OPEN Research Article

Trends in Acromioplasty Utilization During Arthroscopic Rotator Cuff Repair: An Epidemiological Study of 139,586 Patients

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ABSTRACT

Introduction: Acromioplasty remains very common during rotator cuff repair (RCR) despite limited evidence of clinical efficacy. This study observed the incidence of acromioplasty from 2010 to 2018 in Texas using a publicly available database.

Methods: A total of 139,586 records were analyzed from the Texas Healthcare Information Collection database ranging from 2010 to 2018. These cases were divided into those with and without acromioplasty (N = 107,427 and N = 32,159, respectively). Acromioplasty use was standardized as the number of acromioplasties per RCR (acromioplasty rate). Two subgroup analyses were conducted: surgical institution type and payor status.

Results: In 2010, acromioplasty occurred in 84% of all RCR cases with nearly continuous decline to 74% by 2018 ($P < 0.001$). All subgroups followed this pattern except teaching hospitals which displayed insignificant change from 2010 to 2018 ($P = 0.99$). The odds of receiving acromioplasty in patients with neither Medicare nor Medicaid was higher than those with Medicare or Medicaid coverage (odds ratio = 1.36, $P < 0.001$).

Discussion: Overall acromioplasty rates decreased modestly, but markedly, beginning in 2012. Despite this small decrease in acromioplasty rate, it remains a commonly performed procedure in conjunction with RCR. Both the academic status of the surgical facility and the payor status of the patient affect the acromioplasty rate.

Acromial impingement disorder was first proposed as a cause of rotator cuff tears by Neer in 1972.[1] He noted that the presence of a characteristic spur on the anterior-inferior ridge of the acromion would compress and erode the tendinous portion of the supraspinatus muscle, ultimately leading to partial or full-thickness tearing. Neer concluded that 95% of all rotator cuff tears were associated with tendinous impingement from the acromion. Additional support for acromioplasty and rotator cuff

repair (RCR) arose from a cadaveric study by Bigliani[2] in 1986 showing a higher incidence of full-thickness tears in shoulders with a Bigliani type 3 acromion or inferiorly hooking morphology. This supported the notion that acromial impingement was a contributing factor to rotator cuff tears. These two publications led to the regular use of anterior-inferior open acromioplasty in RCR. The prevalence of acromioplasty and coracoacromial release steadily rose, with a marked increase after the introduction of an arthroscopic method in 1987.[3] A meta-analysis of open versus arthroscopic acromioplasty in 2009 demonstrated that arthroscopic acromioplasty resulted in faster return to work and fewer hospital inpatient days.[4] As of 2012, a 2-year nationwide analysis showed 73% to 76% of all RCR were accompanied by acromioplasty.[5] Patient-level charges for RCR with acromioplasty were $4,992 higher than RCR without, representing nearly 20% of total charges.[6] Because arthroscopic RCR is a very common surgical procedure, rates of acromioplasty have notable financial implications for our healthcare system.

Two studies published before the study period questioned the utility of acromioplasty for changing patient clinical outcomes when coupled with RCR. One prospective randomized study published in 2004 found no difference in American Shoulder and Elbow Surgeons (ASES) scores between patients with isolated supraspinatus tears who underwent RCR alone versus RCR with anterior acromioplasty and coracoacromial ligament release at an average of 15 months postoperatively.[7] Another prospective randomized study published in 2007 found no difference in Constant-Murley or Disabilities of Arm, Shoulder and Hand (DASH) scores at 2 years postoperatively between patients with rotator cuff tears and Bigliani type II or III acromions treated with RCR alone versus RCR with acromioplasty.[8] Additional literature published during the study period further questioned the clinical utility of routine acromioplasty in the setting of RCR.[9-11] Most recently, after the conclusion of the study period, a randomized control trial with an average of 7.5-year follow-up demonstrated no difference in patient-reported outcomes, retear rate, or revision rate between patients who underwent arthroscopic RCR with or without acromioplasty, corroborating the data available before the study period that did not support the concurrent use of acromioplasty with arthroscopic RCR.[12] The American Academy of Orthopaedic Surgeons (AAOS) regularly publishes and updates Clinical Practice Guidelines (CPGs) as a synthesis of current literature on a given topic. These guidelines are meant to serve as a reference for clinicians to determine best practices for clinical scenarios. The 2010 CPGs published for RCR included a moderate strength recommendation that "routine acromioplasty is not required at the time of RCR" due to lack of clinical value.[13]

