Structural Evolution of Nonoperatively Treated High-Grade Partial-Thickness Tears of the Supraspinatus Tendon

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Background: High-grade partial-thickness rotator cuff tears (hPTRCTs) are frequently encountered in the shoulder. However, little information is available on the prevalence or timing of tear progression.

Purpose/Hypothesis: The purpose was to prospectively evaluate the structural progression of hPTRCTs with a minimum follow-up of 1 year using magnetic resonance imaging (MRI). The hypothesis was that a substantial portion of hPTRCT patients would experience tear progression or evolution to a full-thickness rotator cuff tear.

Study Design: Case series; Level of evidence, 4.

Methods: Between May 2010 and December 2015, 362 patients were diagnosed with hPTRCT (tear involvement >50% of the mediolateral length of the footprint) of the supraspinatus and were treated nonoperatively. Among these patients, 81 underwent follow-up MRI at least 1 year after initial presentation, and these patients were included in the final analysis. Initial and follow-up MRIs were used to determine whether tears had improved, had not changed, or had progressed. A change in tear involvement of >20% was defined as a significant change. Patients were categorized as follows: (1) a decrease in tear involvement of >20% (improved), (2) an increase or decrease of ≤20% (no change), or (3) an increase in tear involvement of >20% (progressed). Demographic data and morphologic data were analyzed to identify variables related to tear progression. Among them, severity of tendinosis was graded using MRIs: grade 1 (mild tendinosis), mild focal increase in tendon signal; grade 2 (moderate tendinosis), moderate focal increase in tendon signal; and grade 3 (marked tendinosis), marked generalized increase in tendon signal.

Results: At initial diagnosis, 23 were articular-side (28%) and 58 were bursal-side (72%) hPTRCTs. The study cohort was composed of 51 women and 30 men, and the mean patient age was 62.3 years (range, 41-77 years). Follow-up MRI was performed at a mean 19.9 ± 10.9 months (range, 12-52 months). A significant change in tear involvement was observed at follow-up. In 13 patients (16%, 2 articular-side and 11 bursal-side tears), tears were classified as progressed (the progressed group); in 48 patients (59%), tears exhibited no change (the unchanged group); and in 20 patients (25%, 9 articular-side and 11 bursal-side tears), tears were improved (the improved group). Univariate analysis showed initial tendinosis grade was significantly different in the 3 groups (grade 1, 2, and 3: 5, 4, and 4 in progressed; 36, 11, and 1 in unchanged; 10, 8, and 2 in improved group, respectively, $P = .007$).

Conclusion: Although progression of hPTRCT in the long term is uncertain, after 1-year follow-up with MRI, tears progressed in 16% of the tears in this study. Furthermore, some tears were healed or reduced in size, which indicates that decisions to undertake surgical repair at time of presentation may be excessive.

Keywords: rotator cuff tear; high grade; partial-thickness rotator cuff tear; tear progression; healing

Partial-thickness rotator cuff tear (PTRCT) of the supraspinatus is a relatively common shoulder disorder, and approximately 5% to 10% of patients with shoulder pain have a symptomatic PTRCT.[35] It is generally accepted that the articular-sided tear is at least twice as common as the bursal-sided tear and that most partial-thickness tears involve the supraspinatus tendon.[4,5,11,27] Ellman[5] categorized these tears based on location into articular, bursal, and intratendinous areas and classified each as grade 1 (<3 mm), grade 2 (3-6 mm), or grade 3 (>6 mm). The mean thickness of the rotator cuff tendon is 10 to 12 mm[5];

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thus, grade 3 tears are regarded as high-grade PTRCTs (hPTRCTs), as the degree of a tear is described according to tear depth rather than tear area.[5,37]

