Magnetic Resonance Imaging Evaluation of Tendon Integrity Initially After Arthroscopic Rotator Cuff Repair: Single Row Versus Suture Bridge Technique

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Research article

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Abstract

Background: Previous studies have shown re-tear signs of rotator cuff tendon tearing after single row or suture bridge repair during follow-up. Few studies have investigated tendon integrity initially after successful rotator cuff repair. The purpose of this study was to assess and compare the magnetic resonance imaging (MRI) appearance of the completely repaired rotator cuff initially after surgery between single row and suture bridge techniques.

Methods: Fifty patients with full-thickness rotator cuff tears were included in this study. Twenty-five patients underwent arthroscopic rotator cuff repair with single row technique (SR group) or and the other 25 patients underwent double row suture bridge technique (SB group). MRI examinations were performed at the second day after arthroscopic rotator cuff repair. Postoperative rotator cuff integrity was classified into 5 categories according to Sugaya method.

Results: Postoperative MRI revealed 3 type I, 9 type II, 8 type III, 5 type IV, and 0 type V in single-row group (SR group), and 1 type I, 11 type II, 10 type III, 3 type IV, and no type V in suture bridge group (SB group). The postoperative re-tear rate was 20% in SR group and 12% in SB group, while no significant difference of re-tear rate was detected between groups ($p = 0.70$). In the 3 type IV cases of SB group, 1 case was found to have configuration deformity, and the other 2 cases revealed poor tissue quality of rotator cuff under arthroscopy. In the 5 type IV cases of SR group, 3 cases were found to have configuration deformity, and the other 2 cases revealed poor tissue quality of rotator cuff under arthroscopy.

Conclusion: No difference of tendon integrity was detected between single row and suture bridge techniques initially after surgery. The re-tear sign of successfully repaired rotator cuff tendon was related with poor tendon tissue quality and also with configuration deformity after surgery.

Background

Rotator cuff tear (RCT) is common in the elderly leading to loss of athletic ability and weakened strength, which has a significant impact on daily activities [1, 2]. Generally, the clinical effect of surgical repair of rotator cuff injury is excellent. however, the incidence of rotator cuff re-tear after operation is relatively high (about 20–60%) [3]. The ideal rotator cuff repair will make the repaired tendon intact and ensure high initial fixation strength and mechanical stability [4]. According to literature, many factors affect the integrity of the repaired rotator cuff tendon, including the size of the initial rotator cuff tear, location, steatosis, tendon tension and tissue quality, patient age, and surgical technique [5, 6].

So far, a large number of literature reports have studied the integrity and re-tear rate of the tendon after rotator cuff repair [7–10]. Charousset et al. [11] used a single-row technique to repair the rotator cuff and analyzed the integrity of the rotator cuff tendon with computed tomography (CT) arthrogram in patients over 65 years at 6 months after surgery. The results showed that 34 shoulders had re-tear performance, and the re-tear rate was 42%. In addition, Cho et al. [12] used suture bridge technology to repair the rotator cuff and analyzed 87 cases of rotator cuff postoperative tendon integrity with MRI. The average follow-up was 25.2 months. The postoperative MRI tear pattern was divided into type I (failure at the original repair site) and type II (failure around the medial row). A total of 29 cases with re-tearing were found on postoperative MRI, including 12 cases of type I (41.4%) and 17 cases of type II (58.6%). However, the outcome of postoperative tendon integrity initially after surgery was not identified. It is still unknown if there is a difference of retear rate between single row and suture bridge techniques initially after surgery.

Therefore, the purpose of the present study was to assess and compare the tendon integrity between single row and suture bridge techniques initially after surgery using 3.0T MRI. It was hypothesized that the suture bridge technique might have better tendon integrity than the single row technique initially after.

Materials And Methods

Participants

The study was approved by the review board of our hospital's health sciences institution and received written consent from all participants. Patients with torn supraspinatus tendon were invited to participate in this study. Participants were excluded if they have any of the following: (1) massive rotator cuff tear, (2) combined shoulder fracture, (3) combined subscapular tendon tear or subscapular tendon tear, (4) long head of the biceps tendon injury, and (5) patients undergoing revision surgery.

Surgical Technique

All operations were performed by the same senior surgeon. The patient's position was laterally lying. The posterior portal and the anterior portal were used to assess the shoulder joint glenohumeral joint. After performing diagnostic arthroscopy through the posterior portal, the arthroscopy was inserted into the subacromial space through the posterior and a lateral portal was created. After performing a subacromial resection through this lateral portal, the rotator cuff tendon were evaluated and recorded. In addition, the quality of the rotator cuff tendon tissue was also evaluated. If the tendon becomes soft or fragile and the thickness of the tendon is less than half of the normal thickness, the quality of the rotator cuff tendon is considered to be poor [13].

