



Rotator Cuff Repair With Acromioplasty Is Associated With an Increased Rate of Revision and Subsequent Procedures

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Purpose: To evaluate the mid-term rate of revision arthroscopic rotator cuff repair as well as ipsilateral shoulder reoperations after index rotator cuff repair performed with or without acromioplasty in the United States. **Methods:** The Medicare Standard Analytic File, which encompasses the entire Medicare billing and payment data, was queried between 2005 and 2014. Patients undergoing arthroscopic rotator cuff repair were identified and stratified based on whether ipsilateral acromioplasty was concurrently performed using Current Procedural Terminology codes. Groups were matched by age, sex, year of index procedure, and Elixhauser index at a 2:1 ratio. Primary end point was defined as undergoing a repeat ipsilateral shoulder surgery related to the rotator cuff at 5 years of follow-up. Kaplan–Meier survival curves were constructed, and the 2 groups were compared using the log-rank test. **Results:** After matching, 54,209 shoulders in the rotator cuff repair with acromioplasty group and 26,448 shoulders in the rotator cuff repair without acromioplasty group were identified. Shoulders undergoing concurrent acromioplasty at index rotator cuff repair had a significantly increased rate of repeat ipsilateral cuff repair at 5 years postoperatively (8.5% vs 6.8%, $P < .001$). Similarly, there was an increased rate of reoperation of all types to the ipsilateral shoulder in cases where concurrent acromioplasty was performed (9.6% vs 9.1%, $P < .001$). **Conclusions:** Using a large, national database, concurrent acromioplasty at the time of rotator cuff tear was found to be associated with both an increase rate of overall subsequent procedures and revision rotator cuff repair. **Level of Evidence:** III, retrospective comparative study.

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Based on Neer's initial description of the extrinsic theory of subacromial impingement, acromioplasty was performed to remove the anterior undersurface of the acromion to eliminate external compression on the underlying rotator cuff.^{1,2} Proponents of acromioplasty during rotator cuff repair adhere to the concept of extrinsic etiologies of cuff disease and advocate for removal of potential abrasive sharp surfaces that can disrupt repair or cause painful impingement. In contrast, the intrinsic theory of rotator cuff pathology focuses on intratendinous degeneration as the primary cause of rotator cuff abnormalities, thus limiting the utility of acromioplasty in rotator cuff healing.³ Within this theory, acromioplasty may present additional risks such as disrupting the subacromial arch and causing anterosuperior escape.⁴

In the early 2000s, Vitale et al.⁵ reported a 254.4% and 142.3% increase in acromioplasty on a statewide and national level, respectively. Similarly, in an analysis of a publicly available national database, acromioplasty

was performed in 47.3% of rotator cuff repair (RCR) procedures between 2004 and 2009 with significant increase in acromioplasties performed over this period.⁶ More recently, within the same national database, a decrease in concomitant acromioplasty at the time of rotator cuff was seen with a decrease in procedures performed from 2010 to 2015.⁷

Despite the relatively high prevalence of arthroscopic acromioplasty performed with RCRs, current literature debates its benefits. Presently, 1- to 2-year outcomes comparing RCRs with and without acromioplasty have found no significant differences in multiple functional and quality of life-related patient-reported outcomes.⁸⁻¹² Whether acromioplasty during RCR affects retear or reoperation rates in the long term is a topic that remains unclear. Current appropriate-use criteria guidelines from the American Academy of Orthopaedic Surgeons are not absolute and give a moderate-strength recommendation to not perform routine acromioplasty at the time of index RCR.¹³ Meanwhile, longer-term outcomes following acromioplasty have yet to be clearly elucidated, with MacDonald et al.¹⁰ reporting greater rates of reoperations while Shin et al.¹⁴ reporting no difference in failures regardless of acromioplasty. More recently, interest in acromioplasty has focused on lateral impingement, with researchers noting that critical shoulder angles (CSAs) greater than 35° are associated with greater rates of cuff disease, greater contact forces against the underlying cuff, and greater retear rates after repair.¹⁵ Taken in whole, the absolute indications for concomitant acromioplasty at the time of RCR and the long-term results are perhaps less clear than ever.

The purpose of this study was to evaluate the mid-term rate of revision arthroscopic RCR as well as ipsilateral shoulder reoperations after index RCR performed with or without acromioplasty in the United States. We hypothesized that the addition of acromioplasty would have no effect on rotator cuff revision rates or ipsilateral shoulder reoperations at mid-term follow-up.

