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REVIEW ARTICLES

Surgical Approaches for Aortic Root Aneurysm: A Comparative Analysis of the David and Yacoub Techniques

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Abstract

Introduction: This paper compares the David and Yacoub procedures for valve-sparing aortic root replacement, two leading techniques for treating aortic root aneurysms while preserving the native aortic valve. Both methods aim to avoid prosthetic valve replacement and the need for lifelong anticoagulation.

Material and Methods: We reviewed the technical nuances, clinical outcomes, and long-term durability of each technique, incorporating findings from recent and historical studies. Also, we'd like to present two case reports from our clinic showing the application of the David procedure.

Results: The David procedure involves complete excision of the aortic root and reimplantation of the native aortic valve within a Dacron graft. It offers superior long-term durability and lower reoperation rates, particularly in younger patients and those with connective tissue disorders. In contrast, the Yacoub procedure entails partial root resection and remodeling with preservation of the sinuses of Valsalva, making it a viable option for older patients or those with isolated root dilation.

Conclusions: Both the David and Yacoub procedures are advanced techniques for aortic root replacement, each with unique advantages and challenges. The David procedure, with its excellent durability, has consistently delivered successful outcomes. It is especially beneficial for younger patients and those with connective tissue disorders, supporting its role as a preferred approach for long-term outcomes in this population.

Keywords: Aortic root aneurysm, Valve-sparing aortic root replacement, David procedure, Yacoub procedure

Introduction

Aortic root replacement is a life-saving surgical procedure to manage life-threatening conditions, including aortic root aneurysms, aortic dissection, and aortic valve insufficiency. [1] Among these various surgical protocols created, two of the most influential for this specific surgery are the David and Jacoub procedures.[2] They both aim at preserving the patient's native aortic valve, which eliminates the use of prosthetic valve replacement and long-term anticoagulation therapy. [3]

We discuss the technical aspects and long-term outcomes of these procedures here. We specifically illustrate the practical application of the David procedure with two case reports performed at our clinic last year.

Case 1: *A 73-Year-Old Male with Aortic Root and Ascending Aorta Aneurysm*

A 73-year-old male presented in the emergency department with chest pain accompanied by exertional dyspnea and generalized weakness. He had a three-month history of the

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complaints above, which were progressively worsening.

An echocardiogram revealed an ascending aortic aneurysm. The aorta's angio-CT showed a bulging aortic bulb measuring 67 mm, ascending aorta 69 mm, aortic arch 38 mm, and thoracic aorta 28 mm. The heart exhibited enlarged dimensions and left atrial dilation. Coronary angiography was performed, and no stenosis was found in the coronary arteries.

The patient was transferred to the Cardiac Surgery Department for intervention. Preoperative echocardiography showed the left ventricle with an ejection fraction of 45-50%. The ascending aorta was dilated to around 69 mm, with a tricuspid aortic valve.

Moderate to severe aortic regurgitation and mild to moderate mitral regurgitation were noted. Right atrial dilation and mild tricuspid regurgitation were also reported, with a peak systolic pulmonary artery pressure of 50 mmHg. No pericardial effusion was observed. The patient's medical history was significant for hypertension and permanent atrial fibrillation.

Procedure: General anesthesia was induced, and a median sternotomy was performed to open the pericardium and expose the dilated root of the aorta and ascending aorta. The heart was cannulated, and extracorporeal circulation was initiated. The aorta was clamped. Anterograde arrest was achieved with blood cardioplegic solution directly into the coronary ostia. An insufficient aortic valve was noted, with smooth leaflets and no calcium. The ascending aorta and Valsalva sinuses were resected, and after that, the aortic valve and coronary buttons were isolated. The aortic root was freed from the surrounding structures, and a Dacron n.32 mm graft was fixed to the native aortic annulus with 12 polyester 2.0 sutures. According to the David procedure, the valve was reimplanted in the 32 prosthetic Dacron graft tube with three continuous polypropylene 5.0 sutures. Coronary buttons were reimplanted. A hydrostatic test was performed with cardioplegia without observing any bleeding areas and no aortic regurgitation. The distal anastomosis is carried out with continuous 4.0 polypropylene. The heart is then de-aired, and decannulation is completed. A pacemaker is placed in the right ventricle. The prosthesis is well-positioned. Decannulation is performed after protamine application, and the sternum and operative wound are closed.