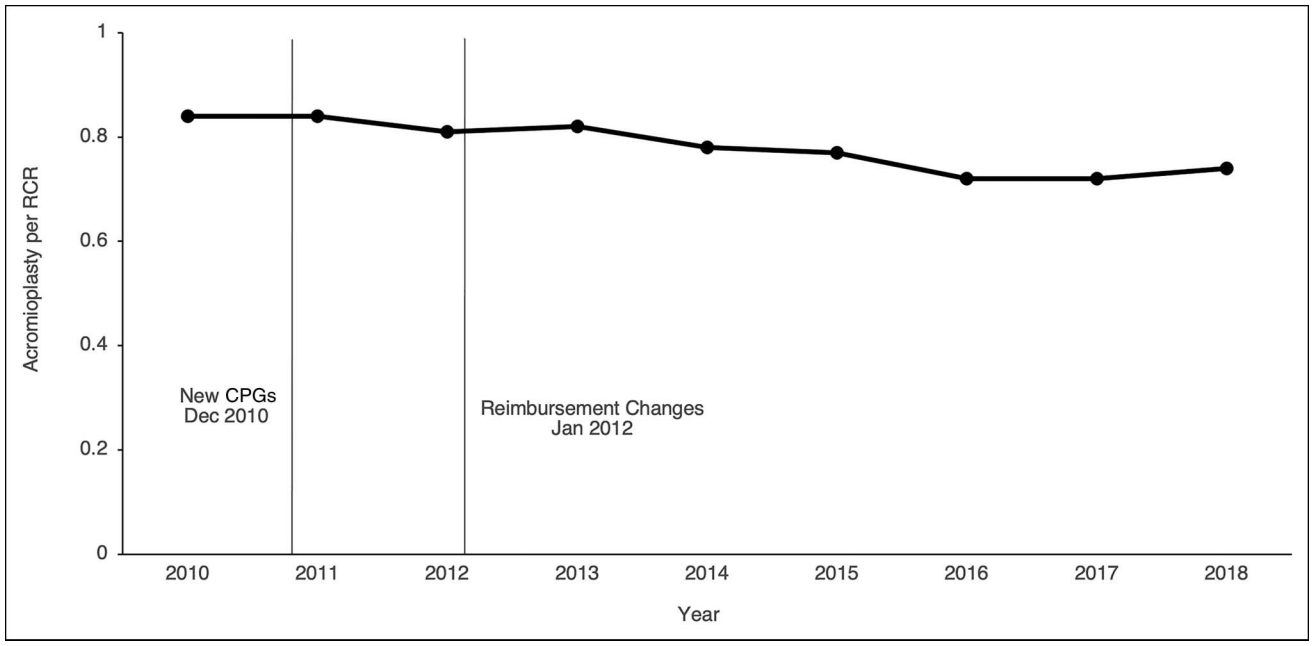
The purpose of this study was to evaluate the use of acromioplasty during arthroscopic RCR in the State of Texas between the years 2010 and 2018. We hypothesized that the percentage of arthroscopic RCR in which acromioplasty was done (acromioplasty rate) would decrease during this time in response to the aforementioned studies and CPGs questioning the utility of acromioplasty. We conducted a subgroup analysis to determine whether two demographic variables, payor status and type of surgical institution, affected acromioplasty rates.

Methods

This study was a retrospective cross-sectional study using deidentified records that are publicly available through the Texas Healthcare Information Collection (THCIC) database.[14] The THCIC includes deidentified records of all patients discharged from eligible hospitals or ambulatory surgical centers beginning in 2010. All eligible surgical centers are required to submit a summary including the diagnostic billing codes, demographic information, and a standardized list of itemized charges for every procedure done. Unlike existing nationwide databases, the THCIC database includes records, regardless of payor status that may not be present in alternative data sources, including worker's compensation, veterans affairs, self-pay, and charity. Also included is the type of procedural setting, the type of facility, and location. Although limited to the State of Texas, this database provides the most comprehensive depth of public health information available for analysis. Because the RCR CPGs were approved and published in December 2010, data from 2011 to 2018 were considered to represent clinical practice in which the CPGs were freely available.

