

Duration of Surgery and Learning Curve Affect Rotator Cuff Repair Retear Rates

A Post Hoc Analysis of 1600 Cases

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Background: Arthroscopic rotator cuff repair can be quite complex and time consuming, particularly early in the surgeon's learning curve.

Hypothesis: Patients who have undergone rotator cuff repair with shorter operative times will be less likely to have a rotator cuff re-tear at 6 months postoperatively.

Study Design: Case-control study; Level of evidence, 3.

Methods: This study was an analysis of data from 1600 consecutive patients (670 partial-thickness and 930 full-thickness tears) who had rotator cuff repair performed by a single surgeon utilizing an arthroscopic, single-row, knotless inverted mattress suture anchor technique. All patients underwent ultrasound at 6 months postoperatively to determine repair integrity. Moving average analysis was performed for the variables of operative time and case number to evaluate the surgeon's learning curve.

Results: For early cases, the mean operative time was approximately 35 minutes. After approximately 450 cases, the operative time plateaued at approximately 20 minutes. The mean operative time for the cohort (\pm SEM) was 22 ± 0.3 minutes, and the mean re-tear rate was 13%. Increased operative time was associated with a re-tear ($r = 0.18$; $P < .001$). Multiple logistic regression analysis revealed that the variables with the most independent effect on retears were larger tear size (Wald statistic = 36; $P < .001$), lower case number (ie, less surgeon experience) (Wald statistic = 28; $P < .001$), older patient age (Wald statistic = 23; $P < .001$), full-thickness tears (Wald statistic = 13; $P < .001$), and lower surgeon-rated repair quality (Wald statistic = 8; $P = .004$). Operative time was not a significant independent factor contributing to retears.

Conclusion: Operative time and rotator cuff re-tear rates decreased as surgical team experience increased. The hypothesis of this study, however, was not supported. The reduced re-tear rate was not related to a reduction in operative time per se but rather to improved surgical team experience and patient factors, such as improved healing with smaller tears in younger patients.

Keywords: shoulder; rotator cuff; imaging; diagnostic ultrasound; general sports trauma

Rotator cuff tears are a common cause of shoulder pain and dysfunction.^{9,13,26,28,48} The prevalence of rotator cuff tears is between 20% and 30% in the general population but increases to 56% among people older than 75 years.^{10,53} Rotator cuff repair is a common surgical procedure. In the United States, 75,000 rotator cuff repair procedures are performed annually.⁴⁶ A re-tear is the most common complication after rotator cuff repair, with reported re-tear rates ranging between 15% and 90%.^{9,26}

Several risk factors for a rotator cuff re-tear after rotator cuff repair have been identified. Advanced patient age at surgery has been identified as a risk factor for retears in a

number of studies.^{26,36,37,52} Some studies^{8,38} have found advanced patient age to be associated with rotator cuff retears on univariate analysis, but it has not been a significant contributing factor on multivariate analysis. Other studies^{14,19} have not found increased patient age to contribute to retears; however, these studies were limited by their small sample size. The initial size of the rotator cuff tear is also an important prognostic factor, with a number of studies^{1,8,26,36,37,52} indicating that larger tears are associated with a higher re-tear rate after surgery compared to smaller tears.

The degree of fatty infiltration and tissue quality have also been implicated as risk factors for rotator cuff retears and inferior outcomes after surgery. A significant association exists between retears and the degree of preoperative fatty infiltration, with there being an increased chance of retears if the degree of preoperative fatty infiltration

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exceeds grade I on the Goutallier scale.^{17,18} Furthermore, fatty infiltration was identified as the most significant independent predictor of retears in 1 study.³⁷ Poor tissue quality has also been associated with an increased risk of tendon defects after surgery.³⁶

Of all upper extremity ambulatory surgical procedures performed in the United States, rotator cuff repair has the highest median operative time of 73 minutes.²² A number of studies[‡] have investigated the association between operative time and infections in total joint arthroplasty. Increased operative time has been associated with higher infection, transfusion, and thrombosis rates in total hip, knee, and shoulder arthroplasty. However, few studies have examined the relationship between operative time and retears after rotator cuff repair. In a previous study,⁴⁸ our group compared operative times and outcomes for 4 types of rotator cuff repair. Open rotator cuff repair was compared to 3 arthroscopic rotator cuff repair methods: repair with Mitek knotted anchors, bursal-sided repair with Opus Magnum knotless anchors (ArthroCare), and undersurface repair with Opus Magnum knotless anchors. Open repair had a mean operative time of 58 minutes and a re-tear rate of 51%, repair with knotted anchors had a mean operative time of 53 minutes and a re-tear rate of 27%, knotless bursal-sided repair had a mean operative time of 38 minutes and a re-tear rate of 27%, and knotless undersurface repair had a mean operative time of 22 minutes and a re-tear rate of 20%. However, no further analysis was performed to examine the relationship between operative time and retears.

