Trends Associated with Open Versus Arthroscopic Rotator Cuff Repair

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Abstract *Background:* Rotator cuff (RTC) repair is performed using open/mini-open or arthroscopic procedures, and the use of arthroscopic techniques is increasing. The extent to which surgery has transitioned from open to arthroscopic techniques has yet to be elucidated. *Questions/Purposes:* The purpose of this study was to evaluate trends in open and arthroscopic rotator cuff repair in the USA and describe tendencies in treatment across gender, age, and geographic region. We hypothesized that surgeons would be more likely to perform arthroscopic rotator cuff repair, with similar trends across the USA. *Methods:* A retrospective review of a comprehensive national insurance database (Humana) was performed using the PearlDiver software for all patients who underwent RTC repair between January 2007 and June 2015. Patients were identified by Current Procedural Terminology (CPT) codes. χ^2 tests evaluated the proportion of arthroscopic surgeries by gender and geographic region; logistic regression analysis assessed differences from 2007 to 2015. *Results:* In the study period, 54,740 patients underwent RTC repair (68% arthroscopic, 52% male), with the highest frequency of RTC repair in patients between 65 and 69 years old. The proportion of open RTC repair increased with increasing patient age, with no significant difference between men and women. The proportion of arthroscopic RTC surgeries increased from

56.9% in 2007 to 75.1% in 2015. The overall trend was 188% increase in total RTC repairs. Arthroscopic repair was more frequent than open repair in all US regions, with the highest proportion in the South. *Conclusion:* Arthroscopic RTC surgery predominates and continues to rise. With increasing patient age, there was an increase in the proportion of open repair. The majority of RTC repairs were performed in patients between 65 and 69 years of age.

KEYWORD rotator cuff tear · rotator cuff repair · shoulder · arthroscopic rotator cuff repair · open rotator cuff repair

Introduction

Rotator cuff pathology is a common cause of upper-extremity disability. The surgical repair of rotator cuff (RTC) tears is common and has progressed with the use of open, mini-open, and arthroscopic procedures [6]. Recent study has demonstrated similar clinical outcomes with both open and arthroscopic techniques [3, 4, 10, 11, 14, 22, 26]. Although traditionally open RTC repair was performed, surgical techniques have evolved over the last two decades, with arthroscopic techniques increasing in use [2, 16, 23]. Previous studies evaluating trends in RTC repair are outdated, susceptible to selection bias, and/or focus on a particular region or patient population [6, 8, 9, 25].

Studies are scarce on current practice patterns in the management of RTC tears. An evaluation of trends in RTC surgery is important in understanding the associated costs to both patients and insurance providers, especially in light of increasing emphasis on quality and cost considerations in value-based payment models. Prior data have been mixed regarding arthroscopic versus open RTC repairs [1, 15]. Therefore, the extent of the recent transition in current treatment preferences has yet to be elucidated. The purpose of this study was to evaluate trends in open and arthroscopic RTC repair in the USA and describe tendencies in treatment across gender, age, and geographic

Level of Evidence: Level III, retrospective comparative study

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region. We hypothesized that surgeons would be more likely to perform arthroscopic RTC repair, with similar trends across the USA.

Methods

A retrospective review of a comprehensive national insurance database (Humana) for all patients who underwent RTC repair between January 2007 and June 2015 was conducted using the commercially available PearlDiver software (Warsaw, IN, USA). In 9 years, from 2007 through the second quarter of 2015, there were 20 million patients covered by private, commercial payers and by Medicare and Medicaid Advantage plans through Humana. The study was deemed exempt from institutional review board approval at our institution.

A query of the Humana database was performed to identify patients who underwent RTC repair by Current Procedural Terminology (CPT) code: open acute repair (CPT 23410), open chronic repair (CPT 23412), and arthroscopic techniques for repair (CPT 29827). To ensure as much data accuracy as possible, we excluded CPT 23420, as this code is commonly used in conjunction with augmentation and tendon transfers and is not directly comparable to arthroscopically fixed RTC repairs. The database does not differentiate between open and mini-open RTC techniques. The open and arthroscopic RTC patients were stratified by year, age, gender, and US geographic region (Midwest, Northeast, West, South).

Statistical Analysis

χ^2 tests were used for dichotomous variables, to determine whether the proportion of arthroscopic surgeries differed between genders or regions. Logistic regression analysis was utilized to determine whether variables differed from 2007 to 2015. Statistical significance for all analyses was set at $p < 0.05$. All data analyses were performed using SAS software (Version 9.4; SAS Institute, Cary, NC, USA).

Results

In the 2007 to 2015 period, 54,740 RTC repairs were identified: 37,223 arthroscopic RTC repairs (68%) and 17,517 open RTC repairs (32%). Male patients accounted for 52% and female patients for 48% of the repairs. Analysis of RTC repair by age group revealed the highest percentage in patients between 65 and 69 years, followed closely by patients between 70 and 74 years (Fig. 1). The proportion of open RTC repair increased with increasing patient age ($p < 0.0001$) (Fig. 2). Over time the proportion of arthroscopic procedures increased from 56.9% in 2007 to 75.1% in 2015 (OR = 2.29, 95% CI = 2.09–2.50), with a corresponding decrease in open RTC repair from 43.1% in 2007 to 24.9% in 2015 (Fig. 3). There was a 188% increase in total RTC repairs from 2007 to 2015, with no significant difference between men and women in the proportion of arthroscopic or open surgeries ($p = 0.22$). Arthroscopic repair was found to be performed more frequently than open repair in all regions ($p < 0.0001$) and was higher in the South (70.9%)

Fig. 1. Frequency of rotator cuff repair by age group.

than other regions (Midwest [62.7%, $p < 0.0001$], Northeast [66.1%, $p = 0.0009$], West [65.5%, $p < 0.0001$]) (Fig. 4).

