Valve repair for aortic insufficiency: surgical classification and techniques

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Abstract

Objective: Valve repair for aortic insufficiency may provide an alternative to aortic valve replacement in selected patients. This repair could be an attempt at permanent correction or palliation to allow the aortic annulus to grow and avoid the use of anticoagulation. Based upon a five-year experience, we proposed a classification according to valvular anatomy which could be a guide to patient and procedure selection.

Methods: Between September 1989 and February 1995, 44 consecutive patients underwent aortic valvuloplasty for aortic incompetence at our institution. Patients’ ages ranged from 19 months to 76 years with a mean of 33 years. The etiology of aortic incompetence was congenital in 30 patients, degenerative in 7 patients, rheumatic in 5 patients, and infective endocarditis in 2. Aortic valve lesions were classified into three different types: type I, aortic annular dilatation (8 patients); type II, excessive aortic leaflet tissue (12 patients); and type III, restricted leaflet motion with or without deficient leaflet tissue (24 patients). Type I needed commissural plication in 7 patients; and aortic annuloplasty, which was simple in 6 patients, and pericardial-augmented in 2. Type II necessitated midleaflet excision in 11 patients and leaflet plication in 7. Type III required leaflet extension in 19 patients, leaflet replacement in 1 patient, aortic valve commissurotomy in 13 patients, augmentation commissurorrhaphy in 2, leaflet shaving in 4, and repair of leaflet perforation in 2.

Results: Postoperative echocardiography revealed a significant decrease in the degree of aortic incompetence. Mean follow-up was 2.6 ± 1.4 years. There was no mortality. Patients improved as is evident by NYHA functional class postoperatively. Eight of the first 13 patients (18%) needed reoperation. Three of these reoperations were bail-out procedures, and 3 patients (7%) who underwent the leaflet extension technique were reoperated upon 19 months to 3 years later. Presently, 23 patients are without anticoagulation, 11 take aspirin and 2 receive coumadin for combined mitral procedures.

Conclusions: Aortic valve repair provides a low risk option with satisfactory intermediate-term results for the treatment of aortic insufficiency in appropriately selected patients. Patient and procedure selection may be based upon the echocardiographic anatomy of the aortic valve, and a comparative risk benefit appraisal with valve replacement. © 1997 Elsevier Science B.V.

Keywords: Aortic valve; Aortic insufficiency; Repair; Valvuloplasty; Technique

1. Introduction

Every malfunctioning aortic valve may ultimately require replacement. However, the unique challenges presented by growing children, elderly patients or women desiring pregnancy necessitate a search for an alternative to valve replacement. Mechanical valves are poor valvular substitutes in young children because they impair normal growth of the native annulus and
require lifetime anticoagulation. Xenografts and homografts are also considered to be poor choices in children because of their rapid degeneration and calcification. Their only advantage, avoidance of anticoagulant therapy, is lost if there are coexisting arrhythmias. The Ross procedure has demonstrated excellent results in children not only because of the growth potential of the pulmonary autograft, but also because it obviates the need for anticoagulant therapy. However, the issue of pulmonary valve replacement is still debated between authors [8] and needs to be resolved.

Aortic valve repair gives selected children a chance to develop an adult sized pulmonary outflow tract minimizing morbidity from repeated pulmonary valve replacement and avoiding anticoagulation. In elderly people too, repair might be the most acceptable procedure to treat heart failure and restore satisfactory aortic valve function without thromboembolic or hemorrhagic complications.

2. Materials and methods

Between September 1989 and February 1995, 44 patients were selected for aortic valve repair procedures at Albert Starr Academic Center for Cardiac Surgery. Informed consent was obtained from the patients or legal guardians. The study was approved by the Ethics Committee on Human Research.

Thirty patients were male (68%) and 14 female (32%). Their ages ranged between 19 months and 76 years with a mean of 33 ± 23 years.

Preoperatively, 7 patients were in NYHA class I (16%), 25 in class II (57%), and 12 patients in class III (27%). Aortic incompetence was mild in 5 patients (11%), moderate in 16 (36%), and severe in 23 (53%). The etiology of aortic incompetence was congenital in 30 patients, degenerative in 7, rheumatic in 5, and infective endocarditis in 2.

Twenty-nine patients had isolated aortic valve pathology; one patient had Marfan’s disease, 3 had VSD, 1 had a large ASD, 4 had significant mitral lesions, 4 had severe coronary artery disease, 1 had truncus arteriosus, and 1 had total repair of tetralogy of Fallot.

