Acute type A aortic dissection complicated by aortic regurgitation: Composite valve graft versus separate valve graft versus conservative valve repair

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Objective: To clarify the merits of various surgical approaches, we studied the outcome after composite valve graft versus separate valve and graft replacement versus conservative valve treatment with replacement of the ascending aorta in patients with acute type A aortic dissection complicated by aortic regurgitation.

Methods: Between 1967 and 1999, 123 patients (mean age 56 ± 15 years) underwent composite valve graft replacement ($n = 21$), separate valve and graft replacement ($n = 20$), or conservative valve treatment ($n = 82$ [commissural resuspension in 46]); follow-up averaged 6.5 years (95% complete).

Results: The 30-day, 1-year, and 6-year survival estimates of $85\% \pm 4\%$, $79\% \pm 5\%$, and $69\% \pm 5\%$ (± 1 standard error of mean), respectively, after conservative valve treatment were similar to $86\% \pm 8\%$, $81\% \pm 9\%$, and $65\% \pm 16\%$, respectively, with composite valve graft replacement and better (but insignificantly so) than $70\% \pm 10\%$, $70\% \pm 10\%$, and $45\% \pm 11\%$, respectively, with separate valve and graft replacement. The 6-year freedom from proximal reoperation was $95\% \pm 3\%$, $89\% \pm 10\%$, and 100% in conservative valve graft, separate valve and graft, and composite valve graft subgroups, respectively ($P =$ not significant). Cox regression multivariable analysis identified that previous sternotomy (hazard ratio [or e^{β}] 95% confidence interval 1.4-10.9, $P = .006$), hypertension (0.99-2.9, $P = .05$), cardiac tamponade (1.1-4.0, $P = .03$), and stroke (1.7-7.0, $P = .001$) increased the hazard of death. No factors predicting a higher likelihood of late proximal reoperation were identified.

Conclusions: In patients with acute type A aortic dissection and aortic regurgitation, there was no significant difference in overall survival or reoperation rates among these surgical approaches. We try to save the valve whenever possible unless the aortic root is pathologically dilated (eg, Marfan syndrome or annuloaortic ectasia) or destroyed by the dissection process, when composite valve graft or valve-sparing aortic root replacement is indicated.

In treating patients with acute dissection of the aortic root complicated by aortic regurgitation (AR), the choice between composite valve graft (CVG) or valve-sparing aortic root replacement and conservative procedures (repair of the aortic root with conservation of the aortic valve and sinuses) (CONS) is largely dictated by operative findings, patient characteristics, and surgeon preference. A prospective, randomized, controlled trial to elucidate the relative merits of radical versus conservative surgical treatment of the

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Read at the Twenty-eighth Annual Meeting of The Western Thoracic Surgical Association, Big Sky, Mont, June 19-22, 2002.

Received for publication June 30, 2002; revisions requested Oct 1, 2002; revisions received June 1, 2003; accepted for publication July 7, 2003.

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J Thorac Cardiovasc Surg 2003;126:1978-86

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0022-5223/2003 \$30.00 + 0

doi:10.1016/S0022-5223(03)01279-0

Figure 1. Patient distribution by year according to aortic root treatment method.

dissected aortic root is logistically impractical; instead, retrospective studies may serve to elucidate the best patient and pathoanatomic substrate amenable to a conservative versus a more aggressive approach to the aortic root and thus refine our surgical decision-making process. We therefore analyzed the outcome of CVG replacement of the aortic root versus subtotal aortic replacement with separate aortic valve and graft (SVG) versus CONS valve treatment with graft replacement of only the tubular segment of the ascending aorta in patients with type A aortic dissection complicated by AR.

