The Journal of **THORACIC AND
CARDIOVASCULAR SURGERY**

Surgery for Acquired Heart Disease

Aortic dissection

Prevalence, cause, and results of late reoperations

From January 1977 to September 1992, 143 patients underwent an emergency operation for type A acute aortic dissection. Because of the location of the intimal tear, the replacement of the ascending aorta was extended to the transverse arch in 42 patients (29.3 %). One hundred ten patients (78 %) survived the operation. During the same period, 32 patients had to be reoperated on once ($n = 24$) twice ($n = 6$), or three times ($n = 2$) for a total of 42 reoperations. Nineteen patients had had the initial repair in our institution, and 13 had been operated on elsewhere. Reoperation was indicated for aortic valve disease ($n = 4$), recurring dissection ($n = 7$) threatening aneurysmal evolution of a persisting dissection ($n = 28$), or false aneurysm ($n = 3$). The redo procedure involved the aortic root and/or ascending aorta in 15 cases (group I), the transverse arch alone in 7 cases (group II), the transverse arch and the descending aorta or the descending aorta alone in 10 cases (group III), or the thoracoabdominal aorta in 10 cases (group IV). The risk factors for reoperation have been analyzed in the 110 survivors initially operated on in our institution. Seven of 18 patients with Marfan's syndrome (38.8 %) versus 12 of 92 without Marfan's syndrome (13 %) were reoperated on ($p = 0.023$). None of the 30 patients surviving arch replacement at initial repair required a reoperation, versus 19 of 80 (23.7 %) patients surviving a replacement limited to the ascending aorta ($p = 0.013$). The overall mortality rate of reoperation was 21.8 % (7/32) with a risk of 16.6 % (7/42) at each procedure (group I, 13.3 %; group II, 0 %; group III, 20 %; group IV, 30 %). Hospital mortality was influenced by emergency operation (5/10) ($p < 0.005$) and thoracoabdominal replacement (3/10) ($p < 0.035$). The late survivals after reoperation are $65.1\% \pm 17.6\%$ at 1 year and $55\% \pm 19.63\%$ at 5 years (Kaplan-Meier, confidence interval 95 %). The late survivals, after the initial repair, of the patients undergoing

Jean E. Bachet, MD, Jean-Luc Termignon, MD (by invitation), Gilles Dreyfus, MD (by invitation), Bertrand Goudot, MD (by invitation), Luca Martinelli, MD (by invitation), Alain Piquois, MD (by invitation), Denis Brodaty, MD (by invitation), Claude Dubois, MD (by invitation), Phillippe Delentdecker, MD (by invitation), and Daniel Guilmet, MD (by invitation), *Suresnes, France*

From the Service de Chirurgie Cardio-vasculaire, Hôpital Foch, Université de Paris—Ouest, Suresnes, France.

Read at the Seventy-third Annual Meeting of The American Association for Thoracic Surgery, Chicago, Ill., April 25-28, 1993.

Address for reprints: J. E. Bachet, MD, Service de Chirurgie Cardio-vasculaire, Hôpital Foch, Université de Paris—Ouest, 40, rue Worth, 92150 Suresnes, France.

J THORAC CARDIOVASC SURG 1994;108:199-206

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0022-5223/94 \$3.00 + 0 12/6/55994

reoperation are $89.6\% \pm 11.0\%$, $79.3\% \pm 14.7\%$, $53.9\% \pm 18.1\%$, and $35.9\% \pm 21.8\%$ at 1, 5, 10, and 12 years, respectively. In conclusion, aortic dissection is an evolving process that may require one or several reoperations after the initial repair. At initial emergency operation, the resection of the entry site, when located on or extending to the transverse arch, has reduced the risk of reoperation, in our experience. Elective reoperation must be considered before the occurrence of complications, especially in patients with Marfan's syndrome. It entails a relatively low risk, except in case of thoracoabdominal replacement, and allows a satisfactory long-term survival. (*J THORAC CARDIOVASC SURG* 1994;108:199-206)

Because the natural prognosis of acute dissection involving the ascending aorta is associated with a mortality rate of 50% at 48 hours,¹ this condition requires one of the most urgent operations in cardiac surgery. At present, the goals of surgery are to save the patient at emergency operation, to perform the most efficient and stable repair, and to prevent late complications, reoperations, and deaths.

