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Abstract

Acute type-A aortic dissection is a surgical emergency and has a high rate of short-term mortality. Aortic dissection is highly under-reported in Pakistan. With the technological developments in its management, arterial cannulation technique of direct true lumen cannulation has emerged with improved outcomes. We aimed to compare the mortality and morbidity outcomes between direct true lumen and conventional cannulation techniques for arterial access in patients with acute type-A aortic dissection under a single-centre retrospective review from 2007 to 2017. Mean age of the participants was 43.3±11.6 vs 45±12.4 years with males being dominant in both groups. Frequency of overall morbidity was high in conventional cannulation group (Group-B), though it did not attain statistical significance, (p>0.999). Mortality rate was also high in Group-B (10% vs 30%), (p=0.582). Direct true lumen cannulation is an equally reliable option for establishing cardiopulmonary bypass due to reduced mortality and morbidity and may be given preference when dissection is extending into femoral and innominate arteries.

Keywords: Acute aortic dissection, type-A dissection, cardiopulmonary bypass, cannulation.

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Introduction

Acute type-A Aortic dissection (AAAD), a challenging clinical and surgical emergency, is associated with a high rate of short-term mortality of around (8-34%).[1] Main challenges associated with this type of procedure include establishing adequate extracorporeal circulation, resecting the torn intima, and protecting vital organs, primarily the brain from ischaemia.[2]

Access to arterial flow can be multiple and are debatable. The conventional method of retrograde perfusion technique using femoral artery cannulation increases the chances of false lumen perfusion, organ malperfusion and risk of stroke.[3] Antegrade flow established via axillary artery is time consuming, may cause arterial injury and insufficient flow problems; while cannulating the aorta directly, poses the risk of cannulating the false lumen.[4,5] A modified technique of direct true lumen cannulation (TLC) can solve these problems. Jakob et al and Conzelmann et al proposed that, under direct vision, cannulation of the true lumen of the ascending aorta could be a safe and rapid method of antegrade arterial perfusion in AAAD with minimal mortality and neurological complications.[6,7] Yamamoto and Kitamura et al's comparison between direct TLC and other cannulation strategies reported no cannulation complications along with reasonable mortality and stroke rates.[8,9] Along with the scarcity of literature on aortic dissection in Pakistan, this new technique has only been recently introduced in the country at Aga Khan University Hospital. No study is available in Pakistan on this subject, while only sparse comparisons have been made worldwide.[8,9] Therefore, we aimed to compare demographic, clinical characteristics, peri-operative and the outcome variables of a newly established direct TLC technique with conventional techniques of cannulation during type-A dissection surgeries at our centre in Pakistan.

Methods

All patients operated for AAAD from 2007 to December 2017 at the Aga Khan University Hospital, Karachi were included in the descriptive, retrospective analytical chart review. Patients were categorised into two groups based on arterial cannulation strategy used (i.e. direct TLC and conventional cannulation strategies) during cardio-pulmonary bypass (CPB). Only 10 TLC eligible cases were identified to be included in this study after excluding five cases with incomplete data in the charts. Their age and gender matched controls (conventional cannulation) were selected in the ratio of 1:1. After ERC approval (5276-Sur-ERC-18), medical charts were retrieved and reviewed. The

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standard operating protocol was used for femoral, axillary and central aortic cannulation. Direct TLC was performed as described by Jakob[6] and Conzelmann[7] along with our modifications.[10] All statistical analyses were performed using IBM SPSS Statistics version 21.0. Normality of all continuous variables was determined. Student t-test for normally distributed variables or Mann Whitney-U test for skewed data was applied to assess group differences. Likewise, Chi-squared or Fisher's exact test was applied for categorical data. A p-value < 0.05 was considered statistically significant.

Results

Our study includeda 20 patients. Direct TLC was performed in 10 patients (Group-A) and other cannulation strategies were performed in the other 10 patients (Group-B). Table 1 demonstrates the comparison of demographics and preoperative characteristics of both groups. Age: 43.3±11.6 vs 45.0±12.4 years, (p=0.755), proportion of male gender: 80% vs 70%, (p>0.999) and BMI: 26.2 ±6.6 vs 26.3 ±5.6 kg/m2, (p=0.959) were comparable between the groups. Main diagnostic tools used were echocardiography and CT Angiogram. All patients were found to have aortic valve regurgitation.

