Original Article

Surgical management and outcomes of coronary artery involvement secondary to acute type A aortic dissection: a retrospective cohort study

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Background: Coronary artery involvement (CAI) remains a fatal comorbidity in the context of acute type A aortic dissection (ATAAD). We evaluated the impact of CAI on the perioperative and short-term outcomes of patients with ATAAD who underwent total arch replacement (TAR) and frozen elephant trunk (FET) implantation and shared our surgical management experience with the involved coronary artery.

Methods: In this retrospective cohort study, a total of 204 patients with ATAAD between June 2019 and December 2021 were enrolled and divided into the CAI group (n=67) and the non-CAI group (n=137). The characteristics of CAI lesions were described according to the Neri classification. Univariable and multivariable analyses were used to identify independent risk factors for in-hospital mortality. Survival analysis was performed using the Kaplan-Meier method and compared using the log-rank test.

Results: Patients in the CAI group had a longer intraoperative duration of cardiopulmonary bypass (CPB) and cross-clamp, and experienced longer mechanical ventilation time and intensive care unit stays postoperatively. Regarding perioperative outcomes, the prevalence rates of new-onset continuous renal replacement therapy requirement (23.9% *vs.* 10.2%, P=0.01) and in-hospital mortality (17.9% *vs.* 7.3%, P=0.02) were higher in the CAI group. Coronary artery malperfusion (CAM) was an independent risk factor for in-hospital mortality. Short-term survival analysis was similar between the two groups (P=0.146).

Conclusions: For patients with ATAAD undergoing TAR and FET implantation, concomitant CAI may complicate surgery and increase in-hospital morbidity and mortality. CAM secondary to CAI was identified as an independent risk factor. However, short-term survival after hospital discharge was comparable between the two groups. Coronary ostium repair is quick and operable for both type A and type B lesions, while optimal management still warrants further investigation.

Keywords: Aortic dissection; coronary artery involvement (CAI); coronary artery malperfusion (CAM); total arch replacement (TAR); frozen elephant trunk (FET)

Submitted Jun 22, 2023. Accepted for publication Oct 20, 2023. Published online Nov 23, 2023.
doi: 10.21037/jtd-23-990
View this article at: https://dx.doi.org/10.21037/jtd-23-990

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Introduction

Acute type A aortic dissection (ATAAD) has been clarified as a high-risk emergency that increases mortality by 1% to 2% per hour from symptom onset (1). Coronary artery involvement (CAI) remains a fatal comorbidity with a reported incidence of 14.5–24.3% (2-4), mainly caused by retrograde dissection involving the coronary artery (CA). In our perspective, CAI demonstrates an unstable state, which may be confined to the coronary ostium without compromising blood flow or may progress to coronary artery malperfusion (CAM) at any time, causing myocardial ischemia or even catastrophic myocardial infarction. The presence of CAI aggravates the condition and is associated with high perioperative mortality even when diagnosed in a timely manner and treated optimally (5). Prompt surgical repair constitutes the primary life-saving approach for patients with ATAAD (6). However, there is still some controversy regarding the optimal strategy for coronary revascularization, particularly the choice between coronary ostial repair (COR) and coronary artery bypass grafting (CABG).

As a high-volume cardiac surgery center in China, we have adopted total arch replacement (TAR) with frozen elephant trunk (FET) implantation for patients with ATAAD involving the transverse arch and proximal descending aorta and have obtained encouraging results over the past decade (7,8). Of note, as an aggressive arch surgical technique, compared to ascending aortic or hemiarch replacement, it has an inevitable tendency toward prolonging cardiopulmonary bypass (CPB) time and cross-clamp time (9), thereby adding to the myocardial ischemia duration correspondingly.

At present, however, few studies have been performed among patients with ATAAD complicated by CAI who underwent TAR and FET implantation. Herein, we provide an analysis of the clinical characteristics, operative management, and perioperative and short-term outcomes of these patients. We present this article in accordance with the STROBE reporting checklist (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-990/rc).

Highlight box

Key findings

- Concomitant coronary artery involvement (CAI) may complicate surgery and increase malignant events for patients with acute type A aortic dissection (ATAAD) undergoing total arch replacement (TAR) and frozen elephant trunk (FET) implantation.
- There was no significant difference in short-term survival between the CAI group and the non-CAI group.

What is known and what is new?

