Early Results of Valve-Sparing Reimplantation Procedure Using the Valsalva Conduit: A Multicenter Study

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Background. This study evaluates the midterm clinical results of valve-preserving aortic root resection by means of a modified conduit incorporating sinuses of Valsalva.

Methods. During a 5-year period, 151 patients with aneurysm of the aortic root underwent a reimplantation type of valve-sparing procedure using the Gelweave Valsalva prosthesis that incorporates sinuses of Valsalva. There were 121 males (80.1%), and the mean age was 56.4 ± 14.4 years (range, 14 to 83). Fourteen percent of the patients had Marfan syndrome and 8.6% had bicuspoid aortic valve. Seven patients (4.6%) suffered from acute aortic dissection. Aortic replacement was extended to the arch in 14 patients (9.3%). Sixteen patients (10.5%) had associated cusp repair.

Results. In-hospital mortality was 3.3%, and it was significantly higher among patients operated on for acute dissection ($p = 0.001$) and in symptomatic patients (III–IV New York Heart Association class; $p = 0.021$). Follow-up (mean, 18 months; range, 1 to 60) was 100% complete. There were 2 late deaths. Ten patients (6.6%) had 3 to 4+ aortic regurgitation, and 8 of these required late aortic valve replacement. Cusp repair was associated with a high incidence of late aortic valve replacement ($p = 0.005$). At 5 years, freedom from aortic valve replacement and freedom from grade 3 to 4 aortic insufficiency was 90.8% ± 3.3% and 88.7% ± 3.6%, respectively.

Conclusions. The reimplantation valve-sparing procedure with the Gelweave Valsalva prosthesis provides satisfactory results for patients with aortic root aneurysm. Aortic cusp repair can lead to late aortic insufficiency. Proper leaflet evaluation is of paramount importance in preventing residual valve regurgitation.


The use of aortic valve-sparing operations has increased in the last years owing to a better understanding of anatomy, function and pathology of the aortic root. The two main surgical procedures adopted are the remodeling and the reimplantation techniques. While the remodeling technique allows a certain reconstruction of the sinuses, it does not stabilize the annulus and carries an higher incidence of residual aortic insufficiency. Conversely, the classical reimplantation prevents progressive annular dilatation but completely abolishes the sinuses.

In fact, the cylindrical shape of the tube has been demonstrated to be a cause of increased stress motion of the valve leaflets, and it might lead to sudden cusps deterioration [1–3]. It is well known that the sinuses of Valsalva are important in assuring normal function of the aortic valve, many technical changes in the original reimplantation procedures have been suggested to create a sort of pseudosinuses [4, 5]. In 2000, it became available as a modified Daenron (C. R. Bard, Haverhill, Pennsylvania) tube, the Gelweave Valsalva graft (Vaskutek, Renfrewshire, Scotland), designed to recreate sinuses of Valsalva of normal shape and dimensions [6]. The advantages of this conduit have been already reported [7–9], not only for valve-sparing procedures but also in cases of Bentall procedures [10]. In the current paper, we describe the combined experience of three cardiac surgery departments in the reimplantation type of valve-sparing procedure using this conduit and analyze the clinical results of the first 151 patients.

Patients and Methods

Between May 2000 and August 2005, 151 patients with aneurysm of the aortic root underwent a valve-sparing operation according to reimplantation procedure using the Gelweave Valsalva prosthesis at S. Orsola Hospital (University of Bologna, Italy), at Istituto Clinico Humanitas (Rozzano, Italy), and at the Tor Vergata University of Rome (Rome, Italy). The study was approved by the
Table 1. Clinical Data