Outcome: The patient had an uncomplicated postoperative recovery and was discharged on postoperative day 6. At follow-up, echocardiography showed a stable aortic root with well-preserved valve function.

Case 2: *A 50-Year-Old Male with an Isolated Aortic Root Aneurysm*

The patient presented to the emergency department with chest pain, dyspnea, and palpitations. He reported a history of these complaints for several months. On echocardiography, an aneurysm of the ascending aorta was noted.

He underwent a CT scan of the aorta, which showed an ascending aorta with aneurysmal dilation up to 5 cm. The arch was measured at 3.4 cm. The aorta at the sinuses of Valsalva measured 55 mm, and the aorta at the Sino-tubular junction measured 52 mm.

Mild to moderate aortic regurgitation was noted. The aorta showed normal contrast throughout the entire trajectory.

Coronary angiography was performed and showed no critical stenosis of the coronary arteries. The patient was transferred to the cardiac surgery department for further intervention.

Procedure: Given the patient's young age and the desire to preserve the native aortic valve, the David procedure was selected. The diseased aortic root was excised with

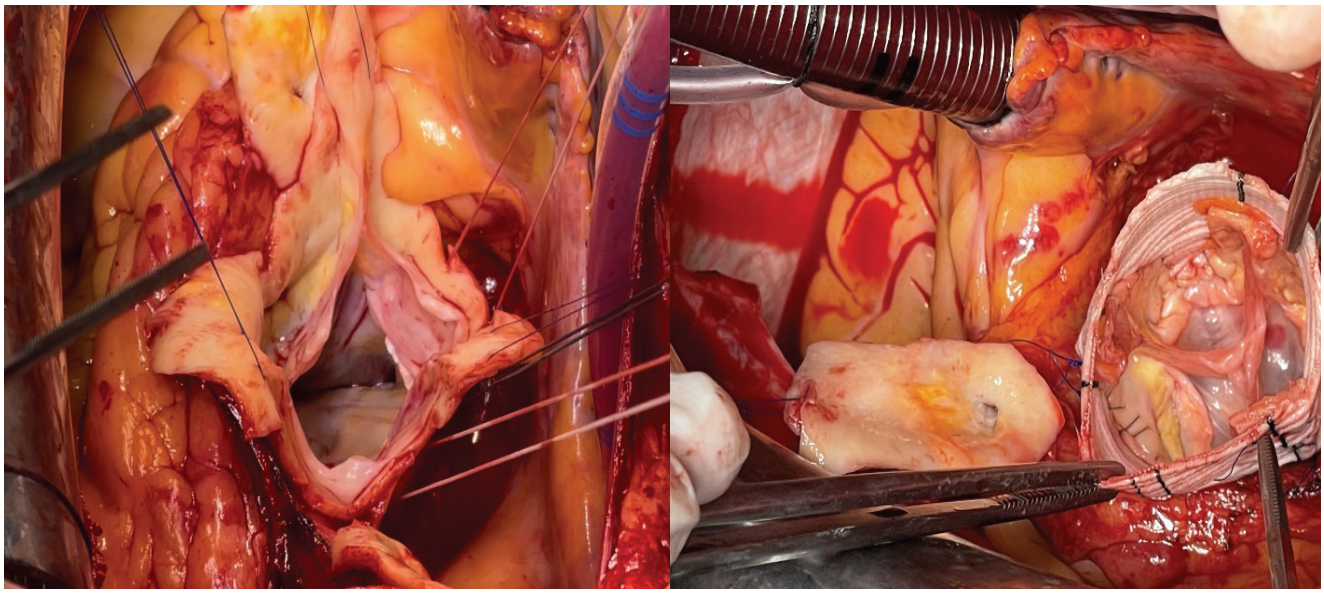

Figure 1. Aortic root excision and reimplantation of the aortic valve into the dacron tube