Standard arthroscopic rotator cuff repair was performed using single-row technique or suture bridge technique according to clinical need. The single-row technique was mainly carried out in the early stages of the study, and the suture bridge technique was gradually being used because it was believed to help improve the tendon integrity of the rotator cuff after repair. In the single-row repair method, 1 or 2 suture anchors (Healix, Mitek, USA) were placed at the footprint of the rotator cuff according to the size of the tear. The suture threads were passed through the inner part of the rotator cuff and were simply knotted (Fig. 1A). In the suture bridge technique, one or two medial row anchors (Healix, Mitek, USA) were used as medial row anchors. The suture threads passed into the inner part of the rotator cuff by using a tissue penetrating instrument, and then 1 or 2 knotless anchors (Bio-PushLock; Arthrex, USA) were inserted to the lateral site of the footprint area to press the rotator cuff tendon to the footprint site (Fig. 1B). After repair, the repaired configuration deformity was defined under arthroscopy as a protrusion of the rotator tissue after repair, including dog ear deformities with a protrusion width greater than its height (Fig. 2A) and beak deformities with a height greater than its width (Fig. 2B) [14].

Mri Scan And Image Analysis

On the second day after surgery, a 3.0T magnetic resonance imaging (MRI) scanner (MAGNETOM Verio, A Tim system, Siemens, Germany) was used to scan the shoulder joint. The scanning sequence mainly included oblique coronal short time inversion recovery, oblique coronal T1-weighted, oblique sagittal T2-weighted, and oblique axial proton density–fat saturation images. All these images were imported into RadiAnt DICOM viewer 4.0.3 software (Medixant) to evaluate the integrity of the rotator cuff.

The repaired rotator cuff tendon integrity was evaluated a previous method: type I, comparing with normal rotator cuff tendon, the repaired rotator cuff tendon seems to have sufficient thickness and low signal intensity; Type II, comparing with normal tendons, the repaired tendon is thick enough accompanied by local areas of high signal intensity; Type III, insufficient thickness with less than half the thickness when compared with normal cuff, but without discontinuity; Type IV, only 1 or 2 slices on the coronal and sagittal oblique images have minor discontinuity, suggesting a small full-thickness tear; Type V: Tendon discontinuities were observed in more than 2 sections on oblique coronal and sagittal images, indicating a moderate or large full-thickness tear [15]. Sugaya type I, II or III cases were considered normal. Sugaya type IV or V cases were considered to be re-tear.

Statistical Analysis

Data analysis was performed using Stata10.0 software (Stata Corp, USA) and the data was reported as mean and standard deviation for description. Chi-square test or Fisher exact test was used to compare the categorical variables. A 2-sample t test or 2-sample Wilcoxon rank sum test was used to compare the continuous variables between groups. Statistic significant was set with P value < 0.05.

Results

A total of 50 patients enrolled in the study had an average age of 58 years including 17 left shoulders and 33 right shoulders. There were 11 men and 39 women. Finally, 25 patients accepted single-row technique (SR group), and 25 patients accepted suture bridge technique (SB group). There were no significant differences in the age, BMI, gender, side, injury time or tear size between the groups (Table 1).

Table 1
Participant Data of the Study Groups.

	SR group (n = 25)	SB group (n = 25)	P value
Age, mean SD, y	57 ± 9	59 ± 8	0.50
Body mass index (kg/m^2)	24.8 ± 2.1	24.7 ± 1.5	0.76
Gender, n	Males, n = 5 Females, n = 20	Males, n = 6 Females, n = 19	0.73
Side, n	Left, n = 7 Right, n = 18	Left, n = 10 Right, n = 15	0.37
Injury time, months	8 ± 8	12 ± 12	0.22
Tear size, mm	20 ± 10.8	21.2 ± 9.7	0.68
Poor tendon tissue quality, n	3	5	0.70
Deformity after repair, n	5	3	0.70

Postoperative MRI revealed 4 type I, 20 type II, 18 type III, 8 type IV, and 0 type V in this cohort (Fig. 3). The postoperative re-tear rate was 16%. When the cohort was divided to the SR group and the SB group, postoperative MRI revealed 3 type I, 9 type II, 8 type III, 5 type IV, and 0 type V in the SR group, and 1 type I, 11 type II, 10 type III, 3 type IV, and no type V in the SB group. The postoperative re-tear rate was 20% in SR group and 12% in SB group, while no significant difference of re-tear rate was detected between groups ($p = 0.70$). In the 3 type IV cases of SB group, 1 case was found to have deformity, and the other 2 cases revealed poor tissue quality of rotator cuff under arthroscopy. In the 5 type IV cases of SR group, 3 cases were found to have deformity, and the other 2 cases revealed poor tissue quality of rotator cuff under arthroscopy.

