RESEARCH ARTICLE

Characteristics of Rotator Cuff Repairs Revised to Shoulder Arthroplasty

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Abstract

Background: Successful repair of a torn rotator cuff may prevent progression to rotator cuff arthropathy. However, previous studies have shown a substantial rate of failure after rotator cuff repair and characteristics of surgically repaired rotator cuffs that go on to shoulder arthroplasty have not been fully elucidated. The purpose of this study was to determine the patient characteristics and rate at which patients who underwent rotator cuff repair progressed to shoulder arthroplasty.

Methods: This was a retrospective study of patients who underwent rotator cuff repair in a large, closed healthcare system in 2008. The EMR was queried for rotator cuff repair CPT with ICD-9 codes for rotator cuff. The resultant dataset was then cross-referenced with a separate internal shoulder arthroplasty registry to determine which patients went onto shoulder arthroplasty. Demographic variables, descriptors of tear pathology and repair characteristics were collected and compared between patients who subsequently underwent shoulder arthroplasty and those that did not.

Results: A total of 882 rotator cuff repair patients were included within this study. Of the initial 882 cuff repairs, there were 12 patients (1.4%) that went on to have arthroplasty. Patients who underwent shoulder arthroplasty after rotator cuff repair were significantly older at time of surgery and had greater comorbidity burdens. Patients who ended up with shoulder arthroplasty had the procedure an average of 4.77 ± 3.28 (SD) years after rotator cuff repair, with 11 of 12 patients having a diagnosis of rotator cuff arthropathy at the time of shoulder replacement.

Conclusion: In a closed system, tracking rotator cuff repairs over 9.1 years revealed a small number that went on to subsequent shoulder arthroplasty. Patients who underwent shoulder arthroplasty were significantly older and had greater comorbidity burdens than those who did not. Patients who underwent shoulder arthroplasty usually either had shoulder arthroplasty within 1 year or after 5 years. Enhanced understanding of which patients may progress to arthroplasty may provide a better initial choice of operative intervention in those patients.

Level of evidence: III

Keywords: Failure rate of rotator cuff repair, Revision, Rotator cuff repair, Shoulder arthroplasty

Introduction

Rotator cuff tears are common among the general population, with over 275,000 rotator cuff repairs (RCRs) being performed in the United States each year (1). Despite the growing prevalence of RCRs, their long-term success rate is often variable, and revision surgery is often required (2, 3).

Rotator cuff repairs have been associated with a high radiographic retear rate (4). However, clinical results often do not directly reflect radiographic findings and patients frequently report satisfactory

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outcomes after RCR despite radiographic failure (5). The natural history of non-surgically treated rotator cuff tears is to progress in size over time with possible progression to rotator cuff tear arthropathy (6-8). However, the incidence of pathologic progression after RCR is unclear. Furthermore, few studies have looked at characteristics of patients who subsequently undergo arthroplasty after RCR. Understanding the characteristics that predispose a patient towards a future revision surgery may better inform clinical decision making when dealing with patients that have rotator cuff tear.

The purpose of this study was to determine the incidence of progression to shoulder arthroplasty after RCR and to elucidate the timing and characteristics of these patients who progressed to shoulder arthroplasty. We hypothesized that a small number of patients who underwent RCR would undergo subsequent shoulder arthroplasty.

Materials and Methods

A closed health care system was reviewed for all rotator cuff repairs performed in 2008. The electronic medical record was queried for rotator cuff repair CPT codes of 29827, 23410, 23412 or 23420 with ICD-9 codes for rotator cuff pathology (726.13, 727.61, 726.10, 840.3-840.6). Patients who were pregnant or less than 18 years old were excluded from the study. Patients with prior ipsilateral RCR, partial tear, or no involvement of the supraspinatus were excluded as well. This dataset was then cross-referenced with a separate prospectively-maintained shoulder arthroplasty registry to determine which patients went on to shoulder arthroplasty (9, 10). Demographic variables such as age and sex were collected. Tear and repair characteristics such as tear chronicity (classified as either acute or chronic), presence or absence of infraspinatus or subscapularis involvement, repair approach (open or arthroscopic) and repair type (single or double row fixation) were also collected. Values are reported as means ± standard deviations. For statistical analysis, T-tests were used to compare continuous variables and Fisher's exact test was used to compare categorical variables. Statistical significance was set at $\alpha < 0.05$.

Results

A total of 882 RCRs meeting inclusion and exclusion criteria were performed in 2008, with an average time of follow up of 9.1 years. Of these, 12 progressed to shoulder arthroplasty (1.4%). Nine of the 12 had reverse total shoulder arthroplasties (RTSA), two had hemiarthroplasties, and one had an anatomic total shoulder arthroplasty. One of these patients subsequently underwent an additional arthroplasty procedure to revise the RTSA due to instability. All but one (11 of 12 patients) had underwent arthroplasty surgery for a diagnosis of rotator cuff arthropathy, with the remaining patient having a diagnosis of glenohumeral osteoarthritis.