- Concurrent coronary artery bypass grafting in the setting of surgery for ATAAD carries a high mortality rate, and the efficacy of preoperative percutaneous coronary intervention remains unclear.
- Coronary ostial repair (COR) is quick and operable for both type A and type B lesions.

What is the implication, and what should change now?

- The presence of CAI aggravates the condition and is associated with high in-hospital morbidity and mortality.
- COR can be attempted as the first-line treatment for the involved coronary artery.

Methods

Study population

In this retrospective cohort study, we considered adult patients with ATAAD who underwent TAR with FET implantation between June 2019 and December 2021. A total of 204 consecutive patients were enrolled and dichotomized according to the presence or absence of CAI. Our enrollment process is presented in *Figure 1*. The profile of CAI was visually inspected by the attending surgeon and captured from electronic medical records. Follow-up information was obtained from phone interviews. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study was approved by the Medical Ethics Committee of Beijing Anzhen Hospital, Capital Medical University (No. 2023155X), and the requirement for informed consent was waived given its retrospective nature.

Definitions and outcomes

Aortic dissection with symptom onset ≤14 days and involving the ascending aorta was designated ATAAD, and the diagnosis was based on preoperative aortic computed tomography angiography and transthoracic echocardiography. The characteristics of CAI lesions were described according to the classification approach proposed by Neri *et al.* (10): in type A lesions, the false lumen was limited to the coronary ostium without propagating to the main trunk of the CA; in type B lesions, dissection created an extensive false channel into the CA itself; and in type C lesions, the true lumen intima of the CA

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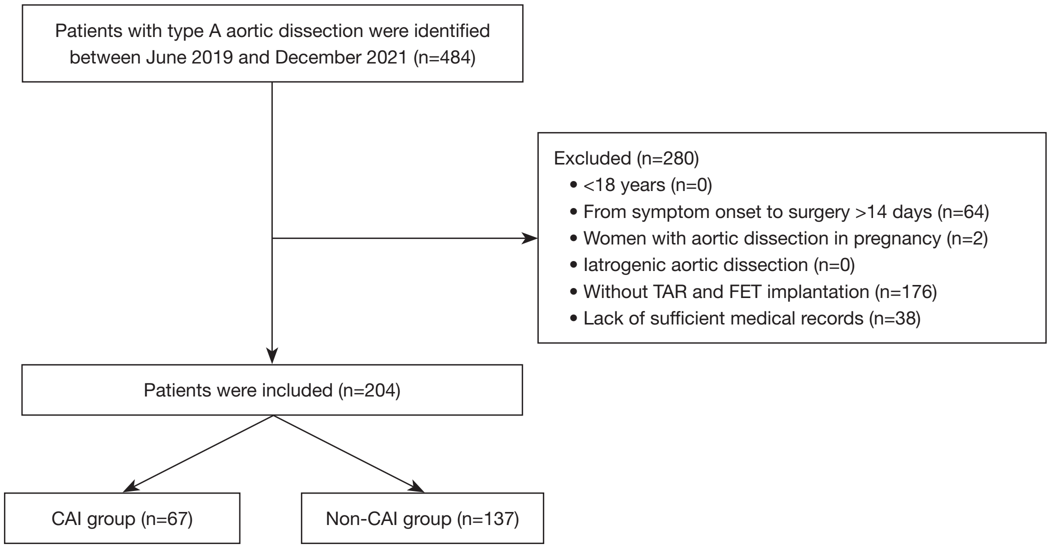

Figure 1 Patient selection flowchart. TAR, total arch replacement; FET, frozen elephant trunk; CAI, coronary artery involvement.

was circumferentially avulsed. CAM was recognized by preoperative elevation of cardiac enzyme levels and any ischemic changes in the electrocardiogram, irrespective of wall motion abnormalities at the involved CA territory. Unlike normal CABG for the involved CA, salvage CABG was performed directly without ligation of the coronary ostium, concerning the speculative existence of CA disease by epicardial palpation or persistent myocardial malperfusion after COR, when one of the following events was encountered after central aortic repair: (I) emerging ST-segment elevation or abnormal regional wall motion; (II) refractory ventricular arrhythmias; and (III) hard to wean from CPB. Operative mortality was defined as death occurring within the initial hospitalization during which the operation was performed. The short-term outcome was defined as all-cause death at maximum follow-up.

