Abstract

Objective: Dilation of aortic annulus, sinuses of Valsalva, and sinotubular junction (STJ) diameters are the characteristic lesions of aortic root aneurysm. The remodeling technique reduces STJ diameter and creates three neo-sinuses of Valsalva. Alternatively, the reimplantation technique reduces both annulus and STJ diameters to the detriment of aortic root dynamics. Although the remodeling technique is recognized as the most physiological valve-sparing procedure, aortic annulus dilation may jeopardize its results. A standardized approach that combines an external subvalvular aortic prosthetic ring annuloplasty with the remodeling technique is suggested. Methods: Eighty-three patients underwent an elective aortic root remodeling procedure, either isolated (group 1, \( n = 34 \)) or combined with an external subvalvular aortic prosthetic ring annuloplasty (group 2, \( n = 49 \)). Preoperative aortic regurgitation was 1.59 ± 1.1 (group 1) and 1.97 ± 1.3 (group 2) (NS). The aortic annulus was more dilated in group 2 than in group 1 (27 ± 2.77 mm vs 26.4 ± 2.3 mm, \( p < 0.01 \)). Residual aortic regurgitation grade II was the conversion criteria for aortic valve replacement. Results: Operative mortality was 3.6% (\( n = 3 \)). Intraoperative conversion for valve replacement was 32.7% in group 1 (\( n = 11 \)) versus 4.2% in group 2 (\( n = 2 \) (\( p < 0.001 \)). In group 1, preoperative annulus diameter was larger for converted than for valve-spared patients (27.6 ± 1.7 mm vs 25.2 ± 1.5 mm, \( p < 0.02 \)). In group 2, implanted aortic ring significantly reduced annulus diameter (20.6 ± 1.8 mm) without significant aortic valve gradient (8.3 ± 3 mmHg). Follow-up was 17.2 ± 13.4 months (group 1) and 10.41 ± 7.95 months (group 2). Reoperation for recurrent aortic regurgitation was 13% in group 1 (\( n = 3 \)) versus 4.2% in group 2 (\( n = 2 \)). Echocardiographic follow-up found residual aortic regurgitation ≤ grade I in 17 patients in group 1 (90%) versus 43 patients in group 2 (95.5%) and of grade II in two patients in group 1 (10%) and two patients in group 2 (4.5%). Conclusion: The addition of external aortic prosthetic ring annuloplasty improves the remodeling technique’s operative reproducibility and short-term results. Therefore, its use as a systematical adjunct to the remodeling procedure is suggested. However, further long-term evaluation comparing this valve-sparing procedure to composite graft replacement should define the best surgical strategy for aortic root aneurysm.

Keywords: Aortic valve sparing; Aortic annuloplasty; Prosthetic ring; Aortic root aneurysm; Aortic annulus dilation

1. Introduction

Although the etiology of aortic root aneurysm is primarily related to dystrophic disease, aortic valve repair is performed in only 1.7% of the cases, versus 46.5% for mitral valve repair [1]. Until recently, composite valve and graft replacement was the only surgical standard for aortic root aneurysm [2]. Since the early 1990s, valve-sparing operations have become an attractive alternative, in the hope that they will result in improved survival and fewer complications. Two different procedures have initially been described [3,4]. The ‘remodeling’ technique (Yacoub et al. [3]) reduces the sinotubular junction diameter and creates three neo-sinuses of Valsalva with a scalloped Dacron tube graft sutured in the supravalvular position. Alternatively, David and Feindel [4] proposed the ‘reimplantation’ of the aortic valve within a straight tube, reducing both the annulus and the sinotubular junction diameters while abolishing the sinuses of Valsalva with impairment of aortic annulus and cusp dynamics [5]. Although the remodeling technique produces a more physiological reconstruction of the aortic root, dilation of the aortic annulus that is almost constant in these patients may lead to early or late failure of the repair [5,6]. Original series now provides 5–10 years follow-up data, but the exact indications and the reproducibility of either technique remain controversial [7–9]. The remodeling technique had been performed at our institution since 1997. Because this technique failed to restore aortic valve competence in
one-third of cases, we suggested combining the advantages of both the remodeling and reimplantation techniques by adding an external subvalvular prosthetic ring annuloplasty to the remodeling procedure [10]. This report summarizes our preliminary experience of 49 aortic root aneurysm patients treated with this combined technique. These patients are compared with a nonmatched cohort of 34 patients who underwent the isolated remodeling technique.