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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<tbody>
<tr>
<td>Number of patients</td>
<td>151</td>
</tr>
<tr>
<td>Sex, male (%)</td>
<td>121 (80.1)</td>
</tr>
<tr>
<td>Age, years (range)</td>
<td>56.4 - 14.4 (14-83)</td>
</tr>
<tr>
<td>Hypertension (%)</td>
<td>74 (49)</td>
</tr>
<tr>
<td>Coronary artery disease (%)</td>
<td>25 (16.6)</td>
</tr>
<tr>
<td>Renal insufficiency (%)</td>
<td>5 (3.3)</td>
</tr>
<tr>
<td>Marfan syndrome (%)</td>
<td>21 (13.9)</td>
</tr>
<tr>
<td>Bicuspid aortic valve (%)</td>
<td>13 (8.6)</td>
</tr>
<tr>
<td>Acute type A dissection (%)</td>
<td>7 (4.6)</td>
</tr>
<tr>
<td>Reoperation (%)</td>
<td>3 (2)</td>
</tr>
<tr>
<td>NYHA (%)</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>48 (31.8)</td>
</tr>
<tr>
<td>II</td>
<td>60 (39.7)</td>
</tr>
<tr>
<td>III</td>
<td>37 (24.5)</td>
</tr>
<tr>
<td>IV</td>
<td>6 (4)</td>
</tr>
</tbody>
</table>

NYHA = New York Heart Association.

Institutional Review Board of each institute, and informed consent was obtained from all patients. Patients' age ranged from 14 to 83 years (mean, 56.4 ± 14.4). There were 121 male (80.1%) and 30 female (29.9%) patients. All patients were preoperatively evaluated with transthoracic or transesophageal echocardiography. Angiography was performed in patients older than 50 years of age or with a history of coronary artery disease. The clinical and demographic profile of patients is described in Table 1.

The Valsalva Graft

The peculiarity of the Valsalva graft is the possibility of reconstructing the sinuses of Valsalva upon graft implantation and pressurization. The graft design has been described in detail elsewhere [6]. Briefly, it is a standard Dacron conduit that incorporates a short segment of the same material with corrugation at a 90-degree angle with respect to the rest of the graft. This segment, called the skirt, has a length equal to the graft diameter, and it is resilient in the horizontal plane so that upon implantation and pressurization, it will generate pseudosinuses of Valsalva. The suture joining these two sections of Dacron acts as a new sinotubular junction.

Operative Procedures

Cardiopulmonary bypass was instituted through cannulation of the right atrium and the ascending aorta. The systemic temperature was lowered to 32°C. In patients who had an aneurysm of the aortic arch or acute type A dissection, a peripheral cannulation, right femoral or axillary artery was preferred. In these cases, a systemic body temperature of 26°C was used, and antegrade selective cerebral perfusion was utilized during the period of circulatory arrest. Myocardial protection was achieved by antegrade infusion of cold (5°C to 10°C) crystalloid HTK solution (Custodiol; Koehler Chemie, Alsbach-Haenlein, Germany) or by intermittent blood antegrade cardioplegia depending on the surgeon preferences. The left ventricle was vented by inserting a cannula through the superior right pulmonary vein.

The surgical procedure followed the steps described by David and Feindel [11] in their original article. After the aortic wall is excised, U stitches of Ethibond 3-0 (Ethicon Inc., Johnson and Johnson Co., Somerville, NJ) are passed below the aortic valve, at the level of the ventriculoarterial junction, in a circular fashion. The aortic annulus is then measured with a standard valve sizer, and a 5-mm larger prosthetic valve is chosen (ie, if the aortic annulus measures 25 mm, a 30-mm Valsalva conduit is used). In case of dilated annulus, the sinotubular junction is sized instead. In detail, once a proper leaflet coaptation is obtained by pulling and aligning on the three commissures, the sinotubular junction can be easily measured and the proper size (+5 mm) of the Valsalva graft can be chosen. In case of an overrated annulus, a subcommisural annuloplasty is performed using pledged Ethibond 2-0 at the level of the interleaflet triangles.