Because PTRCTs are associated with some attachment at the footprint, tendon retraction is not of the same concern as for full-thickness rotator cuff tears (FTRCTs). For this reason, nonoperative treatment is an option for first-line treatment and has been reported to be satisfactory on many occasions.[1,2,6,14,16,26,32,40] However, clinicians and patients should be aware that this tear can progress to FTRCT[19,20,41] and aggravate further via retraction and fatty degeneration to an irreparable tear and rotator cuff arthropathy. Currently, it is commonly believed that a rotator cuff tear is unlikely to heal spontaneously. One histologic study reported that torn ends of tendons showed no signs of active repair and that many sections exhibited evidence of impending FTRCT; that is, only narrow tissue connections were observed on the bursal or articular sides of the cuff tendon.[10] It has also been suggested that spontaneous PTRCT healing appears only on rare occasions.[8] Biomechanical studies have also shown that strain in the remaining intact articular side of the tendon, in cases of hPTRCT, is significantly increased; as a result, partial tears are likely to propagate deeper to FTRCT.[33,42] Based on this information, it is not surprising that many surgeons believe the fate of hPTRCT is FTRCT and therefore favor early surgical repair.[8] Nevertheless, textbooks recommend that nonoperative treatment of the PTRCT should be attempted before surgery. Furthermore, it should be considered that surgical repair cannot guarantee healing and the prevention of future retear.[3,17] These reports and opinions raise certain questions: How often should a patient be monitored after successful nonoperative treatment, and how many patients who progress to FTRCT require surgical repair? Still, little is known about the timing of PTRCT progression to FTRCT.[9]

The purpose of the present study was to evaluate tear progression in hPTRCT of the supraspinatus tendon over a minimum follow-up of 1 year using magnetic resonance imaging (MRI) and to document the prevalence and rate of tear progression in hPTRCT. The hypothesis of this study was that a substantial portion of the study population would exhibit an increase in tear size and conversion to FTRCT.

METHODS

This retrospective review was conducted using data prospectively collected from patients with MRI-proven symptomatic hPTRCT of the supraspinatus between May 2010 and December 2015. The study inclusion criteria were symptomatic hPTRCT of the supraspinatus confirmed by MRI, the receipt of nonoperative treatment, and follow-up MRI at least 1 year after initial presentation. The study protocol was approved beforehand by our institutional review board (IRB No. 1509-073-704).

Patient Follow-up and Nonoperative Treatment

At our institute, nonoperative treatment is initially instituted in patients with hPTRCT. This treatment is based on self-conducted home exercise (stretching), which is taught by a specialized shoulder physical therapist; selective nonsteroidal anti-inflammatory drugs; and the avoidance of heavy lifting and sports activities. The stretching protocol was composed of assisted supine elevation, assisted external rotation, assisted cross-body adduction, and sleeper stretching. All stretching exercises were conducted using firm, gentle continuous pressure with no pulsating force. Exercises were performed for about 30 seconds each, were repeated 3 or 5 times per exercise session, and were conducted 2 to 3 times daily. The use of regional or systemic steroid was avoided because of its reported harmful effects on tenocytes.[18,23,24] Initially, it was requested that patients return to the clinic 2 months after treatment commencement for symptom evaluation. When symptoms improved, nonoperative treatment was continued and patients were followed every 3 months. If a patient experienced no discomfort in motion, he or she was educated on how to do strengthening exercises of the rotator cuff with a sports cord. After a minimum of 1 year of nonoperative treatment, it was recommended that patients undergo follow-up MRI to evaluate tear progression. During the study period, 362 patients were diagnosed and treated conservatively. Among these patients, 214 patients did not come back to the clinic before 1-year-follow-up, and 10 patients underwent surgery for rotator cuff repair since symptom improvement was not satisfactory. Overall, 138 patients visited the clinic for more than 1 year; among these patients, 81 patients underwent follow-up MRI, and these patients were included in the final analysis.

Radiologic Evaluation

Shoulder MRIs were performed using 1.5-T (Sigma HDxt 1.5 T; GE Healthcare) scanners with dedicated shoulder coils. In each case, the patient was placed in the supine position with the forearm in the neutral position. The MRI protocol was as follows: axial fast spin echo proton-density weighted image with fat saturation (repetition time [TR]/echo time [TE]: 2300-3900/30-60 ms; slice thickness: 3 mm; slice gap: 0.3 mm; field of view: 14 cm; matrix: 384 × 269; and echo train length: 7 n), oblique coronal and sagittal fast spin-echo T2-weighted images with fat saturation (TR/TE: 2300-4600/30-50 ms; slice thickness: 3 mm; slice gap: 0 mm; field of view: 14 cm; matrix: 384 × 269; and echo train length: 12 n), and oblique coronal and extended oblique sagittal fast spin-echo T1-weighted images (TR/TE: 400-800/10-15 ms; slice thickness: 3-4 mm; slice gap: 0-0.4 mm; field of view: 14 cm for coronal and 16 cm for sagittal images; matrix: 384 × 269; and echo train length: 4 n).

