

Infection Rates in Arthroscopic Versus Open Rotator Cuff Repair

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Background: The prevalence of rotator cuff repair continues to rise, with a noted transition from open to arthroscopic techniques in recent years. One reported advantage of arthroscopic repair is a lower infection rate. However, to date, the infection rates of these 2 techniques have not been directly compared with large samples at a single institution with fully integrated medical records.

Purpose: To retrospectively compare postoperative infection rates between arthroscopic and open rotator cuff repair.

Study Design: Cohort study; Level of evidence, 3.

Methods: From January 2003 until May 2011, a total of 1556 patients underwent rotator cuff repair at a single institution. These patients were divided into an arthroscopic repair group and an open group. A Pearson chi-square test and Fisher exact test were used, with a subgroup analysis to segment the open repair group into mini-open and open procedures. The odds ratio and 95% CI of developing a postoperative infection was calculated for the 2 groups. A multiple-regressions model was then utilized to identify predictors of the presence of infection. Infection was defined as only those treated with surgical intervention, thus excluding superficial infections treated with antibiotics alone.

Results: A total of 903 patients had an arthroscopic repair, while 653 had open repairs (600 mini-open, 53 open). There were 4 confirmed infections in the arthroscopic group and 16 in the open group (15 mini-open, 1 open), resulting in postoperative infection rates of 0.44% and 2.45%, respectively. Subgroup analysis of the mini-open and open groups demonstrated a postoperative infection rate of 2.50% and 1.89%, respectively. The open group had an odds ratio of 5.645 (95% CI, 1.9-17.0) to develop a postoperative infection compared with the arthroscopic group.

Conclusion: Patients undergoing open rotator cuff repair had a significantly higher rate of postoperative infection compared with those undergoing arthroscopic rotator cuff repair.

Keywords: rotator cuff repair; infection; postoperative complications; arthroscopic; open

Rotator cuff repairs are one of the most common operations orthopaedic surgeons perform on the shoulder, and the prevalence of this procedure continues to rise.⁴ A recent study utilized inpatient and ambulatory surgery databases to observe trends in rotator cuff repairs from 1996 to 2006. Their findings included a noteworthy increase in shoulder

pain-related medical visits, as well as an increased likelihood of these complaints being addressed surgically.⁵ The total volume of rotator cuff repairs increased from 41 per 100,000 people in 1996 to 58 per 100,000 people in 2006. The volume of arthroscopic rotator cuff repairs increased by 600%, while the volume of open rotator cuff repairs increased by only 34%.⁵ Along with similar studies in the literature, these findings indicate a transition from open to arthroscopic rotator cuff repair.^{4,5,7,11,12,16}

Rotator cuff repair complications include postoperative shoulder stiffness, anchor pull-out, failure of the rotator cuff repair, deep venous thrombosis, and postoperative infection.^{9,13} Surgical site infection after rotator cuff repair is a particularly serious complication. Several studies in the literature have analyzed infection rates after rotator cuff repair; however, each study has reported on one specific type of repair or used different studies to compare methods (ie, open vs arthroscopic).^{2,8-10,15} Although these studies seem to imply a lower infection rate after arthroscopic

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surgery, the literature is limited and sample sizes are insufficient to conclude the best clinical practice standards. Additionally, no study to date has directly compared the infection rates after arthroscopic and open rotator cuff repair at a single institution with fully integrated medical records.

Therefore, the purpose of this study was to directly compare the postoperative infection rates after arthroscopic rotator cuff repair with open repairs over a period of 7.5 years, using a large sample size at a single facility with all procedures conducted by the same 3 experienced fellowship-trained sports surgeons. The hypothesis was that there would be no significant difference between the groups in postoperative infection rates.

METHODS

After approval from an institutional review board, all medical records at a single institution were retrospectively reviewed to identify patients who had undergone arthroscopic or open rotator cuff repair from January 2003 until May 2011. The patient records were identified by using current procedural terminology (CPT) codes, including 29827 (arthroscopic rotator cuff repair), 23410 (open acute rotator cuff repair), 23412 (open chronic rotator cuff repair), and 23420 (open complete rotator cuff repair). After obtaining a list of all patients with these CPT codes, the charts were then reviewed for patients returning with postoperative surgical site infection. An in-depth chart review was then performed to confirm the initial repair and development of a postoperative infection as well as determine that the irrigation and debridement performed was specifically to the operative shoulder. For the purposes of this study, infection was defined as only those cases treated with surgical intervention, thus excluding superficial infections treated with antibiotics alone. Many in the literature, including Herrera et al,⁸ have utilized a similar definition to exclude “superficial infections that involved portals or skin only and did not require surgical intervention.”¹⁴

Surgical approach was individualized to each patient at the discretion of the surgeon and depended on patient comorbidities, surgeon comfort level with procedure, and type of rotator cuff tear. The study inclusion criteria included all patients who had received a rotator cuff repair at our institution with the use of an open, mini-open, or arthroscopic technique. Exclusion criteria consisted of prior or current shoulder infection, including osteomyelitis or septic arthritis, inadequate documentation to confirm the initial surgery or the subsequent follow-up appointments, multidirectional instability, concomitant surgery to ipsilateral shoulder (ie, fracture fixation, chondral resurfacing), rotator cuff debridement without fixation, and current use of immunosuppressive therapy. Inadequate documentation included missing operative notes or documentation of follow-up appointments verifying appropriate healing of the incision site. Patients were divided into 2 groups: arthroscopic and open (mini-open and open procedures).