Discussion

Postoperative MRI scan is usually a nontraumatic evaluation method to assess the integrity of the tendon structure after rotator cuff repair [16, 17]. MRI assessment has proven to be a good standard for assessing the rotator cuff tendon integrity after repair [18]. For full-thickness rotator cuff tears, MRI has higher sensitivity and superiority than other methods [19]. The most significant finding of our study was that there were 5 type IV cases in SR group and 3 type IV cases in SB group. There was no significant difference of the postoperative re-tear rate between the SR group and the SB group.

In the past two decades, there have been various repair techniques for rotator cuff repair, such as single-row technology and double-row technology. So far, the suture bridge technology has proved to be equivalent or even better than the traditional double-row technology, because the suture bridge technology can achieve better load sharing between the inserted anchors [20–22]. In the present study, the postoperative re-tear rate of the SR group was 20%, and the re-tear rate of the SB group was 12%, and there was no difference in the post-operative re-tear rate between the SR group and the SB group. In contrast, Kim et al. [23] reported that the single row repair technique might have better tendon integrity than the double row suture bridge repair when remnant tendon was less than 10 mm. They stated that the double row repair might make the medial row to be placed more medially from the musculotendinous junction if the remnant tendon length was less than 10 mm, leading to too much tension on the weak medial muscular portion and subsequently tendon retear in the medial row.

In the present study, the retear sign (Sugaya type IV) was observed in both the SR group and SB group initially after surgery, which is mainly due to poor tissue quality of rotator cuff as well as configuration deformity after repair. Previously, Cho et al.[24] analyzed the re-tear mode of single-row repair technique and double-row suture bridge repair technique using MRI postoperatively. They divided the re-tear mode into type I (repair of cuff tissue at the cuff insertion site was not observed on the greater tuberosity) and type II (remaining cuff tissue remaining at the insertion site despite re-tear). They observed that there were 14 cases of type I (73.7%) and 5 cases of type II (26.3%) in the single-row group, 7 cases of type I (25.9%) and 20 cases of type II (74.1%) in the double-row suture bridge group. The re-tear pattern was quite different between the single-row group and the double-row suture bridge group, which might be due to different repair configuration by different techniques.

Furthermore, tendon quality is considered to be a good prognostic factor for repair integrity [25]. In this study, the SB group found 1 case with normal tendon coverage, and the other 2 cases showed poor rotator cuff tissue quality. Among the 5 type IV cases in the SR group, 3 cases were found to have normal tendon coverage, and the other 2 cases were found to have poor quality of the rotator cuff after arthroscopy. After surgical repair, the normal rotator cuff tendon on MRI may reveal regular or irregular, thickening or thinning, with moderate to low signal intensity [26]. For rotator cuffs with poor tissue quality after repair, postoperative images need to be carefully analyzed, because there was some high signal intensity in the rotator cuff tendon due to inflammation, tendinopathy or granulation tissue [27]. In cases with normal tendons, the re-tear sign on the rotator cuff tendon on MRI may be due to configuration deformities ((such as dog-ear deformity). Specifically, most deformities after rotator cuff repair were remodeled and rotator cuff tendon coverage may improve with time [14, 28]. Previously, Jin et al. [29] found that three patients who were classified as Sugaya type III at three months after surgery appeared as Sygaya type II at one year postoperatively. Such postoperative MRI findings should be interpreted with caution.

The current research has some limitations. First, the sample size of patients included and analyzed was small. The number of patients recruited was not large, which may introduce bias and inaccuracy. In addition, all images were evaluated by a clinician, although patient characteristics were ignored. In the future, two or more independent clinicians will be required to evaluate MRI to rule out the influence of normal and irregular rotator cuff tendons after surgery. Finally, there is a lack of long-term follow-up studies of MRI scans. The repaired tendon may undergo a healing process. After a period of recovery, it is still unknown whether the retear signs will disappear.

Conclusion

No difference of tendon integrity was detected between single row and suture bridge techniques initially after surgery. Successfully repaired rotator cuff tendon re-tear sign will have "pseudo re-tear sign" on MRI at time zero, which is related with poor tendon tissue quality. Such postoperative MRI findings should be interpreted with caution, and meticulous correlation with symptoms and clinical results is recommended.