Once the Valsalva graft size has been selected, one important step is to adapt the height of the skirt to the height of the patients commissures (Fig 1). The key point of the surgical technique when using a Valsalva conduit is the correct placement of the top of the commissures at the level of the union of the skirted section and the standard graft which represents the new ST junction. This is achieved by sizing the height of the commissures from the annulus to the top of the commissure. The three commissures are usually of different heights, and the one in between the right and the left cusp is shorter. Therefore, the base of the skirt can be scalloped accordingly to compensate for this length difference. This can also prevent the impingement of the "annular to sinus junction."

After the annular stitches have been passed through the graft and tied, the commissures are retrieved from inside and are pulled at the level of the neo-sinotubular junction. Next, the valve remnants are secured to the Dacron wall and the coronary buttons reattached to the corresponding sinus.

Sixteen patients (10.6%) had associated cusp repair consisting of one or more of the following procedures: shortening of the free margin either by central plication or by weaving a double layer of 6-0 polytetrafluoroethylene suture in 11 patients; raphe resection with annular plication in 7 patients (in 2 of these, shortening of the free margin by a double layer suture was also performed, and in another 1, an autologous pericardium patch was utilized to reconstruct the leaflet where the raphe was present); suturing of a cusp fenestration with 6-0 polypropylene suture in 3 patients.

Aortic arch or hemiarch replacement was performed in 14 patients (9.3%), and in 1 case, an elephant trunk technique was utilized. Antegrade selective cerebral perfusion was used for cerebral protection in all cases. Twenty-one patients (13.9%) underwent coronary artery bypass, 10 patients (6.6%) underwent mitral valve repair or replacement, 3 patients had atrial septal defect repair,
Table 2. Operative Data

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
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<tr>
<td>Cusp repair (%)</td>
<td>16 (10.6)</td>
</tr>
<tr>
<td>Aortic arch replacement (%)</td>
<td>14 (9.3)</td>
</tr>
<tr>
<td>Hemianarch</td>
<td>9 (6)</td>
</tr>
<tr>
<td>Total arch</td>
<td>3 (2.6)</td>
</tr>
<tr>
<td>Elephant trunk</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>CABG (%)</td>
<td>21 (13.9)</td>
</tr>
<tr>
<td>MVR/MVP (%)</td>
<td>70 (46)</td>
</tr>
<tr>
<td>ASD repair</td>
<td>3 (2)</td>
</tr>
<tr>
<td>Radiofrequency ablation</td>
<td>4 (2.6)</td>
</tr>
<tr>
<td>CPB time, minutes (range)</td>
<td>143 ± 35.4 (99–373)</td>
</tr>
<tr>
<td>CC time, minutes (range)</td>
<td>119 ± 24.1 (67–229)</td>
</tr>
</tbody>
</table>

ASD = atrial septal defect; CABG = coronary artery bypass graft; CC = cross clamp; CPB = cardiopulmonary bypass; MVR = mitral valve replacement; MVP = mitral valve prosthesis.

and 4 patients underwent radiofrequency ablation for atrial fibrillation. Table 2 summarizes the operative data.

Follow-Up

All hospital survivors were available for follow-up at intervals ranging from 1 to 60 months (mean, 18). Follow-up information was obtained by direct examination or by correspondence with the patient. The date of the last inquiry was between May and August 2005. Every patient had an echocardiogram at 3 and 9 months after the operation and then every year. The degree of residual valve regurgitation was assessed semiquantitatively as follows: 0, none; 1, minimal; 2, mild; 3, moderate; 4, severe. In case of valve insufficiency of grade 3 or greater, echocardiography was repeated at shorter intervals. Echocardiographic data are summarized in Table 3.

Statistical Analysis

Statistical analysis was performed with SPSS 11.0 statistical software (SPSS, Chicago, Illinois). Continuous variables were expressed as the mean ± SD and were compared with an unpaired two-tailed t test. Categorical variables were analyzed with a χ² test or Fisher’s exact test where appropriate. Survival analyses were calculated using the Kaplan-Meier actuarial technique; in addition, freedom from grade 3 or 4 aortic insufficiency and freedom from aortic valve replacement were calculated.