2. Materials and methods

Between January 1997 and August 2005, 83 patients with aortic root aneurysms underwent an aortic valve-sparing operation. Thirty-four patients (group 1) were treated with the isolated remodeling technique between 1997 and 2002. Between 2003 and 2005, an external subvalvular aortic annuloplasty, performed with a prosthetic aortic ring, was added to the remodeling technique in 49 cases (group 2). Data were reviewed retrospectively for group 1 and collected prospectively for group 2.

All patients were considered for a valve-sparing operation whenever the aortic cusps were suitable for repair (pliable, uncalcified bicuspid, or tricuspid valve), regardless of the size of the aneurysm or the severity of aortic insufficiency. Operative procedures were performed electively in all cases, except for one patient in group 2 who was operated on emergently to treat a fissured aortic root aneurysm. Patients with aortic dissection were excluded.

Patients were followed-up at 6-month intervals and annually thereafter. Transthoracic Doppler echocardiography was performed in all patients preoperatively, before discharge, and at each follow-up. Aortic insufficiency was estimated as none (grade 0), trivial (grade I), mild (grade II), moderate (grade III), or severe (grade IV) from evaluation by color-flow mapping and continuous-wave Doppler echocardiography [11,12]. Mean systolic flow gradients were recorded. In addition, the aortic root was serially investigated by computed tomography (CT) in all patients.

Mean clinical and echocardiographic follow-up times were 17.2 ± 13.4 months (1—48 months) in group 1 and 10.41 ± 7.95 months (1—25 months) in group 2. No patient was lost to follow-up. Infectious, thromboembolic, and bleeding complications were recorded as recommended by the American Association for Thoracic Surgery and Society of Thoracic Surgeons [13]. Echocardiographic data were obtained at the last follow-up visit.

2.1. Statistical analysis

Continuous variables are expressed as mean ± standard deviation. The Student’s t-test for independent variables was used to test normally distributed variables between the two groups. Analysis of contingency tables was performed by Fisher’s exact test or the χ²-test.

2.2. Operative techniques

In both groups, the remodeling technique was performed as originally described by Yacoub et al. [3]. Before going on cardiopulmonary bypass, transesophageal echocardiography (TEE) was performed to measure the aortic root diameters and to assess the mechanism of aortic insufficiency.

After aortic cross-clamping, the aortic root and valve were carefully inspected (particularly the geometry of the aortic valve and leaflet morphology) to assess their suitability for a valve-sparing procedure (a pliable, uncalcified valve).

Special attention was paid to the direct measurement of the diameter of the native aortic annulus with Hegar’s dilators because the choice of the tube graft and prosthetic aortic ring diameters were based on this criterion (Table 1). A scalloped straight tube Dacron graft was used to replace the aortic root for all patients in group 1 and for 22 patients in group 2. For the last 27 patients in group 2, the technique of root reconstruction was standardized by scalloping a bulged graft (Gelweave Valsalva™) in three symmetrical neo-sinuses using the pre-marks on the tube. The heights of the

<table>
<thead>
<tr>
<th>Native aortic annulus diameter (mm)</th>
<th>≤23</th>
<th>24—25</th>
<th>26—27</th>
<th>28—29</th>
<th>≥30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosthetic aortic ring diameter (mm)</td>
<td>25</td>
<td>27</td>
<td>29</td>
<td>31</td>
<td>33</td>
</tr>
<tr>
<td>Tube graft diameter (mm)</td>
<td>24</td>
<td>26</td>
<td>28</td>
<td>30</td>
<td>32</td>
</tr>
</tbody>
</table>

Fig. 1. Remodeling technique combined with a subvalvular external aortic annuloplasty. (a) Five 'U' stitches are placed in the subvalvular aortic plane. (b) Supravalvular replacement of the aortic root using the remodeling technique.
neo-commissures were cut up to the level of the bulging part of the graft.

