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Original article

# Evaluation of aortic valve in valve sparing root replacement: Reimplantation versus noncoronary sinus replacement

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## Abstract

*Background:* Valve sparing aortic root replacement (VSRR) had been popularized in the last decades because preservation of the native valve allows for better hemodynamics, better left ventricular performance, lesser risk of endocarditis and avoidance of lifelong anticoagulation. Two basic types of VSRR techniques are used: reimplantation of the aortic valve (Tirone David) and remodeling of the aortic root(Yacoub). We compared the David reimplantation technique versus one or two sinus replacement in repair of aortic root aneurysm or dissection associated with aortic regurge.

*Patients & Methods:* Fifty patients were divided into two groups: Group I (25 patients) undergone David reimplantation technique, Group II (25 patients) undergone supracoronary with one or two sinus replacement.

*Results:* There were two deaths (8%) within 30 days in each group. Postoperative significant regurge in Group I occurred in 1 case (4.3%) and in 2 cases (8.6%) in Group II with no significant difference. Cross clamp time was significantly shorter in Group II; 137 ± 37.0 min versus 177 ± 33.0 min in Group I. Significant bleeding occurred in 7 cases (28%) in Group I which was significantly higher than Group II; 1 case (4%).

*Conclusion:* Replacement of one or two sinuses is not inferior to reimplantation technique regarding early survival and correction of aortic regurge. Noncoronary sinus replacement provided better results than reimplantation technique regarding postoperative bleeding and cross clamp time.



*Keywords:* Aorta; Aortic regurge; Valve sparing root replacement; David reimplantation

## 1. Introduction

Cystic medial necrosis (degenerative etiology) is the most common etiology of ascending thoracic aortic aneurysm disease. Smoking has been associated with increased concentrations of elastolytic enzymes [1].

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Genetic causes for aneurysm/dissection include Marfan syndrome, Ehlers-Danlos syndrome and Non-syndromic familial thoracic aortic aneurysms and dissection (nsTAAD) [2].

Bicuspid aortic valve (BAV) is the most common congenital cardiac defect, with prevalence at birth of 1–2%. Males are more often affected than females. In addition to early onset aortic root dilation, BAV is an independent risk factor for dissection and rupture [3].

Multislice Contrast-enhanced computed tomography (MSCT) is a gold standard in diagnosis due to short acquisition time, 3D reconstruction, and its widespread availability. In addition, it extends the scan field-of-view to the upper thoracic branches and the iliac and femoral arteries so assisting in planning surgical or endovascular repair procedures [4].

Transthoracic (TTE) and transesophageal (TEE) echocardiography should be used in a complementary manner. Important data can be obtained by TTE; the TEE exam may be focused only to confirm and assess the extent of dissection along with the morphological features of dissection that impact management [5].

### *1.1. Surgical management*

To manage aortic regurge together with aortic root replacement; two main groups of surgical strategies can be used: valve replacement (modified Bentall) and valve sparing which includes reimplantation technique and remodeling technique with its modifications.

Modified Bentall procedure: Composite graft and mechanical valve replacement of the aortic root and ascending aorta with coronary reimplantation which became the gold standard for treatment of aortic aneurysm and aortic dissection.

Cabrol and colleagues used an 8- to 10-mm Dacron graft anastmosed to coronary ostia during root replacement which is useful in redo cases and hugely dilated root [6].

Aortic reimplantation technique: Tirone David-I (TD I): Reimplantation of the aortic valve within a Dacron tube graft [6].

Yacoub aortic root remodeling technique: Utilizing a tripartite crown-shaped Dacron tube graft. It required coronary reimplantation but did not provide stabilization of the aortic base or specific narrowing of the sino-tubular junction [7].

Another technique was described in Japan in 2008 and published as 'Modified partial aortic root remodeling in acute type A aortic dissection' in which the sinus is left (if one or two Valsalva sinuses are affected) but a U-shaped Dacron patch sutured to the inside of the sinus to reinforce the dissected weakened wall. They proposed its usefulness regarding bleeding, and shorter clamp time [8].

### *1.2. Results of surgical repair*

For valve sparing procedures, over two-thirds of patients remain free of re-development of significant aortic regurge at 8–10 years following surgery [9]. However, the opening and closing behavior of the aortic valve preserved with the remodeling procedure appeared to be more physiologic when compared with the reimplantation technique [9].

Perioperative mortality has varied between 0 and 6% with a 7-year survival of 72–78 ± 8%, these results are comparable to composite valve-graft techniques, in which the operative mortality approximates 3.3–4% [10].

## 2. Aim of the work

This study was carried out to compare the results of David reimplantation technique versus noncoronary sinus replacement in repair of aortic root aneurysm/dissection associated with aortic regurge.