Operative variables are described in Table 2. Thirteen (65%) patients had aortic root replacement with a composite graft and a mechanical valve placement. Six (30%) patients had valve-sparing aortic root replacement. Only one (5%) patient underwent a hemi-arch replacement along with aortic valve resuspension. All 10 patients in Group-A underwent direct TLC. Of the 10 patients in Group-B, CPB was established via retrograde perfusion using femoral artery cannulation in six (60%) patients, and via antegrade perfusion using axillary artery cannulation and central aortic cannulation in two patients each (40%). Amongst arterial injury complications in Group-B, one patient had bleeding via the femoral artery and received a femoral artery patch repair, while the other patient had a failed axillary artery cannulation while cannulating a haemodynamically unstable patient, therefore, the femoral artery was cannulated instead.

Outcome measures are depicted in Table 3. One patient in Group-A died during hospital stay due to multiple organ failure, sepsis and cardiogenic shock. In Group-B out of three, two patients died during hospital stay due to cardiogenic shock and one died within 30 days of the index procedure due to excessive bleeding leading to

Table-1: Comparison of Demographic and Clinical characteristics in True Lumen Cannulation Vs Conventional Cannulation.

Variables	‡Group-A, n=10	†Group-B, n=10	*p*-value
Mean Age (years)	43.3 ±11.6	45.0 ±12.4	0.755
Gender (male) n(%)	8 (80.0)	7 (70.0)	>0.999
Mean BMI (Kg/m2)	26.2 ±6.6	26.3 ±5.6	0.959
Mean SBP (mmHg)	112.3±28.3	107.7±27.3	0.715
Pre-Operative Variables			
Hx of HTN n(%)	8 (80.0)	8 (80.0)	>0.999
Hx of CHF n(%)	Nil	3 (30.0)	0.211
Hx of AKI n(%)	1 (10.0)	3 (30.0)	0.582
Hx of MI n(%)	1 (10.0)	1 (10.0)	>0.999
Mean Pre-op Echocardiography LVEF%	46.1 ±16.1	51.4 ±12.8	0.488
Pericardial effusion n(%)	3 (30.0)	5 (50.0)	0.650
Pericardial Tamponade n(%)	1 (10.0)	3 (30.0)	0.582
Pre-op Shock (SBP<80mmHg) n(%)	2 (20.0)	5 (50.0)	0.350

‡True Lumen Cannulation; †Conventional Cannulation; *±SD: Standard Deviation
BMI: body mass index; SBP: Systolic Blood Pressure; HTN: Hypertension; CHF: Congestive Heart Failure; AKI: Acute Kidney Injury; MI: Myocardial Infarction; LVEF: Left Ventricular Ejection Fraction

Table-2: Comparison of Peri-operative variables in True Lumen cannulation vs Conventional Cannulation.

Variables	‡Group-A n=10	†Group-B n=10	*p*-value
Mean Total procedure time (min)	424 (±58.9)	457 (±101.3)	0.397
Mean CBP Time (min)	237.7 (±35.2)	233.6 (±50.4)	0.835
Mean Cross Clamp Time (min)	142.6 (±61.8)	152 (±51.5)	0.706
Mean Circulatory Arrest Time (min)	35.7 (±6.1)	30.7 (±8.7)	0.185
Mean Hypothermic Circulatory Arrest (^{O}C)	17.15 (±0.9)	23.0 (±5.5)	0.005
Antegrade Cerebral Perfusion n(%)	10 (100.0)	4 (40.0)	0.011
Mean Hospital Length of Stay (days)	7.95 (±4.3)	11.0 (±10.2)	0.359
ICU Stay (days) median (IQR)	3.0 (1.9,6.0)	3.0 (2.0,8.5)	0.661
Mean Intubation Time (hrs)	42.7 (±34.3)	55.8 (±48.4)	0.459
Cannulation Complications n(%)	Nil	2 (20.0)	0.474

LCOS: Low Cardiac Output Syndrome; MI: Myocardial Infarction; Afib: Atrial fibrillation; Median (Interquartile range), Mann Whitney U test applied.

Table-3: Comparison of Outcomes in True Lumen cannulation vs Conventional Cannulation.

