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Selecting The Arterial Cannulation Site In Acute Type A Aortic Dissection: Axillary Artery Or Femoral Artery?

Şahin Şahinalp*, **Ali Kemal Gür**

Department of Cardiovascular Surgery, Yuzuncu Yil University Faculty of Medicine

ABSTRACT

The aim of this study was to investigate the effects of cannulation site (either the right axillary artery or the right/left main femoral artery) on the mortality and morbidity of postoperative acute type A aortic dissection (ATAAD) patients.
A total of 41 ATAAD patients (male:female = 29:12), of whom 15 underwent cannulation of the right axillary and 26 of the common femoral artery, were retrospectively evaluated. Post-operative mortality and morbidity were assessed and statistically analyzed.
Of the participants, 34 (82.9%) were type I and 7 (17.0%) were type II according to the DeBakey classification. Cerebral protection was achieved using deep hypothermia in 14 patients, and by antegrade cerebral perfusion in addition to deep hypothermia in 9 patients. Early postoperative mortality was 17% (n= 7). There were no significant differences between the axillary artery and femoral artery cannulation groups in terms of postoperative mortality and morbidity. However, a greater number of arcus aortic interventions was performed in the group undergoing axillary artery cannulation (Group II). In this group, the rate of antegrade cerebral perfusion was also higher.
Although the cannulation site in patients with ATAAD was not determined to affect mortality and morbidity, both options present advantages and disadvantages. We believe that all relevant factors pertaining to the patient as well as the surgical procedure to be employed should be evaluated in tandem in selecting the optimal cannulation site.

Key Words: Type A aortic dissection, Cannulation, Ascending aorta, Axillary cannulation, Femoral cannulation

Introduction

Acute Type A Aortic Dissection (ATAAD) is an event requiring emergency treatment, with high mortality and morbidity rates associated with cardiovascular surgery. Mortality rates following surgical intervention as high as 25% or greater have been reported in some large case series (1, 2). Although surgery is the only treatment option and has been employed for many years, there is still no consensus regarding the optimal surgical procedure. In particular, studies aimed at reducing high mortality rates have focused on cannulation options, ideal hypothermia level, strategies for protecting the brain during total circulatory arrest, and the steps involved in the surgical procedure, such as aortic segment replacement.

For arterial cannulation, the presence of an artery of suitable diameter, unaffected by aortic dissection, that can be easily and quickly cannulated, is essential. The most commonly used arterial cannulation sites are the common femoral artery (CFA) and the right axillary artery (3, 4). Femoral artery cannulation may result in reverse flow in the thoracoabdominal aorta and may adversely affect perfusion of the brain and other organs (5). This situation, especially as regards to the effect of axillary and femoral artery cannulation on long-term outcomes, remains a topic of debate.

The aim of present study was to investigate the effect of cannulation site selection on postoperative mortality and morbidity in patients operated on for ATAAD who underwent right axillary and CFA cannulation.

Materials and Methods

Forty-three patients who underwent surgery for ATAAD between April 2013 and March 2018 were included in the study and evaluated retrospectively. Patients diagnosed with ATAAD who refused surgical treatment, those who underwent an alternative cannulation (rather than the axillary or femoral arteries), and patients who had received double arterial cannulation were not included in the study. Demographic data,

***Corresponding Author:** Şahin Şahinalp, Department of Cardiovascular Surgery, Yuzuncu Yil University Faculty of Medicine, Van, Turkey
E-mail: ssahinalp@gmail.com, Phone: +90 (505) 799 29 89
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intraoperative data, and post-discharge follow-up data were obtained from hospital records.

The diagnosis of ATAAD for all study participants was based on contrast computed tomography (CT), and unaffected arterial regions were identified for cannulation. All patients prepared for surgery were operated on urgently.