Abbreviations

RCT, Rotator cuff tears (RCT)

MRI, magnetic resonance imaging (MRI)

SR, single-row

SB, suture bridge

Declarations

Ethics approval and consent to participate: The study was approved by the Health Sciences Institutional Review Board of our hospital, and written consent was obtained from all participants.

Consent for publication: Not applicable

Availability of data and material: The datasets during and/or analysed during the current study available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests

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Authors' contributions:

ZD performed the follow-up experiments. SC gave the experiment guidance during this study. ZD and HL analyzed and interpreted the data and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Figures

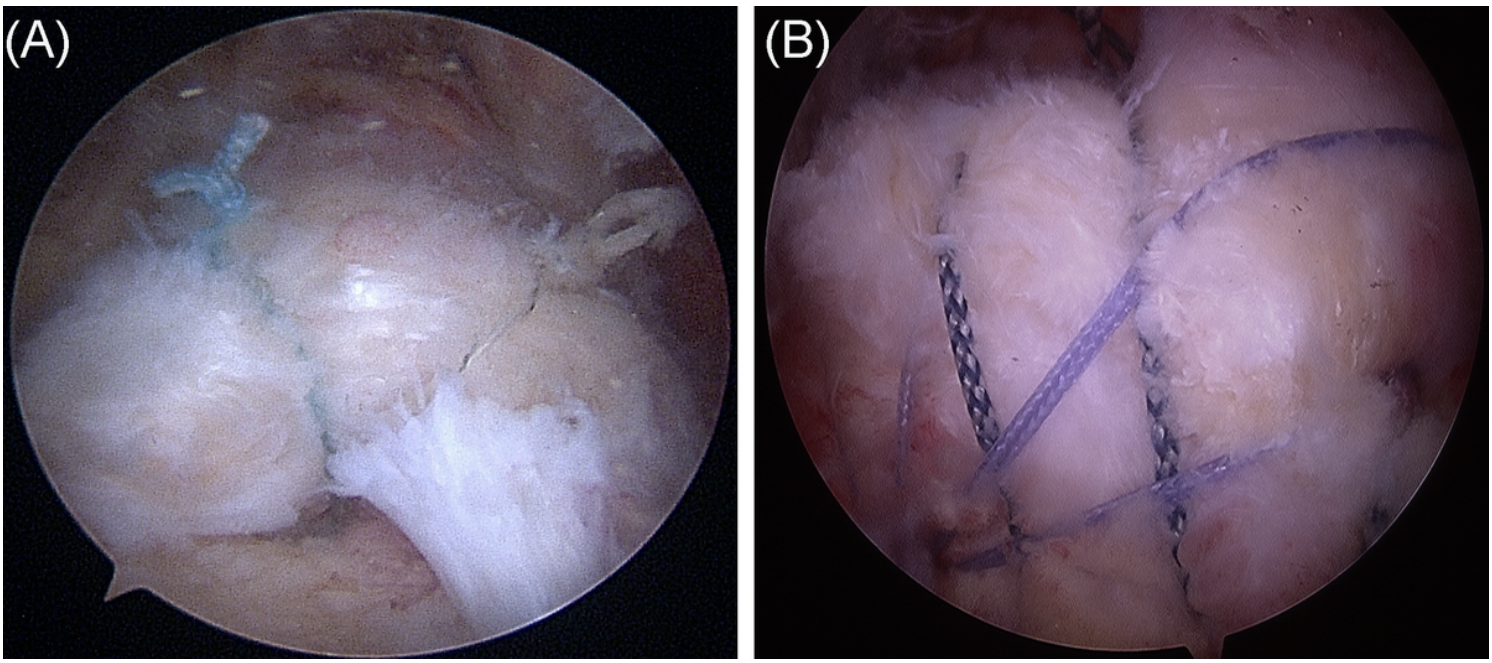
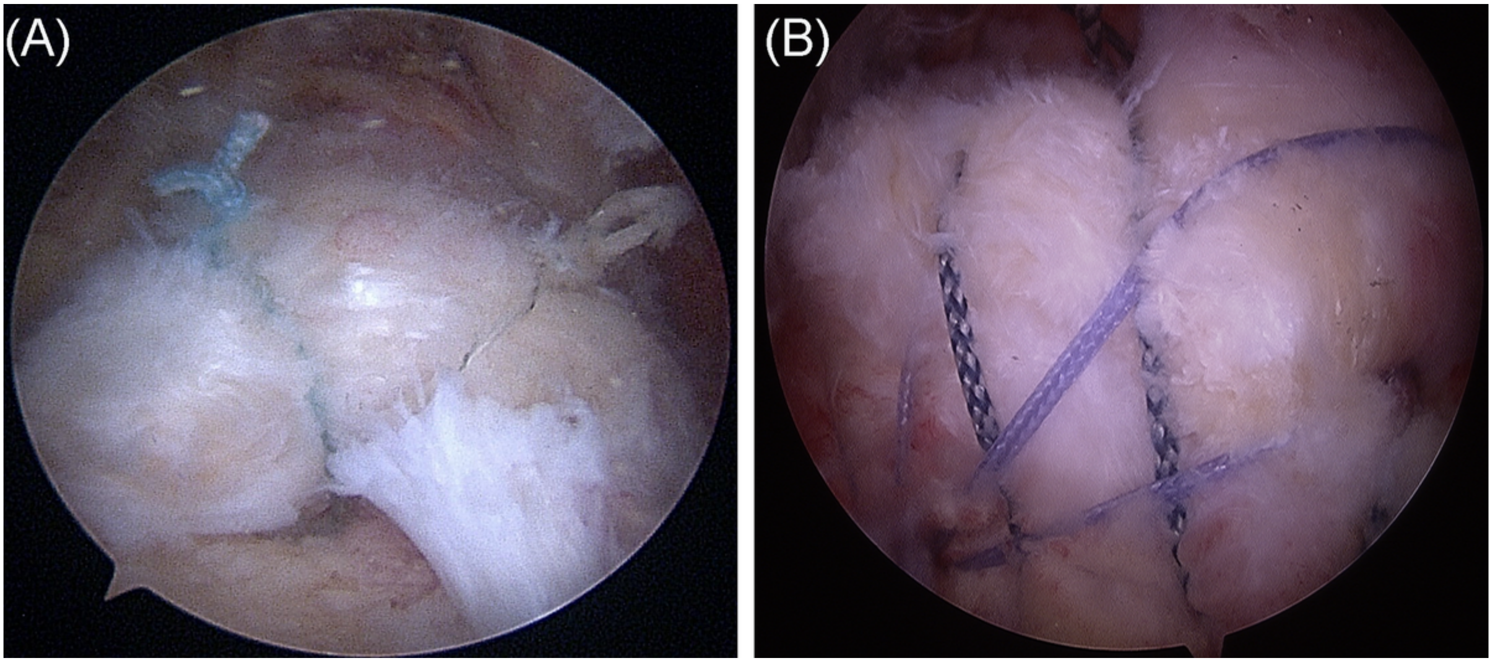


