Current Trends in Rotator Cuff Repair: Surgical Technique, Setting, and Cost


Purpose: The purpose of this study was to evaluate national trends in the surgical setting and hospital costs of shoulder arthroscopy and rotator cuff repair (RCR) using the Florida State surgical database and national inpatient database.

Methods: In part I we analyzed population-adjusted shifts in RCR technique (arthroscopic vs open) in the Florida surgical database from 2000-2007 and quantified the procedural codes associated with arthroscopic and open RCR. In part II we analyzed the Nationwide Inpatient Sample database from 2001-2009 for the total number of inpatient RCRs, the inpatient hospital type (rural, urban non-teaching, or urban teaching), and the cost.

Results: Part I showed a 163% increase in outpatient procedures in Florida, with a 353% increase in arthroscopic RCRs. There was a concurrent decrease in open RCRs; however, the overall trend was a 2-fold increase in total RCRs. Associated procedures such as subacromial decompression, distal clavicle resection, and extensive glenohumeral debridement increased by 440%, 589%, and 1,253%, respectively. Part II showed an overall 58.8% decrease in inpatient RCRs that was similar across all hospital settings, with an increase in RCR-associated hospital charges by 144.9%, whereas hospital costs only increased by 85.2%.

Conclusions: The study confirms a shift toward arthroscopic RCR and associated procedures in the outpatient setting. The increased financial cost partly explains the shift; nevertheless, future studies are needed to further examine national trends.

Clinical Relevance: This study examining RCR trends by hospital type, cost, and setting further elucidates how orthopaedic surgery practice is evolving with the implementation of arthroscopic RCR in the past decade.

Rotator cuff repair (RCR) has evolved considerably in the past decade, most notably with a shift away from open repair toward arthroscopic techniques. Concurrent with this trend toward minimally invasive approaches has been a swing toward performing RCR in the ambulatory surgical setting. The extent to which both of these trends have occurred is not known. Understanding these trends is important to determine policy regarding outpatient surgeries and reimbursements. Presently, both open RCR and arthroscopic RCR have similar clinical outcomes in the published literature, with decreased perioperative morbidity and patient preference cited as factors contributing to the shift toward arthroscopic techniques.1-4 However, surgeon preference has also been shown to be an important determinant in performing inpatient versus ambulatory RCR procedures.5 Moreover, regardless of the technique and setting, surgeon volume has been shown to be the strongest predictor in establishing indications.6 This suggests that, in the absence of clear evidence, surgeons’ existing practice patterns continue to drive surgical decision making in RCR.

The ability to address coexisting shoulder pathology constitutes one of the major advantages of arthroscopic RCR. This has enabled surgeons to perform a variety of procedures along with RCR that were previously inaccessible before the development of arthroscopic techniques. As a result, there has been a significant growth in secondary procedures associated with primary arthroscopic RCR. This trend has recently attracted attention in the orthopaedic literature, yet it remains poorly understood. Arthroscopic RCR was assigned a distinct Current Procedural Terminology (CPT) code in 2003, which allowed its identification as a unique procedural entity in surgical databases. Consequently, the degree to which
associated shoulder procedures have grown along with arthroscopic RCR can be correlated.

We performed a cross-sectional study examining trends in RCR in the Florida Statewide Ambulatory Surgical Database (SASD) and the Nationwide Inpatient Sample database in the 2000s. The purpose of this study was to evaluate national trends in shoulder arthroscopy and RCR over the past decade in 2 parts. For part I, the primary aim was to analyze population-adjusted shifts in RCR technique in the Florida State surgical database since 2000. As a secondary aim, we also examined procedural codes associated with RCR as the index procedure. Part II of our study consisted of analyzing the national inpatient database to examine overall trends in surgical setting and hospital cost of RCR. In this study, ambulatory RCR procedural volume trends from a large statewide database were compared with inpatient trends observed nationally. We hypothesized that there has been a significant increase in arthroscopic RCR and its associated procedures with a simultaneous decrease in open RCR. We also hypothesized a decrease in inpatient RCR procedures and an increase in inpatient RCR cost.

**Methods**

In part I of our study, we reviewed all outpatient CPT codes for shoulder surgery from the Florida SASD between 2000 and 2007. This database is maintained by the Agency for Healthcare Research and Quality as part of the national Healthcare Cost and Utilization Project. The Florida database was chosen because it is one of the largest statewide registries of patient-level demographic information for all ambulatory procedures since 2000. The CPT codes for arthroscopic RCR (29287), open chronic (23412), open acute (23410), and cuff avulsion (23420) procedures were extracted to capture all RCRs. The codes for open chronic, open acute, and cuff avulsion procedures were pooled to represent all open RCRs. We also searched for all shoulder procedure codes that were associated with either open or arthroscopic RCR as the primary or secondary procedural code. The SASD contains a maximum of 10 procedural codes for each admission, enabling us to capture all the coded procedures appearing concurrently with RCR. Table 1 shows a complete list of associated shoulder procedures. The raw procedural volumes were converted to population-based rates by use of published census data for the Florida State population (US Census Bureau Population Finder, [http://www.census.gov/popfinder](http://www.census.gov/popfinder)).