Surgical Procedure: All patients underwent median sternotomy. The axillary and femoral arteries were evaluated by CT prior to cannulation, and either the right axillary or right/left common femoral artery was chosen as cannulation site after ascertaining that the dissection flap was not extended. In axillary cannulation patients, the axillary artery was explored via the distal axillary fossa, and direct cannulation with an arterial cannula was performed without grafting. In patients selected for femoral cannulation, direct cannulation of the CFA was performed without grafting following exploration of the right or left CFA in the inguinal region. For all patients, venous cannulation was performed using a two-stage venous cannula through the right atrium. A vent was inserted through the right superior pulmonary vein. After switching to cardiopulmonary bypass (CPB), as per the planned surgical procedure, the patient's body temperature was cooled to 18-28 degrees Celsius. Cold blood cardioplegia was antegradely administered; in some patients, cardiac arrest was achieved by both antegrade and retrograde cardioplegia delivery, and cardioplegia was repeated at the appropriate intervals. Anastomosis of the proximal portion of the ascending aorta was performed with a Dacron graft of suitable diameter under an aortic cross-clamp, using 3/0 Prolene thread supported by teflon felt stitched as a continuous suture. Patients with aortic valve pathology underwent aortic valve suspension or aortic valve replacement, while those with aortic root pathology additionally underwent aortic root replacement. Anastomosis of the distal portion of the tube graft was performed. In patients undergoing axillary arterial cannulation, distal anastomosis of the ascending aortic graft was achieved using a cross-clamp through the aorta, while the distal aortic segment was free. These patients then underwent unilateral cerebral perfusion and circulatory arrest. In patients undergoing femoral cannulation, distal anastomosis of the ascending aorta was performed using an aortic cross-clamp on the appropriate patients.

Total circulatory arrest (TCA) was achieved in patients with lesions extending to the aortic arch, and selective unilateral carotid artery cannulation was performed to achieve cerebral perfusion. Cardiopulmonary bypass was terminated when the appropriate hemodynamics were achieved by rewarming the ascending aorta and, in some patients, following additional aortic arch graft implantation. The axillary and femoral arteries were directly repaired and closed at the arterial cannulation sites.

Post-operative Follow-up: In the early post-discharge period following the initial evaluation, physical examination, routine blood tests, direct chest X-ray, and computerized tomography (CT) scans were performed every three months.

Statistical Analysis: Data analyses were performed by Statistical Package for Social Sciences, version 21.0, for Windows. Sample size was determined by a power analysis method. The data were expressed as mean ± standard deviation or percent ratio. One-sample Kolmogorov–Smirnov test was used to analyse the distribution of continuous variables. The study groups were compared with the Mann-Whitney U test or chi-square/ Fisher's Exact Test with respect to continuous and categorical variables, respectively. Two tailed $p < 0.05$ was accepted as statistically significant.

Results

A total of 41 patients, 29 males (70.7%) and 12 females (29.3%), participated in the study. The demographic data of the patients are shown in Table 1.

According to the DeBakey classification, 34 patients (82.9%) were Type I and 7 were Type II (17.1%). Twenty-nine patients underwent supracoronary tube graft implantation, 5 underwent supracoronary tube graft implantation in addition to hemi/total arch replacement, and 7 underwent root replacement. Fourteen patients experienced deep hypothermia, and in 9 patients, cerebral protection was achieved by means of antegrade cerebral perfusion in addition to deep hypothermia. The patients' operative data are presented in Table 2.

There were no statistically significant differences between the two groups with respect to operative time, CPB time, cross-clamp time, and total circulatory arrest time. However, the majority of patients who underwent arcus replacement and antegrade cerebral perfusion were in Group II.

