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Arthroscopic distal clavicle excision is associated with fewer postoperative complications than open

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Background: The rate of complications of open compared to arthroscopic distal clavicle excision remain poorly studied. Therefore, the purpose of this investigation was to (1) Identify most recent national trends in the usage of open vs. arthroscopic approaches for distal clavicle excision (DCE) from 2007 to 2017; (2) to identify and compare the complication rates for both approaches, and to identify patient-specific risk factors for complications; (3) to identify and compare the revision rate for both approaches; and (4) to identify and compare the reimbursement of each approach.
Methods: The PearlDiver database was reviewed for patients undergoing DCE from 2007 to 2017. Patients were stratified into 2 cohorts: those undergoing arthroscopic DCE (n = 8933) and those undergoing open DCE (n = 2295). The rate of postoperative complications within 90 days was calculated and compared. The revision rate and reimbursement of the arthroscopic and open approach were compared. Statistical analysis included chi-square testing to compare the rates of postoperative complications and multivariate logistic regression analysis to identify risk factors for complications within 90 days. Results were considered significant at $P < .05$.
Results: The percentage of DCEs performed arthroscopically has significantly increased from 53.9% in 2007 to 69.8% in 2016, with a concomitant decrease in the use of open DCE from 46.1% in 2007 to 30.2% in 2016. The open approach was associated with significantly more postoperative complications, including a significantly greater incidence of surgical site infection (1.9% vs. 0.3%; $P < .001$), wound disruption (0.3% vs. 0.1%; $P < .001$), hematoma (0.9% vs. 0.2%; $P = .001$), and transfusion (0.6% vs. 0.1%; $P < .001$), than arthroscopic DCE. Several risk factors, including open approach, diabetes, heart disease, tobacco use, chronic kidney disease, and female gender, were identified as independent risk factors for complications after DCE. There was no significant difference in revision rate between open and arthroscopic approaches ($P = .126$). The reimbursement of open and arthroscopic DCE procedures were comparable, with median reimbursements of $5408 and $5,447, respectively ($P = .853$).
Conclusion: Both arthroscopic and open DCE techniques were found to have similar reimbursement amounts, with a low rate of complications, although the open technique had a higher rate of early complications such as surgical site infection. Over the study period, there was an increase in the utilization of arthroscopic DCE, while the incidence of the open technique remained constant.

Distal clavicle excision (DCE) is an effective method of treating acromioclavicular (AC) joint pathology.[1,27] First described by both Mumford and Gurd in 1941,[10,18] DCE emerged as an effective means of surgical management in cases where nonoperative methods such as nonsteroidal anti-inflammatories, corticosteroid injections, and physical rehabilitation have failed.[1,6] Traditionally, DCE was performed via an open approach.[10,18] However, arthroscopic DCE has become increasingly common, with 65% to 79% of all DCEs being performed arthroscopically.[2] Whether DCE should be performed via an open or arthroscopic approach remains a controversial topic.[1,15]

Institutional review board approval was not required for this retrospective study.
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The open approach allows for direct visualization of the joint space. However, it risks injury to the superior capsular and ligamentous structures and has been associated with an increased incidence of AC joint instability and postoperative shoulder weakness.[8,11,22,32] The open approach may be preferred in revision cases or cases of isolated distal clavicle osteolysis or arthritis in which visualization of the glenohumeral joint or subacromial space is unnecessary.[1] However, impingement lesions as well as other glenohumeral lesions are often difficult to appreciate on preoperative imaging, and the arthroscopic technique confers the advantage of being able to diagnose and treat these lesions.[15]

The arthroscopic approach is associated with less tissue destruction, improved cosmesis,[4,8] as well as less postoperative pain, faster return to activities of daily living,[4,15] and higher patient satisfaction than the open approach.[3,4,9,12,20,26,41] Cadaveric evidence has demonstrated the technical adequacy of the arthroscopic approach.[24] However, the limited visualization inherent to arthroscopic surgery has sparked concerns over the ability to perform a complete excision of the distal clavicle, especially of the superior-posterior aspect, and consequently result in persistent pain and dysfunction necessitating revision surgery.[24,37]

Previous investigations which studied demographics and trends of patients undergoing arthroscopic vs. open DCE have found that arthroscopic DCEs progressively increased, and open DCEs decreased from 2004 to 2013.[1,2] However, recent data on trends in the usage of these two techniques are lacking. In addition, little evidence comparing the reimbursement and incidence of postoperative complications between arthroscopic and open techniques is available. Therefore, the objectives of this study were to (1) identify most recent national trends in the usage of open vs. arthroscopic approaches for DCE from 2007 to 2017; (2) to identify and compare the complication rates for both approaches, and to identify patient-specific risk factors for complications; (3) to identify and compare the revision rate for both approaches; and (4) to identify and compare the average reimbursement rates of each approach.

