Incidence of postoperative atrial fibrillation in patients undergoing minimally invasive versus median sternotomy valve surgery

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Background: Atrial fibrillation (AF) after cardiac surgery is associated with increased morbidity and hospital length of stay. Our objective was to determine whether a minimally invasive approach to isolated valve surgery reduced the incidence of postoperative AF.

Methods: Patients without a history of arrhythmia, who underwent isolated aortic or mitral valve surgery between January 2005 and August 2011, were included. The incidence of postoperative AF in those who underwent a minimally invasive approach was compared with that of patients undergoing median sternotomy surgery. Resource utilization was approximated on the basis of intensive care unit and total hospital lengths of stay.

Results: A total of 571 patients were identified (413 minimally invasive and 158 median sternotomy). No significant differences in baseline characteristics existed between groups. The incidence of postoperative AF (25% vs 37%; $P = .002$), use of intraoperative blood products (52% vs 83%; $P < .001$), and prolonged intubation (≥ 24 hours) (12% vs 20%; $P = .008$) were significantly less in the minimally invasive group. The intensive care unit and hospital lengths of stay were 45 hours (interquartile range [IQR], 28-66 hours) versus 53 hours (IQR, 45-91 hours) ($P < .001$), and 5 days (IQR, 4-7 days) versus 8 days (IQR, 6-11 days) ($P < .001$) for the minimally invasive and median sternotomy groups, respectively. Multivariable analysis revealed a decreased risk of postoperative AF in patients undergoing minimally invasive surgery (odds ratio, 0.4; 95% confidence intervals, 0.24-0.66; $P < .001$).

Conclusions: A minimally invasive approach for isolated valve surgery reduces postoperative AF and resource use when compared with median sternotomy. (J Thorac Cardiovasc Surg 2013;146:1436-41)

Postoperative atrial fibrillation (AF) is common after cardiac surgery, occurring in 37% to 50% of patients undergoing isolated valve surgery.¹⁻³ In addition to the established preoperative risk factors such as age, hypertension, history of AF, chronic obstructive pulmonary disease, and valvular heart disease,^{1,4} several operative variables significantly affect the incidence of postoperative AF. These include manipulation of the heart and pericardium during surgery, prolonged cardiopulmonary bypass and aortic crossclamp times, and postoperative inflammatory effects.^{5,6} The development of postoperative AF is associated with an increased risk of perioperative morbidity, as well as prolonged hospital length of stay.⁷

In patients undergoing valve surgery, a minimally invasive approach has been associated with less bleeding, decreased wound infections and septic complications, and faster postoperative recovery when compared with

a standard median sternotomy approach.^{8,9} These findings, as well as reduction of in-hospital mortality in elderly patients, are leading to increased acceptance of minimally invasive valve surgery as an alternative to standard median sternotomy surgery.¹⁰⁻¹²

Whereas the association between median sternotomy valve surgery and the development of postoperative AF has been widely established, the effect of a minimally invasive approach on postoperative AF remains less clear. Our study aimed to analyze the effect of minimally invasive valve surgery on the incidence of new-onset postoperative AF in patients undergoing isolated aortic or mitral valve surgery. We analyzed the outcomes of patients who underwent minimally invasive surgery and compared them with a cohort who underwent a median sternotomy approach.

METHODS

After obtaining approval from the Mount Sinai Medical Center Institutional Review Board, we retrospectively evaluated all heart operations performed at our institution between January 1, 2005, and August 31, 2011, to identify patients who underwent isolated mitral or aortic valve surgery and had no history of arrhythmia. Excluded were patients who had previous cardiac surgery, those who had concomitant coronary artery bypass graft surgery and/or surgery on another valve, active infective endocarditis, or emergency surgery. The median sternotomy surgery was performed by a group of 6 surgeons who used only this approach, whereas a single surgeon (J.L.) performed all the minimally invasive surgery.

All patients had their valvular lesions documented by diagnostic catheterization and echocardiography, and all operative reports and echocardiograms were reviewed. The primary outcome was postoperative AF,

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Abbreviations and Acronyms

AF = atrial fibrillation
 CI = confidence interval
 IQR = interquartile range
 OR = odds ratio

which was defined as new onset of AF necessitating treatment. The surgical technique time was compared on the basis of total cardiopulmonary bypass and aortic crossclamp times. Resource use was approximated on the basis of intensive care unit and total hospital lengths of stay. The definitions and variables selected were based on the Society of Thoracic Surgeons database definitions.