Variables	‡Group-A n=10	†Group-B n=10	*p*-value
Mortality n(%)	1 (10.0)	3 (30.0)	0.582
Overall Morbidity§n(%) [A(n=9), B(n=7)]	4 (44.4)	4 (57.1)	>0.999
Multiple Organ Failure n(%)	Nil	3 (42.9)	0.063
Respiratory Failure n(%)	1 (11.1)	2 (28.6)	0.550
Acute Renal failure n(%)	2 (22.2)	3 (42.9)	0.596
Heart Failure/LCOS n(%)	1 (11.1)	2 (28.6)	0.550
Sepsis n(%)	Nil	1 (14.3)	0.438
Acute MIn(%)	1 (11.1)	Nil	>0.999
Arrhythmia/Afibn(%)	Nil	1 (14.3)	0.438
Follow Up Time (weeks) median (IQR)	44.0 (1.5,126)	65.0 (8.0,148)	0.681

‡True Lumen Cannulation; †Conventional Cannulation; §Proportion are reported after excluding mortality cases,Multiple Conditions applied; Median (Interquartile range)

cardiogenic shock.

No significant difference was seen in the post-operative complications amongst the surviving patients of the two groups. There was no neurological injury reported in any group. Overall median follow-up time in both the groups was 46, IQR (5.0-131) weeks, Group-A: 44.0, IQR (1.5-126) vs. Group-B: 65.0, IQR (8.0-148) weeks respectively. Overall follow up rate was 75% and the functional class improved in 91.6% (11/12) from III-IV to I-II. No mortality or re-intervention were reported amongst these patients up till the last follow-up.

Discussion

AAAD has an incidence of around 30 cases per million individuals per year[11] and its management requires an emergent open-heart surgery despite the increased risk of postoperative mortality and morbidity.[12] In Pakistan, there is a huge scarcity of literature on aortic disease. From 1988-2015, only 19 cases of aortic dissection have been documented in the country with a mortality rate of 47.3% (9/19).[13,14] In our study, we found in-hospital mortality rate of 20% amongst AAAD cases which is comparable to internationally published rates ranging from 21-33%.[15]

FAC is the traditional, fastest and easiest accessible site, therefore, its use is preferred in haemodynamically unstable patients instead of axillary approach which may occasionally be too time-consuming.[16,17] The use of FAC, primarily due to a retrograde flow in the aorta, has the maximum rate of mortality, false lumen perfusion, limb ischaemia, coronary and cerebral embolisation and organ malperfusion. Axillary artery cannulation technique has a theoretical advantage in providing an antegrade flow during the cooling period.[16,18] However, cannulation problems of the axillary artery are reported to be as high as 10%.[4,5]

In our study, one patient had difficulty being cannulated via axillary artery due to haemodynamic instability and therefore, the femoral artery was used instead.

Since both peripheral cannulation techniques have certain advantages and disadvantages for AAAD patients, Jakob et al directly cannulated the true lumen during AAAD surgery.[6] Jakob et al and Conzelmann et al., each, in their case series, reported a 0% mortality rate.[6,7] Yamamoto et al reported an 8% mortality rate amongst the TLC group compared to an 11.4% mortality rate in the other cannulation group of antegrade flow.[9] In our study, however, one patient died out of ten amongst Group-A nevertheless, the death was unrelated to cannulation technique per se. Recently, Kitamura et al conducted a similar comparison and reported reasonable stroke and mortality rates and no cannulation complications.[8] Group-A and B specific mortality was estimated to be 10% vs 30% and morbidity was (44.4% vs 57.1%), however, no statistical group difference was detected.

Neurological complication is reported to be 21.1-25.3% amongst TLC patients,[6,7] while amongst direct aortic cannulation it is reported to be 3.8-21.4%, with femoral artery cannulation 3.0-26.4% and with axillary artery cannulation (1.8-14.3%) respectively.[3,19] We had no neurological complications and cannot comment on it.

Kitamura et al reported an 8% cannulation complication rate in the other groups with no cannulation complications in the TLC group.[8] Likewise, we had only two patients in the other group with arterial injury complications. The results of our study showed that direct TLC has minimal complications; it spares peripheral arteries from any injuries and consumes less time in establishing CPB.

Conclusion

Direct TLC ensures antegrade perfusion to the brain and other organs through the true lumen and may improve the surgical outcomes. With experience this option of arterial access is as good as conventional techniques, and in some cases where dissection is extending into femoral and innominate artery, it may be the preferred technique of cannulation.

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