Methods

Database

In this study, the Humana administrative claims database was queried using the PearlDiver Patient Record Database (PearlDiver Inc, Fort Wayne, IN; www.pearldiverinc.com). The database houses deidentified patient information from a variety of insurers including Humana's claims database and the Medicare Standard Analytical files from 2007 to 2017. Data regarding patient demographics, medical comorbidities, postoperative complications, prescription medication usage, geographic information, and procedural volumes were queried using International Classification of Disease Ninth and Tenth Revision (ICD-9 and ICD-10) codes, Current Procedural Terminology (CPT) codes, and National Drug Codes. For this study, the Humana Orthopedic private payer database was used. The advantages of this database include a large national patient population (up to 11 million patients per year), ability to analyze various comorbidities and rare postoperative complications, and the ability to longitudinally track patients. This study was granted exemption from the institutional review board as PearlDiver uses deidentified patient information.

Patient selection and study outcomes

A retrospective analysis of patients undergoing DCE was performed from 2007 to 2017. All patients who underwent open and arthroscopic DCE were identified using the CPT codes 23120 and 29824, respectively. Patients of all ages were included. Patients who were not active for at least 90 days after DCE within the database or for whom laterality data were not available were not included in the study. Laterality data were necessary to ensure that concurrent and revision procedures captured in this study via sequential coding were on the same side as the index procedure. Patients who underwent concurrent rotator cuff repair (RCR), total shoulder arthroplasty (TSA), or superior labrum anterior-posterior (SLAP) repair were excluded from the analysis. Those patients who underwent concurrent biceps tenodesis (BT) (CPT-23430 and CPT-29828) or subacromial decompression (SAD) (CPT-29826) were included. Biceps tenotomy without tenodesis was not included. We limited this study to isolated DCE and DCE with SAD or BT because many patients who undergo combined DCE and RCR, TSA, and SLAP repair may have complications related to the RCR, TSA, or SLAP repair, which would have confounded our analysis. Given the significant differences in the rates at which BT and SAD were performed in open and arthroscopic cohorts, concurrent BT and SAD were included in subgroup multivariate analysis to determine whether or not they were significant confounding variables.

Patient demographics and comorbidities were recorded. To assess annual trends in DCE, the incidence of both open and arthroscopic DCE was plotted against time. In addition, the incidence of postoperative complications including surgical site infection (SSI), death, acute kidney injury, cardiac arrest, deep vein thrombosis, wound disruption, postoperative hematoma, nerve injury, pneumonia, pulmonary embolism, requirement for postoperative blood transfusion, and urinary tract infection within 90 days of surgery was recorded and compared for patients undergoing open and arthroscopic DCE. Patient-specific risk factors for complications were identified.

In order to determine the revision rate for patients undergoing arthroscopic and open DCE, a subset of the patients ($n = 2448$) who had at least 5 years of database activity after their index procedure was identified, and the incidence of ipsilateral subsequent open or arthroscopic DCE was calculated.

Finally, a cost analysis was performed to evaluate the difference in cost between the open and arthroscopic DCE groups. The cost data represent the total reimbursement for the day of surgery. The mean amount of money paid per procedure for open vs. arthroscopic DCE was then compared. The cost data were obtained as part of the output data for queries of the arthroscopic and open DCE.

Statistical analysis

Pearson's chi-square tests were used for univariate analysis to identify possible risk factors for complications. Multivariate logistic regression was performed to identify significant independent predictors, and the resulting odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for all independent predictors of complications after DCE. A subgroup analysis was performed to identify risk factors for complications after open and arthroscopic DCE. Univariate and multivariate analyses were performed using the open source R tool (www.r-project.org) housed within PearlDiver. Statistical significance was defined as $P < .05$.

