Surgical Ablation of Atrial Fibrillation in the United States: Trends and Propensity Matched Outcomes

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Background. **Surgical ablation (SA) for atrial fibrillation (AF) effectively restores sinus rhythm. Incompletely defined risk has previously limited concomitant performance of SA during cardiac operations. The study goals were to define performance trends and risk-adjusted outcomes for contemporary SA.**

Methods. **From July 2011 to June 2014, 86,941 patients with AF, but without endocarditis, underwent primary nonemergent cardiac operations in The Society of Thoracic Surgeons (STS) database. Cochran-Armitage tests examined performance trends of SA for six operative categories: mitral valve repair or replacement (MVRR) with or without coronary artery bypass graft surgery (CABG), aortic valve replacement (AVR) with or without CABG, CABG, AVR with MVRR, stand-alone SA, and other concomitant operations. The risk of concomitant SA was analyzed by propensity matching 28,739 patient-pairs with and without SA by AF type, primary operation, and STS comorbid risk variables using greedy 1:1 matching algorithms.**

Results. **Among all patients with AF, 48.3% (42,066 of 86,941) underwent SA. Mitral operations had the highest rate of SA (MVRR ± CABG 68.4% [14,693 of 21,496]; MVRR + AVR 59.1% [1,626 of 2,750]). The AVR ± CABG and isolated CABG rates were 39.3% (6,816 of 17,349) and 32.8% (9,156 of 27,924), respectively. Nearly half of other concomitant operations underwent SA, 47.6% (6,939 of 14,586). Performance frequency increased throughout the study period. After propensity matching, SA was associated with a reduction in relative risk (RR) of 30-day mortality (RR 0.92, 95% confidence interval [CI]: 0.85 to 0.99) and stroke (RR 0.84, 95% CI: 0.74 to 0.94), but an increase in renal failure (RR 1.12, 95% CI: 1.03 to 1.22) and pacemaker implantation (RR 1.33, 95% CI: 1.24 to 1.43).**

Conclusions. **Contemporary utilization of SA is increasing across all operative categories. Performance of SA is accompanied by a 30-day reduction in mortality and stroke. These findings further refine our understanding of the role of SA in the treatment of AF.**

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Atrial fibrillation (AF) at the time of cardiac operations negatively affects 30-day outcome and survival [1–5]. Surgical ablation (SA) restores normal sinus rhythm and improves long-term quality of life [6–10]. Prior registry trends revealed that adoption of SA concomitant to cardiac operations was limited, and concerns over added

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Abbreviations and Acronyms

ACSD = Adult Cardiac Surgery Database
AF = atrial fibrillation
AVR = aortic valve replacement
CABG = coronary artery bypass graft surgery
CI = confidence interval
LA = left atrium
MVRR = mitral valve repair or replacement
RF = radiofrequency
RR = relative risk
SA = surgical ablation
STS = The Society of Thoracic Surgeons

operative risk may have influenced clinical decision making [11]. Although techniques for SA and experience have improved in recent years, contemporary trends of SA remain incompletely defined. Moreover, for AF patients, recent information suggests operative mortality after cardiac surgery may be improved with SA [12]. The goal of this study was to define performance trends and comparatively assess outcomes of contemporary SA using The Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD).

Material and Methods

Patient Populations

From July 1, 2011, to June 30, 2014, 837,978 cardiac operations were recorded in the STS ACSD; of those, 112,401 (13.4%) had preoperative AF documented. Exclusions were emergent status, endocarditis, reoperation, mechanical circulatory support, transplant, aortic dissection, and pulmonary thromboembolectomy. After exclusions, three populations were studied to examine three objectives: (1) all patients receiving SA were examined for technical procedural trends of SA over time, regardless of AF type documentation; (2) all patients with documented AF type were examined to descriptively assess patients treated with SA or not treated with SA (no-SA); and (3) the risk of adding concomitant SA to a primary cardiac operation was assessed by comprehensive propensity matched comparisons inclusive of AF type, primary operation, and comorbidities, after excluding stand-alone operations owing to lack of a no-SA comparator (Fig 1).

In a first trends analysis, all 62,025 SA patients were utilized to document overall performance trends and energy source utilization over time in six operative categories: isolated coronary artery bypass graft surgery (CABG), mitral valve repair or replacement (MVRR) with or without CABG, aortic valve replacement (AVR) with or without CABG, AVR with or without MVRR, stand-alone SA, and other concomitant operations. A second comparative descriptive analysis of SA versus no-SA included all 86,941 patients with documented AF type, after operative exclusions. These were assessed in total and by each of the six operative categories. Finally, a third comparative outcomes analysis assessed the risk of adding SA as a concomitant procedure. This analysis included all the above concomitant operations by excluding the 2,836 stand-alone SA patients. The resulting cohort of 84,105 patients with documented AF was evaluated by a propensity matched analysis of concomitant SA versus no-SA.

Baseline Characteristics

All relevant procedural STS covariates and baseline characteristics were evaluated using medians with 25th and 75th percentiles for continuous variables and proportions for categoric variables. Descriptive data were compared between groups using the Wilcoxon rank sum test for continuous and ordinal variables, and a Pearson χ^2 test or Fisher's exact test for categoric variables, as appropriate.

Trends Analysis

Temporal trends in SA utilization across the six operative categories were evaluated with Cochran-Armitage trends tests. The 3 years of data were divided into six 6-month sextiles: period 1 (July 1, 2011, to December 31, 2011) to period 6 (January 1, 2014, to June 30, 2014). Total numbers of procedures and incidence of SA for each procedural type were assessed.

Propensity-Matched Comparative Outcome Analysis

To quantify risk-adjusted outcome differences for SA versus no-SA with documented preoperative AF type, a comprehensive propensity matched analysis was performed. Using multivariate logistic regression, probability of treatment assignment to SA versus no-SA (propensity score) was generated from observed covariates and procedures. Missing values (less than 3%) underwent simple imputation in accordance with validated STS models [12]. Group-specific medians were examined for continuous variables, and most common category for categoric variables. Continuous variables were evaluated using restricted cubic spline plots to assess linearity. The final propensity model included the following: AF type (paroxysmal versus persistent), age (linear splines with knot at 75 years), sex, body surface area, creatinine (linear splines with knot at 1.00), ejection fraction (linear splines with knot at 50%), body surface area (quadratic spline), multiplicative interaction between body surface area and sex, New York Heart Association class III to IV, cerebrovascular disease, stroke, chronic lung disease, peripheral vascular disease, home oxygen, sleep apnea, syncope, diabetes type, preoperative myocardial infarction, operative status, previous cardiovascular interventions, previous pacemaker, mitral and tricuspid insufficiency, and operative procedure type (CABG, MVRR ± CABG, AVR ± CABG, AVR + MVRR, other concomitant operations). Propensity scores matched SA and no-SA using a 1:1 greedy 5-to-1 digit-matching algorithm. Only pairs matched on three or more propensity score digits were retained in the final matched sample of SA (n = 28,739) and no-SA (n = 28,739; Supplemental Table). Propensity score distribution and protocol adequacy were assessed to a uniform