Ten patients had bicuspid aortic valves, 1 patient had a quadrileaflet valve, 1 had a trileaflet truncal valve, and 3 patients had dysplastic aortic valves. Aortic valve prolapse was encountered in 18 patients, annular dilatation in 15 patients, retracted leaflets in 18 patients, calcified leaflets in 1 patient, and leaflet perforation in 2 patients.

Thirteen patients (30%) had aortic valve repair combined with other procedures: 1 patient had aortic root enlargement, 3 had VSD repair, 1 had ASD repair, 2 had coronary artery bypass surgery, 2 had mitral valve replacement, 2 had mitral valve repair, 1 had RV/PA conduit replacement post truncus arteriosus repair, and 1 had total repair of tetralogy of Fallot.

3. Operative strategies

3.1. General approach

After the patient is intubated and the central venous and arterial lines are inserted, an echocardiography probe is inserted into the oesophagus. The aortic valve anatomy and function are analyzed, and the transoesophageal probe is left inside the oesophagus to evaluate the valve repair at the end of the operation.

The heart is approached via median sternotomy. A wide and long piece of the native pericardium is harvested, cleaned of fat and connective tissue and placed in a 0.62% glutaraldehyde-buffered solution (Baxter-Edwards CVS Division) at room temperature for 12 min. Then the pericardium is rinsed with normal saline solution for another 10 min in three different baths.

In isolated aortic valve repair, cardiopulmonary bypass (CPB) is established between a cannula in the right atrial appendage and a cannula in the distal end of the ascending aorta, with high flow perfusion and moderate hypothermia (28°C). The aorta is cross-clamped, the heart fibrillated and a left ventricular vent is inserted into the left ventricle through the interatrial groove. A transverse aortotomy is performed just above the sinotubular groove and cold blood cardioplegic solution is delivered directly into the coronary ostia. Cardioplegia is repeated every 20–30 min. Surface cooling is achieved by placing ice slush around the heart. Myocardial temperature is kept below 12°C.

In this series, mean CPB time was 128 ± 50 min, and mean aortic cross-clamping time was 88 ± 38 min.

3.2. Classification and techniques of repair

The worldwide experience in aortic valve repair produced a vocabulary which is useful in establishing a classification of the different techniques used (Table 1).

Type I aortic valve lesions include annular dilatation. This is rarely an isolated lesion but is commonly secondary to leaflet pathology as the primary cause of aortic incompetence. Anuloplasty is used to reduce the diameter of the aortic annulus to render the aortic cusps more coaptive.

3.2.1. Anuloplasty

Commisural plication (Fig. 1A): A transverse mattress suture of fine Dacron is used to plicate the aortic annulus around the commissure in order to reduce the commissural angle.
Table 1
Surgical classification

<table>
<thead>
<tr>
<th>Type I</th>
<th>Annular dilatation</th>
<th>Annuloplasty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type II</td>
<td>Redundant leaflet tissue</td>
<td>Leaflet plication</td>
</tr>
<tr>
<td>Type III</td>
<td>Restricted leaflet motion ± deficient leaflet tissue</td>
<td>Commissurotomy</td>
</tr>
</tbody>
</table>

Reinforced annuloplasty (Fig. 1B): Early in our experience we used three glutaraldehyde-tanned pericardial strips, approximately 3 mm in width, as pledgets to augment a series of annuloplasty horizontal mattress stitches.

Simple annuloplasty (Fig. 1C): Two continuous bast- ing 2-0 Dacron sutures are brought outside the aortic wall at the level of each commissure and tied to each other over a small pledget of Teflon or autologous pericardium.

In type II the redundancy of leaflet tissue results in prolapse. A stitch of 5-0 Prolene is placed through the midpoint of each cusp. Traction on this stitch allows identification of redundant or elongated free margin of a cusp [14].

3.2.2. Leaflet free-margin shortening

Leaflet plication (Fig. 2A): This technique is used when the excessive tissue is adjacent to the commissure. A Dacron stitch is placed through the free-edge of the cusp close to the commissure and then brought through the aortic wall and tied over a pledget of Teflon or glutaraldehyde-preserved pericardium. This procedure has been more frequently applied in cases with concomitant ventricular septal defect. We used this tech- nique in 7 patients.

Mid-leaflet excision (Fig. 2B): Excision of an equilate- ral or isosceles triangle with the base at the free margin. The defect is closed with continuous fine su- ture. This technique is used when prolapse is more central.

