The Egyptian Journal of Hospital Medicine (July 2024) Vol. 96, Page 2330-2336

Early and Short-term Outcomes of Adopting Aortic Valve Re-Implantation Technique Addressing DeBakey Type 1 Aortic Dissection

Mohamed Abdalsalam Shaban*[1], Abdallah Nosair[1], Eman Salah Eldin Elsakaan[2], Ahmed Sultan[1], Mohamed Shehata[1], Hisham M. Elbatanony[3]

[1]Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University, Cairo, Egypt

[2]Medical colleague of General Medicine in Department of Cardiothoracic Surgery, Mansoura University Hospital, Mansoura University, Mansoura, Egypt

[3]Department of Cardiothoracic Surgery, Faculty of Medicine, Beni-Suef University, Beni-Suef, Egypt

***Corresponding author:** Mohamed Abdalsalam Shaban, **Mobile:** (+20) 01024210248, **E-mail:**dr.abdelsalamcts@gmail.com

ABSTRACT

Background: Acute aortic dissection is a critical medical condition that has a significant risk of death and morbidity. The Bentall procedure has become the accepted standard for treating aortic root pathology. The newer trend is to perform the aortic valve-sparing operations to prevent various risks related to prosthetic valves. **Objective:** This study primarily aimed at assessment of the early and short-term results of adopting aortic valve re-implantation technique (Tirone David) addressing DeBakey Type 1 aortic dissection including cardiac function assessment, major cardiac problems, clinical status, quality of life and mortality over 1-year follow-up. **Patients and Methods:** This retrospective study included 49 patients with acute aortic dissection DeBakeytype 1 associated with severe aortic incompetence (AI), intramural hematoma involving the ascending aorta and/or penetrating atherosclerotic ulcer in the ascending aorta. They were operated upon using aortic valve re-implantation technique (Tirone David). **Results:** The mean age was 54.15±13.77 years. Mortality was 0% intraoperatively, 5(10.20%) operative mortality, no late mortality and the overall 1-year survival rate was 44(89.80%). The overall hospital complications rate was13 (26.53%). At 1-year follow-up, there were statistically significant improvements in left ventricular ejection fraction per cent (LVEF%), left ventricular end-diastolic diameter (LVEDD)($p<0.001$), left ventricular end-systolic diameter (LVESD) ($p<0.001$) and AI degree. LVEF improved from 52.54±9.16% preoperatively to 55.67±8.35% ($p=0.015$). AI degree improved from severe AI in 100% of cases to no or trivial AI in 28(63.63%) patients, mild AI in 15(34.09%) patients, moderate AI in 1(2.27%) patient and no patients with severe AI ($p<0.001$). There were no complications in the form of aortic valve (AV) failure. **Conclusion:** The procedure of preservation of the patient's native aortic valve through re-implantation technique (Tirone David operation), when appropriate, is recommended as it allows better left ventricular performance and avoiding the development of valve-related complications (endocarditis, thromboembolic complications and life-long anticoagulation).

Keywords: Acute aortic dissection, Aortic valve re-implantation, Tirone David.

INTRODUCTION

Acute aortic dissection is a critical medical condition that has a significant risk of death and morbidity [(1)]. Consequently, prompt surgical intervention is required since waiting between the incidence of dissection and surgical therapy increases mortality and medical treatment results in an unacceptable high early mortality [(2)].

Acute dissection into the aortic valvular annulus resulting in severe aortic incompetence (AI), rupture of the dissection into the pericardium causing cardiac tamponade, blockage of the coronary artery ostia resulting in myocardial infarction (MI), and end-organ failure owing to aortic branch vessel obstruction are all associated with death from aortic dissection [(3)]. Despite recent advancements in surgical methods, hospital mortality is currently believed to be between 15% and 35%, with a 5-year survival rate of 65–75% [(4)].

In treating aortic root disease (dissection or aneurysm), the Bentall technique [(5)] and its variants [(6)] have been considered the gold standard. Reimplantation of the coronary buttons and replacement of the whole aortic root and valve with a composite valve graft are the procedures involved in this procedure. Aortic root replacement with valve preservation was introduced by **Yacoub and colleagues** [(7, 8)], as well as **David and colleagues** [(9)].

The trend is to perform the aortic valve-sparing operations especially in younger population to prevent them from various risks related to prosthetic valves. The goal is to eliminate the potential risk factors related to valve replacement by artificial valve prosthesis such as thromboembolic and bleeding complications associated with permanent anticoagulation therapy. There is also the risk of premature degeneration of biological valves and prosthetic endocarditis [(10)].

The disadvantages of aortic valve re-implantation operations include high technical difficulty and risk of reoperation due to repair failure. Provided that indications and technical realization are good, it is possible to maintain that the aortic valve (AV) through Tirone David operation as an excellent alternative to Bentall operation or aortic valve replacement (AVR). The increase in the number of sparing operations has an influence on indications toward the early aortic root replacement [(11)].

