60-day Survival Rate under Treatment of Acute Type A Aortic Dissection by Transapical Aortic Cannulation Technique

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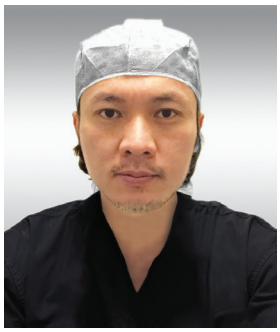

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Abstract

OBJECTIVE: The aim of this study was to show a technique and the results of the 60-day survival rate under treatment of acute type A aortic dissection by transapical aortic cannulation technique.

MATERIALS AND METHODS: The data has been investigated from 12 years of surgery experience since June 2003 in acute type A acute aortic dissection by transapical aortic cannulation technique. This study was approved and reviewed by the ethical committee of the Kawasaki Saiwai Hospital, Kawasaki, Japan. Statistical analysis: Cox proportional hazard regression was employed to analyze risk ratio, and Kaplan Meier curve was used to estimate the survival time. $p < 0.05$ was considered statistically significant.

RESULTS: The study population (n = 309) was investigated for survival analysis. The person-time was 6363.50 person/months. We found that, the death outcome was 29 persons (9.38%). The mortality rate was 4.55/1000 person/months (95% Confidence Interval = 3.17-6.56/1000 person-month)

CONCLUSION: Risk factors influencing the survival rate in acute type A aortic dissection included coronary artery disease, preoperative hemodynamic deterioration, total arch replacement, cardiopulmonary bypass technique using only deep hypothermic circulatory arrest, deep hypothermic circulatory arrest with retrograde cerebral perfusion and deep hypothermic circulatory arrest with antegrade selective cerebral perfusion. The enlargement of ascending aortic diameter and proximal descending aorta diameter increased the death rate by 11% and 18%, respectively. Each time the diameter expanded 1 mm, and the operation time extended by 1 minute, the death rate was increased by 1%.

Keywords: acute type A aortic dissection, transapical aortic cannulation technique, deep hypothermic circulatory arrest

Acute type A aortic dissection is a life-threatening vascular emergency and requires urgent surgical intervention. Though surgical techniques have been improved for more than ten years, the mortality rate remains high. Therefore, the initial diagnosis and treatment is extremely significant for survival since its immediate mortality rate is as high as 1% per hour over the earliest hours.[1]

There are several techniques of cardiopulmonary bypass (CPB) for aortic cannulation: femoral artery cannulation, axillary artery cannulation, and transapical aortic cannulation. The most important of all aortic cannulation sites is the perfusion into the true lumen.

In the case of acute type A acute aortic dissection, many institutes and the cardiac surgeons have chosen the femoral artery for aortic cannulation since the CPB is easily and quickly established in the case of hemodynamic instability. However, the femoral artery cannulation is not always appropriate due to malperfusion of the aorta and it can lead to cerebral embolism from dislodged debris tissue in patients who have severe atheromatous changes in the thoracic aorta.

The axillary artery has been used as the perfusion route thanks to the length of the retrograde perfusion is being shorter than the femoral artery and it is also used for antegrade cerebral perfusion during circulatory arrest.

Another perfusion route is the transapical aortic cannulation mentioned in this article. The most important aims for all aortic cannulation routes are blood perfusion into the true lumen and prevention the damage of the vital organs.

Material and Methods

The study investigated 12 years' of surgery experience in acute type A acute aortic dissection by transapical aortic cannulation Technique. This study was approved and reviewed by the ethical committee of at Kawasaki Saiwai Hospital, Kawasaki, Japan.

Surgical Technique

Firstly, bicaval cannulation was performed for venous drainage, and retrograde cardioplegia was applied to the coronary sinus. After that, a 1 cm incision was made in the apex of the left ventricle (muscular part) lateral to the left anterior descending coronary artery (LAD) and a 24-F cannula (Kurary® thin wall catheter; Kurary Co.; Osaka, Japan) was passed through the apex and across the aortic valve to lie in the proximal ascending aorta. The tip of the cannula was in the sinus of valsalva. trans-esophageal echocardiogram (TEE) was used to check the position of the cannula tip, ensuring an accurate position in the true lumen and avoiding manipulation of the ascending aorta.

A left ventricular vent was created through the right superior pulmonary vein before the cardiopulmonary bypass was established. In most cases of acute type A aortic dissection, we used deep hypothermic circulatory arrest with retrograde cerebral perfusion (RCP) and antegrade selective cerebral perfusion (SCP) as an adjunctive measure for cerebral protection. After circulatory arrest was achieved, the apical cannula was removed.