On MRIs, hPTRCT was diagnosed based on the presence of increased signal intensity in the rotator cuff without partial footprint continuity (>50%) on T2-weighted images. Tears were measured in T2-weighted coronal sections. Ratios of tear lengths to whole footprint lengths (tear ratios) were measured in the coronal plane for articular and bursal surface PTRCTs (Figure 1).

Initial and follow-up MRIs were compared to determine whether tears had improved, were unchanged, or had

Figure 1. Measurement of tear ratios of partial-thickness rotator cuff tears (PTRCTs). Ratios of tear length (red line) to whole footprint length (yellow line) were determined using T2-weighted coronal images.

progressed. A change of >20% in tear ratio was defined as significant, and changes were categorized as follows: (1) a decrease in tear ratio of >20% (the improved group), (2) a tear ratio change (increase or decrease) of ≤20% (the unchanged group), and (3) an increase in tear ratio of >20% (the progressed group).

Other variables were also measured to determine tear progression. Severity of tendinosis was graded using initial and follow-up MRIs[34]: grade 1 (mild tendinosis), mild focal increase in tendon signal; grade 2 (moderate tendinosis), moderate focal increase in tendon signal; and grade 3 (marked tendinosis), marked generalized increase in tendon signal (Figure 2).

Lateral spurs were graded in T1-weighted coronal MRIs as follows: grade 1, mild or no indentation of the rotator cuff tendon; grade 2, spur causing indentation of the rotator cuff tendon; and grade 3, heel-type spur morphology (Figure 3).[30]

Subacromial fluid collection was also graded in T2-weighted coronal images, where grade 1 was defined as minimal or no fluid collection, grade 2 as the presence of some fluid signal in the subacromial and subdeltoid spaces, and grade 3 as a marked fluid signal in subacromial and subdeltoid spaces (Figure 4). Finally, anteroposterior dimensions of tears were measured in oblique sagittal T2-weighted images (Figure 5).

Statistical Analysis

The mean values were compared using the paired t test for continuous variables or using the chi-square test or the Fisher exact test for categorical variables to determine differences between initial and follow-up tear statuses on MRIs. Comparisons of continuous variables in the progressed, unchanged, and improved groups were analyzed using a 1-way analysis of variance. Statistical significance was accepted for P values <.05. To evaluate reliability of measuring tear ratio, inter- and intraobserver reliabilities among 2 raters were evaluated with the interclass correlation coefficient (ICC; a 2-way random model with absolute agreement). The value can range from 0 to 1 (close to 1 indicates high reliability of measurement).

RESULTS

At initial diagnoses, there were 23 articular-side (28%) and 58 bursal-side (72%) hPTRCTs. The mean patient age was 62.3 years (range, 41-77 years), and the cohort was composed of 51 women and 30 men. Fifty-three showed dominant-side involvement. Mean symptom duration before the initial visit was 15.8 months (SD, 24 months; range, 1-120 months). A traumatic event before symptom development was recalled by 18 patients. Follow-up MRI was performed at a mean 19.9 ± 10.9 months (range, 12-52 months) after the initial visit. Spur grades were grade 1 in 39 cases, grade 2 in 27 cases, and grade 3 in 15 cases.

Tear ratios changed significantly at follow-up. Thirteen patients (16%, 2 articular-side and 11 bursal-side tears) experienced a >20% tear ratio increase (the progressed group), 48 patients (59%) a tear ratio change of ≤20% (the unchanged group), and 20 patients (25%) a tear ratio decrease of >20% (the improved group). In the improved group, there are 9 articular-side and 11 bursal-side tears. Mean MRI follow-ups were conducted at 20.9 ± 11.8, 19.7 ± 11.1, and 19.7 ± 10.5 months in the progressed, unchanged, and improved groups, respectively, which did not represent a significant intergroup difference (P = .936). Measurement of tear ratios showed excellent intrarater reliability and good interrater reliability (Table 1).

