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## Aortic root replacement with a composite graft

### Factors influencing immediate and long-term results

Received: 6 December 1994  
Accepted: 21 Februar 1995

Presented at the 8th Annual Meeting of the European Association for Cardio-Thoracic Surgery, The Hague, The Netherlands, September 25–28, 1994

**Abstract** From April 73 to June 94, 203 patients (167 men, 36 women) aged from 10 to 74 years (mean:  $44.8 \pm 15$ ) underwent ascending aortic replacement with composite graft for: dystrophic aneurysm (AN) (130 cases, 64.5%), chronic dissection (CD) (35 cases, 17.2%), type A acute dissection (AD) (38 cases, 18.7%). Forty-six patients (22.6%) suffered from Marfan syndrome (24 AN, 13 AD, 9 CD). Thirty patients (14.7%) had undergone a previous cardiac or aortic operation. The ascending aortic replacement was extended to the transverse arch in 28 patients (13.7%). A mechanical valve was used in 193 cases (95%). Since 1986, the ascending aorta has been totally resected and a gelatin- or collagen-coated vascular prosthesis used. The technique of coronary reattachment has varied with time and according to the aortic lesions. The classic "Bentall" technique was used in 87 patients (43%), the "button" technique in 74 (36%), the "Cabrol" technique in 26 (13%) and a "mixed" technique in 16 cases (8%). The hospital mortality rate was 7.3% (15/203) (AN: 2.3%, CD: 11.4%, AD: 21%). The only predictors of hospital death were emergency AD ( $P < 0.03$ ) and arch replacement ( $P < 0.02$ ). Mean follow-up was  $46 \pm 10$  months (2–246). The overall long-term survival rate was (Kaplan Meier)  $89 \pm 6\%$  at 1 year,  $77.9 \pm 9\%$  at 5 years,  $67.7 \pm 12\%$  at 10 years and  $61.3 \pm 15\%$  at 12 years.

The 10-year survival rate is significantly higher in patients with AN ( $77.8 \pm 11\%$ ) than in those with AD ( $61.6 \pm 17\%$ ) (log. rank:  $P < 0.01$ ). The late survival rate is also significantly higher after the "button" or Bentall reimplantation than after the "Cabrol" or "mixed" methods ( $90 \pm 5\%$  in the "button" group and  $88.7 \pm 6\%$ ,  $83.8 \pm 9\%$  and  $76.6 \pm 12\%$  in the "Bentall" group vs  $80 \pm 18\%$ ,  $63 \pm 21\%$  and  $58 \pm 35\%$  in the "Cabrol" group at 1, 5 and 8 years, respectively). In conclusion, ascending aortic replacement with a composite graft is a safe procedure especially when performed electively in patients with dystrophic aneurysm or Marfan syndrome. The technique of coronary reimplantation has a significant influence on the long-term results. The reimplantation of choice is the "button" technique, especially in the presence of a fragile aortic wall (AD). The "Cabrol" technique must be used when the "button" or the "Bentall" reimplantation is not feasible, for instance during redo procedures. [Eur J Cardio-thorac Surg (1996) 10:207–213]

**Key words** Aortic root · Composite graft · Aortic valve replacement

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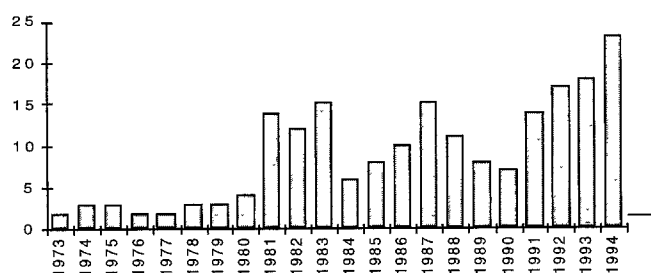
## Introduction

Many pathological conditions, either chronic or emergent, associating an aortic regurgitation with a certain degree of dilatation of the aortic root, require that the aortic valve and the ascending aorta be replaced. It has been clearly established that, in most cases, the techniques in which the valve and the aorta are replaced separately and, thus, which preserve partially or totally the Valsalva sinuses, lead to unsatisfactory mid-term results and to the need for risky reoperations. Accordingly, there is a present consensus within the surgical community which considers that the use of composite grafts in which the coronary arteries are reimplanted is mandatory in the presence of annulo-aortic ectasia (with or without acute dissection), in patients with Marfan syndrome, and that it is advisable in many instances of chronic dissection or dystrophic aneurysm [6–8, 11, 18].