Methods

Patient Population

The cardiovascular surgery database at Stanford University School of Medicine contained 307 consecutive patients who underwent surgery for spontaneous acute type A aortic dissection from January 1967 to July 1999. Of these, 123 patients had more than trivial AR and underwent aortic root reconstruction or replacement. Three treatment groups were defined: Twenty-one patients (17%) were repaired using a CVG from 1989 to 1999, 20 patients (16%) were repaired using an SVG from 1972 to 1992, and 82 patients (67%) were repaired by replacement of the ascending aorta and aortic valve conservation from 1967 to 1999 (CONS) (Figure 1). Within the CONS group, simple commissural resuspension was performed in 46 patients. The diagnosis was made by aortography, computed tomography, magnetic resonance imaging, transthoracic or transesophageal echocardiography, or surgical findings. Patient clinical characteristics are detailed in Appendix 1. Surgeons were categorized by experience as “high volume,” those who performed 30 or more surgical repairs for aortic dissection (5 of 16 surgeons), and “low volume,” those who performed 30 or less repairs (11 surgeons) (Appendix 1). The heterogeneous treatment groups reflected inherent patient selection and surgeon biases.

Definitions

The dissection was classified according to the 1970 Stanford system.¹ The average time lapse from symptom onset to operation

was 48 ± 62 hours. There was no difference in disease acuity among the treatment groups. Patients with type A intramural hematoma were also included (Appendix 1). AR was diagnosed by preoperative echocardiography or aortography.

Operative Methods

Although variability in surgical techniques was present among the individual surgeons and the surgical techniques evolved over the years, the surgical approach uniformly was to resect all of the tubular portion of the ascending aorta and, if identified, the primary intimal tear. Earlier, cannulation of the femoral artery was used for cardiopulmonary bypass, but the right axillary artery became the preferred site for arterial cannulation in the late 1990s.² In recent years, most surgeons have striven to avoid aortic cross-clamping whenever possible, resecting the underside of the transverse aortic arch and performing an open distal “hemiarach” anastomosis using profound hypothermic (20°C – 25°C bladder temperature) circulatory arrest. In the early 1990s, a brief period of retrograde cold blood cerebral perfusion during completion of the open distal anastomosis was used by some surgeons. When the circulatory arrest period is anticipated to be longer than 30 minutes, selective antegrade cerebral perfusion is now used by most surgeons. During antegrade reperfusion and rewarming, attention is then directed to the proximal aortic root.

The most commonly performed proximal aortic procedure was reconstructing the sinotubular junction circumferentially and tube graft replacement of the ascending aorta. The native aortic valve was preserved whenever feasible. The main technical features of valve resuspension included complete transection of the proximal aorta, obliteration of the proximal false lumen down to the level of the aortic annulus with a custom-tailored piece of Teflon (DuPont, Wilmington, Del) felt inside the false lumen, and resuspension of the aortic valve commissures with circumferential suture reconstruction of the aorta.³ Frequently, this proximal cuff was reinforced by an external layer of Teflon felt. We have never relied solely on placing individual pledgeted mattress sutures at the tops of the commissures for this purpose. In the last 2 years, BioGlue (Cryolife, Inc, North West Kennesaw, Ga) has been used instead of Teflon felt. The graft size was based on the goal of restoring the sinotubular junction diameter to approximate the aortic annular

Figure 2. Actuarial survival estimates for all patients subdivided according to treatment group.

diameter. If attempts at commissural resuspension did not result in valvular competency, then aortic valve replacement using either the SVG or CVG approach was performed.

If the sinuses of Valsalva were excessively dilated (because of annuloaortic ectasia; $n = 15$, $71\% \pm 10\%$ of the CVG group [70% confidence interval]), pathologically diseased (eg, the Marfan syndrome [MFS]), or destroyed by the acute dissecting process ($n = 3$, $15\% \pm 8\%$ of CVG) with or without irreparable compromise of the coronary arteries ($n = 3$, $15\% \pm 8\%$ of CVG), complete aortic root replacement was performed. If it was judged that valvular competency could not be satisfactorily restored or if severe valve pathology was present, valve replacement was performed. CVG replacement (mechanical valve = 20; bioprosthetic valve = 1) and reimplantation of the coronary ostia was always performed as an open procedure using Carrel coronary button anastomoses avoiding "wrap inclusion" (Bentall procedure).

In SVG procedures, the bulk of the sinuses of Valsalva were resected leaving small tongues of aortic root tissue surrounding the coronary ostia. After the aortic valve was excised, a mechanical ($n = 1$) or bioprosthetic ($n = 19$) valve was inserted, and a woven synthetic graft was then anastomosed to the proximal and distal aortic cuffs (which were reinforced by 1 or more layers of Teflon felt). The extent of distal aortic resection in patients who underwent operation using hypothermic circulatory arrest and distribution of the location of the primary intimal tear are summarized in Appendix 1.