This study used Current Procedural Terminology (CPT) codes as published by the American Medical Association to define the inclusion criteria. Inclusion criteria were defined as all arthroscopic RCRs (identified as CPT code 29827) done from 2010 through 2018. A total of 139,586 records met these criteria. This data set was then stratified by acromioplasty status which was defined as the presence of CPT code 29826, indicating billing for subacromial decompression. Beginning in

Figure 1



Graph showing RCR with acromioplasty as a percentage of total RCR per year (acromioplasty rate). CPGs = Clinical Practice Guidelines, RCR = rotator cuff repair.

2012, CPT code 29826 became an add-on code requiring a concomitant RCR procedure for acromioplasty to be billed as such. This study used both the free-standing code from 2010 to 2012 and the add-on code from 2012 onward. The yearly incidence of RCR with acromioplasty was standardized each year as a percentage of the total number of RCRs done. This allowed for even comparison across the 9-year time frame and accounted for changes in the overall population and incidence of RCR over time. Procedural settings were defined categorically as teaching and nonteaching hospitals dependent on the status of membership with the Council of Teaching Hospitals and Health Systems. Payor status was defined categorically as those records indicating Medicare, Medicaid, or neither Medicare nor Medicaid (which includes self-pay and charity).

One-way repeated measures analysis of variance (ANOVA) with Bonferoni correction was done to assess year-over-year changes in acromioplasty rate between 2010 and 2018. The abovementioned analyses were repeated to evaluate the acromioplasty rate in teaching and nonteaching hospitals. Nonparametric analyses were substituted when data were not normally distributed. Logistic regression analyses were done to control for interacting subgroups (procedure setting and payor status), and the results for each year are reported as the odds of receiving acromioplasty (odds ratios [ORs] with 95% confidence intervals [CIs]). Statistical analyses were done using SPSS version 26 (IBM). Statistical significance level alpha was set a priori at 0.05.

Results

Overall Trends in Acromioplasty

A total of 139,586 RCRs recorded in the THCIC database from 2010 to 2018 were included. Of these, 107,427 RCRs (76.9%) were accompanied by acromioplasty. Although the raw number of acromioplasties in this study population increased significantly from 2010 to 2018 (7,754 cases in 2010 vs 16,018 cases in 2018; $P < 0.001$), the percentage of RCR with acromioplasties (acromioplasty rate) declined from 0.84 to 0.74 during the same period ($P < 0.001$) (Figure 1 and Table 1). Graphical representation of the year-over-year rate of change in acromioplasty rate compared with 2010 demonstrates a marked decrease beginning in 2012 (Figure 2).

Teaching Versus Nonteaching Hospitals

From 2010 to 2018, there were a total of 13,174 RCRs done within teaching hospitals and 9,387 of these cases (71.3%) included concomitant acromioplasty. From 2010 to 2018, there were a total of 126,412 RCRs done in nonteaching hospitals and 98,040 of these cases (77.8%) included concomitant acromioplasty. 9.4% of

Table 1. Progression of RCR and Acromioplasty Use From 2010 to 2018 With Accompanying Acromioplasty Rates (Acromioplasty per RCR)

Year	All RCR	Acromioplasty	Acromioplasty Rate
2010	9,276	7,754	0.84
2011	10,435	8,774	0.84
2012	12,357	10,057	0.81
2013	14,286	11,744	0.82
2014	15,264	11,893	0.78
2015	16,472	12,671	0.77
2016	19,463	13,974	0.72
2017	20,283	14,542	0.72
2018	21,750	16,018	0.74
Total	139,586	107,427	0.78