Compared to the RCR-only group, the 12 that progressed to arthroplasty were significantly older at the time of

Table 1. Demographics, Tear Pathology and Repair Characteristics

	No Arthroplasty	Arthroplasty	*P-value*
	n = 869	n = 12	
Demographics			
Age, mean (SD)	59.5 (10.3)	66.6 (6.9)	0.004*
Gender			0.379
Female, count (%)	368 (42.3%)	7 (58.3%)	
Male, count (%)	501 (57.7%)	5 (41.7%)	
Handedness			0.99
Non-dominant, count (%)	304 (35.0%)	4 (33.3%)	
Dominant, count (%)	565 (65.0%)	8 (66.6%)	
Occupation			0.317
Non-labor, count (%)	670 (77.2%)	11 (91.7%)	
Labor, count (%)	198 (22.8%)	1 (8.3%)	
Elixhauser Comorbidity Index, mean (SD)	2.2 (1.7)	3.2 (1.8)	0.079
Tear Pathology			
Tear chronicity			0.99
Acute, count (%)	87 (10.0%)	1 (8.3%)	
Chronic, count (%)	781 (90.0%)	11 (91.7%)	

Table 1 Continued.			
Infraspinatus involvement, count (%)	272 (31.3%)	6 (50.0%)	0.210
Subscapularis involvement, count (%)	137 (15.8%)	2 (16.7%)	0.99
Repair			
Approach			0.460
Open, count (%)	155 (17.8%)	3 (25.0%)	
Arthroscopic, count (%)	714 (82.2%)	9 (75.0%)	
Rows			0.244
Single, count (%)	406 (46.7%)	8 (66.7%)	
Double, count (%)	463 (53.3%)	4 (33.3%)	

* statistically significant at $P < 0.05$

Table 2. Patients who underwent shoulder arthroplasty after rotator cuff repair

Patient	Years Between RCR and Arthroplasty	Reason for Arthroplasty	Arthroplasty Type	Revision Arthroplasty?	Pain at Final Follow-up
1	4.6	RCA	RTSA	No	No
2	6.4	RCA	RTSA	Yes	No
3	0.8	RCA	Hemi	No	Yes
4	0.7	RCA	RTSA	No	No
5	8.9	RCA	RTSA	No	No
6	5.2	RCA	RTSA	No	No
7	8.6	RCA	RTSA	No	No
8	8.6	RCA	RTSA	No	Deceased
9	0.7	OA	aTSA	No	No
10	6.9	OA	RTSA	No	No
11	0.8	RCA	Hemi	No	No
12	5.0	RCA	RTSA	No	No

RCA = rotator cuff arthropathy, OA = glenohumeral osteoarthritis, RTSA = reverse total shoulder arthroplasty, HHR = humeral head resurfacing, Hemi = hemiarthroplasty, aTSA = anatomic total shoulder arthroplasty

RCR [Table 1]. Of the 869 patients that solely had an RCR performed, there was a greater predominance of males (42.3% female vs. 57.7% male). However, patients that subsequently underwent arthroplasty were more likely to be female (58.3% female and 41.7% male) though this difference was not statistically significant. The Elixhauser Comorbidity Index was greater for patients who underwent subsequent arthroplasty but not statistically significant. Of the 12 patients who had an arthroplasty, 100% had hypertension, 91.7% (11 out of 12) had hyperlipidemia, and 41.7% (5 out of 12) had obesity. Patients who underwent arthroplasty had a higher incidence of subscapularis and infraspinatus involvement, however these differences were not statistically significant. They were also more likely to have undergone an open RCR, but the differences were also not statistically significant.

The average time between RCR and arthroplasty was 4.77 ± 3.28 years with a bimodal distribution [Table 2]. Five of the 12 (41.7%) patients had shoulder arthroplasty within 1 year of the RCR and seven out of 12 (58.3%) had arthroplasty greater than 5 years after the RCR. The average age at time of arthroplasty for the 12 patients was 72.0 ± 8.2 years old. Of the patients who had an arthroplasty, only one of the 12 had pain at the time of their final follow up.

Discussion

Rotator cuff repair has been associated with a high retear rate, but the rate of progression to subsequent shoulder arthroplasty has not been firmly established (4, 11). In this study, we found that the rate of progression

to shoulder arthroplasty after RCR was fairly low. Those that subsequently underwent shoulder arthroplasty after RCR tended to be older and had greater comorbidity burdens. Furthermore, those that underwent shoulder arthroplasty either underwent the procedure within a year of the RCR or greater than five years after the RCR procedure.

Increased age has been established as a risk factor for inferior healing rates after RCR. Park et al. found that older age (>69 years) was associated with poor healing (12). Similarly, in a study of 1,600 arthroscopic RCRs, Diebold et al. found a low retear rate in patients under 50, a linearly increasing retear rate between the ages of 50 and 69 that increased 5% between each decade, and a significantly increased retear rate after age 70 (13). In our study, we found that patients that underwent subsequent arthroplasty were significantly older at the time of their RCR. This suggests that patients who are older at the time of RCR surgery are at greater risk of retear and pathologic progression. With 11 of 12 patients having a diagnosis of rotator cuff arthropathy, it may also suggest that older patients with large rotator cuff tears may be better treated with RTSA initially (14).