## 3. Patients

The study was a prospective study done in Cardiothoracic Surgery Departments of Cairo University Hospital and Alexandria Main University Hospital in the period from March 2012 till July 2015. Fifty patients having aortic root aneurysm/dissection and significant aortic regurge were divided into two groups:

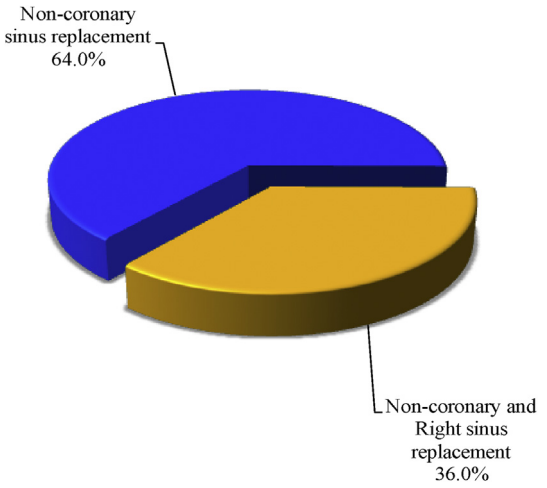


Fig. 1. Distribution of cases in group II.

Group I: Twenty-five patients undergone David reimplantation technique.

Group II: Twenty-five patients undergone noncoronary sinus replacement with (9 cases) or without (16 cases) right sinus replacement (Fig. 1).

### *3.1. Exclusion criteria*

- Patients with organic valvular affection (rheumatic or active endocarditis).
- Patients with previous open heart surgeries (redo patients).
- Patients with recent preoperative myocardial infarction or cardiomyopathy.
- Patients with recent stroke or neurological deficit.
- Marfan syndrome and collagenic diseases.

## 4. Methods

Group I: Tirone david reimpantation: The sinuses were excised leaving coronary buttons. Mattres sutures were placed in horizontal subannular plane and fixed to tube graft that was 3 mm larger than the annulus. Commissures were suspended to the graft. Finally, left then right coronary buttons were attached to the tube graft (Fig. 2).

Group II: In cases of aneurysm, a tongue of the Dacron graft was usually created for replacing the sinus, while in cases of acute dissection, the sinus was left intact and a U-shaped Dacron patch was fixed to the outer surface by interrupted pledgeted prolene 4/0 sutures (Figs. 3 and 4).

## 5. Results

### *5.1. Preoperative data*

#### *5.1.1. Demographic data*

In group I, the average age was 55.08 ± 8.88 years, and in group II was 52.28 ± 12.22 years; the difference was statistically insignificant. There was predominance of males representing 92.0% of each group.

#### *5.1.2. Pathology*

In group I the pathology was aneurysm in 60% of the cases and dissection 40% while in group II aneurysm represented 48% and dissection 52%. There was no significant statistical difference between the groups ($P = 0.001$).

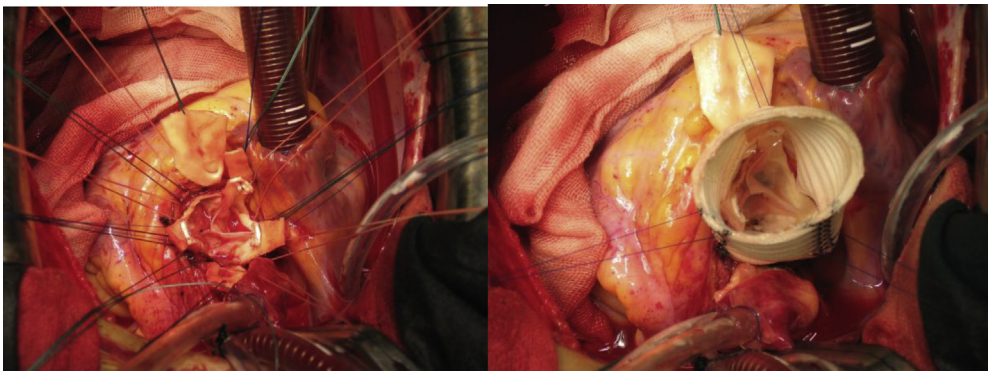

Fig. 2. Tirone David reimplantation technique.