Follow-up

Current follow-up was obtained by telephone or written communication or both. Follow-up was 95% complete ($n = 117$), extended to a maximum of 30.7 years, and totaled 761 patient-years (Appendix 1).

Postoperative Care

Negative inotropic drug treatment was advised indefinitely, even in normotensive patients.^{4,5} Serial aortic surveillance with annual computed tomography or magnetic resonance imaging scans was

also recommended, but compliance with this recommendation could not be ensured.

Statistical Methods

Outcomes. Valve-related complications have been detailed in a previous report.⁶ Time-related events studied included death at any time after operation and reoperation for proximal aortic complications. Freedom from these time-related events was estimated by the nonparametric actuarial Kaplan-Meier method. For freedom from reoperation, a nonfatal event, actual (or observed cumulative frequency) probabilities were also computed. Analyses stratified according to treatment modality were compared using the log-rank test. Early mortality was defined as death within 30 days of treatment or during the same hospitalization, regardless of time. The variability of continuous data is expressed as mean $\pm$ 1 SD, the variability of important fractions or ratios is expressed as $\pm 70\%$ confidence levels (CL), and the variability of actuarial or actual estimates is expressed as ± 1 SEM, approximately equivalent to $\pm 70\%$ CL. Events arising from 1 or more valve-related complications were infrequent and thus were expressed as linearized rates (events per patient-year).

Identification of predictors of outcome. The influence of 25 preoperative characteristics or dissection-related complications (independent variables) on outcome (dependent variables) was analyzed by using SPSS for Windows (Release 10.0.0; SPSS Inc, Chicago, Ill). These independent variables included age, gender, duration of symptoms, year of operation, surgeon experience, shock, acute aortic insufficiency, paraplegia, visceral ischemia, renal dysfunction, peripheral pulse deficit, arch involvement, stroke, coronary artery disease, congestive heart failure, pulmonary disease, liver disease, diabetes mellitus, prior stroke, MFS, hypertension, previous dissection, previous sternotomy, tamponade, and rupture (Appendix 1). The predictors of time-related outcome were identified, and their hazard ratios (HR or e^{β}) with 95% CL were determined from Cox proportional hazards analysis.

Results

Survival

For all patients, the 30-day, 1-year, and 6-year actuarial survival estimates were $85\% \pm 4\%$, $78\% \pm 5\%$, and $65\% \pm 5\%$ (± 1 SEM), respectively. There was no significant difference in overall survival between the 3 treatment groups: The 30-day, 1-year, and 6-year actuarial survival estimates, respectively, were $86\% \pm 8\%$, $81\% \pm 9\%$, and $65\% \pm 16\%$ in the CVG group, $70\% \pm 10\%$, $70\% \pm 10\%$, and $45\% \pm 11\%$ in the SVG group, and $85\% \pm 4\%$, $79\% \pm 5\%$, and $69\% \pm 5\%$ (± 1 SE) in the CONS group (Figure 2). The apparent lower survival estimates in the SVG group were not statistically significant. Risk factors for death at anytime included previous sternotomy ($n = 5$; multivariable HR 4.0, 95% CL 1.5-10.9, $P = .006$; univariable HR 5.2, 95% CL 2.0-13.6, $P = .001$), stroke ($n = 12$; multivariable HR 3.3, 95% CL 1.6-7.0, $P = .001$; univariable HR 2.8, 95% CL 1.4-5.7, $P = .005$), cardiac tamponade ($n = 28$; multivariable HR 2.1, 95% CL 1.1-4.0, $P = .03$; univariable HR 2.2, 95% CL 1.2-4.3, $P = .01$), and hypertension ($n = 65$,

TABLE 1. Causes of late deaths subdivided according to proximal aortic root surgical treatment method