In type III the characteristic anatomical lesion is deficient or retracted leaflet tissue preventing the leaflets from normal coaptation. The restriction of movement at the level of the commissures is managed by an adequate commissurotomy. If the commissure is heavily calcified or fibrotic, a commissurectomy is performed and the commissure is replaced by using the commis- surorrhaphy technique. Fibrosis and calcification of the free-margins is resolved by leaflet shaving. If the com- missures are normal, leaflet extension might be required to achieve good leaflet coaptation.

3.2.3. Commissurotomy

Commissurotomy is performed with a number 11 blade to open the commissure up to the aortic wall.

3.2.4. Repair of leaflet perforation (Fig. 3A)

It can be performed by a simple stitch, or a small patch of glutaraldehyde-prepared native pericardium.
3.2.5. *Augmentation commissurorrhaphy* (Fig. 3B)

Two triangular glutaraldehyde-preserved pericardial patches are fixed to the aortic wall and the two adjacent leaflets in such a way to replace the defective commissure. The patches are sutured with continuous 5-0 Prolene sutures.

3.2.6. *Leaflet shaving*

Leaflet thickening is frequently secondary to jet lesions. The primary cause may be any other type of aortic valve lesion. In this palliative technique, a number 11 blade is used to shave the free-margins of aortic cusps to render them more coaptive.

3.2.7. *Leaflet extension* (Fig. 4)

A piece of glutaraldehyde-preserved pericardium is divided into three equal sized pieces shaped into the normal aortic cusp. These pieces are implanted with single running sutures of 5-0 Prolene along every leaflet free-edge and brought out through a commissure and tied over a pericardial pledget. Commissures are then extended by approximating every two adjacent pericardial extensions to each other with 4-0 Prolene stitches placed through the aortic wall and tied over pericardial pledgets.

3.2.8. *Leaflet replacement*

In one patient we replaced one of the aortic cusps with a pericardial patch with good results.

After each repair, aortic valve competence was evaluated by the following methods: (1) by direct inspection, with gentle traction on the commissures and pressing at the center of the cusps, the free-margin of each leaflet is carefully aligned with its neighbours to check if there is extra leaflet tissue; (2) by observing the arterial pressure curve while unclamping the aorta to check any step-down in the mean arterial pressure curve; (3) by observing the amount of regurgitant blood through the left ventricular vent open to the air immediately after unclamping the aorta; and (4) by transesophageal echocardiography (TEE) during the rewarming phase and after cardiopulmonary bypass.

4. Results

Early surgical complications included: cardiac failure in 5 patients, bleeding in 3, and cardiac arrhythmias in 2 patients. Patients were mechanically ventilated after surgery for 0–82 h (mean = 16 h, S.D. = 18), and kept in the Intensive Care Unit for 1–8.5 days (mean = 2.7 days, S.D. = 1.5). The length of stay in the hospital ranged between 4–21 days (mean = 8 days, S.D. = 3.8). Patients were contacted directly by telephone or letter during the month of February 1995. Their postoperative status was determined by direct examination or by letters from referring cardiologists. There was no mortality. Follow-up ranged from 1 month to 5.2 years with a mean of 2.6 ± 1.4 years, and was complete in 100% of patients. Patients improved as was evident by improvement in NYHA functional class postoperatively.
The aortic valve anatomy and function were evaluated by bidimensional and color-flow Doppler echocardiography. The degree of AI decreased immediately postoperatively. Table 3 shows the late echocardiographic follow-up results of these patients. Eight patients in this series (18%) underwent reoperation (Table 4). If we ignore reoperations due to immediate technical failure, the incidence of reoperation falls to 11%. Three of the five reoperations were subsequent to pericardial leaflet extension, which suggests the incidence of reoperation due to pericardial tissue failure to be 7%.

### 5. Discussion

The annulus, commissures, sinuses of Valsalva and leaflets work in a perfect geometry to achieve competence of the aortic valve [3,19,24,28]. Aortic valve repair has been attempted before the advent of cardiopulmonary bypass using different techniques like circumferential and bicuspidization [29] and bicuspidization [27]. Lillehei in 1958 [18], using cardiopulmonary bypass, also used the bicuspidization technique as well as single cusp enlargement using Ivalone sponge. Later, other techniques had been developed such as plication of the aortic annulus [17] and annuloplasty [4,22]. Mulder described in 1960 a variety of techniques referred to as valvuloplasty [20]. Later, Starr [26] and Spencer [25] described their techniques to repair aortic valve prolapse concomitant with VSD.

