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Early results of direct true lumen cannulation (Samurai technique) in aortic dissection surgery

Cem Atik

Osmaniye Private New Life Hospital, Clinic of Cardiovascular Surgery, Osmaniye, Türkiye

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Abstract

Aim: The aim of this study was to evaluate and compare the clinical outcomes of Direct True Lumen Cannulation (Samurai Technique), axillary artery cannulation and femoral artery cannulation techniques used in aortic dissection surgery.

Materials and Methods: The data of 124 patients who underwent surgical treatment for acute aortic dissection between February 2018 and December 2022 were analyzed rectospectively. Patients were divided into Group 1 (samurai technique cannulation group) and Group 2 (axillary and femoral cannulation group).

Results: When the results were analyzed, preoperative personal and clinical characteristics were found to be similar between the groups. In the inoperative period, the time from skin incision to CPB, hypothermic circulatory arrest time, and time for cooling were shorter in group 1. While there were no cannulation-related complications in group 1, axillary artery dissection developed in two patients in group 2. No significant difference was observed between the groups in postoperative results.

Conclusion: Although there were similar results in the groups in the preoperative and postoperative periods, the more positive results in the surgery show that cannulation with the samurai technique is a preferable method.

Introduction

Acute aortic dissection is a life-threatening medical condition associated with high mortality if not repaired within 48 hours of its onset [1]. While the factors affecting mortality remain unclear, survival of patients depends on the appropriate surgical technique. Rapid cannulation of the true lumen and restoration of adequate perfusion to organs at risk are required for the success of aortic surgery, especially in the presence of preoperative hemodynamic instability and distal organ malperfusion [2,3]. Extracorporeal circulation is required in aortic dissection surgery and cannulation techniques can affect surgical mortality and morbidity. Today, the best cannulation methods for perfect cerebral perfusion are being researched and different techniques are used. Although the optimal arterial cannulation technique for cardiopulmonary bypass (CPB) in aortic disection is controversial, retrograde CPB perfusion with femoral artery cannulation, axillary artery cannulation and Direct True Lumen Cannulation (DTLC-Samurai technique) are widely used in clinical practice [3,4-6] .

The patient's compliance with the vascular anatomy, type of dissection, hemodynamic stability, cerebral and systemic malperfusion symptoms, and surgical experience should be considered when planning the cannulation strategy [3-5].

Cannulation techniques differ in aortic dissection surgery, and each method has its own advantages and disadvantages. In acute aortic dissection, DTLC-Samurai technique of the ascending aorta is a rapid and safe cannulation site that provides antegrade perfusion of the supraaortic and visceral vessels [3]. The DTLC-Samurai technique has the advantage of antegrade body perfusion. The cannulation technique is quite simple and fast. Thus, the transition time from the incision to the extracorporeal circulation is short [4]. Femoral artery cannulation is the easiest and fastest to achieve, but causes retrograde flow in the descending and ascending aorta and can have an effect on plaque rupture and cerebral embolism. Malperfusion may also occur with retrograde flow [3-5]. Although axillary artery cannulation is relatively time-consuming and carries the risk of vascular and nerve injury, it remains a viable choice because of its good cerebral sparing effect and antegrade perfusion [4-6]. Considering the literature informa-

*Corresponding author:
Email address: drcematik@gmail.com (Cem Atik)

tion, while determining the arterial cannulation method; It should be considered that this method creates a fast and satisfactory perfusion flow, prevents the dissection from dilating or aortic rupture, and provides optimal brain protection. According to the patient's aortic vessel condition and hemodynamics, the choice of the most accurate cannulation method should be made with the preference of the surgeon.

Clinical results are important in determining the preferred cannulation method. Therefore, in this study, it is aimed to compare the results of the samurai cannulation technique used in aortic dissection surgery with the results of other cannulation techniques.

Materials and Methods

Study design

In this retrospective observational cohort study, the results of patients who were operated in a single center by a single surgical team were examined. Institutional permission was obtained from Osmaniye Korkut Ata University Ethics Committee and the relevant hospital for the study (Decision Number: 2022/9/6).