Descriptive statistics were performed on all participants as follows: Mean, standard deviation, minimum, and

TABLE 1
Demographic Data on Patients in the Arthroscopic and Open Rotator Cuff Repair Groups^a

	Arthroscopic Group	Open Group	HOV Probability
No. of patients	903	653	
Age, y, mean (range)	58 (15-89)	60 (22-86)	.651
Sex, n			
Male	497	359	.981
Female	406	294	
Smoker, n	292	160	.539
Diabetic, n	231	168	.978
Size of tear, n			
Small	103	125	<.001
Medium	299	284	<.001
Large	383	152	<.001
Massive	115	89	<.001

^aThere was a significant difference in size of tears between the groups, but no difference in age, sex, smoking status, or diabetes. HOV, homogeneity of variance.

maximum were determined for all continuous variables, including age. Counts and percentages were determined for patient sex, smoking status, presence of diabetes, and size of tears. Pearson chi-square test and Fisher exact test were used to detect any significance between the groups. Significance was set at $P < .05$. The odds ratio and 95% CI of developing a postoperative infection was calculated for the 2 groups. A multiple regression was then utilized to identify predictors of the presence of infection.

RESULTS

A total of 2189 patients were identified. After initial screening, 633 patients were excluded; of these, 103 were excluded due to inadequate documentation of the primary procedure or subsequent follow-up. A total of 1556 patients were subsequently enrolled in this study. There were 903 patients with arthroscopic repairs and 653 with open repairs (600 mini-open, 53 open). Descriptive statistics are detailed in Tables 1 to 3. Surgical data are listed in Tables 4 and 5. There were 4 confirmed infections in the arthroscopic group and 16 in the open group, resulting in postoperative infection rates of 0.44% and 2.45%, respectively. When deconstructing the open group, there were 15 confirmed infections in the mini-open subgroup and 1 infection in the primary open group, resulting in postoperative infection rates of 2.50% and 1.89%, respectively. The types of infections were as follows: 7 *Staphylococcus aureus*, 6 *Propionibacterium acnes*, 1 coagulase-negative *Staphylococcus*, 1 *Clostridium*, and 5 that had negative cultures. The infections occurred randomly throughout the study period, developed within 6 weeks of the primary surgery, and were attributable to all 3 treating surgeons. Pearson chi-square analysis and Fisher exact tests were performed between the groups, and a statistically significant difference was found when comparing the infection rates between the arthroscopic and open groups ($P = .002$) (Figure 1). The open group

TABLE 2
Subgroup Analysis: Demographic Data on Patients in the Arthroscopic, Mini-Open, and Open Rotator Cuff Repair Groups^a

	Arthroscopic Group	Mini-Open Group	Open Group	HOV Probability
No. of patients	903	600	53	
Age, y, mean (range)	58 (15-89)	59 (22-86)	62 (34-79)	.858
Sex, n				
Male	497	289	33	.495
Female	406	326	20	
Smoker, n	292	148	12	.487
Diabetic, n	231	155	13	.914
Size of tear, n				
Small	103	125	0	<.001
Medium	299	278	6	<.001
Large	383	138	14	<.001
Massive	115	56	33	<.001

^aThere was a significant difference in size of tears but no significant difference in age, sex, smoking status, or diabetes. HOV, homogeneity of variance.

TABLE 3
Demographic Data of the Noninfected and Infected Patients in the Cohort^a

	Noninfected	Infected	HOV Probability
No. of patients	1536	20	
Age, y, mean (range)	59 (15-89)	52 (31-69)	.01
Sex, n			.071
Male	841	15	
Female	695	5	
Smoker, n	448	7	.468
Diabetic, n	394	5	.950
Size of tear, n			
Small	223	5	.024
Medium	580	3	.083
Large	531	4	.045
Massive	196	8	.004

^aThere was a significant difference in age and cuff tear size between the groups, but no difference in sex, diabetes, or smoking status. HOV, homogeneity of variance.