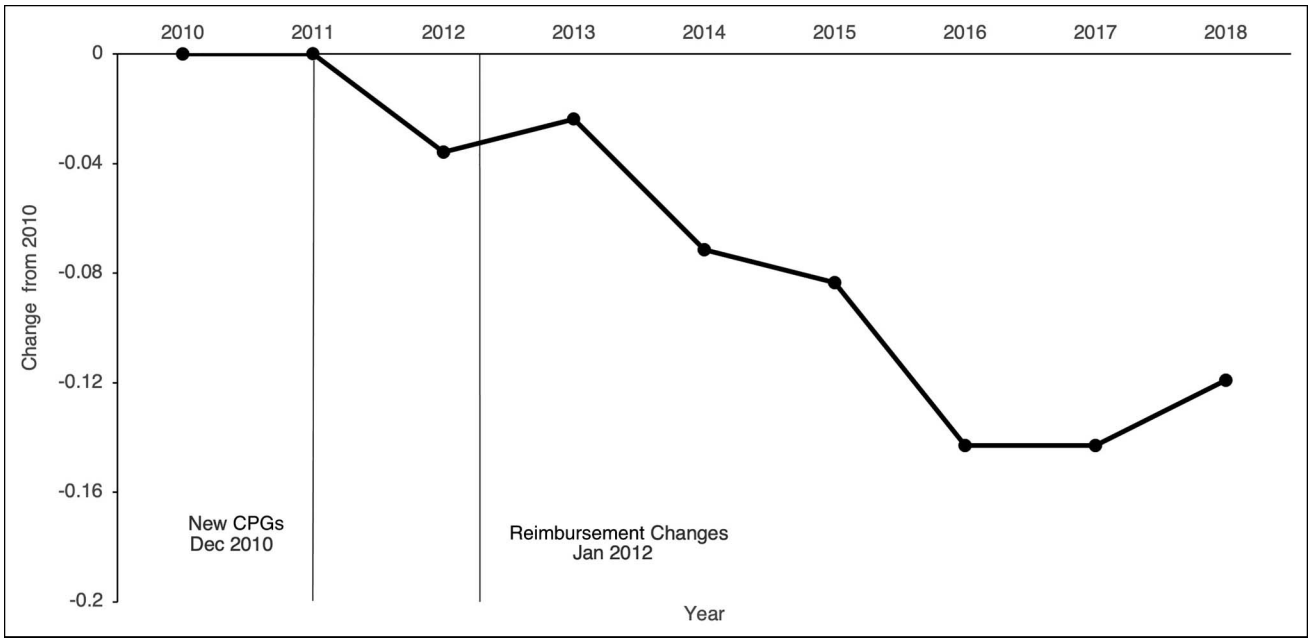
RCR = rotator cuff repair.

total cases were done at teaching hospitals. The total number of acromioplasties in teaching hospitals increased between 2010 and each subsequent time point until 2018 ($P < 0.001$). In 2010, the acromioplasty rate in teaching facilities was 72% compared with 84.6% in nonteaching facilities, which may also be expressed as 53% decreased odds of receiving acromioplasty in a teaching facility compared with nonteaching facilities (OR = 0.47, 95% CI: 0.39 to 0.55, $P < 0.001$). From 2010 to 2018, the acromioplasty rate in teaching facilities did not show any statistically significant change (0.72 in 2010 versus 0.76 in 2018) ($P = 0.99$). Over the entire study period, RCR done in teaching hospitals demonstrated slightly decreased odds of receiving acromioplasty than in nonteaching facilities (OR = 0.94, $P = 0.021$). In nonteaching facilities, this rate decreased over the same period (0.84 in 2010 versus 0.74 in 2018) (Figure 3). A year-over-year change in annual acromioplasty rates demonstrates the decrease beginning in 2012 in nonteaching facilities (Figure 4). In contrast to 2010, logistic regression analysis indicated significantly higher odds (OR = 1.12, 95% CI: 1.00 to 1.26, $P = 0.05$) of receiving an RCR with acromioplasty in 2018 at a teaching hospital than a nonteaching hospital (**Supplemental Table**, http://links.lww.com/JG9/A216).