Data of 124 patients who were operated for acute aortic dissection between February 2018 and December 2022 were analyzed. All transactions performed on the specified dates were included in the study. They were divided into groups according to the type of cannulation performed. Patients operated with the samurai technique were defined as Group 1 (71 patients), and patients operated with femoral or axillary artery cannulation were defined as Group 2 (53 patients; 41 axillary artery cannulation, 12 femoral artery cannulation). Diagnosis of acute aortic dissection; It was defined as diagnosis by echocardiography or computed tomography in the first 12 hours before the operation. The patients were evaluated according to the De Bakey classification [7]. Data were obtained from the patient registry and patient files. Preoperative demographic information, intraoperative and postoperative data were evaluated.

The choice of arterial cannulation was made by the method deemed appropriate by the surgeon (patient's weight, age, gender, additional diseases, neurological status, information in the literature, etc. were taken into account).

Surgical technique

Median sternotomy was applied to all patients, and then the patients were operated with right atrial venous cannulation under cardiopulmonary bypass (CPB). Direct aorta samurai cannulation, femoral or axillary artery cannulation methods were preferred for arterial cannulation.

In the samurai cannulation technique; median sternotomy is performed to access the thoracic cavity and heart. The pericardium is opened to expose the heart and aorta. Heparin, an anticoagulant, is administered to prevent blood clotting during CPB (we planned to go below 24 degrees). The dissected aorta was separated from its anatomical connection to the main pulmonary artery trunk, two surgical tapes were used to suspend the aorta after mobilization. Suspending the aorta in this way provides better access and visualization for the next steps of the procedure. A venous cannula was then carefully inserted into the right atrium of the heart. The venous cannula was then connected to the venous line of the CPB circuit. Inserting the venous cannula and connecting it to the CPB circuit are critical steps in initiating cardiopulmonary bypass. The patient's body was placed in the Trendelenburg position. In the Trendelenburg position, blood is directed through the venous cannula to the venous reservoir within the CPB circuit. Drainage continued until the systolic blood pressure dropped to approximately 40 mmHg. During the surgical procedure, pure oxygen was given to the patient. When the dissected aorta was decompressed and the patient's heart function was temporarily supported by the cardiopulmonary bypass (CPB) circuit, the surgical team opened the ascending aorta. The true lumen was carefully examined and determined by the surgeon. After the true lumen was determined, a flat-tipped 24F femoral artery cannula was placed in the true lumen of the ascending aorta. Placement was done under direct sight. Air was removed from the arterial cannulation line of the CPB machine by low-flow perfusion. After proper insertion was achieved and air-abundance confirmed, the arterial cannula was securely fixed to the sternum retractor. This fixation is important to ensure that the cannula remains stable during the procedure, does not impair blood flow, and ensures full CPB perfusion. The duration of low pressure during arterial cannulation in surgical procedures was less than 90 seconds. As of 2018, direct real lumen cannulation technique (samurai technique) has been used in selected patients in our clinic, and it has been the first cannulation method of choice in the last two years. This technique; It allows a rapid setup of CPB without an additional surgical

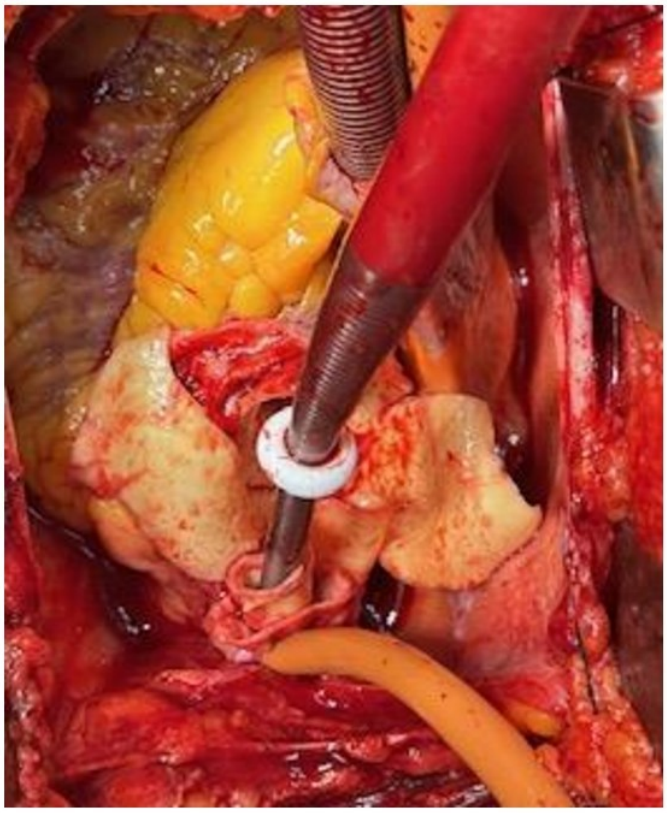

Figure 1. Cannulation with the Samurai technique.