This study primarily aimed at assessment of the early and short-term results of adopting aortic valve re-implantation technique (Tirone David) addressing DeBakey Type 1 aortic dissection including cardiac function assessment, major cardiac problems, clinical status, quality of life and mortality over one year follow-up.

Received: 01/04/2024
Accepted: 30/05/2024

PATIENTS AND METHODS

Study Design: This retrospective study included 49 symptomatic patients with acute aortic dissection DeBakey type 1 associated with severe AI. They were operated upon using aortic valve re- implantation technique (Tirone David) and studied for aortic valve sparing. All surgeries were carried out in Egypt (conducted in the operating theatre of the Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University, and that of Beni-Suef University) using standard open-heart surgical procedures. Data of the study was collected for the operated-upon patients in the period between August 2018 and November 2023. All of the data was analysed and extensively evaluated during the preoperative, intraoperative, and one-year postoperative periods.

Inclusion Criteria: Acute DeBakey type 1 aortic dissection with severe AI, an intramural hematoma affecting the ascending aorta, and/or a penetrating atherosclerotic ulcer in the ascending aorta.

Exclusion Criteria: Patients with previous cardiac surgery, other heart diseases than DeBakey type 1 aortic dissection, chronic dissection, requirement for total aortic arch replacement, patients with aortic valvular endocarditis, patients with concomitant AV lesions like calcific aortic stenosis (AS) or rheumatic aortic disease, and patients undergoing other procedures with aortic root or aortic arch.

Management Regimen

Preoperatively: The assessed preoperative variables were: (a) History taking: demographic data as age and gender, medical history of hypertension, DM, smoking, dyslipidemia, renal disorders, previous stroke or MI, and family history of aortic dissection, (b) Clinical examination: complexion for any marfanoid features, vital signs: blood pressure and heart rate, peripheral pulsations: pulses of upper and lower limb for weak or absent radial or femoral pulse, cardiac examination for evidence of newly onset AI murmur, chest and neurological examination, (c) investigations involving (1) laboratory investigations: CBC, liver and kidney function tests, coagulation profile,(2) electrocardiogram (ECG): resting ECG for heart rate and any associated ischemia or arrhythmias, (3) radiological investigations involving chest X-ray, duplex of carotid and femoral arteries, contrast enhanced multislice (CT) of the thoracic aorta to confirm the diagnosis of aortic dissection by the presence of false lumen and true lumen and of the coronary arteries to detect any associated coronary lesions, and (4) echocardiography [transthoracic (TTE) and transesophageal (TEE)] to assess left ventricular dimensions and function: LVEDD, LVESD, LVEF%, AV morphology, degree of AI, aortic root dimensions and aortic annulus diameter.

Intraoperatively: The analysed operative variables included intraoperative mortality, aortic cross-clamping (ischemic) time, cardiopulmonary bypass (CPB) time, total circulatory arrest (TCA) time, arterial cannulation, TEE findings and inotropic support demand.

Operative Technique: To improve visibility and orientation of the aortic root, the chest was opened via a midline sternotomy, the pericardium was sliced, and the right side of the pericardium was stapled upward. To be employed during the anastomoses, thin pericardial strips were created. To ascertain the cannulation location and the degree of distal aortic replacement, the aortic arch, which includes the genesis of the major vessels, was dissected. After complete heparinization and verification of an active clotting time greater than 450 s, cannulation was carried out. The femoral or right axillary arteries were immediately anastomosed to create an 8 mm tube graft that allowed for arterial access. Direct aortic cannulation was the favoured method in an emergency. A double-staged cannula of the proper size was used to conduct venous cannulation of the right atrium. The right superior pulmonary vein was used to introduce a left ventricular vent.

For retrograde cerebral perfusion during a circulatory arrest, the superior vena cava cannula should be positioned above the azygos vein; cerebral perfusion occurs antegradely in axillary artery cannulation situations. A jugular venous pressure of 20 to 25 mm Hg should be maintained with a flow rate of around 200 to 300 ml/min during retrograde cerebral perfusion. With the use of aortic valve-sizers, the ideal aortic annular diameter was ascertained, and a graft 5 mm bigger was chosen because it would be positioned outside the aortic valve complex. Next, pledgets were positioned on the ventricular side and a series of sub-annular stitches (2/0 ethibond) were positioned horizontally mattress-style along the plane of dissection. At the aortic and LVOT intersection, the sutures then come out from outside the aorta.