Results

A total of 11,228 patients were identified as meeting the aforementioned inclusion criteria. Of these patients, 8933 patients (79.5%) underwent arthroscopic DCE, with the remainder undergoing open DCE. To assess trends in the amount of DCE being performed each year, incidence of both open and arthroscopic DCE was plotted in Fig. 1 against time. The annual incidence of arthroscopic DCE increased from 2007 to 2016. Over the same time

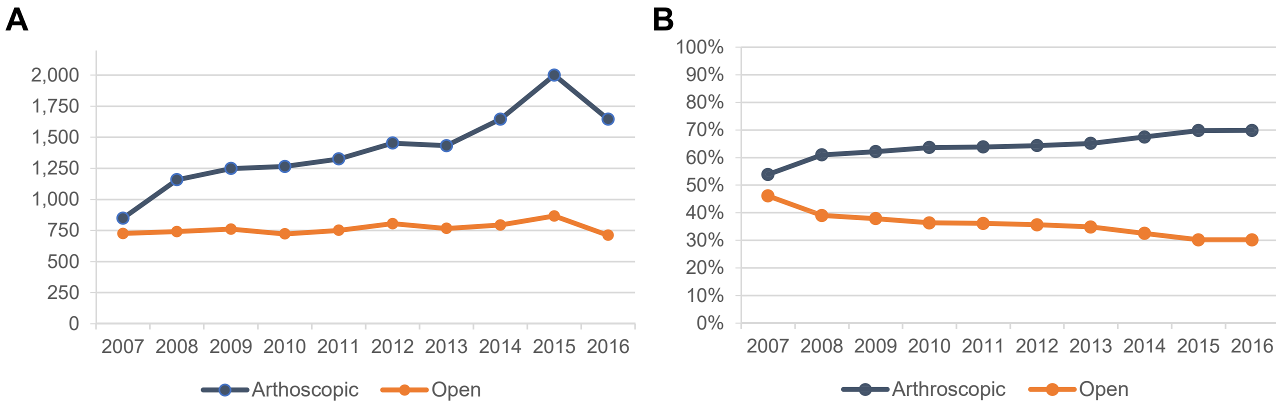

Figure 1 (**A**) The annual incidence (absolute number) of DCE performed arthroscopically vs. open from 2007 to 2016 within the Humana database. (**B**) The annual percentage of DCE performed via an arthroscopic vs. open approach as a percent of total DCE from 2007 to 2016 within the Humana database. *DCE*, distal clavicle excision.

period, the incidence of open DCE remained stable, whereas the percentage of DCEs performed via an open technique decreased significantly over this time period (46.1% in 2007 vs. 30.2% in 2016, $P < .001$) (Fig. 1*A* and *B*). The percentage of DCEs being performed arthroscopically increased over the study period (53.9% in 2007 vs. 69.8% in 2016, $P < .001$). Notably, the ratio of arthroscopic DCE to open DCE decreased across all age groups, and by age 80, patients are equally likely to undergo arthroscopic DCE as open (Fig. 2). Patient demographics for the open and arthroscopic cohorts can be found in Table I.

Open DCE was associated with a significantly greater incidence of postoperative complications (10.8% vs. 7.3%, $P < .001$) relative to arthroscopic DCE (Table II). Specifically, open DCE was associated with a significantly greater incidence of wound disruption (0.3% vs. 0.1%; $P < .001$), postoperative hematoma (0.9% vs. 0.2%; $P = .001$), transfusion (0.6% vs. 0.1%; $P < .001$), and SSI (1.9% vs. 0.3%; $P < .001$) than arthroscopic DCE (Table II).

Multivariate regression identified female gender (OR = 1.61; 95% CI, 1.44-1.80; $P < .001$), congestive heart failure (OR = 1.36; 95% CI, 1.14-1.63; $P < .001$), chronic obstructive pulmonary disease (OR = 1.53; 95% CI, 1.37-1.72; $P < .001$), chronic kidney disease (OR = 1.88; 95% CI, 1.63-2.17; $P < .001$), diabetes (OR = 1.43; 95% CI, 1.28-1.61; $P < .001$), ischemic heart disease (OR = 1.27; 95% CI, 1.22-1.45; $P < .001$), pulmonary heart disease (OR = 3.26; 95% CI, 2.80-3.80; $P < .001$), and tobacco use (OR = 1.24; 95% CI, 1.10-1.39; $P < .001$) as risk factors for complications in patients undergoing DCE (Table III). Notably, open DCE was a significant risk factor for complications after DCE (OR = 1.73; 95% CI, 1.11-2.69; $P = .015$), whereas arthroscopic DCE was not (OR = 0.92; 95% CI, 0.59-1.44; $P = .718$) (Table III).