In another study,²⁶ we examined factors that were predictive of a rotator cuff re-tear and found that increased operative time had a weak positive correlation with an increased re-tear rate ($r = 0.18$). The mean operative time for patients who had an intact repair site was 22 minutes, whereas it was 28 minutes for patients with retears. Results of multiple logistic regression analysis showed that operative time was a significant independent predictor of rotator cuff retears.

The aim of this study was to examine the relationship between operative time and rotator cuff retears at 6 months postoperatively in a large cohort of patients who underwent rotator cuff repair with an arthroscopic, knotless inverted mattress technique. The hypothesis of the study was that patients with shorter operative times would be less likely to have a rotator cuff re-tear at 6 months postoperatively than patients who had longer surgical procedures.

METHODS

This study was a retrospective cohort study that analyzed prospectively collected data from consecutive patients to investigate the association between operative time and the postoperative re-tear rate. All included patients had undergone primary arthroscopic rotator cuff repair by a single surgeon (G.A.C.M.) using a single-row, knotless suture anchor inverted mattress technique between February 2004 and December 2014, and all had undergone ultrasound at 6 months postoperatively to determine repair integrity. Ethics approval for this study was granted by the South Eastern Sydney Local Health District Human Research Ethics Committee (HREC 11/STG/37). Patients were excluded if they underwent revision repair, if the repair was incomplete, if the tear was irreparable, or if a synthetic polytetrafluoroethylene patch was used in the repair procedure. Patients were also excluded if they underwent concurrent procedures, including stabilization, capsular release, and fracture reduction, at the time of rotator cuff repair. Patients who underwent concurrent acromioplasty were included.

Surgical Technique

All rotator cuff repair procedures were performed arthroscopically with the patient placed in the beach-chair position. All patients received anesthesia in the form of an interscalene block. Initial shoulder arthroscopic surgery was performed via a posterior portal to confirm the presence of a rotator cuff tear and to identify other shoulder abnormalities, including labral tears and capsular injuries. After arthroscopic surgery, a lateral portal was created. The edge of the tendon and the footprint were debrided using either a 4.0 mm- or 5.5 mm-diameter arthroscopic shaver. The tendon was initially approached via the glenohumeral joint for undersurface repair to be carried out.⁵¹ Detailed outcomes of this approach alone are presented elsewhere.¹² In cases where undersurface repair was unable to be completed, the tendon was approached from the side of the subacromial bursa, and a bursal-sided repair technique was utilized.³¹ Before repair, partial-thickness tears were converted to full-thickness tears. For all cases, the tendon was secured to the greater tuberosity using a knotless, inverted mattress fixation technique. Sutures were passed via the lateral portal through the edge of the detached tendon using an Opus Smartstitch device (ArthroCare). A T-handled punch was used to create a hole on the greater tuberosity. The suture ends were passed through an Opus Magnum 2 suture anchor (ArthroCare). The anchors were placed into the holes in the greater

[‡]References 2, 3, 15, 21, 34, 35, 40, 41, 50.

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Ethical approval was obtained from the South Eastern Sydney Local Health District Human Research Ethics Committee—Southern Sector (No. HREC/11/STG/37).

tuberosity, and the sutures were tightened to reattach the tendon to the landing site. The operative time was measured and recorded for all cases, defined as the time from the first skin incision and visualization of the glenohumeral joint to the initiation of wound closure.

Postoperative Rehabilitation and Assessment

Postoperatively, all patients were instructed to wear a sling with a small abduction pillow (UltraSling; DJO) for the first 6 weeks. They were provided with a rehabilitation protocol to follow for the first 6 months. In the first 6 weeks, rehabilitation consisted of gentle, passive range of motion exercises. At 6 weeks postoperatively, patients were reviewed by a physical therapist and then commenced isometric strengthening exercises. They were again reviewed by the physical therapist at 3 months postoperatively and then prescribed a program of active resistance exercises. Restrictions were placed on overhead activities. In the first 3 months, overhead activities were not permitted, with the exception of the prescribed exercises. At 3 months postoperatively, patients were permitted to perform limited overhead activities of less than 15 minutes' duration. Patients were also subject to lifting restrictions, with no lifting permitted during the initial 6 weeks postoperatively. Between 6 weeks and 3 months, patients were permitted to lift up to 1 kg to chest height. After 3 months, patients were permitted to lift between 2 and 5 kg, subject to individual progress.

