Outcomes of Elective Aortic Hemiarch Reconstruction for Aneurysmal Disease in the Elderly

Arman Kilic, MD, George J. Arnaoutakis, MD, Joseph E. Bavaria, MD, Ibrahim Sultan, MD, Nimesh D. Desai, MD, PhD, Prashanth Vallabhajosyula, MD, Matthew L. Williams, MD, Rita K. Milewski, MD, PhD, and Wilson Y. Szeto, MD

Division of Cardiovascular Surgery, University of Pennsylvania, Philadelphia, Pennsylvania

Background. **This study evaluated outcomes of elective aortic hemiarch reconstruction for aneurysmal disease in the elderly.**

Methods. **Patients undergoing elective aortic hemiarch reconstruction for aneurysmal disease at a single institution between 2009 and 2014 were retrospectively reviewed. Patients were stratified into nonelderly (aged less than 75 years) versus elderly (aged 75 years or more). Outcomes included operative mortality and morbidity.**

Results. **In all, 629 patients (95 elderly; 15%) were included. Elderly patients had a greater comorbidity burden. Concomitant aortic valve replacement and coronary artery bypass were performed more frequently whereas root replacement was performed less frequently in the elderly. The overall stroke rate was 1.8% and was higher among the elderly (4.2% versus 1.3%, $p = 0.05$), although this difference no longer persisted after risk adjustment (odds ratio 2.54, $p = 0.17$). Median length of intensive care unit and hospital stay were longer in the elderly (64 versus 41 hours and 9 versus 7 days, respectively; each $p < 0.001$). Unadjusted and risk-adjusted operative mortality were similar (2.1% elderly versus 0.9% nonelderly, $p = 0.32$). Elderly patients were less frequently discharged to home (65% versus 95%, $p < 0.001$). Propensity matched analysis confirmed these findings. Moderate hypothermic circulatory arrest with antegrade cerebral perfusion was a safe strategy for the elderly patients, with stroke and operative mortality rates of 0% each.**

Conclusions. **Although elderly patients have a more prolonged recovery after elective aortic hemiarch reconstruction for aneurysmal disease, outcomes are acceptable with low operative mortality and with the majority being discharged home. Moderate hypothermic circulatory arrest with antegrade cerebral perfusion is a safe strategy for this cohort. Advanced age alone should not be viewed as a contraindication in these cases.**

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As the elderly proportion of the population in the United States is expected to grow in coming years, cardiac surgeons will assuredly manage and operate more frequently on older patients. This potential demographic shift may in some cases be offset by the maturation of less invasive transcatheter technology. A prime example of that is in the realm of the aortic valve with the growth of transcatheter aortic valve replacement [1, 2]. Transcatheter and minimally invasive approaches to ascending aortic disease have been described and will likely play an increasingly larger role in the management of these disease entities [3–5]. In this regard, a benchmark analysis of outcomes of open ascending aortic surgery is important for future comparisons and to help further refine care for a generally higher risk patient subset such as the elderly. In this study, we evaluated outcomes of elective aortic hemiarch reconstruction for aneurysmal disease in the elderly.

Patients and Methods

Study Cohort

Adult patients undergoing elective aortic hemiarch reconstruction for aneurysmal disease between 2009 and 2014 at a single institution were retrospectively reviewed. Data were prospectively recorded and maintained in a registry. Cases involving concomitant aortic valve replacement (AVR), coronary artery bypass graft surgery (CABG), and aortic root replacement were included. Patients with dissections and other urgent or emergent cases were excluded from analysis. The Institutional Review Board at the University of Pennsylvania approved this study.

Baseline Characteristics

The study cohort was primarily stratified by age into elderly patients aged 75 years or older and nonelderly patients aged less than 75 years. Baseline characteristics

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Address correspondence to Dr Szeto, Division of Cardiovascular Surgery, University of Pennsylvania Medical Center, Penn Presbyterian Medical Center, Heart Vascular Pavilion, Ste 2A, 51 N 39th St, Philadelphia, PA 19104; email: wilson.szeto@uphs.upenn.edu.