Since the first description of the procedure by Bentall and De Bono in 1968 [2], many techniques have been described, and are still in use, for achieving the total replacement of the aortic root as recently emphasized by Svensson and colleagues [19]. They concern every step of the procedure. There are indeed several ways of securing the tube on the aortic annulus, reattaching the coronary ostia and managing the aortic prosthesis. Our opinion, based on the immediate and long-term results obtained in 203 patients over a 20-year period of time, is that the different techniques are not equivalent and that they may be adapted to the pathological features and to the circumstances of operation. The present retrospective study reports our experience and analyzes the factors influencing the immediate and long-term results, in order to assess this opinion.

## Material and methods

Between April 1973 and June 1994, 203 patients [167 men (82%) and 36 women (18%)], with a mean age of  $45 \pm 15$  years (range: 10–74), underwent an aortic root replacement in our Institution. The number of procedures performed every year increased with time and experience, as indicated in Fig. 1. The cause of operation was dystrophic aneurysm (AN) in 130 patients (64.5%), acute dissection (AD) in 38 patients (18.7%) and chronic dissection (CD) in 35 patients (17.2%). In five adult patients, the aortic aneurysm was asso-



**Fig. 1** Evolution of the number of composite graft replacements performed every year

ciated with an isthmic coarctation. The aortic replacement was performed first and the coarctation was successfully treated a few weeks later.

Marfan syndrome, defined by the simultaneous presence of at least two of the following features: [17] 1) family history, 2) musculo-skeletal abnormalities and/or bilateral subluxation of the lenses, 3) dystrophy of the ascending aorta, was present in 46 patients. Among them, 24 patients suffered from a non-complicated aneurysm, 13 had AD and 9 CD.

The aortic root replacement was performed as the initial procedure in 173 patients (85.2%) and during a redo procedure in the remaining 30 patients (14.7%). The procedure was performed emergently (delay between onset of symptoms and surgery less than 48 h) in 41 patients (20.1%): 36 AD, 3 ruptured aneurysms and 2 ruptured CD.

## Surgical technique

One femoral artery was cannulated in most patients. A single two-stage venous cannula was generally used. At the beginning of our series, 14 patients had non-cardioplegic myocardial protection through moderate hypothermia, permanent perfusion of the coronary ostia from the main arterial line and electrically induced fibrillation. A single dose (1 l) of antegrade cold crystalloid Breitschneider solution was flushed through the coronary ostia in 107 patients whereas, in the remaining 82 patients, the coronary arteries were continuously perfused at a mean flow of 150 ml/min with cold blood (12 °C) derived from the oxygenator through a separate heat exchanger. The coronary cannulae were briefly removed during ostial reattachment. In those latter groups ice slush was added in the pericardium. Warm reperfusion cardioplegia was not used in any patient.

The technique of inserting the composite graft and reimplanting the coronary arteries has evolved with time and varied according to the patients' anatomic data as well as our increasing experience. Until 1993 the composite graft was made intraoperatively from a valvular prosthesis and a Dacron tube assembled together. Besides its obvious economic benefit, this procedure had the advantage of allowing the surgeon to choose any valve substitute and Dacron tube. For the last two years, industrially prepared valved conduits<sup>1</sup> have been employed.

Until 1985, the valvular prosthesis was sewn inside the Dacron tube at about 5 mm of one extremity with a continuous 3/0 polypropylene<sup>2</sup> suture. The rim of the Dacron graft was then secured to the aortic annulus with a running 3/0 polypropylene suture. This technique has two main drawbacks: on the one hand, it reduces the gap between the valvular prosthesis and the coronary ostia and may then make the reimplantation of these structures more difficult; on the other hand, despite many expressed opinions, it seems to us that a running suture increases the risk of uncontrolled bleeding, especially if there is some discrepancy between the diameter of the native annulus and the diameter of the composite graft. Since then, we have preferred to secure the valve and the Dacron graft together to the aortic annulus, with a series of "U" shaped pledgeted stitches. A mechanical valvular prosthesis was used in 193 patients (95%), a bioprosthesis in 8 patients (4%) and a valvular homograft in 2 patients (1%).