Operative techniques

All patients underwent urgent surgery under general anesthesia and standard median sternotomy. Monitoring of cerebral blood flow and oxygen saturation during circulatory arrest periods was performed by near-infrared spectroscopy. Right axillary artery cannulation and right atrial drainage were routinely used for the establishment of CPB. Left ventricular drainage was performed by right upper pulmonary vein intubation.

The ascending aorta was cross-clamped and opened proximal to the innominate artery after topical cooling induced ventricular fibrillation, and cardioplegic solution was delivered antegrade through the coronary ostia for myocardial protection. The aortic valve and root procedures were performed during the cooling phase after CPB was established.

The handling of involved coronary arteries was largely based on a combination of the Neri classification and vascular wall condition. In a minority of patients with type A lesions, the ostium only slightly shifted due to thrombus pushing. In this case, we removed the thrombus completely from the false lumen without additional procedures of the aortic root. The proximal aortic stump was reinforced by both inner and outer Teflon felt strips, and dissected layers were sutured together with a running 4-0 Prolene. For most type A and type B patients, the ostial button was trimmed and anastomosed to the tube graft by a continuous suture of 6-0 Prolene. For type C lesions and severely involved type B lesions, the coronary ostium was ligated, and the saphenous vein (SV) was routinely harvested as the bypass graft and placed on the main trunk or distal to the CA involved. The application of cardioplegic solution was switched from the coronary ostium to the SV graft.

Tetrafurcated grafts (Maquet; Intervascular SAS, La Ciotat Cedex, France) and stent grafts (Cronus; MicroPort Endovascular MedTech Co., Ltd., Shanghai, China) were intended for TAR + FET. Moderate hypothermic circulatory arrest of the lower body was initiated when the

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nasopharyngeal temperature dropped to 28 ℃. After supra-arch vessels were cross-clamped and transected, unilateral antegrade cerebral perfusion (ACP) [5–10 mL/kg/min] was performed via cannula of the right axillary artery. Then, the aortic arch was transected, and the stent graft was placed into the true lumen of the descending aorta. After that, the distal end of the tetrafurcated graft was anastomosed to the FET collar together with the edge of the descending aorta. When distal anastomosis was complete, the tetrafurcated graft was cross-clamped and antegrade perfusion of the lower body was restored through the side branch. For the anastomosis sequence, priority was given to the reconstruction of the left common carotid artery to obtain bilateral cerebral perfusion. Then, the proximal aortic stump was anastomosed to the vascular graft, after which the aortic clamp was removed to restore myocardial perfusion. Finally, the left subclavian artery and the innominate artery were anatomically reconstructed.

Statistical analysis

Categorical variables are represented as numbers (%) and were compared using Chi-squared test or Fisher's exact test. Continuous variables are denoted as medians (interquartile ranges), and were compared by Mann-Whitney *U* test. Univariable analysis was performed first to select clinically relevant variables (P<0.05), which were then included along with previously reported risk factors in the multivariable analysis for adjustment to ascertain independent risk factors (P<0.05) for operative mortality. Short-term survival curves for the two groups were plotted using the Kaplan-Meier method and compared using the log-rank test. All tests were two-sided and deemed significantly different at P<0.05. Statistical analyses were performed using StataMP v17.0 (StataCorp LLC, TX, USA).

Results

Demographic and preoperative characteristics

In our cohort of 204 patients, 67 (32.8%) with a median age of 53.0 years were eventually diagnosed with CAI, among whom 56 (83.6%) were men. Patients in the CAI group appeared to have higher creatinine levels [87.6 (72.4, 111.9) *vs.* 77.9 (65.0, 97.1) µmol/L, P=0.02]. Elevated myocardial injury markers, including troponin I, creatine kinase-MB, and myoglobin, were more commonly seen in patients complicated by CAI [49.3% *vs.* 14.6%, P<0.001; 2.1 (1.2, 6.7) *vs.* 1.3 (0.8, 2.0) ng/mL, P<0.001; and 40.8 (25.2, 124.0) *vs.* 31.8 (17.5, 54.2) ng/mL, P=0.002]. Another underlying preoperative feature relating to CAI, regional wall motion abnormality was observed more often (19.4% *vs.* 8.8%, P=0.03). The CAI group also had a higher prevalence of aortic regurgitation (58.2% *vs.* 29.2%, P<0.001). Other detailed information is summarized in *Table 1*, with unremarkable differences.

