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Radical replacement of the aortic root in acute type A dissection: indications and outcome

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Abstract *Objective.* Failure of the repair at the proximal aorta is an important cause of morbidity and mortality following surgical treatment of acute type A dissection. This review was undertaken to determine the influence of total composite replacement of the ascending aorta and the root on the operative risk and long-term survival.
Methods. In a consecutive series of 73 patients with acute type A dissections between 1985 and 1994, 19 (26%) patients with radical root replacement (group I) were compared with 54 patients who had conventional valve-preserving root reconstruction (group II).
Results. Group I represented a higher operative risk with the presence of significant aortic regurgitation (13/19 68.4% vs 23/54 42.5% $P<0.05$), aortic dilatation (19/19 100% vs 32/54 59.2% $P<0.00$), and coronary dissection (13/19 68.4% vs 3/54 5.5% $P<0.000$). In spite of this there was no difference in operative mortality (3/19 15.7% vs 7/54 12.9%, NS) or the occurrence of major postoperative complications: bleeding (3/19 15.7% vs 7/54 12.9%, NS), respiratory (5/19 26.3% vs 11/54 20.3%, NS), stroke (2/19 10.5% vs 3/54 5.5%, NS). Patients with radical root replacement had substantially better event-free survival at 5 years (87.5% ± 11.7% vs 67.1% ± 8.9%) and 9 years (87.5% ± 21.9% vs 63.0% ± 19.2%).
Conclusions. This experience confirms that, in the treatment of acute type A dissection, an aggressive approach to aortic root pathology is indicated for specific indications, and can be carried out with good early and excellent long-term results.
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Key words Acute dissection · Ascending aorta · Composite replacement · Survival

Introduction

Surgical treatment of type A dissections has significantly improved the survival rate during the acute stage. However, the long-term prognosis still remains less than optimal. A substantial number of survivors of the acute phase are at risk for the development of complications related to the dissected aorta [8, 11]. Unlike complications due to the residual patent false lumen in the distal aorta, the complications that occur at the aortic root can commonly be traced back to the surgical decisions and techniques used during the initial repair. Recognized, and sometimes not so well appreciated, causes of the failure of proximal repair include primary repair of the dissected aorta and inclusion techniques [10], residual or recurrent dissection at the aortic root, progressive aortic regurgitation or attempts at valve preservation in the presence of a dilated root and/or Marfan's syndrome [9, 10, 15]. Application of the techniques developed for composite replacement of the aortic

valve and the root should prevent most of these problems effectively. However, in acute type A dissection composite replacement of the aortic valve and the root has been used only sparingly if at all [2, 9, 15]. We have used radical replacement of the aortic root with increasing frequency for specific indications in the surgical treatment of acute type A dissection of the aorta. The following study was undertaken to determine whether this aggressive approach to aortic root pathology is warranted, whether it increases the surgicl mortality and morbidity and if it, in fact, improves the long-term outcome.

Material and methods

Patients

Seventy-three consecutive patients underwent surgical repair of acute type A dissection between 1986 and 1994. In this group of patients, 19 (26%) (group 1) had radical replacement of the aortic valve, root and the ascending aorta for specific indications. The remaining 54 patients (74%) had conservative repair of the root with preservation of the aortic valve and replacement of the ascending aorta and varying portions of the aortic arch and the descending aorta (group 2). Group 1 included 17 men and 2 women with a mean age of 58.2 years (range 27–77 years), group 2 included 42 men and 12 women with a mean age of 52.4 years (range 28–81 years). The distribution of pertinent associated pathology and the operative findings in both groups is listed in Table 1. There was a total of six patients with Marfan's syndrome or its variants, three in each group.

Table 1 Preoperative variables and the distribution of the intimal tears

Pathology	Group 1		Group 2		*P*
Aortic dilatation	19/19	100%	32/54	59.2%	<0.001
Aortic regurgitation	13/19	68.4%	23/54	42.5%	<0.05
Coronary dissection	13/19	68.4%	3/54	5.5%	<0.000
Contained* or free rupture	14/19	73.9%	29/54	53.7%	NS
Ascending tear	15/19	78.9%	30/54	55.5%	NS
Arch tear	3/19	15.8%	15/54	27.8%	NS
Multiple tears	1/19	5.3%	3/54	5.5%	NS
Descending tear	0/19	0%	5/54	9.3%	NS

* Contained rupture denotes presence of hematoma in the mediastinum or between the aorta and the pulmonary artery without intrapericardial free blood

Table 2 Extent of distal resection

	Group 1	Group 2
Extent of resection		
Ascending	9	21
Hemi arch	10	19
Total arch	0	2
Total arch + descending	0	10
No replacement	0	2