Since 1986, Dacron grafts coated with either Gelseal<sup>3</sup> or Collagene<sup>4</sup> have been employed systematically. Four different methods were used to reimplant the coronary arteries:

- The Bentall conventional technique in 87 patients (43%)
- The "button" technique in 74 patients (36%)
- The Cabrol technique in 26 patients (12%) [9]

<sup>1</sup> Saint-Jude Medical, Les Ulis, France

<sup>2</sup> Prolene, Ethicon Laboratories Inc., Neuilly, France

<sup>3</sup> Vascutek Laboratory Ltd, Meudon, France

<sup>4</sup> L.P.I. Laboratoire Perouse, Bour-La-Reine, France

-- A "mixed" technique in the remaining 16 patients (8%) (Bentall's anastomosis of one ostium associated to "button" anastomosis or short Gore-tex tube grafting of the other ostium, in 9 patients; Bentall's anastomosis of the left ostium and saphenous vein grafting of the right coronary artery in 7 patients)

Wrapping of the composite graft with the aneurysmal sac was not performed routinely. It was performed only in cases of aneurysm after the Bentall or the Cabrol method and mainly according to the surgeon's preference.

The aortic transverse arch was replaced in 28 patients (13.8%) either partially (bevelled distal anastomosis in the concavity of the arch) or totally (single cuff reimplantation of the cephalic vessels), because of the extension of the chronic lesions or the location of the intimal tear during AD. The "open" distal anastomosis was performed under circulatory arrest in all cases. Cerebral protection was achieved through profound hypothermia in six patients and through our technique of "cold cerebroplegia" [1] in 22 patients. The mean-time of cardiopulmonary bypass (CPB) was  $103 \pm 35$  min (45–285) and the mean time of aortic cross-clamping was  $76 \pm 26$  min (37–180) for the entire cohort of patients.

#### Follow-up

The long-term survey was carried out during the second trimester of 1992 and updated in 1994, by means of direct contact with the patients or questionnaires sent to the patients, their family physician and referring cardiologist. If no result was obtained, the patient's birth-place registry office was contacted. In this case, the only available information was the patient's survival or death with date. Follow-up ranges from 2 to 246 months ( $46 \pm 10$  months) and the cumulative follow-up is 690 patients/years. Eight patients (3.9%) were lost to follow-up, and information was obtained only through the birth-place registry in 10 others (5.3%).

#### Statistical methods

Univariate associations between the hospital death and variables presumed to be influential were tested using a two-sample *t*-test (for quantitative variables) or the chi-square statistic (for qualitative variables). A logistic regression model was fitted to calculate the probability of hospital death. The explanatory variables introduced were those found to relate significantly to the hospital death, and a step-wise selection was performed among them. Long-term survival rates were calculated with a non-parametric Kaplan-Meier method. The log rank test was used to compare survival curves between the different groups. The Cox-proportional hazards model was used to describe the effect of explanatory variables on survival times. Confidence intervals are at the 95% level.

### Immediate results

The hospital mortality rate was 7.3% (15 patients out of 203). The causes of death are indicated in Table 1. The risk factors for hospital death are indicated in Table 2. Emergency, transverse arch replacement and type of aortic disease were significantly related to hospital death. These three variables were selected for the logistic model. In other words there is a highly significant difference between the group of patients operated upon on an emergency basis and the group operated upon electively, as the hospital mortal-

**Table 1** Cause of hospital deaths

	Nº
Low cardiac output	6
Haemorrhage	4
Stroke	2
Dysrhythmia	2
Graft thrombosis (Cabrol)	1
	15

**Table 2** Univariate analysis of factors associated with hospital mortality

Acute dissection	$P < 0.001$
Emergency	$P < 0.02$
Arch replacement	$P < 0.02$
Marfan	NS
Ostial reimplantation	NS
Associated CABG	NS
Type of aortic valve	NS