Operative details

Table 2 delineates the surgical techniques, accompanying procedures, and intraoperative conditions. The proximal procedures had disparities depending on whether CA was involved, with the Bentall procedure being performed more frequently in the CAI group (53.7% *vs.* 22.6%, P<0.001) and ascending aorta replacement (AAR) in the non-CAI group (75.2% *vs.* 44.8%, P<0.001). More patients in the CAI group necessitated CABG as a concomitant procedure (20.9% *vs.* 3.6%, P<0.001), which also included salvage CABG (10.4% *vs.* 1.5%, P=0.003). The frequency of aortic valvuloplasty (AVP) and non-coronary sinus replacement in the CAI group was much higher (19.4% *vs.* 5.8%, P=0.003; 19.4% *vs.* 4.4%, P<0.001). Moreover, the CAI group had a longer duration of CPB [207.0 (188.0, 238.0) *vs.* 189.0 (170.0, 206.0) min, P<0.001] and cross-clamp [116.0 (99.0, 144.0) *vs.* 99.0 (87.0, 111.0) min, P<0.001]. Nonetheless, there were no notable differences in circulatory arrest time between the two groups (P=0.06).

Among the 67 patients in the CAI group (*Table 3*), isolated right CAI (40/67, 59.7%) was the most common, followed by bilateral CAI (25/67, 37.3%), while left CAI alone (2/67, 3.0%) was relatively rare. For all patients with type A lesions (31/67, 46.3%), we repaired the coronary ostium and two of them underwent salvage CABG procedure. For patients with type B lesions (30/67, 44.8%), most of them underwent repair (29/30, 96.7%), except for one patient who underwent direct CABG due to severe destruction of the coronary ostium. In addition, five patients underwent a salvage CABG procedure. For the patients with type C lesions (6/67, 8.9%), we performed direct CABG in all cases.

In-hospital morbidity and mortality

Regarding postoperative neurological dysfunction covering stroke and spinal cord injury, no significant differences were observed between the two groups (11.9% *vs.* 8.8%, P=0.47;

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Table 1 Demographic and preoperative characteristics

Variables	CAI group (n=67)	Non-CAI group (n=137)	P value
Male	56 (83.6)	109 (79.6)	0.49
Age (years)	53.0 (44.0, 58.0)	50.0 (40.0, 57.0)	0.08
BMI (kg/m^2)	25.3 (23.5, 28.4)	26.4 (24.2, 29.4)	0.07
Smoking	31 (46.3)	59 (43.1)	0.67
Alcohol consumption	17 (25.4)	31 (22.6)	0.66
Marfan's syndrome	3 (4.5)	9 (6.6)	0.55
Medical history			
Hypertension	44 (65.7)	82 (59.9)	0.42
Diabetes mellitus	0 (0.0)	1 (0.7)	>0.99
CVD	4 (6.0)	12 (8.8)	0.49
Chronic CAD	4 (6.0)	11 (8.0)	0.60
MI	1 (1.5)	1 (0.7)	0.55
COPD	0 (0.0)	1 (0.7)	>0.99
CRF	2 (3.0)	4 (2.9)	0.98
Extremity ischemia	12 (17.9)	20 (14.6)	0.54
Creatinine (μmol/L)	87.6 (72.4, 111.9)	77.9 (65.0, 97.1)	0.02*
Amylase (U/L)	50.1 (38.6, 67.7)	51.4 (38.2, 66.4)	0.79
Myocardial injury markers			
TNI >2 times the normal limit	33 (49.3)	20 (14.6)	<0.001*
CK-MB mass (ng/mL)	2.1 (1.2, 6.7)	1.3 (0.8, 2.0)	<0.001*
Myoglobin (ng/mL)	40.8 (25.2, 124.0)	31.8 (17.5, 54.2)	0.002*
Echocardiography			
LVEF (%)	62.0 (60.0, 65.0)	63.0 (60.0, 65.0)	0.64
LVEDD (mm)	49.0 (45.0, 54.0)	48.0 (44.0, 52.0)	0.29
RWMA	13 (19.4)	12 (8.8)	0.03*
Aortic regurgitation	39 (58.2)	40 (29.2)	<0.001*

Values are presented as n (%) or medians (interquartile ranges). *, statistical significance P<0.05. CAI, coronary artery involvement; BMI, body mass index; CVD, cerebrovascular disease; CAD, coronary artery disease; MI, myocardial infarction; COPD, chronic obstructive pulmonary disease; CRF, chronic renal failure; TNI, troponin I; CK-MB, creatine kinase-MB; LVEF, left ventricular ejection fraction; LVEDD, left ventricular end diastolic diameter; RWMA, regional wall motion abnormality.

