



## Single-Centre Experience in the Management of Type a Acute Dissection with Cross Clamp Technique

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### Abstract

**Introduction:** Standard surgical therapy of type A dissection consists of replacing the ascending aorta and, if necessary, the aortic root and or aortic arch with resection of the entry tear. The debate regarding the best surgical approach is still open. The purpose of this study is to evaluate clinical outcome after surgery for acute type A dissection limited to ascending aorta replacement with distal clamping in normothermic cardiopulmonary bypass.

**Materials and Methods:** Between January 2010 and March 2016, 154 consecutive patients underwent surgical operation for type A aortic dissection at our Institution. This study is focused on 103 of them operated using standard aortic normothermic cross clamp technique, as the aortic arch was not involved. There were 69 (67%) male with a mean age of  $63.3 \pm 12.9$  years (range: 31-84 years). Major morbidity, operative mortality and two-year actuarial survival were analysed.

**Results:** Emergency operations were performed in all patients. An aortic repair involving the aortic root was necessary in 23 patients (n°7 treated with valve sparing and 16 with a valve conduit). Overall median cardiopulmonary bypass time was 114 (IQR 88-146) minutes and aortic cross clamp time was 87 (IQR 63-111) minutes. Median intensive care and hospital stay were 4 and 9 days respectively. In-hospital mortality was 7%. The 2-year overall survival after discharge was 87%.

**Conclusions:** This study shows that type A aortic dissection in selected patients can be treated with aortic cross clamp avoiding hypothermic arrest or moderate hypothermia with cerebral perfusion. Results are encouraging and the follow-up suggests that it could be considered a good alternative.

**Keywords:** Type A dissection; Cross clamp technique; Open distal anastomosis; Axillary arterial cannulation

### Introduction

Acute aortic dissection is a serious condition requiring immediate diagnosis and treatment by surgical repair. There are, however, uncertainties related to which techniques should be followed and implemented. It is questioned whether open or closed surgery should be used, which is the ideal cannulation site for extra corporeal circulation and whether hypothermia is superior to normothermia. Our group, for a number of reasons reported in the discussion, believes that the standard close normothermic approach with aortic cross clamping is the preferable one, providing the intimal tear is in the ascending aorta.

The major criticism to our approach is related to the potential additional lesion to the distal aorta caused by the clamp. The advantages include limited hypothermic circulatory arrest, less intra and postoperative bleeding and less incidence of renal insufficiency. We report our experience on 103 consecutive patients, in terms of operative and post-operative outcome.

### Methods

#### Patients

Between June 2010 and February 2016, 154 consecutive adult patients referred to our centre underwent emergency cardiac surgery for acute type A aortic dissection. In all patients diagnosis was based on multislice computed tomography imagining confirmed by intraoperative transesophageal echocardiography.

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**Table 1:** Baseline characteristics of the patients.

		Total population N=154	Aortic root or ascending aorta replacement N=103	Total aortic arch or hemiarch replacement N=51
Age (yr)	Mean ± SD	64.4 (12.2)	63.3 (12.9)	66.8 (10.3)
	Median (IQR)	66 (58-74)	65 (53-73)	67 (58-73)
	Min-Max	31-84	31-84	33-83
Male gender	N (%)	105 (68)	69 (67)	36 (71)
Body mass index	Mean ± SD	27.5 (4.5)	27.4 (4.4)	27.7 (4.7)
	Median (IQR)	26.7 (24.4-29.7)	26.7 (24.2-29.4)	26.6 (24.4-29.7)
	Min-Max	18.9-43.2	18.9-43.2	19.5-41.2
Familiarity	N (%)	16 (11)	9 (9)	7 (14)
Hypertension	N (%)	107 (69)	69 (67)	38 (74)
Diabetes	N (%)	8 (5)	5 (5)	3 (6)
Dyslipidemia	N (%)	47 (31)	31 (30)	16 (31)
Smokers	N (%)	64 (42)	37 (36)	27 (53)
COPD	N (%)	13 (8)	9 (9)	4 (8)
Renal insufficiency	N (%)	9 (6)	7 (7)	2 (4)
Previous CVD	N (%)	8 (5)	4 (4)	4 (8)
CVD at presentation	N (%)	12 (8)	8 (8)	4 (8)
Peripheral arterial disease	N (%)	23 (15)	15 (15)	8 (16)
Preoperative Mechanical Ventilation	N (%)	39 (25)	22 (21)	17 (33)
Preoperative Cardiogenic Shock	N (%)	43 (28)	28 (27)	15 (29)
Ejection Fraction	Mean ± SD	54.7 (7.2)	54.6 (7.3)	54.7 (7.1)
	Median (IQR)	55 (50-60)	55 (50-60)	55 (50-58)
	Min-Max	20-65	25-65	20-60
EuroSCORE	Mean ± SD	13.1 (3.6)	13.0 (3.9)	13.2 (2.8)
	Median (IQR)	13 (10-15)	12.5 (10-15)	13 (10-15)
	Min-Max	27 (7)	27 (6)	22 (7)

