Long-Term Hemodynamic Performance of the Aortic Valve After David I: An Echocardiographic Study

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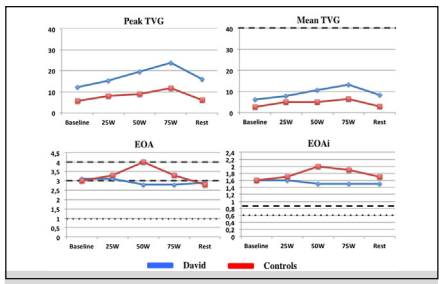
Despite optimal hemodynamics at rest, the performance of the aortic valve under stress conditions long after David I procedure is still debated. From 2001-2014, 73 patients underwent reimplantation with David I technique. Aortic valve function of 13 patients (age 61.2 ± 8.72) with a follow-up of at least 5 years (6.3 ± 0.9 years) was assessed at exercise echocardiographic stress test on a stationary cycle. Patients who had undergone concomitant procedure, with recurrent aortic insufficiency or mitral valve incompetence, were excluded. In all, 8 healthy volunteers served as controls. Transvalvular gradients progressively increased during the steps in both groups (*P*-within < 0.001), being higher in David patients (*P*-between < 0.001), but never reaching a clinical significance (David Peak gradient 23.8 ± 9.3 mm Hg; Mean gradient 13.2 ± 5.1 mm Hg). Effective orifice area (EOA) and EOA index did not change during the test in David patients, whereas Controls showed a progressive increase of functional valve area to a peak at 50 W (Controls EOA 4.0 ± 0.5 cm^2; EOA index 2.0 ± 0.3 cm^2/m^2). In conclusion, David I procedure ensures good hemodynamics during high-flow conditions at long-term follow-up. The reimplantation of the functional aortic annulus inside a rigid tube determines a paradoxical reduction of functional aortic valve area, secondary to the increased stroke volume, without any clinically relevant increase in transvalvular gradients. These data confirm the reliability of David I in the long term, even under physical stress conditions.

Semin Thoracic Surg 27:257–263

Keywords: aortic valve repair, reimplantation, aortic root, exercise echocardiography



Variation of peak and mean transvalvular gradients, EOA, and EOAi during the test in David and Controls. Dashed lines indicate normal reference values. Dotted lines indicate reference values for the diagnosis of severe aortic stenosis.

Central Message

Despite the absence of neo-sinuses, David I procedure ensures good hemodynamics during high-flow conditions at long-term follow-up.

Perspective

Aortic valve dynamics is not impaired after David I procedure and did not translate into clinically significant gradients under high workloads. This study confirms the reliability of the technique and gives further insights into the physiology of the aortic valve after the reimplantation inside a straight tubular graft.

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INTRODUCTION

The reimplantation technique, originally described by David and Feindel in 1992, is aimed to address the dilation of the aortic root both at the level of the aorto-ventricular junction and sinotubular junction, so as to guarantee a better stabilization of the functional aortic annulus.[1]

However, the reimplantation of the functional aortic annulus into a straight tubular graft—the so-called David I—has always stimulated the debate regarding the hypothesis of altered hemodynamics derived by the absence of the sinuses of Valsalva.

Accordingly, several studies have demonstrated that the sinuses of Valsava actively contribute to the opening and closing mechanisms of the aortic valve.[2–5]

However, despite a better motion of the aortic leaflet has been demonstrated in presence of neo-sinuses,[4,5] the clinical superiority of the newly described reimplantation techniques over the original David I has never been claimed.[6,7]

Accordingly, we sought to evaluate the aortic valve function during echocardiographic stress test late after David I, in those patients with the longest follow-up from our recently published series.[8]

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1043-0679/$-see front matter

http://dx.doi.org/10.1053/j.semtcvs.2015.06.011

PATIENTS AND METHODS

Patient Profile and Surgical Technique

From December 2002-November 2014, 73 consecutive patients underwent valve-sparing aortic root replacement with the reimplantation technique for root aneurism with or without aortic insufficiency (AI).

All procedures were performed using a single straight tubular Dacron graft (mean diameter 28.8 ± 1.3 mm), as previously described.[8] There was no operative death.

Overall, 58 patients underwent isolated reimplantation procedure, with or without additional procedures on the aortic valve.

Three patients underwent redo surgery on the aortic valve for endocarditis. Overall, 56 patients (80.0%) had no residual AI at last follow-up, 10 (14.3%) had trivial AI, 3 (4.3%) had mild AI, and 1 (1.4%) had moderate AI.

Patient Selection, Study Design, and Endpoints

The main aim of this study was to evaluate the performance of the aortic valve under increasing workload long after David I procedure.

Institutional Review Board approved the study and informed consent was obtained from each patient.

Accordingly, to avoid selection biases, we enrolled only those patients who had undergone isolated reimplantation procedure, with preserved systolic function (defined as a left ventricular ejection fraction ≥ 55%) and with a follow-up ≥5 years. Patients who had undergone concomitant procedures (apart from adjunctive leaflet repair at the time of the David procedure) with any grade of aortic regurgitation or any grade of mitral regurgitation were excluded.

Therefore, 13 patients, whose baseline characteristics are described in Table 1, were selected and underwent exercise echocardiographic stress test on a stationary cycle. Of these patients, 4 (33.3%) had a bicuspid aortic valve. Additional procedures on the aortic valve were 1 subcommissural annuloplasty (7.7%), 1 patch augmentation in a bicuspid valve (7.7%), 1 plication of the free margin (7.7%), and 1 reinforcement of the free edge with an over-and-over 5-0 polytetrafluoroethylene running suture (7.7%).

To ascertain the potential differences in the dynamics of the aortic valve under high workload, 8 healthy volunteers were enrolled and served as Controls.

Table 1. Baseline Characteristics and Preoperative Echocardiographic Details

	David $n = 13$	Controls $n = 8$	P
Age (y)	54.4 ± 8.9	52.1 ± 7.8	0.78
Gender (M)	12 (92.3%)	7 (87.5%)	0.72
Height (m)	171.9 ± 7.3	173.2 ± 6.9	0.83
Weight (kg)	79.5 ± 9.1	78.1 ± 10.4	0.75
Body surface area (m^2)	1.95 ± 0.13	1.94 ± 0.51	0.89
Body mass index (kg/m^2)	26.9 ± 3.1	26.1 ± 5.3	0.65
Systemic arterial hypertension	6 (46.2%)	0	0.023
Chronic renal insufficiency	0	0	–
Peripheral vascular disease	0	0	–
Current smoker	1 (7.7%)	0	0.42
Insulin-dependent diabetes mellitus	0	0	–
NYHA—3-4	0	0	–
Annulus (*mm*)	25.8 ± 2.0	22.5 ± 0.8	<0.001
Sinuses of Valsalva (*mm*)	45.8 ± 7.7		
Sinotubular junction (*mm*)	42.5 ± 8.2		
Ascending aorta (*mm*)	48.9 ± 7.7		
Aortic insufficiency—etiology			
1*b*	10 (76.9%)		
1*b* + 2	2 (15.4%)		
1*b* + 3	1 (7.7%)		
Aortic insufficiency—grading			
1+	5 (38.5%)		
2+	5 (38.5%)		
3+	2 (15.3%)		
4+	1 (7.7%)		