Tendinosis grades were not significantly different at follow-up MRI. However, subacromial fluid collection was significantly different. There were many exchanges in the fluid collection grades in patients. Anteroposterior dimensions of tears exhibited a slight but nonsignificant decrease in size (Table 2).

Univariable analysis of relations between tear ratio changes and study variables revealed a significant relation for initial tendinosis grade only (Table 3).

In the improved group, 10 cases (12%, 4 articular-side and 6 bursal-side tears) showed complete resolution at follow-up MRI, meaning that the hPTRCT lesion confirmed at initial MRI was not evident at follow-up MRI (Figures 6 and 7).

In contrast, 3 of the 13 patients (1 articular-side and 2 bursal-side tears) in the progressed group progressed to FTRCT (Figure 8).

At every visit, patients were asked about their subjective shoulder status: worse, no change, better, much better, or no symptom. No patient-reported symptom was worse at the time of MRI follow-up. “No change” in symptom was checked in 3, “better” in 19, “much better” in 36, and “no

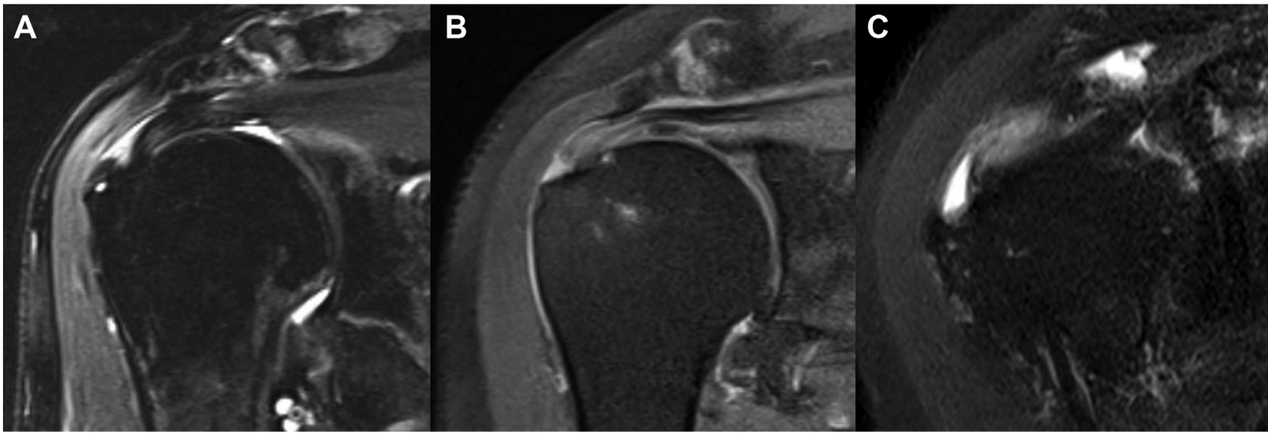

Figure 2. Tendinosis grading: (A) grade 1 (mild tendinosis), mild focal increase in tendon signal; (B) grade 2 (moderate tendinosis), moderate focal increase in tendon signal; and (C) grade 3 (marked tendinosis), marked generalized increase in tendon signal.