Technique for Minimally Invasive Mitral Valve Surgery

All patients were placed in the supine position and underwent anesthetic induction and intubation with a single-lumen endotracheal tube. A roll was placed underneath the right scapula in patients undergoing a minimally invasive mitral valve procedure. Every patient had a Swan-Ganz catheter (Edwards LifeSciences, Irvine, Calif) and a radial arterial line placed. A transesophageal echocardiogram Doppler probe was placed intraoperatively to evaluate the diseased valves, as well as to assess the postoperative results.

In all cases, a femoral platform was used to establish cardiopulmonary bypass. A 2- to 3-cm incision was made in the inguinal crease. A 5-0 Prolene polypropylene purse-string suture (Ethicon, Inc, Somerville, NJ) was placed on the femoral artery and vein. After heparinization, a Seldinger technique was used to cannulate the femoral vessels. The femoral artery was cannulated with a 16F to 18F arterial cannula (Edwards LifeSciences), and the femoral vein was cannulated with a 25F venous cannula (Medtronic BioMedicus, Minneapolis, Minn). Transesophageal echocardiography was used to aid in the placement of the venous cannula in the superior vena cava.

For the mitral valve procedures, a 5- to 6-cm skin incision was made in the fourth to fifth intercostal space at the site of the anterior axillary line. The mitral valve was accessed through the Waterston groove and then through the atrial septum into the left atrium. A specially designed atrial lift retractor and atrial exposure device was used for visualization of the mitral valve, and mitral valve repair or replacement was carried out in the standard fashion. The left atrial appendage was not ligated in any of the patients. A 4-0 Prolene polypropylene suture was used to close the left atrium. If significant peripheral vascular disease was present in patients undergoing mitral valve procedures, then axillary artery cannulation was performed.

For aortic valve procedures, a 5- to 6-cm transverse right parasternal incision was made over the second to third intercostal space. In all aortic valve procedures, the second or third costochondral cartilage was transected to allow adequate exposure of the aorta. At the completion of the operation, the rib was reattached to the sternum with a 1-cm metal plate (Synthes Inc, West Chester, Pa) and a fiber wire was placed in a figure-of-8 fashion. In all cases, the pericardium was opened above the phrenic nerve and over the aorta to facilitate exposure. A transverse aortotomy was performed to expose the aortic valve, and valve replacement was carried out under direct vision with standard techniques. In aortic valve procedures, a left ventricular vent was inserted into the left ventricle via a purse-string suture in the right superior pulmonary vein. If significant peripheral vascular disease had been present, then central aortic cannulation would have been performed, which was not the case in any of the patients.

By means of transesophageal echocardiographic guidance, a retrograde coronary sinus catheter was directly inserted through the incision, and a purse-string suture was placed in the right atrium. Cardiopulmonary bypass was initiated at 32°C to 36°C using a closed membrane oxygenator

and roller pump. Venous drainage was augmented with vacuum assistance applying negative pressures of 30 to 70 mm Hg as needed to decompress the right heart. Transincisional direct aortic crossclamping was performed with a flexible and retractable shaft crossclamp (Novare Surgical Systems, Cupertino, Calif). One dose of cold blood cardioplegic solution was given antegradely to establish electromechanical arrest of the heart. Thereafter, cold blood cardioplegic solution was given retrogradely throughout the procedure at 20- to 25-minute intervals. If retrograde cardioplegia was not possible, a cannula was left in the ascending aorta to deliver antegrade cardioplegia, or the heart was fibrillated. All procedures were performed with specially designed long-shafted minimally invasive instruments (Geister, Tuttlingen, Germany). Carbon dioxide was infused into the operative field during the entire procedure. Air from the heart was removed with a needle in the root of the aorta and under transesophageal echocardiographic guidance. The heart was not directly manipulated during deairing maneuvers. If needed, the chest wall was compressed externally to aid in deairing. With the heart empty, both atrial, and ventricular pacing wires were placed. After cardiopulmonary bypass had been discontinued and protamine administered, decannulation was performed. The purse-string sutures were tied, and the femoral artery was directly repaired with 5-0 Prolene polypropylene suture. A single chest tube was left in the pleural space. For pain relief, all patients had an On-Q pain relief system inserted (I-Flow Corporation, Lake Forest, Calif). Two catheters were placed in the intercostal space to deliver 0.25% bupivacaine for 72 hours. The thoracotomy incision was closed in the routine fashion.

