

# Perfusion Pressure Does Not Affect Neurologic Outcome in Axillary Artery Side Graft Cannulation in Type A Aortic Dissection

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## ABSTRACT

**Objective.** Antegrade selective cerebral perfusion (ASCP) through the right axillary is a safe and effective method for cerebral protection in aortic surgery. In the present study, we evaluated whether or not pressure control in ASCP affected the neurologic outcome.

**Method.** Sixty-two patients (17 female, 45 male) with a mean age of  $53.9 \pm 9.4$  years (range, 23-74 years) with a diagnosis of Type A aortic dissection were operated on by using the right axillary artery side graft cannulation technique. ASCP with pressure control was used in the first 37 (59.6%) patients (group 1), whereas ASCP with flow control was used in the consecutive 25 patients (39.4%) (group 2). The groups were compared according to postoperative neurologic outcomes.

**Results.** The hospital mortality rate was 9.7% with 6 patients. The mean ASCP flows of group 1 was  $663 \pm 76$  mL/min and  $692 \pm 51$  mL/min in group 2. This difference was not statistically significant ( $P = .120$ ). The neurological dysfunction rates were 2.7% in group 1 with 1 patient and 8% in group 2 with 2 patients ( $P = .560$ ).

**Conclusion.** In this study, we could not find a statistically significant difference in patients treated with ASCP through the right axillary applicated with pressure control versus flow control.

## INTRODUCTION

The ascending aorta is the most common arterial cannulation site for cardiopulmonary bypass (CPB). However, in aortic dissections the right axillary artery serves as a good cannulation site for arterial inflow. Direct cannulation of this artery and cannulating the side graft that is implanted to the artery

are some modifications that have been used since Sabik and colleagues popularized the technique of using the right subclavian/axillary artery for arterial inflow for complex cardiac operations [Sabik 1995].

Antegrade selective cerebral perfusion (ASCP) through the right axillary artery has been proven to be a safe and effective method for cerebral protection in aortic surgery. However, whether pressure control in ASCP affects the neurologic outcome remains unclear. This study was performed to determine whether or not pressure-controlled ASCP was superior to flow-controlled ASCP.

## MATERIALS AND METHODS

Between May 2001 and September 2005, patients who were diagnosed with type A aortic dissection and underwent operation were included in the study. The patients who had aortic arch replacement and the patients who had cerebral malperfusion prior to surgery were excluded from the study. A total of 62 patients who had ascending aorta replacement were included in the study. There were 17 (27.4%) female and 45 (72.6%) male patients. Mean age of the patients was  $53.9 \pm 9.4$  years (range, 23-74 years). Twenty-seven (43.5%) patients were hypertensive. Acute aortic dissection was present in 45 (72.6%) patients. All of the patients were operated on by using the right axillary artery side graft cannulation technique. The patients were evaluated as 2 independent groups. ASCP with pressure control was used in the first 37 (59.6%) patients (group 1) and ASCP with flow control was used in the consecutive 25 (39.4%) patients (group 2). This is a retrospective study. The data were collected from the preoperative, perioperative, and postoperative patient database of our hospital with the permission of the Internal Review Board. The study was approved by the local ethics committee.

The groups were compared according to preoperative data, operative findings, and postoperative neurologic outcomes (transient neurologic dysfunction: postoperative confusion, agitation, delirium, prolonged obtundation, double vision, delayed awakening more than 24 hours, transient parkinsonism with negative brain computed tomography scanning results, and complete resolution before discharge [Borst 1995, 1996]).

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### Surgical Techniques

The operations were performed under general anesthesia. Arterial lines were routinely placed on both radial arteries for pressure monitoring. Preoperative routine upper extremity arterial examination was done to every patient to avoid any malperfusion.