Table 3. Echocardiographic Data

<table>
<thead>
<tr>
<th>Grade of aortic regurgitation (%)</th>
<th>Early Postoperative</th>
<th>Last Visit*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–1+</td>
<td>104 (71.2)</td>
<td>95 (69.8)</td>
</tr>
<tr>
<td>2–</td>
<td>35 (2.2)</td>
<td>39 (28.7)</td>
</tr>
<tr>
<td>3–</td>
<td>5 (3.4)</td>
<td>2 (1.5)</td>
</tr>
<tr>
<td>4–</td>
<td>2 (1.4)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

* Eight patients reoperated on during follow-up were excluded; 2 patients died during follow-up and were excluded.

Fig 1. Techniques described: adjustment of the Valsalva graft to the patient’s valve remnants to obtain the correct placement of the commissures at the level of the prosthesis sinotubular junction. See text for details.
Subgroup comparisons were made by means of the log-rank test.

Results

Early Outcomes

There were 5 in-hospital deaths (3.3%): 2 due to multiple organ failure, 2 due to low cardiac output, and 1 due to intestinal ischemia. Three of these patients were operated on because of acute type A aortic dissection and 2 because of annuloaortic ectasia. In-hospital mortality was significantly higher among patients operated on for acute dissection (42.9% versus 1.4%; \( p = 0.001 \)) and among symptomatic patients (New York Heart Association class III to IV; 9.5% versus 0.9%; \( p = 0.021 \)). One patient operated on for acute dissection had an acute severe aortic insufficiency on the second postoperative day. At reoperation, a commissural detachment causing prolapse of the leaf and the noncoronary cusp was found. The patient underwent aortic valve replacement with a mechanical valve, leaving the reimplanted aortic tissue inside the graft. Three days later, a transesophageal echocardiogram showed a malfunction of the valve due to a mechanical leaflet blockage. This had been caused by some aortic wall tissue becoming detached from the graft. The patient underwent a third operation for total root replacement with a compositevalved graft. Weaning from cardiopulmonary bypass with a compositevalved graft. Weaning from cardiopulmonary bypass was impossible, and a biovascular assist device was implanted. The patient died 2 days later. Two other deaths occurred in patients operated on for acute dissection with peripheral malperfusion and tamponade. They died of multiple organ failure during the postoperative period. The fourth patient was operated on for annuloaortic ectasia, but the postoperative course was complicated by aortic dissection originating from the distal anastomosis; renal insufficiency developed and the patient died of multiple organ failure on the 12th postoperative day. The last patient underwent successful reimplantation procedure associated with CABG but died of intestinal ischemia after 12 days.

Four patients required rethoracotomy for bleeding. At discharge, 5 patients had grade 3 and 2 patients had grade 4 residual aortic regurgitation.

Late Outcomes

There were 2 late deaths (1.4%). The causes of death were gastric hemorrhage and multiple organ failure. Both patients had only trivial aortic regurgitation. The 5-year survival for all patients was 91.2% ± 3.4% (Fig 2).

Eight patients were reoperated on during follow-up and required aortic valve replacement because of residual aortic regurgitation. Five of these patients had already a significant valve regurgitation at the time of discharge and were reoperated on within a period between 1 month and 20 months. Two patients had a rapid appearance of aortic valve regurgitation because of endocarditis in 1 case and leaflet elongation (probably due to extreme growth spur in a marfan child) in another case. The last patient (who had a grade 2 residual valve regurgitation at the time of discharge because of untreated leaflet prolapse) had a progressive worsening of valve regurgitation with initial ventricular enlargement. Two patients with grade 3 residual aortic regurgitation since hospital discharge are asymptomatic with normal left ventricular size and function and are being followed closely by serial echocardiograms. The incidence of re-operation was significantly higher among patients who had undergone cusp valve repair (25% versus 3%; \( p = 0.005 \)). In fact, 4 of the reoperated patients with grade 3 to 4 aortic insufficiency had a cusp repair procedure.