Methods

The Medicare Standard Analytic File, a national database of deidentified patient data, was queried through PearlDiver software (PearlDiver Inc., Fort Wayne, IN; www.pearldiverinc.com) from 2005 to 2014. With the PearlDiver research tool, deidentified information of more than 25 million patients can be accessed across the country. Patient information can be retrieved using Current Procedural Terminology (CPT) codes, *International Classification of Disease, Ninth and Tenth Revision*, codes, and National Drug Codes. Available information includes age, sex, race, region, comorbidities, complications, prescription medications, and discharge status. Patients included in the database

Table 1. Current Procedural Terminology (CPT) Codes Used

Code	Definition
CPT-23130	Excision procedures on the shoulder
CPT-23410*	Repair of ruptured musculotendinous cuff (e.g., rotator cuff), open; chronic
CPT-23412*	Repair of ruptured musculotendinous cuff (e.g., rotator cuff), open; chronic
CPT-23420*	Reconstruction of complete shoulder (rotator) cuff avulsion, chronic (includes acromioplasty)
CPT-23472*	Arthroplasty, glenohumeral joint; total shoulder (glenoid and proximal humeral replacement (e.g., total shoulder)
CPT-29805	Arthroscopy, shoulder, diagnostic, with or without synovial biopsy (separate procedure)
CPT-29806	Arthroscopy, shoulder, surgical; capsulorrhaphy
CPT-29807	Arthroscopy, shoulder, surgical; repair of SLAP lesion
CPT-29819	Arthroscopy, shoulder, surgical; with removal of loose body or foreign body
CPT-29820	Arthroscopy, shoulder, surgical; synovectomy, partial
CPT-29821	Arthroscopy, shoulder, surgical; synovectomy, complete
CPT-29822	Arthroscopy, shoulder, surgical; debridement, limited
CPT-29823	Arthroscopy, shoulder, surgical; debridement, extensive
CPT-29824	Arthroscopy, shoulder, surgical; distal claviclectomy including distal articular surface (Mumford procedure)
CPT-29825	Arthroscopy, shoulder, surgical; with lysis and resection of adhesions, with or without manipulation
CPT-29826	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty, with coracoacromial ligament (i.e., arch) release, when performed
CPT-29827*	Arthroscopy, shoulder, surgical; with rotator cuff repair
CPT-29828	Arthroscopy, shoulder, surgical; biceps tenodesis

*Selected as revision procedure.

received treatment in various care settings and can be tracked longitudinally.

For this study, patients undergoing arthroscopic RCR were identified using the CPT code for arthroscopic rotator cuff repair (29827). Patients were stratified based on whether they underwent ipsilateral acromioplasty, simultaneously, using the CPT code 29826. Acromioplasty and nonacromioplasty groups were then matched by age, sex, year of index procedure, and Elixhauser comorbidity index at a 2:1 ratio. Patients without a minimum follow-up of 2 years or those who underwent index RCR without a specified laterality code were excluded from analysis. Primary end points for both groups were any subsequent ipsilateral shoulder procedure related to the rotator cuff. Multiple CPT codes were used to identify recurrent procedures. To account for differences in procedural coding, all potential redundant codes were used to ensure inclusion of various potential reoperations. Codes corresponding to revision procedures are also indicated in Table 1.

Table 2. Demographics of Included Patients

	With Acromioplasty (n = 54,209)	Without Acromioplasty (n = 26,448)	P Value
Age, y			.94
64 and younger	17.8%	18%	
65-69	32.2%	32.4%	
70-74	25.5%	25.3%	
75-79	15.5%	15.4%	
80-84	6.1%	6.1%	
85 and older	1.3%	1.4%	
Unknown	1.5%	1.4%	
Sex			.82
Female	50.9%	50.9%	
Male	47.6%	47.6%	
Unknown	1.5%	1.4%	
Elixhauser Comorbidity Index	6.40 ± 4.03	6.41 ± 4.04	.27

Statistical analysis used χ^2 tests to compare demographic data between groups undergoing concomitant acromioplasty and those without. Kaplan–Meier survival curves were constructed and the 2 groups were compared using the log-rank test. Analyses were performed with SPSS (Version 23; IBM Corp., Armonk, NY).

