

Trends in Surgical Management of Shoulder Instability

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Background: Optimal surgical management of anterior shoulder instability remains controversial. There is a need to assess the most recent trends for primary and revision shoulder stabilization surgery using a national database significantly larger than those previously utilized.

Hypothesis: Most shoulder stabilization procedures are performed arthroscopically. Examining revision procedures, we hypothesized that open procedures would result in decreased revision stabilizations compared with arthroscopic procedures and that most revision procedures would be open Bankart or bone transfer procedures regardless of the index procedure technique.

Study Design: Descriptive epidemiology study.

Methods: The MarketScan Database was searched using International Classification of Diseases–Ninth Revision (ICD-9) and Current Procedural Terminology (CPT) codes to identify patients who underwent any shoulder stabilization procedure between 2008 and 2012. Regression analysis was used to evaluate trends between patient groups. The Cochran–Armitage trend test was used to identify differences in trends seen yearly. Odds ratios (ORs) were calculated to compare the likelihood of undergoing a revision stabilization procedure.

Results: A total of 66,564 shoulder stabilization procedures were identified from 2008 through 2012: 60,248 arthroscopic stabilization procedures (90.5%) and 6316 open stabilization procedures (9.5%), including 1623 bone block procedures. Arthroscopic stabilization procedures increased in total number and percentage of all procedures in each year of the study. Bone block procedures increased in number each year, although other open procedures decreased during the study period. Males underwent more stabilization procedures, while patients between the ages of 10 and 19 years were most likely to undergo any procedure. Patients who underwent bone block stabilization were significantly less likely to undergo a second stabilization procedure during the study period when compared with open Bankart repair (OR, 0.582; 95% CI, 0.405–0.836; $P < .05$) and arthroscopic Bankart repair (OR, 0.587; 95% CI, 0.418–0.824; $P < .05$). No statistically significant difference in revision stabilization was seen when comparing arthroscopic versus open Bankart repair (OR, 0.934; 95% CI, 0.863–1.139).

Conclusion: Although the number of arthroscopic shoulder stabilization surgeries continues to increase, our data show a consistent increase, not seen in prior studies, in the number of bone block procedures. Contrary to some studies, there was no significant difference in the likelihood of a second procedure between patients initially undergoing arthroscopic compared with open Bankart repair.

Keywords: shoulder instability; Bankart repair; trends

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The optimal technique and approach to address anterior shoulder instability remains controversial. Arthroscopic procedures offer the theoretical advantages of decreased morbidity, decreased loss of motion, avoidance of a subscapularis tenotomy, and the ability to address concomitant intra-articular pathology, and studies have shown a faster return of preoperative muscle strength.^{14,15,25,33,45} However, higher recurrent instability after arthroscopic stabilization when compared with open stabilization has been reported.^{11,33,39,49} A review of the literature, including meta-analyses, reveals conflicting study data on the optimal method of surgical stabilization for anterior shoulder instability, and a lack of consensus on ideal technique remains.[§] Open bone transfer

[§]References 5, 11, 13, 15, 19, 26, 28, 33, 36, 42, 44, 48.

procedures such as Latarjet-Bristow and osteoarticular allograft augmentation of the glenoid are recommended for treatment of large osseous defects in the glenoid, humeral head, or both, which are demonstrated risk factors for failure of arthroscopic treatment.^{7,9}

Given the conflicting data, epidemiological results and practice trends using large databases can elucidate how orthopaedic surgeons are applying the available data as well as evaluate recurrence of instability after surgical treatments of anterior shoulder instability. Several recent studies have sought to evaluate trends in orthopaedic surgery for the treatment of conditions such as shoulder instability as well as superior labral tears, hip arthroscopy, and end-stage ankle arthritis.^{34,41,47,51,52} These studies aid in clarifying appropriate indications and treatment algorithms, especially in conditions where debate exists regarding the best treatment.