Early postoperative mortality was 17.0% (n = 7). The results for the two groups were similar with

Table 1. Demographic characteristics of the participants

Parameter	Group I (n=26)	Group II (n=15)	p value *
Age (years)mean ± SD (min-max)	51 ± 4 (47-56)	57 ± 15 (26-85)	0.73
Body Mass Index (kg/m²) mean ± SD	28.65 ± 2.69	27.93 ± 3.61	0.71
Gender (Male, %)	16 (55.2%)	13 (44.8%)	0.09
Diabetes Mellitus (%)	24 (63.2%)	14 (36.8%)	0.91
Hyperlipidemia (%)	8 (44.4%)	10 (55.6%)	0.12
Smoking (%)	12 (54.5%)	10 (45.5%)	0.77
Family history of Ischemic Heart Disease (IHD) (%)	26 (66.7%)	13 (33.3%)	0.06
Acetylsalicylic Acid (ASA) usage (%)	14 (93.3%)	9 (69.2%)	0.12
Clopidogrel usage (%)	9 (60.0%)	4 (30.8%)	0.12
Statin usage (%)	14 (93.3%)	10 (76.9%)	0.31
Alcohol use (%)	2 (15.4%)	2 (15.3%)	0.64
Ejection Fraction (%) ± SD	49.94 ± 7.27	53.28 ± 7.8	0.22
Chronic Obstructive Lung Disease (%)	24 (64.9%)	13 (35.1%)	0.62
Systolic Blood Pressure (mm Hg) mean± SD	130.55 ± 17.31	137.85 ± 18.88	0.23
Diastolic Blood Pressure (mm Hg) mean ± SD	66.11 ± 7.77	69.64 ± .,4	0.22
Recent Myocardial Infarction (%)	6 (60%)	4 (40%)	0.77

* P-values were obtained using the Mann-Whitney U test for continuous variables and the χ2 test for categorical variables. A p-value of less than .05 was considered statistically significant

Table 2. Perioperative characteristics of the participants

Parameter		Group I (n=26)	Group II (n=15)	*p* value *
Cross-Clamp Time mean± SD		91.67 ± 22.02	117.75 ± 51.02	0.01
Cardiopulmonary Bypass (CPB) Time mean ± SD		167.51 ± 53.38	186.63 ± 51.66	0.04
Total Operative Time mean± SD		369.44 ± 57.67	373.92 ± 89.08	0.97
Glasgow Coma Scale		12.83 ± 2.69	14.01 ± 0.93	0.18
Physiologic Index	1	5 (19.2%)	6 (40%)	0.17
	2	14 (53.8%)	8 (53.3%)	
	3	7 (26.9 %)	1 (6.7%)	
	4	0	0	
Total Circulatory Arrest (TCA) Time mean ± *SD*		24.67 ± 7.44	27.01 ± 6.05	0.53
Cerebral Protection	None	20 (76.9%)	7 (46.7%)	0.18
	Antegrade	2 (7%)	7 (46.7%)	
	Only Deep Hypothermia	4 (15.4%)	1 (6.7%)	
DeBakey Classification	Type I	20 (76.9%)	14 (93.3%)	0.23
	Type II	6 (23.1%)	1 (6.7 %)	
Procedure	Supracoronary Tube Graft Implantation	22 (84.6%)	7 (46.7%)	0.26
	Supracoronary Tube Graft Implantation + Hemiarch/Total Arch Replacement	1 (3.8%)	4 (26.7%)	
	Aortic Root Replacement	3 (11.5%)	4 (26.7 %)	

* P-values were obtained using the Mann-Whitney U test for continuous variables and the χ2 test for categorical variables. A p-value of less than .05 was considered statistically significant

Table 3. Postoperative characteristics of the patients included in the study

	Group 1	Group 2	p
	(n=26)	(n=15)	
Prolonged ventilation, n(%)	11(42.3)	6(40)	
Acute renal failure, n(%)	4(15.3)	3(20)	
Hemodialysis, n(%)	1(3.8)	1(6.6)	
Hemomhage-related re-exploration, n(%)	3(11.5)	2(13.3)	
Cardiac arrest, n(%)	3(11.5)	2(13.3)	0.496
Stroke, n(%)	3(11.5)	2(13.3)	
Atrial fibrillation, n(%)	4(15.3)	3(20)	
Hospital length of stay (days), n(%)	9(34.6)	10(66.6)	
Operative mortality, n(%)	4(15.3)	3(20)	

**P*-values were obtained using theX square. A p-value of less than .05 was considered statistically significant

regard to postoperative data (Table 3). In the axillary cannulation group, two patients were reexplored due to post-operative ischemia of the upper extremity, one patient undergoing a saphenous vein interposition graft and the other undergoing embolectomy. In addition, three patients who underwent femoral cannulation developed wound infections in the groin.

