Hemiarch Reconstruction Versus Clamped Aortic Anastomosis for Concomitant Ascending Aortic Aneurysm

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Background. **Deep hypothermic circulatory arrest (DHCA) is often avoided in patients with concomitant ascending aortic pathology when treating another cardiac disease to avoid increased risk of morbidity and mortality. We hypothesized that the use of DHCA with retrograde cerebral perfusion (RCP) does not add incremental risk to ascending aortic replacement alone in the setting of concomitant cardiac surgery.**

Methods. **A total of 408 ascending aortic ± hemiarch replacements and aortic (root), mitral, or tricuspid valve(s); coronary artery bypass grafting; or MAZE procedures were performed for concomitant cardiac disease. DHCA with RCP was used for all hemiarch replacements or the ascending aorta was replaced with an aortic cross-clamp proximal to the innominate artery. Propensity score matching was used to match similar ascending aorta patients versus hemiarch patients; the final propensity score–matched patients on age, sex, body mass index, previous heart surgery, preoperative aortic insufficiency, preoperative aortic stenosis, preoperative ejection fraction, and operative variables.**

Results. **Propensity score matching yielded 116 pairs of non-hemiarch patients versus 116 hemiarch patients. Within the propensity score–matched cohort, there were no differences in postoperative stroke (1.7% versus 3.4%; $p = 0.41$), new postoperative dialysis (6.0% versus 5.2%; $p = 0.78$), postoperative renal insufficiency (27.6% versus 19.8%; $p = 0.16$), 30-day mortality (2.6% versus 3.4%; $p = 0.701$), or 1-year mortality (4.3% versus 4.3%; $p = 1.00$)**

Conclusions. **Hemiarch replacement using DHCA with RCP does not increase the risk of operative complications compared with a normothermic, clamped-distal aortic anastomosis, and therefore its use should not be limited when planning complex multi-procedural reconstructions during elective ascending thoracic aortic replacement with concomitant cardiac surgery.**

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Current American Heart Association guidelines recommend operative intervention for significant ascending aneurysms (size greater than 4.5 cm in greatest diameter) at the time of cardiac surgery for other disease (eg, aortic valve replacement [AVR], coronary artery bypass grafting [CABG]). Although guidelines exist, the exact timing of thoracic aortic aneurysm (TAA) repair remains a topic of debate and can be surgeon or patient specific. This indecision is, however, not without merit, as it has been shown that ascending repair in the setting of concomitant heart surgery increases operative morbidity and mortality, although not to a level of statistical significance [1].

There have been 2 well-established surgical approaches to repair ascending TAAs, which include (1) ascending aortic replacement with a distal ascending aortic cross-clamp or (2) hemiarch replacement with circulatory arrest [2–4]. The former requires placement of an aortic cross-clamp just proximal to the brachiocephalic vessel with distal arch cannulation. The hemiarch approach brings with it the risks associated with circulatory arrest. The choice of surgical approach remains controversial with risks and benefits with each method.

Circulatory arrest is often avoided in patients with concomitant ascending aortic pathology when treating other cardiac disease based on the presumption of increased risk of morbidity and mortality. We hypothesized that the use of deep hypothermic circulatory arrest (DHCA) with retrograde cerebral perfusion (RCP) does not add incremental risk to ascending aortic replacement alone in the setting of concomitant cardiac surgery.

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Patients and Methods

This was a retrospective study of prospectively collected data for our clinical aortic database. This was approved by the institutional review board and informed consent was waived since this was a retrospective chart based review. All patients (N = 408) who underwent elective ascending aortic aneurysm replacement in the setting of concomitant cardiac surgery (aortic valve, aortic root, mitral valve, and tricuspid valve repair or replacement; CABG or MAZE procedures) between January 2011 to December 2016 were included. All surgeries were performed concurrently in the same time period. Surgeons who performed these operations were experienced with both circulatory arrest and clamped aortic anastomoses. Emergent cases (ie, acute aortic dissections and ruptured aneurysms) were excluded from analysis. Patients with aortic arch aneurysms were excluded. The total patient population (N = 408) was divided into 2 cohorts, comprising the patients who underwent concomitant hemiarch procedures (n = 248) and the patients who underwent concomitant ascending aortic replacement with a distal cross-clamp (non-hemiarch procedures) (n = 160). All procedures had neurocerebral monitoring with electroencephalogram and somatosensory evoked potentials for the entirety of the procedure. RCP was used in patients undergoing hemiarch replacement. For non-hemiarch procedures, DHCA was not required and the ascending aorta was replaced with an aortic cross-clamp placed proximal to the innominate artery.