Statistical Methods

Continuous variables were expressed as the mean $\pm$ 1 standard deviation or median and interquartile range (IQR). Variables with a normal distribution were compared by use of an independent *t* test, whereas those variables that did not exhibit a normal distribution were compared with a Mann-Whitney *U* test. A χ^2 analysis was used to compare dichotomous variables. Comorbidities and risk factors that could have a significant influence on the development of postoperative AF, including surgical procedural variables, were evaluated by univariable analysis. Those with a *P* value of .25 or less were included, in addition to established risk factors for AF, in a logistic regression analysis to determine their independent effects. The statistical analyses were performed using SPSS version 17 (SPSS, Inc, Chicago, Ill).

RESULTS

A total of 571 patients were identified, 413 in the minimally invasive group and 158 in the median sternotomy group. There were no significant differences in baseline preoperative characteristics between the 2 groups (Table 1).

In the entire cohort of patients, 160 had postoperative AF and 411 did not. The mean age was 72.5 ± 9.5 years versus 64.5 ± 14.2 years ($P < .001$), and the median preoperative creatinine value was 1.0 mg/dL (IQR, 0.8-1.2 mg/dL) versus 0.91 mg/dL (IQR, 0.8-1.1 mg/dL) ($P = .005$) in patients in whom postoperative AF developed versus those in whom it did not, respectively. Patients with postoperative AF had a higher incidence of older age (≥ 65 years; 81% vs 56%; $P < .001$), diabetes mellitus (37% vs 19%; $P < .001$), hypertension (90% vs 82%; $P = .02$), prior stroke (9% vs 5%; $P = .04$), and preoperative beta-blocker use (64% vs 50%; $P = .002$) as compared with those without postoperative AF (Table 2).

TABLE 1. Baseline characteristics of the minimally invasive versus median sternotomy groups

Variables	Minimally invasive (n = 413)	Median sternotomy (n = 158)	P value
Age (mean $\pm$ SD)	67.2 $\pm$ 14	65.7 $\pm$ 12.4	.26
Age > 65 y	267 (65%)	91 (58%)	.12
Female gender	222 (54%)	91 (58%)	.41
Body mass index (median, IQR)	27 (24-30)	28 (24-31)	.1
Diabetes mellitus	93 (23%)	44 (28%)	.18
Hypertension	345 (84%)	137 (87%)	.35
Previous myocardial infarction	49 (12%)	13 (8%)	.21
Previous stroke	24 (6%)	11 (7%)	.61
Chronic obstructive pulmonary disease	100 (24%)	44 (28%)	.37
Preoperative beta-blocker	224 (54%)	83 (53%)	.72
Preoperative creatinine (median, IQR)	0.94 (0.8-1.1)	0.93 (0.8-1.2)	.71
Ejection fraction (mean $\pm$ SD)	56 $\pm$ 10	54 $\pm$ 12	.13
Ejection fraction $\leq$ 30%	17 (4%)	12 (8%)	.09

SD, Standard deviation; IQR, interquartile range.

There were 230 (56%) versus 106 (67%) aortic valve replacements and 183 (44%) versus 52 (33%) mitral valve operations in the minimally invasive versus median sternotomy groups, respectively ($P = .01$ for both). Of the mitral valve operations, there were 121 (66%) versus 28 (54%) repairs and 62 (34%) versus 24 (46%) replacements in the minimally invasive and median sternotomy groups, respectively ($P = .1$ for both). The type of valvular disease was not significantly different between the 2 groups. For aortic valve surgery in the minimally invasive group, the types of disease were 35 (59%) senile degenerative aortic