Results

A total of 77,335 patients undergoing arthroscopic RCR were queried from the PearlDiver Patient Record Database. After matching, there were 54,209 shoulders in the RCR with acromioplasty group (51,535 patients) and 26,448 shoulders in the RCR without acromioplasty group (25,800 patients). Using the Elixhauser Comorbidity Index, we found no significant differences in any of the matched parameters between the 2 groups ($P > .27$) (Table 2). Revision RCR was the most commonly performed subsequent procedure in both groups (32.3% with acromioplasty vs 35.7% without acromioplasty), followed by subacromial decompressions (28.8% with acromioplasty vs 19.9% without acromioplasty). Lastly, conversion to arthroplasty was more prevalent in the no acromioplasty group compared with the acromioplasty group (1.37% vs 0.61%) (Table 3).

Shoulders undergoing concurrent acromioplasty at index RCR had a small but significantly increased rate of repeat ipsilateral RCR at 5 years' postoperatively (8.5% vs 6.8%, $P < .001$) (Fig 1). Furthermore, there was an increased rate of reoperation of all types to the ipsilateral shoulder in cases where concurrent acromioplasty was performed (9.6% vs 9.1%, $P < .001$) (Fig 2).

Table 3. Revision Procedures following Index Rotator Cuff Repair

CPT Code	Procedure Name	With Acromioplasty (N, %)	No acromioplasty (N, %)
CPT-29826	Arthroscopy, shoulder, surgical; decompression of subacromial space with partial acromioplasty with or without coracoacromial release	4323 (28.8)	977 (19.9)
CPT-29805	Arthroscopy, shoulder, diagnostic with or without synovial biopsy (separate procedure)	43 (0.29)	26 (0.53)
CPT-29806	Arthroscopy, shoulder, surgical; capsulorrhaphy	41 (0.27)	29 (0.59)
CPT-29807	Arthroscopy, shoulder, surgical; repair of SLAP lesion	221 (1.47)	76 (1.55)
CPT-29819	Arthroscopy, shoulder, surgical; with removal of loose body or foreign body	221 (1.47)	108 (2.20)
CPT-29820	Arthroscopy, shoulder, surgical; synovectomy, partial	85 (0.57)	49 (1.00)
CPT-29821	Arthroscopy, shoulder, surgical; synovectomy, complete	74 (0.49)	25 (0.51)
CPT-29822	Arthroscopy, shoulder, surgical; debridement, limited	807 (5.38)	351 (7.16)
CPT-29823	Arthroscopy, shoulder, surgical; debridement, extensive	1084 (7.23)	376 (7.67)
CPT-29824	Arthroscopy, shoulder, surgical; distal claviclectomy including distal articular surface (Mumford procedure)	1708 (11.38)	330 (6.73)
CPT-29825	Arthroscopy, shoulder, surgical; with lysis and resection of adhesions, with or without manipulation	297 (1.98)	125 (2.55)
CPT-29827	Arthroscopy, shoulder, surgical; with rotator cuff repair	4839 (32.3)	1750 (35.7)
CPT-29828	Arthroscopy shoulder biceps tenodesis	522 (3.48)	186 (3.79)
CPT-23472	Arthroplasty, glenohumeral joint; total shoulder (glenoid and proximal humeral replacement (e.g., total shoulder))	91 (0.61)	67 (1.37)
CPT-23412	Repair of ruptured musculotendinous cuff (e.g., rotator cuff) open; chronic	368 (2.45)	223 (4.55)
CPT-23410	Repair of ruptured musculotendinous cuff (e.g., rotator cuff) open; acute	113 (0.75)	103 (2.10)
CPT-23420	Reconstruction of complete shoulder (rotator) cuff avulsion, chronic (includes acromioplasty)	135 (0.90)	86 (1.75)
CPT-23130	Acromioplasty or acromionectomy, partial, with or without coracoacromial ligament release	31 (0.21)	16 (0.33)

CPT, Current Procedural Terminology.

