Trends in surgical ablation at the time of cardiac surgery among patients with atrial fibrillation

Haley N. Jenkins, MD,[a] Aaron J. Weiss, MD, PhD,[a] Jean-Luc A. Maigrot, BS,[a] Guangjin Zhou, PhD,[b] Siran M. Koroukian, PhD,[b] A. Marc Gillinov, MD,[a] Lars Svensson, MD, PhD,[a] and Edward G. Soltesz, MD, MPH[a]

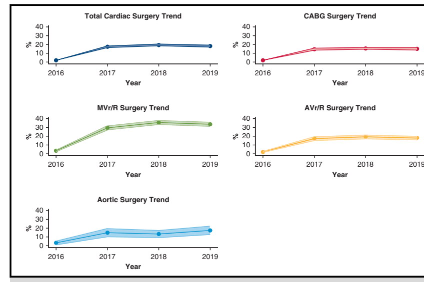
ABSTRACT

Background: The 2017 American Association for Thoracic Surgery (AATS) guidelines support surgical ablation in patients undergoing cardiac surgery with preoperative atrial fibrillation (AF) owing to a reduction in early mortality and improved overall safety. We explored practice patterns changes and outcomes in patients undergoing concomitant surgical ablation following the guideline change.

Methods: We identified 19,246 patients with preoperative AF who underwent cardiac surgery between 2016 and 2019 from the Florida and Maryland State Inpatient Databases. Rates of surgical ablation by procedure type were temporally trended across years. Secondary outcomes included complications, inpatient mortality, and hospital readmissions. Using multivariable logistic regression, we identified patient variables associated with concomitant surgical ablation.

Results: A total of 2738 patients (14.3%) with AF underwent a concomitant surgical ablation. The rate of surgical ablation increased from 2.1% to 17.4% ($P < .001$) from 2016 to 2017 but remained unchanged thereafter. Postoperative mortality was lower in the surgical ablation cohort (2.7% vs 3.7%; $P = .006$), although with a higher rate of pacemaker insertion (11.8% vs 7.2%; $P < .0001$). Patients with a high-risk Elixhauser score (odds ratio [OR], 0.83; 95% confidence interval [CI], 0.73-0.95), lower income (OR, 0.66; 95% CI, 0.57-0.75), or African American or Hispanic race/ethnicity (OR, 0.80; 95% CI, 0.67-0.96 and OR, 0.82; 95% CI, 0.71-0.96, respectively) had lower odds of undergoing concomitant surgical ablation.

Conclusions: Despite a class I-2a recommendation by the AATS, surgical ablation continues to be underutilized in clinical practice, especially in patients with high-risk comorbidities, with lower incomes, or from minority populations. Surgeons should be mindful of guideline-directed AF management in these vulnerable populations. (JTCVS Open 2023;16:333-41)



Rates of concomitant surgical ablation in patients with atrial fibrillation by year.

CENTRAL MESSAGE

Despite current guidelines and a favorable safety profile, concomitant surgical ablation continues to be underused in clinical practice, especially in minority and low-income populations.

PERSPECTIVE

Given that an increasing number of patients presenting for cardiac surgery have atrial fibrillation, several societies have updated their guidelines to support concomitant surgical ablation, based on its overall safety and high success rate. Our data further confirm the relative safety of surgical ablation and demonstrate that socioeconomic factors may contribute to the low overall adoption in clinical practice.

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia, with a prevalence of approximately 3% in the United States, increasing up to 10% in patients being considered for cardiac surgery.[1-3] AF is associated with a 4-to 5-fold increased risk of stroke and a 2-fold increased risk of mortality, owing primarily to cerebrovascular events

From the [a]Department of Thoracic and Cardiovascular Surgery, Kaufman Center for Heart Failure and Recovery, Heart, Vascular and Thoracic Institute, Cleveland Clinic, Cleveland, Ohio; and [b]Department of Population and Quantitative Health Sciences, Case Western Reserve University School of Medicine, Cleveland, Ohio.
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Address for reprints: Edward G. Soltesz, MD, MPH, Department of Thoracic and Cardiovascular Surgery, Heart, Vascular, and Thoracic Institute, Cleveland Clinic, 9500 Euclid Ave, Desk J4-1, Cleveland, OH 44195 (E-mail: soltese@ccf.org).
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Abbreviations and Acronyms

AATS	= American Association for Thoracic Surgery
AF	= atrial fibrillation
AVr	= aortic valve repair
AVR	= aortic valve replacement
CABG	= coronary artery bypass graft
CI	= confidence interval
ICD-10	= International Classification of Diseases, Tenth Revision
IQR	= interquartile range
MVr	= mitral valve repair
MVR	= mitral valve replacement
OR	= odds ratio
POA	= present on admission
PPM	= permanent pacemaker
SD	= standard deviation
SID	= State Inpatient Database
STS	= Society of Thoracic Surgeons

and progressive atrial and ventricular dysfunction.[4,5] To address the increased morbidity and mortality associated with AF, a number of surgical- and catheter-based options to treat AF are now available.[4,6-8] Since the original "cut and sew" Cox-Maze procedure was introduced in 1987, the surgical lesion set for AF is now achieved primarily through a combination of bipolar radiofrequency ablation and cryotherapy. Left atrial appendage closure is commonly performed concomitantly, given that the appendage is responsible for approximately 90% of embolic complications in patients with AF.[3,9,10]