Payor Status

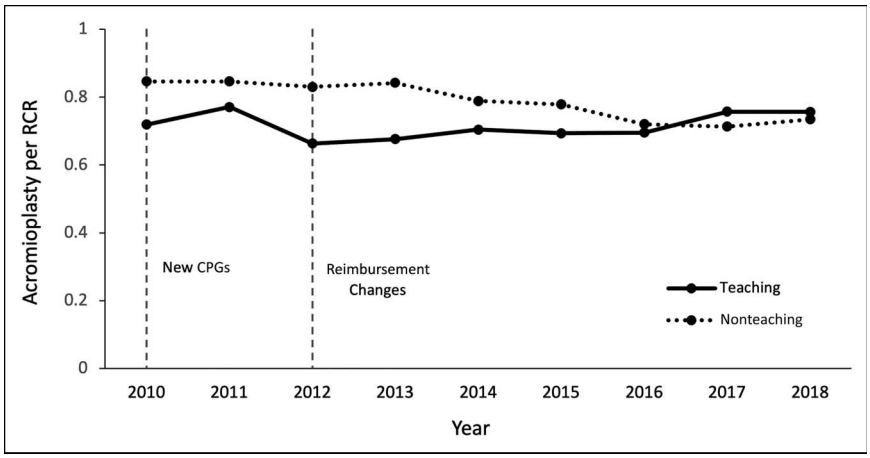
The second subgroup analysis was stratified by payor status (defined as Medicare, Medicaid, or neither Medicare nor Medicaid). The year-over-year changes for all three payor groups closely resembled the overall declining trend beginning in 2012 (Figure 5). Medicaid-covered RCR had the lowest overall acromioplasty rate (Figure 6) and a corresponding 41% decreased odds of receiving acromioplasty compared with those with non-Medicaid coverage, regardless of the facility type (OR = 0.59, 95% CI: 0.55 to 0.63, $P < 0.001$). The acromioplasty rate in subjects with Medicare coverage declined from 0.82 in 2010 to 0.72 in 2018, with an

Figure 2



Graph showing the ratio of acromioplasty rates per year compared with the initial year of 2010.

Figure 3



Graph showing acromioplasty rates stratified by academic status of surgical institution from 2010 to 2018 (teaching and nonteaching). CPGs = Clinical Practice Guidelines, RCR = rotator cuff repair.

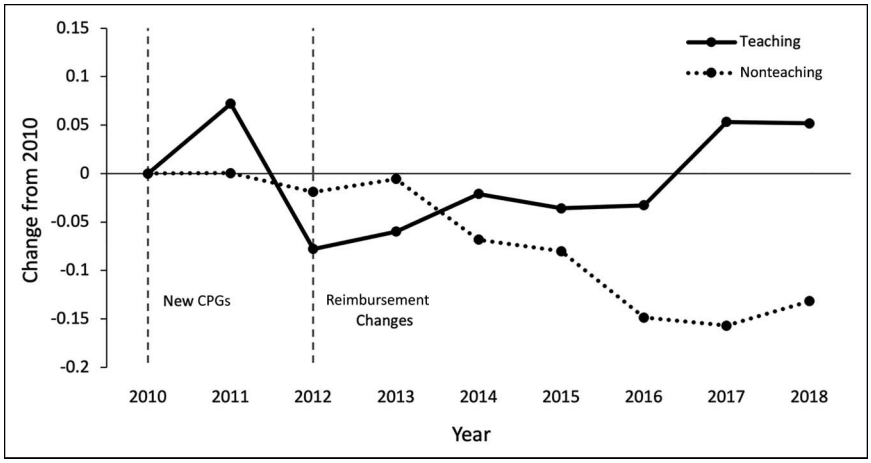
overall 21% decreased odds of receiving acromioplasty compared with those with non-Medicare coverage (OR = 0.79, 95% CI: 0.76 to 0.81; $P < 0.001$). In patients with neither Medicare nor Medicaid coverage, the acromioplasty rate decreased from 0.84 in 2010 to 0.75 in 2018, with an overall 36% increased odds of receiving acromioplasty, regardless of facility type (OR = 1.36, 95% CI: 1.33 to 1.40, $P < 0.001$).

Discussion

Over the 9-year study period, acromioplasty rates exhibited an overall 10% decline across the entire cohort, aided by a 9% decrease in acromioplasty rates in Medicare-covered and Medicaid-covered cases. This decrease in acromioplasty rates was seen is all subgroups except for teaching hospitals, in which no notable change was seen during the study period. This study was not designed to definitely answer why surgeons choose to perform any given procedure. However, through a comprehensive analysis of large numbers of patients, this study closely reflects clinical practice with value in investigating possible correlations. There are several factors that may contribute to the observed change in acromioplasty rate.