	CVG		SVG		CONS	
	N	(%)	N	(%)	N	(%)
Dissection rupture/extension			1	(2)	10	(12)
Sudden, unexplained			1	(2)		
Arrhythmia			2	(4)		
Myocardial infarction			1	(2)		
Congestive heart failure			1	(2)	7	(9)
Sepsis	1	(2)				
Renal failure			1	(2)	3	(4)
Respiratory failure/pneumonia			1	(2)	5	(6)
Stroke			1	(2)	4	(5)
Anticoagulant hemorrhage			1	(2)		
Malignancy					2	(2)
Suicide/accident					1	(1)
Unknown					2	(2)

CVG, Composite valve graft; SVG, separate replacement of the aortic valve and ascending aorta; CONS, aortic valve conservation.

multivariable HR 1.7, 95% CL 0.99-2.9, $P = .052$; univariable HR 1.9, 95% CL 1.1-3.1, $P = .02$). Neither treatment method nor “high-volume surgeons” were associated with any difference in survival.

Early Death

The hazard of death was highest immediately after operation (Figure 2). There was no difference in early death rate among the treatment groups (Appendix 1). A Cox proportional hazards regression model showed that shock (HR 5.8; 95% CL 1.5-23.4; $P = .01$) and stroke (HR 5.0; 95% CL 1.2-20.0; $P = .02$) predicted a higher likelihood of early death.

Late Death

Death from aortic-related complications was defined as that caused by progression of dissection and/or rupture and those that were sudden and unexplained. The causes of late death are listed in Table 1. None of the patients in the CVG group died from an aortic-related complication; 2% of the patients in the SVG group and 15% of the patients in the CONS group could have possibly died as the result of an aortic complication. This raw fractional difference in cause of late deaths did not attain statistical significance. Stroke accounted for 5% of late deaths in the CONS group and 2% in the SVG group. Anticoagulant-related hemorrhage did not cause any late deaths in the CVG group but was responsible for 2% of late deaths in the SVG group. Comorbidities, such as congestive heart failure, accounted for a high proportion of late deaths in the CONS group relative to the CVG and SVG groups, but more patients with residual aortic valve regurgitation were not detected at follow-up in the CONS group. Sepsis led to 1 late death in the CVG group in the absence of evidence of endocarditis at autopsy.

Figure 3. Actual freedom from proximal aortic reoperation estimates in all patients subdivided according to how the proximal aortic reconstruction was surgically performed.

Proximal Aortic and Aortic Valve Reoperation

The 6-year actuarial freedom from proximal aortic or aortic valve reoperation was $95\% \pm 3\%$, $89\% \pm 10\%$, and $100\% \pm 2\%$ in the CONS, SVG, and CVG subgroups, respectively ($P =$ not significant [NS]). Specifically, the 6-year actuarial freedom estimates from proximal aortic reoperation were $99\% \pm 1\%$, $89\% \pm 10\%$, and $100\% \pm 2\%$ in the CONS, SVG, and CVG subgroups, respectively ($P =$ NS); the 6-year actuarial freedom estimates from aortic valve reoperation were $94\% \pm 4\%$, $88\% \pm 12\%$, and $100\% \pm 2\%$, respectively ($P =$ NS). The 6-year actual freedom from proximal aortic or aortic valve reoperation was $98\% \pm 1\%$, $95\% \pm 1\%$, and $100\% \pm 2\%$ in the CONS, SVG, and CVG groups, respectively, and did not differ significantly among any of the treatment groups (Figure 3). No risk factors predictive of proximal aortic or aortic valve reoperation could be identified, including MFS. Treatment method was not associated with any difference in the probability of proximal aortic or aortic valve reoperation.

Major Morbidity and Valve-Related Complications

There was no significant difference in the rate of early postoperative bleeding or neurologic complications among treatment methods (Appendix 1). The number of valve-related events was few, particularly in the CVG group; there also was no statistical difference in the linearized rate of valve-related complications (Table 2).