The efficacy of surgical ablation in restoring sinus rhythm at 1 year approaches 90%, with the additional benefit of potential freedom from anticoagulation and antiarrhythmic medications along with their associated side effects.[8] In clinical practice, a wide range of lesion sets and surgical techniques are used, including the full biatrial Cox-Maze IV lesion set, an isolated left atrial maze lesion set, or bilateral pulmonary vein isolation. Current data on the relative effectiveness in restoring normal sinus rhythm between each lesion set are limited; however, most evidence supports performing a full biatrial Cox-Maze IV procedure.[11,12] Several studies have confirmed that the addition of surgical ablation at the time of cardiac surgery does not increase operative mortality, although it has been associated with a 2- to 3-fold higher rate of permanent pacemaker (PPM) insertion.[12,13]

In light of the safety and effectiveness of concomitant surgical ablation, the Society of Thoracic Surgeons (STS) updated their guidelines in 2017 to recommend concomitant surgical ablation as a class 1 indication in patients with preoperative AF undergoing isolated mitral valve, aortic valve, coronary artery bypass graft (CABG), or CABG with aortic valve procedures.[14] Updated expert consensus in 2017 from the Heart Rhythm Society similarly supported a class 1 recommendation for concomitant open (such as mitral valve) surgical ablations for symptomatic AF and concomitant closed (such as CABG and aortic valve surgery) for symptomatic AF intolerant to standard medical therapy.[15] The American Association for Thoracic Surgery (AATS) updated their guidelines in 2017, noting that it is reasonable (class 2a recommendation) to perform a concomitant surgical ablation on a patient presenting with AF owing to its safety, reduction in late stroke, and significant improvement in quality of life.[16] Furthermore, the AATS supports a class 1 recommendation regarding a reduction in 30-day operative mortality following concomitant ablation.[16]

Despite these notable society-based guideline recommendations, the adoption of concomitant surgical ablation in clinical practice has lagged. Reported rates of surgical ablation at the time of mitral surgery are as high as 30% to 60%, and rates of surgical ablation during aortic valve or CABG procedures are 15% to 40%.[13] The primary aim of this study was to determine the temporal trends in surgical ablation performed before and after the change in AATS guidelines supporting the use of concomitant surgical ablation. We also wanted to understand which patients were less likely to be offered a concomitant surgical ablation. Secondary aims included comparing patient preoperative characteristics, postoperative outcomes, and rates of readmission between AF patients who received a surgical ablation and those who did not. Given the current evidence, we hypothesize that concomitant ablation will remain underused in clinical practice despite demonstrated safety and patient benefits.

METHODS

A retrospective patient cohort was identified from the Florida and Maryland State Inpatient Database (SIDs) from January 2016 to December 2019. The Florida and Maryland SIDs are administrative databases developed by the Healthcare Cost and Utilization Project and maintained by the Agency for Healthcare Research and Quality. The Florida SID and Maryland SID were selected for this study because of their specific present on admission (POA) indicator. These databases are particularly useful in population-based studies of cardiac surgery and AF, given that AF is a common postoperative complication of cardiac surgery and its preoperative diagnosis can be confirmed using a POA indicator.

The Florida SID and Maryland SID were queried from January 1, 2016, to December 31, 2019, for all adult (≥18 years) patients with a preoperative diagnosis of AF who underwent cardiac surgery. Preoperative AF was identified with a POA flag and was defined as paroxysmal, persistent, long-standing persistent, or permanent AF that was documented prior to the index operation using International Classification of Diseases, 10th Revision (ICD-10) diagnostic codes. Patients undergoing CABG, aortic valve repair (AVr) or replacement (AVR), mitral valve repair (MVr) or replacement (MVR), aortic surgery, or a combination of the above were included in the study using ICD-10 procedure codes. Patients were then divided into 2 cohorts: those receiving a concomitant surgical ablation at the time of the index operation and those who not receiving an ablation. Patients who underwent catheter-based ablation, had a heart transplant, or had a mechanical circulatory assist device at the time of operation were excluded. Surgical ablation was defined as any creation of an AF lesion set through an open atrial approach or via pulmonary vein isolation, excluding any transcatheter lesion sets. Because the Florida and Maryland SID track patients across years, longitudinal data on readmissions were established at 90 days and 180 days. Multiple readmissions linked to individual patients were recorded, and patients who died during the follow-up period after discharge were excluded from the readmission cohorts assessed. This study was deemed exempt from review by the Cleveland Clinic Institutional Review Board, which waived the requirement for informed consent because only deidentified data were used.