The forceps' teeth had never been used on the AV leaflets when these sutures were being placed. All that was done for them was to use closed forceps. Care was taken with these sutures at the transition zone between the muscular and membranous septum in the commissure between the right coronary and noncoronary sinus so as not to injure the bundle of His. The graft made of Dacron was ready. It was sliced to a length of 5 to 6 cm, which allowed the AV to be re-suspended and made the next surgical procedures easier. After that, the sub-annular stitches were inserted through the graft while taking care to preserve the aortic root's shape.

The graft was subsequently fastened around the aortic annulus by tying the subannular sutures. After that, the three commissures were re-suspended in a horizontal mattress pattern using 4/0 polypropylene suture. The stitches leave the graft at intervals of 6-7mm. This discrepancy resulted from the neo-sinotubular junction's effective diameter being decreased and three artificial bulges that matched the

neo sinuses being created. Maintaining the relative height of re-suspension of each commissure and the spacing between each re-suspension was crucial to prevent distortion of the AV leaflet placement. This was accomplished by running the sutures transmurally through the graft while maintaining a comparable tension on each commissure and the graft. At this stage, a close-up of the re-suspended valve could be acquired. To provide an indication of the effectiveness of the reimplantation, the valve was examined and subjected to a saline test. Using 4/0 polypropylene suture material, the remains of the aortic wall from whence the cusps emanate were sutured to the graft in a continuous transmural running suture line. It was crucial to carefully position these sutures to ensure the aortic root's eventual hemostasis. After finishing this layer, the valve was tested once again using an infusion of the root in saline. Every now and again, one of the pamphlets may prolapse. This might be fixed by utilising 7/0 polypropylene sutures to decrease the afflicted leaflet's free margin's circumference.

Standard procedures were followed for the re-implantation of the left coronary button, starting with the creation of an appropriately sized hole in the graft and using 5/0 polypropylene suture material. After reimplantation, we discovered that sufficient mobilisation aids in avoiding kinking or stretching. In some cases, we re-implanted the right coronary button after the left, and in other cases, after the distal anastomosis. We occasionally employed an 8 mm Dacron tube graft in conjunction with the modified Cabrol method.

Postoperatively:
The assessed postoperative variables included hemodynamic status in the ICU, duration of mechanical ventilation, duration of inotropic support, total ICU stay, immediate postoperative mortality, morbidity and adverse complications during hospital stay, total duration of hospital stay, routine prior-to-discharge TTE, postoperative one-year morbidity, mortality, complications, complete general and cardiological assessment, and one-year follow-up TTE.

Ethical Approval: The study was conducted in the Cardiothoracic Surgery operating theater of Cairo University Hospitals and that of Beni-Suef University. It was approved by the Research Ethics Committee (REC) and its approval number was FMBSUREC/03032024/ Elbatanony. To participate in the study, each patient signed a written informed permission form. The Helsinki Declaration was observed throughout the study's duration.

Statistical Analysis

SPSS V. 21.0 was used to organize, tabulate, and statistically analyze the obtained data. Frequency and percent distributions for qualitative data were computed using the relevant (χ^2)-test or Fischer's exact test. We compared the minimum and maximum values of quantitative data, as well as the mean ± standard deviation, using the t-student test. We calculated the correlation between the parameters using the Spearman's rank correlation coefficient. p-value ≤ 0.05 was deemed significant.

RESULTS

Preoperative Data: The study involved 49 patients. Their mean age was 54.15 ± 13.77 years (range: 41-69). At presentation, all of them had severe retrosternal pain, severe AI and were admitted to the ICU on an emergency basis for emergent surgical intervention (Table 1).

Table (1): Preoperative data

Males/Females	32 (65.30%)/17 (34.69%)
Hypertensives	43 (87.75%)
Smokers	23 (46.93%)
Diabetics	22 (44.89%)
Dyslipidemics	25 (51.02%)
COPD	2 (4.08%)
Pregnancy	1 (2.04%)
Atrial fibrillation	6 (12.24%)
Family history of aortic dissection	7 (14.28%)
History of stroke	4 (8.16%)
History of chronic renal disease	2 (4.08%)
History of PVD	1 (2.04%)
Marfan syndrome	5 (10.20%)
Mean FBG level	143.15 ± 29.24 mg/dl
Mean creatinine level	1.03 ± 0.24 mg/dL
Mean Hb	11.87 ± 1.55 gm/dL
Mean INR	1.1 ± 0.26
Normal sinus rhythm	33 (67.34%)
Strain pattern	16 (32.65%)
Old MI	9 (18.36%)
BAV	8 (16.32%)
Mean aortic annulus diameter	24.37 ± 1.75 mm
Mean aortic root diameter	43.85 ± 5.11 mm
Mean LVEF%	52.54 ± 9.16
Mean LVEDD	59.45 ± 6.04 mm
Mean LVESD	47.12 ± 2.89 mm
Pericardial effusion	25 (51.02%)
SWMAs	9 (18.36%)
Mean ascending aorta diameter	57.43 ± 11.94 mm
Flap extent into ascending aorta	6 (12.24%)
Flap extent into aortic arch	2 (4.08%)
Flap extent into descending aorta	41 (83.67%)

COPD: chronic obstructive pulmonary disease; PVD: peripheral vascular disease, FBG: fasting blood glucose; Hb: hemoglobin; INR: international neutralized ratio; MI: myocardial infarction; BAV: bicuspid aortic valve; LVEF%: left ventricular ejection fraction per cent; LVEDD: left ventricular end-diastolic diameter; LVESD: left ventricular end-systolic diameter; SWMAs: segmental wall motion abnormalities.