Procedures and surgical techniques

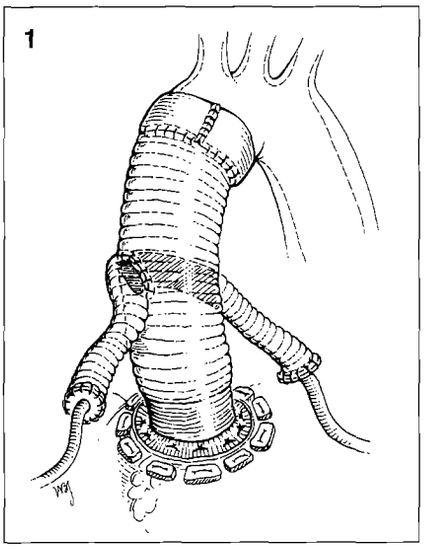
The proximal repair in group 1 consisted of radical replacement of the aortic valve, the root, the ascending aorta and varying portions of the aortic arch with a composite conduit and reimplantation of the coronary arteries. In group 2 the aortic valve was preserved by its resuspension or root repair in addition to replacement of the ascending aorta and varying portions of the aortic arch and the descending aorta, as dictated by the operative findings. In two patients, the aortic valve was replaced separately. All distal anastomoses were constructed with the "open" technique during a period of hypothermic circulatory arrest. The extent of the repair and replaced portions of the aorta are summarized in Table 2.

For the radical replacement of the aortic root, prefabricated conduits containing tilting disc valves were used in 3, and bileaflet disc valves were used in 16, patients. The average conduit size was 24.3 mm (range 21–27 mm). The conduits were implanted by three principle surgical methods. 1. Classic Bentall [3] procedure was used on two patients. The aortic valve was replaced with a composite conduit and the in situ coronary orifices were anastomosed to the conduit. The remnant of the ascending aorta was wrapped around the conduit for hemostasis. The open distal anastomosis was made to full thickness aorta during circulatory arrest. 2. Modified Bentall procedure [16] was used in seven patients in whom the coronary orifices were dissected out with surrounding buttons of aortic tissue and directly anastomosed to the conduit. The aortic remnant was completely excised removing all dissected tissues from the root. The mattress fixation sutures for the composite graft were placed from outside the perimeter of the root through the annulus. The coronary button anastomoses were reinforced with strips or washers of Teflon felt. This technique yields a secure proximal repair with absolute hemostasis at the root. 3. Cabrol modification of the Bentall procedure was used in ten patients. In two patients it was used as originally described by Cabrol [5] where the in situ coronary orifices were anastomosed to a separate Dacron graft, which was in turn anastomosed to the side of the main conduit. In the remaining eight patients, the coronary orifices were dissected out as buttons with surrounding aortic tissue prior to end-to-end anastomosis to the "Cabrol" graft. The remnant of the aorta was totally excised (Fig. 1). The distal extent of the aortic replacement in nine patients (47%) was confined to the ascending aorta, and it extended into the proximal portion of the aortic arch in the remaining ten patients (53%).

For conservative repair, simple reconstruction of the root in preparation to ascending graft anastomosis was adequate in 21 patients. In 30 patients with significant aortic valve regurgitation due to commissural detachment, additional resuspension of the valve was necessary. In all patients particular emphasis was placed on removing all dissected tissues from the root as far as possible. This required the nearly complete removal of the non-coronary sinus in most patients. Two patients had separate aortic valve and graft replacement of the ascending aorta due to persistent aortic regurgitation in spite of resuspension of the valve commissures. One patient had valve-preserving root replacement. The extent of distal aortic replacement in patients with conservative root repair was ascending only in 21 (38%), ascending and proximal portion of the aortic arch in 19 (35%), total arch and/or descending in 12 (23%). Two patients (4%), one with iatrogenic dissection and one with retrograde dissection, were treated without replacement. The average ascending aortic graft size (usually size matched to the diameter of the sinotubular ridge) was 29 mm (range 24–38 mm).