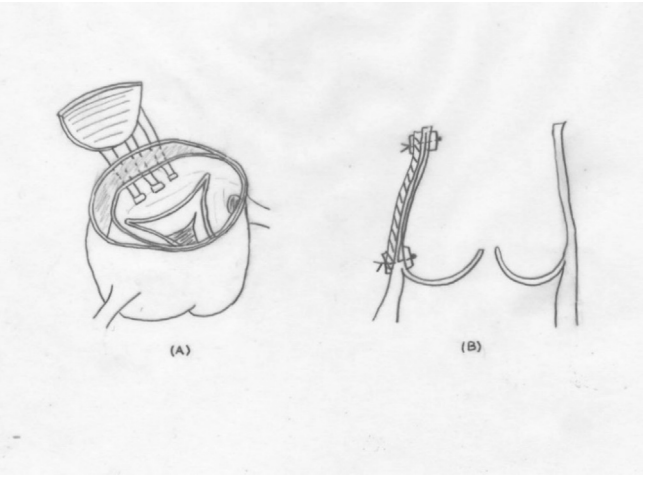


Fig. 3. Non-coronary sinus replacement in acute dissection. U-shaped Dacron patch is fixed to the outer surface by interrupted pledgeted prolene 4/0 sutures.

Fig. 4. Ascending and non-coronary sinus replacement in acute dissection case.

Table 1
Comparison between the two groups according to degree of AR.

| Degree of AR | Group I | | Group II | | $\chi^2$ | $^{MC}p$ |
|---|---|---|---|---|---|---|
| | No. | % | No. | % | | |
| **Preoperative** | | | | | | |
| No | 0 | 0.0 | 0 | 0.0 | 5.710 | 0.068 |
| Trivial | 0 | 0.0 | 0 | 0.0 | | |
| Mild | 0 | 0.0 | 5 | 20.0 | | |
| Moderate | 13 | 52.0 | 12 | 48.0 | | |
| Severe | 12 | 48.0 | 8 | 32.0 | | |
| **Postoperative** | | | | | | |
| No | 10 | 43.5 | 14 | 60.9 | 3.018 | 0.455 |
| Trivial | 8 | 34.8 | 6 | 26.2 | | |
| Mild | 4 | 17.4 | 1 | 4.3 | | |
| Moderate | 1 | 4.3 | 2 | 8.6 | | |
| Severe | 0 | 0.0 | 0 | 0.0 | | |

$\chi^2$: Chi square test.
MC: Monte Carlo for Chi square test.

#### *5.1.3. Degree of aortic regurgitation (AR)*

Group I: Preoperatively there was moderate -severe AR in 100% of cases and no - trivial AR in 80% postoperative which was statistically significant. In Group II: Preoperatively there was moderate - severe AR in 80% of cases and no - trivial in 88% postoperative which was statistically significant (Table 1).

### *5.2. Operative data*

#### *5.2.1. Cross clamp time*

In group I: the average was 177.0 ± 33.0 min, while in group II the average cross clamp time was 137.0 ± 37.0 min. There was significant statistical difference between the groups.

#### *5.2.2. Mode of arterial cannulation*

In both groups the main route was femoral artery followed by direct aortic then axillary artery cannulation Fig. 5.

#### *5.2.3. Significant bleeding (resternotomy or left open)*

In group I: it occurred in 28% of cases, while in group II in 4% of cases. There was significant statistical difference between the groups (P = 0.049).

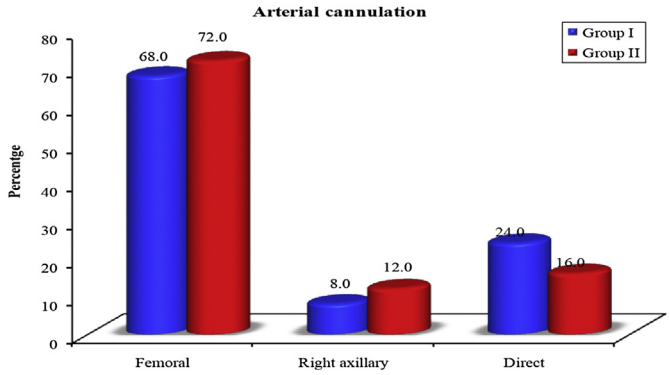


Fig. 5. Comparison between the two studied groups according to arterial cannulation.

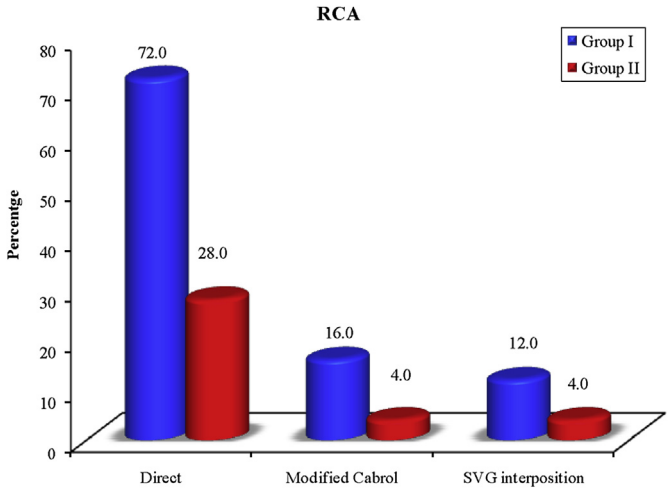


Fig. 6. Comparison between the two studied groups according to Rt coronary artery (RCA).