Trends in shoulder stabilization surgery have been previously evaluated by Owens et al.⁴¹ These authors analyzed practice patterns for Bankart repair in the United States from 2003 through 2008 among 4562 cases submitted by surgeons in their first 2 years of practice to the American Board of Orthopaedic Surgeons (ABOS) database. They found that an increasing proportion of Bankart repairs were being done arthroscopically by newly trained orthopaedic surgeons, but the results were limited by the number of cases and the specific cohort of surgeons. Zhang et al⁵² looked at trends in shoulder stabilization surgery by analyzing data from the PearlDiver Patient record database, which contains records for approximately 11 million unique patients insured through United Health, for all patients undergoing shoulder stabilization surgery from 2004 through 2009. Their results confirmed that the findings of Owens et al⁴¹ were not unique to newly trained orthopaedic surgeons during that time period but were true of all orthopaedic surgeons found within their database.

Our purpose was to assess the practice trends for shoulder stabilization surgery with regard to the type of procedure performed and any trends related to patient age or sex during a more recent time period, without concerns for observer effect, or Hawthorne effect,³¹ as potentially can be seen during a boards collection window; we also wanted to access a larger volume of patients (compared with the PearlDiver database) by utilizing the MarketScan Commercial Claims and Encounters Database. Our secondary purpose was to evaluate the incidence and specifics of revision stabilization after previous primary stabilization, not done in previous big data studies on this subject. Our hypothesis was that most shoulder stabilization procedures remain arthroscopic despite a growing incidence of open procedures, including bone block procedures. Additionally, we hypothesized that reoperation rates would be decreased after open procedures as compared with arthroscopic procedures and that revision procedures performed would be mostly open Bankart or bone transfer procedures regardless of the index procedure technique.

METHODS

A search of the MarketScan Commercial Claims and Encounters Database was conducted to identify all

individuals who underwent shoulder stabilization procedures from 2008 through 2012. The MarketScan Database is a medical and drug insurance claims database that contains inpatient and outpatient records and services from over 100 insurance companies and large employers. The database contains information for over 39 million individual patients for each year included in our study. We searched the database for patients who underwent any of 4 procedures designated by the following Current Procedural Terminology (CPT) codes: 29806 (arthroscopy, shoulder, surgical; capsulorrhaphy), 23455 (capsulorrhaphy, anterior; with labral repair [eg, Bankart procedure]), 23460 (capsulorrhaphy, anterior, any type; with bone block), and 23462 (capsulorrhaphy, anterior, any type; with coracoid process transfer). Patients were further characterized by sex, 10-year age groups from younger than 10 years through 60 to 69 years, and year of the initial procedure.

Data were also divided between index procedures and revision procedures, defined as any of the 4 designated procedures done after an initial designated procedure. We included any revision stabilization procedure done after an initial stabilization as a "revision," as the rates of contralateral surgery are low and well defined in the literature.³⁶ These rates of contralateral limb surgery would also be expected to affect patients undergoing surgical stabilizations similarly in all technique groups, thus the rate of revision stabilization would remain similar among technique groups.³⁶

Multivariable logistic regression was used to evaluate differences in surgical trends between individual patient groups delineated by age and sex. In particular, odds ratios (ORs) and confidence intervals (CIs) were calculated to compare the likelihood of undergoing a revision stabilization procedure after 1 of the 4 index procedures. Additionally, the Cochran-Armitage trend test was used to identify statistically significant differences in trends seen yearly over the course of the study period. All statistical tests were 2-sided, and a *P* value less than .05 was considered statistically significant. SAS 9.3 (SAS Institute Inc) was used for all analyses.

RESULTS

A total of 66,564 surgical shoulder stabilization procedures were identified between the years of 2008 and 2012, inclusively. There were 60,248 arthroscopic stabilization procedures (90.5%) and 6316 open stabilization procedures (9.5%), including 1623 bone block procedures (CPT 23460 or 23462), during the study period (Table 1). There was an increase in the number and incidence of arthroscopic stabilization procedures seen in each year of the study, with 9245 cases being performed in 2008 (2.2 cases per 10,000 people) and increasing to 14,991 cases in 2012 (2.8 cases per 10,000 people; *P* < .0001). The percentage of stabilization procedures that were arthroscopic also increased each year, beginning with 88.22% in 2008 and increasing to 91.79% in 2012 (*P* < .0001) (Figure 1).