At 6 months postoperatively, all patients returned for an assessment. This included completion of the modified L'Insalata questionnaire,²⁷ a physical examination,⁴⁵ and ultrasound. Ultrasound to evaluate repair integrity was performed by a single experienced musculoskeletal sonographer. Ultrasound was performed with a Logiq 9 or Logiq E9 machine (at case 600) (General Electric) with a high-frequency (12 MHz) linear transducer. Ultrasound was performed per a technique that has previously been described.⁵ The sonographer was not blinded. Her diagnostic accuracy was 99% sensitive and 93% specific.²⁴

Statistical Analysis

Continuous data are reported as mean \pm SEM. Correlation analysis (Spearman rank order) was performed between the variables of operative time and retears at 6 months using SPSS (IBM), a distribution-free analytical method. The accepted level of statistical significance was set at $P < .05$.

Moving averages were plotted for operative time and re-tear rate. The dataset was ordered by operative time in ascending order. The average re-tear rate for the 160 patients (10% of the cohort) with the shortest operative times was calculated and plotted. Then, the average re-tear rate for patients 2 to 161 in the dataset ordered by operative time was recalculated to form the second point. This continued by moving along one patient and recalculating the new average until the end of the dataset had been reached. Moving averages were also calculated for the operative time by case number to construct the surgeon's learning curve as well as for the re-tear rate by case number.

Multiple logistic regression was performed using Sigma-Plot software (Systat Software). The dependent variable was the presence or absence of a rotator cuff re-tear at 6 months postoperatively. Independent variables included patient age; patient sex; tear thickness; tear size; case number; operative time; concurrent acromioplasty; workers' compensation status; number of anchors; surgeon-rated tissue quality, tendon mobility, and repair quality; and type of surgical repair (bursal sided, undersurface, or both). The strength of the effects of an independent variable on the dependent variable (repair integrity) was reflected in the Wald statistic generated by multiple logistic regression analysis.

RESULTS

During the study period between February 2004 and December 2014, there were 2260 patients who underwent rotator cuff repair. Patients who underwent the following concurrent procedures were excluded because the additional surgical procedures would have increased the operative time: 32 patients with concurrent stabilization, 29 with concurrent capsular release, 7 who underwent concurrent calcific debridement, 3 with concurrent distal clavicle excision, and 4 who were treated for avulsion fractures. A further 186 patients whose primary surgery was revision rotator cuff repair were excluded, leaving 1999 patients. Of these, 398 patients who did not undergo ultrasound at 6 months postoperatively and 1 patient without operative time recorded (missing data) were excluded. Some of the patients in this study have been included in previous studies.^{11,25,41,46,50}

Ultimately, 1600 patients were included in this study. The overall re-tear rate was 13% (211/1600) at 6 months postoperatively. A total of 277 patients (17%) underwent concurrent acromioplasty: 233 of 1389 (17%) in the intact group and 44 of 211 (21%) in the re-tear group ($P = .144$, Fisher exact test).

The mean (\pm SEM) patient age of the cohort was 59 ± 0.3 years, ranging between 15 and 91 years. There were 885 male and 715 female patients. In addition, there were 930 patients with full-thickness tears and 670 patients with partial-thickness tears. Of the patients with full-thickness tears, 33 had a tear with a size of $<1 \text{ cm}^2$, and 577 had a tear between 1 and 4 cm^2 . The remaining 320 patients had a large tear of $>4 \text{ cm}^2$. The mean overall tear size was $3.5 \pm 1.3 \text{ cm}^2$. On average, 2 anchors were used per surgery. The mean operative time was 22 ± 0.3 minutes (range, 4-110 minutes). Table 1 shows the characteristics for the intact and re-tear groups.

Among those with a partial-thickness tear, 29 of 670 patients had a re-tear at 6 months postoperatively, with a re-tear rate of 4%. For those with full-thickness tears $<1 \text{ cm}^2$, the re-tear rate at 6 months postoperatively was 3% (1/33). For patients with full-thickness tears between 1 and 4 cm^2 , the re-tear rate was 13% (73/577). Patients with full-thickness tears $>4 \text{ cm}^2$ had a re-tear rate of 34% (108/320) (Figure 1).