The development of artificial heart valves with the ease of their implantation led to the abandonment of those primitive attempts of valve repair. However, complications associated with artificial valves such as thrombosis, thromboembolism, anticoagulation-related hemorrhage and structural failure, coupled with reports of successful atrioventricular valve repair in the last decades have revived surgeons' interest in aortic valve repair.

Carpentier, in an attempt to cure aortic regurgitation, described in 1983 [5] various techniques of aortic valve repair such as annuloplasty with a basting suture of 2-0 Tevdek, midleaflet excision for leaflet prolapse, commissurotomy and leaflet shaving for restricted leaflet motion.

Trusler, described in 1973 his method to correct aortic valve prolapse by securing the redundant aortic cusp against the aortic wall with pledgetted mattress stitch, then a hood of fine Dacron cloth is sutured over the two cusps to further support the repair [30].

The concept of using pericardial tissue in the reconstruction of the aortic valve was raised by Ross in the early 1960's [23]. In 1987, Batista and associates published their clinical experience with stentless pericardial monopatch for aortic valve replacement [2]. In 1988, Al-Fagih et al. described the use of glutaraldehyde-preserved bovine pericardium for aortic leaflet extension in a group of 20 patients with rheumatic aortic valve insufficiency [1]. During the same year Duran described his surgical techniques to repair rheumatic aortic valve lesions using commissurotomy, leaflet free margin unfolding, annuloplasty by commissural plication and supra-aortic crest enhancement with satisfactory results in a group of patients with stenotic valves with or without regurgitation [9,10]. Later, the same author analyzed his results in 107 patients who underwent valve repair for aortic insufficiency [11]. In addition to his previously described techniques he used cusp extension with either bovine or autologous pericardium [12,13]. In 1991, Cosgrove reported his series of 28 patients with aortic insufficiency due to leaflet prolapse, with 75% of his patients with bicuspid valves [7]. He used mid-leaflet excision followed by annuloplasty using the commissural plication technique with Teflon pledges. There was only one reoperation in his series with a mean follow-up of 6.9 months. The known advantages of reconstructive surgery encouraged us to adopt aortic valve repair techniques whenever the patient’s condition and valve anatomy permitted. Two-dimensional and Doppler color-flow echocardiography [21] was essential in planning technical strategies in advance by offering a fairly precise idea about the anatomy and function of the aortic valve.

In order to appropriately analyze aortic valve lesions, we classified these lesions into three major types: type I consisted of annular dilatation, which could be found alone or secondary to associated lesions. Initially we had used annuloplasty augmented with pericardial strips. Later, we abandoned this technique as it is time consuming and bears no advantage above the simple annuloplasty (Fig. 1C). In children, because of the flexibility of the aortic annulus, commissural plication seems to reduce the annular size quite satisfactorily by

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**Table 2**  
Clinical results

<table>
<thead>
<tr>
<th>NYHA</th>
<th>Preoperatively</th>
<th>Postoperatively</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>16%</td>
<td>57%</td>
</tr>
<tr>
<td>II</td>
<td>57%</td>
<td>43%</td>
</tr>
<tr>
<td>III</td>
<td>27%</td>
<td>0%</td>
</tr>
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</table>

**Table 3**  
Echocardiographic results

<table>
<thead>
<tr>
<th>AI</th>
<th>Preoperatively</th>
<th>Postoperatively</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trivial</td>
<td>0%</td>
<td>48%</td>
</tr>
<tr>
<td>Mild</td>
<td>11%</td>
<td>43%</td>
</tr>
<tr>
<td>Moderate</td>
<td>36%</td>
<td>9%</td>
</tr>
<tr>
<td>Severe</td>
<td>53%</td>
<td>0%</td>
</tr>
</tbody>
</table>
Table 4
Reoperations