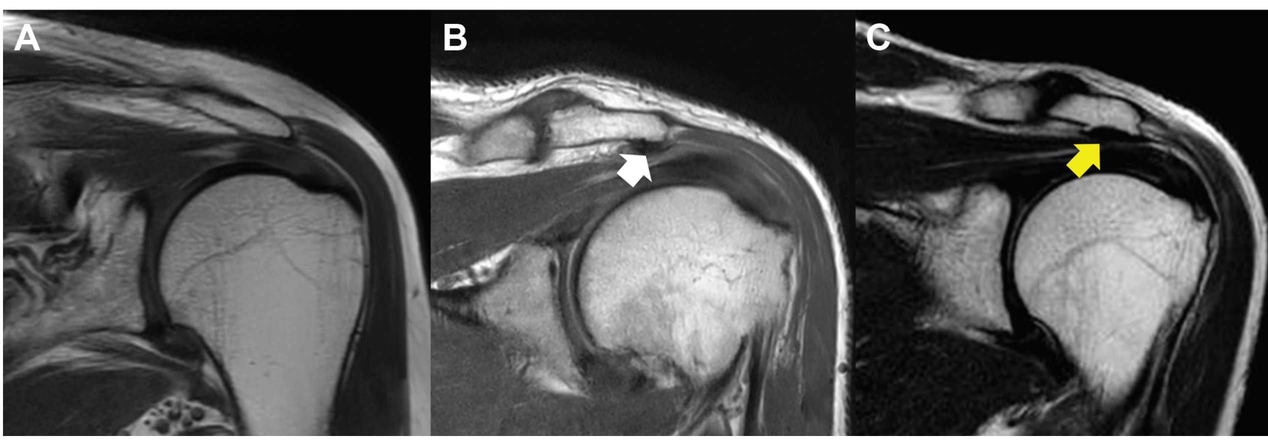

Figure 3. Spur grades. (A) Grade 1, mild or no indentation of the rotator cuff tendon. (B) Grade 2, spur causing indentation of the rotator cuff tendon (arrow). (C) Grade 3, heel-type spur (arrow).

Figure 4. Subacromial fluid collection. (A) Grade 1, minimal or no fluid collection. (B) Grade 2, some fluid signal in the subacromial and subdeltoid spaces. (C) Grade 3, marked fluid signal in subacromial and subdeltoid spaces.

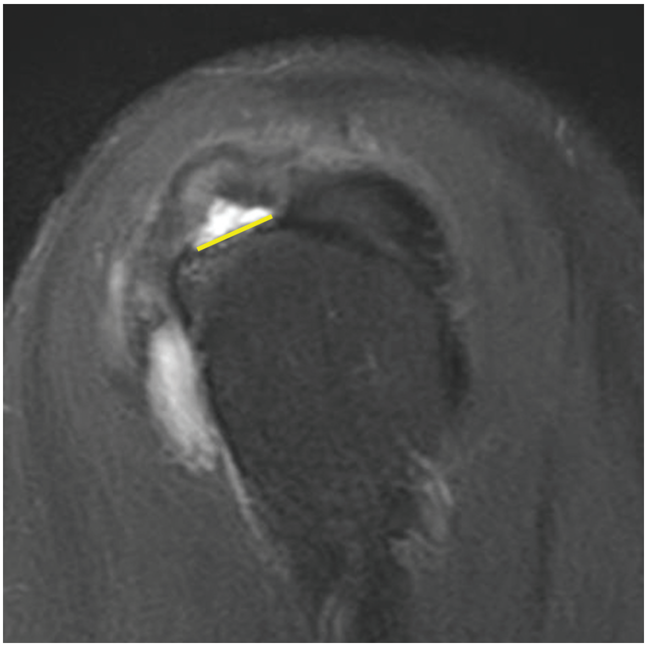

Figure 5. Measurement of anteroposterior dimensions of rotator cuff tears in oblique sagittal T2-weighted images. A section with greatest tear extension was chosen, and tear length was measured using a ruler tool (line).

symptom" in 23. There was no correlation between overall tear progression rating and symptom status (P = .815).

DISCUSSION

The main finding of this study is that tear severity progressed in only 13 patients (16%) over a 1-year period. However, tear severity decreased in 20 patients (25%), and 10 hPTRCT lesions (12%) disappeared completely, which could be considered as complete healing. The incidence of anatomic deterioration was lower in the present study than in previous studies, in which the anatomic deterioration rate has been reported to range from 8% to 80% for conservatively treated PTRCT.[20,25,26,41] We attribute this difference to the use of different study designs. Previous studies, with the exception of the study performed by Yamanaka and Matsumoto,[41] included patients with PTRCT or FTRCT and placed focus on FTRCT, whereas we included only patients with PTRCT.