The operations were performed under moderate degree hypothermia with a nasopharyngeal temperature of 25°C to 28°C. The temperature was decreased to 25°C for operations in which ASCP times were expected to be more than 30 minutes, whereas it was stabilized to 28°C for shorter ASCP times. Both of the radial artery pressures were checked at the beginning of CPB for the presence of malperfusion. After cross clamping the ascending aorta, we accomplished cardiac arrest with antegrade infusion of isothermic hyperkalemic blood cardioplegia. Arrest was maintained by a continuous retrograde infusion of maintenance cardioplegia. Open distal anastomosis was done in all of the patients. Continuous ASCP by clamping the brachiocephalic and left carotid arteries proximally was done during the distal reconstruction. The proximal left subclavian artery was not clamped during the ASCP. In group 2, the ASCP flow was regulated in a way so that the right radial arterial pressure was 50 to 60 mmHg. The ASCP flow was stabilized to 8 to 10 mL/kg per minute in group 2 without considering the right radial artery pressure.

### Statistical Analysis

Statistical analysis was done with SPSS 10.0 statistical software program (SPSS, Chicago, IL, USA). Continuous variables were expressed as the mean  $\pm$ 1 standard deviation. Comparison of the continuous variables was done by Mann-Whitney *U* test. The difference between the groups according to categorical variables was analyzed by chi-square test. *P* values less than .05 were considered to be statistically significant.

## RESULTS

The hospital mortality rate was 9.7% with 6 patients. The mortality rate of group 1 was 8.1% with 3 patients (low cardiac output in 1 patient, gastrointestinal system ischemia in 1 patient), and respiratory insufficiency and hypoxia in 1 patient), and the mortality rate of group 2 was 12% with 3 patients (low cardiac output in 1 patient and respiratory insufficiency and hypoxia in 2 patients). The mortality rates were not statistically significant (*P* = .463). There were 27 acute dissections (72.9%) in group 1 and there were 18 acute dissections in group 2 (72%) (*P* = 1.000).

The mean ASCP flows of the groups were 663  $\pm$  76 mL/min in group 1 and 692  $\pm$  51 mL/min in group 2. This difference was not statistically significant (*P* = .120). The ASCP durations were 37  $\pm$  11 minutes in group 1 and 37  $\pm$  8 minutes in group 2. The difference was not statistically significant (*P* = .818). Transient neurological dysfunction occurred in 1 (2.7%) patient in group 1 and in 2 (8%) patients in group 2 (1/37 patients in group 1 delayed awakening more than 24 hours, 1/19 patients in group 2 delayed awakening more than 24 hours, and there was postoperative confusion and agitation in 1 patient; *P* = .560). The power of the study calculated according to alpha error of transient neurological dysfunction

### Clinical Characteristics of the Groups

Characteristics	Group 1, n = 7	Group 2, n = 25	<i>P</i>
Mean age, y	53.4 $\pm$ 10.5	54.6 $\pm$ 7.6	.725
Male:female	24:13	21:4	.147
Marfan syndrome	3 (8.1%)	1 (4%)	.642
Hypertension	20 (54.0%)	7 (28%)	.067
Diabetes	1 (2.7%)	1 (4%)	1.000
Smoking	7 (18.9%)	5 (20%)	1.000
Peripheral vascular disease	1 (2.7%)	1 (4%)	1.000
Chronic obstructive pulmonary disease	1 (2.7%)	3 (12%)	.294
Coronary artery disease	3 (8.1%)	1 (4%)	.642
Previous cardiac or aortic operation	7 (18.9%)	2 (8%)	.292
Atrial fibrillation	0 (0%)	1 (4%)	.403
Cardiac tamponade	4 (10.8%)	2 (8%)	1.000
Acute aortic dissection	27 (72.9%)	18 (72%)	1.000
Cardiopulmonary bypass time, min	168 $\pm$ 66	140 $\pm$ 38	.076
Total myocardial ischemia time, min	109 $\pm$ 38	93 $\pm$ 30	.100
Antegrade selective cerebral perfusion time, min	37 $\pm$ 11	37 $\pm$ 8	.818
Antegrade selective cerebral perfusion flow, mL/min	663 $\pm$ 76	692 $\pm$ 51	.120
Transient neurologic dysfunction	1 (2.7%)	2 (8%)	.560
Stroke	0 (0%)	0 (0%)	
Mortality	3 (8.1%)	3 (12%)	.463
Intensive care unit length of stay, d	2.9 $\pm$ 1.7	2.8 $\pm$ 1.5	.727
Length of hospitalization, d	7.2 $\pm$ 2.2	7.1 $\pm$ 1.6	.922

was 0.60. The postoperative data of the groups are seen in the Table.