Figure 1

Repair configuration after arthroscopic rotator cuff repair. (A) single row repair technique. (B) double-row (suture bridge) repair technique.



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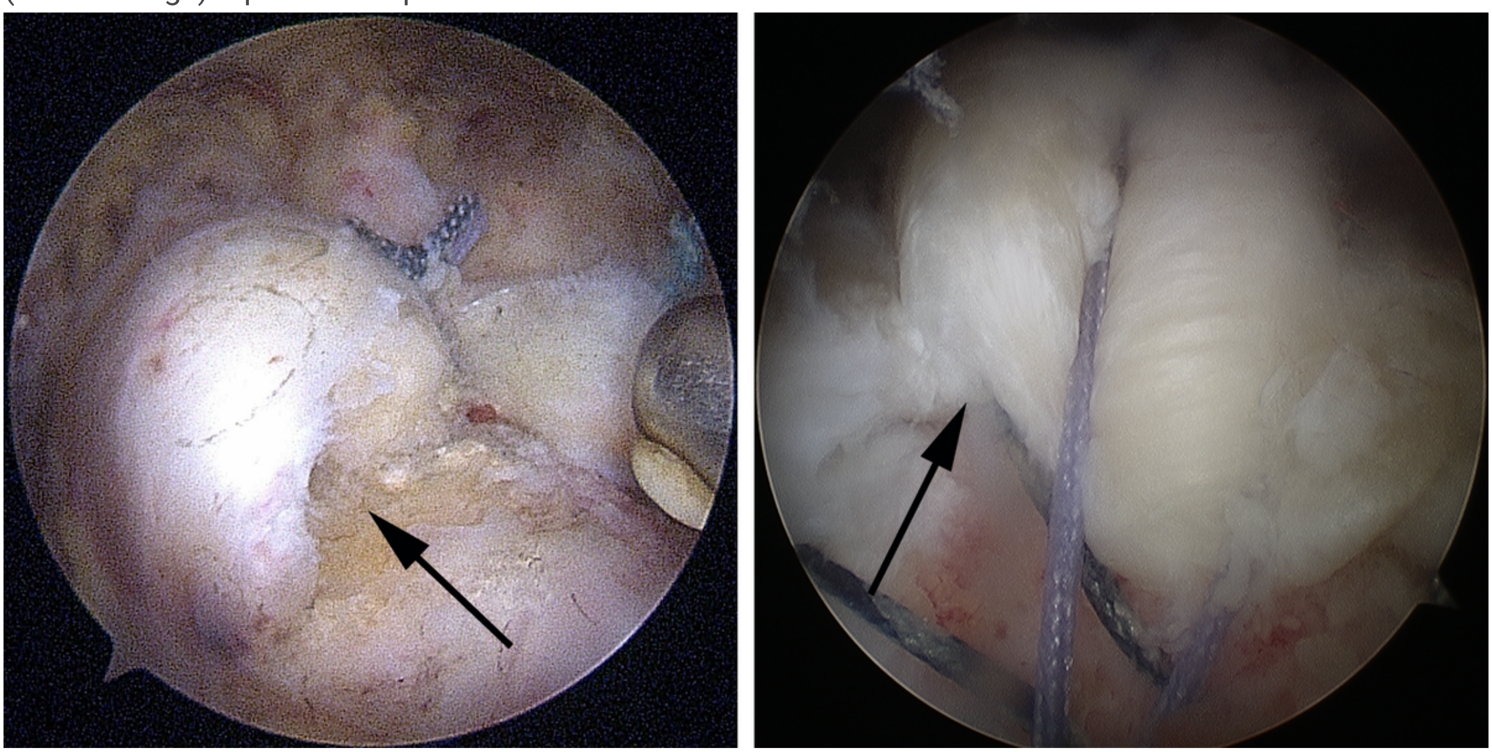
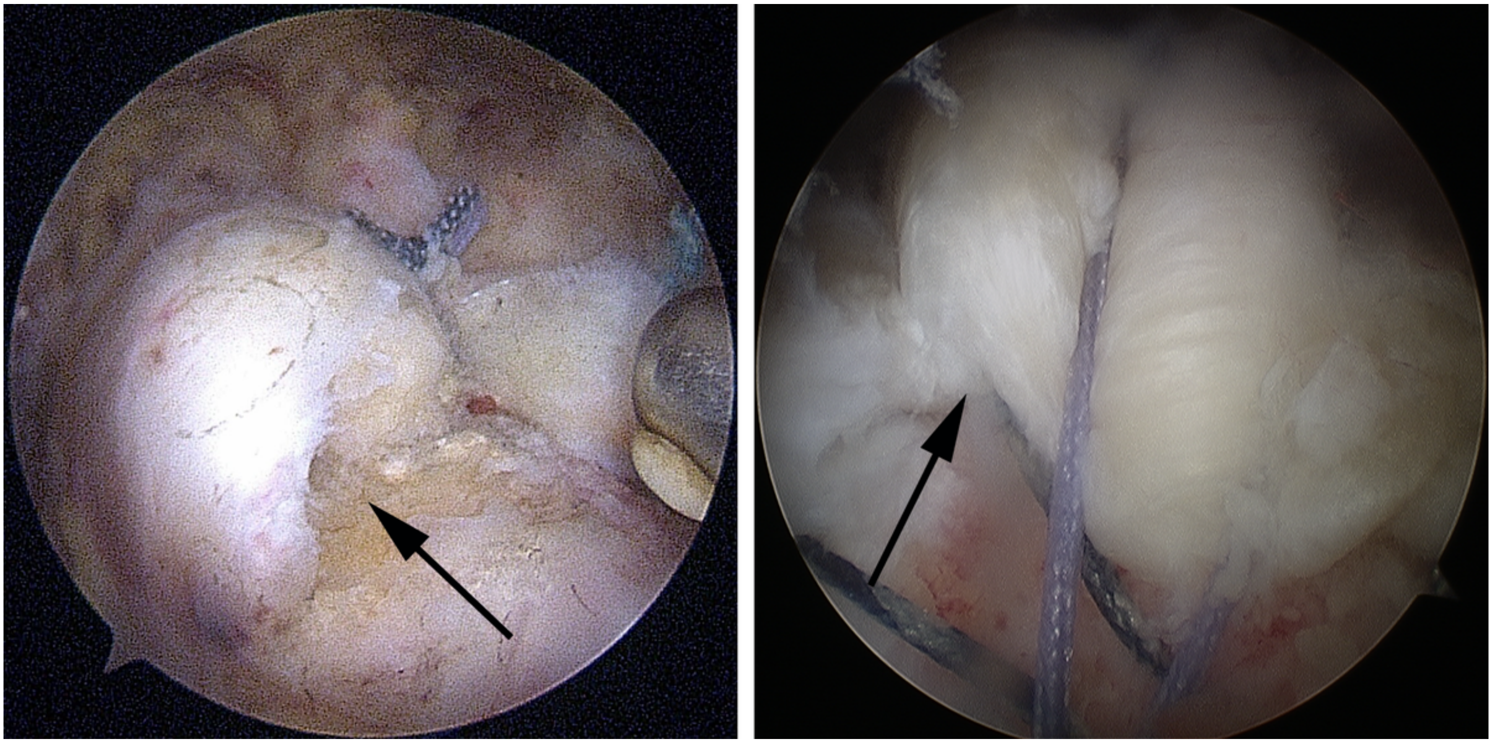