Subgroup analysis identified female gender (OR = 1.76; 95% CI, 1.30-2.38; $P < .001$), congestive heart failure (OR = 1.91; 95% CI, 1.32-2.73; $P < .001$), diabetes (OR = 1.58; 95% CI, 1.15-2.17; $P = .005$), pulmonary heart disease (OR = 1.70; 95% CI, 1.11-2.56; $P = .012$), and tobacco use (OR = 1.42; 95% CI, 1.04-1.91; $P = .024$) as risk factors for complications in patients undergoing open DCE and female gender (OR = 1.83; 95% CI, 1.53-2.18; $P < .001$), chronic obstructive pulmonary disease (OR = 1.54; 95% CI, 1.28-1.84; $P < .001$), chronic kidney disease (OR = 1.79; 95% CI, 1.46-2.19; $P < .001$), ischemic heart disease (OR = 1.34; 95% CI, 1.11-1.62; $P = .002$), and pulmonary heart disease (OR = 2.37; 95% CI, 1.85-3.01; $P < .001$) as risk factors for complications in patients undergoing arthroscopic DCE (Table IV). Notably, concurrent SAD and BT were not noted to be significant risk factors for complications after open or arthroscopic DCE (Table IV).

There was no significant difference in the revision rate between patients undergoing arthroscopic and open DCE (1.39% vs. 0.70%; $P = .126$) (Table V).

Fig. 3 demonstrates a reimbursement comparison between open and arthroscopic DCE. In the Humana population, $5408 was the median reimbursement for open DCE, while $5447 was the average reimbursement for arthroscopic DCE ($P = .853$).

Discussion

The principle findings of this investigation are as follows: (1) The percentage of DCEs performed arthroscopically has significantly increased from 53.9% in 2007 to 69.8% in 2016, with a concomitant decrease in the use of open DCE from 46.1% in 2007 to 30.2% in 2016, a change that appears to be driven by an increase in the utilization of arthroscopic DCE, as the incidence of open DCE has remained stable; (2) the open approach was associated with significantly more postoperative complications than the arthroscopic approach, and several risk factors, including open approach, diabetes, heart disease, tobacco use, chronic kidney disease, and female gender, were identified as independent risk factors for complications after DCE; (3) there was no significant difference in revision rate between open and arthroscopic approaches; and finally, (4) there was no significant difference in the average reimbursement of either approach.

In a previous investigation, Alluri et al used a national database to study the trends in arthroscopic and open DCE from 2004 to 2009.[1] The authors found that over this time period, the incidence of arthroscopic DCE increased significantly, whereas the incidence of open DCE significantly decreased.[1] The results of our investigation demonstrated a similar increase in the incidence of arthroscopic DCE from 2007 to 2017. The observed increase in the utilization of arthroscopic DCE over the last two decades is likely multifactorial. The arthroscopic approach affords the unique benefit of being able to diagnose and treat shoulder pathology[27] that may not have been evident on preoperative imaging, a luxury unavailable when DCE is performed via an open approach. Arthroscopic DCE is achieved in a minimally invasive fashion that avoids detaching the deltoid fascia or violating the superior or posterior AC ligaments, which may contribute to less postoperative AC joint instability or shoulder weakness relative to the open approach.[5,11,16,31] Arthroscopic training in residency, fellowship, and various courses is continually improving, and surgeons early in practice are increasingly comfortable with arthroscopic management of AC pathology.[1,2]

