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Original Article

Outcomes of supra coronary aortic repair technique in patients with acute aortic dissection type A

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Abstract: Background: Acute aortic dissection type A (AADA) is a fatal event that requires an emergent surgical operation. Here, we decided to evaluate the outcome of supra coronary aortic repair technique in patients with type A acute aortic dissection for 16 years in Isfahan Chamran hospital that one surgeon performed. Methods: This is a retrospective descriptive cross-sectional study performed in 2019 in Isfahan on documents of 54 patients who underwent supra-coronary repair surgery for type A aortic dissection during 2004 to 2019. We collected patient's demographic information, the condition of patient's vital signs at the time of admission to the hospital and before surgery, the cardiopulmonary bypass (CPB) time and other variables. We also collected data regarding patient's mortality and possible surgical complications. Results: Evaluation of surgical complications showed that acute renal failure (ARF) was the most common complication (87%) followed by postoperative bleeding in ICU that required surgical operation (18.5%), neurologic complications (13%), acute respiratory distress syndrome (ARDS) (9.3%) and chronic renal failure (CRF) (1.9%). The mortality rate was 14.8% (8 patients). The most frequent reason for mortality was bleeding (50%), major neurologic complications (37.5%), multiple organ failure (25%), cardiac failure (12.5%) and CRF (12.5%). Patients with mortality had significantly higher age compared to other patients (P = 0.03), significantly higher duration of CPB use (P = 0.03), higher frequency of irregular peripheral pulses (P = 0.01), higher frequency of abnormal carotid pulses (P = 0.04), and higher bleeding volume in the ICU (P = 0.04). Conclusion: Age, disturbed preoperative clinical condition, postoperative bleeding, and organ failure could increase the rates of mortality of AADA.

Keywords: Aortic dissection, risk factor, complication, mortality

Introduction

Acute aortic dissection type A (AADA) is a fatal event with an annual incidence of 0.5-2.95 per 100,000. AADA occurs in the ascending aorta, the curved part of the aorta that extends upward from the heart. This tear may extend along the upper part of the aorta and down toward the abdomen [1, 2]. Epidemiologic studies have also reported a higher prevalence of disease in the male gender and aged over 60 years [3]. According to the Stanford classification, the condition is divided into two types A and B. Type A involves the ascending aorta and root with or without extension to the aortic arch or descending aorta [4]. Type A aortic dissection is the most common type of aortic dissection and is more likely to be acute than chronic. The most common symptoms of AADA include sudden severe chest or upper back pain, sudden severe abdominal pain, loss of consciousness, shortness of breath, symptoms similar to myocardial infarction and different pulse power in upper or lower limbs [4-6].

Different risk factors have been reported for aortic dissection. These factors include hypertension, atherosclerosis, aortic aneurysm, bicuspid aortic valve, aortic coarctation and connective tissue disorders [7]. Definitive treatment of type A aortic dissection is a surgery performed in one of two techniques: supra-coronary or aortic root replacement [7, 8].

In the supra-coronary repair method, the patient is supported by a Cardiopulmonary bypass (CPB) machine with or without the use of a total circulatory arrest (TCA) with deep hypothermia

(15-18°C). In the next step, the entire ascending aorta will be removed and the proximal and distal ascending aorta and even parts of the aortic arch are repaired. Then the ascending aorta is replaced by a synthetic graft [9, 10]. On the other hand, treatment of type B aortic dissection could be conducted medically and endovascular method repair might be required in some instances [11].

Without surgical repair, the prognosis of AADA can be very poor and so its mortality rate increases by 1-2% per hour. 52% of these patients die within the first 24 hours [12]. The mortality rate of aortic dissection could be 50% within the first week and 75% within the first month [13]. However, with advances in early diagnosis and new surgical techniques over time, these rates have been significantly reduced.

It should be noted that the difference in the mortality rate of patients after surgery is completely dependent on the condition of patients before surgery. The mortality rate in hemodynamically unstable patients such as shock and heart failure and tamponades and renal ischemia, could be very high and in patients with stable conditions could be very low [7, 14, 15].

Therefore, considering that a study has not been performed on patients with AADA operated by supra-coronary repair method in our region, we decided to evaluate the outcome, results and complications of this surgical technique in a descriptive study.