Fig. 2. Proportion of open versus arthroscopic rotator cuff repair by age group.

Fig. 3. Proportion of open versus arthroscopic rotator cuff repair by year, 2007–2015.

Discussion

Rotator cuff pathology is common, and the trends in RTC surgery have significant financial implications, but precise data are scarce on current practice patterns in the management of RTC injury. The purpose of this study was to evaluate trends in open and arthroscopic RTC repair in the USA and describe tendencies in treatment across gender, age, and geographic region. To our knowledge, this is one of the largest studies comparing trends associated with open versus arthroscopic RTC repair. Zhang et al. demonstrated that the percentage of arthroscopic cases increased from 48.8% in 2004 to 74.3% in 2009, but that study is now outdated [25].

Fig. 4. Proportion of open versus arthroscopic rotator cuff repair by United States geographic region.

Our study has several limitations. Large datasets lack detail, limiting the inferences that can be drawn. For instance, CPT codes are broad, and specifics on general-trained versus fellowship-trained orthopedists, RTC complexity factors including partial-thickness versus full-thickness tear, size of tear, type of repair performed, or duration of time since surgery were not provided in the dataset. Additionally, outcomes and complications were not recorded.

Our data demonstrate that the frequency of RTC repair is rising, with a 188% increase from 2007 to 2015. This is consistent with a previous study, which reported a 281% increase in RTC repairs from 1995 to 2009 [7]. The observed increase may be the result of improvements in diagnostic modalities, along with an increase in orthopedic surgeons qualified to manage these conditions [5]. Additionally, as the US population is aging and remaining more physically active, there is a higher demand from patients who meet criteria and could benefit from RTC repair [21].

With respect to age, previous studies have documented an increasing prevalence of RTC tears with increasing age [6, 18–20, 24, 25]. We found that the majority of repairs are performed on patients between ages 65 and 69 years, followed closely by those between 70 and 74 years. A recent study showed the highest incidence of RTC repair in the 50-to-59-year age group, followed by 60-to-69-year age group [25], although this study did not include Medicare data, likely resulting in a younger age of patients. When evaluating the proportion of arthroscopic versus open surgery across age groups, it was found that with increasing age, there was an increase in the proportion of open repair. Similarly, younger patients had a higher proportion of arthroscopic repair. The known correlation of increasing patient age and size of RTC tear may explain the trend; with increasing size of tear, there is a tendency to prefer an open approach [12, 17]. Male patients accounted for 52% of repairs and female patients for 48% of the cases, with no difference in regard to gender and open versus arthroscopic RTC repair.

Regarding open versus arthroscopic surgical techniques for RTC repair, analysis revealed that arthroscopic RTC surgery predominates (more than 75%). Based on our data, the majority of RTC repairs are now performed arthroscopically, with 68% arthroscopic and 32% open techniques. Our findings are consistent with previous studies confirming a shift from open to arthroscopic methods [6, 13, 25]. The trend of arthroscopic RTC repair increased from 56.9% in 2007 to 75.1% in 2015, with an overall increase of 18% over 8 years. In a recent study evaluating a state-wide surgical database, Iyengar et al. demonstrated a 335% increase in arthroscopic RTC repair and a concomitant significant decrease in open techniques and increases in associated procedures such as subacromial decompression, distal clavicle resection, and glenohumeral debridement [8]. Although evidence has not supported improved outcomes with arthroscopic techniques [3, 4, 10, 11, 14, 22, 26], over the study period the incidence of open RTC repair decreased from 43.1 to 24.9%. A dramatic improvement in surgical instrumentation and techniques that facilitate arthroscopic repair,

as well as increased popularity among newly trained orthopedic surgeons, could account for this observed trend.

Geographic analysis revealed that in all US regions arthroscopic repair was performed more frequently than open repair. The proportion of arthroscopic RTC repair was significantly higher in the South than in other regions. There was no significant difference in age or gender trends by geographic region, similar to a previous study's findings [6].

Our results highlight important trends in RTC surgery, with a shift in practice from open to arthroscopic techniques. Future studies could help elucidate the variables responsible and difference in utilization of surgical intervention to ensure that appropriate education and access to care are available to all patients.

Compliance with Ethical Standards

Conflict of Interest: Molly A. Day, MD, Robert W. Westermann, MD, Nicholas A. Bedard, MD, Natalie A. Glass, PhD, declare that they have no conflicts of interest. Brian R. Wolf, MD, MS, reports receiving personal fees from ConMed, Smith & Nephew, and Arthrex, as well as grants from the Orthopaedic Research and Education Foundation, outside the submitted article.

Human/Animal Rights: N/A

Informed Consent: N/A

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

IRB Approval: The study was deemed exempt from IRB approval at our institution.

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