## DISCUSSION

The most important advantage of right axillary artery cannulation is that it provides antegrade perfusion of the brain during open distal aortic reconstruction. Some surgeons use deep hypothermia and retrograde cerebral perfusion when the circulatory arrest period exceeds 30 minutes even in the case that they cannulate the axillary artery [Sabik 1995; Neri 1999; Whitlark 2000; Svensson 2002; Yavuz 2002]. In this study, ASCP at moderate degree hypothermia (25°C-28°C) was used during open distal aortic reconstruction.

The brain is supplied by the 2 internal carotid arteries and the 2 vertebral arteries that form the Circle of Willis [Snell 1992]. Underperfusion of the contralateral cerebral hemisphere is hypothetically difficult in the right axillary artery side graft cannulation, unless there is an anomaly in the arterial bed, due to the fact that side graft cannulation permits perfusion of the vertebral artery besides the carotid artery. Besides, clamping the left carotid artery during ASCP is important for the maintenance of the adequate pressure of the Circle of Willis.

The side graft cannulation technique gives the possibility of indirect pressure monitoring of cerebral perfusion through the right radial arterial line. ASCP pressure is monitored throughout the ASCP. This will avoid the undesired high pressure oscillations that may occur by constant antegrade selective cerebral flow. Svensson reported that higher ASCP was associated with a greater risk of stroke and neurocognitive deficit [Svensson 2002]. The present study did not show a statistically significant difference according to the neurologic outcomes between pressure-controlled ASCP and flow-controlled ASCP. Neurological outcomes of patients were evaluated in a completely subjective manner, but this is a retrospective study, and the only data that could be obtained concerning the postoperative neurologic status were whether patients had transient or permanent neurologic dysfunction. Moreover, the number of patients enrolled in this study is relatively low. This may be the reason why no statistically significant differences were observed. However, although the number of the study population was low, the incidence of transient neurological dysfunction was higher in the flow-controlled ASCP in comparison to the pressure-controlled ASCP (8% versus 2.7%).

We can speculate that this may be due to high antegrade cerebral flow pressure or due to unwanted pressure oscillations, but there is no statistical verification. Nevertheless, regulation of the ASCP flow by pressure measurement may provide better cerebral protection, but more detailed randomized studies with higher populations should be carried out to prove this.

Shekar et al reported that an elevated perfusion pressure recorded through a right radial arterial catheter with the arterial inflow into the right axillary artery had not accurately reflected the systemic and, therefore, the cerebral perfusion pressure while on CPB. They concluded that this was because of the vasodilators that dropped the true systemic perfusion pressure that went unnoticed for an extended period resulting in global hypoperfusion. The authors thought that the entire output from the CPB flowed through the cannulated axillary artery, and hence there was higher flow down the ipsilateral arm, resulting in the higher pressures recorded. They concluded that the arterial pressure monitoring should not be done in the ipsilateral upper extremity [Shekar 2005]. In spite of the fact that we did not use deep hypothermia as Shekar et al did, this speculation may not be made for our patients.

In another study, the use of an end-to-side graft was declared to result in hyperperfusion injury to the extremity

unless the distal vessel was occluded [Strauch 2004]. Although there has not been such a case reported, it seems to be theoretically possible. We did not meet such a complication in any of the groups either. But from a hypothetical point of view, side graft perfusion with pressure control would possibly result in less hyperperfusion.

The present study is not a randomized study but an observational one. There may be temporal relationship in terms of outcome. The patients in group 1 were operated on first so there may be the factor of the surgeon's learning curve. Yet, the same surgical team carried out the operations, and the ASCP times of the groups were statistically similar. Therefore the influence of the training effect of the surgeon on the outcome will be less. Our experience with a small number of patients needs to be confirmed by studies of larger groups of patients.

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