Later, RCP was started; aortotomy was performed and distal trimming was conducted to prepare for distal anastomosis. Next, SCP was inserted into the right brachiocephalic artery and RCP was stopped. Then, distal anastomosis was repaired with one branch graft. After the anastomosis was repaired, CPB was reestablished through the branch graft for aortic return, so the distal anastomosis was checked for leakage before rewarming was started.[2] Finally, the incision in the left ventricular apex was closed with 5-0 polypropylene interrupted sutures, while the proximal anastomosis was performed above the Sinotubular Junction (STJ) about 10 mm.

Indications for Transapical Aortic Cannulation

1. Coexistence of abdominal or iliac aneurysm
2. Coexistence of chronic peripheral arterial occlusive disease
3. Dissection of femoral artery due to extension of aortic dissection
4. Considerably narrow true lumen with crescent shape, compressed by the false lumen in aortic dissection

Contraindication for Transapical Aortic Cannulation

1. Severe aortic stenosis
2. Severe calcified ascending aorta[3]
3. Severe aortic regurgitation

Statistical Analysis

Data was processed using STATA statistic data analysis Version 11.0 software (StataCrop LP, 4905 Lakeway Drive, College Staton, Texus 77845-4512, USA). Continuous values were expressed as the mean ± standard deviation. Risk factor relevant variables with $p < 0.05$ on univariate analysis were incorporated into the multivariate models. Cox proportional hazard regression analysis was employed for risk ratio and Kaplan Meier curve for the survival time. Differences were considered statistically significant at $p < 0.05$.

Study Population

From June 2003 to September 2014, a total of 309 patients with acute type A aortic dissection underwent transapical aortic cannulation technique were investigated.

Inclusion criteria: Patients with a diagnosis of acute type A aortic dissection operated by transapical aortic cannulation technique were enrolled. The CPB that were used included deep hypothermic circulatory arrest (DHCA), DHCA with RCP, DHCA with antegrade selective cerebral perfusion (SCP), and DHCA with RCP and SCP. Exclusion criteria: Patients whose femoral artery or the axillary artery was used for aortic cannulation were excluded.

Results

The study population (n = 309) was analyzed for survival rate. The person-time was 6363.50 person/month. The death totaled 29 patients (9.38%). The mortality rate was 4.55/1000 person/month (95% confidence interval = 3.17-6.56/1000 person/month).

The study population comprised 179 males (57.93%) and 130 females (42.07%). The mean average age by SD was 65.12 ± 13.77 years, and the glomerular filtration rate (GFR) was 70.17 ± 36.52 ml/min/1.73 m.[2]

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The average ejection fraction (EF %) was 59.48 ± 8.11, Size of Sinus of Valsalva was 36.67 ± 5.18 mm, sinotubular junction was 33.43 ± 6.05 mm, ascending aorta diameter was 46.70 ± 6.53 mm, aortic arch diameter was 35.62 ± 5.79 mm and proximal descending aorta diameter was 32.61 ± 4.61 mm (Table 1).

The CPB used included DHCA, RCP, SCP, and DHCA with RCP and SCP. Operation time was 432.67 ± 123.35 minutes, CPB time was 235.16 ± 79.73 minutes, Cross clamp time was 176.02 ± 62.91 minutes, Circulatory arrest time was 61.44 ± 19.38 minutes, RCP time was 46.30 ± 20.88 minutes, SCP time was 16.54 ± 31.95 minutes and brain ischemic time was 25.05 ± 26.98 minutes. Temperature was controlled and measured at Rectal temperature of 22.72 ± 1.71 °C, Bladder temperature of 22.43 ± 1.98 °C and tympanic membrane temperature of 17.38 ± 1.71 °C (Table 1).