incision, while cooling the patient and protecting the myocardium with antegrade and/or retrograde cardioplegia, allowing immediate initiation of proximal aortic repair and reducing the total time of surgery. In addition, organ and cerebral malperfusion can be prevented by providing antegrade systemic perfusion in the early period in the samurai technique. Direct true lumen cannulation is provided in 1-2 minutes, while allowing a short-term preliminary examination of the distal aorta (Figure 1) [8-10]. Antegrade cerebral perfusion technique was used through the right brachiocephalic artery to provide cerebral protection [11].

Femoral artery cannulation was performed by turning the femoral artery through a direct skin incision. With axillary artery cannulation, cannulation-related atheroembolic events are reduced, malperfusion is less common during cardiopulmonary bypass, and antegrade brain perfusion can be performed more easily. For this reason, it has been preferred to femoral artery cannulation in recent years [12]. In axillary artery cannulation, perfusion was achieved with a 10 mm vascular graft anastomosed to the axillary artery. CPB was routinely started. After the aortic incision, distal repairs were performed first. Then, the proximal aorta was evaluated and one of the appropriate surgical procedures was preferred (ascending aorta graft replacement, bentall op., david op., separated valve and graft replacement).

Statistical analysis

A statistical package program was used to perform the analysis. All data were retrospectively collected, and statistical data were expressed as percent or mean ± standard deviation. Continuous data were analyzed using the Student's t test. A p value < 0.05 was considered to be statistically significant.

Results

The presented Table 1 contains the personal and clinical data of the patients. When the analysis of these data is examined; there was no statistically significant difference between the two groups in terms of age, BMI, gender, concomitant diseases, smoking status, De Bakey aortic dissection classification, and clinical presentation ($p \geq 0.05$). It was observed that the majorities of the patients were male, had HT disease and were operated for Type 1 aortic dissection (Table 1).

The data during the operation were evaluated in terms of both groups and the results are presented in Table 2.

When the data about the operation process is examined; A statistically significant difference was found between the groups in terms of the time from the skin incision to entering CPB, the duration of hypothermic circulatory arrest, and the time taken for cooling. These times were found to be shorter in group 1 ($p \leq 0.05$). The difference between the groups in terms of the temperature reached for hypothermic circulatory arrest was also statistically significant, and the temperature was lower in group 1 ($p \leq 0.05$). It was determined that the most isolated aortic replacement was performed in both groups, while no complications related to cannulation were observed in group 1, axillary artery dissection developed in two patients in group 2 ($p \geq 0.05$) (Table 2).

Table 1. Personal and clinical data of patients.

	Group 1 (n:71)	Group 2 (n:53)	P value
Age (avg.)	64.25±4.23	67.50±3.97	0.32
Gender			
Male	43 (60.56%)	35 (66.03%)	0.27
Woman	28 (39.44%)	18 (33.97%)	0.24
BMI (avg.)	25.41±6.87	24.9±8.11	0.36
Concomitant diseases			
HT	59 (83.09%)	42 (79.24%)	0.28
DM C	43 (60.56%)	31 (58.49%)	0.59
OPD	39 (54.92%)	34 (64.15%)	0.66
CAH	24 (33.80%)	22 (41.50%)	0.17
Smoking	44 (61.97%)	36 (67.92%)	0.07
De Bakey Classification			
Type 1	58 (81.69%)	44 (83.01%)	0.14
Type 2	13 (18.30%)	9 (16.98%)	0.22
Clinical Presentation*			
Tamponade	23 (32.39%)	14 (26.41%)	0.36
Cardiogenic Shock	6 (8.45%)	3 (5.66%)	0.48
Aortic Insufficiency	28 (39.44%)	21 (39.62%)	0.88
Emerging Neurological Deficit	7 (9.86%)	5 (9.44%)	0.94
Pain	59 (83.09%)	44 (83.01%)	0.13

BMI; body mass index, HT; hypertension, DM; diabetes mellitus, COPD; chronic obstructive pulmonary disease, CAD; coronary artery disease.
* There are admissions to the hospital with one or more findings.