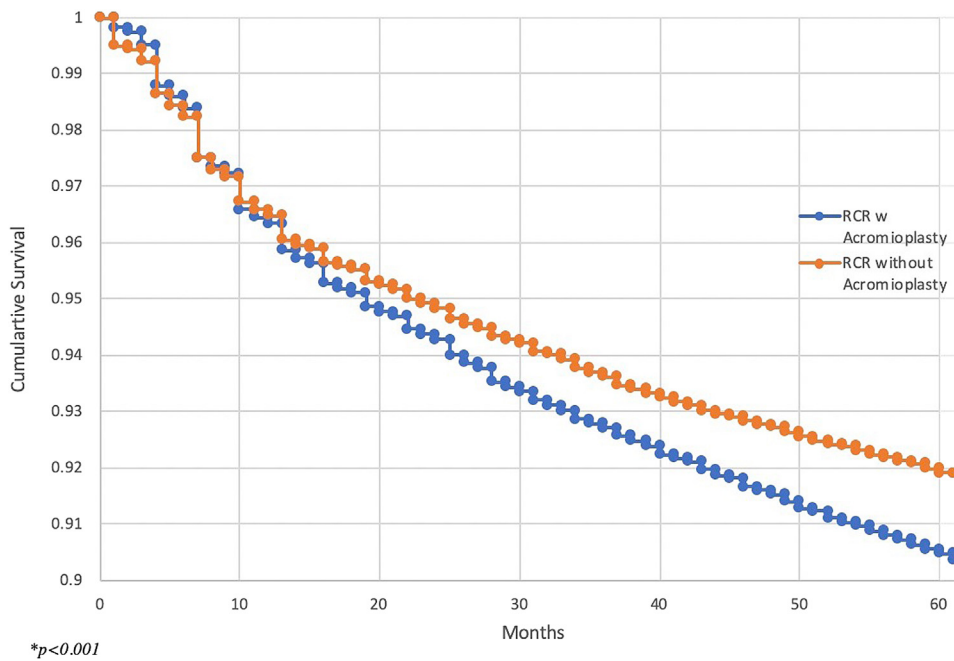


Fig 1. Kaplan–Meier curve depicting time to reoperation following arthroscopic rotator cuff repair procedure. (RCR, rotator cuff repair.)

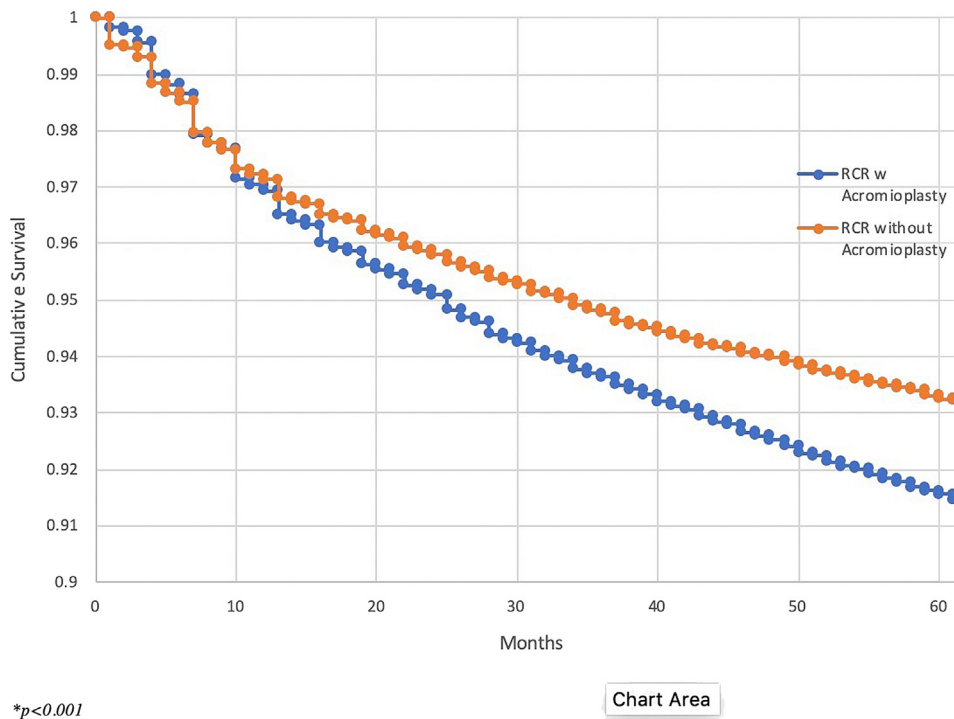


Fig 2. Kaplan–Meier curve depicting time to rotator cuff revision procedure (open and arthroscopic) following arthroscopic rotator cuff repair. (RCR, rotator cuff repair.)