In group 2, the remodeling technique was associated with a subvalvular external aortic annuloplasty using a prosthetic aortic ring. After resection of the sinuses of Valsalva to within 2 mm of the aortic annulus, the subvalvular plane (also called the aorto-ventricular junction or subaortic outflow tract) was dissected externally down to 2 mm below the nadir of insertion of each of the cusps [14].

Five 2.0 coated, pledgeted sutures (Ethibond, Ethicon, Inc., Somerville, NJ, USA) were placed inside out as 'U' stitches (3 mm large) circumferentially in the subvalvular plane (Fig. 1a). Three stitches were placed 2 mm below the nadir of insertion of each cusp, and two stitches were placed below two of the three commissures at the base of the interleaflet triangles (no suture was placed at the base of the interleaflet triangle situated between the right and non-coronary sinuses to avoid injury to the bundle of His).

After the remodeling technique was performed (Fig. 1b), the five anchoring 'U' stitches were passed through the inner aspect of the prosthetic aortic ring. It was then pulled down externally and tied separately in the subvalvular position below the suture line of the neo-aortic root (Fig. 2a). The external prosthetic aortic ring was obtained from a slice of the Dacron tube graft used to reconstruct the aortic root. The valve coaptation was then evaluated. In the case of residual valve prolapce (five cases in group 2), the free edge of the cusp was re-suspended using a continuous running suture of Goretex® [15]. Coronary ostia buttons were then re-implanted, and the distal anastomosis of the remodeling technique was performed (Fig. 2b).

3. Results

The mean patient age was 49.3 ± 15.1 years (range 15—81 years). Patient characteristics for both groups are summarized in Table 2. The preoperative native aortic annulus’ mean diameter was significantly dilated in both groups (26 ± 1.9 mm vs 27.1 ± 2.7 mm for groups 1 and 2, respectively, \( p < 0.01 \)) (Table 3). Marfan syndrome was present in 15 patients in group 1 and 16 patients in group 2. A bicuspid valve was present in four patients in group 2. Concomitant cardiac procedures are detailed in Table 2.

3.1. Operative characteristics

In group 1, 11 patients (32.7%) required intraoperative conversion to aortic valve replacement (Table 3). The preoperative aortic annulus diameter of these converted patients was larger than that of the patients with a successful valve-sparing procedure (27.6 ± 1.7 mm vs 25.2 ± 1.5 mm, \( p < 0.02 \)). Dilation of the aortic annulus diameter was the only risk factor for conversion in this group.

Group 2 experienced significantly less conversions (\( n = 2, 4.2\% \), \( p < 0.001 \)) despite having the same aortic annulus diameter as the converted patients from group 1 (Table 3). The first converted patient in group 2 presented an inappropriate indication for valve sparing; this patient had a supravalvular atheromatous aneurysm associated with mildly retracted cusps but without aortic annulus dilation. The second failure was related to distortion of the valve geometry during reconstruction of the root.

The degree of aortic insufficiency, size of aortic root aneurysm, or presence of Marfan syndrome had no effect on the risk for conversion in either group.

Adjunct use of the prosthetic aortic ring extended cross-clamp time by 16 min and cardiopulmonary bypass time by 25 min (Table 1). The mean diameter of the implanted aortic ring was 27.02 ± 1.61 mm, producing significant reduction of the mean native aortic annulus diameter (20.5 ± 1.6 mm) without significant aortic valve gradient (8.3 ± 3 mmHg).
3.2. Hospital mortality and morbidity

In group 1, one patient (2.9%) with occlusive coronary lesions associated with aneurysms of both coronary ostia died in hospital from myocardial infarction on the first postoperative day. Two patients (4%) in group 2 died in the early postoperative period (one due to massive pulmonary embolism and one due to mesenteric ischemia). Altogether, three patients required re-exploration of the mediastinum for bleeding (two patients from group 1 and one patient from group 2). An atrioventricular block requiring pacemaker implantation was observed in one patient from group 1 and in two patients from group 2. One patient from group 2 presented a cardiorespiratory arrest related to a transient atrioventricular block. One patient was reoperated for a mediastinitis (group 2), and two patients suffered from a