Surgical therapy consists mainly in replacing the ascending aorta, regardless of the extension of the pathologic process. Acute aortic insufficiency, when present, is generally cured by valve resuspension but may require aortic valve replacement in some instances.² In patients with annuloaortic ectasia or documented aortic dystrophy, the use of a composite graft is necessary. More recently, extension of the aortic replacement to the transverse arch has been proposed when the intimal tear is located on this portion of the vessel.³⁻⁶ These surgical procedures have dramatically improved the immediate results, and the hospital mortality rate has been lowered to about 10% to 20% in most reported experiences.⁷⁻¹³

However, because of the extent of the disease or limited replacement of the aorta, most surviving patients continue to have a patent false lumen and may have aneurysmal evolution or recurrence of the dissecting process, necessitating late reoperation.^{1, 11, 14, 15}

The present study reports on our experience of 42 late reoperations performed in 32 consecutive unselected patients, previously operated on for type A acute dissection of the aorta and having a new dissecting process or the aneurysmal evolution of a patent false lumen. Through this experience, we analyze the prevalence and risk of late reoperation in the 110 survivors among the 143 patients who had undergone an emergency operation for acute dissection in our institution.

Patients and methods

Between January 1977 and September 1992, 143 patients aged 15 to 78 years (mean 45 ± 15 years) underwent emergency surgery for Stanford type A acute dissection of the aorta in the Department of Cardiovascular Surgery at Hospital Foch.

In all patients, gelatin-resorcine-formol glue (Cardial,

Technopole, Saint-Etienne, France) was used to reinforce the dissected tissues and the sutures before Dacron prosthesis was secured.^{8, 16, 17} In 42 patients (29%), the replacement of the ascending aorta was extended to the transverse portion of the arch.^{3, 18} Twenty-four patients (16.8%) had Marfan's syndrome, clearly defined by the presence of three criteria.¹⁹ In this latter group, 21 patients (87.5%) underwent a Bentall procedure,²⁰ whereas this operation was needed in only 16 patients (13.9%) among 122 without Marfan syndrome ($p < 0.002$). The overall hospital mortality rate is 23% (33/143). Thus 110 survivors were discharged from the hospital and surveyed from 6 to 186 months.

During the same period of time, 32 patients (nine women and 23 men) aged 27 to 78 years (mean 50 ± 22 years) had to be reoperated on one or several times (Fig. 1): 24 patients were reoperated on once, six twice, and two patients were reoperated on three times, for a total of 42 reoperations. Nineteen patients had had their first emergency procedure in our institution (19/110 = 17.2%) and 13 had been operated on elsewhere (Table I). Mean delay between the emergency operation and the first reoperation was 65 ± 20 months (4 to 85 months). Neither the presence of Marfan's syndrome, the type of acute aortic dissection, nor the technique used at first operation had any influence on the delay between the initial procedure and the first reoperation according to analysis of variance.

Twelve patients (36.3%) had Marfan's syndrome and seven of them (58%) had had a Bentall procedure at the first operation. None of these patients had undergone replacement of the transverse arch during the first procedure.

Reoperation was indicated for aortic root aneurysm or valve regurgitation (or both) in four cases, infectious false aneurysm on the distal suture in three cases, new dissecting process at a site distant from the initial dissection in five cases, and complicated evolution of a false lumen persisting beyond the initial repair in 30 cases (Table II). Ten reoperations (23.2%) had to be performed on an emergency basis in nine patients (28.1% of patients). As indicated in Table III, the reoperations have been classified into four groups according to the aortic segment involved in the repair. Five patients have had a multistage complete replacement of the aorta (Bentall, transverse arch, total thoracoabdominal aorta) after three or four operations (total 17), with one death (20% patients) and a risk of 5.8% (1/17) at each procedure.