Operative Data: No intraoperative mortality was encountered. The intimal tear site was found in the ascending aorta in 41 (83.67%) patients and in the aortic arch in the rest 8 (16.32%) patients. In all patients, the ascending aorta was replaced by a synthetic graft. Its average diameter was 29.23 ± 1.64 mm. For 41(83.67%) patients, graft replacement was limited to the ascending aorta till the innominate artery and for the rest 8 (16.32%) patients, the hemiarch was replaced (Table 2).

Table (2): Operative Data.

Mean total operative time	425.86 ± 96.30 min.
Mean aortic cross clamping time	156.34 ± 30.22 min.
Mean CPB time	235.31 ± 31.11 min.
Mean TCA time	29.45 ± 8.30 min.
Femoral arterial cannulation	34 (69.38%)
Axillary arterial cannulation	7 (14.28%)
Common carotid arterial cannulation	5 (10.20%)
Combined arterial cannulation	3 (6.12%)

CPB: cardiopulmonary bypass; TCA: total circulatory arrest.

All patients were admitted to surgery with TTE that documented severe AI. However, intraoperative TEE was fundamentally and essentially applied in all cases before initiating CPB and after weaning off it for the meticulous assessment of the AI (Table 3).

Table (3): Intraoperative TEE

AI	Before CPB	After CPB	P value
No-trivial	0	37 (75.51%)	**<0.001**
Mild	0	12 (24.49%)	**<0.001**
Moderate	4 (8.16%)	0	**<0.001**
Moderate-to-severe	11 (22.45%)	0	**<0.001**
Severe	34 (69.39%)	0	**<0.001**

AI: aortic incompetence; CPB: cardiopulmonary bypass.

Postoperative Data:

Operative mortality was 5 (10.20%), which all occurred during the postoperative ICU period. The remaining 44 (89.80%) survivors were discharged to the ward after stabilization of their hemodynamics and cessation of inotropic supports. Postoperative TTE prior to hospital discharge revealed mean LVEF% of 50.54 ± 3.23 (p= 0.169), 30 (68.18%) patients without residual AI (p <0.001), 4(9.09%) patients with residual trivial AI (p <0.001), 10 (22.72%) patients with residual mild AI (p <0.001), and non with residual more grades of AI (Table 4).

Table (4): Postoperative data

Mean duration of mechanical ventilation	49.15 ± 24.78 hours
Mean duration of inotropic support	55.63 ± 18.55 hours
Mean total blood loss within 48 hours	980.30 ± 355.50 cc
Mean total duration of ICU stay	115.55 ± 42.35 hours
CVAs	5 (10.20%)
Bleeding complications (Re-exploration)	3 (6.12%)
ARF	7 (14.28%)
Complete heart block	1 (2.04%)
Arrhythmias	11 (22.44%)
Prolonged ventilation >48 hours	5 (10.20%)
Superficial wound infections	8 (16.32%)
Deep wound infections	2 (4.08%)
Pericardial effusion	5 (10.20%)
Sternal dehiscence	2 (4.08%)
The overall hospital complication rate	13 (26.53%)
Mean total duration of hospital stay	13.57 ± 1.31 days

ICU: intensive care unit; CVAs: cerebrovascular accidents; ARF: acute renal failure.

The whole duration of the study was 5.25 years. The mean time of returning to routine work was 63.56 ± 10.09 days. The mean time of the one-year follow-up clinical assessment and TTE was 367.11 ± 11.25 days. No late mortality, major cardiac problems or cerebrovascular adverse events happened during the follow-up period. There were statistically significant improvements in LVEF%, LVEDD, LVESD and AI degree (Table 5). The overall one-year survival rate was 44 (89.80%).