Patient demographic data included age, sex, race, median household income, and medical insurance type. The Elixhauser comorbidity index, a well-established method of categorizing patient comorbidity burden using ICD-10 diagnoses divided into 31 categories, was used to quantify the preoperative comorbidity profile and was stratified into low-risk (score <5), medium-risk (6-15), and high-risk (16+) groups.[17] The CHA_2DS_2-VASc score, a point-based system used to stratify the risk of stroke in AF patients, was also calculated from the preoperative data collected.[6] Continuous variables were recorded as mean and standard deviation (SD), and categorical variables were recorded as count and proportion or as median and interquartile range (IQR).

To examine rates of surgical ablation per year from 2016 to 2019, a linear regression trend test was used to trend rates of ablation per year and establish significance between years. Preoperative comorbidity and socioeconomic profiles were established between the 2 cohorts by comparing demographic characteristics, Elixhauser scores, and CHA_2DS_2-VASc scores using the nonparametric Wilcoxon rank-sum test for continuous variables and the chi-square test for categorical variables. Rates of postoperative in-hospital complications were compared using the chi-square test. Postoperative outcomes also were assessed by hospital volume, regarding both surgical ablations and overall cardiac surgery volume per hospital per year. To accomplish this, surgical centers were equally distributed into 4 quartiles based on both annual surgical ablations and overall cardiac surgery volume. Mortality, overall complication rates, and length of stay were analyzed by chi-square analysis.

A multivariable logistic regression model was developed to determine factors associated with receiving a surgical ablation, with results presented as odds ratio (OR) with 95% confidence interval (CI). Demographic information, Elixhauser score, and type of surgical procedure were included in the multivariable logistic analysis. Outcomes at 90 days and 180 days were analyzed using in-hospital readmission data. For each readmission within the 90-day or 180-day range, the primary and secondary diagnosis for that hospital admission was queried and recorded as the leading conditions for readmission. Rates of the most frequent diagnoses at readmission were compared between the surgical ablation and cardiac surgery only cohorts using the chi-square test. A P value < .05 was considered to indicate statistical significance. All analyses were performed using the SAS System for Unix 9.4 (SAS Institute).

RESULTS

Our study population comprised 19,246 patients with AF who underwent cardiac surgery. Of those, only 2738 patients (14.3%) received a concomitant surgical ablation. Preoperative characteristics, including age and sex, were clinically similar in the cardiac surgery alone cohort and the surgical ablation cohort (Table 1). The mean Elixhauser comorbidity index was higher in the cardiac surgery alone cohort compared to the surgical ablation cohort (9.89 ± 6.64 vs 9.44 ± 6.51; P = .008). The median CHA_2DS_2-VASc score was 4 (IQR, 3-5) in both cohorts (P < .001).

TABLE 1. Preoperative patient characteristics of patients with AF undergoing cardiac surgery alone versus cardiac surgery with surgical ablation

	Value		
Variable	Surgery alone (N = 16,508)	Surgical ablation (N = 2738)	*P* value
Sex, n (%)			.003
Male	11,731 (71.1)	1871 (68.3)	
Race, n (%)			.145
White	13,145 (79.6)	2229 (81.4)	
Black	1088 (6.6)	161 (5.9)	
Hispanic	1550 (9.4)	232 (8.5)	
Median household income, n (%)			<.001
$1-$24,999	4855 (29.4)	640 (23.4)	
$25,000-$34,999	5221 (31.6)	906 (33.1)	
$35,000-44,999	3976 (24.1)	707 (25.8)	
$45,000+	2214 (13.4)	447 (16.3)	
Insurance, n (%)			.818
Medicaid	661 (4.0)	115 (4.2)	
Medicare	12,338 (74.7)	2018 (73.7)	
Private	2783 (16.9)	481 (17.6)	
Uninsured	249 (1.5)	40 (1.5)	
Age, y, mean ± SD	70.4 ± 9.7	69.6 ± 9.0	<.001
Elixhauser score, mean ± SD	9.89 ± 6.64	9.44 ± 6.51	.001
CHA_2DS_2-VASc, median (IQR)	4 (3-5)	4 (3-5)	<.001

SD, Standard deviation; *IQR*, interquartile range; *AF*, atrial fibrillation.

Overall rates of surgical ablation were highest in patients undergoing isolated mitral valve surgery, 27.27% of whom received an ablation. Lower rates of ablation were observed in the isolated CABG, AVR/r, and aortic surgery cohorts (11.34%, 13.31%, and 9.09%, respectively), as well as in patients with combination surgery (Table 2). Between 2016 and 2017, when the guidelines changed, overall rates of surgical ablation increased considerably (from 2.1% to 17.4%; $P < .001$) but remained stagnant thereafter, at 19.6% in 2018 and 18.4% in 2019. A subanalysis by surgical type showed a similar trend, with the mitral surgery group again demonstrating the highest rates of surgical ablation (2016, 5.2%; 2017, 29.7%; 2018, 35.8%; and 2019, 33.9%). The rest of the surgical case types also demonstrated a higher rate of ablation in 2017 compared to 2016, with rates then leveling off thereafter (Figure 1). Patients undergoing aortic surgery had the lowest rates of concomitant ablation (2016, 0%; 2017, 8.3%; 2018, 9.2%; 2019, 13.1%), with rates in the CABG group (2016, 1.7%; 2017, 14.7%; 2018, 15.8%; 2019, 15.2%) and AVR/AVr group (2016, 2.3%; 2017, 17.2%; 2018, 19.5%; 2019, 18.1%) similar to the overall trend.