Table 2. In-operative clinical data.

	Group 1 (n:71)	Group 2 (n:53)	P value
Isolated Aortic Replacement	37 (52.11%)	23 (43.39%)	0.45
Aortic Root Surgery (Bentall, David Op.)	10 (14.08%)	11 (20.75%)	0.38
Aortic+Hemi Arch Replacement	19 (26.76%)	17 (32.07%)	0.33
Aortic+Total Arch Replacement	5 (7.04%)	2 (3.77%)	0.59
Skin Incision-CPB Time (minutes)	51±12.08	64±14.92	**0.04**
Complication Due to Cannulation	0	2 (3.77%)	0.11
CPB Time (minutes)	191±28.33	211±32.11	0.12
X Clamp Time (minutes)	106±18.71	119±18.90	0.16
Hypothermic Circulation Arrest Time (minutes)	21±7.72	27±8.84	**0.05**
Time Taken for Cooling (minutes)	27±9.02	38±11.57	**0.03**
Cooling Degree (°C)	21.9±9.33	23.7±9.78	**0.05**

Postoperative data were evaluated for both groups and the results are presented in Table 3. When the data in the post-operative period is examined; There was no statistically significant difference between the two groups in terms of postoperative results ($p \geq 0.05$). In both groups, multi-organ failure developed in one patient who underwent surgery for shock. The number of patients requiring hemodialysis was found to be similar in the two groups, and there were no patients requiring permanent dialysis (Table 3).

Three patients died in Group 1 and two patients in Group

Table 3. Postoperative clinical data.

	Group 1 (n:71)	Group 2 (n:53)	P value
Bleeding-Revision	8 (11.26%)	7 (13.20%)	0.28
Hemodialysis	12 (16.90%)	9 (16.98%)	0.45
Length of Stay in Intensive Care (mean, days)	3.20±4.67	3.50±4.23	0.34
In-Hospital Death	6 (8.45%)	5 (9.43%)	0.22
30 Days of Death	7 (9.86%)	5 (9.43%)	0.40
New Neurological Event	8 (11.26%)	8 (15.09%)	0.10
Multi Organ Failure	1 (1.40%)	1 (1.88%)	0.12

2. The remaining patients in both groups were discharged without any neurological sequelae. One patient in Group 1, who was discharged from the hospital, was admitted to the emergency room on the 21st postoperative day and died.

Discussion

In aortic dissection surgery, inadequate organ perfusion is a critical factor affecting patient outcomes, including mortality and morbidity. The primary goal is to provide perfusion to the true lumen of the aorta as soon as possible. "Direct true lumen cannulation" for cardiopulmonary bypass (CPB) perfusion was first introduced by Borst et al. defined by. The technique of direct cannulation of the ascending aorta (DTLC) is highlighted as a specific approach for aortic dissection surgery. Several studies have shown that DTLC is a safe and effective method [2-5,13-18]. A limited number of studies comparing cannulation methods have been found in the literature.

In our study, the number of patients in the groups in which cannulation was performed with the samurai technique and the other two methods, respectively; Isolated Aortic Replacement 37 (52.11%)- 23 (43.39%), Aortic Root Surgery (Bentall, David Op.) 10 (14.08)-11 (20.75%), Aortic+Hemi Arch Replacement 19 (26.76%)-17 (32.07%), Aorta+Total Arch Replacement 5 (7.04%)-2 (3.77%) people. The total 30-day mortality was 12 (9.67%) in all patients. Engin et al. (2018) in his study; In Engin et al.'s study, a significant majority of patients (70%) underwent isolated ascending aorta replacement or hemiarch replacement combined with ascending aorta replacement. The total mortality rate among all patients who underwent surgical intervention for aortic disease in their study was notably higher at 26.4%, which suggests a higher overall mortality compared to our study [19].

It is important to note that differences in patient populations, surgical techniques, and study periods may contribute to differences in mortality rates between studies. A higher mortality rate was reported in the study by Engin et al., possibly due to differences in patient characteristics or changes in surgical practices over time.

