Intra- and Inter-rater Agreement on Magnetic Resonance Imaging Evaluation of Rotator Cuff Integrity After Repair

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Purpose: To investigate the intra- and inter-rater agreement of magnetic resonance imaging (MRI) evaluations of rotator cuff integrity at 6 and 24 months after arthroscopic rotator cuff repair (ARCR). **Methods:** Three shoulder surgeons reviewed 68 MRI scans from 34 patients who had undergone ARCR and MRI examination at both 6 and 24 months after surgery. Postoperative rotator cuff integrity was investigated by using Owen, Sugaya, and Hayashida classifications to determine whether the rotator cuff was intact or whether there was a partial-thickness retear or full-thickness retear and Burks score to assess tendon appearance. Multirater kappa statistics were used to measure intra- and inter-rater agreement. Kappa values were interpreted according to guidelines adapted from the work of Landis and Koch. **Results:** All classifications had similar intra- and inter-rater agreement ($\kappa = 0.14$ to 0.67, 0.23 to 0.60, respectively), but no intra- or inter-rater agreement scored "excellent." Inter-rater agreement after ARCR was higher at 24 months ($\kappa = 0.31$ to 0.60) than at 6 months ($\kappa = 0.23$ to 0.44) in all evaluations. Reviewers identified full-thickness retears with a moderate to good degree of inter-rater agreement in all evaluations, at both 6 months ($\kappa = 0.42$ to 0.73) and 24 months ($\kappa = 0.61$ to 0.80) after ARCR. However, poor inter-rater agreement ($\kappa = 0.13$ to 0.19) was found in the identification of partial-thickness retears in all evaluations at 6 months after ARCR. **Conclusions:** Shoulder surgeons showed better intra- and inter-rater agreement in predicting full-thickness tears compared with partial-thickness tears. The inter-rater agreement at 24 months after ARCR was superior to that at 6 months in predicting not only full-thickness retear but also partial-thickness retear. MRI evaluation of rotator cuff integrity at 6 months after ARCR may be less reliable, regardless of which classification system is used. **Level of Evidence:** Level III, retrospective comparative study.

Rotator cuff tear is a common injury of the shoulder joint and often requires surgical repair. Arthroscopic rotator cuff repair (ARCR) has become a popular treatment for these tears. The improved integrity of the repair site after rotator cuff repair has been reported to give a better functional outcome,[1-7] although some investigators have shown that structural outcome is not correlated with functional outcome.[8-10] The double-row suture anchor technique and the suture-bridge technique have been reported to improve the biomechanical construct with less tendon retear rate.[1,11-13] These techniques, however, have not been sufficient to prevent development of retears. Therefore, retears after repair have been a matter of concern to shoulder surgeons.

Recently, magnetic resonance imaging (MRI) has become commonly used to assess rotator cuff integrity before and after arthroscopic repair, and classification and scoring systems have been established.[14-17] Several studies have reported on inter-rater agreement in the assessment of rotator cuff integrity before surgery.[18-23] It has been reported that radiologists and/or orthopaedic surgeons had good agreement for predicting full-thickness rotator cuff tears but variable (poor to good) agreement in predicting the partial-thickness tear before surgery.[18-21,23] However, few studies have assessed the inter- and intraobserver reliability of these

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classification and scoring systems. It is important to know the degree of reliability of MRI assessment after ARCR to decide the postoperative management of patients who underwent ARCR.

Rotator cuff retears occur primarily between 6 and 26 weeks after ARCR, and few additional tears occur thereafter.[24] Some studies have used MRI images taken at 6 months after surgery to compare functional outcomes and repair integrity.[3,16,25] However, it has been reported that MRI appearance of the rotator cuff after arthroscopic repair showed considerable variability during the first postoperative year and did not correlate with outcome. It has been suggested that it was not prudent to consider the tendon repair as failed according to tendon irregularity, thinning, or increased signal intensity during the first operative year.[26] Therefore, the purpose of this study was to investigate the intra- and inter-rater agreement of MRI evaluations of rotator cuff integrity at 6 and 24 months after ARCR. Our hypotheses were that the agreement for assessment of full-thickness retear was higher than that of partial-thickness retear and that intra- and inter-rater agreements after ARCR were higher at 24 months than those at 6 months.