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Abbreviations and Acronyms

ACP = antegrade cerebral perfusion
AVR = aortic valve replacement
CABG = coronary artery bypass graft surgery
CI = confidence interval
DHCA = deep hypothermic circulatory arrest
MHCA = moderate hypothermic circulatory arrest
OR = odds ratio
RCP = retrograde cerebral perfusion

were compared between these groups. These characteristics included preoperative variables such as patient age, sex, race, body mass index, diabetes mellitus, hyperlipidemia, chronic kidney disease, hypertension, smoking, coronary artery disease, chronic lung disease, liver disease, immunosuppression, connective tissue disorder, history of cancer, peripheral arterial disease, cerebrovascular disease, family history of coronary artery disease, most recent creatinine level, most recent white blood cell count, most recent hematocrit, prior open heart surgery, and left ventricular ejection fraction. Intraoperative variables included concomitant procedures including AVR, CABG, or aortic root replacement, intraoperative blood product utilization, lowest core body temperature, cerebral perfusion strategy, cardiopulmonary bypass time, aortic cross-clamp time, circulatory arrest time, arterial cannulation site, and venous cannulation site.

Operative Technique

Briefly, the operative strategy entailed either deep hypothermic circulatory arrest (<20° C) with retrograde cerebral perfusion (DHCA-RCP) or moderate hypothermic circulatory arrest (25° to 28°C) with antegrade cerebral perfusion (MHCA-ACP). The selection of DHCA-RCP versus MHCA-ACP was at the discretion of the surgeon. All patients had continuous electroencephalogram and near-infrared spectroscopy monitoring. In patients with DHCA-RCP, cardiopulmonary bypass was initiated with central cannulation of the ascending aorta, right atrium, and superior vena cava. Circulatory arrest was initiated on achieving electroencephalogram silence with RCP delivered through the cardioplegia circuit after snaring of the superior vena cava. Central venous pressures were maintained between 20 and 25 mm Hg. The MHCA-ACP patients underwent either axillary cannulation or direct innominate cannulation and right atrial cannulation. The ACP was initiated with flows maintained between 10 and 12 mL $\cdot$ kg^{-1} $\cdot$ min^{-1} with a right radial arterial pressure of 50 to 60 mm Hg. Aggressive hemiarch reconstruction was performed in all patients with resection of most of the lesser curve of the aortic arch.

Outcomes

The primary outcome was operative mortality, defined as 30-day or inhospital mortality. Secondary outcomes included complications, length of hospital and intensive care unit stay, and rates of hospital discharge to home versus facility. Separate risk-adjusted models for operative mortality and postoperative stroke were generated by incorporating variables associated with each of these outcomes in univariate logistic regression analysis that had an exploratory p value of less than 0.10. The inclusion of each covariate was evaluated backward and forward using the likelihood ratio test, and the performance of the final multivariable model was evaluated using the c-index. A subgroup analysis was conducted comparing outcomes of MHCA-ACP versus DHCA-RCP in the elderly patients. All continuous data in this study are presented as mean $\pm$ SD, and all categoric data as number (percentage). Data analyses were performed with version 11 STATA statistical software (StataCorp, College Station, TX). A 1:1 nearest neighbor propensity score matching without replacement using logistic regression analysis (inclusion criteria of $p < 0.05$ in univariate analysis) to identify matching variables was also utilized to compare outcomes between well-matched elderly and nonelderly patients. Variables included in the propensity score matching were sex, body mass index, hypertension, peripheral arterial disease, prior open heart surgery, cerebrovascular disease, myocardial infarction, coronary artery disease, concomitant AVR, concomitant CABG, concomitant root replacement, cross-clamp time, and antegrade versus retrograde cerebral perfusion. The PSMATCH2 statistical module for STATA was used for this analysis. In this study, continuous variables were compared using the unpaired Student's t test, and categoric variables were compared using the χ^2 test. In the propensity matched analysis, comparisons of categoric outcomes were performed with McNemar's test.

Results

Comparison of Baseline Characteristics

The study cohort consisted of 629 patients, of whom 95 (15.1%) were elderly. In addition to being older, elderly patients had a higher proportion of females and lower body mass index (Table 1). As expected, bicuspid aortic valves were present more frequently among younger patients. The elderly cohort had a greater comorbidity burden, with higher rates of hypertension, peripheral arterial disease, cerebrovascular disease, myocardial infarction, and coronary artery disease (Table 1).

Concomitant procedures varied between the groups, with concomitant AVR or CABG being performed more frequently and aortic root replacements being performed less frequently in the elderly (Table 1). Operative strategy was similar, with the majority of cases (95%) being performed with direct aortic arterial cannulation. DHCA-RCP was most commonly performed, and was performed at similar rates in both cohorts. Cardiopulmonary bypass and circulatory arrest time were comparable, although aortic cross-clamp time was shorter in the elderly cohort (Table 1).