Table 1: Demographics and general characteristic of participants in the study

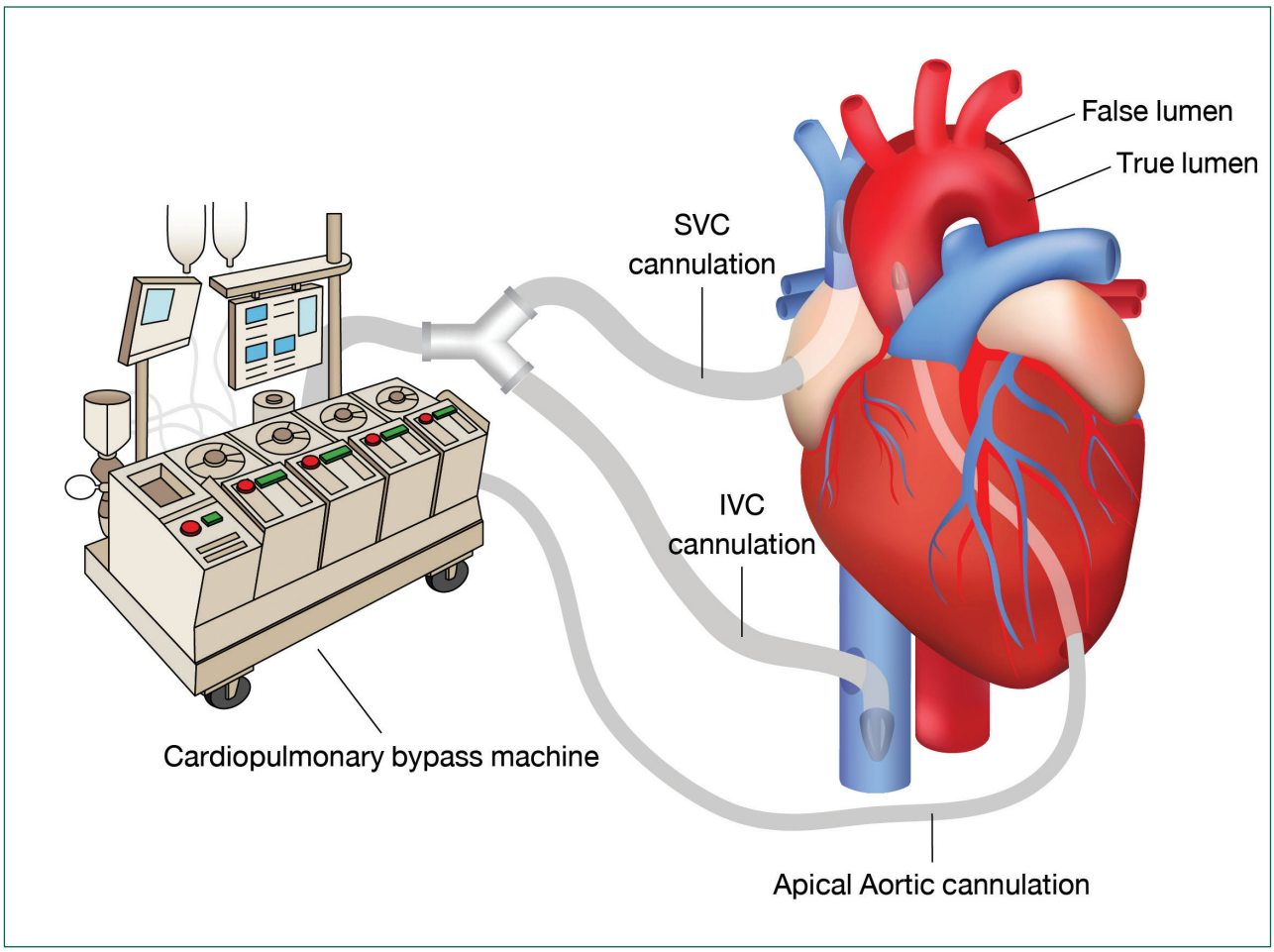
Characteristic	Mean (SD)	Min	Max
Age (years)	65.12 (13.77)	27	94
GFR (ml/min/1.73 m^2)	70.17 (36.52)	4.1	287.5
Operation and CPB Time (Minute)			
Operation time	432.67 (123.35)	262	1007
CPB Time	235.16 (79.73)	146	840
Cross Clamp Time	176.02 (62.91)	74	556
Circulatory Arrest Time	61.44 (19.38)	3	142
RCP Time	46.30 (20.88)	3	107
SCP Time	16.54 (31.95)	0	155
Brain Ischemic Time	25.05 (26.98)	0	99
General characteristic of the Aortic			
EF (%)	59.48 (8.11)	39	78
Sinus of Valsalva (mm)	36.67 (5.18)	26	62
STJ (mm)	33.43 (6.05)	22	55
Ascending Aorta (mm)	46.70 (6.53)	31	80
Aortic Arch (mm)	35.62 (5.79)	24	55
Proximal Descending Aorta (mm)	32.61 (4.61)	22	51
Temperature (°C)			
Rectal Temp	22.72 (1.71)	16.7	29.8
Bladder Temp	22.43 (1.98)	15.3	31.5
Tympanic Membrane Temp	17.38 (1.71)	11.4	25.6

CPB = Cardiopulmonary bypass, RCP = Retrograde cerebral perfusion, SCP=Selective cerebral perfusion
EF= Ejection fraction, STJ = Sinotubular junction, GFR= Glomerular infiltration rate, Temp = Temperature

The confounding factors were controlled by using Cox proportional hazard regression analysis and other factors influencing survival rate and risk factors (Table 2). In this study, the population of; the female group had had a higher rate of death with adjusted hazard ratio (AHR), 95% confidence interval (95% CI) = 0.81 and 0.25-2.61. The coronary artery disease (CAD) and nonCAD group had AHR and 95% CI = 7.27 and 1.17-45.17 (Figure 1), respectively.