Surgical Technique

Patients undergoing hemiarch replacement were performed under DHCA. Patients were cooled to isoelectric electroencephalogram. RCP was utilized using a cardioplegia line that was connected to an SVC cannula which was snared at the time of circulatory arrest. The side port of the internal jugular catheter was utilized and a pressure of 25 mm Hg was used to ensure adequate RCP. All ascending aortic replacements were performed with aortic arch cannulation and a cross clamp at the base of the innominate artery.

Statistical Analysis

Continuous variables are reported as mean ± SD; categorical variables are reported as frequency (percentage). Baseline characteristics are compared using *t* tests for continuous variables and chi-square tests for categorical variables (Fisher's exact tests when necessary due to small cell sizes). Immediate perioperative and postoperative outcomes are also compared using *t* tests for continuous variables and Fisher's exact tests for categorical variables; long-term survival for each group is presented using Kaplan-Meier curves, and the difference tested using Cox proportional hazards regression. Due to baseline differences between treatment groups, we also performed a propensity score–matched analysis. The final multivariable logistic regression model used to generate the propensity scores included all preoperative variables shown in Table 1 as well as selected operative variables (AV repair, AVR, root replacement, and concomitant CABG). After calculating the propensity scores, patients undergoing hemiarch replacement were randomly sequenced and matched 1:1 without replacement to non-hemiarch patients using a caliper distance of 0.10, resulting in 116 matched patient pairs. Between-group comparisons were repeated in the propensity-matched population to ensure adequate balance in risk profile, and outcomes are then summarized in the matched population. All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Results

All baseline characteristics are described in Table 1 and operative variables are described in Table 2. There were no statistically significant differences between the 2 cohorts (hemiarch versus non-hemiarch) with respect to age, sex, prior diabetes mellitus, or severe chronic obstructive pulmonary disease. Preoperative renal failure requiring dialysis was only present in 2 patients in the combined patient population (1 patient in each group). Peripheral vascular disease was more common in the hemiarch group (53.2%) compared with the non-hemiarch group (40.6%) ($p < 0.001$). A greater number of patients in the non-hemiarch cohort (33.8%) had prior heart surgery compared with the hemi-arch group (21.4%) ($p = 0.005$). Nearly half (47.1%) of the total patient population had bicuspid aortic valves with no statistically significant differences between groups. Twenty-four (5.9%) patients had chronic aortic dissections with no significant difference among the cohorts. There were significantly more patients with severe preoperative aortic stenosis in the non-hemiarch group when compared with the hemiarch group (54.4% versus 19.4%; $p < 0.001$). Significantly more patients underwent AV repair in the hemiarch group (10.9%); however, more patients underwent AVR in the non-hemiarch group (35.6%) ($p < 0.001$). There were no statistical differences among groups regarding the number of patients that underwent aortic root procedures. Concomitant CABG was performed more frequently in the non-hemiarch group compared with the hemiarch group (38.1% versus 21.8%; $p < 0.001$). Concomitant mitral, tricuspid valve surgery, and MAZE procedures were performed in 13 (3.2%), 6 (1.5%), and 10 (2.5%) of the total combined patient populations, with no significant differences in frequencies among groups.

Cardiopulmonary bypass (CPB) time was longer in the hemiarch group (210 ± 61.9 minutes) compared with the non-hemiarch group (183 ± 74.1 minutes) ($p < 0.001$). Aortic cross-clamp time was similar between groups (hemiarch: 152 ± 53.4 minutes; non-hemiarch: 144 ± 57.5 minutes; $p > 0.139$). The number of patients who received blood products during hospitalization was similar between the 2 groups (Table 3).

Propensity score matching (Tables 4 and 5) (caliper distance = 0.10) was used to create a cohort of similar patients that received each treatment. Final matching produced similar patient populations in the 2 groups