<table>
<thead>
<tr>
<th>No</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Initial surgical procedure</th>
<th>Late procedure</th>
<th>Reason for reoperation</th>
<th>Time to reoperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>39</td>
<td>M</td>
<td>MLE</td>
<td>AVR</td>
<td>Technical failure</td>
<td>Immediately</td>
</tr>
<tr>
<td>2</td>
<td>39</td>
<td>M</td>
<td>LE</td>
<td>AVR</td>
<td>Technical failure</td>
<td>Immediately</td>
</tr>
<tr>
<td>3</td>
<td>60</td>
<td>F</td>
<td>Simple AA + MLE of a prolapsed cusp in a quadrileaflet AV with annular dilatation and amyloid heart disease</td>
<td>AVR</td>
<td>Technical failure</td>
<td>2.5 months</td>
</tr>
<tr>
<td>4</td>
<td>11.5</td>
<td>M</td>
<td>LE</td>
<td>Ross</td>
<td>Calcification and retraction of the pericardial tissue</td>
<td>19 months</td>
</tr>
<tr>
<td>5</td>
<td>66</td>
<td>F</td>
<td>LE (degenerative AV lesions, hypertensive disease and thyroidecctomy)</td>
<td>AVR</td>
<td>Retraction of the pericardial tissue</td>
<td>2 years</td>
</tr>
<tr>
<td>6</td>
<td>13.4</td>
<td>M</td>
<td>LE + supercrystal VSD closure + repair of the right sinus of Valsalva</td>
<td>LE</td>
<td>Dehiscence and shrinkage of the pericardial tissue</td>
<td>3.5 years</td>
</tr>
<tr>
<td>7</td>
<td>30</td>
<td>M</td>
<td>MLE + LP (bicuspid AV)</td>
<td>AVR</td>
<td>Annoying systolic murmur</td>
<td>4 years</td>
</tr>
<tr>
<td>8</td>
<td>10.3</td>
<td>M</td>
<td>Simple AA</td>
<td>Ross</td>
<td>Moderate AI</td>
<td>4 years</td>
</tr>
</tbody>
</table>

Key: N, Patient; F, female; M, male; AV, aortic valve; AI, aortic incompetence; AVR, aortic valve replacement; LE, aortic valve leaflet extension; MLE, aortic valve midleaflet excision; AA, aortic annuloplasty; Ross, Ross procedure; CP, commissural plication; LP, aortic leaflet plication; VSD, ventricular septal defect.

Closing the commissural angles (Fig. 1A). Three synthetic strips could be useful to reinforce the fragile annulus (Fig. 1B). Type II contains aortic lesions with redundant leaflet tissue and valve prolapse. If the cusp redundancy is close to the commissure, we use commissural suspension (Fig. 2A). If the prolapsing portion is central, we normally use the midleaflet excision technique (Fig. 2B) [6]. Type III is composed of a variety of lesions with deficient leaflet tissue as their primary cause. This is encountered in most rheumatic, endocarditic and jet lesions. Leaflet perforations can be repaired by direct suture or a pericardial patch (Fig. 3A). Mildly calcified or fibrosed cusps can be shaved with a sharp blade to render their surfaces coaptive with the other cusps. Fused commissures may benefit from commissurotomy unless the whole anatomy of the commissure is deformed. In this case this commissure can be replaced with the commissurotomy technique (Fig. 3B). If the leaflets do not coapt because of lack of tissue or restricted motion, the pericardial leaflet extension may be helpful in establishing sufficient coaptation (Fig. 4). In leaflet extension, it is essential to trim the pericardial patches very precisely to avoid any excess tissue that causes fluttering of the pericardial extensions and their subsequent degeneration (shrinkage, retraction and calcification). This technique seems to be less successful in childhood, either because of the small size of the annulus and its predisposition to higher turbulence, or because of the metabolic background in children. Leaflet extension remains a palliative procedure, however aortic repair without using additional tissue would be more likely to result in a durable cure.

In general, bicuspid valves seem to us more amenable to valvuloplasty techniques than tricuspid or quadricuspid valves. This is probably due to the shorter coaption line in bicuspid valves.

It is essential to assess valvuloplastic procedures perioperatively to spare the patient undue reoperation. A pediatric cystoscope or ureteroscope can be introduced into the aortic root [16] or the left ventricle [15] to visualize the aortic valve while injecting clear fluid into the aortic root. However, immediate postoperative transesophageal echocardiography remains the best tool to evaluate the anatomical and functional results of aortic valve repair.

Our criteria for selection of patients for aortic valve repair include: (1) aortic insufficiency; (2) minimal calcification of the aortic valve; (3) adequate flexibility of aortic valve leaflets; (4) no other valve disease necessitating valve replacement; and (5) adequate myocardial function.

Candidates for aortic valvuloplasty should be willing to accept the idea of ‘temporary surgery’ in order to palliate symptoms, either to avoid using anticoagulants, compromising the growth of their aortic annulus or both. The shadow of a potential reoperation should be put in balance with a better quality of life.