TABLE 1
Patient Characteristics^a

	Intact (n = 1389)	Retear (n = 211)	P
Age, y	58 ± 0.3 (18-91)	65 ± 0.8 (15-88)	<.0001
Sex, male:female, n	750:639	135:76	.0074
Tear thickness, partial:full, n	641:748	29:182	<.0001
Tear size, cm ²	2.9 ± 1.0 (0.4-5.6)	7.5 ± 5.7 (2.5-6.4)	<.0001
Operative time, min	21 ± 0.3 (4-110)	28 ± 0.4 (5-106)	<.0001
No. of anchors, mean (range)	2.0 (0-6)	2.7 (1-6)	<.0001

^aData are reported as mean ± SEM (range) unless otherwise indicated.

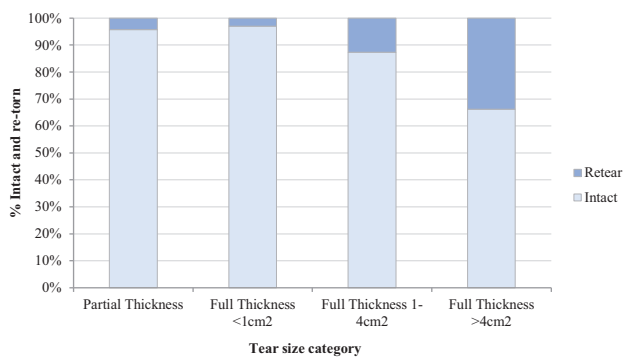


Figure 1. Percentage of patients with intact and return rotator cuffs at 6 months postoperatively for each of the tear size categories.

The mean operative time varied between the 4 tear size groups. It was shortest in the partial-thickness tear group, with a mean of 19 ± 0.5 minutes (range, 4-110 minutes), followed by the small full-thickness tear group (21 ± 2.6 minutes [range, 5-55 minutes]) and the medium full-thickness tear group (22 ± 0.5 minutes [range, 4-97 minutes]). The mean operative time was greatest in the large full-thickness tear group with 28 ± 0.8 minutes (range, 4.5-106 minutes) (Figure 2).

Operative Time and Retears

There was a correlation between operative time and retears. Spearman correlation analysis between operative time and retears indicated a weak positive correlation ($r = 0.18$; $P < .001$), implying that patients with a shorter operative time were less likely to re-tear at 6 months compared to patients with longer operative times. The cohort was then divided into 4 groups based on tear size: partial-thickness tears, small full-thickness tears (<1 cm²), medium full-thickness tears (1-4 cm²), and large full-thickness tears (>4 cm²), and correlation analysis between operative time and retears was performed for each of the 4 groups. There were weak positive correlations between increased operative time and an increased re-tear rate for

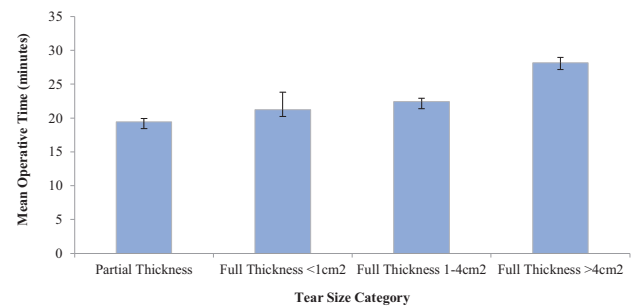


Figure 2. Mean operative time for each of the tear size categories. Error bars indicate SEMs.

the partial-thickness tear group ($r = 0.12$; $P = .002$) and the large full-thickness tear group ($r = 0.13$; $P = .018$). However, these relationships were not evident in the small and medium full-thickness tear groups.

Moving average analysis was performed to investigate the relationship between operative time and re-tear rate. The dataset was ordered by operative time in ascending order. The increment for the moving average was set at 160 patients, which corresponds to 10% of the cohort. The first point on the graph corresponded to the average re-tear rate for the 160 patients with the shortest operative time. This was repeated for patients 2 to 161, then patients 3 to 162, and so on, as ordered by increasing operative time until the end of the dataset was reached. The overall trend showed a higher re-tear rate for patients with longer operative times (Figure 3).

Surgeon Experience and Operative Time

To determine the effect of surgeon experience on operative time, moving average analysis was performed for the variables of case number and operative time. Patients were ordered chronologically by surgery date, with the first patient designated as case number 1 and the final patient in the cohort designated as case number 1600. The surgeon started collecting his data 9 years into practice and not long after starting arthroscopic rotator cuff repair. With increasing surgeon experience, as measured by the case number, the mean operative time decreased over time, plateauing at a mean of approximately 20 minutes after 450 cases (Figure 4).