Discussion

In most patients presenting with acute type A aortic dissection complicated by AR, the aortic valve can be conserved by commissural resuspension and supracoronary aortic grafting. In most series, the number of repaired valves expressed as a percentage of total number of regurgitant

TABLE 2. Linearized rates (%/patient-year) of valve-related complications tabulated according to type of proximal surgical procedure performed

	CVG		SVG		CONS	
	N	Rate	N	Rate	N	Rate
Residual valve disease	0	0	3	2 ± 3.1	7	1.2 ± 1.2
Stroke	0	0	2	1.3 ± 2.5	3	0.5 ± 0.8
Peripheral thromboembolism	0	0	1	0.7 ± 1.9	0	0
Hemolysis	0	0	0	0	0	0
Anticoagulant-related						
Hemorrhage	1	1.3 ± 2.5	0	0	0	0
Endocarditis	0	0	0	0	1	0.2 ± 0.5

Rate is events/100 patient-years, which is equivalent to %/patient-year ($\pm 70\%$ confidence limits).

valves ranged from 51%⁶⁻⁹ to 100%.¹⁰ At Stanford, the aortic valve has been conserved in acute dissection with increasing frequency during the last decade (Figure 1): The fraction of leaking aortic valves repaired increased from $52\% \pm 6\%$ in a 1991 2-center report⁶ (Duke University) to $67\% \pm 4\%$ in this present study. Despite our increased zeal for preservation of the aortic valve, the actuarial estimate of freedom from aortic valve reoperation is still high ($94\% \pm 4\%$ at 6 years) compared with the earlier Stanford-Duke estimate of 100% at 5 years.⁶ These results indicate that the surgeons over the years consistently adhered to fairly uniform anatomic and pathologic guidelines in terms of what procedure to perform. Patients with MFS, annuloectasia, and extensive aortic root dissection only rarely had the valve conserved, as other groups advocate.^{6,9-15} For example, Casselman and colleagues¹³ reported that an aortic valve annulus greater than 27 mm in diameter was associated with a 4.2-fold increase in relative risk of aortic root reoperation.

Contrary to our experience, the use of Teflon felt for reconstruction of the aortic root has not met with widespread uniform success.^{9,13,16} Niederhauser and colleagues⁹ reported that at 2 years, patients who underwent gelatin-resorcin-formaldehyde (GRF) (or "French" glue) reconstruction of the aortic root had an increased freedom from reoperation on the aortic root (92% vs 70% , $P = .02$) and event-free survival (77% vs 41% , $P = .02$) compared with simple suture resuspension. Although we recognize the benefits of a tissue adhesive in creating a sturdy substrate for suturing and have moved to BioGlue as a substitute for Teflon felt, we remain dubious about GRF in light of recent reports of GRF-related tissue necrosis of the aortic root.¹⁷

Overall, supra-commissural aortic valve resuspension has exhibited relatively excellent long-term durability in this and other series.^{6-8,10,11,16,18} There is, however, 1 confounding factor: The reported long-term durability of the repair may artifactually be better when all patients are considered instead of just those with AR.^{8,11,18,19} Pessotto and coworkers⁷ and Mazzucotelli and coworkers¹¹ reported that the presence of moderate-to-severe aortic insufficiency

in patients portends an increased rate of reoperation ($>37\%$ - 39% of patients) compared with patients with no or mild AR. Kirsch and colleagues from the Hôpital Henri Mondor²⁰ reported that severe AR increased the HR of reoperation on the proximal aorta by 3.6-fold (1.44 - 9.07 ; 95% confidence interval) and recommended more frequent consideration of CVG (or valve-sparing aortic root replacement) at the time of the initial operation in patients with severe AR. We concur given that moderate-to-severe AR may be a surrogate for more pronounced aortic root disease.

Freedom from aortic root reoperation was independent of both surgical treatment method and patient-related risk factors. The MFS did not emerge as a risk factor for reoperation, as intuition would dictate, perhaps because most patients with MFS received a CVG procedure. The fact that this analysis was unable to identify factors predicting an increased likelihood of reoperation reflects appropriate patient selection for the various procedures, namely, customizing the operative procedure to the patient and his or her disease.