Figure 2

(A) The dog-ear deformity after arthroscopic rotator cuff repair. The width of the protrusion part was greater than the height. (B) The bird-beak deformity with the height was greater than the width. The tendon tissue quality was poor.



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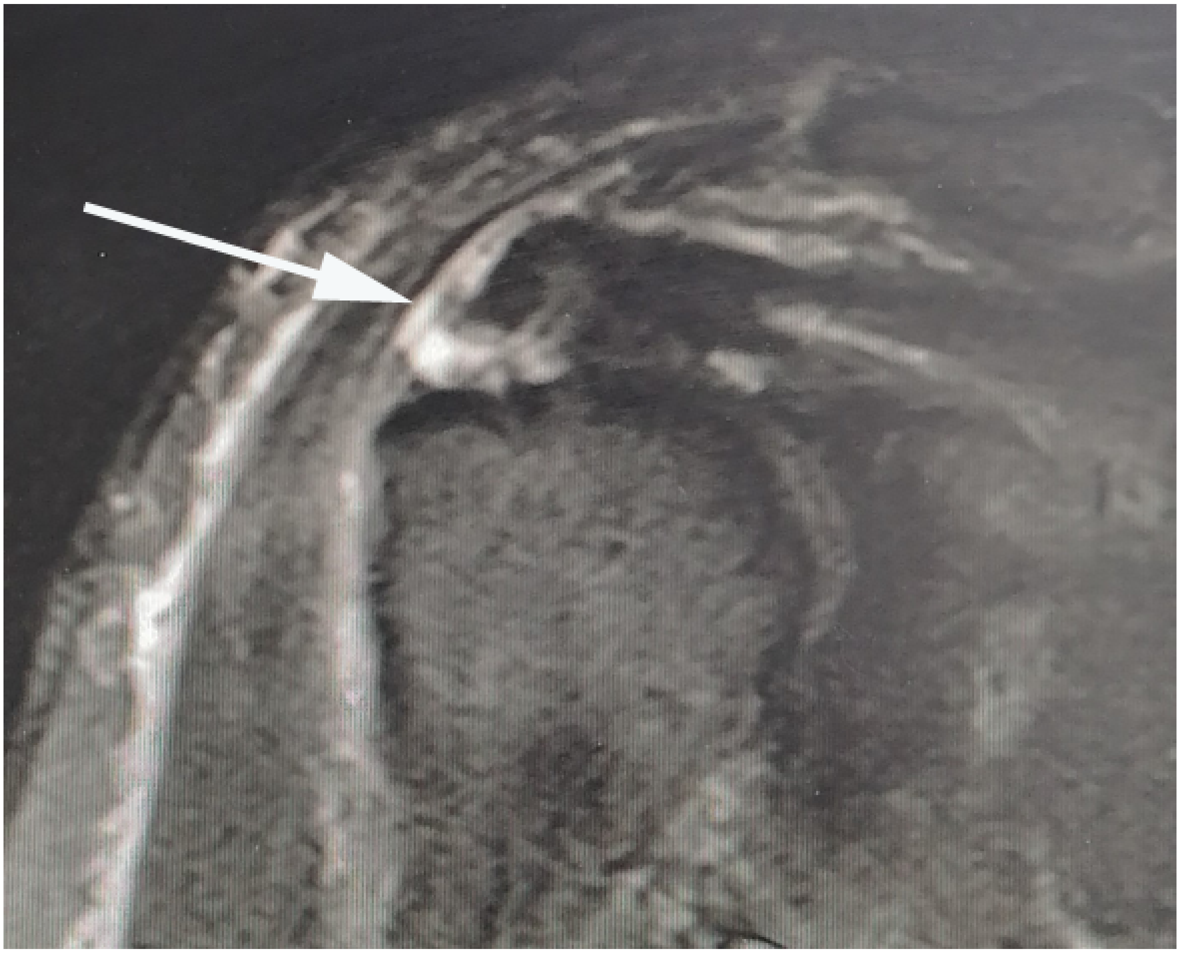