Discussion

Emergency surgical intervention is an effective and vital treatment method that reduces mortality and morbidity in ATAAD patients. However, surgical intervention presents its own risks and a multidisciplinary approach should be employed following surgery. In the literature, a number of factors related to type of surgery and postoperative morbidity and mortality have been identified, including dissection site, classification, clinical severity, and post-diagnosis illness duration (6-9). Hoefer et al. (6), in their mortality study on 64 patients at a 10-year follow-up, reported a hospital mortality rate of 14%. In that study, the mean length of stay in postoperative intensive care was 5 days. The length of intensive care unit (ICU) stay was related to age, body mass index, cardiopulmonary bypass time, and aortic cross-clamp time. In the present study, early stage hospital mortality was 17% and the mean hospital stay was 9.36 days. Similarly, the mean age at which patients were diagnosed with ATAAD was consistent with the literature. In a study of 2137 patients with acute aortic dissection type A, patients undergoing resuscitation had the highest mortality, and shorter operative time was associated with better outcomes. Cannulation sites and surgical technique, however, were not associated with mortality rates (8).

The surgical mortality of ATAAD operations remains high, and the search for a solution to reduce mortality has targeted cannulation strategy one of the targets. The axillary artery was introduced as an alternative cannulation site to the femoral artery due to retrograde flow and issues of cerebral embolization and malperfusion in the thoracoabdominal aorta. However, the question of which is the most suitable cannulation site in ATAAD patients remains a topic of debate (10-12). In a study comparing patients with ATAAD who underwent subclavian and femoral cannulation, Reuthebuch et al. found that postoperative neurological dysfunction was significantly lower in the group undergoing subclavian cannulation (13). Stamou et al. evaluated 305 ATAAD patients who underwent axillary and femoral cannulation, finding no significant differences in stroke and mortality rates or long-term outcomes. However, they did report longer CPB times and lower rates of aortic arch surgery in the patients who underwent axillary cannulation (14). The results of the present study were similar with respect to early mortality, stroke, prolonged ventilation, and length of hospital stay. However, cerebral protection and aortic arch surgery rates were higher in the axillary cannulation group, although the differences were not statistically significant. These results may be explained by the small number of patients in our study. In addition to deep hypothermia with axillary cannulation, selective cerebral perfusion may be simpler and, by not requiring further cannulation, may present a surgical advantage. Similarly, distal anastomosis of the tube graft performed without a cross-clamp, to be implanted into the ascending aorta while performing cerebral perfusion with axillary cannulation, allows for a safer and easier operation. Although there are situations in which axillary artery cannulation may be advantageous, the narrower diameter of the artery to be cannulated relative to the femoral artery may result in vascular complications. In the current study, two patients who underwent axillary cannulation developed ischemia in the right arm in the postoperative period and additional vascular intervention was necessary. Non-healing wounds and infections in the wound sites in the groin following femoral cannulation should not be ignored, especially in obese patients. Three patients who underwent femoral cannulation in the present study developed infections in wound sites, requiring prolonged antibiotherapy.

When considering cannulation options in patients with ATAAD, both types present certain advantages and disadvantages. Factors such as the aortic segment involved, the clinic performing the surgery, type of surgical procedure planned, and the individual characteristics of the patient should all be considered when selecting the cannulation site.

Limitations: The major limiting factors of the present study include the limited number of participants, the retrospective nature of the study, and the lack of long-term results. Similar studies on this topic involving a greater number of patients would be useful in clarifying cannulation strategies for patients with ATAAD.

The arterial cannulation site exhibited no significant effect on mortality or morbidity in patients with ATAAD. We believe that the cannulation site should be selected based upon the type of surgery that is anatomically most viable in a region not affected by dissection, as well as on the expertise and preference of the surgeon.

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