Discussion

Using a large, national database, we found that concomitant acromioplasty at the time of index rotator cuff tear was associated with an increase in both of overall subsequent procedures and revision RCR at 5 years of follow-up. Acromioplasty is a procedure

commonly performed during RCR.^{5,6} In the current national epidemiologic investigation, an acromioplasty was performed in 67.2% of the 80,657 RCR investigated, despite the American Academy of Orthopaedic Surgeons' current recommendations. Objective benefits of acromioplasty include increased available working

space and improved visualization during cuff repair. Proposed postoperative benefits include limiting extrinsic pressure on the repaired rotator cuff tendon that could ultimately lead to recurrent symptomatic tearing, necessitating revision. However, the current investigation did not find the latter to be valid.

Several investigations have evaluated outcomes with and without acromioplasty, with the general consensus showing no significant differences across a battery of clinical outcome scores.^{10-12,16} However, data on reoperation rates remain variable. In the multicenter randomized control study by MacDonald et al.¹⁰ that assessed outcomes after arthroscopic full-thickness RCR with and without acromioplasty, 4 (9%) patients randomized to the nonacromioplasty group had ongoing postoperative symptoms and pain, prompting consideration for reoperation. Of these patients, one half were diagnosed with a recurrent rotator cuff tear. Comparatively, no patient who underwent an acromioplasty procedure at the time of RCR underwent a repeat procedure at 24 months' postoperatively.¹⁰ A subsequent randomized prospective trial by Abrams et al.¹⁶ found 75% (n = 3) of patients who did not undergo initial acromioplasty underwent revision cuff repair at 2 years postoperatively compared with 1 patient electing for revision repair in the acromioplasty group. Of note, these reported differences in revision rates did not reach statistical significance, as the examined cohorts were likely underpowered.

There are several possible explanations for the findings in our investigation. Currently, retear rates after primary RCR are widely variable and range from 13.1% to 79% depending on initial tear characteristics.¹⁷ Furthermore, the decision to proceed with revision repair is dependent on several patient-related factors, such as the degree of dysfunction, pain, and hindrance to quality of life. Acromioplasty was originally geared toward eliminating the anterior aspect of the acromion and previous literature on reoperation rates mostly focused on acromial morphology and the subsequent effect on revision in their respective non-acromioplasty cohorts. One could surmise that until recently, this was likely the most common technical approach to performing an acromioplasty.¹⁸ More recently, there has been a body of literature focusing on the CSA, an anatomic measurement describing the lateral extension of the acromion, and its relationship to rotator cuff tears.¹⁹⁻²¹ A cadaveric study by Katthagen et al.¹⁵ comparing traditional anterolateral acromioplasty and lateral acromioplasty showed that although traditional acromioplasty was able to reduce the CSA, it was less effective than the combination of both lateral and anterolateral techniques (1.8° reduction vs 2.8°). A later clinical study Gerber et al.²² further supported this concept with favorable clinical outcome scores and cuff strength at 30 months postoperatively following lateral

acromioplasty at the time of RCR. Despite the relatively new concept of the CSA, and the need for further long-term clinical trials to evaluate its efficacy, it is possible that traditional anterior based acromioplasty was not able to correct the CSA and may serve as a rationale for the longer-term failures and reoperations found in our investigation. Future studies would be helpful to elucidate whether a combination of lateral or anterolateral acromioplasty with or without coracoacromial (CA) ligament resection in patients with increased CSA alters the subsequent rate of revision surgery needed. However, significant study is needed to validate these potential claims with comparative, long-term follow-up data, postoperative imaging to assess changes in bony morphology and cuff healing, and analyses of clinical and patient-related outcomes following these procedures.

Another potential technical explanation for the current findings involves anterosuperior escape of the humeral head following CA ligament release. The CA ligament serves as a restraint to superior subluxation of the humeral head and is integral to stability of the shoulder.²³ Removal of the CA ligament could lead to anterosuperior escape of the humeral head and predispose patients to subsequent rotator cuff arthropathy requiring further reoperations or arthroplasty after cuff repair. This investigation found that the conversion to arthroplasty was more prevalent in the no acromioplasty group compared with the acromioplasty group (1.37% vs 0.61%) but is limited by a shorter length of follow-up that may be necessary to reveal which cohort ultimately results in greater rates of arthroplasty. The exact management of the CA ligament during acromioplasty is still up for debate as the inherent contributions of the CA ligament to impingement syndrome or cuff degeneration are also unclear.^{24,25} Traditional teaching has suggested removal of the CA ligament from the acromial insertion^{1,18,26-28}; however perseverance, or in some cases, repair of the ligament also have been described.²⁹⁻³² Although no studies have specifically attempted to link CA ligament excision and the risk of rotator cuff retear, a biomechanical study Budoff et al.³³ does provide some insight on the effects of CA ligament excision on cuff function. Following excision, there was a 25% to 30% increase in the forces required by the rotator cuff to maintain glenohumeral mechanics.³³ Increased stress, on a previous RCR, following CA ligament excision could act as a predisposing factor for retear and thus a potential cause for a revision procedure. The aforementioned sequelae of acromioplasty and potential CA ligament excision may explain the increased rate of revision subacromial decompression with acromioplasty (28.8%) versus the rate without acromioplasty (19.9%), but this interpretation is limited by the nature of this study. Although this correlation cannot be directly proven from our