To better understand why demonstrated concomitant ablation rates were lower than expected despite the changes in numerous society guidelines, a multivariable regression analysis was performed to predict factors associated with receipt of ablation. The results showed that patients receiving concomitant surgical ablation had greater odds of undergoing mitral valve surgery (OR, 2.32; 95% CI, 2.06-2.62; $P < .001$). Patients with a high-risk Elixhauser score (OR, 0.83; 95% CI, 0.73-0.95; $P = .01$), incomes in the lowest quartile (OR, 0.66; 95% CI, 0.57-0.75; $P < .001$), or who were African American race (OR, 0.80; 95% CI, 0.67-0.96; $P = .016$) or Hispanic ethnicity (OR, 0.82; 95% CI, 0.71-0.96; $P = .013$) had significantly lower odds of receiving a surgical ablation. Patient sex, medical insurance type, and $CHA_2DS_2VAS_C$ score were not significantly associated with receiving an ablation (Figure 2).

Despite low rates of concomitant ablation, postoperative outcomes in the surgical ablation cohort were overall favorable compared to the cardiac surgery only cohort. In-hospital mortality was significantly lower in the surgical ablation cohort (2.7% vs 3.7%; $P = .005$) with an overall shorter length of stay (mean, 11.25 days vs 12.52 days; $P < .001$). In the surgical ablation cohort, rates of prolonged intubation >72 hours (4.8% vs 6.4%; $P < .001$), cardiogenic shock (2.9% vs 4.2%; $P < .001$), renal failure requiring dialysis (0.6% vs 1.1%; $P = .011$), and bleeding (21.1% vs 23.3%; $P = .012$) were significantly lower. The rate of stroke was similar in the surgical ablation cohort and the cardiac surgery alone cohort (0% vs 0.6%; $P = .052$). However, the surgical ablation cohort had a significantly higher PPM requirement (11.8% vs 7.2%; $P < .001$) and a higher non-AF arrhythmia burden (18.6% vs 15.3%; $P < .001$) (Table 3). Discharge to home (13.5% of the surgical ablation cohort vs 13.8% of the cardiac surgery alone cohort; $P = .6746$) or to home with home health care (49.3% vs 46.0%; $P = .002$) was similar in the 2 cohorts.

TABLE 2. Surgical ablation rate by surgical type over all years

Procedure type	Surgery alone, n (%)	Surgical ablation, n (%)
CABG	11,526 (88.0)	1573 (12.0)
MVR/MVr	2823 (75.0)	939 (25.0)
AVR/Avr	4436 (86.6)	685 (13.4)
Aortic	863 (87.8)	120 (12.2)

CABG, Coronary artery bypass grafting; *MVR*, mitral valve replacement; *MVr*, mitral valve repair; *AVR*, aortic valve replacement; *AVr*, aortic valve repair.

Postoperative outcomes were similarly assessed by hospital volume to better elucidate hospitals' experience with overall outcomes following concomitant ablation. Hospital volume by number of concomitant surgical ablations per year per hospital was divided into 4 quartiles ranging from ~1 to 2 ablations in the lowest quartile to >18 ablations in the highest quartile. There was no significant difference in mortality demonstrated between quartiles among patients receiving an ablation (3.6%, 3.0%, 2.6%, and 1.8% in the lowest through highest quartiles, respectively; $P = .237$). Hospital volume also was characterized by overall cardiac surgery volume per year per hospital and divided into 4 quartiles, with <45 surgeries per year per hospital in the lowest-volume quartile and >111 in the highest-volume quartile. The highest-volume quartile had a significantly higher rate of concomitant surgical ablations compared to the lowest-volume quartile (26.99% vs 18.96%; $P < .001$).

On multivariable analysis, undergoing cardiac surgery at centers in the highest-volume quartile was predictive of receipt of surgical ablation (OR, 1.615; 95% CI, 1.426-1.829; $P < .001$). There was no difference in mortality rate among patients receiving a concomitant surgical ablation based on overall cardiac surgery volume (0%, 0%, 2.9%, and 2.6% in the lowest-volume through highest-volume quartiles, respectively; $P = .687$), although with power limited by the sample size. Higher-volume cardiac surgery centers did show a decreased mean length of stay (8, 9, 7, and 7 days in the lowest through highest quartiles, respectively; $P = .002$), but no difference in overall complication rate (59.6%, 60.3%, 59.5%, and 58.5%; $P = .922$).