At 5 years, freedom from late aortic valve replacement and freedom from combined grade 3/4 aortic insufficiency and aortic valve replacement was 90.8% ± 4.3% and 88.3% ± 3.3%, respectively (Fig 5A, B). The sinuses of Valsalva were well reproduced, as shown by echocardiography, in all patients (Fig 4). Some patients also underwent other imaging modality such as computed tomography scan, magnetic resonance imaging, or angiography that confirmed the echocardiographic findings (Figs 5, 6).

Comment

Aortic valve-sparing procedures are particularly appealing for patients with aortic root dilatation because these procedures avoid the problems of prosthetic heart valves, but pose the problem of the long-term durability of the spared aortic valve. Residual aortic valve regurgitation is the Achilles' heel of this type of surgical procedure. Among the two major techniques of valve-sparing procedures, remodeling (12) or reimplantation (11), the latter has gained popularity in the past years because it provides a better annulus stabilization, which has been shown as an important variable in the long-term durability of the result.

The drawbacks of the reimplantation technique is that it completely abolishes the sinuses of Valsalva that have been
alteration in the opening and closing characteristics of the valve leaflets that could induce, with time, thickening and rolling of the cusps' free margins [1, 2].

It goes without saying that a perfect postoperative result with absence of residual aortic regurgitation is required if we want to compare, in terms of long-term benefit, the positive effect of the presence of sinuses of Valsalva. Presence of more than trivial residual valve

demonstrated of paramount importance in assuring a physiologic movement of the aortic leaflets and at the same time reducing leaflet stress. For these reasons, several variations in the original David I technique have been introduced by various authors [4, 5, 13]. Nonetheless, the classic David I technique has demonstrated encouraging medium-term results in an adult [14, 15] as well as in a Marfan [16, 17] population in various reports. Our preference goes to the use of the Valsalva graft (Gelweave Valsalva) because it has all the advantages of the reimplantation procedure while allowing a proper reconstruction of the sinuses without significant modification in the surgical technique. It is hoped that the anatomical reconstruction that is possible using the Valsalva graft could contribute to a better and longer preservation of valve integrity. It has been proved that the absence of sinuses, among other factors, causes an

Fig. 4. Postoperative echocardiographic aspect of the aortic root in a patient after a reimplantation procedure with the Valsalva graft.

Fig. 5. Postoperative magnetic resonance image of a Marfan syndrome patient 3 years after aortic reimplantation procedure with the Valsalva graft.
regurgitation is the sign of cusp malalignment, torsion, altered coaptation, and cusp prolapse among others; all these different anatomical factors will invariably tend to a progressive worsening with time, with the consequent increase of valve insufficiency.

Imperfect results, independently from the technical or anatomical reasons that have caused them, should not be considered if the scope of the study is to ascertain whether the presence of physiologic eddy currents inside the reconstructed sinuses are important in preserving valve integrity in the long term. In any case, imperfect results with more than trivial residual valve regurgitation should not be accepted because the patient will face a second operation within a short time.

The initial results of this multicenter study clearly show that an imperfect result in the immediate postoperative period should be strongly avoided. In fact, excluding one case of endocarditis and a pediatric case with a significant growth spur, all reoperated patients had already evidence of grade 2 or higher aortic regurgitation at time of discharge. Furthermore, all patients were reoperated on in a period ranging from 1 to 20 months. This clearly indicates that residual aortic valve regurgitation has a tendency to worsen at a rapid pace. If the postoperative transesophageal echocardiogram shows a more than trivial valve regurgitation, it is advisable reopen the graft and either fix the problem if possible or, better, immediately proceed for valve replacement. Most of the failures reported are obviously the consequence of our learning curve. All centers did not have a previous direct experience with the implantation technique of valve-sparing procedure, which started only after the Valsalva graft became available. Therefore, we must consider not only a learning curve for the correct use of the graft but also for the surgical procedure itself.