10.4% *vs.* 4.4%, P=0.10), while the new-onset continuous renal replacement therapy (CRRT) requirement was 23.9% *vs.* 10.2% (P=0.01). Patients with CAI experienced longer mechanical ventilation time [41.5 (14.5, 111.5) *vs.* 17.3 (13.5, 42.5) h, P=0.004] and correspondingly prolonged intensive care unit stays [103.2 (46.1, 205.9) *vs.* 55.5 (22.4, 107.7) h, P=0.009], but there was no significant difference in the length of hospitalization between the two groups (P=0.13). Further postoperative-related events are listed in *Table 4*. We provide a detailed description of in-hospital mortality in the CAI group in Table S1. Early mortality occurred in 12 (17.9%) patients in the CAI group, including respiratory failure in four patients, stroke and multiple organ dysfunction syndrome in three patients

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Table 2 Operative characteristics

Variables	CAI group (n=67)	Non-CAI group (n=137)	P value
Proximal procedure			
AAR	30 (44.8)	103 (75.2)	<0.001*
Bentall	36 (53.7)	31 (22.6)	<0.001*
Wheat	1 (1.5)	1 (0.7)	0.55
David	0 (0.0)	2 (1.5)	>0.99
AVP	13 (19.4)	8 (5.8)	0.003*
CABG	14 (20.9)	5 (3.6)	<0.001*
Salvage CABG	7 (10.4)	2 (1.5)	0.003*
Non-coronary sinus replacement	13 (19.4)	6 (4.4)	<0.001*
Extra-anatomic bypass	2 (3.0)	9 (6.6)	0.29
Cardioplegia			0.16
HTK	64 (95.5)	123 (89.8)	
Del Nido	3 (4.5)	14 (10.2)	
CPB time (min)	207.0 (188.0, 238.0)	189.0 (170.0, 206.0)	<0.001*
Cross-clamp time (min)	116.0 (99.0, 144.0)	99.0 (87.0, 111.0)	<0.001*
Circulatory arrest time (min)	21.0 (17.0, 25.0)	22.0 (19.0, 26.0)	0.06
Rectal temperature (℃)	25.4 (24.7, 26.3)	25.4 (24.5, 26.7)	0.67
Nasopharyngeal temperature (℃)	24.6 (24.2, 25.0)	24.6 (24.0, 25.2)	0.82

Values are presented as n (%) or medians (interquartile ranges). *, statistical significance P<0.05. CAI, coronary artery involvement; AAR, ascending aorta replacement; AVP, aortic valvuloplasty; CABG, coronary artery bypass grafting; HTK, histidine-tryptophan-ketoglutarate; CPB, cardiopulmonary bypass.

each, malignant arrhythmia in one patient, and distal aortic dissection rupture in one patient. In the non-CAI group, in-hospital mortality occurred among 10 (7.3%) patients, including stroke and multiple organ dysfunction syndrome in four patients each, respiratory failure in one patient, and myocardial infarction in one patient. Compared to the non-CAI group, patients in the CAI group experienced a higher postoperative mortality rate (P=0.02).

After multivariable adjustment for male sex, age, body mass index (BMI), amylase, AAR, CPB time, and cross-clamp time, CAM was identified as an independent risk factor for operative mortality [odds ratio (OR), 12.223; 95% confidence interval (CI): 3.047–49.040; P<0.001], as shown in *Table 5*.

Follow-up and short-term outcomes

All hospital survivors were followed up, and our work was fully completed in December 2022. The average follow-up period was 24.7±11.8 months for the CAI group and 26.3±10.3 months for the non-CAI group (P=0.35). *Figure 2* shows the visual results of the Kaplan-Meier survival analysis and log-rank test between the two groups, with no statistical significance (P=0.146). A total of five patients in the CAI group did not achieve post-discharge survival, including one patient who experienced renal failure at 1 month, three patients who experienced stroke at 1, 13, and 30 months, and another patient who experienced distal aortic dissection rupture at 17 months. There were five deaths in the non-CAI group during follow-up, including three patients who died of distal aortic dissection rupture at 2, 12, and 18 months and two patients who died of stroke at 3 and 4 months.