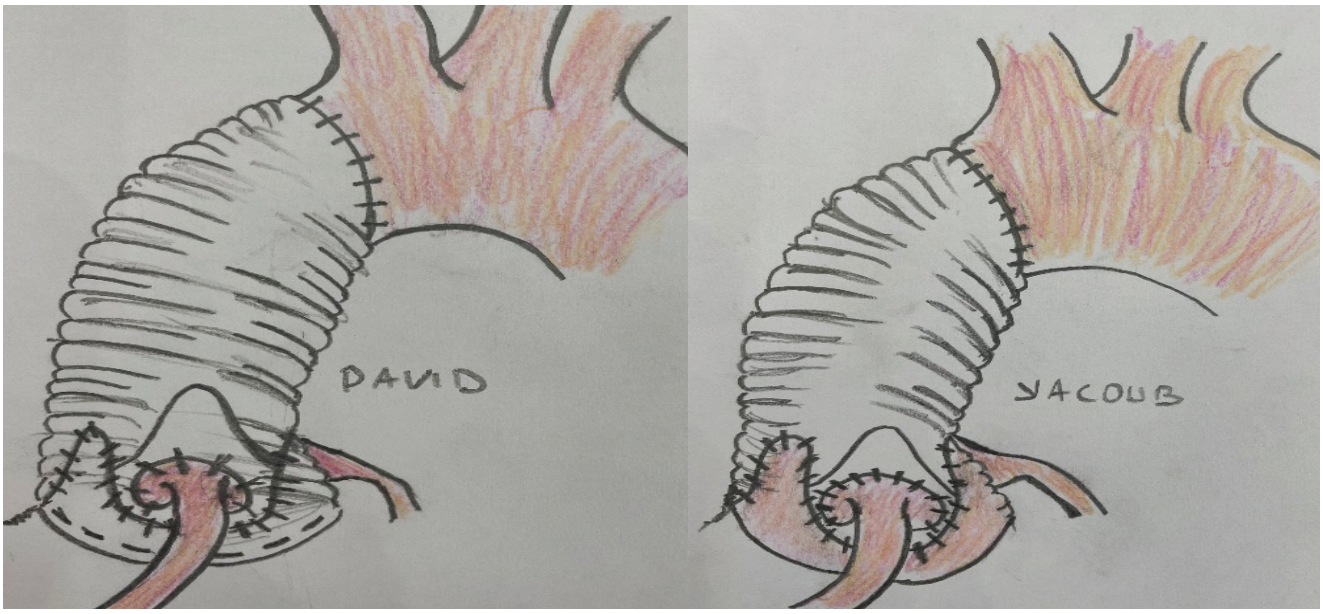

Figure 2. Schematic explanation of the different techniques

utmost care, and the aortic valve was reimplanted into a Dacron tube as described in the first case. The graft was meticulously tailored to support the aortic annulus, and the reconstruction was completed with excellent intraoperative valve competence.

Outcome: The patient's postoperative course was marked by an episode of atrial fibrillation converted into sinus rhythm by Cordarone infusion. He was discharged on the 7th postoperative day. Follow-up echocardiography showed a well-functioning aortic valve with no regurgitation and a stable aortic root diameter.