Table (5): One-year follow-up LVEF%, LVEDD, LVESD and AI degree. Categorical variables are expressed as numbers and percentages and continuous variables as mean and SD

Variable	Preoperative	One-year Postoperative	P value
LVEF%	52.54 ± 9.16	55.67 ± 8.35	**0.015**
LVEDD	59.45 ± 6.04 mm	55.10 ± 3.11 mm	**<0.001**
LVESD	47.12±2.89 mm	42.67±1.85 mm	**<0.001**
AI degree			
No-trivial	0	28 (63.63%)	**<0.001**
Mild	0	15 (34.09%)	**<0.001**
Moderate	0	1 (2.27%)	**<0.001**
Severe	49 (100%)	0	**<0.001**

LVEF: left ventricular ejection fraction per cent; LVEDD: left ventricular end-diastolic diameter; LVESD: left ventricular end-systolic diameter; AI: aortic incompetence.

DISCUSSION

The main aim of surgery in acute aortic dissection DeBakey type 1 is to save the patient's life by replacing the ascending aorta to prevent its rupture and correcting the AI to direct the blood stream into the true aortic lumen thus preventing systemic malperfusion [12]. Many surgical approaches have been developed over the past 50 years, starting with case reports, to treat patients with DeBakey type 1 aortic dissection that is linked with substantial AI [5].

Our study population- with a relatively acceptable sized sample- represented a homogenous illustrative sector of those patients carrying the pathology of acute DeBakey type 1 aortic dissection with significant AI and associated with multiple comorbidities and risk factors. Our cohort's preoperative profile characteristics showed comparable results to other reported cohorts. **Kallenbach *et al.*** [13] reported on 22 patients. **Rylski *et al.*** [14] reported on 86 older patients and demonstrated higher rates of morbidity and mortality reaching 35.5% in those > 80 years. They also stated that the gender-related alterations in aortic geometry offer an explanation for the preponderance of aortic dissection in young male patients. However, when age increases above 70 years old, the ratio returns to normal between the sexes. The mean age of our study group is higher than what **Lee *et al.*** [15] reported (mean age: 37 ± 11 years) and nearly is equal to what **Subramanian *et al.*** [16] reported (mean age: 53 ± 15 years). Patients with Marfan syndrome are less than what **Lamana *et al.*** [17] and **Subramanian *et al.*** [16] reported [31 (17.3%) and 11 (7%) respectively] and more than what **Beckmann *et al.*** [18] and **Forteza *et al.*** [19] reported [1 (1.1%) and 4 (4%) respectively). Patients with BAV in our study are more percentagely represented than what **Subramanian *et al.*** [16] and **Lamana *et al.*** [17] reported [23 (14.6%) and 39 (12%) respectively].

In our study, only patients with severe AI were included and patients with acute DeBakey type 1 aortic dissection linked to no mild or moderate AI were excluded. **Skripochnik *et al.*** [20] in their study had 12 (17.1%) patients with moderate AI and 17 (24.3%) patients with severe AI while **Lamana *et al.*** [17] had 61 (34.5%) with moderate AI. LVEF% in our study group was comparable to other studies. **Kerendi *et al.*** [21] reported on patients with mean LVEF% of 53.6 ± 14.

While aortic annulus diameter measurement for our study group is more than reported by **Roshdy *et al.*** [22], which was 23.31 ± 1.78 mm, aortic root diameter measurement is less than what **Lamana *et al.*** [17] reported, which was 44.5 ± 9.3 mm. Debakey classification classified the patients of our study into type I: 47 (95.91%) and type II: 6 (12.24%), a proportion of patients that is similarly reported by others [14-18].

In our study, CPB was 235.31 ± 31.11 min, which is nearly equal to that reported by **Beckmann *et al.*** [18] [231 ± 63 min.] and longer than that reported by **Lamana *et al.*** [17] [158 ± 31 min.] and **Kallenbach *et al.*** [13] [212 ± 56 min.]. Our mean total operative time was 425.86 ± 96.30 min, which is longer than that reported by **Lamana *et al.*** [17] [292 ± 130 min.] and **Subramanian *et al.*** [16] [328 ± 104 min.].

Our mean aortic cross clamping time was 156.34 ± 30.22 min, which is nearly equal to that reported by **Kallenbach *et al.*** [13] [157 ± 24 min.] and longer than that reported by **Leyh *et al.*** [23] [143 ± 18 min.]. Our mean TCA time was 29.45±8.30 min which is nearly equal to that reported by **Leyh *et al.*** [23] [29 ± 9 min.] and shorter than that reported by **Kallenbach *et al.*** [13] [35 ± 18 min.] and **Rios *et al.*** [24] [35 ± 11 min.].

Regarding the arterial cannulation in our study, there were 34 (69.38%) patients with femoral cannulation, 7 (14.28%) patients with axillary cannulation, 5 (10.20%) patients with common carotid cannulation and 3 (6.12%) patients with combined cannulation. A study done by **Forteza *et al.*** [19] reported that arterial cannulation was through femoral artery (76%), axillary artery (20%) and aortic arch (4%).