stenosis, 55 (24%) bicuspid aortic stenosis, 32 (14%) bicuspid aortic insufficiency, and 8 (3%) aortic insufficiency owing to aortic root dilatation or aortic valve leaflet prolapse; for mitral valve surgery, the types of diseases were 103 (56.4%) myxomatous mitral regurgitation, 41 (22.3%) functional mitral regurgitation, and 39 (21.3%) rheumatic mitral regurgitation. For median sternotomy, the aortic valve diseases were 58 (55%) senile degenerative aortic stenosis, 29 (27%) bicuspid aortic stenosis, 16 (15%) bicuspid aortic insufficiency, and 3 (3%) aortic insufficiency owing to aortic root dilatation or aortic valve leaflet prolapse; for mitral valve surgery, they were 30 (58%) myxomatous mitral regurgitation, 11 (21%) functional mitral regurgitation, and 11 (21%) rheumatic mitral regurgitation. The mean cardiopulmonary bypass time was 117 ± 37 minutes in the minimally invasive group versus 89 ± 40 minutes in the median sternotomy group ($P < .001$) and the mean aortic crossclamp time was 87 ± 31 minutes versus 67 ± 32 minutes ($P < .001$). For the minimally invasive group versus the median sternotomy group, respectively, the incidence of perfusion time greater than 100 minutes was 63% versus 29% ($P < .001$), use of intraoperative blood products was 52% versus 83% ($P < .001$), incidence of prolonged intubation (≥ 24 hours) was 12% versus 20% ($P = .008$), and intensive care unit readmission was 2% versus 6% ($P = .02$). The total intensive care unit length of stay was 45 hours (IQR, 28-66 hours) versus 53 hours (IQR, 45-91 hours) ($P < .001$), and the total hospital length of stay was 5 days (IQR, 4-7 days) versus 8 days (IQR, 6-11 days) ($P < .001$) in the minimally invasive versus median sternotomy groups (Table 3).

Postoperative AF occurred in 25% of patients in the minimally invasive group versus 37% of patients in the median sternotomy group ($P = .002$). On analysis, the incidence of postoperative AF in the minimally invasive versus the median sternotomy groups was 26% versus 39% of aortic valve replacements ($P = .02$) and 22% versus 35% of

TABLE 2. Baseline characteristics in patients with postoperative AF versus no AF

Variables	Postoperative AF (n = 160)	No postoperative AF (n = 411)	P value
Age (mean $\pm$ SD)	72.5 $\pm$ 9.5	64.5 $\pm$ 14.2	<.001
Age > 65 y	130 (81%)	228 (56%)	<.001
Female gender	97 (61%)	216 (53%)	.08
Body mass index (median, IQR)	28 (24-30)	27 (24-30)	.39
Diabetes mellitus	59 (37%)	78 (19%)	<.001
Hypertension	144 (90%)	338 (82%)	.02
Previous myocardial infarction	18 (11%)	44 (11%)	.85
Previous stroke	15 (9%)	20 (5%)	.04
Chronic obstructive pulmonary disease	43 (27%)	101 (25%)	.57
Preoperative beta-blocker	103 (64%)	204 (50%)	.002
Preoperative creatinine (median, IQR)	1.0 (0.8-1.2)	0.91 (0.8-1.1)	.005
Ejection fraction (%, mean $\pm$ SD)	55 $\pm$ 11	56 $\pm$ 11	.66
Ejection fraction $\leq$ 30%	7 (4%)	22 (5%)	.63

AF, Atrial fibrillation; SD, standard deviation; IQR, interquartile range.

TABLE 3. Operative results and clinical outcomes

Variables	Minimally invasive (n = 413)	Median sternotomy (n = 158)	P value
Mortality	4 (0.9%)	1 (0.6%)	.7
Bleeding requiring reoperation	7 (1.7%)	4 (2.5%)	.52
Deep wound infection	0	1 (0.6%)	.11
Stroke	4 (0.9%)	1 (0.6%)	.7
Prolonged intubation (>24 h)	48 (12%)	32 (20%)	.008
Intensive care unit length of stay (h, median, IQR)	45 (28-66)	53 (45-91)	<.001
Intensive care unit readmission	10 (2%)	10 (6%)	.02
Hospital length of stay (d, median, IQR)	5 (4-7)	8 (6-11)	<.001
Postoperative AF	101 (25%)	59 (37%)	.002

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

TABLE 4. Multivariable predictors of postoperative AF

Variables	95 % CI			P value
	Odds ratio	Lower CI	Upper CI	
Minimally invasive surgery	0.4	0.24	0.66	<.001
Age	1.07	1.05	1.1	<.001
Preoperative beta-blocker	1.73	1.12	2.69	.01
Female gender	1.77	1.13	2.77	.01
Prolonged ventilation (>24 h)	2.03	1.19	3.46	.01
Diabetes mellitus	2.28	1.43	3.62	.001

Hypertension, chronic obstructive pulmonary disease, myocardial infarction, ejection fraction less than 35%, mitral valve surgery, cardiopulmonary bypass time greater than 100, and use of intraoperative blood products were included in the multivariable analysis and were not significant. AF, Atrial fibrillation; CI, confidence interval.