Interestingly, we found that tendinosis might affect tear progression. In fact, initial tendinosis grade was the only variable found to be significantly associated with tear progression. This result concurs with that of a previous study in which tendinosis grade was found to be an important prognostic factor of anatomic results for the repair of PTRCTs and small FTRCTs.[3] In this previous study, tears with a higher tendinosis grade had a failure rate that was 7.64 times higher than those with a lower tendinosis grade. However, other clinical and morphological variables, including spur severity, were not found to be related to tear progression.

Most clinicians would agree with the principle that the initial treatment of hPTRCT should be nonoperative.[9] In general, the results of nonoperative treatment for PTRCT are excellent in studies.[21,31,39] However, despite satisfactory results for nonoperative treatment, an increasing number of clinicians recommend surgical treatment because of the possibility of tear progression to FTRCT and subsequent tendon retraction and muscle fatty degeneration, which are considered to be poor prognostic factors.[12,13,15,22] Early surgical intervention for painful tears is undertaken to prevent the tear enlargement and muscle degeneration that can occur with nonoperative treatment and to increase the likelihood of tendon healing.[7,12,13,15,22,29,38]

However, the rate of progression of hPTRCTs has not been determined, which implies immediate repair after a diagnosis of hPTRCT may not be well founded. The recent trend toward surgical repair might be due to the evolution of arthroscopic surgical techniques, which are considered minimally invasive.[4] However, the healing rate of surgical PTRCT repair is not 100% but, rather, between 65% and 88%,[3,17] so the failure rate is not negligible. When PTRCT repair fails, the result is usually FTRCT; that is, the condition progresses rather than simply recurs. In the present study, healing failure rates were lower than the surgical repair failure rates. In fact, only 3 (6%) of our patients progressed to FTRCT. Furthermore, with an anatomic aggravation rate of 16% observed in the present study, our results were similar or better than the retear rates encountered after surgical repair for PTRCT in previous studies at around 1 year.

Several studies have described the progression of PTRCT to FTRCT during follow-up.[20,25,26,41] Yamanaka and Matsumoto[41] performed an arthrographic follow-up at >2 years on 40 articular-side PTRCTs treated conservatively and found 10% decreased in size, 10% disappeared, and 80% were unchanged, enlarged, or had progressed to full-thickness lesions. However, this study was limited by the inclusion of only articular-sided PTRCTs and by the use of arthrography as a means of evaluating tear progression. In a prospective study with a 5.1-year follow-up, Keener et al[20] reported that tear progression was observed in 49% of shoulders in a mixed population of FTRCT and PTRCT, median time to enlargement was 2.8 years, 44% of those with a PTRCT experienced tear enlargement, and median time to enlargement was 3.3 years for PTRCT. In contrast, Maman et al[26] examined tear progression for PTRCTs and FTRCTs by MRI and noted that 48% of tears reexamined at more than 18 months had enlarged, whereas only 19% of tears followed for less than 18 months had enlarged. However, similar to the present study, the risk of progression was lower for partial-thickness tears (8%) than for full-thickness tears (52%).[26] The mean interval from initial MRI to follow-up MRI was 19.9 months in our study, which is similar to the study of Maman et al. However, it is much shorter than that in the study of Keener et al[20]; therefore, progression over longer time periods is yet to be determined.

According to our results, 20 (25%) of our patients demonstrated a decrease in tear size by MRI, and 10 of these patients (12.3%) achieved complete healing. Yamanaka and Matsumoto[41] first reported that small articular-sided

TABLE 1
Assessment of Intrarater and Interrater Reliability[a]

	Intrarater Reliability		Interrater Reliability	
	Initial MRI	Follow-up MRI	Initial MRI	Follow-up MRI
Rater 1	0.963 (0.936-0.979)	0.987 (0.977-0.993)	0.867 (0.764-0.925)	0.872 (0.773-0.928)
Rater 2	0.956 (0.925-0.969)	0.968 (0.941-0.974)		

[a]Data are reported as ICC (95% CI). ICC, interclass correlation coefficient; MRI, magnetic resonance imaging.