Values display total number of patients reported as mean ± standard deviation or as median (IQR: Interquartile range) where indicated.

\*CVD: Cerebrovascular Accident; Euro SCORE: European System for Cardiac Operative Risk Evaluation

The choice between aortic root repair or replacement was made according to each surgeon's choice, based on tear position, aortic leaflets pathology and clinical condition. The current analysis is focused on 103 (67%) patients underwent ascending aorta replacement using a cross clamp technique instead of circulatory arrest with open distal anastomosis. The choice of surgical technique was based on the extension of aorta damage. In the remaining 51 patients there was an aortic arch tear, for this reason, a total or partial aortic arch replacement was required. All data (both baseline and follow-up) were prospectively collected according to our approved database.

### Surgical technique

A totally intravenous anaesthesia and orotracheal intubation was used in all patients. Careful transesophageal echocardiographic observation of flow in the true and false lumen as well as intimal flap movement was observed. In addition, aortic valve function was assessed. Since 2013, the INVOS™ system to check cerebral oximetry was used. All patients received a full median sternotomy. Extracorporeal circulation was established through venous cannulation of the right atrium with a three-stage MC2X cannula (Medtronic, Inc Minneapolis, Minn) with femoral (n°66) or axillary (n°37) arterial cannulation (EOPA arterial cannula Medtronic, Inc Minneapolis, Minn). In seven patients also venous femoral cannulation was chosen. The left ventricle was vented, through the right upper pulmonary

vein. After cardiopulmonary bypass institution, the circulation was cooled to 32°C. The aorta was cross-clamped and hypothermic 4°C blood cardioplegia (St Thomas with procaine) was administered in retrograde or antegrade fashion into the aortic root just to stop the heart and then directly into the coronary ostia in case of aortic regurgitation [1-3]. Alternatively a crystalloid cardioplegic solution (Bretschneider) was infused. A transverse incision of the ascending aorta was performed carefully searching for the intimal tear. The aortic root was replaced when involved by the intimal tear or in case of dissection of coronary arteries or severe dilatation of the root using Bentall-De Bono operation or a valve sparing technique. Depending on the root pathology, the aortic valve and the valsalva sinuses were replaced using a complete root replacement. In case of a tear limited to the sopracoronary aorta a straight Dacron prosthesis was implanted. At this point, we are used to stop the extracorporeal circulation for less than 1 minute, remove the aortic clamp and inspect the arch. In case of absence of additional intimal tear in the clamp site, the aorta was cross clamped again and the distal anastomosis reinforced with Teflon felt strip performed. When an intimal aortic arch tear was found, a complete hemiarch or total arch replacement using moderate hypothermia and selective cerebral perfusion was mandatory. This finding was present in 51 (33%) patients. Accordingly, we excluded from the present analysis these patients because they were at higher risk due to the more extensive disease (Table 2) as demonstrated by longer operative times. Ventricular pacing wires were placed on the