In our study, the percentage of femoral artery cannulation was much higher than axillary artery cannulation, which could be explained by the high experience in femoral cannulation and the more difficult and time-consuming procedure during exposure of axillary artery, so axillary cannulation was done in cases of femoral artery dissection or small caliber to avoid malperfusion. Also, common carotid cannulation is a safe and rapid method. The modified Cabrol technique for coronary re-implantation was used in 11 (22.44%) patients of our study population, which is equal to the percentage reported by **Roshdy *et al.*** [22] in which it was used in 11 (22%) patients and equal to double the percentage reported by **Lamana *et al.*** [17] which was 11.7%.

Intraoperatively, the intimal tear site was found in the ascending aorta in 41 (83.67%) patients and in the aortic arch in the rest 8 (16.32%) patients. However, **Kallenbach *et al.*** [13] reported finding of the dissection flap in the ascending aorta in 3/22(13.64%) patients or in both the ascending aorta and the aortic arch in the remaining 19/22(86.36%) patients. In all patients, the ascending aorta was replaced by a synthetic graft. Its average diameter was 29.23 ± 1.64 mm for 41 (83.67%) patients. Graft replacement was limited to the ascending aorta till the innominate artery and for the rest 8 (16.32%) patients, the hemiarch was replaced. However, the outcome wasn't markedly different in relation to the intimal tear. **Rios *et al.*** [24] reported that replacement of the ascending aorta was the most frequently performed procedure in 78.2% of cases and the difference in the outcome was insignificantly remarkable among different types of operations.

In our study, TEE pre-CPB downgraded the preoperative TTE 100% severe AI to 4 (8.16%) moderate AI, 11 (22.45%) moderate-to-severe AI and 34 (69.39%) severe AI. TEE post-CPB downgraded

the AI into 37 (75.51%) no-trivial AI and the rest 12 (24.49%) mild AI ($p<0.001$). This confirmed the importance of application of TEE intraoperatively.

In our study, the mean mechanical ventilation time was 49.15 ± 24.78 hours and the mean total ICU stay was 115.55 ± 42.35 hours. **Kallenbach *et al.*** [13] reported shorter both mean mechanical ventilation time of 20 ± 80 hours and mean total ICU stay of 50 ± 16 hours. **Rios *et al.*** [24] reported longer durations of mean mechanical ventilation time of 59.6 ± 2.17 hours and mean total ICU stay of 151.2 ± 290.4 hours.

The mean total duration of hospital stay in our study was 13.57 ± 1.31 days, which is longer than that reported by **Skripochnik *et al.*** [20] [10.0 ± 8.10 days] and shorter than that reported by **Kallenbach *et al.*** [13] [21 ± 14.4 days] and **Rios *et al.*** [24] [13.2 ± 13.7 days].

All the reoperations were due to re-exploration for bleeding and nothing related to valve failure. Patients re-opened for bleeding were 3(6.12%). Patients who had new neurological complications were 5 (10.20%), renal impairment were 7 (14.28%), respiratory insufficiency were 5 (10.20%), superficial sternotomy wound infection were 8 (16.32%), deep sternotomy wound infection and sternal dehiscence were 2 (4.08%), arrhythmias (supraventricular tachycardia "SVT" or AF) were 11 (22.44%), 1 (2.04%) patient with complete heart block and 5 (10.20%) patients with pericardial effusion. Research conducted by **Kerendi *et al.*** [21] reported that patients who needed re-exploration for bleeding were 6 (15%), while patients who had renal failure were 7 (17.5%), pneumonia were 9 (22.5%) and one patient with stroke (2.5%). In our study, the postoperative bleeding (within 48 hours) was less than what others reported about other operations like Bentall operation [13,14,20,21,24]. This could explain the role of Tirone David technique to provide better haemostatic quality in cases of aortic dissection where the coagulopathy is frequently present after CPB weaning.

In our study, the operative mortality was 5 (10.20%), which all occurred during the postoperative ICU period. We had no intraoperative mortality. According to the recent registry, operative mortality is 10–20% [25, 26]. However, some investigators claim higher rates of 19-32% [2, 27]. **Rios *et al.*** [24] reported 11 (17.5%) intraoperative mortality. **Ikeno *et al.*** [28] reported 37 (13.86%) operative mortality.