Methods and material

Study design

This is a retrospective descriptive cross-sectional study that was performed in 2019 in Isfahan Chamran hospital affiliated to Isfahan University of Medical Sciences. The current study was conducted on documents of patients that underwent supra-coronary repair surgery for type A aortic dissection during 2004 to 2019. The study protocol was approved by the Research Committee of Isfahan University of Medical Sciences and the Ethics committee has confirmed it.

Inclusion and exclusion criteria

The inclusion criteria were diagnosis of type A of aortic dissection, undergoing surgical treatment by one expert cardiac surgeon, surgical treatments during 2004 to 2019 and signing the written informed consent to participate in the study. Diagnosis criteria for type A aortic dissection were performed by clinical manifestations of the disease and imaging evaluations. These assessments were widening of the aorta on chest X-ray, blood pressure discrepancy between upper limbs, and definite diagnosis by computed tomography (CT) scanning. The exclusion criteria were lack of consent, incomplete medical data, undergoing surgeries with other methods and undergoing surgery by other surgeons.

Data collection

By using a checklist, patients' demographic information, including gender, age, and history of previous illness, including hypertension, diabetes, and heart disease, were extracted from records. Also, the condition of the patient's vital signs at the time of admission to the hospital and before surgery was recorded. The patients' history was reviewed, and the main complaints of the registered patients were recorded. All information about the CPB of the technique used and other variables were obtained from the operation reports. We also collected data regarding patients' mortality and possible surgical complications. These data were collected by either visiting the patients or via telephone calls.

Statistical analysis

The obtained data were entered into the Statistical Package for Social Sciences (SPSS) (version 24, SPSS Inc., Chicago, IL). Quantitative data were reported as mean ± standard deviation and qualitative data as frequency distribution (percentage). Independent t-test, Chi-square were used to analyze the data. *P*-value < 0.05 was considered as significance threshold.

Results

Study population

In the present study, data of 54 patients were analyzed. The study population consisted of 39 males (72.2%) and 15 females (26.8%) with a mean age of 48.1 ± 3.36, ranging from 18 to 79 years. The most common cardiac symptoms among patients were chest pain (92.59%),

Table 1. Demographic data of the included patients

Variable		Mean ± SD/N (%)
Age (years)		48.61 ± 13.72
Gender	Male	39 (72.2%)
	Female	15 (27.8%)
Patient's symptoms	Chest pain	50 (92.6%)
	Back pain	19 (35.2%)
	Neck pain	2 (3.7%)
	Pain in limbs	6 (11.1%)
	Abdominal pain	6 (11.1%)
	Dyspnea	27 (50%)
Diagnosis by CT angiography		14 (25.9%)
Diagnosis by trans esophageal echocardiography		54 (100%)
Past medical history	Hypertension	15 (27.8%)
	Smoking	11 (20.4%)
	Alcohol use	7 (13%)

dyspnea (50%), back pain (35.9%), abdominal pain (11.1%), limb pain (11.1%) and pain in the neck (3.7%) (**Table 1**).

Patient's signs and imaging

The most common signs among patients were abnormal peripheral pulses (46.29%), hypertension (27.8%), decreased levels of consciousness (27.7%), hemodynamic imbalance (25.92%), abnormal carotid pulse (12.96%) and tamponade (14.8%). Based on our data, all patients (100%) underwent trans-thoracic echocardiography (TTE), 25.9% of them underwent CT angiography, 3.7% of patients underwent trans-esophagus echocardiography and 1.9% underwent aortography as the diagnostic method (**Table 1**).

Hospitalization characteristics

The mean duration of surgery was 373 minutes ranging from 91 to 600 minutes. The mean hospitalization duration was 9.63 days ranging from 2 to 23 days. 38 patients (70.28%) used the TCA with the mean duration of 44 minutes (ranging from 25 to 72 minutes). Evaluation of surgery complications showed that acute renal failure (ARF) was the most common complication (87%) followed by postoperative bleeding in ICU that required surgical operation (18.5%), neurologic complications (13%), acute respiratory distress syndrome (ARDS) (9.3%) and chronic renal failure (CRF) (1.9%) (**Table 2**).

Patient's mortality

The in-hospital mortality rate in the current study was 14.8% (8 patients). In all cases with mortality, the type A aortic dissection was continued to the aortic arch and descending aorta (A1 type of Stanford classification). The most frequent reason for mortality was bleeding (50%), major neurologic complications (37.5%), multiple organ failure (25%), cardiac failure (12.5%) and CRF (12.5%) (**Table 2**).