TABLE 2
Changes in Variables Observed at Follow-up MRI[a]

	Initial	Follow-up MRI	*P* Value
Tendinosis grades, 1:2:3	51:23:7	50:26:5	.685
Subacromial fluid collection, minimal:moderate:severe	60:17:4	61:15:5	.011
Anteroposterior dimension, mm, mean ± SD	8.8 ± 2.8	7.8 ± 4.2	.051

[a]MRI, magnetic resonance imaging.

TABLE 3
Differences Observed at Follow-up for Each of the Study Variables in the Progressed, Unchanged, and Improved Groups

	Progressed	No Change	Improved	*P* Value
Sex, male:female	5:8	19:29	6:14	.752
Age, y, mean ± SD	62.2 ± 7.0	62.3 ± 7.5	62.5 ± 9.0	.992
Dominant-side involvement, yes:no	10:3	32:16	11:9	.388
Trauma history, yes:no	3:10	9:39	6:14	.594
Articular:bursal	2:11	12:36	9:11	.131
Symptom duration, mo, mean ± SD	25.9 ± 41.9	15.0 ± 21.3	11.0 ± 10.0	.206
Spur grade (1:2:3)	3:6:4	26:13:9	10:8:2	.250
Initial tendinosis grade (1:2:3)	5:4:4	36:11:1	10:8:2	.007
Subacromial space fluid grade (1:2:3)	8:5:0	39:8:1	13:4:3	.069
Initial tear ratio, %, mean ± SD	61.2 ± 11.1	64.7 ± 10.8	67.0 ± 10.5	.322
Initial anteroposterior dimension, mm, mean ± SD	9.2 ± 3.2	8.4 ± 2.5	9.3 ± 3.1	.449

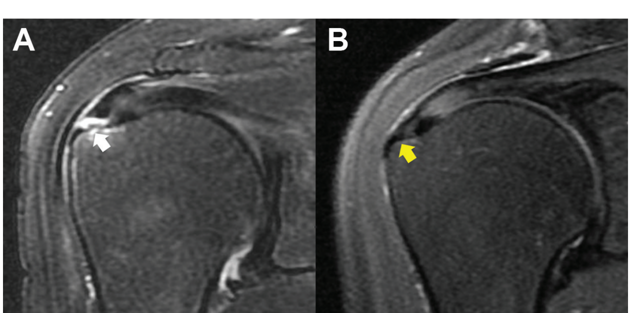

Figure 6. T2- weighted coronal magnetic resonance image (MRI) of a 64-year-old female patient. (A) The patient had a high-grade bursal-side partial-thickness rotator cuff tear (PTRCT) at initial MRI (arrow), (B) but no lesion was evident at follow-up MRI (2 years later) (arrow).

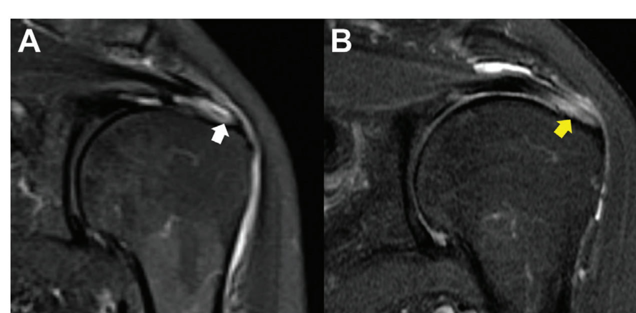

Figure 7. T2- weighted coronal magnetic resonance image (MRI) of a 67-year-old female patient. (A) The patient had a high-grade articular-side partial-thickness rotator cuff tear at initial MRI (arrow), (B) but at follow-up MRI (14 months later), the previous observed footprint detachment was not seen (arrow).