After decreasing from 1235 in 2008 to 1208 in 2009, the number of open procedures continued to increase each year,

TABLE 1
Stabilization Case Distribution by Year

Year	Total No. of Patients in Database	Total No. of Stabilization Cases	Arthroscopic		Total Open		Open Bankart		Open Bone Block	
			n	%	n	%	n	%	n	%
2008	41,275,020	10,480	9245	88.22	1235	11.78	1061	10.12	174	1.66
2009	39,970,145	11,443	10,235	89.44	1208	10.56	995	8.70	213	1.86
2010	45,239,752	12,965	11,746	90.60	1219	9.40	904	6.97	315	2.43
2011	52,194,324	15,345	14,031	91.44	1314	8.56	887	5.78	427	2.78
2012	53,131,420	16,331	14,991	91.79	1340	8.21	846	5.18	494	3.02

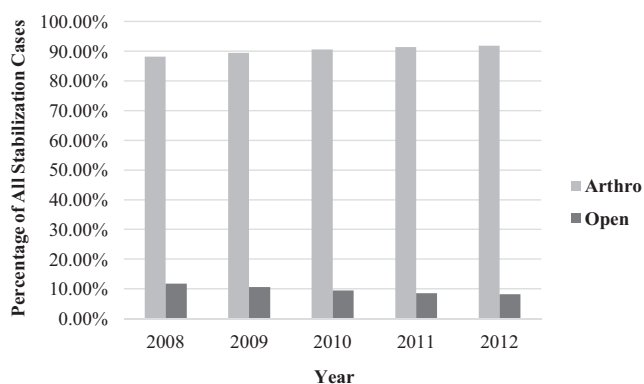


Figure 1. Arthroscopic versus open case distributions by year.

reaching 1340 in 2012. This coincided with an increase in the number of bone block procedures each year (from 174 cases in 2008 to 494 cases in 2012) despite a concurrent decrease in the number of open Bankart repairs (from 1061 cases in 2008 to 846 cases in 2012) ($P < .0001$). Open procedures decreased each year as a percentage of the total number of stabilization procedures, starting at 11.78% in 2008 and decreasing to 8.21% in 2012 ($P < .0001$) (Figure 1).

For the entire study period (2008-2012), males underwent more stabilization procedures, with 48,804 cases compared with 17,760 cases for females (Table 2). Although both males and females underwent predominantly arthroscopic stabilization procedures—89.76% and 92.58%, respectively—males were more likely to undergo an open stabilization procedure compared with females (10.24% vs 7.42%, $P < .0001$) (Table 2). Neither sex was more likely to undergo a revision procedure (5.2% vs 5.3%, $P = .578$).

Patients in the age group of 10 to 19 years underwent the most procedures overall at 21,740 (32.66%), of which 19,879 (91.4%) were arthroscopic procedures (Figure 2). Patients aged 20 to 29 years underwent the second most procedures, at 17,176 (25.80%), and each successive decade saw a step-wise decrease in the overall percentage of patients undergoing any stabilization procedure, with patients aged 60 to 69 years undergoing 1817 (2.73%) procedures. Arthroscopic procedures were significantly more common than open procedures for all age groups, ranging from 84.21% to 91.62% of procedures within each age group. Patients aged 20 to 29

years had the second-highest rate of open procedures at 11.66% (2002 total open procedures). Only patients younger than 10 years of age had a higher rate of open procedures at 15.79% (3 total open procedures, all of which were bone block procedures).

Out of 57,252 patients who initially underwent arthroscopic stabilization (CPT code 29806), 3200 (5.59%) underwent at least 1 other stabilization surgery during the study period. Of those patients, 2765 (86.41%) underwent a repeat arthroscopic stabilization, 222 (6.94%) underwent an open Bankart repair, and 213 (6.66%) underwent a bone block procedure (Table 3 and Figure 3).