While the difference in Elixhauser Comorbidity Indices between groups in our study was not statistically significant, patients who underwent subsequent arthroplasty generally had an increased comorbidity burden at the time of RCR. A majority of patients who underwent shoulder arthroplasty had hyperlipidemia and hypertension, and a large proportion had moderate to severe obesity. Previous studies have also identified inferior outcomes after RCR in patients with increased comorbidity burdens (15-17). Berglund et al. found that obesity resulted in earlier plateaus in improvement after RCR with lower functional scores and Werner et al. demonstrated that hyperlipidemia was associated with increased risk of revision surgery after primary arthroscopic RCR (16). Therefore, patients' comorbidities should be taken into consideration when deciding upon if a patient should be a candidate for rotator cuff repair (17).

The size of the rotator cuff tear has also been determined to be a major factor in the integrity of the repair, with larger tears generally having inferior outcomes (18). Park et al. found that the retear rate for repairs less than 2 cm was 10.6% but was 34.2% for tears greater than 2 cm.12 In our cohort, patients who had subscapularis or infraspinatus involvement had higher rates of arthroplasty but the differences were not statistically significant, possibly due to low power.

In this study, the repair technique utilized (single row versus double row) and method of approach (open versus arthroscopic) did not result in significant differences in terms of undergoing subsequent shoulder arthroplasty. The effect of repair technique on clinical RCR outcomes is still debated. Mascarenhas et al. conducted a study evaluating double-row vs. single-row RCR; out of eight meta-analyses that were reviewed, three found that double row repair provided better structural healing for all tears regardless of size; however, six found that there was no difference between single row and double row RCR when it came to patient outcomes (19). Our results are in line with the latter studies, as we did not find a significant difference in terms of number of rows between the RCR-only and arthroplasty groups.

The natural progression of rotator cuff tears is thought to be a gradual increase in tear size along with humeral head migration until rotator cuff tear arthropathy occurs (6-8). Chalmers et al. found that while there were significant progressions in Samilson-Prieto (SPO) grade for glenohumeral osteoarthritis, Hamada grade for rotator cuff arthropathy, and a decrease in acromiohumeral interval (AHI) suggesting superior humeral migration in patients with asymptomatic rotator cuff tears during the first 5 years of follow up, the changes were minimal.7 Our study also supports this theory of rotator cuff pathology progression. It is likely that in some patients, the RCR was unable to halt pathologic progression and these patients then progressed to rotator cuff arthropathy which required shoulder arthroplasty. While the results of our study are in agreement with Chalmers et al., our study also included patients that had full-thickness tears, were symptomatic and sought surgery. Therefore, the possibility of pathological progression in our cohort may have been higher (20).

The average time from RCR to arthroplasty in this study was 4.77 ± 3.28 years. Patients who progressed to arthroplasty did so in a bimodal distribution, with patients either undergoing subsequent arthroplasty within 1 year of the RCR (4 patients) or more than 5 years after the RCR (7 patients). Additionally, rotator cuff tear arthropathy was the reason for arthroplasty in nearly all patients who underwent arthroplasty in this study, suggesting pathologic progression occurred despite attempts to repair the rotator cuff. Therefore, close monitoring in the year after RCR for the need for subsequent arthroplasty may be warranted, especially if a patient is older and has a greater number of comorbidities.

There were several limitations to this study. This study only included patients who underwent RCRs in 2008. While this resulted in a moderate time frame for follow up, the total number of patients who underwent shoulder arthroplasty after RCR was limited. Unfortunately, due to the small number of patients, any distinguishing factors for those cuff repairs that needed eventual conversion to arthroplasty were unable to be found. While we looked solely at patients who had RCRs, the indications for shoulder arthroplasty are not exclusively related to rotator cuff pathology, and the development of osteoarthritis can be associated with many factors beyond just rotator cuff pathology. The patient population was also derived solely from a single closed health care system and thus may not be reflective of the entire population. Another limitation stems from the lack of information regarding the incidence of progression to arthroplasty in patients with non-treated rotator cuff tears. The patient population used for this study consisted only of patients who had undergone RCRs, and so comparisons could not be made to a group that did not undergo RCRs.

After 9.1 years of follow up after rotator cuff repair, only a small number of patients (1.4%) progressed

to shoulder arthroplasty. Factors associated with subsequent arthroplasty include increased age and comorbidity burden. Patients who underwent shoulder arthroplasty after RCR tended to progress to arthroplasty within 1 year after RCR or after 5 years. Having a greater understanding of which characteristics may predispose a patient to subsequent arthroplasty and distribution of timing of subsequent arthroplasty may provide greater insight into which primary operative surgical intervention is most suitable.

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