*5.2.4. Reimplantation of RCA*

Direct reimplantation was the main technique used followed by Cabrol technique then saphenous vein graft (SVG) interposition Fig. 6.

*5.3. Postoperative data*

*5.3.1. 30-day mortality*

In group I there were two mortalities (8%), and also in group II there were two mortalities (8%). There was no significant difference.

*5.3.2. Echo data*

In group I The LVESD decreased from 4.32 ± 0.05 preoperatively to 3.7 ± 0.4 postoperatively and EF improved from 59.0 ± 0.5 to 59.0 ± 0.5, both of them were significant.

LVEDD decreased from 6.3 ± 0.07 preoperatively to 6.1 ± 0.5 postoperatively which was not statistically significant.

In group II The LVESD decreased from 4.4 ± 0.5 preoperatively to 3.9 ± 0.6 postoperatively and EF improved from 60.0 ± 0.9 to 62.0 ± 0.7, both of them were significant.

LVEDD decreased from 5.9 ± 1.2 preoperatively to 5.7 ± 0.5 postoperatively which was not statistically significant.

For the degree of postoperative aortic regurge please refer to 5.1.3.

## 6. Discussion

In the study of Paul Urbanski et al., they included 206 patients (87.3%) with chronic aneurysm and 30(12.7%) with acute aortic dissection. Nine patients had Marfan disease and 37 had BAVs [11].

In his 25-year experience with valve sparing root replacement, Tirone E. David included 371 patients 47% had moderate or severe AR, 35.5% had Marfan syndrome, 12.1% had type A aortic dissection, 9.2% had BAV, 8.4% had mitral regurge, 16.1% had aortic arch aneurysm, and 10.2% had coronary artery disease [13].

Only two cases of BAV were encountered in this study (in Group I) and was not considered contraindication for valve sparing root replacement. This was consistent with P. Urbanski, Tirone E. David and in the study of Badiu et al. (2010) [12]. In the later study, 102 patients underwent aortic valve-sparing procedures for ascending aortic aneurysm or dissection and were assigned to three different groups according to the aortic valve pathology: BAV (n = 11), tricuspid aortic valve (TAV) with AR less than severe (n = 51), and TAV with severe AR (n = 40). They concluded that

there was no significant difference in terms of re-operation or survival between patients, who presented with BAV or TAV [12].

Tirone David study concluded freedom from significant AR (moderate or severe) of 99.7 ± 0.3 at 1 year and 78.0 ± 4.8 at 18years follow up [13]. They showed that uncorrected cusp prolapse had probably been the most common cause of early valve failure and stressed on the importance of cusps' coaptation height and coaptation length and similar results were obtained by Kunihara and colleagues [14]. In Urbanski study, the actuarial freedom from AR grade 3 or more at 8 years was 95.2% [15].

In Tirone David study, the cross clamp time was 117 ± 27 min lower than our study (group I) mostly because the percentage of aortic dissection cases was less than our study (9.5% vs 40% respectively), and the concomitant cases (mitral surgery, CABG, etc.) only represented 17.5% of the cases [13]. In Paul Urbanski et al. study, cross clamp time was 107 ± 30 min which was also less than our results; the dissection cases represented only 12.7% of the cases [11]. However, in their study on dissection cases the cross clamp time was longer; 120 ± 36 (with a range of 48–214) minutes [15].

Regarding significant bleeding, in Tirone David study Thirty-four patients (9.1%) required reopening of the chest for bleeding and/or pericardial tamponade [13]. In Paul Urbanski study, rethoracotomy for bleeding was necessary in 13 (6%) patients in the entire population and in 7 (23%) patients of the acute dissection subgroup.

Regarding Mortality, in group I there was two (8%) mortalities; one patient developed cerebrovascular stroke 24 h postoperatively and died due to complications of pneumonia, the other one died from visceral ischemia (severe bleeding per rectum). While in group II; two mortalities occurred (8%) due to myocardial infarction and cardiogenic shock on postoperative day 5 in one patient and the other developed multiorgan failure mostly attributed to septicaemia. The mortality rate is comparable to that in other studies [10].

## 7. Conclusion

Replacement of one or two sinuses of Valsalva, when properly selected, is effective as a valve sparing root replacement technique and can correct aortic regurge even of severe degrees. Replacement of one or two sinuses is not inferior to reimplantation technique regarding survival. Noncoronary sinus replacement provided better results than reimplantation technique regarding postoperative bleeding and cross clamp time.

## Conflict of interest

No conflict of interest.

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