Out of 4562 patients who initially underwent open Bankart repair (CPT code 23455), 278 (6.09%) underwent at least 1 other stabilization surgery during the study period. Of those patients, 119 (42.81%) underwent arthroscopic stabilization, 117 (42.09%) underwent repeat open Bankart repair, and 42 (15.11%) underwent a bone block procedure (Table 3 and Figure 3).

Out of 1492 patients who initially underwent a bone block stabilization procedure (CPT codes 23460 and 23462), 59 (3.95%) underwent at least 1 other stabilization surgery during the study period. Of those patients, 38 (64.41%) underwent a repeat bone block procedure, 18 (30.51%) underwent arthroscopic stabilization, and 9 (15.25%) underwent open Bankart repair (Table 3 and Figure 3).

Patients who underwent bone block stabilization were significantly less likely to undergo a revision stabilization procedure during the study period when compared with open Bankart repair (OR, 0.582; 95% CI, 0.405-0.836; $P < .05$) and arthroscopic Bankart repair (OR, 0.587; 95% CI, 0.418-0.824; $P < .05$). No statistically significant difference was seen when comparing arthroscopic versus open Bankart repair (OR, 0.934; 95% CI, 0.863-1.139).

DISCUSSION

Several studies have used the MarketScan database to analyze different aspects of orthopaedic disease and treatment.^{3,4,29} The results of these studies were supported by the large number of patients and associated information available through the database, which we believed would also be helpful in reassessing trends in the management of anterior shoulder instability over the past 5 years. This topic has been the subject of a significant amount of

TABLE 2
Case Distribution by Sex

Sex	Total No. of Unique Patients	Total No. of Stabilization Cases	Arthroscopic		Total Open		Open Bankart		Bone Block		Patients Undergoing Revision Procedure	
			n	%	n	%	n	%	n	%	n	%
Male	45,159	48,804	43,806	89.76	4998	10.24	3697	7.58	1301	2.67	2355	5.21
Female	16,517	17,760	16,442	92.58	1318	7.42	996	5.61	322	1.81	880	5.33

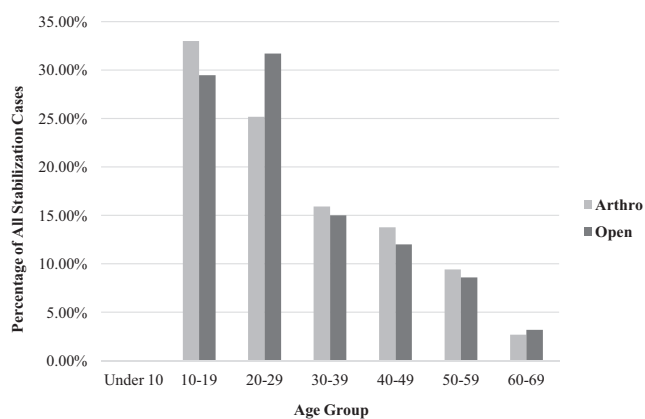


Figure 2. Distribution of all cases amongst age groups.

research, yet there is little conclusive evidence on the most effective management. Based on previous studies,^{41,52} we hypothesized that arthroscopic management of instability would continue to grow but that increased revision rates would be seen when compared with open procedures. Additionally, we sought to evaluate revision procedures and hypothesized that, despite the growth of arthroscopic procedures overall, open procedures would constitute the majority of revision procedures.

As seen in the studies by Zhang et al⁵² and Owens et al,⁴¹ we found that the majority of cases during the study period (87.7%) were performed arthroscopically and that the proportion of cases done arthroscopically continued to increase among all orthopaedic surgeons. The trend of increasing arthroscopic procedures may be secondary to patient preference for arthroscopic over open shoulder procedures, seen by Sperling et al,⁴⁶ or, given that the same trend was seen in candidates for board certification by Owens et al,⁴¹ may also be secondary to a similar trend in orthopaedic training programs. This may also reflect a lack of comfort with open procedures by surgeons recently completing training. Open Bankart procedures and open procedures as a whole decreased in proportion in the years evaluated in this study.