There were no significant differences in readmission rates at 90 days between the 2 cohorts, with 720 patients (29.4%) readmitted in the surgical ablation cohort versus 4328 patients (29.1%) in the cardiac surgery alone cohort ($P = .710$). Among those who were readmitted, the surgical ablation cohort had a lower rate of readmission for renal failure (11.4% vs 15.4%; $P < .005$), with no significant differences in the rates of readmission for heart failure (26.8% vs 26.5%; $P = .875$), acute respiratory failure (18.9% vs 16.5%; $P = .116$), sepsis (8.2% vs 9.9%; $P = .159$), or

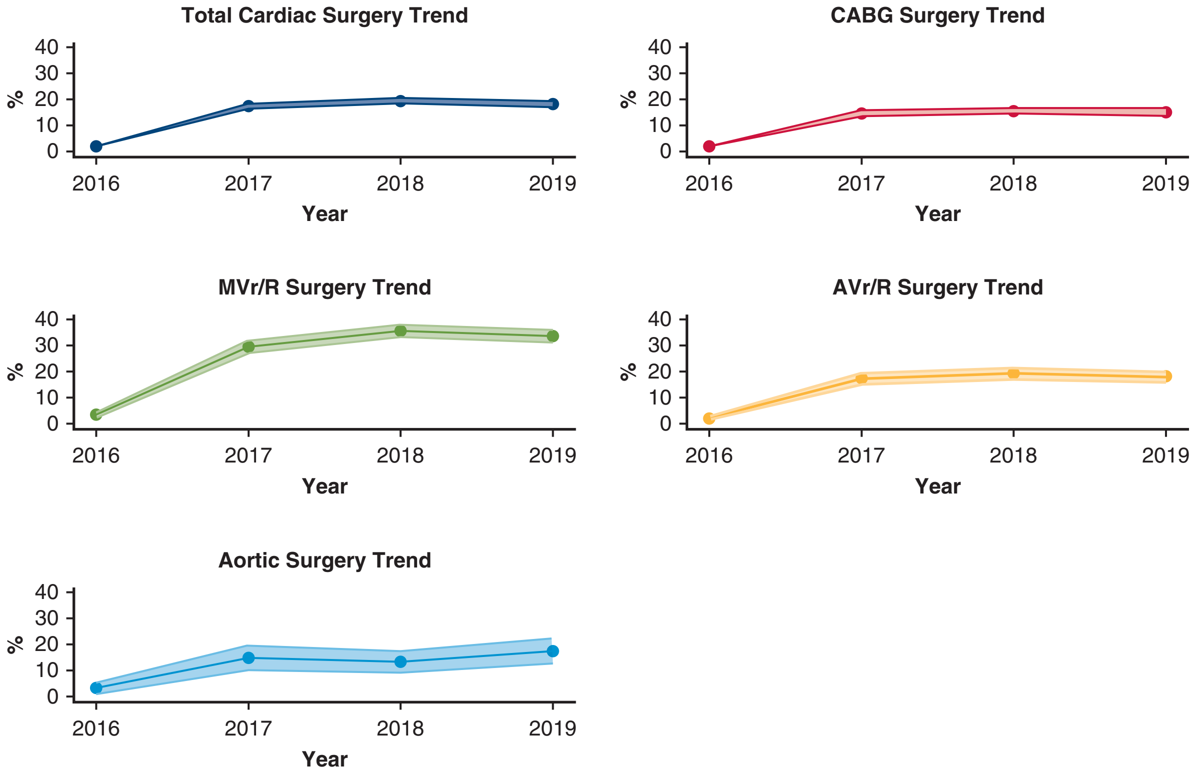

FIGURE 1. Temporal trend in rates of concomitant surgical ablation among patients with preoperative atrial fibrillation from January 2016 to December 2019. The *vertical black line* represents the 2017 guideline changes. *CABG*, Coronary artery bypass grafting; *MVr/R*, mitral valve repair/replacement; *AVr/R*, aortic valve repair/replacement.

bleeding (3.9% vs 4.1%; $P = .779$). Rates of readmission for AF were significantly higher at 90 days in the surgical ablation cohort (25.8% vs 16.9%; $P < .001$). The rate of readmission for PPM placement was higher in the surgical ablation cohort (4.2% vs 2.8%; $P = .055$), but with borderline significance (Table 4). At 180 days, overall rates of readmission were also similar in the surgical ablation and cardiac surgery alone cohorts (34.7% vs 35.3%; $P = .591$). Among those patients readmitted, there continued to be a higher rate of readmission for AF or atrial flutter (27.4% vs 18.2%; $P < .001$) and PPM insertion (5.8% vs 3.6%; $P = .004$) in the surgical ablation cohort. There was a lower readmission rate for renal failure (13.8% vs 17%; $P = .026$) in the surgical ablation cohort. Readmission for heart failure (26.8% vs 27.2%; $P = .812$), sepsis (10.0% vs 11.5%; $P = .219$), and bleeding (4.9% vs 5.0%; $P = .867$) remained similar in the surgical ablation and cardiac surgery alone cohorts (Table 5).