**Table 2:** Intra-operative data.

		Total population N=154	Study population N=103	Patient excluded N=51
<b>Operative technique</b>				
Ascending aorta (AA) only	N (%)	80 (52)	80 (78)	0 (0)
Aortic root	N (%)	23 (15)	23 (22)	0 (0)
Total arch	N (%)	23 (15)	0 (0)	23 (45)
Partial Arch	N (%)	28 (18)	0 (0)	28 (55)
<b>CPB time, min</b>	Mean $\pm$ SD	149.7 (78.9)	124.5 (58.4)	200.4 (90.5)
	Median (IQR)	134.5 (100-180)	114 (88-146)	177 (115-190)
<b>Cross-clamp time, min</b>	Mean $\pm$ SD	102.5 (48.5)	89.7 (33.9)	128.4 (62.0)
	Median (IQR)	92 (69-126)	87 (63-111)	120 (75-135)
<b>Intubation time, min</b>	Mean $\pm$ SD	93.9 (140.5)	77.4 (124.1)	127.5 (165.6)
	Median (IQR)	36.5 (14-108)	35 (12-88)	60 (22-130)
<b>Intubation time &gt; 96 min</b>	N (%)	39 (25)	22 (21)	17 (25)

Values display total number of patients reported as mean  $\pm$  standard deviation or as median (IQR: Interquartile Range) where indicated.

right ventricle and the patient weaned from cardiopulmonary bypass. Transesophageal echocardiography was used to assess the heart contractility and eventually the prosthesis function. Cannulas were removed and protamine was administered at 1:1 ratio to heparin.

### Statistical analysis

Continuous variables were tested for normal distribution with the Kolmogorov-Smirnov test and were reported accordingly as mean  $\pm$  SD or as median and Interquartile Range (IQR). Minimum and maximum values are also presented. Categorical variables are presented as frequencies and percentages. The curve of the overall survival after discharge was estimated using the Kaplan-Meier product-limit estimator. Statistical analyses were performed using R version 3.2.0 for Windows (The R foundation for Statistical Computing).

## Results

Baseline characteristics of the 103 patients are shown in Table 1, while Table 2 shows the intraoperative data. Out of 154 patients, 103 were treated with cross clamp technique instead of circulatory arrest with open distal anastomosis (Table 2). Mean age was  $63.3 \pm 12.9$  years (range: 31-84 years), 69 were males (67%). All patients received, at least, an ascending aorta replacement with cross clamp technique. Overall median cardiopulmonary bypass time was 114 (88-149), whilst aortic cross clamp was maintained for 87 (63-111) minutes. Twenty-three patients received a complete aortic root replacement. We used a valve conduit in 16 of them (Bio-Bentall in 7 and a mechanical one in 9). A valve sparing operation (VascutekGelweaveValsalva graft, Vascutek-Terumo, Scotland, UK) was performed in the remaining 7 patients. When a tear was limited to the supracoronary aorta a straight Dacron prosthesis was implanted (Gelweave graft, Vascutek-Terumo, Scotland, UK) (n=80, 78%). Table 3 reports the early post-operative data. Notably the incidence of postoperative stroke was relatively high (11%). It is important to note that in 4 of these 11 patients preoperative cardiogenic shock and mechanical ventilation were already present before admission in our centre. Relatively high was also the incidence of prolonged mechanical ventilation (21%), but admissible considering the elevated number of patients already intubated at admission in our hospital. Postoperative hospital mortality occurred in 7 patients (7%). We have lost information of thirteen patients out of the remaining 96 (14%) leaving 83 patients for the analyses of post-discharge outcomes. Median follow-up time was:

0.8 years (min: 0.1, max: 5.5) and nine patients (11%) died during follow-up. One patient was re-operated and died during the hospital recovery. The 2-year overall survival after discharge was 87% (Figure 1).

## Discussion

Surgical repair is the gold standard treatment for acute type A aortic dissection. This can be performed with a variety of techniques mainly concerning the cannulation sites for extracorporeal circulation, the body temperature and the open or closed surgery. However, despite a consensus for open distal repair when possible, the debate around open vs. Closed surgery is still opened [4-7]. The introduction of axillary artery cannulation instead of femoral one is an interesting alternative especially in case of need for cerebral perfusion leading an antegrade systemic flow. The open distal repair allows a good visualization of aortic anastomosis, prevents damages of the aortic wall at the clamp site and allow a good estimation of false and true lumen. In addition avoiding cross clamp prevents potential increase of pressure in the false lumen which, in turn, could result in new tears. Studies comparing different techniques are scanty and often the patient's populations are not comparable [5-9]. In those centers where both techniques are used, the open distal anastomosis is mainly used in case of hemiarch or total arch replacement. Conversely, when the aortic arch is not involved by intimal tear, a cross clamp is preferred. Thus, open repair is mainly offered to patients with more extensive and severe disease.