**Table 3** Predictive probability of death using the logistic-regression model (95% confidence limits)

	Composite graft with arch replacement	Composite graft without arch replacement
Acute dissection	50% (0.22–0.78)	16% (0.10–0.37)
Chronic dissection	18% (0.1–0.49)	3% (0.01–0.17)
Aneurysm	15% (0.09–0.58)	1.6% (0.01–0.06)

ity rates are, respectively, 2.3% in the AN group, 11.4% in the CD group and 21% in the AD group ( $P < 0.005$ ). This difference is emphasised by the fact that since 1988 there has been no death among those with an aneurysm operated on electively. Transverse arch replacement was significantly associated with an increased hospital mortality in each group of aortic disease after multivariate analysis ( $P < 0.003$ ). The predicted probability of death according to the nature of the aortic disease and the type of procedure performed, is shown on Table 3. Thirteen patients (6.4%) experienced a major postoperative non-fatal complication: low cardiac output and multiorgan failure in six (3%), permanent stroke in four (1.9%), mediastinitis in one (0.7%), ischemic colitis in one (0.7%) and perforated peptic ulcer in one (0.7%).

**Table 4** Cause of late death

	Without reoperation	With reoperation
Low cardiac output		1 <sup>a</sup>
Bleeding		2 <sup>a</sup>
Neurologic disorder	6	
Rupture of acute dissection	1	2 <sup>a</sup>
Pulmonary infection		1 <sup>a</sup>
Endocarditis	1	
Valve thrombosis		1 <sup>a</sup>
Chronic heart failure	4	
Cancer	1	
Sudden death	4	
Unknown	6	
	23	7 <sup>a</sup>

<sup>a</sup> During or after reoperation**Table 5A** Reoperations related to the initial surgical procedure

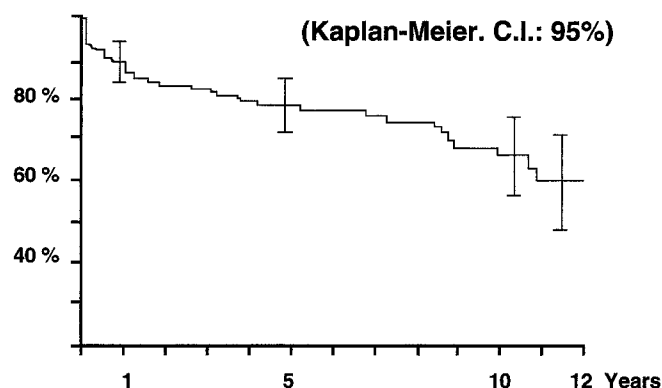
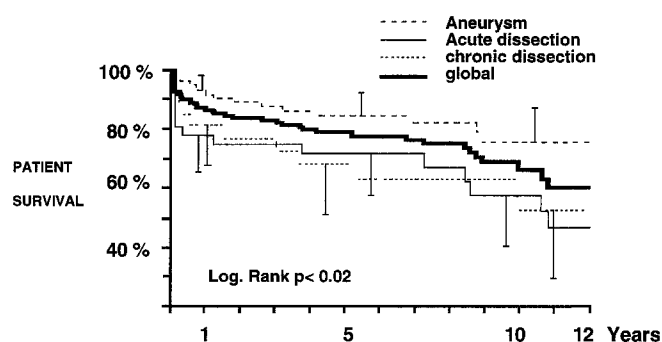
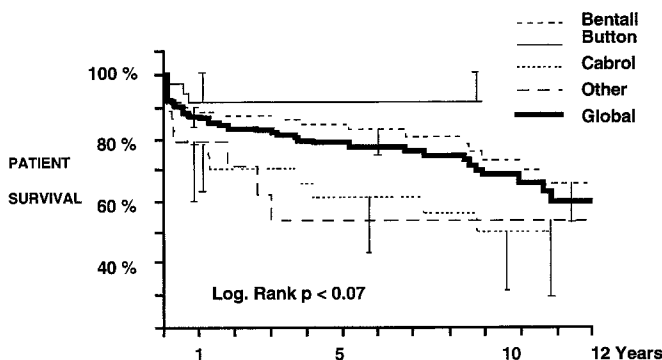
	N <sup>o</sup>	Deaths
Aortic valvular replacement	5	1
Coronary artery bypass grafts	2	1
False aneurysm at the distal suture	3	2
False aneurysm at coronary reattachment	2	
Pacemaker	3	
	15	4