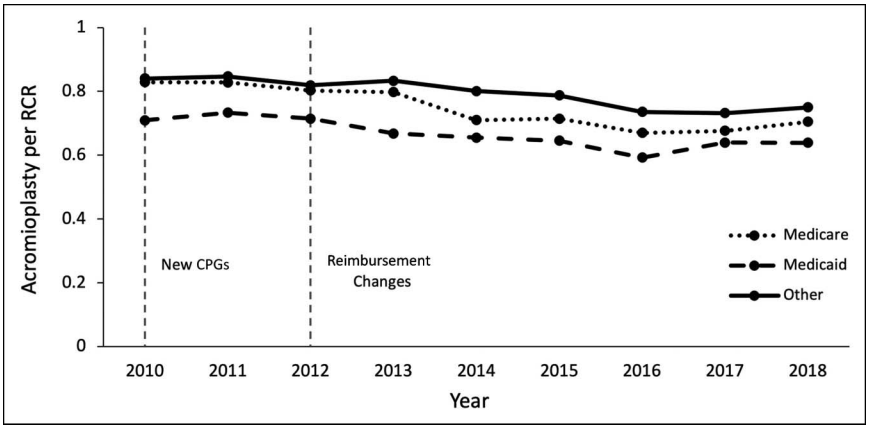
As mentioned previously, the 2010 CPGs published for RCR included a moderate strength recommendation that "routine acromioplasty is not required at the time of RCR" due to lack of clinical value.[13] Moderate strength recommendations against a treatment or procedure indicate that the benefits of a procedure are outweighed

Figure 4



Graph showing the ratio of acromioplasty rates per year compared with the initial year of 2010 and stratified by academic status of the surgical institution (teaching and nonteaching). CPGs = Clinical Practice Guidelines, RCR = rotator cuff repair.

Figure 5

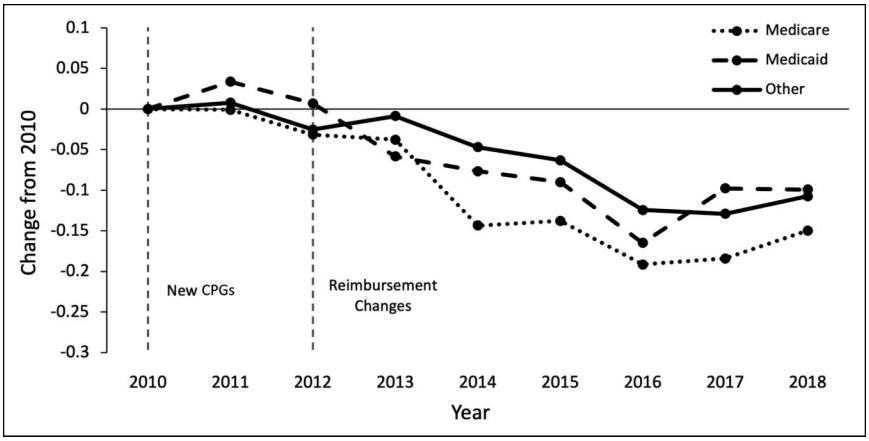


Graph showing the ratio of acromioplasty rates per year compared with the initial year of 2010 and stratified by payor status (Medicare, Medicaid, and neither Medicare nor Medicaid). CPGs = Clinical Practice Guidelines, RCR = rotator cuff repair.

by the potential risks.[13] The 2010 CPGs were approved by the AAOS on December 4th, 2010, and were based off of a systematic review of RCR problems.[13] It referenced the two level-II studies described in the Introduction of this study.[7,8] Neither referenced article found a notable difference in clinical outcomes between RCR with and without acromioplasty. Considering the lack of clinical utility and increased patient-level charges, RCR with acromioplasty increases the financial burden on patients with no distinct improvement in outcomes. Despite the decrease in acromioplasty rate over the study period, in 2018, 74% of arthroscopic RCRs still include concomitant acromioplasty. In selected clinical settings, an acromioplasty may be indicated, but when 74% of RCR contain acromioplasties, it seems that the procedure is being done routinely which is against current evidence-based guidelines outlined by the CPGs. The modest decrease in acromioplasty rate over this period may reflect inconsistent adoption of CPGs by providers or may suggest that other factors contribute to the decision to include as to whether to perform acromioplasty in conjunction with RCR. The decrease in acromioplasty was not observed until 2012, despite publication of the CPGs in December 2010. Assuming that the 2010 CPGs did influence the rate of acromioplasty during the study period, the timing of the decline in acromioplasty may represent an expected delay in adoption of evidence-based techniques or inadequate CPG dissemination. Perhaps the terminology of the CPG recommendation as "moderate" does not seem to indicate that the recommendations should be adopted.