mitral valve operations ($P = .07$). Multivariable analysis revealed minimally invasive surgery (odds ratio [OR], 0.4; 95% confidence intervals [CI], 0.24-0.66; $P < .001$), age (OR, 1.07; 95% CI, 1.05-1.1; $P < .001$), preoperative beta-blocker use (OR, 1.73; 95% CI, 1.12-2.69; $P = .01$), female gender (OR, 1.77; 95% CI, 1.13-2.77; $P = .01$), prolonged ventilation for 24 hours or more (OR, 2.03; 95% CI, 1.19-3.46; $P = .01$), and diabetes mellitus (OR, 2.28; 95% CI, 1.43-3.62; $P = .001$) to be independent predictors of postoperative AF (Table 4).

Among patients who had postoperative AF, there was an increased incidence of prolonged intubation (≥ 24 hours) (24% vs 10%; $P < .001$), acute renal failure (4% vs 1%; $P = .05$), pneumonia (7% vs 2%; $P = .01$), and reintubation (11% vs 3%; $P < .001$) as compared with patients without postoperative AF. The total intensive care unit length of stay was 53 hours (IQR, 44-98 hours) versus 46 hours (IQR, 29-64) ($P < .001$), and the total hospital length of stay was 8 days (IQR, 6-11 days) versus 5 days (IQR, 4-7 days) ($P < .001$) when comparing patients who had postoperative AF versus those without postoperative AF (Table 5).

DISCUSSION

AF after cardiac surgery remains a common postoperative complication and is associated with significant morbidity. Patients in whom AF develops postoperatively are also at increased risk of myocardial infarction, congestive heart failure, renal injury, sepsis, and longer intensive care unit and hospital lengths of stay.^{4,7} In-hospital stroke is nearly 2 times more likely, and in-hospital and late-term mortality are increased by more than 50%.⁷ Furthermore, in patients who have undergone coronary artery bypass grafting surgery, it is estimated that postoperative AF increases hospital length of stay by 5 days and total hospital cost by more than \$10,000 per patient.¹³ In the present study, we hypothesized that by reducing surgical trauma and inflammation and improving postoperative recovery, a minimally invasive approach to valve surgery would decrease the incidence of postoperative AF when compared with standard median sternotomy surgery.

TABLE 5. Postoperative outcomes in patients with AF

Variables			P value
	AF (n = 160)	AF (n = 411)	
In-hospital mortality	0	5 (1%)	.16
Bleeding necessitating reoperation	5 (3%)	6 (2%)	.19
Deep wound infection	0	1 (0.2%)	.53
Prolonged intubation	38 (24%)	42 (10%)	<.001
Acute renal failure	6 (4%)	5 (1%)	.05
Sepsis	5 (3%)	5 (1%)	.12
Pneumonia	11 (7%)	10 (2%)	.01
Reintubation	17 (11%)	13 (3%)	<.001
Stroke	1 (0.6%)	4 (1%)	.69
Intensive care unit length of stay (h, median, IQR)	46 (29-64)	53 (44-98)	<.001
Hospital length of stay (d, median, IQR)	5 (4-7)	8 (6-11)	<.001

AF, Atrial fibrillation; IQR, interquartile range.

Our study demonstrated that in patients undergoing isolated valve surgery, a minimally invasive approach provides an overall 60% reduced risk of developing postoperative AF despite, paradoxically, significantly longer cardiopulmonary bypass and aortic crossclamp times, which have been shown in prior studies to be risk factors for development of postoperative AF.^{5,14} Bleeding necessitating transfusion of blood products and prolonged mechanical ventilation, both independent predictors of AF development after cardiac surgery,^{15,16} were reduced by 37% and 40%, respectively, in patients undergoing minimally invasive surgery, perhaps explaining the paradox. The downstream effects of AF prevention were multiple. Patients who underwent minimally invasive surgery had a 66% reduction in intensive care unit readmission, a 15% reduction in total intensive care unit length of stay, and a 38% reduction in total hospital length of stay. When coupling these results with the longer length of hospitalization and postoperative complications observed in patients who had postoperative AF, it is very likely that performing valve surgery via a minimally invasive approach had a significant impact on resource use and total health care cost.