Follow-up

All patients were followed by serial computed tomography (CT) scans. Clinical follow-up was updated by recent examination, phone



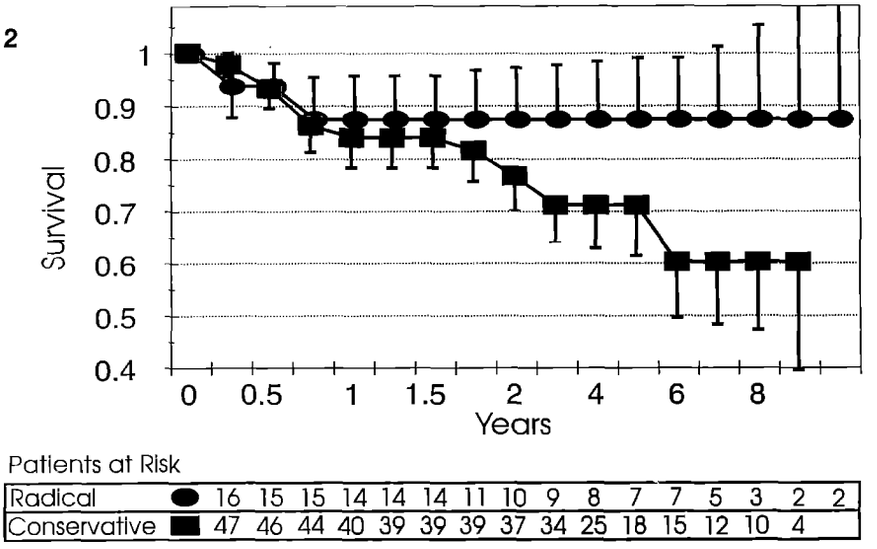


Fig. 1 Modified Cabrol procedure preferentially used for the treatment of coronary dissection (see text for details)

Fig. 2 Comparative event-free survival (Kaplan-Meier)

contact or information obtained from primary care physicians. Three patients were lost to follow-up, none in the group with radical root replacement. The overall mean follow-up was 3.9 years, 4.07 years in the group with radical root replacement.

Statistical analysis

The difference in various preoperative factors, hospital mortality and occurrence of major postoperative complications were compared between the two groups. Statistical variance was tested with the chi-square test; probability values less than 0.05 were considered significant. Actuarial curves for late event-free survival rates were constructed by the Kaplan-Meier linearized product method and compared for both groups.

Results

Preoperative variables and pathology

There were significant differences between patients who had radical replacement of the aortic root and those who had conservative root repair in terms of the incidence of dilatation of the ascending aorta (>38 mm diameter) (19/19, 100% vs 32/54, 59%, $P<0.001$), aortic regurgitation (13/19, 68% vs 23/54, 42%, $P<0.05$) and the presence of coronary dissection (13/19, 68% vs 3/54, 6%, $P<0.0001$). Patients with radical replacement also had a higher incidence of free or contained rupture (14/19, 74% vs 29/54, 54%, NS). There were no significant differences observed in the distribution of the intimal tears and incidence of preoperative hemodynamic compromise or new neurologic symptoms.

Hospital mortality and postoperative complications

Ten patients died in the hospital (overall mortality 10/73, 13.6%). There was no significant difference in hospital mortality following radical replacement of the aortic root (3/19, 15.7%) or conservative root repair (7/54, 12.9%). The cause of hospital mortality following radical replacement was pulmonary embolism in one, myocardial infarction related to coronary dissection in one and technical, due to kinking and resultant clotting of the left limb of an in situ Cabrol graft, in the last patient.

Major postoperative complications were observed with similar frequencies in the two groups. Postoperative bleeding requiring reexploration occurred in 3/19, 15.7%, following radical replacement and in 10/54, 18.5%, following conservative root repair. Insignificant differences were seen in the incidence of other complications, like cardiac (mostly rhythm disturbances) 6/19, 31.5% vs 17/54, 31.4%, respiratory 5/19, 26.3% vs 16/54, 29.6%, renal failure requiring temporary dialysis 1/19, 5.2% vs 7/54, 12.9% and stroke 2/19, 10.5% vs 5/54, 9.2%.

Long-term results

There were two late deaths among 16 patients discharged from the hospital following radical replacement of the aortic root. One death resulted from an infected Bentall graft at 3 months postoperatively, and the other patient died as a result of necrotizing enterocolitis and bowel perforation 7 months postoperatively. There have been no aorta-related late events in the survivors. The event-free survival in discharged patients following radical replacement of the aortic root at 1, 5 and 9 years is 87.5% ± 8.3, 87.5% ± 11.7 and 87.5% ± 21.9, respectively. There were seven late deaths and seven late events (four related to the ascending aorta

and aortic valve) among 47 patients discharged from the hospital following conservative root repair. There were three reoperations. In two patients composite root replacement for dilating root and increasing aortic insufficiency (AI) was necessary. One patient required late closure of a persistent Cabrol fistula. One patients has moderate Al and will probably require valve replacement in the future. The event-free survival in this group of patients is 84.9% ± 5.2, 73.1% ± 8.9 and 63.0% ± 19.2, respectively. Although statistically not significant, there is a distinct trend towards improved event-free survival following radical replacement of the aortic root (Fig. 2).