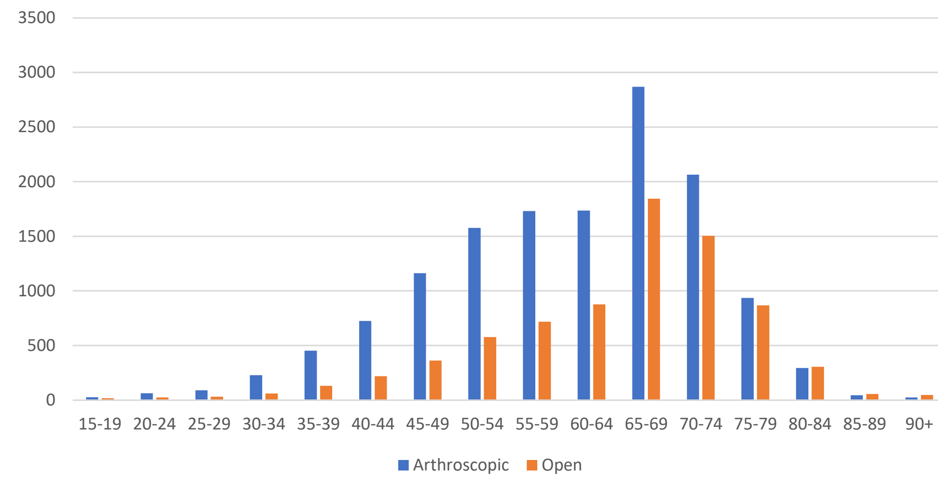

Figure 2 Age distribution of patients undergoing arthroscopic vs. open DCE from 2007 to 2017 within the Humana database. *DCE*, distal clavicle excision.

Table I
Patient demographics.

Demographics	Arthroscopic	%	Open	%	*P* value
Total, n	8933		2295		
Male sex	4785	53.6	1348	58.7	<.001
Age ≥45	7817	87.5	1984	86.4	.174
Obesity	3144	35.2	815	35.5	.796
Tobacco use	3093	34.6	881	38.4	<.001
CCI					<.001
0	3947	44.2	931	40.6	
1	2027	22.7	508	22.1	
2	1022	11.4	274	11.9	
3	726	8.1	204	8.9	
≥4	1211	13.6	378	16.5	
Concurrent procedures					
SAD	8354	93.5	662	28.8	<.001
BT	988	11.1	117	5.1	<.001

BT, biceps tenodesis; *CCI*, Charlson Comorbidity Index; *SAD*, subacromial decompression.

Table II
Postoperative complications within 90 days.

Complication	Arthroscopic	%	Open	%	*P* value
AKI	54	0.6	20	0.9	.206
Cardiac arrest	6	0.1	0	0.0	1.000
DVT	8	0.1	3	0.1	.205
Wound disruption	5	0.1	8	0.3	<.001*
Hematoma	19	0.2	21	0.9	.001*
Nerve injury	4	0.0	0	0.0	.782
Pneumonia	114	1.3	39	1.7	.145
PE	36	0.4	11	0.5	.746
Transfusion	11	0.1	13	0.6	<.001*
UTI	321	3.6	81	3.5	.933
SSI	25	0.3	43	1.9	<.001*
Death	46	0.5	8	0.3	.753
All complications	649	7.3	247	10.8	<.001*

AKI, acute kidney injury; *DVT*, deep vein thrombosis; *PE*, pulmonary embolism; *UTI*, urinary tract infection; *SSI*, surgical site infection.
*Indicates any value of *P*<.05.

However, the results of this study demonstrate that open DCE is still being performed, albeit at less than half the overall rate of arthroscopic DCE. It is likely that several factors underpin this finding. First, the cohort of patients who underwent open DCE were significantly older than those who underwent arthroscopic DCE. Older patients often present with pathology that may be more effectively treated through an open approach, such as AC joint cysts, large superior osteophytes, and revision cases. On the other hand, younger patients who present with osteolysis may be more amenable to treatment through arthroscopic techniques. Another potential explanation is that these cases represent the practice of those surgeons who were trained to perform the procedure via an open approach.[1] Further retrospective studies are necessary to confirm whether these trends are based on the offending diagnosis requiring DCE or surgeon preference.

Notably, Alluri et al found that arthroscopic DCE was more common in younger patients (50 to 59 years old) than open DCE, which was most common in patients aged 60 to 69 years.[1] The

Table III
Risk factors for 90-d complications after DCE.

Variable	OR (95% CI)	P value
Open DCE	1.73 (1.11-2.69)	.015*
Arthroscopic DCE	0.92 (0.59-1.44)	.718
Female gender	1.61 (1.44-1.80)	<.001*
CHF	1.36 (1.14-1.63)	<.001*
COPD	1.53 (1.37-1.72)	<.001*
CKD	1.88 (1.63-2.17)	<.001*
Diabetes	1.43 (1.28-1.61)	<.001*
IHD	1.27 (1.22-1.45)	<.001*
PHD	3.26 (2.80-3.80)	<.001*
Tobacco use	1.24 (1.10-1.39)	<.001*

DCE, distal clavicle excision; *CHF*, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *CKD*, chronic kidney disease; *IHD*, ischemic heart disease; *PHD*, pulmonary heart disease; *OR*, odds ratio; *CI*, confidence interval.
*Indicates any value of P<.05.