**Table 5B** Reoperations related to the aortic disease

	N <sup>o</sup>	Deaths
Aortic isthmic coarctation	5	
Mitral valve replacement	2	
Aortic arch replacement	8	1
Thoracoabdominal aortic replacement	6	2
	21	3

### Long-term results

Thirty patients (18.4%) died during the period of follow-up. The causes of death are indicated in Table 4. Twenty-eight patients had to be reoperated on at least once for a total of 36 reoperations. The hospital mortality rate of those reoperations was 25% (7/28), whereas the risk of death for each reoperation was 19% (7/36). The cause of death during or after reoperation is indicated in Table 5. Nine patients experienced a major neurologic complications. Three were embolic (permanent strokes) and six were hemorrhagic. These complications resulted in five deaths, all in the hemorrhagic group. Three patients experienced a transient ischemic episode.

**Fig. 2** Overall survival**Fig. 3** Survival according to aortic lesions**Fig. 4** Survival and coronary reattachment

The overall long-term survival rate (including hospital mortality) is  $89.0 \pm 6\%$  at 1 year,  $77.9 \pm 9\%$  at 5 years,  $66.7 \pm 12\%$  at 10 years, and  $61 \pm 15\%$  at 12 years (Fig. 2). There is, however, a striking difference in the mortality rates of patients operated upon on an emergency basis and those operated upon electively. At 1, 5 and 10 years, respectively, the survival rates are:  $90.8 \pm 5\%$ ,  $82.6 \pm 9\%$  and  $77.8 \pm 11\%$  in the AN group vs  $81.5 \pm 9\%$ ,  $67.3 \pm 12\%$  and  $61.6 \pm 17\%$  in the AD group (Fig. 3). Interestingly enough,

there is also a significant difference in the mortality rates according to the technique of coronary reimplantation. At 1, 5 and 8 years, respectively, the survival rates are:  $91 \pm 9\%$  in the "button group",  $88.7 \pm 6\%$ ,  $83.8 \pm 9\%$  and  $76.6 \pm 12\%$  in the "Bentall" group vs  $80 \pm 18\%$ ,  $63 \pm 21\%$  and  $58 \pm 35\%$  in the "Cabrol" group (Fig. 4).

## Discussion

Our experience of complete replacement of the aortic root by means of a composite graft is in accordance with the recently published literature on the whole [1, 4, 5, 7, 9, 12, 14–16, 18, 19]. Although there might be some difference in the type of patients operated upon (percentage of Marfan patients or proportion of AD, for instance), most authors report a low hospital mortality and a significant difference between patients operated on an emergency basis or those operated on electively [10, 12, 13, 15, 18]. In this latter group, the mortality rate has been reduced to zero in Gott's series [9] and in the present series for the last 6 years. Most authors also describe their technical evolution and report their results with the original "Bentall" technique or with its various modifications [3–7, 11, 12, 14–16, 18, 19]. It is quite understandable that, during the 20-year duration of the present series, the surgical technique has evolved. This evolution has concerned every step of the procedure (assembling of the composite graft, reattachment of the coronary ostia, blood-tightness of the vascular prosthesis and the suture etc...).

The intraoperative choice of the different methods has depended on several factors. The Bentall technique has been the method of choice since the beginning of our series and is still in use. It has been held responsible for the occurrence of false aneurysms at the site of coronary reimplantation [14, 19]. We have observed this complication in only two cases and then in patients with severe Marfan syndrome operated upon for AD. We believe that, in the group of elective patients, the risk of false aneurysm or late dilatation of the anastomotic site is reduced provided the diameter of the reimplantation is small (no more than 7–8 mm). In cases of AD, however, it may be difficult to take the whole thickness of the aortic wall into the suture and there is a high risk of uncontrolled bleeding. For these reasons, and since 1989, we have preferred to use the "button" method in cases of fragile aortic wall, or when the distance between the aortic annulus and the coronary ostia seems too short to allow an easy reattachment without tension. We do not share Svensson's opinion [19] that the "button" technique is time-consuming, (as it takes only a few minutes to dissect free the two ostia) and that it may be the cause of damage to the main left coronary artery, the circumflex artery or the first septal perforator. None of these complications has been observed in the present series.