DISCUSSION

Our results demonstrate that despite 2017 AATS, STS, and Heart Rhythm Society guideline changes supporting concomitant surgical ablation at the time of cardiac surgery in patients with a preoperative diagnosis of AF, surgical ablation continues to be underused in clinical practice. Although there was an initial increase in the rate of surgical ablation after publication of the guidelines, utilization leveled off and remained at still low levels thereafter. Low rates of surgical ablation at the time of cardiac surgery were seen regardless of the type of surgery being performed. However, patients receiving mitral valve surgery were more likely to receive a concomitant ablation, perhaps because of the left atrial exposure required to complete the operation and the fewer additional steps needed to complete an ablation. However, patients undergoing CABG and AVR/r had a <20% rate of surgical ablation despite meeting class 1 recommendations for surgical ablation. This may be due to hesitation to add additional case components by exposing the left atrium; however, evidence supports that the additional steps involved in performing surgical ablation provide lifelong benefits to the patient with an acceptable safety profile, despite longer cardiopulmonary bypass times.[14,15]

Although reducing cardiopulmonary bypass and cross-clamp times should always be a goal, our data show that the additional time invested in performing a surgical ablation does not worsen in-hospital outcomes. In fact, patients receiving a surgical ablation had lower in-hospital mortality and shorter length of stay, although this result may be confounded by fewer morbid conditions in the ablation population. The surgical ablation cohort also had slightly lower rates of ischemic and hemorrhagic stroke (although not

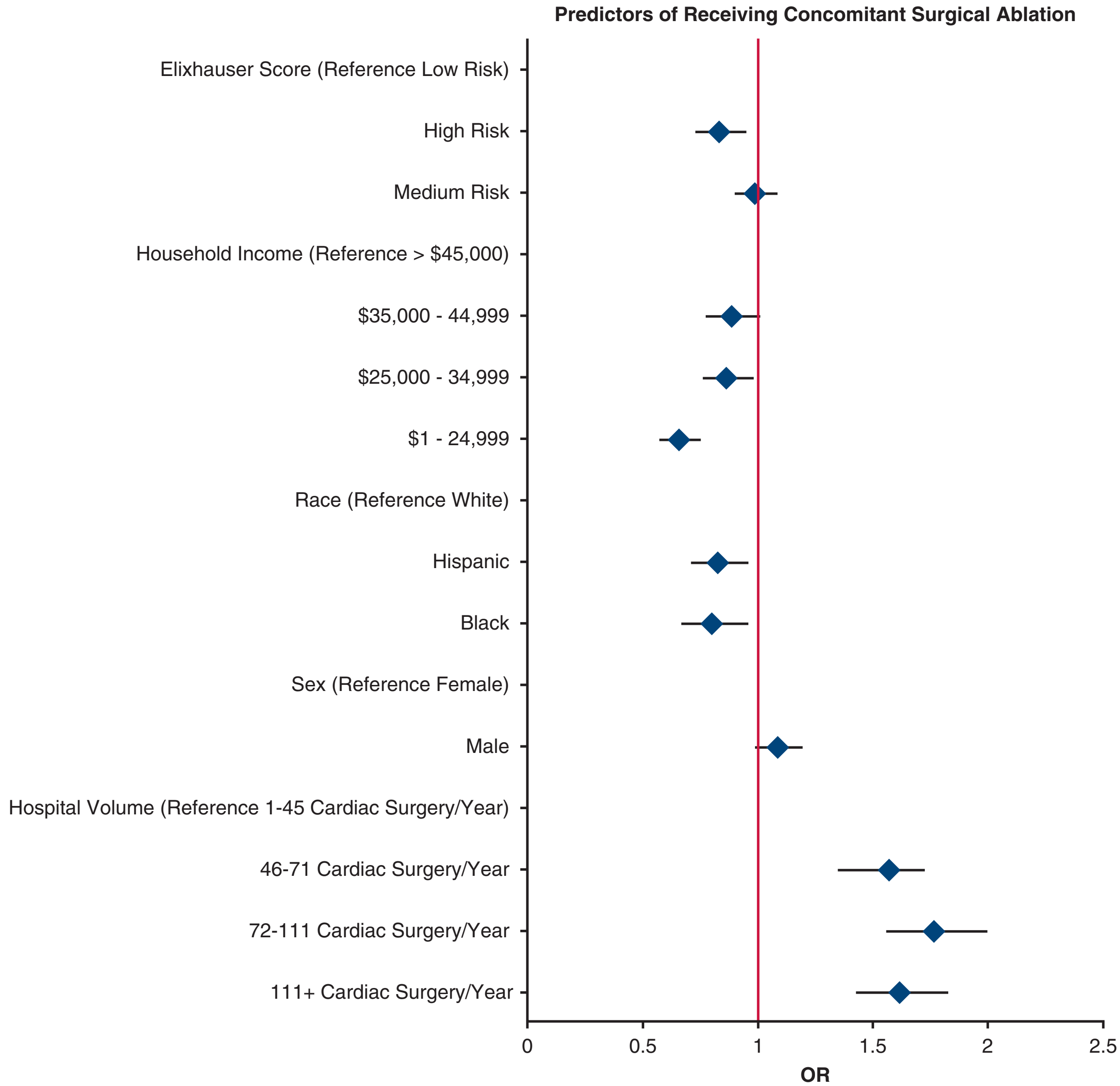

FIGURE 2. Forest plot demonstrating the odds ratio (*OR*) and 95% confidence interval (*CI*) of receiving a surgical ablation given each preoperative factor.