Results

Hospital mortality. The overall hospital mortality rate is 21.6% (7/32 patients) and the risk of death is 16.6% for each operation (7/42). The hospital mortality

Table I. Place and type of first procedure and type of first reoperation

First procedure	Hôpital Foch	Other center	First reoperation	No.
Isolated suture	0	1	Bentall	1
Intraluminal prosthesis	0	1	Replacement of ascending aorta	1
Replacement of ascending aorta	10	9	AVR	2
			Replacement of ascending aorta	1
			Bentall	4
			Bentall + arch replacement	2
			Arch replacement	2
			Replacement of arch + AVR	1
			Replacement of arch + descending aorta	5
			Replacement of descending aorta	2
Bentall procedure	7	2	Replacement of ascending aorta	1
			Bentall + arch replacement	1
			Arch replacement	4
			Replacement of thoracoabdominal aorta	3
Replacement of thoracoabdominal aorta	2	0	Bentall	1
			Replacement of thoracoabdominal aorta	1
	19	13		32

AVR, Aortic valve replacement.

rates differ greatly according to the type of procedure performed at reoperation. They range from 0% in group II (0/8) to 30% in group IV (3/10), (see Table III). However, because of the small numbers in each group, the differences remain beyond the limits of statistical significance.

Conversely, the difference in mortality between patients having an emergency operation (5/9, 55%) and patients having an elective operation (2/23, 8.6%) is highly significant (χ^2 , $p < 0.005$). Also significant is the difference in the risk of death for each type of reoperation: 50% (5/10) for emergency operations and 6.2% (2/32) for elective procedures (χ^2 , $p < 0.005$). Risk of death is also influenced by thoracoabdominal replacement (χ^2 , $p < 0.035$).

Late results. The period of the survey ranges from 3 to 236 months (mean 42 ± 21 months, CI* 95%) after the first reoperation and from 5 to 284 months (mean 107 ± 25 months, CI 95%) after the initial acute dissection. Two patients had been lost to follow-up 6 and 156 months after reoperation. Eight patients died after a mean delay of 34 ± 11 months (range 3 to 120 months). The overall survivals after the first reoperation are therefore $65.1\% \pm 17.6\%$ at 1 year and $55\% \pm 19.63\%$ at 5 years (Kaplan-Meier, CI 95%, including hospital mortality) (Fig. 2). The survivals after the initial acute dissection for patients undergoing reoperation are $89.6\% \pm 11.0\%$, $79.3\% \pm 14.7\%$, $53.9\% \pm 18.1\%$, and $35.9\% \pm 21.8\%$ at 1, 5, 10, and 12 years, respectively (Fig. 3).

*CI = Confidence interval.

Table II. Indication for reoperation

	Elective	Emergency	Total
Recurring or increasing pain	10	0	10
Impending or actual rupture	6	3	9
Increasing aneurysmal volume	5	2	7
New dissecting process	4	1	5
Increasing aortic regurgitation	4	0	4
Distal false aneurysm	0	3	3
Neurologic disorders	2	1	3
Dysphagia	1	0	1
	32	10	42

Discussion

Technical improvements^{13, 16, 21-23} in emergency operations for acute aortic dissection, associated with better preoperative and postoperative management of the patients, have resulted in an acceptable hospital mortality rate in recent years.¹¹ Whatever technique is used, however, surgery remains essentially imperfect and palliative.

A brief review of the literature shows that the rate of late reoperations for complications of a remaining dissection or recurrence of the dissecting process ranges from 13% to 30% at 10 years.^{8, 11, 12, 24-26} Our experience is in accordance with the data in the literature, because we had to reoperate on 19 patients (17.2%) in the group of 110 patients on whom we had initially operated. The number of patients who might require a late reoperation may be higher, because spontaneous rupture of a persisting dissecting aneurysm is responsible for 10% to 50% of late deaths.

Fig. 1. Delay between emergency operation for acute dissection and first reoperation.