Lawton and colleagues have just concluded a study demonstrating that open distal anastomosis with deep hypothermic circulatory arrest and antegrade cerebral perfusion is associated with a significant improvement in survival. However, it should be noted that the closed group was smaller (n°49 pts) than the open one [9].

In addition, also the German Registry for Acute Aortic Dissection Type A concludes that hypothermic circulatory arrest and Antegrade selective Cerebral Perfusion (ACP) led to similar results if arrest times were less than 30 minutes antegrade cerebral perfusion for longer arrest periods is advisable [10].

Our study confirms and extends previous reports. We report encouraging result with the closed technique. The major strengths of our study are the numbers of cases, the prospective data collection, the long and complete follow-up data, the expertise of operators in

**Table 3:** Early post-operative outcome.

		Total population N=154	Study population N=103	Patient excluded N=51
Reoperation for bleeding	N (%)	17 (11)	9 (9)	8 (16)
Atrial Fibrillation	N (%)	51 (33)	34 (33)	17 (33)
Inotropic support	N (%)	27 (18)	14 (14)	13 (25)
Stroke	N (%)	19 (12)	11 (11)	8 (16)
Dialysis	N (%)	9 (6)	6 (6)	2 (4)
Blood transfusion	N (%)	140 (91)	91 (88)	50 (98)
Red blood cell units	Mean ± SD	7.5 (7.6)	5.6 (4.6)	10.7 (10.7)
	Median (IQR)	5 (2-10)	4 (2-7.5)	7 (2-10)
	Min-Max	Feb-42	23-Feb	Feb-42
Fresh frozen plasma or platelet units	Mean ± SD	3.8 (3.8)	2.7 (2.0)	5.8 (5.3)
	Median (IQR)	3 (2-5)	2 (1-3)	4 (2-5)
	Min-Max	21-Jan	11-Jan	21-Jan
Intensive Care Unit stay (days)	Mean ± SD	7.7 (7.4)	6.5 (6.4)	9.9 (8.9)
	Median (IQR)	4.5 (2.6-10)	4 (2.5-8)	7.3 (2.5-8)
	Min-Max	Jan-35	Jan-35	1.5-34
In-hospital mortality	N (%)	17 (11)	7 (7)	10 (20)

\*Four of them had preoperative cardiogenic shock and were already ventilated at time of presentation

Values display total number of patients reported as mean ± standard deviation or as median (IQR: Interquartile Range) where indicated.

this kind of surgical approach and the study population reflecting the daily clinical practice. From our data and experience, we remark that some peculiarities should be followed to improve and optimize the results. Firstly, is crucial to inspect the clamp site, taking advantage to the period of circulatory arrest (which has to be maintained less than one minute), to avoid the high incidence of intimal flap in the arch. This might contribute to avoid the high rate of redo surgery reported by Nguyen et al. [8]. Secondly, the retrograde femoral artery perfusion should also be avoided whenever possible, especially in a closed technique because of the risk the over pressure in the false lumen. Eleven of our patients suffered from postoperative stroke: four of them had preoperative cardiogenic shock and were already ventilated at time of presentation; but the remaining 7 had a femoral artery cannulation. Thirdly, in contrast to others [11], we also suggest to avoid a hypothermic cardiopulmonary bypass in favor of a normothermic one. The advantages are less intra and postoperative bleeding and a lower incidence of renal insufficiency due to the long cardiopulmonary bypass time necessary to reach 18°C [12].

In conclusion, based on our experience, we suggest adopting the close technique in normothermic cardiopulmonary bypass when the intimal tear is “before the arch”. In all cases, the preferred atrial cannulation site is the axillary one as it allows to change strategy if it is necessary. The fast lumen inspection when still in circulatory arrest and the accurate distal anastomosis which we always performed resulted in a low rate of aortic reoperation.

## Disclosures

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