If other procedures are added on the valve cusps, such as triangular resection or plication, free-edge reinforcement to correct an intrinsic leaflet prolapse, or a cusp prolapse that has been induced by a suboptimal orientation of the valve, the chances of ending up with an imperfect result are much higher. As a matter of fact, among all patients who required an aortic valve replacement, half of them had received some sort of cusp plasty.

On the other hand, it appears evident from this initial experience that a proper root and sinuses reconstruction remains stable at least for the time considered. It is therefore evident that only these patients should be considered in a long-term evaluation to ascertain whether the use of the Valsalva graft, with optimal sinuses reconstruction, is superior for preserving valve integrity.

In conclusion, this initial experience from three different centers has shown satisfactory midterm results. Proper patient selection and correct surgical technique will contribute to better root reconstruction. Patients with satisfactory reconstruction show, for the time being, stable results over time.

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DISCUSSION

DR JOHN S. IKONOMIDIS (Charleston, SC): What was your
method for sizing the grafts in those patients?

DR DE PAULIS: In order to choose the graft size we measure the
annulus only when the annulus is not over-rotated. I would say
no more than 27 mm. We size the annulus after all the lower
sutures have been passed below the annulus, and then we add
5 mm to that measure. In this way we are taking into account
the thickness of the tissue, because the graft has to go outside
the root. In case the annulus is over-rotated, you need to pull the
top of the commissures toward the head of the patient until
you obtain a good coaptation of the three leaflets. At that point,
you measure the diameter of the sinotubular junction and still add 5
mm. So usually you end up always with a measure of the graft
that is between 30 and 32 mm, for an adult population.

DR IKONOMIDIS: Did you ever encounter a situation where the
valve commissures were so high that they did not conform to
the anatomy of the graft?

DR DE PAULIS: The graft is designed in a way that the skirt of
the graft has a one-to-one proportion between its height and its
diameter. This is slightly different than the normal proportion
for the aortic root, because in the normal aortic root, the height
of the root is 70% of the diameter. So the height of the skirt is
already longer than the normal proportion of the root. So for
90%, I would say even 93% of the cases, it is more than enough.
In case you have a very big Marfan patient with elongated
commissures, you can use the small collar just to increase the
length of the skirt. Actually, in our experience, in all of these
skirt, the skirt was never shorter than needed. Usually the
skirt is longer than you need, so you have to make it shorter in
the majority of cases.

Originally we had two designs of this graft, one with an open
ead of the skirt and the second one with a collar, because the
collar was meant to attach the valve in case you wanted to do a
Bentall procedure. But then for practical purposes, we decided
to have only one design, so in case you do not need the collar,
you just cut it out and have an open end for your graft.

DR A. W. ATKINSON (Raleigh, NC): I have two questions. One,
I think from your first or second slide, that 40% of the patients
had severe aortic insufficiency prior to surgery, is that correct?

DR DE PAULIS: About 70% of the patients had it, they were
equally divided between 2+ and 3+.

DR ATKINSON: But they had significant, we would say, aortic
insufficiency?

DR DE PAULIS: Yes.

DR ATKINSON: Although that was not the primary reason to
do the surgery? It was the size of the aorta?

DR DE PAULIS: Yes, the primary reason was always the size of
the aortic root.

DR ATKINSON: Several people have suggested that the leaflets
deteriorate as time goes on when you have aortic insufficiency so
that we should push for earlier operations to prevent late
degeneration after the surgery. I wondered if you could address
that issue?

And the other question was, you used it, at least in a few
instances, for acute dissections, and most people have felt that
a normal valve can be reestablished in most cases and be used
rather than a prosthetic root replacement, and I just wondered if
there was a particular indication to use this than the standard
procedures?