Table IV
Subgroup analysis of open vs. arthroscopic risk factors for 90-d complications.

Variable	Open		Arthroscopic	
	OR (95% CI)	P value	OR (95% CI)	P value
Female gender	1.76 (1.30-2.38)	<.001*	1.83 (1.53-2.18)	<.001*
CHF	1.91 (1.32-2.73)	<.001*	1.17 (0.91-1.49)	.225
COPD	1.15 (0.83-1.59)	.401	1.54 (1.28-1.84)	<.001*
CKD	1.20 (0.83-1.70)	.322	1.79 (1.46-2.19)	<.001*
Diabetes	1.58 (1.15-2.17)	.005*	1.14 (0.94-1.37)	.186
IHD	1.09 (0.77-1.53)	.632	1.34 (1.11-1.62)	.002*
PHD	1.70 (1.11-2.56)	.012*	2.37 (1.85-3.01)	<.001*
Tobacco use	1.42 (1.04-1.91)	.024*	1.12 (0.93-1.34)	.240
SAD	0.62 (0.42-1.89)	.112	0.75 (0.35-1.42)	.410
BT	0.57 (0.22-1.23)	.198	3.55 (0.52-14.8)	.120

CHF, congestive heart failure; *COPD*, chronic obstructive pulmonary disease; *CKD*, chronic kidney disease; *IHD*, ischemic heart disease; *PHD*, pulmonary heart disease; *SAD*, subacromial decompression; *BT*, biceps tenodesis; *OR*, odds ratio; *CI*, confidence interval.
*Indicates any value of P<.05.

Table V
Revision rates for patients who have a minimum of 5 y follow-up within the Humana database.

Open DCE		Percent requiring revision	P value
Total, n	861		.126
Revision, n	6	0.70	
Arthroscopic DCE			
Total, n	1587		
Revision, n	22	1.39	

DCE, distal clavicle excision.

results of our study support this finding—the ratio of arthroscopic DCE to open DCE decreased across all age groups, and by age 80 years, patients are equally likely to undergo arthroscopic DCE as open. In addition, Alluri et al found that of patients undergoing DCE, SAD was performed with 23% of open DCE, whereas it was 95% with arthroscopic DCE.[1] The present investigation finds that patients undergoing arthroscopic DCE were significantly more likely to undergo SAD (89.0% vs. 16.3%) than those undergoing open DCE. Interestingly, subgroup multivariate analysis revealed that these concurrent procedures were not significantly associated with complications in either the open or arthroscopic cohort.

Several studies have reported the complication rates associated with both open and arthroscopic DCE. However, the reported incidences of complications vary widely in the literature, likely as a result of small sample sizes in available studies and varied definitions of postoperative complications. In studies that have examined the complication rate of open DCE, complications including infection, postoperative pain or weakness, stiff shoulder, residual AC joint sensitivity, scar sensitivity, and hypertrophic scar formation have been reported to range from 0% to as high as 64%.[5,7–9,12,13,17–19,26,28,29,34,35,39,40] The range of complication rates after arthroscopic DCE has been similarly broad, ranging from 0% to 33.3%.[3,5,13,14,16,20,23,36,38,41] Our investigation found that overall complication rates for both arthroscopic and open DCE were low. However, a significantly greater incidence of postoperative complications within 90 days of surgery was seen in patients undergoing open DCE. To our knowledge, this is the first study that has directly compared complication rates of open and arthroscopic DCE. Most notably, 1.9% of patients who underwent open DCE developed an SSI compared with 0.3% in those managed arthroscopically. In addition, patients who underwent open DCE were three times more likely to suffer a wound disruption. Although rare, those undergoing open DCE were four times more likely to suffer a postoperative hematoma and six times more likely to suffer a postoperative transfusion relative to arthroscopic DCE.

