Elevated Stroke Risk Associated With Femoral Artery Cannulation During Mitral Valve Surgery

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Minimally invasive mitral valve (MV) surgery, often requiring femoral artery (FA) cannulation, is increasingly being adopted. There is concern about increased stroke rates associated with minimally invasive MV surgery. This study aims to examine whether FA cannulation is independently associated with increased stroke rates in minimally invasive MV procedures. MV procedures from January 2004 to June 2012 were reviewed using our institutional Society of Thoracic Surgeons database. We included 384 patients after the exclusion of patients with emergency procedures, with infective endocarditis, who underwent other concomitant procedures, who were older than 60 years, and with nonstandard aortic clamping (endoballoon or no clamp). Patients were divided into 2 groups: those who underwent aortic cannulation ($n = 327$) and those who underwent femoral cannulation ($n = 57$). Risk adjustments through multivariable regression were used to identify independent predictors for various outcomes. Adjustments were made for cardiopulmonary bypass and aortic clamp times. Preoperatively, the femoral cannulation group had less baseline cerebrovascular disease ($P = 0.032$), heart failure ($P = 0.028$), and atrial fibrillation ($P = 0.012$). Other baseline characteristics were similar. The aortic cannulation group had shorter cardiopulmonary bypass ($P < 0.001$) and clamp times ($P < 0.001$). There were more repairs done in the FA cannulation group as opposed to replacements. Risk-adjusted outcomes showed a higher incidence of permanent stroke in the femoral cannulation group ($P = 0.032$). Other outcomes were not significantly different. In conclusion, FA cannulation may be associated with increased stroke rates in isolated MV surgery. Antegrade arterial cannulation (direct aortic or axillary cannulation) may be preferable in minimally invasive MV procedures. Randomized trial data are needed.

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	Odds Ratio	95% CI		P
		Lower	Upper	
Operative mortality	0.000	0.000	0.000	0.997
Blood products requirement	1.338	0.633	2.829	0.466
Permanent stroke	9.633	1.216	76.290	0.032*
Prolonged ventilation	0.857	0.249	2.949	0.806
Renal failure	1.055	0.222	5.004	0.946
Atrial fibrillation	0.548	0.239	1.255	0.155
Total ICU hours				0.254
Days from surgery to discharge				0.337

ICU, intensive care unit. Table 3 is the central picture.

Risk-Adjusted Outcomes of the FA Cannulation Group in Relation to Aortic Cannulation Group.

Central Message

Minimally invasive MV surgery is associated with an increased stroke rate. The reason behind this association should be investigated.

Perspective

Minimally invasive MV surgery is associated with an increased stroke rate. Highly variable techniques and approaches are labeled as minimally invasive MV surgery. The first step toward a potential improvement is to localize the exact technique(s) or approach(es) that may be the reason behind the increased stroke rate. Our results point an observation that may allow for improvement.

See Editorial Commentary page 104–105.

INTRODUCTION

Minimally invasive mitral valve (MV) surgery has been a paradigm shift in heart valve surgery. It is not restricted to a single approach, and much variation exists regarding the conduct of the operation.[1,2] With the lack of well-powered randomized controlled trials, strong evidence comes from the largest retrospective study to date by Gammie et al[3] that addresses minimally invasive MV surgery. Patients undergoing less-invasive MV surgery were indentified and labeled based on the presence of femoral artery (FA) cannulation recorded in the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database. Despite the informative well-powered results, a worrisome conclusion was that minimally invasive MV surgery may independently increase the risk of permanent stroke.

Although most available minimally invasive MV surgery clinical data show positive outcomes, certain negative outcomes exist and may be associated with specific technical steps

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adopted during minimally invasive MV surgery rather than the entire procedure. Cannulation for cardiopulmonary bypass minimally invasive MV surgery can be performed using multiple access vessels. However, distal cannulation, typically via the FA, implies retrograde flow within the aorta toward the great vessels. Currently, there is debate whether this retrograde aortic flow may be a cause for increased cerebral emboli originating in the descending aorta. A modification of minimally invasive MV surgery to include proximal cannulation of the ascending aorta directly or the axillary artery has been advocated by some surgeons, including our group, in an attempt to attenuate neurologic injury.