reaching statistical significance) despite presumed longer cardiopulmonary bypass times. Although the surgical ablation cohort did have higher in-hospital rates of arrhythmia and PPM placement, these factors did not seem to increase length of stay or mortality rate. Numerous studies also have supported the overall safety of surgical ablation, showing comparable perioperative morbidity profiles.[14-16]

Our follow-up data at 90 days and 180 days continued to support the overall safety and financial efficiency of concomitant surgical ablation. Readmission rates were similar in the 2 cohorts at both 90 days and 180 days, with the surgical ablation cohort showing lower or similar rates of readmission for heart failure, bleeding, acute respiratory failure, and renal failure. However, the surgical ablation cohort had significantly higher rates of readmission for AF or atrial flutter. This well-established perioperative complication of surgical ablation is largely due to inflammatory myocardial changes secondary to ablation. As ablated tissue evolves to form scar tissue and fully inhibits atrial reentry pathways, rates of AF and atrial flutter decrease, with data showing up to 90% freedom from AF and atrial flutter at 12 months.[8] Because our follow-up was limited to 180 days, the full benefit of surgical ablation in reestablishing sinus rhythm is underestimated. Furthermore, the rate of PPM placement was significantly higher in the surgical ablation cohort. This well-established complication should be discussed with the patient prior to proceeding with surgical ablation, balancing the complications

TABLE 3. In-hospital outcomes of patients with AF undergoing cardiac surgery alone versus cardiac surgery with surgical ablation

Variable	Surgery alone (N = 16,508), n (%)	Surgical ablation (N = 2738), n (%)	*P* value
Hospital mortality	616 (3.7)	73 (2.7)	.006
Complications			
Any complication	10,138 (61.4)	1618 (59.1)	.021
Stroke	105 (0.6)	*	.052
Ischemic	101 (0.6)	*	.069
Hemorrhagic	*	0 (0.0)	.249
Cardiac complications	7759 (47.0)	1266 (46.2)	.459
Non-AF arrhythmia	2521 (15.3)	510 (18.6)	<.001
Pacemaker placement	1185 (7.2)	324 (11.8)	<.001
Myocardial infarction	3798 (23.0)	386 (14.1)	<.001
Acute heart failure	2930 (17.7)	518 (18.9)	.139
Cardiogenic shock	453 (2.7)	46 (1.7)	.001
Non–dialysis-dependent renal failure	184 (1.1)	16 (0.6)	.011
Pneumonia	699 (4.2)	79 (2.9)	.001
Pulmonary embolism	55 (0.3)	*	.048
Deep vein thrombosis	94 (0.6)	11 (0.4)	.27
Respiratory failure	1062 (6.4)	132 (4.8)	.001
Sepsis	240 (1.5)	18 (0.7)	.001
Bleeding	3839 (23.3)	577 (21.1)	.012

AF, Atrial fibrillation. *Indicates fewer than 10 pateints were included.

associated with long-standing AF with the relatively good safety profile of PPM.

With data supporting the overall safety and cost efficacy of concomitant surgical ablation, our next question was why the procedure is not performed more broadly. Using multivariable analysis, we explored preoperative predictors of receiving a surgical ablation to better answer this question. Higher-volume cardiac surgery centers were significantly

TABLE 4. Readmission rates and outcomes of patients with AF undergoing cardiac surgery alone versus cardiac surgery with surgical ablation at 90 days

Variable	Surgery alone (N = 4328), n (%)	Surgical ablation (N = 720), n (%)	*P* value
Overall mortality	246 (5.7)	34 (4.7)	.297
Cardiac complications	2456 (56.7)	464 (64.4)	.001
Pacemaker placement	123 (2.8)	30 (4.2)	.055
Heart failure	1148 (26.5)	193 (26.8)	.875
HTN heart disease	887 (20.5)	179 (24.9)	.008
AF and flutter	732 (16.9)	186 (25.8)	<.001
Other arrhythmia	147 (3.4)	26 (3.6)	.769
Pericardial effusion	107 (2.5)	26 (3.6)	.077
Myocardial infarction	247 (5.7)	30 (4.2)	.093
Hypotension	95 (2.2)	14 (1.9)	.668
Cardiogenic shock	26 (0.6)	*	.467
Noncardiac complications	2248 (51.9)	353 (49.0)	.148
Acute respiratory failure	715 (16.5)	136 (18.9)	.116
Acute kidney failure	668 (15.4)	82 (11.4)	.005
Pneumonia	385 (8.9)	64 (8.9)	.995
Sepsis	427 (9.9)	59 (8.2)	.159
Pleural effusion	39 (0.9)	11 (1.5)	.116
Pulmonary embolism	105 (2.4)	16 (2.2)	.741
Wound infection	363 (8.4)	43 (6.0)	.027
Non-GI bleeding	178 (4.1)	28 (3.9)	.779
Electrolyte abnormality	174 (4.0)	33 (4.6)	.481

HTN, Hypertension; *AF*, atrial fibrillation; *GI*, gastrointestinal. *Indicates that fewer than 10 patients were included.