Table III. Classification of reoperations according to aortic segment replaced

	No.	Hospital death	%	Late death	%
Group I	15	2	13.3	4	30
Aortic valve replacement	3	0		0	
Replacement of ascending aorta	3	1		2	
Bentall	6	0		1	
Bentall + replacement of transverse arch	3	1		1	
Group II	7	0	0	1	14.2
Replacement of transverse arch	7	0		1	
Group III	10	2	20	3	37
Replacement of transverse arch + descending aorta	7	2		3	
Replacement of descending aorta	3	0		0	
Group IV	10	3	30	0	0
Replacement of thoracoabdominal aorta	9	3		0	
Replacement of abdominal aorta	1	0		0	
	42	7	21.8 (pt) 16.6 (reop.)	8	32

Table IV. Risk factors influencing late reoperation

Patients' condition	No.	Survivors	Reoperation	%	p Value
Arch replacement	42	30	0	0	<0.013
No arch replacement	101	80	19	23.7	
Marfan	24	18	7	38.8	<0.023
Non-Marfan	119	92	12	13	

In patients with Marfan's syndrome, surgery is obviously palliative because complete replacement of the vessel is physiologically and technically unrealistic.^{27, 28} In the whole group of patients undergoing late reoperation, 12 (37.5%) had Marfan's syndrome. This figure is

disproportionately high inasmuch as patients with Marfan's syndrome comprised only 16.2% (χ^2 , $p < 0.05$) in the total cohort of patients with acute dissections.

In the group of patients initially operated on in our institution, the rate of reoperation was significantly higher in patients with Marfan's syndrome (7/18, 38.8%) than in those without Marfan's syndrome (12/92, 13%) (χ^2 , $p < 0.05$) (Table IV). Moreover, in the series of eight patients who underwent two reoperations, seven (87.5%) had Marfan's syndrome and among them two had to undergo a third reoperation. Those late redo procedures were related to the evolution of the aortic disease in all cases.

Does the result of the initial procedure influence the likelihood of late reoperations and, if so, in what patients? In the present study, 15 patients had to be reoperated on

Fig. 2. Survival after the first reoperation (Kaplan-Meier, CI 95%).

Fig. 3. Survival, after the initial operation for acute dissection, of patients having a reoperation (Kaplan-Meier, CI 95%).

because of a complication involving the previously repaired ascending aorta. Among them, 11 patients had not undergone the initial emergency procedure in our institution. In nine patients the initial emergency aortic replacement had been unsatisfactory (e.g., aortic suture, intraluminal prosthesis, persistence of a regurgitant aortic valve). They all required a second procedure on the ascending aorta (see Table I), as did the five patients with Marfan's disease who had not undergone a Bentall procedure at the first operation. On the contrary, in the eight patients who had undergone a Bentall procedure at the first operation, seven of whom had Marfan's syndrome, the redo procedure was related to a technical defect in one case only. These results confirm that in patients with Marfan's syndrome the aortic root must be totally

replaced with a valved conduit even in the absence of important annuloaortic ectasia.

Because we have not used intraluminal prostheses during the emergency initial procedure, we do not know if their use increases the risk of late reoperation.

Surgical experience and pathologic studies have demonstrated that in up to 30% of patients with acute type A dissection the intimal tear is located in the transverse arch.^{1,3-6} In those cases, replacing only the ascending aorta, and leaving the entry site in place, may lead to late complications. Thus a question remains controversial and still unresolved: In such cases, does the extension of the aortic replacement to the transverse arch reduce the likelihood of late reoperation? Therefore, should the transverse arch be replaced at the initial emergency operation

when (and only when) the intimal tear is located on this portion?^{3-6, 29, 30} We have advocated this policy for more than a decade.^{3, 6, 8, 31} This attitude seems to be shared at present by an increasing number of authors.^{4, 5, 32, 33}

We consider that resection of the intimal tear is mandatory and that its presence on the transverse arch is a pressing indication to replace this aortic portion. This opinion is justified by the fact that in the 30 patients who survived emergency arch replacement, no one required a late reoperation (0%) whereas the arch had to be replaced at late reoperation in 10 patients (12.5%) of the 80 survivors who had had no arch replacement. This difference is statistically significant (χ^2 , $p = 0.02$) (Table IV).

However, inasmuch as no randomized study was carried out (and moreover would be unrealistic), we do not know what the long-term prognosis of those patients would have been if the transverse arch had been preserved and the intimal tear not resected. Nevertheless, there is a strong suggestion that resecting the arch when the intimal tear is located on it would result in fewer late reoperations.