The actuarial estimate of freedom from reoperation in the SVG group was "artificially" lowered by the strong competing hazard of death; when expressed as an actual estimate, freedom from reoperation was comparable to that in the CONS and CVG groups (Figure 3). Nonetheless, we basically abandoned the SVG procedure in 1989 (Figure 1). Indeed, Moon and colleagues¹⁹ reported a very high operative mortality rate of $50\% \pm 16\%$ for patients undergoing SVG; however, similar to our findings, they found no difference in late aortic reoperation or survival depending on which aortic root operative technique was performed initially. Patient survival, including early postoperative mortality, also was not influenced by treatment method; it seems that patient substrate was the main determinant of survival, a finding corroborated by Niederhauser and colleagues.⁹ The predictors of short- and long-term survival were patient-related and dissection-related factors, which for the most part cannot readily be modified. There is some debate concerning whether long-term survival and operative mortality risk after either an aggressive or a more conservative

aortic root procedure are comparable in centers with special thoracic aortic expertise.^{8,9,11,18,19} Ergin and coworkers²¹ from Mount Sinai reported that patients undergoing total root replacement represented a higher operative risk subset as the result of having substantial AR and coronary dissection, but paradoxically had substantially better event-free survival estimates at 5 years ($88\% \pm 12\%$ vs $67\% \pm 9\%$) and 9 years ($88\% \pm 22\%$ vs $63\% \pm 19\%$); these authors recommended that root replacement should be considered more frequently. On the other hand, data reported by Sabik and colleagues¹⁸ from the Cleveland Clinic showed that CVG carried a significant adverse impact on overall survival ($P = .0009$), primarily in the early hazard phase. von Segesser and coworkers⁸ have argued that simple preservation of the valve offers a sound long-term prognosis without exposing the patient to undue risk. The general consensus today^{6-8,13-15,18-20,22} indicates that a more aggressive surgical approach (eg, CVG) should be considered only in special circumstances.

The David “reimplantation”²³ or Yacoub “remodeling”²⁴ methods of valve-sparing aortic root replacement combined the benefits of aortic root replacement as well as preservation of the aortic valve; thus, this may be an even better alternative for repair of the dissected aortic root in highly selected patients with an acute type A aortic dissection and AR. The early results reported by Graeter and colleagues from Homburg,²⁵ Leyh and colleagues²⁶ from Lubeck, and the cardiovascular surgical group from Hannover²⁷ have been encouraging. The outcome after CVG and CONS procedures reported in this article will serve as clinical benchmarks in the future to assess the putative long-term benefits of this “ultraradical” valve-sparing surgical approach as applied to these very challenging patients.

Limitations

The current study was limited by the absence of universal follow-up echocardiographic data; it is therefore highly likely that the freedom from aortic valve reintervention rate was underestimated by some patients having moderate or possibly even severe AR yet not having undergone reoperation. We were unable to demonstrate any long-term benefit or drawbacks associated with repairing the native aortic valve compared with replacement with either a mechanical or a biologic valve substitute in terms of structural and nonstructural valve failure, anticoagulant-related hemorrhage, endocarditis, or thromboembolic events, but because late attrition was high and serial echocardiographic surveillance was incomplete, this may be attributable to inadequate statistical power.

Acute AR was present in only 123 of 307 patients (40%), which is less than the 59% and 100% reported by Ehrlich and coworkers²⁸ and Niederhauser and coworkers, respectively.⁹ This discrepancy is probably attributable to different methods for classifying the severity of acute AR rather than

the acuity of disease. A possible selection bias may have been introduced by excluding 28 patients in the CVG and SVG groups who did not have AR preoperatively; analysis of all 307 patients with or without AR did not change the major conclusions, but SVG was associated with a higher probability of proximal aortic reoperation.

Conclusion

There was no significant difference in overall survival or proximal reoperation rates after either an aggressive or a conservative operation for patients with acute type A aortic dissection. We concur with the editorial philosophies espoused recently by Elefteriades¹⁴ and Kron²² that the best operation is one that is customized to each individual patient. We presently prefer CONS, CVG, or David reimplantation valve-sparing aortic root replacement depending on the individual patient and specific pathoanatomic features encountered.