Mortality and related factors

Our data showed that patients with mortality had significantly higher age compared to other patients (58.2 vs. 46.9 years, P = 0.03), significantly higher duration of CPB use (276.3 vs. 198.1 minutes, P = 0.03), higher frequency of abnormal peripheral pulses (28% vs. 3.4%, P = 0.01), higher frequency of irregular carotid pulse (42.9% vs. 10.6%, P = 0.04), and higher bleeding volume in the ICU (2160 vs. 1374 ml, P = 0.04). All cases with mortality had type A1 (by Stanford classification) of aortic dissection (P = 0.001) (**Table 3**).

We found no significant differences between cases with or without mortality regarding the following factors: the decreased level of consciousness by the time of admission (P = 0.6), duration of aortic cross-clump (P = 0.13) and conducting TCA (P = 0.1). It should also be mentioned that there was no significant relationship between neurologic disorders and performing TCA (P = 0.12).

Discussion

Acute aortic dissection type A (AADA) is a dangerous cardiovascular condition that requires emergency surgery. Despite the passage of time and diagnostic and therapeutic advances, the disease is still associated with high morbidity and mortality [16, 17].

In this disease, the surgeon can choose four types of surgery to perform, which are: 1-Supra-coronary repair of ascending aorta and repair of aortic valve; 2-Supra-coronary repair of ascending aorta with replacement of the aortic

Table 2. Patient's mortality and surgical complications

Variable		Mean ± SD/N (%)
Mortality		8 (14.8%)
Mortality cases	bleeding	4 (7.4%)
	Heart failure	1 (1.9%)
	Chronic kidney disease	1 (1.9%)
	Neurologic complications	3 (5.6%)
Complications	Neurologic	7 (13%)
	Acute respiratory distress syndrome (ARDS)	5 (9.3%)
	Acute renal injury	47 (87%)
	Chronic renal failure	1 (1.9%)
	Respiratory failure	2 (3.7%)
Blood injection during surgery (litter)		3.81 ± 1.49
Hospitalization duration (days)		9.63 ± 5.17
Surgery duration (minute)		373 ± 95.91
Total circulatory arrest duration (minute)		44.0 ± 8.80
Cardiopulmonary bypass duration (minute)		209.76 ± 71.56
Requiring repeated surgery		10 (18.5%)
Requiring aortic valve repair		1 (1.9%)

Table 3. Differences between patients with and without mortality

Variable		Group		*P*-value
		Mortality (N = 8)	Survived (46)	
Total circulatory arrest duration (mean ± SD) (minute)		48,14 ± 8.31	43.06 ± 8.77	0.171
Bleeding volume (mean ± SD) (ml)		2160,00 ± 1248,19	1374,44 ± 761,54	0.046
Repeated surgery (N (%))		5 (62.5%)	39 (84.7%)	0.774
Impaired consciousness (N (%))		3 (37.5%)	12 (26.1%)	< 0.001
Acute renal injury (N (%))		6 (75%)	41 (89.1%)	< 0.001
Abnormal peripheral pulse (N (%))		7 (87.5%)	18 (39.1%)	0.001
Aortic dissection type	1	1 (12.5%)	9 (19.6%)	0.804
	2	7 (87.5%)	37 (80.4%)	< 0.001

valve; 3-Complete replacement of aortic root (Bental procedure); 4-Preserving the aortic valve *and r*eplacing the aortic root [18, 19].

Studies have shown that the last two methods, despite having higher morbidity and mortality in the perioperative period than the first two methods, in the long term, are associated with fewer complications, including the need for reoperation due to aortic root dilatation, aortic root dissection, and AI recurrence [18, 20].

The present study evaluated surgical complications regarding supra-coronary repair surgery for AADA. Based on our results, ARF, post-operation bleeding, and neurologic complications were the most common complications. In patients with mortality, the most frequent mortality reasons were bleeding, major neurologic complications, and multiple organ failure. Based on our data, patients with mortality had significantly higher age, higher duration of CPB use, higher frequency of abnormal peripheral pulses, higher frequency of the irregular carotid pulse, and higher bleeding volume in the ICU. These could be considered significant risk factors related to mortality in patients.