Forward Stepwise Regression and Multiple Logistic Regression

Forward stepwise regression analysis was performed to identify factors that had an independent effect on the re-tear rate. The dependent variable was retears, and the independent variables were operative time, case number, patient age, tear thickness, tear size, surgeon-rated tissue quality, patient sex, workers' compensation status, number of anchors, surgeon-rated repair quality, surgeon-rated tendon mobility, and whether the tendon was repaired using a bursal-sided approach or an undersurface approach. The nonsignificant variables are listed in Table 2. The significant

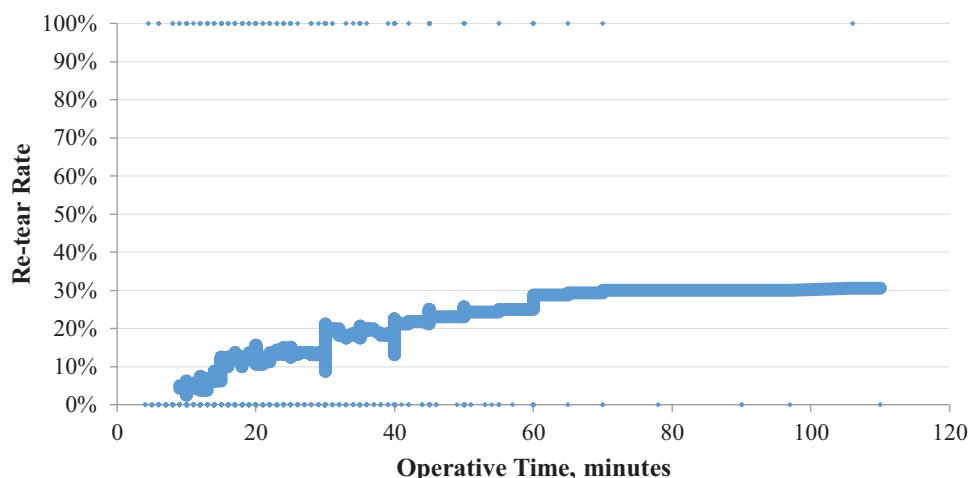


Figure 3. Moving average graph for operative time and rotator cuff retears (%), with an increment of 160 patients in a total of 1600 patients.

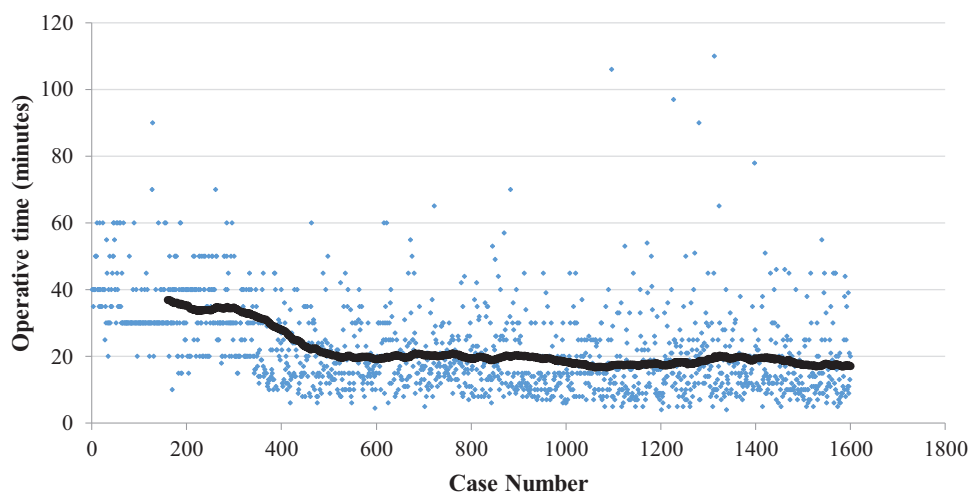


Figure 4. Moving average analysis for operative time and case number, with an increment of 160 patients in a total of 1600 patients.

independent variables that influenced the retear rate were patient age, tear size, repair quality, case number (all $P < .001$), and tear thickness ($P = .017$); that is, a retear at 6 months was more likely in older patients with large full-thickness tears repaired earlier in the surgical team’s learning curve and when tendon quality was assessed as “poor.”