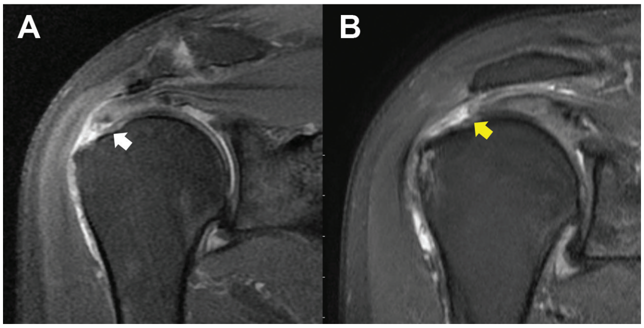

Figure 8. T2-weighted coronal magnetic resonance image (MRI) of a 69-year-old female patient. (A) The patient had a high-grade bursal-side partial-thickness rotator cuff tear at initial MRI (arrow). (B) At follow-up MRI (26 months later), the tear had progressed to full-thickness tear and retraction was observed (arrow).

PTRCTs secondary to trauma in young patients appeared to have the potential to self-heal as determined arthrographically. Maman et al[26] and Safran et al[32] also described a decrease in tear size for 5 of 63 (8%) RCTs (both FTRCT and PTRCT) and 5 of 61 (8%) FTRCTs, respectively. On the other hand, Fukuda[9] concluded rotator cuff tears do not heal and that rotator cuff lesions not only fail to heal spontaneously but also have a strong tendency to progress. However, based on our findings and those of previous studies, healing of a torn rotator cuff is possible, although it should be added that the nature of newly formed tissue in tear lesions has yet to be determined. We suggest that serial MRI studies be conducted on such healed cases to better understand the healing potential of torn rotator cuff tendons.

The diagnosis of PTRCT by imaging is also a concern. A systematic review of electronic databases, which included 2751 shoulders of 2710 patients, revealed that the pooled sensitivity and specificity of MRI for PTRCT were 0.80 (95% CI, 0.79-0.84) and 0.95 (95% CI, 0.94-0.97), respectively.[36] Accordingly, we believe that our use of MRI for the diagnosis and follow-up of hPTRCTs increased diagnostic accuracy and our ability to quantify anatomic alterations. MR arthrography possibly increased diagnostic accuracy of articular-side tears. However, the purpose of our study is not verification of accuracy of diagnosis but evaluation of tear progression in MRIs at different time points. In addition, a recent meta-analysis showed the diagnostic accuracy of supraspinatus pathology is similar in both MRA and MRI.[28]

Several limitations of the present study warrant consideration. First of all, not all patients registered at our outpatient clinic were included. A considerable number dropped out during follow-up or refused MRI after their symptoms had subsided, as the majority of the patients were visiting from long distances and the cost of MRI is not negligible. Thus, the dropout rate was considerable and could have introduced selection bias. However, the authors believe 81 cases is an adequate number to assume a population. Second, the criteria used to assess tear progression and recovery were somewhat subjective. There was no reference suggesting how much of a tear increment could be regarded as aggravation in partial tears because there has not been an MRI-based follow-up study. Two raters performed separate measurement and underwent reliability analysis, and the mean difference of the tear ratio was 9.4% ± 6.3% between the 2 raters. We set a conservative cutoff value of 20% to overcome measurement error. Based on the Ellman[5] classification, the difference between grades is 3 mm; therefore, if we consider 12 mm as the average length of the footprint, 25% tear involvement at the footprint is the difference between grades. In this classification, there is no exact rationale for a cutoff value of 3 mm. We think 20% is appropriate as a cutoff value for determination of worsening or improvement based on measurement data. Furthermore, we used tear ratios rather than tear widths to minimize the error associated with the difference in axis of the MRI cutting in 2 different time point MRIs. Finally, the follow-up time was short; that is, the mean time between initial MRI and follow-up MRI was 19.9 ± 10.9 months (range, 12-52 months). Thus, we suggest a long-term follow-up study be conducted to verify our results. Nevertheless, the results obtained show hPTRCT progression is commensurate with nonoperative treatment at initial presentation.

CONCLUSION

Although progression of hPTRCT in the long term is uncertain, according to the investigation using MRI during a 1-year interval, tear progression is not as frequent as generally thought. Monthly, or too frequent, evaluation with a special imaging modality may not be necessary and could increase medical costs. Furthermore, some tears healed or reduced in size, which indicates decisions to undertake surgical repair at the time of presentation may be excessive.

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