The acromioplasty rate in nonteaching hospitals paralleled the overall trend, but the rate in teaching hospitals

Figure 6



Graph showing acromioplasty rates stratified by payor status from 2010 to 2018 (Medicare, Medicaid, and neither Medicare nor Medicaid). CPGs = Clinical Practice Guidelines.

began lower and remained constant. We can speculate on possible reasons for this difference including efforts for trainees to gain experience in the technique, that RCR may take longer to perform by a trainee, or that acromioplasty may be required for enhanced visualization. Alternatively, it is possible that academic institutions are interested in other concepts described in recent literature. For example, the concept of the critical shoulder angle was first introduced in the literature in 2013, during the study period.[15,16] There is interest in exploring lateral acromioplasty as a method for reducing critical shoulder angle and potentially improving patient clinical outcomes, which may affect the incidence of RCR with acromioplasty in the academic hospital subset.

The 2012 inflection point in acromioplasty rate corresponds temporally to a change in the reimbursement for the acromioplasty CPT code implemented on January 1, 2012. The acromioplasty code was changed from a stand-alone CPT code to an add-on code, with reimbursement as indicated by the relative value units assigned to the code decreasing from 19.58 to 5.24. An observational study by a private orthopaedic group in Houston, TX, noted that the average payment by Medicare for acromioplasty procedures decreased 36.3% from 2011 to 2012 because of the relative value units change.[17] The timing of this reimbursement change on January 1, 2012, precedes the drop in RCR with acromioplasty incidence found in 2012. Private insurance carriers typically mirror changes in Medicare reimbursement structure. It is possible that financial factors contributed to decreasing acromioplasty rates in addition to the CPGs. Lower acromioplasty rates in Medicaid patients, that typically reimburse at a lower rate than other insurances, and higher acromioplasty odds ratios in neither Medicaid nor Medicare patients support this potential interpretation.

Limitations of this study include the observational nature and the fact that the cases surveyed are reflective of the acromioplasty rate in Texas rather than the national trend. However, the comprehensive nature of the Texas database overshadows its limited geographic footprint. The current population of Texas is approximately 29 million and includes a mix of urban and rural environments. The database also includes all cases, regardless of payor status, done during the period, and as a result, is more comprehensive and generalizable than many published national databases. Because we have shown that the acromioplasty rate varies by payor, we felt that the use of existing national databases, which are limited by type of insurance, may not provide as accurate of a representation of acromioplasty rate.

A major limitation inherent to a retrospective database study is that it relies on CPT codes to classify patient into acromioplasty groups. We cannot definitely say that an acromioplasty was done, but rather, that it was billed. Billing practices may vary by surgeon and insurance provider, and specific acromioplasty techniques are likely variable as well. However, CPT codes are commonly used as surrogates of whether a surgical procedure was done and are a foundation of retrospective data analysis in large databases. Regardless of the specific acromioplasty technique, the financial implications of acromioplasty billing remain influential from a societal perspective.

Finally, the cause for changes in surgeon behavior is important and drives the changes in acromioplasty rate as seen in the study. Although the identification of these causes is out of the scope of the study, we can identify correlations that can be further explored in future research. Owing to the lack of similar studies, there is no standard or comparison to be made to evaluate the adoption time of CPGs. This study cannot compare the outcomes of patients treated with and without acromioplasty. Owing to the large sample sizes, the statistical significance of some differences may be overpowered.

Conclusion

The percentage of RCR that was done with concurrent acromioplasty decreased a modest, but statistically significant, amount from 84% in 2010 to 74% by 2018. The trend of decreasing yearly acromioplasty rates was paralleled in nonteaching hospitals, but not in teaching hospitals, which displayed insignificant change from 2010 to 2018. Acromioplasty is more commonly done in patients without Medicare or Medicaid. Despite CPGs recommending the nonroutine use of acromioplasty, surgeons continue to perform acromioplasty with RCR in most of the cases throughout all subcategorizations analyzed.