Multiple logistic regression analysis was then performed to determine the Wald statistic for each of the significant factors. The dependent variable was retear rate. The independent variables were tear size (Wald statistic = 36; $P < .001$), case number (Wald statistic = 28; $P < .001$), patient age (Wald statistic = 23; $P < .001$), tear thickness (Wald statistic = 13; $P < .001$), and surgeon-rated repair quality (Wald statistic = 8; $P = .004$) (Table 3). Hence, the likelihood of retears was increased for patients who had larger tears, underwent surgery earlier in the surgeon’s learning curve, were older at the time of surgery, had full-thickness tears as opposed to partial-thickness tears, and had lower surgeon-rated repair quality.

TABLE 2
Factors With No Significant Independent Effect on Retears on Multiple Logistic Regression Analysis

	Wald Statistic	<i>P</i>
Operative time	1.30	.25
Tissue quality (surgeon ranked)	0.32	.57
Patient sex	2.62	.11
Workers’ compensation status	0.72	.40
No. of anchors	0.05	.82
Tendon mobility (surgeon ranked)	2.39	.12
Repair type (undersurface vs bursal sided)	1.63	.20

Case Number and Retears

In light of the results from multiple logistic regression, moving average analysis was performed between retears

and case number. As with the other analyses, the increment was set at 160 patients per moving average. The overall trend demonstrated an improvement in the retear rate with increasing surgeon experience (Figure 5).

Factors Predicting Operative Time

Forward stepwise regression was performed to determine the variables that were predictive of operative time. The variables entered into stepwise regression analysis were patient sex, workers' compensation status, tear thickness, tear size, number of anchors, tissue quality, tendon mobility, repair quality, whether the repair type was undersurface or bursal sided, and case number. The factors that were associated with longer operative times in this analysis were larger tear size, more anchors used, lower surgeon-rated repair quality, bursal-sided as opposed to undersurface repair, and surgeon inexperience as measured by the case number, with $P < .001$ for all significant variables (Table 4).

DISCUSSION

The principal aim of this study was to evaluate the effect of operative time on rotator cuff retears at 6 months postoperatively in a cohort of 1600 consecutive patients. The study

hypothesis was that patients with shorter operative times would be less likely to retear at 6 months postoperatively. This hypothesis was not supported. Although a weak positive, statistically significant correlation was observed between the variables of operative time and retears, particularly for partial-thickness tears and large full-thickness tears, multiple logistic regression showed that operative time was not a significant independent factor contributing to rotator cuff retears. The significant independent factors that were identified on multivariate analysis as being predictive of a rotator cuff retear were larger preoperative tear size, older patient age, lower case number, full-thickness tears, and lower surgeon-ranked repair quality.

The overall retear rate for the cohort was 13% (211/1600). Compared to other reported retear rates, this was a favorable result.^{4,8,9,16,26,32,39,43} The retear rate improved with increasing surgeon experience, with the most recent retear rate being 5%. There was a spike in the retear rate at approximately the 600-case mark; this corresponded to the purchase of a new ultrasound machine. This spike in the retear rate was likely caused by the sonographer overcalling retears.

The baseline characteristics were different for patients with an intact repair site at 6 months compared to those with a retear. Patients who reteared were older, were more likely to have a full-thickness tear (rather than a partial-thickness tear) at index surgery, had larger preoperative tear sizes with more anchors used in the repair procedure, and had longer operative times. There was a higher percentage of male patients (64%) in the retear group compared to the intact group (54%).

Although overall a statistically significant, univariate positive correlation between operative time and retears was observed in this study, logistic regression analysis did not find operative time to have an independent effect on the retear rate. The relationship between operative time and rotator cuff retears has not been widely studied. In a previous study,⁴⁸ we examined the effect of operative time on the outcomes of rotator cuff repair for 4 different operative

TABLE 3
Independent Predictors of a Retear
on Multiple Logistic Regression Analysis

	Wald Statistic	P
Tear size	36	<.001
Case number	28	<.001
Patient age	23	<.001
Tear thickness	13	<.001
Repair quality (surgeon ranked)	8	.004