The preoperative hemodynamic deterioration and non-preoperative hemodynamic deterioration group had AHR and 95% CI = 4.10 and 1.04-16.24 (Figure 2), respectively. In the operative procedure groups: the total arch replacement (TAR) had AHR and 95% CI = 5.01 and 1.12-23.14, while the Aortic Root Replacement (ARR) had AHR and 95% CI = 2.88 and 0.21-40.23; comparable to the hemiarch replacement (HAR) group (Figure 3). The CPB group was compared among DHCA, DHCA combined with RCP, DHCA combined with SCP and DHCA combined with RCP and SCP groups, indicating AHR and 95% CI = 11.89 and 1.30-108.74 (Figure 4).

Regarding the enlargement of the ascending aortic diameter and proximal descending aorta diameter, the death rates were AHR and 95% CI = 1.11 and 1.02-1.21, AHR and 95% CI = 1.18 and 1.07-1.03, respectively when the diameter expanded each 1 mm. The results of operation times were AHR and 95% CI = 1.01 and1.00-1.01 when the operation time extended each 1 minute. Concerning the natural histology of the aortic wall group: the atherosclerosis compared with the degenerative group had AHR and 95% CI = 4.23 and 0.99-18.00 (Figure 5), respectively; that was marginally significant (Table 3).



Transapical Aortic Cannulation Technique

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Table 2: Percentage of pain reduction at each follow-up period.

Demographics	Event of Death			*p
	Alive	Death	Total	
Gender				
Male	157 (56.07)	22 (75.86)	179 (57.93)	0.040
Female	123 (43.93)	7 (24.14)	130 (42.07)	
Age groups (Years)				
< 60	92 (32.86)	13 (44.83)	105 (33.98)	0.263
60-70	85 (30.36)	5 (17.24)	90 (29.13)	
> 70	103 (36.79)	11 (37.39)	114 (36.89)	
Risk Factor				
History of Neurological				
No	241 (86.07)	21 (72.41)	262 (84.79)	0.051
Yes	39 (13.93)	8 (27.59)	47 (15.21)	
CAD				
No	268 (95.71)	26 (89.66)	294(95.15)	0.148
Yes	12 (4.29)	3 (10.34)	15 (4.85)	
Moderate AR				
No	236 (84.29)	26 (89.66)	262 (84.79)	0.443
Yes	44 (15.71)	3 (10.34)	47 (15.21)	
Severe AR				
No	255 (91.07)	27 (93.10)	282 (91.26)	0.712
Yes	25 (8.93)	2 (6.90)	27 (8.74)	
Cardiac Tamponade				
No	225 (80.36)	21 (72.41)	246 (79.61)	0.312
Yes	55 (19.64)	8 (27.59)	63 (20.39)	
Sinus rhythm				
No	114 (40.71)	25 (86.21)	139 (44.98)	0.000
Yes	166 (59.29)	4 (13.79)	170 (55.02)	
Atrial fibrillation (AF)				
No	272 (97.14)	28 (96.55)	300 (97.09)	0.857
Yes	8 (2.86)	1 (3.45)	9 (2.91)	
Hypertension (HT)				
No	153 (54.64)	25 (86.21)	178 (57.61)	0.001
Yes	127 (45.36)	4 (13.79)	131 (42.39)	
Dyslipidemia				
No	256 (91.43)	28 (96.55)	284 (91.91)	0.336
Yes	24 (8.57)	1 (3.45)	25 (8.09)	
Diabetic Mellitus (DM)				
No	268 (95.71)	28 (96.55)	296 (95.79)	0.831
Yes	12 (4.29)	1 (3.45)	13 (4.21)	
Smoke				
No	193 (68.93)	19 (65.52)	212 (68.61)	0.706
Yes	87 (31.07)	10 (34.48)	97 (31.39)	
Impending Rupture				
No	274 (97.68)	24 (82.76)	298 (96.44)	0.000
Yes	6 (2.14)	5 (17.24)	11 (3.56)	
Preoperative Hemodynamic Deterioration				
No	235 (83.93)	19 (65.52)	254 (82.20)	0.014
Yes	45 (16.07)	10 (34.48)	55 (17.80)	
Histology of Aortic Wall				
Degenerative	47 (16.79)	7 (27.14)	54 (17.48)	0.001
Dissection	188 (67.14)	10 (34.48)	198 (64.08)	
Atherosclerosis	45 (16.07)	12 (41.38)	57 (18.45)	
Operation				
Procedure				
HAR	241 (86.07)	20 (68.97)	261 (84.74)	0.015
ARR	12 (4.29)	1 (3.45)	13 (4.21)	
TAR	27 (9.64)	8 (27.59)	35 (11.33)	
CPB				
DHCA&RCP&SCP	75 (26.79)	3 (10.34)	78 (25.24)	0.002
DHCA or DHCA&RCP or DHCA&SCP	205 (73.21)	26 (89.66)	231 (74.76)	