Previous investigations have cited concerns over limited visualization with the arthroscopic approach, which could compromise an effective and complete DCE. An incomplete excision would, in turn, result in persistent pain and dysfunction necessitating revision surgery.[24,37] We observed that the percent of patients requiring a revision surgery within 5 years of their DCE was 0.70% and 1.39% for open and arthroscopic approaches, respectively. The rate of revision was not significantly different ($P = .126$) for these groups.

The economic comparison of open vs. arthroscopic DCE remains poorly elucidated. Authors who advocate for the economic superiority of the arthroscopic approach cite the fact that the arthroscopic approach may be performed in an outpatient setting and allows for faster return to employment, whereas the open approach may require an inpatient stay and longer employee disability.[25] Alternatively, arthroscopic procedures often require longer setup times and expensive instrumentation.[27] A more recent study by Robertson et al found no significant difference in operation times between the open and arthroscopic DCE.[33] Our investigation examined the total reimbursement for the day of surgery within the Humana database and found no significant differences in the reimbursement amounts between open and arthroscopic DCE. However, observed reimbursement rates may be confounded by the fact that concurrent procedures such as SAD and BT are frequently performed with DCE, especially when performed arthroscopically.

Limitations

There are several, well-documented, limitations to this study inherent to large national databases such as PearlDiver.[21,30] First, the accuracy of the information is directly related to the accuracy of the coding process, as ICD and CPT codes were used to query the data. Second, the database is unable to define whether or not the procedure we captured was truly a primary DCE. It is also possible that a patient had a DCE performed before being under Humana coverage. Third, patient-reported outcomes are not documented in this database, and therefore, the impact of open vs. arthroscopic DCE on these outcomes could not be assessed. Fourth, because patients undergoing BT were included in this cohort, it is unclear if SSI or wound disruption was related to the DCE incision(s) or an incision used to perform an open BT. However, BT was more commonly performed in the arthroscopic DCE cohort in the present study, yet higher SSI and wound disruptions rates were found in the open DCE cohort. In addition, BT and SAD were both included in subgroup multivariate regressions, and neither was shown to be significantly associated with complications after arthroscopic or open DCE. Finally, operative and postoperative information such as

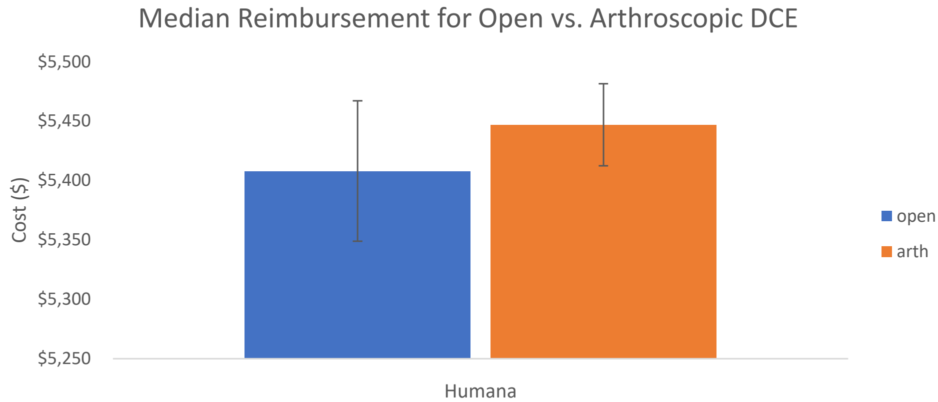

Figure 3 Median cost of open surgery was $5408, and arthroscopic was $5447. There was no significant difference in the cost of open vs. arthroscopic surgery among Humana patients ($P = .853$). *DCE*, distal clavicle excision.

operative time, time under anesthesia, incision size, and rehabilitation protocol were not available within the database.

Conclusion

Both arthroscopic and open DCE techniques were found to have similar reimbursement amounts, with a low rate of complications, although the open technique had a higher rate of early complications such as SSI. Over the study period, there was an increase in the utilization of arthroscopic DCE, while the incidence of the open technique remained constant.

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Samuel A. Taylor is a paid consultant for DJ Orthopaedics and Mitek.
Lawrence V. Gulotta is a paid consultant and paid presenter or speaker for and received research support from Biomet; received IP royalties from and is a paid presenter or speaker for Exactech, Inc; is in the editorial or governing board of HSS Journal; has stock or stock options in Imagen, Inc and Responsive Arthroscopy, Inc; and is a paid presenter or speaker for Smith & Nephew.
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