Methods

Patient Selection

The institutional review board at our university approved the protocol of this study. Potential subjects were identified retrospectively through a review of one surgeon's database from 2006 to 2010. The inclusion criteria were as follows: complete rotator cuff tear confirmed during arthroscopic surgery; complete repair (complete tuberosity coverage attainable); minimum 2 years of follow-up; and MRI for evaluation of the integrity of the rotator cuff tendons at both 6 and 24 months after surgery. Revision surgery was not included in this study. We retrospectively reviewed our database and initially included 88 patients who, between 2006 and 2010, had received arthroscopic rotator cuff repairs from a single experienced shoulder surgeon (T.M.) using the double-row technique or a combination of double-row and suture-bridge at our University.[1,11-13]

The titanium suture anchors (diameter, 5 mm; Corkscrew, Arthrex) with two No. 2 permanent sutures (FiberWire, Arthrex) were placed for all surgical procedures. No PEEK (polyether ether ketone)/bioabsorbable anchor was placed.

Of these 88 patients, 34 did not complete the 2-year follow-up and 20 did not undergo postoperative MRI scans at either 6 or 24 months after surgery. Consequently, our final study group consisted of 68 MRI scans of 34 shoulders from 34 patients (20 female and 14 male; mean age, 68.1 years [range, 57 to 81 years]; Table 1).

Table 1. Summary of Patients

Patient	Age (years)	Gender	Tear Size	Type of Repair
1	62	Female	Large	DR and SB
2	79	Male	Small	DR and SB
3	81	Male	Medium	DR and SB
4	69	Female	Medium	DR and SB
5	60	Female	Medium	DR and SB
6	63	Male	Medium	DR and SB
7	75	Female	Medium	DR and SB
8	66	Male	Medium	DR and SB
9	73	Female	Medium	DR and SB
10	62	Female	Large	DR and SB
11	59	Male	Medium	DR and SB
12	66	Female	Large	DR and SB
13	65	Male	Medium	DR and SB
14	65	Male	Large	DR and SB
15	59	Female	Medium	DR and SB
16	80	Female	Large	DR and SB
17	80	Female	Medium	DR and SB
18	63	Male	Medium	DR and SB
19	65	Female	Medium	DR and SB
20	62	Male	Medium	DR and SB
21	71	Male	Medium	DR and SB
22	63	Female	Large	DR and SB
23	71	Female	Large	DR and SB
24	71	Male	Medium	DR and SB
25	73	Female	Medium	DR and SB
26	69	Female	Medium	DR and SB
27	64	Female	Medium	DR and SB
28	68	Female	Medium	DR and SB
29	69	Female	Medium	DR and SB
30	68	Male	Large	DR and SB
31	79	Female	Small	DR
32	57	Female	Small	DR
33	70	Male	Small	DR
34	70	Male	Small	DR

DR, double-row technique; DR and SB, a combination of double-row and suture-bridge.

Magnetic Resonance Imaging

Magnetic resonance imaging was performed with a 1.5-Tesla closed-type scanner (MRT-2000/V2; Toshiba, Tokyo, Japan). Oblique coronal, oblique sagittal, and axial T2-weighted images were acquired for structural and qualitative assessment of the rotator cuff tendon, and repair integrity was determined.

The slice thickness was 4 mm, with an interslice gap of 0.5 mm. Postoperative cuff integrity was evaluated according to 4 previously established methods.

One of the authors (A.H.) reviewed the clinical data and MRI images. Patients included in the study were considered by this author to meet the criteria of having good-quality MRI images of the shoulder joint and rotator cuff at both 6 and 24 months after ARCR. The author who selected the MRI study sets did not evaluate any of the MRI images.

MRI Evaluations

Three orthopaedic shoulder surgeons (K.Y., T.K., Y.I.) independently reviewed 68 MRI scans of 34 shoulders