This improved prognosis might not be the case in patients with Marfan's syndrome. As stated earlier, the necessity for late reoperation in those patients relates to the pathologic state of the distal aorta. It is unlikely that the distal aorta would be greatly affected by arch replacement at the first emergency procedure. This theory is confirmed by the fact that 10 second and third reoperations in this study were carried out in patients with Marfan's syndrome. The dissected aorta had been left distal to the repair at the previous operation, because an extended replacement would have been difficult and unsafe and a further reoperation, if necessary, would be safer. Only two of these reoperations had to be performed on an emergency basis. The remaining procedures were planned and performed electively. This attitude has been rewarding, because no patient died during those reoperations.

In this series, emergency surgery is the only determinant risk factor of death at univariate (χ^2 , $p < 0.005$) and multivariate analysis. In other words, elective reoperation in the presence of an evolving dissecting aneurysm entails an acceptable risk. The decision to reoperate, mandated by the occurrence of new symptoms, was made 32 times in 23 patients. Reoperation resulted in two hospital deaths (8.6%) and a risk of 6.2% for each reoperation.

The present study confirms that replacement of the ascending aorta must be as complete as possible and that a primary intimal tear on the transverse arch and failure to resect the arch during the first emergency operation predisposes to reoperation. We therefore reach the following conclusions:

1. In patients with Marfan's syndrome, the ascending

aorta and the aortic valve must be replaced systematically with a composite graft at the initial emergency operation.^{27, 28, 34}

2. In all patients, if the intimal tear is located on the ascending aorta, this segment alone should be replaced and the aortic valve preserved whenever possible.² When (and only when) the intimal tear is located in or extends to the transverse arch, this segment should be partially or totally replaced.

Patients surviving an emergency operation, especially those with Marfan's syndrome, must be submitted to routine survey on a 1-year basis by noninvasive techniques. During this survey, elective reoperation should be considered in the presence of an evolving dissecting aneurysm before the occurrence of an acute complication that inevitably will lead to a much more risky reoperation or death before any procedure can be undertaken.

Addendum

Since submission of this article, six additional reoperations were performed in five patients. Two patients had been previously operated on in our institution and three in another center. No hospital deaths occurred. The overall mortality rate is presently 18.9% and late survival is 68% at 1 year and 58% at 5 years.

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Discussion

Dr. Hans G. Borst (Hannover, Germany). I would like to comment briefly on our own experience with reoperations for aortic dissection performed in a 15-year time span starting from 1978. We have operated on about 340 patients for aortic dissection, half of them for the acute variety and about 100 for the chronic type A variety. Ninety patients were operated on for type B dissection. A total of 116 repeat operations were done in 92 patients within 4 years of the primary procedure, for a rate of 27%, similar to yours.

On the basis of the figures shown by Dr. Bachet and by us, we can conclude that patients with aortic dissection must be closely watched and operated on electively at the optimal time. The only exception is a substantial proportion of patients with DeBakey's type II dissection, which we consider to be a curable disease in most instances. Interestingly, our early mortality was similar to that of Dr. Bachet, 16% for all these reoperations. I was a little surprised, however, Dr. Bachet, that you had so much trouble with the thoracoabdominal aneurysms. We had only one death in 20 operations. I would like to know the reasons for that, because usually thoracoabdominal redo operations are distant from the primary site and therefore easier to perform.

My second comment refers to the risk of redo operations at the original site. We find that these operations are much more problematic than those performed on distant portions of the aorta.

Dr. Denton A. Cooley (Houston, Tex.). Although gelatin-resorcin glue is available in some countries, particularly to repair acute dissections, it has not been approved by the Food and Drug Administration for use in the United States.

I would like Dr. Bachet to comment on his use of resorcin

glue. Does it have any toxic effects, since it is activated with formalin? Does it interfere with late healing? Perhaps we can use the glue in cases where others have used extensive sandwiching of felt strips to enhance anastomoses. Furthermore, I noticed that the Bentall procedure was used rather frequently in patients with dissecting type A aneurysms. Is the glue useful in avoiding the need for the Bentall-type repair in type A aneurysms?