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APPENDIX 1. Characteristics of 123 patients with acute type A aortic dissection complicated by aortic regurgitation, subdivided into those repaired using composite valve grafting, separate aortic and valve graft replacement, or aortic valve conservation

	All patients (n = 123)		CVG (n = 21)		SVG (n = 20)		CONS (n = 82)	
	N	(%)	N	(%)	N	(%)	N	(%)
Demographics								
Age (mean $\pm$ SD) (yr)	56 $\pm$ 15		51 $\pm$ 19*		51 $\pm$ 15*		59 $\pm$ 13*	
Gender								
Male	84	(68)	15	(71)	15	(75)	54	(66)
Female	39	(32)	6	(29)	5	(25)	28	(34)
Surgeon experience	100	(81)	20	(95)**	10	(50)**	70	(85)**
Presentation								
Duration of symptoms (hrs)	48 $\pm$ 62		40 $\pm$ 39		45 $\pm$ 47		51 $\pm$ 70	
Year of operation	1987 $\pm$ 9		1996 $\pm$ 3**		1982 $\pm$ 5**		1986 $\pm$ 10**	
Year of operation (range)	1967-1999		1989-1999		1973-1992		1967-1999	
Shock	12	(10)	2	(10)	2	(10)	8	(10)
Paraplegia	3	(2)	0	(0)	0	(0)	3	(4)
Visceral ischemia	0	(0)	0	(0)	0	(0)	0	(0)
Renal dysfunction	25	(20)	0	(0)*	6	(30)*	19	(23)*
Peripheral pulse deficit	58	(47)	5	(24)	11	(55)	42	(51)
Extent of dissection								
Ascending aorta	14	(11)	2	(10)	2	(10)	10	(12)
Asc Ao + Arch	18	(15)	4	(19)	4	(20)	10	(12)
Asc Ao + Arch + Dsc Thor Ao	28	(23)	4	(19)	2	(10)	22	(27)
Asc Ao + Arch + Dsc Thor Ao + Abd Ao	63	(51)	11	(52)	12	(60)	40	(49)
Intramural hematoma	1	(1)	0	(0)	0	(0)	1	(1)
Stroke	12	(10)	1	(5)	1	(5)	10	(12)
Associated conditions								
CAD	31	(25)	6	(29)	3	(15)	22	(27)
CHF	10	(8)	1	(5)	1	(5)	8	(10)
Pulmonary disease	27	(9)	12	(6)	15	(12)	15	(12)
Liver disease	5	(4)	0	(0)	1	(5)	4	(5)
Diabetes mellitus	7	(6)	2	(10)	1	(5)	4	(5)
Prior stroke	7	(6)	0	(0)	0	(0)	7	(9)
Marfan syndrome	14	(11)	8	(38)**	3	(15)**	3	(4)**
Hypertension	65	(53)	8	(38)*	7	(35)*	50	(61)*
Previous aortic dissection	2	(2)	2	(10)**	0	(0)**	0	(0)**
Previous sternotomy	5	(4)	1	(5)	0	(0)	4	(5)

APPENDIX 1. Continued

	All patients (n = 123)		CVG (n = 21)		SVG (n = 20)		CONS (n = 82)	
	N	(%)	N	(%)	N	(%)	N	(%)
Operative findings								
Tamponade	28	(23)	7	(33)	2	(10)	19	(23)
Aortic rupture	57	(46)	10	(48)	8	(40)	39	(48)
Site of PIT								
Asc Ao	107	(87)	19	(91)	18	(90)	70	(85)
Arch	8	(7)	0	(0)	2	(10)	6	(7)
Dsc Thor Ao	3	(2)	1	(5)	0	(0)	2	(2)
Unknown	5	(4)	1	(5)	0	(0)	4	(5)
Arch resection	24	(20)	10	(48)**	0	(0)**	14	(17)**
Resection of PIT	111	(90)	18	(86)	18	(90)	75	(92)
Aortic crossclamp time (min)	90 ± 42		143 ± 38**		106 ± 45**		72 ± 26**	
Cardiopulmonary bypass time (min)	147 ± 63		216 ± 64**		157 ± 66**		127 ± 48**	
Coronary artery bypass graft	11	(16)	0	(0)	5	(25)	6	(12)
Postoperative complications								
Bleeding	13	(11)	3	(15)	3	(18)	7	(9)
Stroke	13	(11)	1	(5)	3	(16)	9	(12)
Follow-up								
Follow-up period	6.5 ± 6.1		3.7 ± 3.0		7.6 ± 7.6		7.0 ± 6.2	
Early death	20	(16 ± 3.3)	3	(14 ± 7.8)	6	(30 ± 11)	11	(13 ± 3.8)