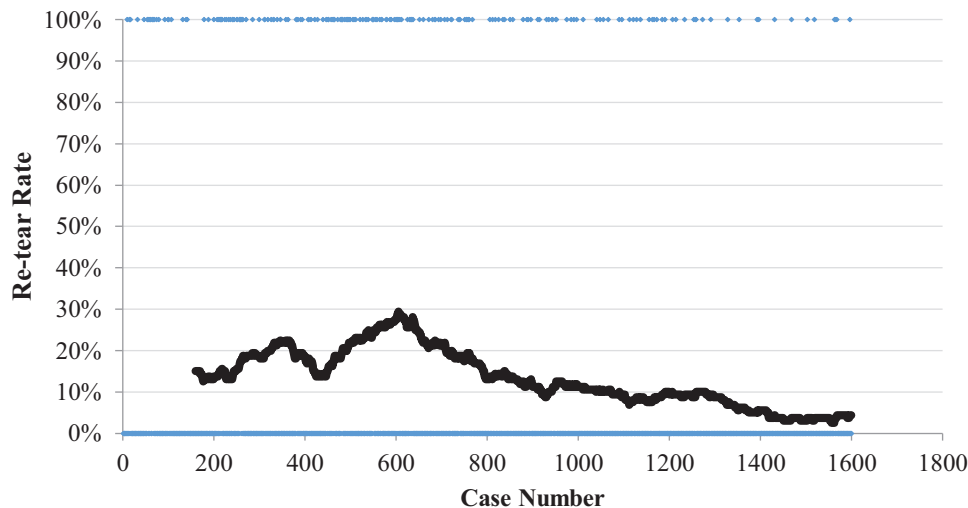


Figure 5. Moving average for case number and retears, with an increment of 160 patients in a total of 1600 patients.

TABLE 4
Factors Predictive of Operative Time
on Multiple Linear Regression Analysis

	<i>t</i> Value	Direction	<i>P</i>
Case number	12	Negative	<.001
Undersurface repair	10	Negative	<.001
No. of anchors	5	Positive	<.001
Repair quality (surgeon ranked)	5	Negative	<.001
Tear size	3	Positive	<.001

techniques and found that the undersurface repair technique had the shortest operative time (22 minutes) and the lowest retear rate (20%) and that open repair had the highest operative time (58 minutes) and the highest retear rate (51%). A shorter operative time was also associated with increased supraspinatus and external rotation strength at 6 months postoperatively. Our group previously investigated factors that were predictive of a rotator cuff retear in a cohort of 1000 patients.¹² We found that operative time was a significant independent predictor of rotator cuff retears at 6 months postoperatively. Other factors that were identified to be significant independent predictors of a retear were anteroposterior tear length, mediolateral tear length, tear thickness, and patient age at surgery.

The mean operative time for arthroscopic rotator cuff repair decreased over the study period with increasing surgeon experience. The mean operative time for the earliest cases in this series was close to 35 minutes. After approximately 450 cases, the mean operative time decreased to approximately 20 minutes. Few studies have evaluated the learning curve for arthroscopic rotator cuff repair. Guttman et al²⁰ evaluated 1 surgeon's first 100 arthroscopic rotator cuff repair cases and measured the learning curve by observing the change in operative time. They found that the most rapid decrease in operative time occurred over the first 10 cases, with a gradual decline between cases 10 and 100. However, their study did not evaluate functional or clinical outcomes with increasing surgeon experience. The results of our study demonstrated that the rotator cuff retear rate decreased with increasing surgeon experience, and this is, to the best of our knowledge, the first study to demonstrate an improvement in rotator cuff retear rates with increasing surgeon experience.

Older patient age was a factor identified on multiple logistic regression analysis as a significant independent predictor of rotator cuff retears. The mean age of patients who retear their rotator cuff was 65 years compared to 58 years for the patients with an intact repair site. This is consistent with the findings of several other studies^{6,8,25,36,44} that have observed a higher retear rate among older patients. In a previous study,¹¹ we used ultrasound to evaluate rotator cuff integrity at 1 year after arthroscopic rotator cuff repair in patients aged ≥ 70 years. The overall retear rate was 32%, with further analysis showing that older patients in the cohort were more likely to retear than younger patients. Charoussat et al⁶ assessed retear rates at 6 months postoperatively using computed tomography arthrography in

patients older than 65 years and found an overall retear rate of 42%. Chung et al⁸ assessed factors affecting rotator cuff healing and found age to be a significant contributor to retears on univariate analysis but not on multivariate analysis. Nho et al³⁶ found that age was a significant independent factor affecting retears in their study (odds ratio, 1.08).