In the last decade, despite improvements in diagnostic methods and surgical techniques, the overall mortality rate has been around 10 to 25%. The most important determinants of mortality can be factors such as patient age - hemodynamic and neurological status of the patient during referral - the extent of dissection and its progression to the distal aorta - CPB

time - TCA use - TCA time and volume of postoperative bleeding. In our study, factors such as patient age - extent, and progression of dissection from ascending to the distal aorta - in severe postoperative bleeding and CPB time were significantly associated with patient mortality, consistent with other studies.

Evaluation of surgical complications related to supra-coronary repair surgery for AADA could be significantly valuable in clinical practice. Preoperative shock and extension of dissection to the abdominal aorta were significant risk factors for early mortality. They also evaluated the importance of cerebral malperfusion as one of the critical complications of this surgery. It was stated that preoperative neurological symptoms and partial or complete thrombosis of the supra-aortic branch vessels were identified as independent predictors of perioperative cerebral malperfusion. It was indicated that organ failures, especially ARF, could contribute to higher mortality rates [21]. The results of these studies were in line with our findings. We also suggested that preoperative neurologic complications, severe post-operation bleeding, higher duration of CBP use and higher age were significant risk factors.

Another study showed age, need for catecholamines at referral, preoperative resuscitation, need for intubation before surgery, preoperative hemiparesis, coronary malperfusion, visceral malperfusion, and dissection extension the descending aorta, and previous cardiac surgery were independent predictors of the 30-days mortality rate [15].

In a study of 154 patients, Montalvo and colleagues emphasized that the most critical risk factors for mortality in these patients were preoperative shock, ventricular arrhythmias, and high-density red blood cell transfusions, which align with our findings [22]. In our study, the overall mortality rate of patients was 14.8%, and the most common cause of mortality in patients was bleeding after surgery.

According to the International Registry of Acute Aortic Dissection, the in-hospital mortality rate after dissection surgery was 26% between 1996 and 1998 [23]. The German Registry for Acute Aortic Dissection also reported a mortality rate of 17% in the first 30 days after dissection surgery between 2006 and 2009 [24].

Although supra-coronary repair of the aorta in patients with connective tissue disorders can be associated with higher morbidity and mortality in the peri-operation period than in other patients, this method can also be used in these patients. In the study of Miderhausen and his colleagues, performing coronary artery bypass grafting on type A acute aortic dissection patients is considered a safe method [20]. Mazzucotelli and his colleagues have also reported long-term outcomes of supra-coronary repair surgery in terms of echo findings and good clinical outcome. Refer to this method as a method of choice regardless of the severity of the patient's AI [25].

Another point is that we reported a higher mortality rate compared to the mentioned previous studies. We believe that this issue could be due to variations in the study populations and patient's characteristics. The important point of this study was to evaluate and compare different risk factors in patients with or without mortality in our study. Based on our findings, higher age, higher duration of CPB use, higher frequency of abnormal peripheral pulses, higher frequency of the abnormal carotid pulse and higher bleeding volume in the ICU were the most important risk factors for mortality.

In 2021, Gomibuchi and others reported that occlusion or severe stenosis of supra-aortic branch vessels are important risk factors for complications in patients undergoing surgical operations. It was mentioned that further studies should be conducted to assess different risk factors for this issue [26]. Lin and colleagues also reported that higher duration of CBP use and disturbed clinical conditions before the surgeries could increase the mortality rates [27]. These data also show the importance of similar studies in this area. Despite many advances in the diagnosis and treatment of type A acute aortic dissection, the disease is still considered a catastrophic event. It is still associated with high morbidity and mortality.

We consider our results unique because, to the best of our knowledge, no previous similar studies have been conducted in our region. By evaluating the complications and their risk factors among patients, new insights were given into the performance of this operation. The limitations of our study were restricted study population and conducting this study in a single medi-

cal center, while multi-centric studies on larger populations could provide more significant data on this issue.

Conclusion

By evaluating the complications of supra-aortic repair of type A aortic dissection, we showed that ARF, post-operation bleeding and neurologic complications were the most common complication. In patients with mortality, the most frequent mortality reasons were bleeding, major neurologic complications and multiple organ failure. We recommend that special attention should be given to patients with higher age, disturbed preoperative hemodynamic status, clinical and neurologic conditions and higher bleeding in ICU.

Disclosure of conflict of interest

None.

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