CVG, Composite valve graft; SVG, separate replacement of the aortic valve and ascending aorta; CONS, aortic valve conservation; *visceral ischemia*, compromised arterial perfusion of any intra-abdominal organ diagnosed by angiography or computed tomography or magnetic resonance imaging; *renal dysfunction*, compromised renal perfusion by angiography, acute anuria, renal infarction, or serum creatinine ≥ 3 or *blood urea nitrogen* ≥ 40 ; *peripheral pulse deficit*, loss of blood flow to extremities as documented by physical examination, angiography, or computed tomography; *Asc Ao*, ascending aorta; *Dsc Thor Ao*, descending thoracic aorta; *Abd Ao*, abdominal aorta; *CAD*, coronary artery disease as indicated by a previous diagnosis of coronary disease or myocardial ischemia or infarction; *CHF*, congestive heart failure; *pulmonary disease*, diagnosis of chronic obstructive pulmonary disease or significant lung ailment; *liver disease*, total bilirubin > 2.0 at the time of diagnosis; *prior stroke*, history of strokes or transient ischemic attacks; *aortic rupture*, presence of blood in the pericardial cavity; *site of PIT*, site of primary intimal tear diagnosed either on preoperative imaging or at operation; *surgeon experience*, "high-volume" surgeons who performed 30 or more surgical repairs for aortic dissection (comprising 5 of 16 surgeons in the database) versus 11 "low-volume" surgeons who performed 30 or less repairs; bleeding, postoperative hemorrhage requiring reoperation. * $P < .05$; ** $P < .01$ by either χ^2 test or analysis of variance.

Discussion

Dr H. Storm Floten (Portland, Ore). For their continued fine work in the management of acute type A dissection, I commend Dr Lai, Dr Miller, and their associates at Stanford University. Acute type A dissection is a condition that still tightens the sphincters of the best of heart surgeons and still bears an early operative mortality rate in the neighborhood of 25%. In their article they give a flawless statistical analysis comparing 3 standard methods of dealing with acute dissection of the root and aortic insufficiency. They show that there is no statistical difference in the early or late survival or in the reoperation rate for the 3 methods. Factors affecting mortality were reoperation, hypertension, tamponade, and stroke. The highest risk of death was immediately after surgery, and early death was predicted by shock and prior stroke. At the Starr-Wood cardiac group and the Oregon Health Sciences University in Portland, we have adopted much of the same philosophies as Stanford in the management of this condition. Most cases involve valve repair or composite graft repair when we encounter MFS, annular ectasia, or dilated root. We have not used separate valve replacement and sleeve graft in saving the sinuses. Our philosophy has been that if we cannot save the valve, why save the sinuses that are the primary problem? This leaves the operative decision largely between the 2 techniques of composite graft or

valve repair. Frankly, we find that in a normal-sized aorta the commissural resuspension and sinus repair is an easier procedure, and we are comforted by the report indicating that we may be doing the right thing. The conduit procedure is easier when encountering MFS, a dilated aorta, or annular ectasia. The most difficult cases are when there is a normal-sized root or small root that has massive dissection, maybe all 3 sinuses, and, in particular, when I see staining of blood south of the annulus down into the endocardium and myocardium. These cases are going to really require a conduit graft in my experience to avoid valve incompetence and sinus rupture. We have not been able to consistently duplicate the valve-preserving root-replacement procedures of David and Yakoub, and I am reluctant to embrace their operations for acute pathology that we are discussing today. Your techniques at Stanford are hallmark to the success in management of acute dissection. Complete resection of the aorta above the sinotubular junction facilitated by profound hypothermia, no crossclamp, open anastomosis at the arch and beyond, retrograde cerebral perfusion, and selective antegrade perfusion are all critical techniques to be used. We still repair the root with Teflon felt in the false lumen of the sinuses and resuspend the aortic commissures. In addition, we turn the adventitia in over the top of the felt to thereby circumferentially reconstruct the aortic root.