In this study, the retear rate for large full-thickness tears was 34% (108/320) compared to 3% for small full-thickness tears (1/33). On multiple logistic regression analysis, the size of the rotator cuff tear was the factor that was most predictive of retears. Lambers Heerspink et al²⁵ reviewed 3 medium-quality studies that showed that larger tears were more likely to retear than smaller tears. A study by Miller et al³² assessed the integrity of rotator cuff repair of large and massive tears by serial ultrasound, and by 6 months, 41% of the cohort had return. Nho et al³⁶ found the size of the tear to be an important factor predicting retears on multivariate analysis. Large to massive tears generally have greater degrees of tendon retraction and fatty infiltration than smaller tears, which are not good prognostic factors for rotator cuff healing.⁷ Histologically, large rotator cuff tears have less fibroblast cellularity, blood vessel proliferation, and inflammation,²⁹ which may help to explain why larger tears are more likely to retear.

In the present study, partial-thickness tears were less likely to retear compared to full-thickness tears, particularly larger tears. This finding is largely comparable to results obtained by other authors. Peters et al⁴² found lower retear rates for partial-thickness tears compared to full-thickness tears of 5% and 10%, respectively, at 6 months and 10% and 20%, respectively, at 2-year follow-up. The results of Chung et al,⁷ are in contrast with these findings. During surgery, partial-thickness tears were converted to full-thickness tears and repaired, and the authors found that retear rate was 35% for partial-thickness tears and 14% for small full-thickness tears. The partial-thickness tears had more severe tendinosis, which may explain the higher retear rate.

Surgeon-rated repair quality was also a significant independent predictor of retears in this study, albeit with a weaker association than other variables. Meyer et al³⁰ also found that the quality of surgical repair is a factor that may affect healing of the repaired rotator cuff tendon.

Operative time was affected by several different variables. Forward stepwise regression analysis found that faster operative times were associated with increased surgeon experience, the undersurface repair technique, fewer anchors, higher surgeon-ranked repair quality, and smaller tears. A handful of studies have also investigated factors that affect operative time. Williams et al⁴⁹ compared the operative times for open and arthroscopic rotator cuff repair and found that the mean operative time for arthroscopic repair was slower at 83 minutes compared to open repair, with a mean operative time of 62 minutes. However, we previously⁴⁷ found that arthroscopic rotator cuff repair was faster than open rotator cuff repair, with median operative times of 40 and 60 minutes, respectively. Other authors have reported the results of an anchorless transosseous suture repair technique, with a significant drawback of this procedure being a long operative time (range, 80–176 minutes).²³

Because there is a learning curve associated with performing the procedure, differing levels of surgeon experience with arthroscopic surgery may explain the variance between authors.²⁰ The surface from which the tendon was approached during repair was one of the factors that affected operative time. In a previous study,³³ we reported a mean operative time of 48 minutes for bursal-sided repair and 16 minutes for undersurface repair. The shorter operative time for undersurface repair may be because there is no need to dissect bursal tissue or perform acromioplasty. Performing acromioplasty may result in bleeding, which can impair tendon visualization.^{33,51}

There are several limitations to this study. First, all patients in this study were operated on by the same surgeon; therefore, the results of this study may not be applicable to other surgeons. There may be differences in operative time and surgeon experience at other institutions. Second, the follow-up period of 6 months was relatively short in comparison to other studies. However, there is evidence to suggest that there is no significant increase in the re-tear rate between 6 months and 2 years postoperatively.^{31,32} The retrospective design of this study is another limitation. Some factors that may have affected the re-tear rate, such as fatty infiltration, were unable to be assessed because this information had not been routinely collected. Another limitation of this study is that there were 2 ultrasound machines used during the course of the study. The introduction of the new ultrasound machine corresponded to a temporary increase in the re-tear rate at approximately the 600-case mark (Figure 5), likely to be attributed to the learning curve of using the new machine and the potentially increased sensitivity of the new machine to detect tears.

This study also has a number of strengths. This is the largest study to assess the effect of operative time on rotator cuff retears, with a sample size of 1600 consecutive patients. Furthermore, data were collected prospectively with a systematic and standardized method of data collection. All patients were operated on by the same surgeon, which increases the internal validity of this study.

CONCLUSION

This study demonstrates that surgical duration did not exert a significant independent effect on rotator cuff retears at 6 months postoperatively. Rather, larger tear sizes, relative inexperience of the surgeon and surgical team, increased patient age, full-thickness tears, and lower repair quality were all significant independent factors that were predictive of a re-tear. Operative time itself was also affected by several factors, with smaller tear sizes, fewer anchors, an undersurface repair technique, greater surgeon experience, and higher repair quality being factors that were predictive of shorter operative times. Logistic regression analysis showed that the reduced re-tear rate in this study was not due to shorter operative times per se but rather due to improved experience of the surgical team and patient factors, such as better healing with smaller tears in younger patients.

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