TABLE 5. Readmission rates and outcomes of patients with AF undergoing cardiac surgery alone versus cardiac surgery with surgical ablation at 180 days

Variable	Surgery alone (N = 4948), n (%)	Surgical ablation (N = 780), n (%)	*P* value
Overall mortality	318 (6.4)	44 (5.6)	.297
Cardiac complications	2844 (57.5)	504 (64.6)	.001
Pacemaker placement	180 (3.6)	45 (5.8)	.004
Heart failure	1346 (27.2)	209 (26.8)	.812
HTN heart disease	1065 (21.5)	204 (26.2)	.004
AF and flutter	900 (18.2)	214 (27.4)	<.001
Other arrhythmia	194 (3.9)	34 (4.4)	.561
Pericardial effusion	111 (2.2)	25 (3.2)	.101
Myocardial infarction	300 (6.1)	32 (4.1)	.029
Hypotension	120 (2.4)	17 (2.2)	.676
Cardiogenic shock	34 (0.7)	*	.884
Noncardiac complications	2617 (52.9)	407 (52.2)	.712
Acute respiratory failure	818 (16.5)	155 (19.9)	.021
Acute kidney failure	843 (17.0)	108 (13.8)	.026
Pneumonia	460 (9.3)	82 (10.5)	.281
Sepsis	569 (11.5)	78 (10.0)	.219
Pleural effusion	41 (0.8)	*	.210
Pulmonary embolism	110 (2.2)	16 (2.1)	.761
Wound infection	364 (7.4)	43 (5.5)	.063
Non-GI bleeding	248 (5.0)	38 (4.9)	.867
Electrolyte abnormality	223 (4.5)	36 (4.6)	.892

HTN, Hypertension; *AF*, atrial fibrillation; *GI*, gastrointestinal. *Indicates that fewer than 10 patients were included.

more likely to perform concomitant surgical ablation when indicated, perhaps suggesting a level of surgeon/institution comfort performing this procedure at play.

Interestingly, patients self-identifying as black or of Hispanic ethnicity and patients with household incomes in the lowest quartile ($1-$24,999/year) were significantly less likely to receive a surgical ablation. As minority and low-income cohorts have been historically underrepresented in medicine, confounding preexisting medical conditions may be a factor in this finding, although the argument can be made that the poorest population has the most to benefit from surgical ablation, with the long-term potential to preclude the need for costly antiarrhythmics and anticoagulants and avoid complications of prolonged AF. Patients deemed high risk by their Elixhauser score also were significantly less likely to receive surgical ablation, possibly due to surgeons' concerns about prolonged cardiopulmonary bypass times in this high-risk population. Although this is a valid concern, the long-term complications of AF carry their own risks.

Given the demonstrated safety of performing a concomitant surgical ablation, we feel that the risk of surgical ablation is acceptable in most cases, with benefits that outweigh the risk of life-long AF. Although current guidelines support performing concomitant surgical ablations, uptake in clinical practice remains low. Perhaps making concomitant surgical ablations an STS quality metric would increase compliance and lead to better patient care.

Limitations

Although our study provides insight into the trends and outcomes of concomitant surgical ablation among patients with preoperative AF, it has some inherent limitations. The Florida and Maryland SIDs are administrative databases based on billing data and thus provide only discharge-level information. Clinical data, such as surgical technique used to perform surgical ablation, are absent. Therefore, actually differentiating between patients receiving a complete biatrial Maze procedure and those receiving a pulmonary vein isolation is impossible, because ICD-10 codes do not differentiate between the 2 entities. One benefits of SIDs is the use of a POA flag to include only groups (ie, patients with preoperative AF) in a population. However, it is important to note that previous studies have reported an accuracy of POA coding of approximately 74%, with for-profit institutions tending to overcode diagnoses.[18] Furthermore, we did not differentiate type of preexisting AF (chronic/persistent vs paroxysmal) between our cohorts, and we intend to investigate this in future studies.

Relying on accurate preoperative coding of comorbidities is necessary for accurate follow-up data to differentiate preexisting conditions from postoperative complications. Although we found this difficult to delineate by simply querying for ICD-10 diagnoses postoperatively, we were able to overcome this issue by instead querying for the leading 2 diagnoses at each readmission event. Despite these limitations, the Florida and Maryland SIDs were ideal for investigating the objective of this study.

CONCLUSIONS

Despite updated AATS recommendations supporting the safety and reduction in early postoperative mortality after concomitant surgical ablation, surgical ablations remain underused in clinical practice, especially in patients with a high-risk Elixhauser score, low-income patients, and minority patients. However, data suggest that surgical ablation is a safe procedure, associated with significantly decreased length of stay and lower in-hospital costs. Surgeons should be more judicious in implementing surgical ablation in their practice to adhere to current society guidelines and allow patients the potential freedom from life-long use of anticoagulation and antiarrhythmic therapy and the risks associated with prolonged AF.

Conflict of Interest Statement

Dr Soltesz has been a consultant for Abiomed, Atricure, and Abbott. Dr Gillinov serves as a consultant for AtriCure, Medtronic, Edwards Lifesciences, Abbott, CryoLife, and ClearFlow. The other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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