However, **Rios *et al.*** [24] reported higher rates of operative mortality of 18 (20.7%) as well as **Rylski *et al.*** [14] who reported higher rates of morbidity and mortality reaching 35.5% in patients > 80 years. Our postoperative mortalities were 2 (4.08%) patients due to myocardial failure, 1 (2.04%) patient due to multiorgan failure, 1 (2.04%) patient due to renal failure and 1 (2.04%) patient due to respiratory tract infection (pneumonia). **Beckmann *et al.*** [18] reported 14 (15.9%) 30-day mortality rate. These deaths were caused by mesenterial ischemia in one patient, stroke in two patients, cerebral haemorrhage in two patients, sepsis in four patients, cardiac failure in three patients, and multiorgan failure in two patients. **Roshdy *et al.*** [22] reported 8 (12%) hospital mortality rate. One patient passed away from extensive bleeding after surgery, while another patient died from poor cardiac output and failed to wean off the bypass. Three patients passed away in the intensive care unit after surgery; two of them had multiorgan failure and one had respiratory failure. The whole duration of the study was 5.25 years. We had no late mortality and major cardiac problems or cerebrovascular adverse events during the one-year follow-up period in our study that lasted for 5.25 years and the overall one-year survival rate was 44 (89.80%). **Ikeno *et al.*** [28] reported 3.5% late mortality in the first year and overall, 17.98% of their follow-up that lasted for 6.5 ± 4.6 years. **Gariboldi *et al.*** [29] reported overall one-year survival 96% in their study that lasted for 4.45 years. There were statistically significant improvements in LVEF%, LVEDD ($p<0.001$), LVESD ($p<0.001$) and AI degree. LVEF% improved from 52.54 ± 9.16 preoperatively to 55.67 ± 8.35 ($p=0.015$), which is very close to what **Lamana *et al.*** [17] reported [60±7]. AI degree improved from severe AI in 100% of cases to no or trivial AI in 28 (63.63%) patients, mild AI in 15 (34.09%) patients, moderate AI in 1 (2.27%) patient and no patients with severe AI ($p<0.001$). Moreover, there were no complications in the form of AV failure. **David *et al.*** [30] reported moderate AI in 9 (3.1%) patients and severe AI in 2 (0.7%) patients. **Roshdy *et al.*** [22] reported freedom from AI in 82% of their 50-patients cohort and **Beckmann *et al.*** [18] reported no AI in 28 (73.7%) patients, mild AI in 8 (21%) patients and moderate AI in 2 (5.3%) patients and none with severe AI.

Our evolving results of the AV sparing (Tirone David) operation were comparable with the results published and reported in the literatures. In spite of the fact that - due to higher technical difficulty-, the mean total operative time, the mean duration of the extracorporeal circulation (CPB time) and the mean cardiac arrest period (aortic cross clamping time) were relatively long, we demonstrated lower incidence of complications or AV failure in the follow-up period.

STUDY LIMITATIONS

There are several limitations on our study. It's a retrospective one. The cohort was relatively small; yet acceptable when compared to other prior published smaller cohorts. The follow-up duration wasn't long enough.

CONCLUSION

The procedure of preservation of the patient's native aortic valve through re-implantation technique (Tirone David operation), when appropriate, is recommended as it allows better left ventricular performance and avoiding the development of valve-related complications (endocarditis, thromboembolic complications and life-long anticoagulation).

- **Conflict of interest:** None.
- **Funding:** Self-funded.