***$p < 0.05$**

Note: CAD= Coronary artery disease; AR= Aortic regurgitation; HAR= Hemiarch replacement; ARR= Aortic root replacement; TAR= Total arch replacement
CPB= Cardiopulmonary bypass; DHCA= Deep hypothemic circulatory arrest; RCP= Retrograde cerebral perfusion; SCP= Selective cerebral perfusion

Table 3: Univariate and multivariate analysis of risk factors in Acute Type A Aortic Dissection

Risk factor	Univariate analysis			Multivariate analysis		
	HR	95% CI	*p	AHR	95% CI	*p
Gender	1.44	0.58-3.61	0.434	0.81	0.25-2.61	0.722
Age groups (years): < 60	1	-	-	1	-	-
60-70	0.36	0.11-1.19	0.096	0.27	0.06-1.91	0.083
> 70	0.58	0.25-1.37	0.218	0.74	0.27-2.07	0.571
History of Neurological	1.69	0.71-4.04	0.235	1.05	0.34-3.24	0.932
CAD*	1.19	0.36-4.03	0.770	**7.27**	**1.17-45.17**	**0.033***
Moderate AR	1.95	0.56-6.86	0.296	0.87	0.18-4.14	0.856
Severe AR	2.65	0.60-11.72	0.198	0.51	0.08-3.07	0.462
Cardiac Tamponade	0.90	0.39-2.07	0.809	0.27	0.05-1.50	0.137
Sinus rhythm	0.22	0.05-0.96	0.044	0.67	0.02-25.33	0.827
Atrial fibrillation (AF)	4.36	0.53-36.31	0.172	2.61	0.02-294.10	0.691
Hypertension (HT)	0.74	0.25-2.16	0.579	1.20	0.08-16.99	0.892
Dyslipidemia	4.37	0.53-36.31	0.172	3.38	0.23-49.84	0.375
Diabetic Mellitus (DM)	4.37	0.53-36.31	0.172	0.44	0.03-7.10	0.566
Smoke	0.99	0.44-2.25	1.000	1.79	0.50-6.39	0.371
Impending Rupture	0.99	0.37-2.65	0.994	3.03	0.61-15.11	0.177
Preoperative Hemodynamic Deterioration*	2.09	0.93-4.69	0.074	**4.10**	**1.04-16.24**	**0.044***
Histology of Aortic Wall						
Degenerative	1	-	-	1	-	-
Dissection	0.79	0.31-2.05	0.633	4.32	0.83-22.43	0.081
Atherosclerosis	0.71	0.29-1.74	0.449	4.23	0.99-18.00	0.051
Procedure						
HAR	1	-	-	1	-	-
ARR	3.18	0.39-25.82	0.279	2.88	0.21-40.23	0.432
TAR*	2.22	0.91-5.39	0.080	**5.01**	**1.12-23.14**	**0.035***
CPB						
DHCA&RCP&SCP	1	-	-	1	-	-
DHCA or DHCA&RCP or DHCA&SCP*	3.35	1.01-11.09	0.048	**11.89**	**1.30-108.74**	**0.028***
Operation Time (min)*	1.00	0.99-1.03	0.680	**1.01**	**1.00-1.01**	**0.027***
CPB Time (min)	1.00	0.99-1.01	0.511	1.00	0.99-1.02	0.745
Cross Clamp Time (min)	1.00	0.99-1.01	0.933	0.98	0.96-1.00	0.065
Circulatory Arrest Time (min)	1.00	0.99-1.02	0.717	1.03	0.99-1.07	0.206
Brain Ischemic Time (min)	0.98	0.95-1.00	0.065	0.96	0.91-1.01	0.116
EF (%)	0.98	0.94-1.01	0.208	1.01	0.95-1.08	0.658
Sinus of Valsalva (mm)	1.06	0.97-1.15	0.213	1.01	0.89-1.15	0.850
STJ (mm)	0.96	0.91-1.02	0.187	1.07	0.96-1.19	0.248
Ascending* (mm)	0.97	0.91-1.03	0.345	1.11	1.02-1.21	0.022*
Arch (mm)	0.96	0.89-1.03	0.209	0.95	0.87-1.04	0.299
Proximal Descending* (mm)	0.99	0.93-1.05	0.692	1.18	1.07-1.30	0.001*
GFR	1.00	0.99-1.01	0.470	1.00	0.99-1.01	0.887