Discussion

In this article, we reviewed patients in our institution who

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Table 3 CAI details

Variables	CAI group (n=67), n (%)
Neri classification	
A	31 (46.3)
B	30 (44.8)
C	6 (8.9)
CAI side	
Isolated left	2 (3.0)
Isolated right	40 (59.7)
Bilateral	25 (37.3)
CAM	20 (29.9)
Management	
COR	53 (79.1)
CABG	14 (20.9)
Normal	7 (10.4)
Salvage	7 (10.4)

CAI, coronary artery involvement; CAM, coronary artery malperfusion; COR, coronary ostium repair; CABG, coronary artery bypass grafting.

underwent TAR and FET implantation due to ATAAD, and operative management and outcomes were given particular focus in the context of CAI. The incidence of CAI (67/204, 32.8%) was higher than that in previous series, which might have resulted from a selection bias by the wider and more critical involvement of the patient population we defined. Isolated right CAI was more prevalent than bilateral CAI or left CAI alone, which was in line with previous studies (2,5,11,12). Plausible explanations for this finding may be associated with the intimal tear location and curvature of the aorta. Those with left CAI may have died without adequate diagnosis, thus leading to survival bias (2,13). CAI patients had a conceivably higher rate of combined aortic regurgitation and aortic root involvement and thus had a higher prevalence of AVP and root replacement (14). Similar trends were also obtained in our cohort.

We performed urgent surgery on all admitted patients, seeking to eliminate aortic pathology within a limited amount of time. However, the optimal surgical strategy to restitute adequate myocardial perfusion is contentious. Since the classic Neri classification was established (10), there seemed to be a consensus on COR for type A lesions and CABG for type C lesions after two decades of

Table 4 In-hospital morbidity and mortality

Variables	CAI group (n=67)	Non-CAI group (n=137)	P value
Stroke	8 (11.9)	12 (8.8)	0.47
Spinal cord injury	7 (10.4)	6 (4.4)	0.10
CRRT	16 (23.9)	14 (10.2)	0.01*
ECMO	0 (0.0)	1 (0.7)	>0.99
Reoperation for bleeding	5 (7.5)	5 (3.6)	0.30
Re-intubation	7 (10.4)	9 (6.6)	0.33
Tracheotomy	2 (3.0)	11 (8.0)	0.17
Mechanical ventilation (h)	41.5 (14.5, 111.5)	17.3 (13.5, 42.5)	0.004*
Length of stay			
ICU (h)	103.2 (46.1, 205.9)	55.5 (22.4, 107.7)	0.009*
In-hospital (days)	14.0 (10.0, 19.0)	15.0 (12.0, 21.0)	0.13
In-hospital mortality	12 (17.9)	10 (7.3)	0.02*

Values are presented as n (%) or medians (interquartile ranges). *, statistical significance P<0.05. CAI, coronary artery involvement; CRRT, continuous renal replacement therapy; ECMO, extracorporeal membrane oxygenation; ICU, intensive care unit.

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Table 5 Univariable and multivariable analyses for in-hospital mortality

Variable	Univariable analysis		Multivariable analysis†	
	OR (95% CI)	P value	OR (95% CI)	P value
CAI	2.771 (1.130–6.794)	0.026	1.379 (0.566–4.457)	0.379
Neri classification				
A	0.876 (0.182–4.214)	0.869	0.565 (0.105–3.036)	0.505
B	4.618 (1.642–12.988)	0.004	3.160 (0.914–10.927)	0.069
C	6.350 (1.034–39.009)	0.046	2.372 (0.193–29.113)	0.499
CAI side				
Isolated left	NA	NA	NA	NA
Isolated right	1.814 (0.582–5.655)	0.304	1.047 (0.284–3.860)	0.944
Bilateral	4.939 (1.669–14.612)	0.004	3.251 (0.787–13.438)	0.103
CAM	12.955 (4.591–36.552)	<0.001	12.223 (3.047–49.040)	<0.001
Management				
COR	2.174 (0.808–5.846)	0.124	1.675 (0.564–4.980)	0.353
CABG	4.875 (1.631–14.569)	0.005	1.050 (0.173–6.362)	0.958
Salvage CABG	7.867 (1.937–31.944)	0.004	2.649 (0.357–19.661)	0.341

†, adjusted for male sex, age, BMI, amylase, AAR, CPB time, and cross-clamp time. OR, odds ratio; CI, confidence interval; CAI, coronary artery involvement; NA, not applicable; CAM, coronary artery malperfusion; COR, coronary ostium repair; CABG, coronary artery bypass grafting; BMI, body mass index; AAR, ascending aorta replacement; CPB, cardiopulmonary bypass.