DR DE PAULIS: Regarding the lack of the aortic
dissections, I would say that it is true, that normally in aortic
dissections the valve is normal. So the failure we encountered
for the dissected cases was due to the fact that the commissures
tore down. In that case, it needed to be reoperated on shortly
after the operation. So I think the David operation in the case
of aortic dissection is a good option because it avoids the need to
glue the sinuses, especially the noncoronary sinus that is
typically dissected. In that case, you have to make sure you
maintain the right geometry, because distortion can be the only
cause of failure of this normal valve.

As to your first question, of course if you operate at an earlier
stage, the results are much, much better. In all these fatalities, you
will notice that most of the cases had already 3+ aortic regur-
gitation at discharge. So that means basically a bad patient
selection and also depends of the learning curve, because all of
these centers had a learning curve either for the use of the graft
but also for the reimplantation procedure, because in our
country, the number of reimplantation procedures clearly
started with the availability of this graft. So it is difficult,
especially in the beginning of the experience, to judge if the
leaflet is prolapsing or if the leaflet is healthy. Of course, now we
know that if you operate at a early stage with a smaller aortic
root, the chances for you to get very healthy leaflets are much
higher. So today I would not go for a valve-sparing procedure if an aortic root is too large and for a long period of time.

DR ATKINSON: To carry the argument, how about Marfan's patients particularly? I understand their leaflets are okay but their aortic wall is diseased, and since they have a high risk of dissection, would you recommend this procedure for prophylactic treatment of a Marfanoid root?

DR DE PAULIS: Yes. Actually there now is a good amount of data from a group in Germany, from Tirone David, even from Johns Hopkins University, that the Marfan population, especially if you get it early, is a very good population because you have very good results and very stable results. Only one bad experience we had in a Marfan child, he was operated on at the age of 13, and then the result was perfect for 1 year. He had no residual aortic regurgitation. And then he grew up half a meter in 6 months, and he went from 1+ to 4+. So the valve was replaced. At the operation, all three leaflets were elongated in a symmetric way. By putting a stitch just in the middle at the noduli of Arantius, you would see a perfectly normal valve, but all three leaflets were tremendously elongated. That is the only bad experience in the Marfan patient. The other ones remained pretty stable over time.

DR VINCENT L. GOTT (Baltimore, MD): That was an excellent paper. I wish that Duke Cameron could be here to discuss this paper; he is very enthusiastic about the De Paulis procedure and has used it almost exclusively for the last 2 years. In Dr Cameron's surgical series, presented as a poster at this meeting, he has 51 patients, two thirds of them Marfan's, and 1 of them had 4+ aortic insufficiency and 6 had 2+ aortic insufficiency preoperatively. At late follow-up, there is no aortic insufficiency in any of the 51 patients; all 51 are alive and the overall results have been excellent. Maybe you commented on this and I missed it, but what was the relationship between preoperative aortic insufficiency and those patients who had significant late aortic insufficiency?

DR DE PAULIS: Actually, I am aware, I watched the poster from Dr Cameron, and it does reflect his experience not only in the Marfan population but also with that type of valve-sparing procedure, because the most important thing is just selection of patients. I watched, and out of those 51 patients that he presented in his poster, the majority had only 1 or 2+ aortic insufficiency, and the diameter of the root was not so big. That is very, very important to get a good result and also a long-lasting result.

Actually, I didn't say it, but most of the patients who had residual valve regurgitation had already very large root and severe, 3 or 4+, aortic regurgitation. At the time of the initial experience, the most difficult part was, first, to judge if the leaflet was prolapsing, and second, to establish the right height of the coaptation, because it is especially difficult to judge in a transverse prospection the level of the leaflets. And so if they are not perfectly on the same plane, one—even if it is not prolapsed—will go a little bit at a lower level, and then we will get some residual regurgitation.

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