Discussion

The David Procedure: *Valve-Sparing Aortic Root Replacement: Reimplanting*

The David procedure, popularized by Dr. Tirone David in 1992, is a valve-sparing aortic root replacement procedure for patients with aneurysms of the aortic root associated with a functional but regurgitant aortic valve. [4, 5, 6]

The operation, which has been performed for more than 30 years, involves resection of the aneurysmatic or diseased segment of the aortic root while preserving the aortic valve leaflets.[4]

The aortic valve is reimplanted by carefully repositioning it inside a synthetic Dacron graft, which replaces the cut-out aortic root. The graft is fixed deeply in the aortic annulus to support it, avoiding annular dilatation and ensuring valve competence over the long term. It is tailored to fit the annulus individually. This procedure, by reconstructing the root around the native valve, restores the valve's competence, and regurgitation is prevented.[7]

Long-term studies have established the durability and effectiveness of the David procedure. In a seminal article by David et al., the 20-year survival was 80%, while freedom from reoperation was 92% [4]. Other authors, such as de *Kerchove et al.,* have corroborated these findings. Thus, the operation brought about excellent long-term valve function with meager rates of valve-related complications, even with bicuspid aortic valves [8]. Meanwhile, the role of getting the most perfect outcomes is enormous for the technical experience and patient-related characteristics.[8]

The Jacoub Procedure: *Remodeling of the Aortic Root: Remodeling*

Another innovative technique developed for reconfiguring the aortic root without damaging the aortic valve and aortic root structures, particularly the sinuses of Valsalva, is the Jacoub procedure.

The Jacoub procedure involves the partial excision of the aortic root, not the complete excision as in the David procedure, where aortic root excision is practically total. An artificial graft is sewn directly onto the remaining aortic wall. [10] It is cut out to fit around the native aortic valve, and thus, the essential valvular complex is preserved in its normal anatomical position and function. [10]

Preserving Valsalva's sinuses is one of the cardinal features of the Jacoub operation. This is important in maintaining physiological blood flow and valve dynamics. [10, 11] Also, it allows us to avoid the most extensive re-reconstruction needed in the David procedure.

Lansac's and other surgeons' modification of the original procedure by adding an external ring annuloplasty suggests that it could be an excellent option in patients with dilated aortic annulus to achieve valve competence and prevent dilatation in the future [12].

A study by Lenoir et al. compared reimplantation and remodeling with ring annuloplasty over more than 15

years in 142 patients, with a mean follow-up of 3.9 years (100% complete). They concluded that mid-term outcomes following remodeling or reimplantation were comparable and that implementing an extra-aortic ring annuloplasty effectively stabilizes annular dimensions [13, 14].

Despite the advantages and pitfalls of specific techniques, the outcome greatly depends on the surgeons' experience and skill. Reimplantation has a longer CPB time and aortic clamping time than remodeling, which results in longer learning curves for younger surgeons [15, 16].

The David and Jacoub procedures are entered under the preservation of the native aortic valve. However, they differ in supporting valve and aortic root reconstruction.

The reimplantation technique used in David's operation provides the most secure support to the hypothetically relatively unimpaired aortic annulus, which would prevent dilation in the future and provide physiological competence of the valve for an extended period. In contrast, we can retain the native anatomy of the aortic root through the Jacoub procedure, which may improve the physiological blood flow pattern and potentially reduce stress over the valve leaflets.

Although higher-quality studies with larger population sizes and more extended follow-up data are required for further analysis, the current meta-analysis indicates that patients who undergo reimplantation procedures have a significantly lower late mortality and reoperation rate than those who undergo remodeling procedures. However, no significant difference in early mortality or postoperative moderate to severe aortic regurgitation was exhibited between the two groups [17, 18].

Conclusion

David and Jacoub's procedures remain among the most advanced techniques of aortic root replacement. With varying advantages and corresponding challenges, the David procedure exhibits the solidest and longest-lasting valve durability, especially in younger patients and patient populations with associated connective tissue disorders. The Jacoub procedure is slightly less durable in the long term and offers a less invasive approach, with preservation of the native root anatomy; thus, it can be of value to some patient profiles. Ultimately, the decision to perform one procedure or the other depends on the team's experience and the patient's characteristics.

COI Statement: This paper has yet to be submitted in parallel, presented fully or partially at a meeting, podium, or congress, published, or submitted for consideration beforehand.

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