REFERENCES

1. **Jonker F, Schlosser F, Indes J *et al.* (2010):** Management of Type A Aortic Dissections: A Meta-Analysis of the Literature. Ann Thorac Surg., 89: 2061-2066.
2. **Mehta R, O'Gara P, Bossone E *et al.* (2002):** International Registry of Acute Aortic Dissection (I RAD) Investigators. Acute type A aortic dissection in the elderly: clinical characteristics, management, and outcomes in the current era. J Am Coll Cardiol., 40: 685–692.
3. **Cambria R (2002):** Surgical treatment of complicated distal aortic dissection. SeminVasc Surg., 15: 97-107.
4. **Halstead J, Meier M, Etz C *et al.* (2007):** The fate of the distal aorta after repair of acute type Aaortic dissection. J Thorac Cardiovasc Surg., 133: 127–135.
5. **Bentall H, Debono A (1968):** A technique for complete replacement of the ascending aorta. Thorax, 23: 338-9.
6. **Piehler J, Pluth J (1982):** Replacement of the ascending aorta and aortic valve with a composite graft in patients with non-displaced coronary ostia. Ann Thorac Surg., 33: 406-9.
7. **Yacoub M, Fagan A, Stassano P *et al.* (1983):** Results of valve conserving operations for aortic regurgitation. Circulation, 68: 321-24.
8. **Sarsam M, Yacoub M (1993):** Remodeling of the aortic valve annulus. J Thorac Cardiovasc Surg., 105: 435-438.
9. **David T, Feindel C (1992):** An aortic valve-sparing operation for patientswith aortic incompetence and aneurysm of the ascending aorta. J Thorac Cardiovasc Surg., 103: 617–622.
10. **Hammermeister K, Sethi G, Henderson W *et al.* (2000):** Outcomes 15 years after valve replacement with a mechanical versus a bioprosthetic valve: final report of the Veterans Affairs randomized trial. J Amer Coll Cardiol., 36: 1152–8.
11. **Aicher D, Langer F, Lausberg H *et al.* (20007):** Aortic root remodeling: ten-year experience with 274 patients. J Thoracic Cardiovasc Surg., 134: 909–15.
12. **Erbel R, Aboyans V, Boileau C *et al.* (2014):** 2014 ESC Guidelines on the diagnosis and treatment of aortic diseases: Document covering acute and chronic aortic diseases of the thoracic and abdominal aorta of the adult. The Task Force for the Diagnosis and Treatment of Aortic Diseases of the European Society of Cardiology (ESC). Eur Heart J., 35: 2873–926.
13. **Kallenbach K, Hagl C, Walles T *et al.* (2001):** Results of valve-sparing aortic root reconstruction. Ann Thorac Surg., 74: 2026-2033.
14. **Rylski B, Hahna N, Beyersdorfa F *et al.* (2017):** Fate of the dissected aortic arch after ascending replacement in type A aortic dissection. European Journal of Cardio-Thoracic Surgery, 51: 1127–1134.
15. **Lee H, Cho Y, Sung K *et al.* (2015):** Clinical outcomes of valve-sparing root replacement in acute type A aortic dissection. Scand Cardiovasc J., 49: 331-36.
16. **Subramanian S, Leontyev S, Borger M *et al.* (2012):** Valve-sparing root reconstruction does not compromise survival in acute type A aortic dissection. Ann Thorac Surg., 94: 1230-4.
17. **Lamana F, Dias R, Duncan J *et al.* (2015):** Surgery of the aortic root: should we go for the valve-sparing root reconstruction or the composite graft-valve replacement is still the first choice of treatment for these patients? Rev Bras Cir Cardiovasc., 30: 343-52.
18. **Beckmann E, Martens A, Alhadi F *et al.* (2016):** Is Bentall Procedure Still the Gold Standard for Acute Aortic Dissection with Aortic Root Involvement? Thorac Cardiovasc Surg., 64: 116-23.
19. **Forteza A, Martín C, Centeno J *et al.* (2009):** Acute type A aortic dissection: 18 years ofexperience in one center (Hospital 12 de Octubre). Interact Cardiovasc Thorac Surg., 9 (3): 426-30.
20. **Skripochnik E, Michler R, Hentschel V *et al.* (2013):** Repair of aortic root in patients with aneurysm or dissection: comparing the outcomes of valve-sparing root replacement with those from the Bentall procedure. Rev Bras Cir Cardiovasc., 28: 435-41.
21. **Kerendi F, Guyton R, Vega J *et al.* (2010):** Early results of valve-sparing aortic root replacement in high-risk clinical scenarios. Ann Thorac Surg., 89 (2): 471-6.
22. **Roshdy A, Farouk A (2014):** Re-Implantation aortic valve sparing in the setting of acute ascending aortic dissection. Journal of the Egyptian Society of Cardio-Thoracic Surgery, 22: 7-10.
23. **Leyh R, Schmidke C, Barlets C *et al.* (2000):** Valve-sparing aortic root replacement (remodeling/ reimplantation) in acute type A dissection. Ann Thorac Surg., 70: 21-24.
24. **Rios F, Perez D, Soca G *et al.* (2020):** Predictive factors of mortality in acute aortic dissection and validity of the EuroSCORE algorithm in a small-sized cardiac surgery institution. Braz J Cardiovasc Surg., 35 (6): 878-883.
25. **Easo J, Weigang E, Holzl P *et al.* (2012):** Influence of operative strategy for the aortic arch in DeBakey type I aortic dissection: analysis of the German Registry for Acute Aortic Dissection Type A. J Thorac Cardiovasc Surg., 144: 617–23.
26. **Okita Y (2015):** Surgery for thoracic aortic disease in Japan: evolving strategies toward the growing enemies. Gen Thorac Cardiovasc Surg., 63: 185–96.
27. **Olsson C, Hillebrant C, Lisa J *et al.* (2011):** Mortality in acute type A aortic dissection: validation of the Penn classification. Ann Thorac Surg., 92 (4): 1376-1382.
28. **Ikeno Y, Yokawa K, Koda Y *et al.* (2018):** The fate of the downstream aorta after open aortic repair for acute DeBakey type I aortic dissection: total arch replacement with elephant trunk technique versus non-total arch replacement. European Journal of Cardio-Thoracic Surgery, 55: 966–974.
29. **Gariboldi V, Grisoli D, Kerbaul F *et al.* (2007):** Long-term outcomes after repaired acute type A aortic dissections. Interact Cardiovasc Thorac Surg., 6 (1): 47-51.
30. **David T, Armstrong S, Manlhiot C *et al.* (2013):** Long-term results of aortic root repair using the reimplantation technique. J Thorac Cardiovasc Surg., 145 (3): 22-25.