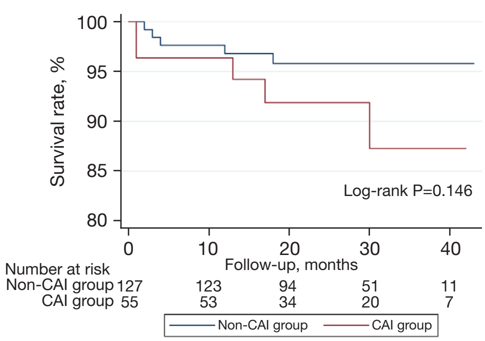

Figure 2 Kaplan-Meier plot for the CAI group versus the non-CAI group. The numbers of patients at risk are listed below the plot. CAI, coronary artery involvement.

investigation and review, whereas the debate was focused mainly on the management of type B lesions. In addition to being simple and less invasive, CABG was also perceived as a safe option when the severity of the involved coronary stenosis could not be determined intraoperatively. Given the preponderance mentioned above, several centers considered CABG as the ideal choice (3,4,15). Nonetheless, Morjan and coauthors (16) found that concurrent CABG in the setting of surgery for ATAAD carried a high mortality rate. Neri *et al.* (10) believed that COR not only preserved the original coronary anatomy and provided antegrade perfusion, but also avoided competitive blood flow from bypass grafts and the potential for coronary re-dissection. Kreibich and colleagues (11) suggested that COR could be attempted as long as antegrade cardioplegic solution was able to be delivered through the coronary ostium, and performed on more than half of the patients with type B lesions (20/32, 62.5%). We considered COR to be a quick and operable method as well, having not to consider issues such as bridge vessel quality and long-term patency and thus performing COR for almost all type B lesions (29/30, 96.7%). Essential elements for successful COR lie in the removal of the thrombus around the coronary ostium and radical closure of the false lumen to ensure patency of the involved CA while not causing a fresh intimal tear. Salvage CABG was performed on five (17.2%) patients, and two of them did not survive the operation. Under our practice patterns, the mortality rate of patients who received solely COR for type B lesions was 25% (6/24). Only one of these

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patients died from malignant arrhythmia which was deemed to be associated with our COR strategy. The superiority of COR or CABG in the management of CAI, especially among patients with type B lesions, still warrants further investigation with a larger cohort.

In prior small case series and case reports, some patients with combined CAM were misdiagnosed with acute coronary syndrome and received percutaneous coronary intervention (PCI) treatment (12,17,18), whereas positive outcomes were achieved after surgery. Due to the presence of an intimal flap, stenting is challenging with a high risk of the guidewire inserting into the false lumen, while uneventful PCI remains the most rapid reperfusion strategy without doubt. In our study, two patients with CAM were prioritized for PCI treatment, and both were successfully discharged following subsequent surgery. A recent multicenter registry (5) compared a staged approach (i.e., PCI prior to surgical procedures) to direct open repair, and found potential improvement in clinical outcomes, albeit without a significant difference (24.3% *vs.* 33.8%, P=0.269). The concept of PCI acting as a bridge procedure to a later repair seems to be an intriguing solution that allows comprehensive assessment of frail patients and rational allocation of medical resources (19). However, it remains unclear whether the time consumed by PCI worsens the outcome of aortic disease and what the fate of an implanted stent in the absence of antiplatelet agents will be like. Until it is determined which patients may benefit most from the staged approach, prompt surgery will always be the first line of treatment in this lethal clinical scenario.