had an OR of 5.645 (95% CI, 1.9-17.0) of developing a post-operative infection compared with the arthroscopic group. The subgroup analysis demonstrated a statistically significant difference between the arthroscopic and mini-open groups ($P = .001$) (Figure 2). The pairwise comparison between the arthroscopic and open and mini-open and open groups could not be run due to the small sample size of the open subgroup. A multiple regressions model was run to predict the presence of infection from age, sex, smoking, diabetes, surgical time, number of anchors, size of rotator cuff tear, and surgical technique. These variables statistically predicted the presence of infection—

TABLE 4
Surgical Data Between the Arthroscopic and Open Groups^a

	Arthroscopic Group	Open Group	HOV Probability
No. of patients	903	653	
Surgical time, min, mean (range)	95 (15-223)	64 (18-213)	<.01
Anchors, n, mean (range)	3.4 (0-8)	1.6 (0-6)	<.01
Surgical technique, n			
Side-to-side repair	81	136	<.01
Single row	148	462	<.01
Double row	670	42	<.01

^aThere was a significant difference in surgical time, number of anchors used, and surgical technique utilized between the 2 groups. HOV, homogeneity of variance.

TABLE 5
Surgical Data for the Noninfected and Infected Patients Within the Cohort^a

	Noninfected	Infected	HOV Probability
No. of patients	1536	20	
Surgical time, min, mean (range)	82 (15-373)	75 (19-176)	.422
Anchors, n, mean (range)	3 (0-8)	3 (1-5)	.853
Surgical technique, n			
Side-to-side repair	217	0	.1597
Single row	596	14	.1218
Double row	706	6	.4044

^aThere was no significant difference in fixation technique, surgical time, or number of anchors used. HOV, homogeneity of variance.

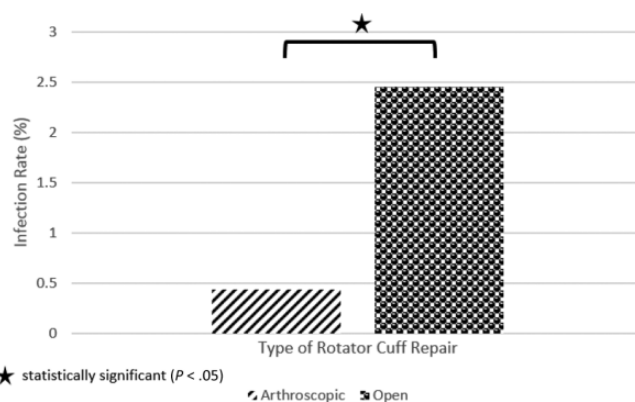


Figure 1. Infection rates after rotator cuff repair: There was a statistically significant difference in infection rates between the arthroscopic and open groups.

$F(8, 1293) = 4.833, P < .005, R^2 = 0.029$ —with age and surgical technique being the only variables to add statistical significance to the prediction ($P < .05$).

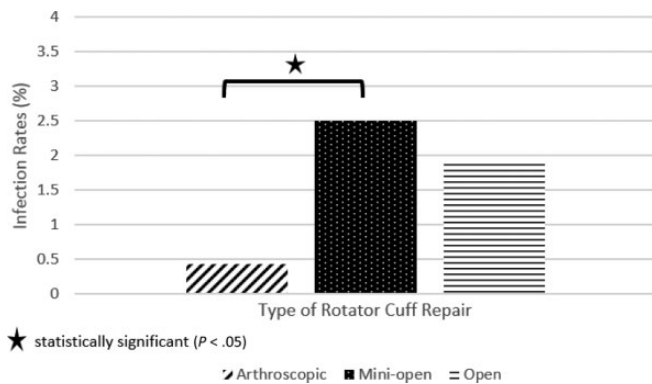


Figure 2. Subgroup analysis of infection rates after rotator cuff repair: There was a statistically significant difference in infection rates between the arthroscopic and mini-open groups as well as the arthroscopic and open groups. There was no statistical difference between the mini-open and open groups ($P = .97$).

DISCUSSION

This study directly compared the rates of postoperative infection between arthroscopic and open repair of the rotator cuff. There was a significantly lower rate of infection in the patients who underwent arthroscopic repair. The rate of postoperative infections was 0.44% and 2.45% for arthroscopic and open rotator cuff repairs, respectively. The majority of infections (13 of 20) were either *S aureus* or *P acnes*. The open group was 5.6 times more likely to develop a postoperative infection than the arthroscopic group.