Discussion

The competence of the aortic valve in a dissected root can be restored using conservative surgical techniques with either simple resuspension of the commissures [17], Teflon remodelling of the root [6] or with valve-preserving root replacement [7]. Preservation of the native aortic valve with these conservative techniques is possible in 70%–80% of the patients, and does not affect the surgical mortality or long-term survival [9, 12, 19]. However up to 20% of the patients will require aortic valve replacement because of residual or progressive postoperative aortic regurgitation within 10 years [9, 15, 18]. It is also well known that the long-term results of separate valve and graft replacement of the ascending aorta and lesser operations in patients with medial degenerative disease of the aorta including dissections are less than optimal [13, 14, 18]. In spite of this, in the surgical treatment of acute type A dissection, separate valve and ascending aortic graft replacement remains the second most frequently reported procedure after conservative root repair [2, 9, 15]. There is little doubt that, in the past, the expected increase in mortality and morbidity associated with a more extensive operation played a major role in the common reluctance to accept the radical replacement of the aortic root as an option [9]. A current change in this conservative attitude is evident. Svensson and associates [18] reported 11 composite replacements in their recent series of 37 patients with acute proximal dissections and Bachet and associates reported an incidence of 13.9% for the Bentall procedure in acute non-Marfan's dissections among a series of 143 patients over 15 years [2]. The currently reported incidence of 26% in this experience reflects one of the most liberal uses of these procedures in acute type A dissection without any significant increase in the surgical mortality or morbidity.

The indications and the surgical techniques for the radical replacement of the aortic root have evolved during this experience. Conservative root repair consisting of simple resuspension and remodelling is reserved for patients with normal-sizes aortic roots and structurally normal aortic valves. Separate replacement of the aortic valve and the ascending aorta is only rarely indicated for intraoperative failure of resuspension or in patients with abnormal aortic valves or previous valve replacement. In all these cases the prerequisite of a conservative root repair is the complete removal of all dissected tissues from the root. Regardless of the repair method employed, we strongly believe that leaving behind dissected tissues, especially in a dilated root, courts future problems if not immediate disaster. We have no experience with the use of gelatine-resorcinol-formol glue. Whether the use of this compound improves the long-term stability of the proximal repair without its being necessary to remove all dissected tissues from the aortic root is open to question [1, 2, 15].

All other patients, including all those with Marfan's syndrome, those with dilated roots and dilated sinotubular ridge and patients with dissection extending into the coronary ostia, are candidates for radical replacement of the aortic root. Patients with dissection of coronary ostia represent a particularly challenging problem. Fann and associates [9], in the combined Stanford-Duke series of dissections, have suggested a separate valve graft replacement as a compromise solution to this difficult problem. However, it is unclear how this may result in a stable root repair and, at the same time, maintain coronary patency in a badly dissected root. They have cautioned against the use of a composite replacement in this situation because of anticipated difficulties of direct anastomosis of the dissected coronary orifices to the composite graft.

Alternatively, closure of the coronary ostia followed by saphenous vein bypass grafting to the distal coronaries has also been used with poor long-term results [4, 18]. The described use of the Cabrol modification is ideally suited for dealing with the challenge of the dissected coronary ostium. Dissection of the coronary ostia on buttons of surrounding aortic tissue and end-to-end anastomosis to the Cabrol graft ensures the repair and reinforcement of even the most seriously dissected coronary orifice. It also prevents problems associated with the lay and eventual compression or kinking of this graft by allowing certain mobility at the coronary anastomoses at both ends. This technique eliminates all potential problems enumerated as arguments against the use of the composite root replacement in the presence of coronary dissection [9]. In all other patients a standard modified Bentall procedure, with reimplantation of the coronary arteries on buttons of surrounding aortic tissue and total excision of the remnant of the ascending aorta with full thickness anastomoses at both ends, remains the procedure of choice.

The use of composite grafts containing mechanical valves in the present series has proved to provide a durable repair free of anticoagulant-related complications. Concerns about the use of anticoagulants in patients with acute dissections, in the past, led to avoidance of mechanical prostheses in this situation and to the acceptance of the inevitable late reoperation associated with bioprostheses

[9, 15]. The absence of anticoagulation-related complications in our experience confirms Svensson and associates' [18] contention that the postoperative use of anticoagulants is not contraindicated in patients with acute dissections and that these patients are not at a greater risk of distal rupture because of anticoagulation.