We have never used any Teflon ring to reinforce the coronary sutures, but Gelatine-Resorcinol-Formol Glue<sup>5</sup> has often been used in AD cases. Since 1992, fibrin glue has also been routinely sprayed on the proximal and coronary anastomoses to reinforce the hemostasis.

The "Cabrol" method, although elegant and easy, has never been used systematically. In our experience, the supposed easier access to the anastomoses after completion of the procedure was never proved [3]. In young patients with Marfan syndrome the very long-term outcome of the small Dacron graft is unknown and may prove to lead to difficult and risky reoperations. There is also continuing uncertainty concerning the possibility of acute thrombosis of one limb of the coronary graft and the possibility of myocardial infarction or sudden death [4]. This was, indeed, the cause of the only early sudden death observed in the present series. Conversely, this technique is extremely useful in cases of reoperation in which mobilization of the aortic root is made very difficult by tight adhesions. It is presently our method of choice in such cases. We totally agree with Cabrol [3, 4] and Svensson [19] that the coronary graft must be placed on the posterior and right side of the aortic graft to avoid kinking of the left limb and deadly thrombosis of the left coronary ostium.

Although no randomised study was carried out, wrapping has never proved to be of benefit, in our experience. On the contrary, as stressed by Kouchoukos [10], we are convinced that this method does not prevent bleeding and is associated with a high risk of false aneurysm or graft tamponade. This technique has, therefore, been totally discarded since 1988. Similarly, the use of a fistula between the wrapped ascending aorta and the right atrial appendage [3] seems to be at best useless and at worst deleterious. In the present series this procedure was performed 11 times during the early 1980s. Four patients (36%) have shown evidence of persisting left-to-right shunts, requiring reoperation in two cases. Those changes in the methods of surgery were adopted consequent to our increasing experience and in view of the improving results. It seems that they have been beneficial and were validated by the retrospective analysis of the data.

If we consider the entire population of patients ( $n=203$ ) the presence of Marfan syndrome and the replacement of the transverse arch in patients with AD was not associated with a significantly lower long-term survival rate. By contrast, the nature of the aortic disease ( $P<0.02$ ) and the type of coronary reimplantation ( $P<0.01$ ) had a significant influence (log rank test). The nature of the aortic disease and the technique of coronary reattachment included as explanatory variables in the Cox-model proved to be significantly related to the survival time ( $P<0.003$ ). The presence of Marfan syndrome was not. More precisely, the odds ratio (OR) for a patient with AD vs AN was 3.28. There was no significant difference between AD and CD.

<sup>5</sup> Cardial, St Etienne, France

The OR of the Cabrol technique vs the "button" technique is 4.55. Nevertheless, it is only fair to make clear that these two techniques cannot be compared precisely, as their indications were different and the "Cabrol" method was used mostly in patients with AD or during redo procedures. There was no significant difference between the Bentall technique and the "button" one. This is in accordance with the results obtained by Svensson and associates [19]. In their series, the "button" technique was not associated with a lower hospital mortality rate but was associated with a better long-term survival and a zero of reoperations. In the present study, when only hospital survivors are considered ( $n=188$ ), the technique of coronary reimplantation is the only significant variable in the model, and the OR remains similar to that of the previous analysis.

If we consider only the whole group of patients with aortic dissection, either acute or chronic, again only the technique of coronary reattachment was significantly associated with long-term survival whereas neither the presence of Marfan syndrome nor replacement of the transverse arch, was. Finally, if we consider patients with aortic dissection, either acute or chronic, surviving surgery, the technique of coronary reimplantation still had a significant influence.

In summary, our present technical policy consists in:

- securing the graft and the valve to the aortic annulus with a single series of "U" shaped pledgeted stitches,

- using the Bentall or the "button" technique of coronary reattachment in cases with large chronic lesions,
- using the "button" technique in cases of fragile aortic wall (AD) or short distance between the coronary ostia and the composite graft,
- reserving the Cabrol method for the cases in which no other technique is feasible.