***p* < 0.05**

Note: HR= Hazard ratio; AHR= Adjusted Hazard ratio; CI= Confidence Interval; CAD= Coronary artery disease; AR= Aortic regurgitation; HAR= Hemiarch replacement ARR= Aortic root replacement; TAR= Total arch replacement; CPB= Cardiopulmonary bypass; DHCA= Deep hypothemic circulatory arrest; RCP= Retrograde cerebral perfusion SCP= Selective cerebral perfusion; EF= Ejection fraction; STJ= Sinotubular junction; GFR= Glomerular infiltration rate

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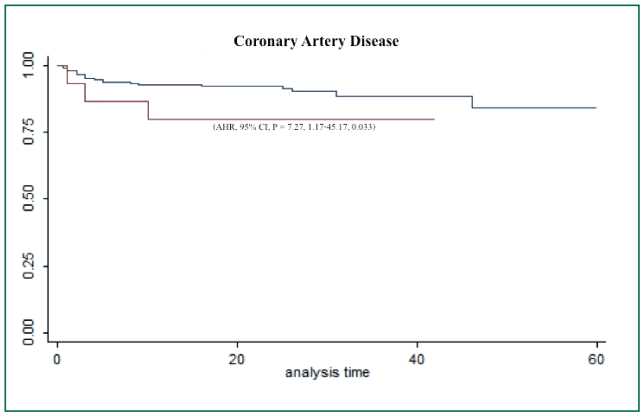

Figure 1: Kaplan-Meier curves show the comparison of patients with coronary artery disease and non-coronary artery disease: AHR and 95% CI = 7.27 and 1.17-45.17 ($p \leq 0.05$), respectively.

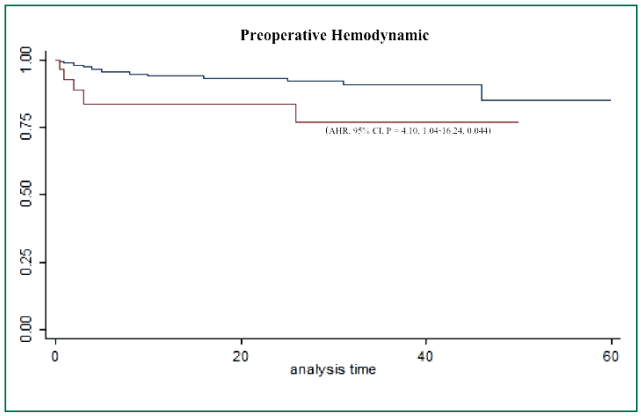

Figure 2: Kaplan-Meier curves show the comparison of patients with preoperative hemodynamic deterioration and non-preoperative deterioration: AHR and 95% CI = 4.10 and 1.04-16.24 ($p \leq 0.05$), respectively.

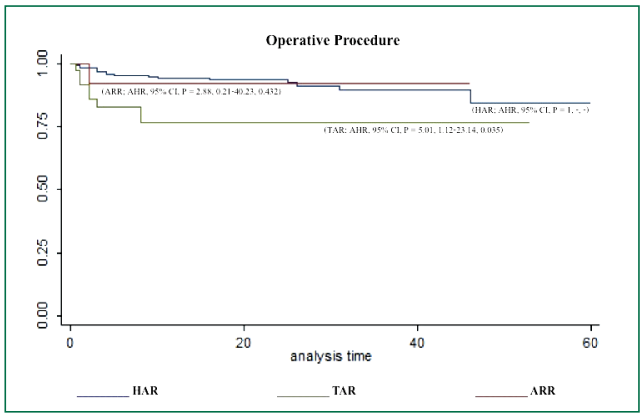

Figure 3: Kaplan-Meier curves show the comparison of the Total Arch Replacement (TAR) and Aortic-Root Replacement (ARR) to hemiarch replacement (HAR): AHR at 95% CI = 5.01 and 1.12-23.14, AHR at 95% CI = 2.88 and 0.21-40.23, AHR at 95% CI = 1, -, - ($p \leq 0.05$), respectively

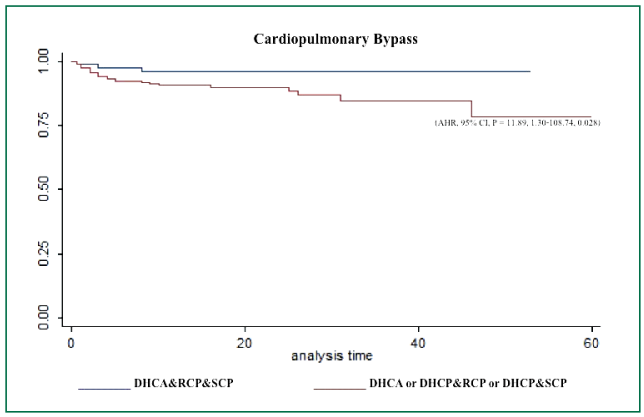

Figure 4: Kaplan-Meier curves show the Deep Hypothermic circulatory arrest (DHCA) combined with RCP (Retrograde cerebral perfusion) and SCP (Antegrade selective cerebral perfusion). Compared to DHCA or DHCA and RCP or DHCA and SCP: AHR and 95% CI = 11.89 and 1.30-108.74. AHR and 95% CI = 1, -, - ($p \leq 0.05$), respectively.