In our study, the CAI group had an elevated rate of in-hospital morbidity and mortality, which may have resulted from additional CA-related procedures that complicated the surgery, increasing CPB time and cross-clamp time. Previous studies that identified a population in whom the TAR + FET procedure was applied in our center revealed that the prolongation of CPB time was not only a risk factor for CRRT after surgery, but also for 90-day postoperative mortality, with possible reasons including inflammatory response, hypotensive periods, and differing degrees of hemolysis (20,21). Wang *et al.* (4) found that acute coronary involvement increased short-term operative mortality among patients even without myocardial ischemia. CAI is an unstable condition, and CAM may occur at any time due to the dissection process, even during intraoperative hemodynamic changes (18). CAM is relatively uncommon, with a reported incidence of 6.1–10.2% (11,15,22,23). Those with CAM (20/204, 9.8%) secondary to CAI mainly had Neri B and Neri C lesions (18/20, 90.0%). Our results indicated significantly increased mortality (10/20, 50.0%) when CAM was present. After multivariable adjustment, CAM was also identified as an independent risk factor for in-hospital mortality (OR, 12.223; 95% CI: 3.047–49.040; P<0.001). Since CAI is more likely to manifest as malperfusion compared to the involvement of other organ vessels, and has an adverse impact on patient prognosis (24), it is necessary to pay sufficient attention to concomitant CAI and to treat the involved CA in a timely manner for better outcomes.

In addition to the inherent limitations of retrospective studies, the conclusions of this study are constrained by its small sample size from a single center. There are also limitations to the dissemination of our findings in light of the fact that the TAR + FET procedure may not be as intensively used in other centers. Moreover, we merely conducted a short-term follow-up, and we will continue to focus on the long-term outcomes.

Conclusions

For ATAAD patients undergoing TAR with FET implantation, concomitant CAI may complicate surgery and increase in-hospital morbidity and mortality. CAM secondary to CAI was identified as an independent risk factor for postoperative mortality. However, short-term survival after hospital discharge was comparable between the CAI group and the non-CAI group. In our practice patterns, COR acted as a quick and operable method for both type A and type B lesions, and although it was accompanied by a higher rate of salvage CABG, it did not seem to contribute additional cardiac-related adverse events. Nevertheless, an optimal myocardial reperfusion strategy still necessitates continued investigation and debate.

Acknowledgments

Funding: This work was supported by the Beijing Municipal Science & Technology Commission (No. Z191100006619093).

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-990/rc

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Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-990/dss

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-990/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-23-990/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). This study received approval from the Medical Ethics Committee of Beijing Anzhen Hospital, Capital Medical University (No. 2023155X), and the requirement for informed consent was waived given its retrospective nature.

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Cite this article as: Wang H, Jia B, Zhong Y, Chen S, Luo C, Qiao Z, Ge Y, Li C, Liu Y, Zhu J. Surgical management and outcomes of coronary artery involvement secondary to acute type A aortic dissection: a retrospective cohort study. J Thorac Dis 2023;15(12):6436-6446. doi: 10.21037/jtd-23-990

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Supplementary

Table S1 Details of in-hospital mortality in the CAI group

No.	Sex	Age (years)	CAI side	Neri classification[†]	Management[‡]	Salvage CABG	Graft site	Cause of death
1	M	48	Bilateral	A/C	Repair/CABG	No	AO-SVG-RCA	Stroke
2	M	58	Bilateral	B/B	Repair/repair	Yes	LSCA-SVG-LAD	Respiratory failure
3	M	67	Right	C	CABG	No	AO-SVG-RCA	MODS
4	M	65	Right	B	Repair	No	–	MODS
5	M	68	Bilateral	B/B	Repair/repair	No	–	Respiratory failure
6	M	55	Bilateral	B/B	Repair/repair	No	–	Stroke
7	M	47	Right	B	Repair	No	–	MODS
8	M	38	Bilateral	B/B	Repair/repair	No	–	Stroke
9	M	40	Bilateral	B/B	Repair/repair	No	–	Malignant arrhythmia
10	M	55	Bilateral	A/A	Repair/repair	Yes	LSCA-SVG-RCA	Distal aortic rupture
11	F	43	Right	A	Repair	No	–	Respiratory failure
12	F	58	Right	B	Repair	Yes	LCCA-SVG-PDA	Respiratory failure

[†], the Neri classification for left CAI is indicated before the "/" and the Neri classification for right CAI is indicated after the "/"; [‡], the management approach for the left coronary artery is presented before the "/" and the management approach for the right coronary artery is presented after the "/". CAI, coronary artery involvement; CABG, coronary artery bypass grafting; M, male; F, female; AO, aorta; SVG, saphenous vein graft; RCA, right coronary artery; LSCA, left subclavian artery; LAD, left anterior descending artery; MODS, multiple organ dysfunction syndrome; LCCA, left common carotid artery; PDA, posterior descending artery.

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