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Patient characteristics</th>
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<tbody>
<tr>
<td>Number of patients</td>
<td>Isolated remodeling 34</td>
</tr>
<tr>
<td>Age (years) (mean ± SD) [range]</td>
<td>48.7 ± 14.9 [15—75]</td>
</tr>
<tr>
<td>Sex</td>
<td>Male, n (%) 24 (70)</td>
</tr>
<tr>
<td>NYHA I</td>
<td>23</td>
</tr>
<tr>
<td>NYHA II</td>
<td>11</td>
</tr>
<tr>
<td>NYHA III</td>
<td>0</td>
</tr>
<tr>
<td>Bicuspid aortic valve, n (%)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Marfan syndrome, n (%)</td>
<td>15 (44)</td>
</tr>
<tr>
<td>Aortic aneurysm diameter (mm)</td>
<td>54.78 ± 5.9</td>
</tr>
<tr>
<td>Aortic regurgitation (mean grade)</td>
<td>1.59 ± 1.1</td>
</tr>
<tr>
<td>Cardiopulmonary bypass time (min) [range]</td>
<td></td>
</tr>
<tr>
<td>All patients</td>
<td>138.4 ± 22 [74—220]</td>
</tr>
<tr>
<td>Patients without additional procedures</td>
<td>123 ± 25 [74—192]</td>
</tr>
<tr>
<td>Aortic cross-clamp time (min) [range]</td>
<td></td>
</tr>
<tr>
<td>All patients</td>
<td>114.7 ± 27 [52—185]</td>
</tr>
<tr>
<td>Patients without additional procedures</td>
<td>101 ± 24 [52—153]</td>
</tr>
<tr>
<td>Additional procedures</td>
<td></td>
</tr>
<tr>
<td>Mitral valve repair, n (%)</td>
<td>3 (8.8)</td>
</tr>
<tr>
<td>Pulmonary vein exclusion, n (%)</td>
<td>0</td>
</tr>
<tr>
<td>Septal abscess treatment, n (%)</td>
<td>0</td>
</tr>
<tr>
<td>Coronary artery bypass, n (%)</td>
<td>5 (15)</td>
</tr>
<tr>
<td>Coronary ostia repair, n (%)</td>
<td>2 (6)</td>
</tr>
<tr>
<td>Patent foramen ovale closure, n (%)</td>
<td>0</td>
</tr>
<tr>
<td>Cusp resuspension, n (%)</td>
<td>0</td>
</tr>
</tbody>
</table>

NYHA: New York Heart Association classification.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Preoperative and postoperative echocardiographic data</th>
</tr>
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<tbody>
<tr>
<td>Isolated remodeling (n = 34)</td>
<td>Remodeling + subvalvular annuloplasty (n = 49)</td>
</tr>
<tr>
<td>11 intraoperative conversions 23 valves spared</td>
<td>2 intraoperative conversions 47 valves spared</td>
</tr>
</tbody>
</table>

Preoperative

Aortic regurgitation

None/trace (0 or 1+) | 7 | 12 | 0 | 15 |
Mild (2+) | 1 | 6 | 1 | 14 |
Moderate (3+) | 2 | 5 | 0 | 14 |
Severe (4+) | 1 | 0 | 1 | 4 |
Mean | 1.3 ± 1.5 | 1.5 ± 0.97 | 3 | 1.9 ± 1.32 |
Mean aortic annulus diameter (mm) | 27.6 ± 1.7 | 25.2 ± 1.5 | 27 | 27 ± 2.77 |

Postoperative

Aortic regurgitation

None/trace (0 or 1+) | 0 | 19 | 0 | 47 |
Mild (2+) | 8 | 4 | 1 | 0 |
Moderate (3+) | 3 | 0 | 1 | 0 |
Severe (4+) | 0 | 0 | 0 | 0 |
Mean | 2.3 ± 0.7 | 1 ± 0.7 | 2.5 | 0.18 ± 0.39 |
Mean aortic annulus diameter (mm) | 26 ± 2.4 | 26 ± 2.7 | 26 | 27.02 ± 1.61 |
Mean aortic tube diameter (mm) | 26 ± 2.4 | 26 ± 2.7 | 26 | 27.02 ± 1.61 |
transient ischemic attack (patent foramen ovale in one case). In group 1, one patient developed an abdominal aortic dissection.