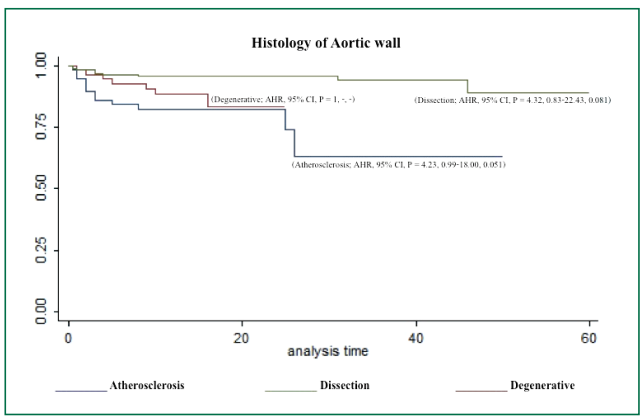

Figure 5: Kaplan-Meier curves show the comparison of the patients with atherosclerosis and dissection with degenerative: AHR at 95% CI = 4.23 and 0.99-18.00, AHR at 95% CI = 4.32 and 0.83-22.43, AHR and 95% CI = 1, -, - ($p \leq 0.05$), respectively.

Discussion

Femoral artery cannulation is the standard option in many cases because CPB is established quickly, in the case of hemodynamic instability.[4,5] It presents the highest rate of mortality including stroke, retrograde cerebral embolization, organ malperfusion and perfusion into the false lumen.[6] Reuthebuch and co-authors reported that the extension of dissection to the cerebral vessel, ascending aorta, and infrarenal abdominal aorta presented a mortality rate of 23.3% and was higher in the femoral cannulation group.[7] Reece et al.,[8] Chiappini el al.,[9] Moizumi et al.,[10] and Nourael et al.[11] reported mortality rates of 23%, 17%, 22%, 30% and 40%, respectively; in femoral cannulation groups. Recently, the axillary artery has been increasingly used for perfusion route. A number of reports have noted different mortality rates between the axillary and femoral cannulation. Tiwari KK et al.[13] reported that femoral artery cannulation had a higher mortality from 6.5% to 40%., while 3% to 8.6% for axillary artery cannulation, and 0%-15% for direct aortic cannulation.[12-14] Kamiya et al.[15] used direct ascending aortic

cannulation and percutaneous femoral artery cannulation. The result showed that the femoral artery cannulation had higher mortality.

Khaladj et al.[16] reported direct ascending aortic cannulation: the cannula tip was inserted by the Seldinger method and placed in the true lumen under the guidance of epiaortic echo or TEE.[17,18] The innominate artery[19] or carotid artery[20] has also been used for the perfusion route, but rarely. Besides, the left ventricular apex has been used (Transapical Aortic Cannulation approach).[21,22] Zwart et al.[23] reported that retrograde passage of a cannula across the aortic valve was used as a part of the left ventricular support system. Though, this technique presented a success rate over 90% in cases of Acute Type A Aortic Dissection; the Transapical Cannulation was safer and simpler than femoral cannulation.[24]

Conclusion

The risk factors influencing the survival rate in Acute Type A Aortic Dissection included CAD, Preoperative Hemodynamic Deterioration, Total Arch Replacement, CPB technique using only DHCA, DHCA with RCP and DHCA with SCP. The enlargement of the Ascending Aortic diameter and Proximal Descending Aorta diameter increased the death rate by 11% and 18%, respectively, when the diameter expanded each 1 mm. Each time the operation time extended 1 minute, the death rate would increase by 1%. The results of this study can be used to brief the patients before surgery. Though no completely perfect perfusion route exists, the risk factors, the underlying diseases, the status of patients or the associated complications before surgery, and the surgeons' experience should be taken into consideration. Any routes can be used for perfusion, and adverse results should be carefully checked just when perfusion is started. However, ensuring successful restoration of the true lumen is the priority.