Part II of our study consisted of evaluating cost and volume data from the Healthcare Cost and Utilization Project Nationwide Inpatient Sample discharge database from 2001-2009. This database represents 20% of US inpatient discharges; each visit is weighted to allow estimates of national totals. Rotator cuff procedures were identified by International Classification of Diseases, Ninth Revision, Clinical Modification code 83.63. In addition to the total number of procedures, we extracted data on hospital type (rural, urban non-teaching, or urban teaching) and total hospital charge for each visit. Hospital charges from each visit were used to calculate cost estimates by use of average cost-to-charge hospital markup ratios, regional variations in wages, and year-to-year inflation.

We used Poisson regression with adjustment for overdispersion to analyze incidence trends for procedures, with the time in years as the predictor variable, the number of cases as the dependent variable, and the population size of Florida adjusted per 10,000 persons as the offset. This method generates incidence rate ratios that reflect the estimated percent year-to-year change (an incidence rate ratio of 1.0 represents no change). We used the Cochran-Armitage test to evaluate changes in the proportion of RCR cases among all cases. Differences in cost over each year were analyzed with 1-way analysis of variance. Trends of costs and charges over each year were analyzed with Spearman correlation. Statistical significance was set at $P < .05$. All statistical analyses were performed with STATA software, version 12 (StataCorp, College Station, TX).

**Results**

The data summary from part I of the study is shown in Table 2. Overall, there was a 163% increase in population-adjusted total outpatient surgical procedures in Florida between 2000 and 2007. Starting from 2003, when arthroscopic RCR was assigned a unique CPT code, there was a 353% increase (relative risk [RR], 1.27; confidence interval [CI], 1.13 to 1.44; $P < .001$) in arthroscopic rotator cuff procedures. Concurrently, there was a significant decrease in the incidence of pooled open rotator cuff procedures during this same period (RR, 0.93; 95% CI, 0.92 to 0.94; $P < .001$). Overall, there was a 2-fold increase in total RCRs (RR, 1.07; 95% CI, 1.03 to 1.11; $P = .001$) that suggested that the rate of increase in arthroscopic RCRs significantly outpaced the rate of decrease in open RCRs. Analysis of the trend in open versus arthroscopic

<table>
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<th>Procedure</th>
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<td>Acromioplasty</td>
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<td>Partial synovectomy</td>
<td>29820</td>
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<td>Complete synovectomy</td>
<td>29821</td>
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procedures (Fig 1) showed a significant shift toward arthroscopic procedures \( (P < .0001) \). From 2003 onward, there was a significant increase in several procedures associated with RCR (Fig 2). Most notably among these associated procedures were a 440% increase in subacromial decompression (RR, 1.35; 95% CI, 1.21 to 1.51; \( P < .001 \)), a 589% increase in distal clavicle resection (RR, 1.40; 95% CI, 1.22 to 1.60; \( P < .001 \)), and a 1,253% increase in extensive glenohumeral debridement (RR, 1.80; 95% CI, 1.61 to 2.02; \( P < .001 \)).

Part II of the study showed an overall 58.8% decrease in inpatient RCRs from 2000 to 2009 (Fig 3). This decrease was similar across the types of hospitals (rural, urban non-teaching, and urban teaching) in which the procedure was performed (69.7%, 56.9%, and 56.5%, respectively). There was also an increase in hospital charges between 2001 and 2009 by 144.9% \( (P < .001; \text{Spearman } \rho = 0.458) \). Estimated hospital costs during this time increased by 85.2% \( (P < .001; \text{Spearman } \rho = 0.314) \). The rate of rise in hospital charges was significantly higher than that of estimated hospital costs (Fig 4).
Discussion