The findings of your study provide valuable information regarding the distribution of procedures and mortality rates in your specific patient population, and it is important to consider these factors when interpreting and comparing the results of different studies in the field of aortic surgery.

In our study, patients who were cannulated with the samurai technique experienced advantages such as shorter cooling times, lower temperatures for hypothermic circulatory arrest, and no complications related to cannulation. Axillary artery dissection occurred in two patients who underwent femoral or axillary artery cannulation. Mortality rates were similar in the two groups. In-hospital death was 6 (8.45%), 30-day death was 7 (9.86%), new neurological event was 8 (11.26%) in the samurai technique group, and in-hospital death was 5 (9.43%), 30-day death 5 (9.43%), new neurological event 8 (15.09%) in the femoral or axillary artery cannulation group.

Kitamura et al. (2023), the results of 146 patients who underwent emergency aortic repair for acute type A aortic dissection using the samurai technique (between 2013 and 2023) were evaluated. Kitamura et al. used the samurai technique in 146 patients who underwent emergency aortic repair due to acute type A aortic dissection. Researchers observed cerebral malperfusion in a patient who underwent samurai cannulation [20].

El Beyrouti et al. conducted a study on 528 patients who underwent surgery for type A aortic dissection from 2006 to 2017. The researchers aimed to investigate surgical techniques and their impact on patient outcomes. They used the DTRC-samurai technique for patients in shock, showing signs of cardiac tamponade or hypoperfusion, potential cerebral perfusion, or requiring resuscitation. Contrary to our study, El Beyrouti et al. reported that the DTRC-samurai technique was associated with longer cardiopulmonary bypass (CPB) perfusion times. In addition, the in-hospital mortality rate was 10.1% and the 30-day mortality rate was 11.55% in patients who underwent the DTRC-samurai technique. El Beyrouti et al. observed that approximately 8% of patients in both the DTRC-samurai technique group and another group experienced new neurological events after surgery [2].

Wahid et al. (2020) reported lower morbidity and mortality in patients who underwent DTRC [21].

Kitamura et al. (2018) in their study reviewed the results of 100 patients who underwent surgery for type A aortic dissection and compared the samurai technique with other cannulation methods. There were no significant differences in preoperative demographic characteristics between the groups. In the samurai technique group, 30-day mortality was reported at 5%, and in-hospital mortality was 7%. In the other group (using different cannulation techniques), the 30-day mortality was slightly higher at 8%, and in-hospital mortality was 15%. The study noted three complications related to cannulation [3].

Conzelmann et al. (2009), in their study involving 29 patients, presented the results of DTRC application as follows; no surgical problems were observed, temporary hemofiltration was required in two patients, and neurological disorders occurred in six patients [15].

Emrecan et al. (2006) in their studies evaluated 60 patients who underwent aortic dissection surgery. Two patients (10.5%) who underwent axillary artery direct cannulation developed axillary artery dissection, highlighting a potential complication of this method. One patient (5.2%) experienced right upper extremity ischemia as a result

of axillary artery cannulation. No surgical complications were observed in patients who underwent lateral graft cannulation. However, a total of four neurological complications occurred, indicating the importance of monitoring and managing neurological risks in these surgeries. The study reported six postoperative deaths. [22].

Conclusion

According to the results of our study; It was determined that Skin Incision-CPB Time, Complication Due to Cannulation CPB Time, X Clamp Time, hypothermic Circulation Arrest Time, Time Taken for Cooling times were shorter in the samurai cannulation group. However, it was also found that complications and death rates did not differ between groups. Although there were similar results in the groups in the preoperative and postoperative periods, the more positive results in the surgery show that cannulation with the samurai technique is a preferable method.

Our study and studies in the literature provide further information on the outcomes associated with different cannulation techniques. It shows that the pros and cons of each method, as well as patient-specific factors, should be carefully evaluated in determining the most appropriate approach for aortic dissection surgery, and that neurological complications and vascular complications are important considerations in the selection of cannulation methods. Conducting larger and multicenter studies and careful patient selection based on these results are very important for improving surgical techniques and patient outcomes.

Conflict of interest

The authors declare no conflicts of interest.

Informed consent

Informed consent was obtained from patients participating in the study.

Ethical approval

Institutional permission was obtained from Osmaniye Korkut Ata University Ethics Committee and the relevant hospital for the study (Decision Number: 2022/9/6).

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