But the most important conclusion drawn from the present study might be that the hospital mortality rate between patients operated upon on an emergency basis is ten-fold higher than the hospital mortality rate of patients operated upon electively. This difference is even greater if we consider that there was no hospital death in the last 89 elective patients (over a 6-year period). These data underline the importance of indication and timing of surgery in patients with an AN of the aortic root [13]. We are convinced that any diagnosed aneurysm of this type, whether in Marfan or non-Marfan patients, should be sent to surgery as soon as the diameter of the aorta reaches 5–6 cm or shows evidence of increase at two successive (6-month delay) measurements [13, 14, 20]. Before surgery is undertaken the patients should be maintained on  $\beta$ -blockade therapy. The association of close survey under medical therapy and undelayed elective surgery represents the safer and most rewarding way of saving these, generally young, patients.

## References

1. Bachet J, Guilmet D, Goudot B, Termignon JL, Teodori G, Dreyfus G, Brodaty D, Dubois C, De Lentdecker P (1991) Cold cerebroplegia: a new technique of cerebral protection during operations on the transverse aortic arch. *J Thorac Cardiovasc Surg* 102:85–94
2. Bentall HH, De Bonno A (1968) A technique for complete replacement of the ascending aorta. *Thorax* 23:338–339
3. Cabrol C, Pavie A, Gandjbakhch I, Villemot JP, Guiraudon G, Laughlin L, Etievent P, Cham B (1981) Complete replacement of the ascending aorta with reimplantation of the coronary arteries. A new surgical approach. *J Thorac Cardiovasc Surg* 81:309–315
4. Cabrol C, Pavie A, Mesnildrey P, Gandjbakhch I, Laughlin L, Bors V, Corcos T (1986) Long-term results with total replacement of the ascending aorta and reimplantation of the coronary arteries. *J Thorac Cardiovasc Surg* 91:17–25
5. Coselli JS, Crawford ES (1989) Composite valve-graft replacement of aortic root using separate Dacron tube of coronary arter reattachment. *Ann Thorac Surg* 47:558–565
6. DeBakey ME, McCollum CH, Crawford ES, Morris GC Jr, Howell J, Noon GP, Lawrie G (1982) Dissection and dissecting aneurysms of the aorta: Twenty-year follow-up of five hundred twenty-seven patients treated surgically. *Surgery* 121:1118–1134
7. Donaldson RM, Ross DN (1982) Composite graft replacement for the treatment of aneurysms of ascending aorta associated with aortic valvular disease. *Circulation*, 66 (suppl 1):116–120
8. Gott VL, Pyeritz RE, McGovern CJ, Cameron DE, McKusick VA (1986) Surgical treatment of aneurysms of ascending aorta in the Marfan syndrome. *N Engl J Med* 314:1070–1074
9. Gott VL, Pyeritz RE, Cameron DE, Greene PS, McKusick VA (1991) Composite graft repair of Marfan aneurysm of the ascending aorta. results in 100 patients. *Ann Thorac Surg* 52:38–45
10. Grey DP, Ott DA, Cooley DA (1983) Surgical treatment of aneurysm of the ascending aorta with aortic insufficiency. A selective approach. *J Thorac Cardiovasc Surg* 86:864–877
11. Crawford ES (1983) Marfan syndrome. Broad spectral surgical treatment. *Cardiovascular manifestations. Ann Surg* 198: 487–505
12. Taniguchi K, Nakano S, Matsuda H (1991) Long-term survival and complications after composite graft replacement for ascending aortic aneurysm associated with aortic regurgitation. *Circulation* 84 (suppl III):31–39
13. Kouchoukos NT, Marshall WG, Wedge-Stecher TA (1986) Eleven-year experience with the composite graft replacement of the ascending aorta and aortic valve. *J Thorac Cardiovasc Surg* 92:691–705
14. Kouchoukos NT, Wareing TH, Murphy SF, Perillo JB (1991) Sixteen-year experience with aortic root replacement: results of 172 operations. *Ann Surg* 214:308–320