Zhang et al⁵² specifically evaluated coracoid transfer procedures from other bone block procedures in their analysis. They noted an increase in the number of coracoid transfer procedures over their study period but no increase in other bone block procedures. These authors reported that all bone

block procedures in 2008 and 2009 made up 1.74% and 1.98% of stabilization procedures, respectively. This is similar to our rates of 1.66% and 1.86%, respectively, during those same years. Our data showed a similar increase in the overall number of open bone block procedures each year, but it also showed a stepwise increase in the proportion of procedures done as an open bone block during our study period, indicating a new trend toward open bone block procedures not seen in prior studies. This may be secondary to the significantly higher number of patients within the MarketScan database used in our study compared with previous studies, which would decrease any sampling bias. This also may be a result of the known role of bone loss in shoulder instability and failed instability surgery as well as several recent studies showing the success of such bone block procedures.^{2,8,16,23,30,35}

Also similar to the study by Zhang et al,⁵² we saw that patients aged 10 to 19 years have the greatest percentage of shoulder stabilization procedures, with each successive decade seeing a stepwise decrease in the percentage of total stabilization procedures. Other studies have shown younger age to be a risk factor for shoulder instability, recurrent instability, and need for operative intervention.^{20-22,24,50} Few procedures were seen in individuals younger than 10 years, although this age group was most likely to have an open procedure (15.79%), all of which were bone block procedures. Individuals aged 20 to 29 years were the next most likely to undergo an open procedure (11.66%) as well as undergo a bone block procedure (3.76%). Our study did show 3 open bone block procedures in patients younger than 10 years, which may reflect tuberosity avulsion fractures that were coded as "stabilization" procedures.

Male sex has been shown to be a risk factor for both initial and recurrent shoulder instability.^{28,33} Although males underwent significantly more stabilization procedures during the study period, they were not more likely than females to undergo a revision procedure (5.2% [2355/45,159] vs 5.3% [880/16,517]; $P = .578$). Males were more likely to undergo any open procedure (10.24% vs 7.42%; $P < .0001$) and, specifically, a bone block procedure (2.67% vs 1.81%; $P < .0001$) (Table 2). This may be secondary to the higher incidence of bony defects in anterior instability seen in males.³²

Prior studies have shown conflicting results regarding the most reliable shoulder stabilization procedure with regard to both recurrent instability and the need for revision stabilization surgery.^{10,18,19,33,36,39,43} Contrary to our hypothesis, patients initially undergoing an initial

TABLE 3
Distribution of Revision Stabilization Procedures by Index Procedure^a

Index Procedure CPT Code	Total Initial Patients	Total Patients With Revision Stabilization Surgery	%	Total Repeat Procedures	Unique Patients With Secondary CPT Code					
					23455	%	29806	%	23460, 23462	%
29806	57,252	3200	5.59	22,188	222	6.94	2765	86.41	213	6.66
23455	4562	278	6.09	1064	117	42.09	119	42.81	42	15.11
23460, 23462	1492	59	3.95	225	9	15.25	18	30.51	38	64.41

^aCPT, Current Procedural Terminology. CPT 29806 corresponded to arthroscopic stabilization; CPT 23455 to open Bankart repair; and CPT 23460, 23462 to bone block procedure.