We hypothesize that FA cannulation and retrograde aortic blood flow are associated with worse neurologic outcomes following mitral surgery. In this study, we aim to assess the effect of cannulation site on clinical outcomes following mitral surgery. We excluded or adjusted for all potential baseline and procedural risk factors for stroke that may confound results.

PATIENTS AND METHODS

The Methodist Hospital institutional adult cardiac surgery database was interrogated for procedures performed during the period from January 2004 to July 2012. Baseline patient characteristics, procedural data, clinical events, and outcomes were recorded prospectively in the database by a dedicated center. Institutional review board approval was obtained as per the Houston Methodist Hospital Research Institute policy. Data for MV surgery were studied. All patients who underwent concomitant procedures were excluded (coronary artery surgery, aortic valve surgery, tricuspid valve surgery, or arrhythmia corrective surgery). From the isolated MV surgery cases, we excluded patients older than 60 years, those who underwent nonelective procedures (preoperative cardiogenic shock or infective endocarditis), and those having no aortic occlusion or having endoluminal balloon aortic clamps.

We used the STS adult cardiac surgery database v2.61, having 4 different fields for cannulation strategy. The groups are arterial cannulation via the aorta or the FA, each with venous cannulation through either the atrial or caval access or the femoral or jugular access. All patients who underwent FA cannulation disregarding the venous cannulation method were selected, and the rest undergoing aortic cannulation constituted the control group. All STS definitions have been published elsewhere.[4] The primary end point was postoperative permanent neurologic deficit.

STATISTICAL ANALYSIS

Central tendency for continuous variables was expressed in medians and interquartile ranges, and for categorical variables, it was expressed as percentages. Baseline characteristics, procedural characteristics, and unadjusted outcomes were compared using the chi-square test for categorical variables, the Student t test for normally distributed continuous variables, and the Mann-Whitney U test for nonparametric continuous variables. Normality if distribution was based on the Shapiro-Wilk test.

Multivariable regression analyses were done, with linear regression used for continuous dependent variables and a logistic model for dichotomous ones. All independent variables clinically related to outcomes (including cross-clamp and total perfusion times) as well as those with a statistical $P < 0.2$ were included in the regression analyses to determine independent effects. Significance was based on a 95% CI. Analysis was done using the Statistical Package for the Social Sciences (SPSS) v.17 (SPSS Inc, Chicago, IL).

RESULTS

During the period from January 2004 to July 2012, MV procedures were recorded. Concomitant coronary artery surgery or aortic valve surgery was excluded. From the remaining 1032 isolated MV surgery cases, patients were excluded if they had preoperative cardiogenic shock, had infective endocarditis, underwent concomitant tricuspid valve procedure or arrhythmia corrective surgery, had no aortic occlusion or endoluminal balloon aortic clamp, and were older than 60 years. After all exclusions, 384 patients were included, of whom 57 underwent cannulation through the FA.

Baseline differences between the 2 groups are shown in Table 1. The FA cannulation group had a lower percentage of patients with baseline cerebrovascular disease (2% vs 11%, $P = 0.032$), a lower prevalence of preoperative heart failure (16% vs 30%, $P = 0.028$), and less number of patients with atrial fibrillation (7% vs 21%, $P = 0.012$). The aortic cannulation group consistently had shorter perfusion times ($P < 0.001$) and cross-clamp times ($P < 0.001$). Mitral repair as opposed to replacement was more common among the FA cannulation group (82% vs 67%, $P = 0.017$).

Unadjusted outcomes showed that the FA cannulation group had higher stroke rates (5.3% vs 0.6%, $P = 0.004$) and shorter length of stay from date of surgery to discharge (7 vs 9 days [median], $P = 0.001$). Other outcomes are displayed in Table 2.