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# Innominate *versus* axillary artery cannulation for the hemiarch repair

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ABSTRACT

*Background:* Innominate artery cannulation has gained some popularity over the last decade as an alternative to axillary artery cannulation for providing selective antegrade cerebral perfusion during repair of the ascending aorta and arch. Innominate artery cannulation provides several advantages including avoidance of an additional incision and use of a larger caliber artery to provide less resistance to high flow during bypass and selective antegrade cerebral perfusion. We hypothesize that these advantages make innominate artery cannulation superior to axillary artery cannulation as it can decrease operative times and potentially decrease blood loss.

*Methods:* This was a single-center retrospective analysis of 206 patients who underwent hemiarch replacement between 2009 and 2017. All patients qualified including emergent cases. Groups were separated by mode of cannulation: axillary and innominate. Outcomes evaluated included cardiopulmonary bypass (CPB) time, cross-clamp time, circulatory arrest (CA) time, postoperative transfusions, intensive care unit length of stay, development of any neurological complications, end-organ failure, and mortality. Subgroup analysis was performed for elective and emergent cases.

*Results:* Axillary and innominate artery cannulation accounted for 37% ($n = 77$) and 67% ($n = 129$) of cases, respectively. There was no difference in patient characteristics except for a higher incidence of renal disease in the axillary group (16% *versus* 6%, $P = 0.05$). More emergent cases were performed in the axillary group (61% *versus* 17%, $P < 0.001$). Innominate cases had shorter CPB times (189 *versus* 150 min, $P < 0.001$) and CA (22.5 *versus* 11 min, $P < 0.001$) times overall. In the elective subgroup, CA times were shorter for the innominate cases. However, the emergent subgroup displayed no difference in operative times. Less transfusions were given in the innominate group including units of red blood cells (2 [0-6] *versus* 0 [0-2], $P < 0.001$), units of platelets (2 [1-3] *versus* 1 [0-2], $P = 0.001$), and units of plasma (6 [2-9] *versus* 2 [0-4], $P < 0.001$). A similar trend was observed in the elective subgroup. No difference in transfusions was observed in the emergent subgroup. There was no statistical difference in remaining outcomes between cases of axillary and innominate cannulation in the combined, elective, and emergent groups.

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*Conclusions:* Alternate cannulation strategies for open arch anastomoses are evolving with a trend toward using the innominate artery. These data suggest that innominate cannulation is at least equivalent to, and may be superior to, axillary cannulation. The innominate artery provides a larger conduit vessel for perfusion and this decrease in resistance to flow, allowing for faster cooling and rewarming, maybe why CPB times were lower in this group. Innominate cannulation is a safe and potentially advantageous technique for hemiarch repair.

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## Introduction

Management of ascending aortic disease continues to evolve as experience with this pathology increases.[1-3] Aortic arch repair is facilitated by circulatory arrest (CA) that allows for technical repair while minimizing field bleeding.[4] However, CA requires initiation of total body hypothermia to minimize end-organ damage. Furthermore, to reduce neurologic complications, brain perfusion with selective antegrade cerebral perfusion (SACP) has evolved as a neuroprotective adjunct.[5-7] The most accepted approach for administration of SACP is through axillary artery cannulation.[2,6] However, cannulation of the axillary artery requires, in addition to the median sternotomy, an axillary incision with potential for blood loss outside of the pericardial wall. Furthermore, in some patients, the axillary artery can be small, which may be sufficient for cerebral perfusion but is not uncommonly inadequate for total body perfusion.

Other sites described for the delivery of SACP include sewing a conduit on either carotid or ostial cannulation of the innominate or left common carotid.[8-10] The innominate artery is accessible through the median sternotomy and provides a larger caliber conduit for delivery of SACP.[11] This technique has gained recent momentum as a more versatile option for antegrade cerebral perfusion during arch replacement.[1,12,13] Despite this, however, axillary artery cannulation remains the default cannulation site for many physicians.

## Methods

This was a single-center retrospective analysis of 206 patients who underwent hemiarch replacement between 2009 and 2017 in approval with the Colorado Multiple Institutional Review Board. All patients were included along with emergent cases. Groups were separated by mode of cannulation: axillary or innominate. Operative parameters evaluated included cardiopulmonary bypass (CPB) time, cross-clamp time, CA time, and nadir temperatures during CA. The units of red blood cell (RBC), platelet (PLT), and fresh frozen plasma (FFP) transfused postoperatively were also assed. Additional outcomes included intensive care unit length of stay, development of any neurological complications, end-organ failure, and mortality. Subgroup analysis was performed for elective and emergent cases.

### *Operative techniques*

Patients undergoing hemiarch replacement was defined as replacement of the ascending aortic arch with the distal anastomosis in zone 0 with or without other indicated procedures. Those undergoing innominate artery cannulation received a perfusate via a side graft through the innominate artery (Fig. 1). Conversely, the axillary artery was cannulated via a side graft after exposure through an infraclavicular incision.

Early in experience, the preference at our institution was to cannulate the axillary artery. As our experience grew and experience from other groups demonstrated the feasibility of innominate cannulation, we started to use the innominate artery more frequently. The decision to perform axillary or innominate cannulation has, however, remained at the discretion of the operating surgeon.

### *Statistical analysis*

All statistical analysis was carried out using open source RStudio (RStudio, Inc). Normality in continuous data was evaluated using the Shapiro–Wilk test with an alpha level of 0.05. Central tendency was evaluated for in continuous data using either Student's *t* test if the samples had a normal distribution or otherwise using the Mann–Whitney *U*-test. Discrete variable analysis was conducted using the Pearson's chi-squared test. In cases when an outcome in any group was less than 5, the Fisher's exact test was used. Continuous results are summarized as mean where the data are normal and otherwise the median. Sample variability for operative times is summarized as the ± standard error of mean/median, whereas for the transfusions, the interquartile range is presented.

## Results

### *All patients*

A review of the University of Colorado Cardiac Surgery Database revealed a total of 206 patients who underwent hemiarch repair. Axillary and innominate artery cannulation accounted for 37% ($n = 77$) and 63% ($n = 129$) of cases, respectively.

Patient characteristics and demographics are summarized in Table 1. The two groups had similar characteristics and comorbidities except for a higher incidence of renal disease in the axillary group (15.6% *versus* 6.2%, $P = 0.05$). In addition, more emergent cases were performed in the axillary group (61% *versus* 17.1%, $P < 0.001$).

Operative times are summarized in Figure 2A. Innominate cases had shorter CPB (189 *versus* 150 min, $P < 0.001$) and CA (22.5 *versus* 11 min, $P < 0.001$) times overall. Postoperative transfusions were also less in the innominate group including