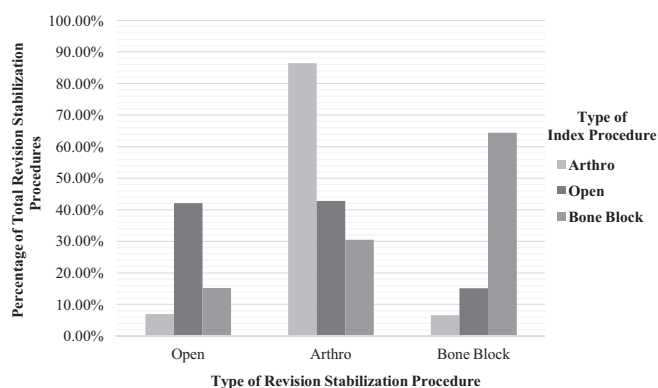


Figure 3. Types of revision stabilization procedures by index procedure.

arthroscopic Bankart repair were not statistically more likely to undergo a revision stabilization procedure when compared with those initially undergoing an open Bankart repair. Although we did not directly study recurrent instability overall, our database did not demonstrate a greater incidence of revision surgery for recurrent instability after arthroscopic stabilization when compared with open Bankart stabilization. As seen in prior studies,^{5,6} patients undergoing initial bone block stabilization, who typically consist of those with worse prognostic factors such as contact athletes and patients with the presence of bone loss, were statistically less likely to undergo a revision stabilization procedure when compared with both arthroscopic and open Bankart repair.

Although revisions for arthroscopic Bankart repair have been traditionally performed as open procedures,^{12,16,30,38} success has been shown in patients undergoing revision arthroscopic Bankart repair after previous arthroscopic and open Bankart repairs.^{17,27,37} The most common procedure seen after arthroscopic stabilization in our study was another arthroscopic stabilization (86.41%), suggesting that the shift toward arthroscopic stabilization procedures includes not only index procedures but revision procedures as well. Even after open Bankart repair, the proportion of arthroscopic to open revision Bankart was almost equal (42.81% vs 42.09%).

Bone block procedures have been advocated in patients with significant bone loss, significant laxity, and failed prior shoulder stabilization surgery.^{1,2,5,7,16,30,33} As one would expect, patients undergoing an index bone block

procedure were most likely to undergo another bone block procedure if they had a second stabilization surgery in our study (64.41%).

Several limitations exist for this study. Given the length of the study period, our data on revision stabilization procedures are limited by the fact that the fixed database years do not account for procedures done prior to the study period. Therefore, we had to assume that the first procedure occurring during the study period was the primary procedure for the patient, with any procedure done after it being the revision procedure. Additionally, the fixed study period resulted in only 1- or 2-year follow-up for some patients. Actual rates of revision stabilization may be higher if all patients had equivalent follow-up. This cross-sectional analysis relied on data searching CPT codes for open and arthroscopic shoulder stabilization procedures, and thus the accuracy of the data is subject to errors in coding. Because of limitations in the database, specifically with CPT coding, we could not confirm that additional stabilization procedures performed after a primary stabilization procedure were ipsilateral versus contralateral limb surgery. Additionally, we did not include details reported for those undergoing surgical intervention (eg, sports participation, bony anatomy, number of dislocations) or those performing the surgery (eg, training or surgical experience) that could affect the procedure chosen or the likelihood of bilateral surgery. As the rates of additional stabilization procedures were below the rates of contralateral limb stabilization procedures reported in the literature (7.4%), and the need for revision would be expected to affect patients undergoing surgical stabilizations similarly in all technique groups, the rate of revision stabilization would likely remain similar among technique groups.⁴⁰ As such, we have made the assumption that all subsequent stabilization procedures after a primary stabilization were in fact revision procedures. To further define appropriate treatment algorithms, more studies are needed to better understand the changes in distribution of revision procedures and the effect, if any, on patients' clinical outcomes.

CONCLUSION

Based on the results of our study using a large national database, we have demonstrated that arthroscopic stabilization procedures continue to increase in both number and

proportion when compared with open procedures, despite a consistent increase in bone block procedures during our study period. The data suggest that this trend in arthroscopic stabilizations is not only true for index procedures but for revision procedures as well. Contrary to our hypothesis, revision stabilization procedures were not more likely in patients who initially underwent an arthroscopic procedure when compared with non-bone block open procedures. Further research is needed to identify the influences behind the growing trend toward arthroscopic and bone block procedures and what effect, if any, the trends will have on outcomes and algorithms for how we approach shoulder stabilization surgery moving forward.

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