It is of importance to emphasize that cases which required reoperation occurred early in our experience where reoperation was a bail-out procedure. This involves the learning-curve as a major factor in this kind of plastic surgery. At present, we avoid the use of leaflet extension in children. However, we still believe that leaflet extension is a useful technique in adult patients.

In conclusion, aortic valve repair provides a low risk option with satisfactory intermediate-term results for the treatment of aortic insufficiency in appropriately selected patients based upon valve anatomy and a comparative risk benefit appraisal with valve replacement.
Acknowledgements

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References


Appendix A. Conference discussion

Dr O. Alfieri (Brescia, Italy): This is a very nice paper. Yesterday we had heard Dr Duran talking about the repair of aortic insufficiency, and he had, if I recall well, about 17% of his patients having recurrence of insufficiency. So it is pretty close to yours. I have a question. With the Type III lesion, if you don’t advise extension of the cusp, what is the method of correction? What do you advise for those lesions?

Dr S. Haydar: How do you mean?

Dr O. Alfieri: In the Type III lesion, where you have the restricted motion, lack of tissue, you don’t advise to use expansion of the cusp. Then what is the way of correcting those lesions?

Dr S. Haydar: We advise leaflet extension in these patients to correct these lesions, but...

Dr A. Carpentier (Paris, France): No, what he is saying is that you told us that this particular group of patients is one in which you had a higher proportion of reoperation. So his question is, would you still advise using this operation today or are you waiting for a longer follow-up?

Dr S. Haydar: We still advise this technique in adults. As you saw, three of our reoperations were in children. Probably the incidence of degeneration of the pericardial tissue is higher in children than for adults.

Dr N. V. Mandke (Bombay, India): I was just thinking that, as you have rightly said, addition of any tissue, basically biological tissue, whether it is from your own body or otherwise, would degenerate at a later stage. I worked with Dr. Yacoub a while ago and he used to do cusp advancement using a piece of pericardium. We stopped doing it because at a later date all patients came back. I personally feel that if you have deficient tissue or the approximation of the cusps is not really good, I think the worthwhile thing to do is to reduce the size of the annulus and that would probably give you a good long-term result. Thank you.
Dr S. Haydar: Well, in these cases, the leaflet tissue is not very mobile or flexible. I don’t think that reducing the annular size, only, would help in maintaining good aortic valve function.

Dr A. Carpentier: Don’t you think it would be wise to distinguish between, say, patients above 30 years of age and patients below 30 years of age? In the first group of patients you have an alternative, which are the new biological valves, which certainly gives you more reliable results, whereas this approach seems to me more appealing for those patients in whom valve replacement with a biological valve is more contraindicated. Can’t we reach an agreement on this statement? Would you agree with that?

Dr S. Haydar: Yes, in children...

Dr A. Carpentier: So you agree with that?

Dr S. Haydar: Sure, I agree with you...

Dr A. Carpentier: Okay. Let’s try to reach another agreement, which is, even though in this particular group of patients, particularly in rheumatic valvular disease, we are disappointed by the Type III group; that is to say, each time you have to share the cusp, each time you have to make some leaflet advancement, it’s okay, but one must accept having a rather high reoperation rate within the following, say, five or six years. So it is probably not the final solution to this problem. So Type III, I would be reluctant even in this young age group. Would you agree with that?

Dr S. Haydar: Yes, but we don’t have enough rheumatic...

Dr A. Carpentier: Okay. Now, let me advance a little bit and try to imagine your own child and then try to balance, particularly if you don’t want to have any anticoagulation. Then you will say, “Well, I want to have a result lasting as long as possible, at least to the age of 20”. And so the point I want to make, and I’m sure you share this opinion, is certainly a word of caution with regard to aortic valve replacement, and I’m sure you share this opinion, because…could you tell us the number of valve replacements you have done in the same time as you did these valve repairs?

Dr S. Haydar: It is much higher.

Dr A. Carpentier: You don’t have the figure?

Dr S. Haydar: I don’t have the figure.

Dr A. Carpentier: It’s probably a very, very high proportion of valve replacement versus valve repair, isn’t it?

Dr S. Haydar: Yes.

Dr A. Carpentier: So I think everybody would agree that there is some disenchantment, and we must have the courage to say that, with regard to aortic valve repair, coming from many different groups; however, this doesn’t mean that there is not still a place for it. However, you need to have pliable tissue, enough leaflet tissue, it’s a good operation most probably for congenital malformation, but one should be extremely reluctant to propose this operation in rheumatic valvular disease.