This seemingly aggressive approach, that removes all diseased aorta from the aortic root in acute type A dissection, could be carried out without undue increase in mortality and morbidity compared to the results of more conservative procedures in the same institution and other centers [2, 8–10, 15]. The operative mortality of 15.7% for radical replacement of the aortic root in the current series compares favorably to the reported mortality rates of valve resuspension (15%) and separate valve and ascending aortic replacement (25%) in the combined Stanford-Duke series of acute dissections [9]. There is a clear trend towards better event-free survival following radical replacement of the aortic root.

This experience indicates that radical replacement of the aortic root is probably an underutilized option, which solves some of the technically most challenging dissection-related problems at the aortic root. Intelligent application of these techniques will help improve the long-term outlook for patients with acute type A dissection of the aorta.

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Discussion

Dr. M. Turina (*Zurich, Switzerland*): Thank you, *Dr. Ergin*, for this paper which goes contrary to the present trend in development of dissection surgery in Europe. If I may interject the first question, do you think that the fact that you do not have, or have only a limited access to, the French glue might have caused the change in your technique? You have surely read about European experience with the glue and I am sure that you have seen such procedures being performed. The present trend in Europe, when dealing with an acute type A dissection, is to resuspend and salvage aortic valve under practically all conditions.

Dr. Ergin: First let me qualify my answer with admitting that, as you well know, we do not have access to the glue and therefore no first hand experience with its use. However, we also resuspend and try to save the native valve in all patients if possible, that is provided that all dissected tissue can be removed from the root in the process. But, as you have seen, the major indication in our experience for the radical replacement of the root is the dilatation of the aortic root. I don't know what the long-term results in such patients would be, even with the use of the glue. I believe that preservation of a dissected root in the presence of intrinsic disease and dilatation of the sinuses invites immediate disaster or long-term problems. I am not sure that the use of the glue will affect the ultimate prognosis in this situation.

Dr. H. Borst (*Hannover, Germany*): This is a very interesting presentation and, of course, brings up a real fundamental question. I fully agree with you that, if there is the slightest sign of root dilatation, the root should go. Of course some of these patients are hypertensive and they have some dilatation anyway, without really having root ectasia, and it's very difficult to short them out.

Also, I guess some of the patients will come to surgery with a normal aortic root and then start dilating nevertheless, and this is really what you have shown. So, when repairing a root, one has to be as sure as possible that there is no underlying ectasia. I also think that if a patient has Marfan, he should not have a repair.

What I'm a little surprised about is the fact that your late mortality is so high. Why weren't these patients reoperated? If a root repair breaks down, we see no problem in inserting a conduit secondarily.

Dr. Ergin: The actuarial survival curve that I showed was the event-free survival curve, which included dissection-related events, such as complications and reoperations as well as late deaths. The event-free survival in the group that had the conservative root repair was about 60%. This is quite similar to what has been reported in the literature.

There is ample clinical evidence showing that long-term results of preservation of the root in the presence of intrinsic disease of the aorta is not good. I cannot imagine a root that is more diseased than one that is dissected. Again, to reiterate what I have just said in responding to Dr. Turina's question, regardless of the repair used with or without the glue, if dissected tissues are left behind that root will remain diseased and at risk.

Dr. A. Welz (*Munich, Germany*): One technical question. What type and size of graft did you use for the modified Cabrol procedure? And do you have data on the long-term patency of those grafts?

Dr. Ergin: We used 8–10 mm preclotted woven Dacron grafts prior to the availability of the Hemashield graft, which is our current choice. All these patients were included in the final analysis of event-free survival. There were no events related to the coronary grafts in the follow-up.

Dr. R. Dion (*Brussels, Belgium*): If you perform a radical replacement of the aortic root, you have to prescribe anticoagulants. One of the reasons why I would try to repair the aortic valve is to avoid secondary complications in relation to the persistence of the false lumen distal to the repair. In my mind, in the absence of anticoagulation, a persistent false lumen distal to the repair is more likely to close due to delayed thrombosis. May I ask you whether you could elaborate on the differential persistence of the false lumen after both procedures (replacement vs repair of the aortic valve)?

As always, I very much enjoyed your excellent presentation.

Dr. Ergin: This is an interesting question. Traditionally there has been an understandable reluctance for the use of chronic anticoagulation in the setting of aortic disease, and particularly following dissection; because of the fear of increasing the incidence of leak or rupture. In this series there were no such complications in patients who had radical root replacement, although they were all anticoagulated. This confirms a similar observation reported from Baylor earlier.

We have not specifically looked at distal false lumen patency in patients with chronic anticoagulation. The overall rate of false lumen patency for the entire series is little less than 50%, which is substantially lower than what is generally reported in the literature. You have brought up an important point; I should go back and look at the patients with composite grafts and note whether they, in fact, have a higher incidence of patency.