3.3. Clinical follow-up

After discharge, patients were treated with antiplatelet agents. No late deaths, bleeding, thromboembolic, or endocarditis events were reported in either group during follow-up.

3.4. Reoperations during follow-up

In group 1, three patients underwent mechanical valve replacement for recurrent aortic regurgitation 6, 9, and 25 months, respectively, after their initial surgery (Table 4). In one case, regurgitation was related to a left coronary cusp prolapse, which had been underestimated at the first intraoperative TEE. In the two other cases, the jet was central due to further dilation of the aortic annulus.

In group 2, two patients required reoperation for significant aortic regurgitation 3 and 5 months, respectively, after their initial surgery (Table 4). In both cases, an eccentric grade I+ aortic regurgitation was present at the first intraoperative TEE and was related to residual cusp prolapse, which was neglected. At reoperation, cusp prolapse was confirmed as the cause of valve failure.

In both groups, valve replacement was performed via a usual ‘aortotomy’ on the Dacron tube graft using standard technique for implantation of a mechanical valve. All patients recovered promptly from the second operation.

3.5. Echocardiographic follow-up

Echocardiographic follow-up data are presented in Table 5. At discharge, the grade of aortic regurgitation in group 2 was less important than in group 1 (0.18 ± 0.39 in group 2 vs 1.4 ± 0.9 in group 1, p < 0.001).

The aortic cusps appeared thin and pliable in all cases at last echocardiographic follow-up (17.2 ± 13.4 months (1–48 months) in group 1 and 10.41 ± 7.95 months (1–25 months) in group 2). In group 1, 18 patients (90%) showed no or grade I aortic regurgitation and two patients (10%) showed grade II.

In group 2, 43 patients (95.5%) had no or grade I aortic regurgitation, and two patients (4.5%) had stable grade II. The aortic annulus diameter remained significantly reduced (27.1 mm preoperative diameter, 20.5 mm postoperative diameter, and 21.4 mm follow-up diameter). The mean systolic gradient across the aortic valve was 7.3 ± 3.2 mmHg.

CT scan of the thoracic aorta was systematically performed in order to assess diameter of the remaining aorta and to check the integrity of the reconstructed aortic root (Fig. 3).

4. Discussion

Composite valve and graft replacement has become the surgical standard for aortic root aneurysms, with an operative mortality rate of less than 5% [2]. However, this treatment exposes the patient to the drawbacks of a mechanical valve, especially the requirement for life-long anticoagulation therapy. Even if the risks of thromboembolism and bleeding are low in these young patients, their life expectancy will increase the cumulative risk of valve-related morbidity.

Although aortic valve sparing has been advocated as an alternative approach, the lack of technical standardization has limited its spread to highly specialized centers, leading surgeons to consider the statement that ‘the actual performance of this operation remains more art than science’ [16].

Over the past two decades, advances in dynamic anatomic knowledge lead to the development of two different valve-sparing procedures for the treatment of aortic root...
Fig. 3. CT scan showing postoperative reconstruction of the aortic root using the remodeling technique combined with a subvalvular aortic ring: (a) long axis and (b) short axis (with measure of the total aortic surface area).

