 2. Measurement of the rotator cuff tear length.
The rotator cuff tear length (L) is evaluated using up to three linear distance measurements that acceptably approximated the curved articular surface of the humeral head on MR images.

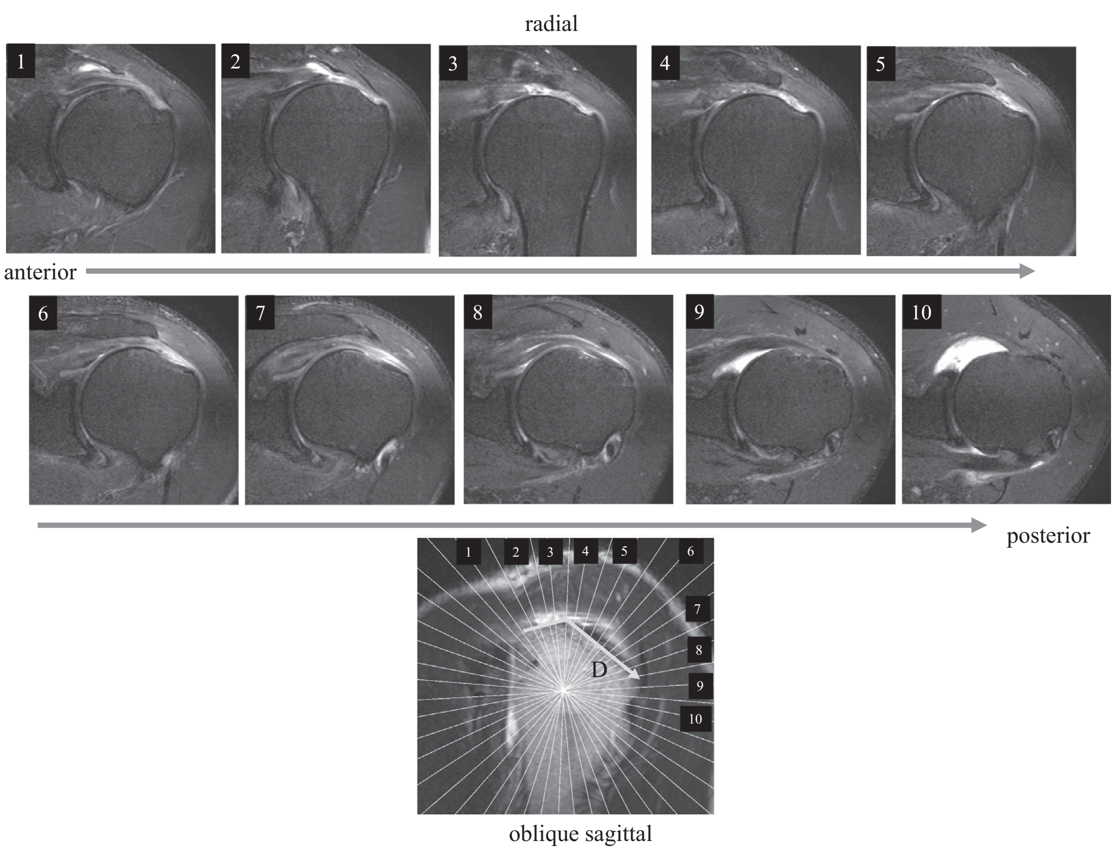

Fig. 1. Radial MR images.
A total of 24 radial slice MR images were acquired at 7.5° intervals using the line connecting the midpoints of the glenoid fossa and humeral head as the rotational axis.