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References

1. Hagan PG, Nienaber CA, Isselbacher EM, et al. The International Registry of Acute Aortic Dissection (IRAD): new insights into an old disease. *JAMA* 2000;283: 897-903
2. Yamamoto S, Hosoda Y, Yamasaki M, et al. Transapical aortic cannulation for acute aortic dissection to prevent malperfusion and cerebral complications. *Tex Heart Inst J*. 2001;28(1):42-3.
3. Golding LA. New cannulation technique for the severely calcified ascending aorta. *J Thorac Cardiovasc Surg* 1985;90:626-7.
4. Shimokawa T, Takanashi S, Ozawa N, et al. Management of intraoperative malperfusion syndrome using femoral artery cannulation for repair of acute type A aortic dissection. Ann *Thorac Surg* 2008;8:1619-24.
5. Fusco DS, Shaw RK, Tranquilli M, et al. Femoral cannulation is safe for type A dissection repair. *Ann Thorac Surg* 2004;78:1285-9.
6. Orihashi K, Sueda T, Okada K. Detection and monitoring of complications associated with femoral or axillary arterial cannulation for surgical repair of aortic dissection. *J Cardiothorac Vasc Anesth* 2006;20:20-5.
7. Reuthebuch O, Schurr U, Hellermann J, et al. Advantages of subclavian artery perfusion for repair of acute type A dissection. *Eur J Cardiothorac Surg* 2004;26:592-8.
8. Reece TB, Tribble CG, Smith RL, et al. Central cannulation is safe in acute aortic dissection repair. *J Thorac Cardiovasc Surg* 2007;133:428-34.
9. Chiappini B, Schepens M, Tan E, et al. Early and late outcomes of acute type A aortic dissection: analysis of risk factors in 487 consecutive patients. *Eur Heart J* 2005;26:180-6.
10. Moizumi Y, Motoyoshi N, Sakuma K, et al. Axillary artery cannulation improves operative results for acute type A aortic dissection. *Ann Thorac Surg* 2005;80: 77-83.
11. Nouraei SM, Nouraei SAR, Sadashiva AK, et al. Subclavian cannulation improves outcome of surgery for type A aortic dissection. Asian Cardiovasc Thorac Ann 2007;15:118-22.
12. Lee HK, Kim GJ, Cho JY. Comparison of the Outcomes between Axillary and Femoral Artery for Acute Type A Aortic Dissection. *Korean J Thorac Cardiovasc Surg* 2012; 45:85-90.
13. Tiwari KK, Murzi M, Bevilacqua S. Which cannulation (ascending aortic cannulation or peripheral arterial cannulation) is better for acute type A aortic dissection surgery? *Interact Cardiovasc Thorac Surg* 2010;10:797-802.
14. Immer FF, Moser B, Krähenbühl ES. Arterial access through the right subclavian artery in surgery of the aortic arch improves neurologic outcome and mid-term quality of life. *Ann Thorac Surg* 2008;85:1614-8.
15. Kamiya H, Kallenbach K, Halmer D, et al. Comparison of ascending aorta versus femoral artery cannulation for acute aortic dissection type A. *Circulation* 2009;120:S282-S286.
16. Khaladj N, Shrestha M, Peterss S, et al. Ascending aortic cannulation in acute aortic dissection type A: the Hannover experience. *Eur J Cardiothorac Surg* 2008;32:792-7.
17. Conzelmann LO, Weigang E, Mehlhorn U, et al. How to do it: direct true lumen cannulation technique of the ascending aorta in acute aortic dissection type A. Interact Cardiovasc *Thorac Surg* 2012;14(6):869-70.
18. Inoue Y, Takahashi R, Ueda T, et al. Synchronized epiaortic two-dimensional and color Doppler echocar- diographic guidance enables routine ascending aortic cannulation in type A acute aortic dissection. *J Thorac Cardiovasc Surg* 2011;141:354-60.
19. Di Eusanio M, Ciano M, Labriola G, et al. Cannulation of the innominate artery during surgery of the thoracic aorta: our experience in 55 patients. *Eur J Cardiothorac Surg* 2007;32: 270-3.
20. Urbanski PP, Lenos A, Lindemann Y. Carotid artery cannulation in aortic surgery. *J Thorac Cardiovasc Surg* 2006;132:1398-403.
21. Matsushita A, Manabe S, Tabata M, et al. Efficacy and pitfalls of transapical cannulation for the repair of acute type A aortic dissection. *Ann Thorac Surg* 2012;93: 1905-9.
22. Wada S, Yamamoto S, Honda J, et al. Transapical aortic cannulation for cardiopulmonary bypass in type A aortic dissection operations. *J Thorac Cardiovasc* Surg 2006;132: 369-72.
23. Zwart HH, Kralios A, Kwan-Gett CS, et al. First clinical application of transarte- rial closed-chest left ventricular (TaCLV) bypass. *Trans Am Soc Artif Intern Organs* 1970;16:386-91.
24. Robicsek F. Apical aortic cannulation: application of an old method with new paraphernalia. *Ann Thorac Surg* 1991;51: 330-2.

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