15. Lewis CTP, Cooley DA, Murphy MC, Talledo O, Vega D (1992) Surgical repair of aortic root aneurysms in 280 patients. *Ann Thorac Surg* 53:38–46
16. Lytle BW, Mahfood SS, Cosgrove DM, Loop FD (1990) Replacement of the ascending aorta. Early and late results. *J Thorac Cardiovasc Surg* 99:651–658
17. Pyeritz RE, McKusick VA (1979) The Marfan syndrome: diagnosis and management. *N Engl Med* 300:772–777
18. Svensson LG, Crawford ES, Coselli JS, Safi HJ, Hess KR (1990) Dissection of the aorta and dissecting aortic aneurysms: improving early and long-term surgical results. *Circulation* 82 (suppl 4):24–48
19. Svensson LG, Crawford ES, Hess KR, Coselli JS, Safi HJ (1992) Composite valve graft replacement of the proximal aorta: comparison of techniques in 348 patients. *Ann Thorac Surg* 54:427–439
20. Treasure T (1993) Elective replacement of the aortic root in Marfan syndrome. Editorial. *Br Heart J* 69:101–103

## Discussion

**Dr. H. Borst** (*Hannover, Germany*): I was struck by the relatively large proportion of acute dissections that you put a conduit in. Why is that? I mean, normally we try to maintain the valve. Were those patients who have annuloectasia plus acute dissection?

**Dr. J. Bachet:** Most of these patients were Marfan patients. In this series we had 46 Marfan patients, and in the acute dissection group we had 13 Marfan patients. They all had a Bentall or a button technique. This explains the high rate of composite grafts implanted in patients with acute dissection.

**Dr. A. Cobanoglu** (*Portland, Oregon, USA*): I wanted to indicate that we agree with your conclusions, particularly those related to coronary implantation techniques. I think that the type of coronary implantation affects not only late survival but also early survival too, in that, in our experience, acute bleeding rates and the need for blood transfusions have been lower in those where we have used the Carrel button technique of implantation. Also over the last few years we have sort of had an evolution of this technique, and I wanted to find out whether you applied this technique in your experience. We have cut out a donut of Teflon, or some soft prosthetic material, and we have passed the coronary button through it, thus leaving the Teflon outside the button, and then reattached the coronary button to the aorta. I believe that this really reduces the chance of bleeding to a minimum. Have you used this technique?

**Dr. J. Bachet:** Of course immediate and late results have sort of a relationship, and if you get good immediate results, you are supposed to get good late results. We have turned to the button technique because we believe that, with this method, it is much easier to take the whole thickness of the aortic wall especially in patients with fragile aortic walls, like patients with dissection or old patients. That is why, I think, we have got better results.

Concerning the Teflon doughnut, which some of your colleagues in the United States call the life-saver, we have never used this adjunct, for two reasons: during surgery for acute aortic dissection, as you know, we use the G.R.F. glue, which is a much better life-saver than Teflon, and otherwise, in chronic patients, we have never felt it necessary.

**Dr. M. Turina** (*Zurich, Switzerland*): I enjoyed the paper very much. There is one question which is obvious to my mind. This series spans quite a long time. Did you analyze the date of the operation as a separate risk factor? I think we have all been through this experience, that the diseases which were very lethal 15 years ago, like acute dissection going into the arch, can be operated upon with very good survival rates today. Is the date of the operation a predictor of death?

**Dr. J. Bachet:** Of course, we were much less experienced at the beginning than we are now. And as I showed on the slides, we haven't lost any patient for 6 years in the group of elective operations. But even at

the beginning of our experience death was not very frequent in elective operations, as the mortality rate is only 2.3% for the whole series; that makes five patients. So I do think it is a very safe operation.

**Dr. V. Velebit** (*Meyrin, Switzerland*): I noticed that you mentioned that one of the risk factors for death is extension of your prosthesis into the arch. I believe in a recent paper that you wrote you suggest doing that to prevent late complications. How do you get around this?

**Dr. J. Bachet:** I'm sorry, but I think there is a misunderstanding. What I wrote, and I stick to it of course, is that in acute dissection, when the intimal tear is located in the arch, you had better replace the arch. I insist on that because, as you know, this has been controversial for many years, especially in the United States, and it has taken about 10 or 12 years for many excellent colleagues to get to our point. However, the data analysis has shown that in the few patients with acute dissection requiring complete replacement of the aortic root with a composite graft, extending the aortic replacement to the arch was associated with a much higher risk. This is completely different from the problem of extending the replacement of the aorta to the arch in all Bentall patients. In the present study, acute dissection was not the only cause of operation. There were also patients with chronic aneurysm. In this latter group, the statistics have shown that extending the aortic replacement to the arch entails a higher but acceptable risk of mortality.