References

1. Neer CS: Anterior acromioplasty for the chronic impingement syndrome in the shoulder: A preliminary report. *J Bone Joint Surg Am* 1972;54:41-50.

2. Bigliani L, Morrison D, April E: The morphology of the acromion and its relationship to rotator cuff tears. *Orthop Trans* 1986;10:228.

3. Yu E, Cil A, Harmsen WS, Schleck C, Sperling JW, Cofield RH: Arthroscopy and the dramatic increase in frequency of anterior acromioplasty from 1980 to 2005: An epidemiologic study. *Arthrosc J Arthroscopic Relat Surg* 2010;26:S142-S147.

4. Davis A, Kakar S, Moros C, Kaye EK, Schepsis AA, Voloshin I: Arthroscopic versus open acromioplasty: A meta-analysis. *Am J Sports Med* 2009;38:613-618.

5. Jarvis DL, Waterman BR, Verma NN: Is acromioplasty ever indicated during rotator cuff repair? *Arthrosc J Arthroscopic Relat Surg* 2019;35:1639-1640.

6. Li L, Bokshan SL, Ready LV, Owens BD: The primary cost drivers of arthroscopic rotator cuff repair surgery: A cost-minimization analysis of 40,618 cases. *J Shoulder Elbow Surg* 2019;28:1977-1982.

7. Gartsman GM, O'Connor DP: Arthroscopic rotator cuff repair with and without arthroscopic subacromial decompression: A prospective, randomized study of one-year outcomes. *J Shoulder Elbow Surg* 2004;13: 424-426.

8. Milano G, Grasso A, Salvatore M, Zarelli D, Deriu L, Fabbriciani C: Arthroscopic rotator cuff repair with and without subacromial decompression: A prospective randomized study. *Arthrosc J Arthroscopic Relat Surg* 2007;23:81-88.

9. Abrams GD, Gupta AK, Hussey KE, et al.: Arthroscopic repair of full-thickness rotator cuff tears with and without acromioplasty: Randomized prospective trial with 2-year follow-up. *Am J Sports Med* 2014;42: 1296-1303.

10. MacDonald P, McRae S, Leiter J, Mascarenhas R, Lapner P: Arthroscopic rotator cuff repair with and without acromioplasty in the treatment of full-thickness rotator cuff tears: A multicenter, randomized controlled trial. *J Bone Joint Surg Am Vol* 2011;93:1953-1960.

11. Shin S-J, Oh JH, Chung SW, Song MH: The efficacy of acromioplasty in the arthroscopic repair of small- to medium-sized rotator cuff tears without acromial spur: Prospective comparative study. *Arthrosc J Arthroscopic Relat Surg* 2012;28:628-635.

12. Waterman BR, Newgren J, Gowd AK, et al: Randomized trial of arthroscopic rotator cuff with or without acromioplasty: No difference in patient-reported outcomes at long-term follow-up. *Arthroscopy* 2021;37:3072-3078.

13. Pedowitz RA, Yamaguchi K, Ahmad CS, et al.: Optimizing the management of rotator cuff problems. *J Am Acad Orthop Surg* 2011;19: 368-379.

14. Texas Department of State Health Services Center for Health Statistics: *Texas Hospital Outpatient Discharge Research Data Files, 2010-2018*, 2010.

15. Kaiser D, Bachmann E, Gerber C, Meyer DC: Influence of the site of acromioplasty on reduction of the critical shoulder angle (CSA)—an anatomical study. *BMC Musculoskelet Disord* 2018;19:371.

16. Moor BK, Bouaicha S, Rothenfluh DA, Sukthankar A, Gerber C: Is there an association between the individual anatomy of the scapula and the development of rotator cuff tears or osteoarthritis of the glenohumeral joint?: A radiological study of the critical shoulder angle. *Bone Joint J* 2013; 95-B:935-941.

17. Elkousy H, Gartsman GM, Edwards TB, Heaps B, Laughlin MS, Press CM: Financial impact of third-party reimbursement changes for CPT code 29826: Experience of a large group practice. *J Bone Joint Surg Am* 2014; 96:e183.