aneurysm: the remodeling technique and the reimplantation technique [3,4]. Indeed, experimental work described the aortic root as a functional unit, including the sigmoid-shaped aortic annulus, the interleaflet triangles, and the sinuses of Valsalva [17]. Dynamic anatomy reports showed that the three-dimensional sigmoid shape of the aortic annulus could be divided into two two-dimensional planes: one at the base of the aortic annulus (also called the ventriculo-aortic junction or subaortic outflow tract [14]), and one at the sinotubular junction [18,19]. Dilation of both of these diameters is characteristic of the lesions of aortic root aneurysms. The remodeling technique reduces the sinotubular junction diameter and creates three neo-sinuses of Valsalva by means of a scalloped Dacron tube graft sutured in the supravalvular position [3]. Alternatively, reimplantation of the aortic valve within a straight tube reduces both the annulus and the sinotubular junction diameters [4]. Schäfers et al. [6] first suggested the diameter of the aortic annulus base, or aortoventricular junction, as a criterion to select the appropriate valve-sparing technique. They elected to treat aortic root aneurysms with the remodeling technique when the aortic annulus diameter was normal and with the reimplantation technique when the aortic annulus diameter was dilated. However, aortic root aneurysm, also known as ‘annulo aortic ectasia,’ is almost constantly associated with a primary dilated aortic annulus diameter [6,20,21]. Recent publications [9,22] show a trend toward the reimplantation technique because it stabilizes the aortic annulus. Indeed, compared with the remodeling technique, the main advantage of the reimplantation technique is that the proximal anastomosis realizes a subvalvular external annuloplasty. However, major pitfalls of this technique are the withdrawal of the sinuses of Valsalva and the inclusion of the interleaflet triangles within a graft tube, therefore impairing aortic annulus and cusp dynamics [4—6]. Inclusion of the aortic valve into a straight tube might compromise the durability of the repair and explain the reported cases of early valve deterioration [23]. To respect the dynamic anatomy of the aortic root, our group has favored the remodeling technique since 1997. However, out of the first 34 patients selected (group 1), this valve-sparing procedure was only successful and reproducible in two-thirds of the cases. This report emphasizes that isolated reduction of the sinotubular junction diameter was not sufficient to restore aortic valve competency in all cases. The only risk factor for intraoperative failure was a dilated native aortic annulus (diameter \( \geq 25 \) mm). The learning curve effect and the use of strict intraproductive TEE conversion criteria (aortic regurgitation \( \geq \) grade II) might explain part of these results. However, this high intraoperative conversion rate is consistent with the 30% of patients with grade II or III aortic regurgitation observed during the follow-up in the remodeling technique original series [3,8,9,24].

Therefore, the remodeling technique and the reimplantation technique should be chosen in a complimentary rather than competitive fashion, combining advantages of both approaches by adding a subvalvular external prosthetic aortic annuloplasty to the physiological reconstruction of the aortic root according to the remodeling technique [10]. The addition of an external subvalvular prosthetic ring dramatically modified our surgical strategy for aortic root aneurysm, with a 102% increase in aortic valve-sparing procedures. Moreover, all patients with Marfan syndrome are now candidates for this technique (vs 55% before May 2003). The rate of intraoperative conversion dropped from 32.7% in group 1 to 4% in group 2 (\( p < 0.001 \)). In group 2, two patients were reoperated for significant recurrence of aortic insufficiency related to residual cusp prolapse. Retrospective analysis of the initial intraoperative TEE recordings revealed eccentric grade I aortic regurgitation, probably related to a neglected initial cusp prolapse. Since those two early failures, the protocol was changed to include careful investigation of intraoperative leaflet coaptation during the TEE and by sight. As others have suggested [25], aggressive cusp resuspension is advocated whenever an eccentric jet is identified.

Two cases of postoperative atroventricular block at the beginning of our experience with the subvalvular annuloplasty procedure lead us to remove the sixth anchoring stitch above the commissure between the noncoronary and right coronary sinuses of Valsalva to avoid damage to the bundle of His.

In our experience, the remodeling technique combined with a subvalvular external aortic annuloplasty has provided better short-term results than did the isolated remodeling
technique. This new technique was performed in four different institutions by 11 different surgeons, confirming its reproducibility and standardization.

Evidence for the superiority of this new procedure is limited by the short-term follow-up in both groups and the small sample size. Moreover, statistical meaning of the results is lowered by the comparison of the retrospectively collected data in group 1 with that collected prospectively for group 2.

It remains unknown whether a valve-sparing procedure provides better long-term results than a composite graft replacement. Because of the multiplicity and the lack of standardization for valve-sparing techniques, objective, and long-term evaluation are needed to pursue evidence-based medical data. A standardized approach for valve-sparing procedures is an indispensable prerequisite for a prospective randomized trial. This preliminary report enhances the feasibility of the remodeling technique associated with an external subvalvular aortic annuloplasty as a single, standardized procedure that combines the advantages of the current valve-sparing techniques. A prospective, multicenter randomized open trial, the CAVIAAR study (Conservative Aortic Valve surgery for aortic Insufficiency and Aneurysm of the Aortic Root) will be enrolling over 3 years inclusion, 120 patients with this new standardized valve-sparing procedure to compare to 120 patients with mechanical valve replacement and will be proceeding in 29 French cardiac surgery centers. Main endpoint is a combined criteria of mortality and morbidity (reoperations, thromboembolic or hemorrhagic events, endocarditis, congestive heart failure), which will provide objective evaluation on a long-term follow-up. Standardization and rigorous long-term clinical evaluation should allow us to define the actual best surgical strategy for patients with aortic root aneurysm.