Open repair is a familiar procedure to most orthopaedic surgeons. It has a lower learning curve than arthroscopic repair, allows a faster setup, and requires less time in the operating room. In addition, open repair allows for easier transosseous fixation, which replicates the supraspinatus tendon footprint more effectively, theoretically provides better healing potential, and facilitates placement of a modified Mason-Allen stitch, which provides a stronger method to grasp the tendon than a simple stitch.^{1,6}

On the other hand, the arthroscopic technique allows for a smaller incision, minimizes the risk of deltoid detachment, improves the ability to treat intra-articular lesions, and causes less postoperative pain.^{3,11,16} Despite the benefits of a completely arthroscopic procedure, it should be noted that it is technically demanding, has a steep learning curve, and requires a large-volume practice to obtain proficiency.^{6,12} Fortunately, the proficiency of the surgeon has been shown to improve quickly, as noted by one study that reported the arthroscopic surgical time to be significantly longer (96.5 minutes) in the surgeon's first 10 arthroscopic procedures than in the second 10 (48.4 minutes).⁷ Given the numerous advantages and disadvantages of open versus arthroscopic repair, it is easy to appreciate the dilemma faced by general orthopaedists weighing whether to abandon their familiar open techniques and learn a more time-consuming and difficult arthroscopic procedure. However,

given the significantly higher rate of infections with open repairs presented in this study, treating surgeons may elect for an all-arthroscopic approach.

Postoperative surgical site infection leads to multiple secondary surgeries, inpatient status, administration of long-term intravenous antibiotics, and potentially more pain and morbidity for the patient. The literature supports a postoperative infection rate of 0.27% to 1.9% after open or mini-open rotator cuff repair and a postoperative infection rate of 0.0016% to 0.23% after arthroscopic repair, based on comparisons made among multiple surgeons at multiple institutions. McFarland et al¹⁰ conducted a review of arthroscopic rotator cuff repairs in 1997, noting a postoperative infection rate of 0.04% to 0.23%. Randelli et al¹⁵ analyzed over 9000 shoulder arthroscopies performed from 2005 to 2006 at various facilities. Their data showed an overall rate of infection of 0.0016%. A case series of 360 patients who received mini-open rotator cuff repairs between 1991 and 2000 had a reported infection rate of 1.9%.¹³ The mini-open infection rate is similar to the reported infection rates after open repair, reported to range from 0.27% to 1.9% in a 2007 study.²

The data in this study concur with the literature, although our infection rate was higher than reported. This may be due to the strict exclusion criteria or presence of multiple comorbidities of the patients, many of which were not explored for this study. Many patients with rotator cuff repairs during this time had concomitant surgeries, such as open fracture fixation, that excluded them from this study. However, none of the excluded patients had subsequent infections on initial evaluation. This, in essence, may increase the percentage of infections encountered in this study. Additionally, at our institution we are fairly aggressive with subsequent debridement if infection is suspected. Five of the 20 patients had culture-negative infections, which may indicate presence of postoperative hematomas versus actual infection. As well, our institution is a tertiary referral center, and many of our patients have multiple comorbidities or rotator cuff tears on which other institutions would not operate, although this was not thoroughly explored in our study. Last, because of an upgrade in the electronic medical records, some patients with a rotator cuff repair during this time frame may not have been identified.

The large sample size and limited number of surgeons at a single institution help control for variation in care and documentation, allowing more confident clinical application of these numbers.^{9,10,15} In a multicenter study, variance in scrub techniques, operative protocol for staff handoffs, wound closure/care techniques, operative ventilation design, and so forth, are difficult to control. While it is impossible to account for every variable, this study attempts to minimize these variabilities, as all the data came from 3 fellowship-trained sports surgeons operating at a single facility with the same support staff under the same operating room protocol.

Despite attempts to provide data from a large sample with reduced variability in care, several weaknesses of this study warrant mentioning. While integrated medical records were utilized to confirm that the patient samples

and groupings were appropriate, this study was retrospective, and potential still exists for missed infections in all patient groups, especially with the updated electronic medical record system. There was also a significant difference in size of rotator cuff tears between the study groups, with the arthroscopic group having overall larger tears than the open group. Additionally, there was a large variation in number of patients between the mini-open and open groups, so a statistically significant comparison could not be performed between the 2 groups in the subgroup analysis. However, the primary purpose of this study was to compare open with arthroscopic procedures, thereby combining mini-open and open surgeries.

CONCLUSION

The purpose of this study was to compare postoperative infection rates between arthroscopic and open rotator cuff repairs at a single institution, under the care of 3 surgeons over a 7.5-year period, in an effort to provide conclusive evidence for clinical decision making. The study data indicated postoperative infection rates after arthroscopic and open rotator cuff repairs to be 0.44% and 2.45%, respectively. The open group was 5.6 times more likely to develop a postoperative infection than the arthroscopic group. These numbers are consistent with reported infection rates in the current literature, and our statistical analysis has found this difference to be significant. Because of the large sample size and consistency in terms of facility, staff, and integrated protocols, this study facilitates confident clinical judgment and confirms substantial evidence in the current body of knowledge related to the open versus arthroscopic debate. By reducing variability, these results strongly suggest that arthroscopic rotator cuff repair is associated with significantly fewer postoperative infections when compared with mini-open or open repairs.

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