In the current era of health care economics, payers and policymakers are closely reviewing elective orthopaedic procedures to look for evidence of clinical efficacy to justify their cost. Arthroscopic procedures, which have grown rapidly in popularity, are increasingly being subject to such scrutiny. In a previous study by Vitale et al., acromioplasty was shown to have increased significantly in the state of New York between 1996 and 2006 with respect to overall volume and population-based incidence. In this study the rise in acromioplasty was mirrored by a concomitant increase in these procedures reported by American Board of Orthopaedic Surgery step II candidates, suggesting a correlation between the observed trends in acromioplasty and evolution in orthopaedic training. As a result of this published study, there has been considerable focus and attention among members of the orthopaedic community regarding emphasizing appropriate indications for acromioplasty procedures. Previous studies have shown that the population-based incidence of arthroscopic RCR continues to rise as it becomes a standard part of orthopaedic training. RCR now represents one of the most popular procedures in orthopaedics, ranked 14th among all cases submitted to the American Board of Orthopaedic Surgery in 2006, and thus will likely face scrutiny in the face of changes in the valuation of health care procedures. Indeed, the importance of monitoring national trends in orthopaedics cannot be overstated in the current health care climate. Recent changes in coding and reimbursement for arthroscopic acromioplasty in response to its perceived overuse underscore the importance of understanding procedural volume, cost, and reimbursement (2012 Medicare Physician Fee Schedule, Centers for Medicare and Medicaid Services).

Our study shows that in a relatively brief 5-year period after the identification of arthroscopic RCR as a unique entity, there was a significant increase in the use of this procedure in a large statewide surgical database. In this same period, there was a modest decrease in open RCR that implies a concomitant shift toward minimally invasive techniques. Contrary to our hypothesis, however, this shift was significantly unbalanced, yielding a global increase in the use of RCR. Our findings indicate that arthroscopic procedures are not simply supplanting open procedures, suggesting that other factors are contributing to this overall rise in RCR volume.

A likely contributing factor to the aforementioned finding was the rapid increase in the volume of procedures associated with arthroscopic RCR in the period examined. Notably, there were significant increases in subacromial decompression, distal clavicle resection, and glenohumeral debridement procedures that outpaced that of arthroscopic RCR itself (440%, 589%, and 1,253%, respectively). These trends are not surprising given that concomitant intra-articular glenohumeral procedures are not possible in open RCR without arthroscopy, yet some of our observations merit review. For example, the disproportionate rise in extensive glenohumeral debridement between 2006 and 2007 is almost certainly due, in large part, to a shift in coding practices. The increase in subacromial decompression and glenohumeral debridement procedures seen in our study may be the result of extracting codes from procedures that were previously included in the global billing of open RCR. It is likely that increased diagnostic sophistication (i.e., advanced imaging) and expanding surgical skill sets have increased the volume of clinically indicated associated procedures, with the goal of improving surgical outcomes of RCR.

We also showed a nationwide 58.8% decrease in inpatient RCRs from 2000 to 2009 that was seen nationally across all hospital types. Combined with the increase in total RCR procedures nationally shown in prior studies, this suggests a shift to the ambulatory setting that warrants further explanation. Again, the
factors contributing to this trend are numerous. We hypothesized that changes in cost may have been one of the driving forces associated with this phenomenon. Indeed, we found an 85.2% increase in hospital costs associated with RCR, showing that performing RCR in the inpatient setting grew significantly more costly in the period studied. Because RCR procedures in healthy patients were increasingly performed in the ambulatory setting, it is likely that an increase in inpatient costs was due to increased medical comorbidities. Moreover, hospital charges grew by 144.9%, showing that inpatient RCR became increasingly financially inefficient for payers, possibly further contributing to the shift to the ambulatory setting.

**Limitations**

The weaknesses of this study are predominantly those inherent to surgical database review, which relies on the accuracy of procedural coding to generate external validity. Although the Florida SASD represents one of the most comprehensive statewide procedural databases encompassing diverse population demographic data, it is possible that the ambulatory procedural trends observed cannot be generalized to a national scale. Some of the trends observed, especially initially in the study period, may also have reflected a lag between changes in coding policy and their late adoption in coding practice by surgeons who continued to use open codes for arthroscopic procedures. Furthermore, our study design precludes determining causality; thus any association between trends, such as cost and procedural volume, are inferential by nature.

The study confirms a shift in RCR toward arthroscopic techniques and the outpatient setting despite the lack of evidence showing superiority of a particular technique with respect to clinical outcomes. The evolution of arthroscopy has expanded the armamentarium and profoundly increased the technical sophistication of the rotator cuff surgeon. However, whether arthroscopy has resulted in increased efficiency in the global delivery of this procedure remains controversial. Interestingly, a recent study of the New York SASD showed that mini-open RCR technique required less operative time and was less expensive than arthroscopic technique. In the current health care economics climate, increased utilization will require justification by appropriately expanding indications and demonstrably improved outcomes.

**Conclusions**

The study confirms a shift toward arthroscopic RCR and associated procedures in the outpatient setting. The increased financial cost partly explains the shift; nevertheless, future studies are needed to further examine national trends.

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**References**