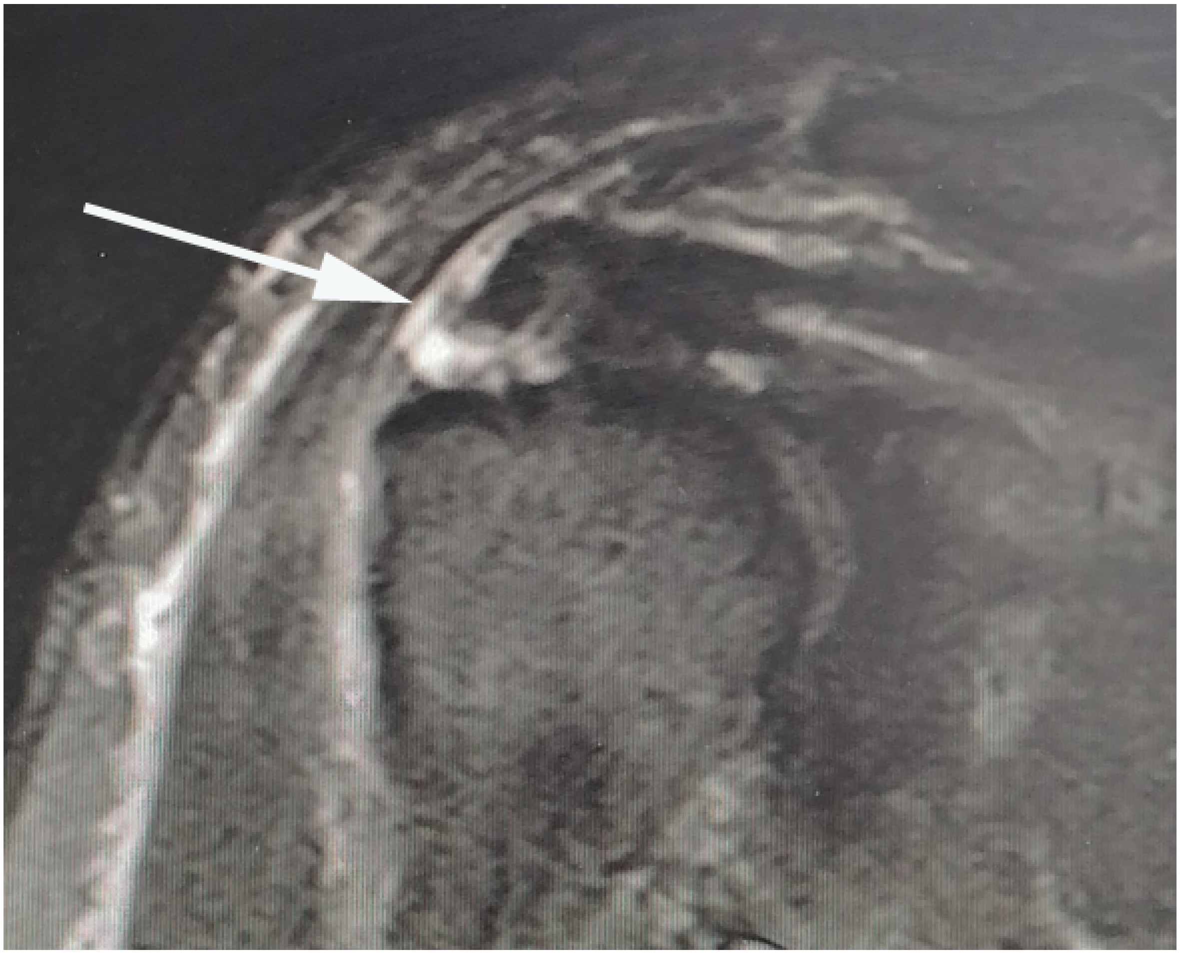


Figure 3

The retear sign (Type IV based on Sugaya's classification) on postoperative oblique coronal magnetic resonance imaging at 2nd day after rotator cuff repair.



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