investigation, it again highlights additional technical aspects of acromioplasty that could negatively affect rotator cuff healing and lead to reoperations.

The current investigation found statistically significant greater reoperation and revision rates in patients following acromioplasty; however, attention must be paid to the clinical relevance of our findings. The percentage of revisions at 5 years postoperatively differed by 1.7%, whereas reoperations differed by 0.5%, respectively. Given the large sample size afforded by the Medicare Analytic Standard file, these differences were found to be significant on a population level yet the individual clinical impact of this difference is difficult to extrapolate from our findings. To better elucidate the individual clinical consequences of acromioplasty, the incorporation of patient-reported outcomes in longitudinal, multicenter trials would be indicated to better characterize the clinical effects of the reported differences. In addition, more granular information on the individual surgeon- and patient-specific indications for acromioplasty such as tear characteristics, acromial spur size, presence of CA ligament abrasion in the subacromial space, or lateral edge angle would help to further refine what subset of patients may benefit from acromioplasty at the time of RCR, and to what degree of an acromioplasty is acceptable to optimize outcomes in those patients.⁴ Thus, while the results presented here are intriguing, provide larger-scale and longer-term data than what is currently in the literature, and are contrary to our hypothesis, the authors recommend exercising caution in their interpretation. As opposed to providing evidence for the discontinuation of acromioplasty during RCRs, the authors believe the data highlight a need for further investigation of long-term outcomes to ensure patients who may benefit from an acromioplasty are not deprived of it.

Limitations

The Medicare Standard Analytic File provides a large cohort to evaluate complications and rates of subsequent procedures; however, it is not without limitations. As this database collects retrospective data, we are unable to report, speculate or standardize the operative indications, tear characteristics specific operative techniques, or postoperative rehabilitation protocols used for each procedure in our investigation, and as such, this limits the generalizability of some of our findings. Specifically, rotator cuff failure is dependent on a variety of tear characteristics such as the size, degree of tendon involvement and fatty atrophy.³⁴ Further, additional information, such as the presence of comorbidities such as diabetes, smoking status, and osteoporosis, are unable to be assessed in this study.³⁵ We addressed this limitation through the matching of our respective cohorts. In addition, we lack information on initial and postoperative radiographic parameters,

the classification of acromial morphology that could provide additional data on risk factors for reoperation or revision or specific indications for any revision procedures being performed. For example, we are unable to comment on whether a sufficient acromioplasty was performed, or to what degree the CA ligament was recessed, in order to perform the procedure. In such instances, specific technical aspects of the procedure could have contributed to long-term effects on cuff function and thus contributed to our findings. The results of this study are also subject to potential errors in accurate coding within the database. Although the database is audited, the accuracy of coding is unknown, and similar to most database studies, is a major limitation to our findings. Furthermore, surgeon selection bias to include acromioplasty may be significant and associated with increased rates of revision surgery. More aggressive surgeons, either by virtue of their previous training or their field of practice, may have significant impact on treatment decisions and make them more likely to perform a second surgery based on a patient's presentation and symptoms. Lastly, as there is currently no individual CPT code for reverse total shoulder arthroplasty, the CPT code 23472, corresponding to glenohumeral arthroplasty, was selected as a revision procedure following RCR. This limitation is inherent to most database studies focused around shoulder procedures. This code was selected under the assumption that reverse total shoulder arthroplasty would be performed in the setting of rotator cuff arthropathy or massive irreparable cuff tears following a failed RCR; however, this cannot be confirmed, given this deficit in coding data.

Conclusions

Using a large, national database, concurrent acromioplasty at the time of rotator cuff tear was found to be associated with both an increase rate of overall subsequent procedures and revision RCR.

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