The data regarding minimally invasive valve surgery and its effect on postoperative AF are equivocal. A meta-analysis of 10 studies by Murtuza and associates,¹⁷ which included 2262 patients undergoing aortic valve replacement, found no difference in the incidence of postoperative AF or surrogate outcome measures such as stroke and intensive care unit and hospital lengths of stay between patients undergoing minimally invasive versus median sternotomy valve surgery. A separate meta-analysis and systematic review by Cheng and colleagues,¹⁸ concerning 8 studies with a total of 10,347 patients, found that minimally invasive mitral valve surgery was associated with an 18% reduction in postoperative AF when compared with a conventional

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sternotomy approach ($P = .03$). Our study showed a total reduction in the incidence of postoperative AF when using a minimally invasive approach for isolated valve surgery. This was driven by a significant decrease in postoperative AF among patients undergoing aortic valve replacement and a strong trend toward less postoperative AF in those undergoing mitral valve surgery. The reduction in AF noted with the minimally invasive approach may be due to decreased trauma leading to a reduction in inflammation. However, presently there are not sufficient data to make firm conclusions as to the exact mechanism of this reduction.

In addition to age and prolonged ventilation, which are widely established risk factors for the development of AF after cardiac surgery, we identified several independent predictors of postoperative AF.^{1,4,16} First, preoperative beta-blocker use was associated with a 73% increased risk of postoperative AF. When compared with patients who were not receiving preoperative beta-blockers, patients on beta-blocker treatment were older (68.6 ± 12.8 years vs 64.6 ± 14.1 years; $P = .02$) and had a higher incidence of hypertension (95% vs 72%; $P < .001$), prior myocardial infarction (14% vs 7%; $P = .009$), and at least moderate left ventricular systolic dysfunction (ejection fraction $\leq 35\%$, 12% vs 3%; $P < .001$). All of these have been shown to increase the risk of AF after cardiac surgery, thus confounding the analysis of beta-blocker use and AF.^{1,4,16,19,20} Furthermore, sympathetic tone and right atrial norepinephrine levels are increased acutely after cardiac surgery.²¹ Second, women were observed to have a 77% increased risk of postoperative AF. When compared with male patients, women had significantly longer cardiopulmonary bypass (116 ± 40 vs 102 ± 38 minutes; $P < .001$) and aortic crossclamp times (87 ± 32 vs 75 ± 31 minutes; $P < .001$), and it has been postulated that prolonged ischemia from inadequate atrial cooling and myocardial protection during cardioplegia triggers AF in vulnerable patients.^{5,14,22} Women also had a greater incidence of at least moderate left ventricular systolic dysfunction when compared with men (ejection fraction $\leq 35\%$; 11% vs 4%; $P = .004$), which has been shown to be an independent predictor of postoperative AF.²⁰ Finally, diabetic patients had a greater than 2-fold increase in the risk of postoperative AF. Diabetes mellitus has been established as a strong independent predictor of AF development. Although the exact mechanism is not known, chronic microvascular ischemia and metabolic abnormalities are likely causes.²³ Interestingly, in patients undergoing surgery for mitral valve disease and in those with a left ventricular ejection fraction less than 35%, 2 subgroups of patients who historically have been observed to be at increased incidence of postoperative AF,^{20,24} we observed no significant association between surgery and AF development. The lower incidence of AF in the patients who had mitral valve surgery may be due to the fact that, when compared

with patients undergoing aortic valve replacement, they were younger (63.0 ± 13.9 years vs 69.4 ± 12.7 years; $P < .001$), were less likely to have diabetes mellitus (14% vs 31%; $P < .001$), were less likely to have a cardiopulmonary bypass time exceeding 100 minutes (46% vs 59%; $P = .002$), and had less postoperative renal failure (0.4% vs 3%; $P = .03$), and thus were less prone to the development of AF. The lack of an increased incidence of AF in patients with a left ventricular ejection fraction of less than 35% may be due to the fact that in this subgroup of patients preoperative beta-blocker use was far more common as compared with the remainder of the cohort (80% vs 52%; $P < .001$) and therefore may have been better protected.

The main limitation of our study is that it is a retrospective, single-center study. The surgical approaches were performed by 2 different teams of surgeons, which introduces a potential uncontrollable confounder. Furthermore, all minimally invasive operations were performed by a single surgeon, who is the study's senior author (J.L.). Finally, comparison of the surgical techniques was limited to in-hospital outcomes.

In conclusion, in patients without a history of arrhythmia, a minimally invasive surgical approach for aortic or mitral valve surgery substantially reduces the incidence of postoperative AF. Furthermore, this likely has a significant impact on health care resource utilization. This approach should be considered as an alternative to standard median sternotomy valve surgery.

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