Dr. M. Arisan Ergin (*New York, N.Y.*). Between 1985 and 1993 a total of 122 patients were operated on for type A acute and chronic dissections. Sixty-three primary operations were done for acute dissection. Fifty-three patients survived and were discharged. They were followed up for 3 months to 8 years. Six late reoperations were done in this group of patients; one was an aortic valve replacement for persistent regurgitation and the remainder were mostly for distal aortic disease.

In contrast, 59 operations done for chronic type A dissections included 18 reoperations for sequelae related to acute type A dissection repair done elsewhere. The mortality in this group of patients was similar to the figures reported by Dr. Bachet and just mentioned by Dr. Borst. Overall mortality was 17%. Two striking findings in this group were that seven patients had Marfan's syndrome and 11 of these reoperations were clearly related to the failure of the first operation. These patients required a combination of ascending aortic replacement and the Bentall procedure, and in eight patients the arch was replaced. In addition, four patients had distal resections.

The failure of the proximal repair in these patients can be traced to three primary causes: (1), redissection at the aortic root in two patients, one of whom had Marfan's syndrome; (2) an attempt at valve preservation in a dilated root, which was the most common cause of failure of the proximal repair; (3) attempted primary repair that led to failure in three patients. In four additional patients, use of the intraluminal graft directly or indirectly contributed to the failure.

In our experience with the 53 patients with acute type A aneurysms who were discharged, the freedom from reoperation at 5 years is about 85% and at 8 years about 77%. Even though it may sound paradoxical, we believe that a radical operation that removes all proximal disease in the initial procedure for the treatment of the acute dissection may be the more conservative approach. I believe that a sound, proximal repair is imperative for reducing the rate of reoperation in these patients. It is inevitable that some patients will require reoperation for problems related to the distal residual dissection. However, as Dr. Borst just mentioned, these usually can be handled easily with reduced mortality.

I have two questions: First, what are your current indications for total root replacement in acute type A dissections? Second, we all know that you have been a proponent of the glue since its

inception. The glue obviously allows one to do a more conservative operation in acute dissection. Do you think the glue contributed in any way to the higher rate of failure at the proximal site?

Dr. Bachet. I would like to thank Dr. Borst, Dr. Cooley, and Dr. Ergin for their comments. There are a lot of questions to be answered.

Dr. Borst pointed out the numerous deaths among our patients who underwent thoracoabdominal replacement. I can give you a clear explanation. When we refer to thoracoabdominal replacement in this experience, we refer to huge thoracoabdominal aneurysms extending from the subclavian artery to the bifurcation, that is, Stanley Crawford group II. We know that in this group of patients, especially with chronic dissection, the risk of paraplegia is at its maximum. In our experience, paraplegia has always been a cause for death. No paraplegic patient was discharged after this kind of operation. Besides, three of the four persons who died after thoracoabdominal replacement were operated on an emergency basis. That is the main reason why they died, either during the operation or in the intensive care unit.

Dr. Cooley, without any doubt the use of glue has offered a very impressive improvement in the results of surgery of acute dissection and has allowed us to perform this kind of operation simply and safely. I am aware of the concern that the glue might be toxic because it contains formalin. However, the risk of acute dissection is so important and the risk of oncogenicity of formalin is so low that I think those two risks should not be compared. When the house is on fire, you call the firemen even though they will wet the rug by entering the house. I believe the toxicity of formalin is not a problem at all. However, the company that makes the glue is trying to replace the formalin by another product that will be efficient and nontoxic.

I have no proof that the glue is directly useful in preventing late reoperation, but I'll say that improving the immediate results obviously improves the late results, and that makes the glue very efficient in this respect.

Dr. Ergin concerning the total replacement of the aortic root, our policy is rather simple. At emergency procedure, all patients with Marfan's disease have a total aortic root replacement. We believe, as do many other colleagues, that the risk of late dilatation of the root is very high if the sinuses of Valsalva are left in place and that the risk of death is not increased by performing this technique. Doing so, we are convinced that we reduce the risk of late reoperation. In this study, the great proportion of aortic root replacements during late reoperation is linked to the fact that most patients of this group did not undergo their first emergency procedure in our institution and that their repair was unsatisfactory.