References


Appendix A. Conference discussion

Dr M. Song (Seoul, Korea): We have also developed a new aortic valve repair technique for various causes of aortic regurgitation, and it was presented in this morning’s session. I have a couple of suggestions for you.


Secondly, I am wondering whether a valve-sparing operation is really the best method for patients with aortic root aneurysm.
instead of reduction of entire aortic annulus. And secondly, if you put the outer ring instead of inside placement, it will make the aortic annulus wall wrinkle into the luminal side, and it might cause aggravation of aortic regurgitation.

Dr Lansac: I had the luck to study very carefully the aortic annulus dynamics in Professor Carlos Duran’s lab. Indeed, the aortic annulus expands during systole. The aortic ring that we implanted in that study was a 3 mm height slice of the Dacron tube we used to perform the remodeling technique. We are developing with industry an expansible ring that will mimic the natural expansion of the aortic annulus. The main difference between remodeling and reimplantation is that there is a full reduction of the aortic annulus diameter when you perform a reimplantation. This technique not only stabilizes the annulus but also reduces its diameter circumferentially. The subvalvular annuloplasty is based on the same principles as the reimplantation, because I think it is important to reduce the whole aortic annulus diameter. Furthermore, with the device that we are developing, we aim to mimic the aortic annulus natural dynamics.

To answer the other question about placing the ring outside or inside, I think it is more logical to put the ring outside because the expansion of the aortic annulus will go against the prosthesis and that will reduce tension as well as the number of sutures fixing the ring.

Dr K. Widenka (Katowicz, Poland): If I may ask you a question, why not choose the David operation if you are fixing the annulus anyway? I think it is much simpler. I have done a few Yacoub procedures, then I decided to do a David, and I never went back. I do only David operations. It is a much safer operation, it is much quicker, and the patients do not bleed after that. You are fixing the annulus anyway, so it is more or less the David operation.

Dr Lansac: The principles of the subvalvular aortic annuloplasty are exactly the same. For long-term results, I think it is better to mimic nature by reproducing neosinuses of Valsalva, in order to avoid early leaflets deterioration against the tube reported with the reimplantation technique using a straight tube. Even if you use either the Valsalva prosthesis or other tricks to recreate neosinuses of Valsalva, it still remains an inclusion technique disrespectful of the interleaflet triangles, which are inside the prosthesis. Therefore, it reduces the size of the neosinuses of Valsalva by approximately one-third of the circumference. So I believe the Valsalva graft is a very good graft to perform more physiological reconstruction of sinuses of Valsalva with the remodeling technique. The whole idea is to take advantages of both techniques rather than to choose between them. By adding an aortic expansible ring in subvalvular position to the Remodeling technique, we standardize aortic valve sparing procedure in a more physiological way.

Dr H.-J. Schaefers (Homburg/Saar, Germany): I disagree with the statement that the David operation is a quicker operation. It really takes more time. What you described reminds me of a modification Tirone David proposed about 10 years ago and he subsequently abandoned because the mid- to long-term results were suboptimal. So you are not the first group to start that. But if I look at your data analysis, these were subsequent patients: the first group treated early on and then the second group later. Is it possible that simply surgical experience and judgment made the difference and better results?

Dr Lansac: That is a very good point but I had no time to develop that in this presentation. Indeed, the learning curve was part of those initial, let’s say, bad results, but it doesn’t only explain them all. The same team operated the two groups of patients. Furthermore, seven other surgeons performed some of the cases of the second group operations as part of the preliminary study before beginning the randomized trial. As soon as we started adding subvalvular annuloplasty to the remodeling technique, we increased our rate of successful operations. The whole idea of that project is to standardize aortic valve-sparing procedure. But first of all, it needs to be evaluated by a randomized trial, in order to establish evidence-based medicine of the benefits of valve sparing procedure versus valve replacement.