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Open surgery versus endovascular repair of ruptured thoracic aortic aneurysms

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Background: **Ruptured descending thoracic aortic aneurysm (rDTAA) is a cardiovascular catastrophe, associated with high morbidity and mortality, which can be managed either by open surgery or thoracic endovascular aortic repair (TEVAR). The purpose of this study is to retrospectively compare the mortality, stroke, and paraplegia rates after open surgery and TEVAR for the management of rDTAA.**

Methods: **Patients with rDTAA treated with TEVAR or open surgery between 1995 and 2010 at seven institutions were identified and included for analysis. The outcomes between both treatment groups were compared; the primary end point of the study was a composite end point of death, permanent paraplegia, and/or stroke within 30 days after the intervention. Multivariate logistic regression analysis was used to identify risk factors for the primary end point.**

Results: **A total of 161 patients with rDTAA were included, of which 92 were treated with TEVAR and 69 with open surgery. The composite outcome of death, stroke, or permanent paraplegia occurred in 36.2% of the open repair group, compared with 21.7% of the TEVAR group (odds ratio [OR], 0.49; 95% confidence interval [CI], .24-.97; $P = .044$). The 30-day mortality was 24.6% after open surgery compared with 17.4% after TEVAR (OR, 0.64; 95% CI, .30-1.39; $P = .260$). Risk factors for the composite end point of death, permanent paraplegia, and/or stroke in multivariate analysis were increasing age (OR, 1.04; 95% CI, 1.01-1.08; $P = .036$) and hypovolemic shock (OR, 2.47; 95% CI, 1.09-5.60; $P = .030$), while TEVAR was associated with a significantly lower risk of the composite end point (OR, 0.44; 95% CI, .20-.95; $P = .039$). The aneurysm-related survival of patients treated with open repair was 64.3% at 4 years, compared with 75.2% for patients treated with TEVAR ($P = .191$).**

Conclusions: **Endovascular repair of rDTAA is associated with a lower risk of a composite of death, stroke, and paraplegia, compared with traditional open surgery. In rDTAA patients, endovascular management appears the preferred treatment when this method is feasible. (J Vasc Surg 2011;53:1210-6.)**

Thoracic aortic aneurysm rupture is a cardiovascular catastrophe with an estimated incidence of 5.0 per 100,000 people per year.[1,2] The yearly rate of aortic rupture, dissection, and/or death for aneurysms larger than 6 cm is around 15%,[3-5] and only a small fraction of all patients with ruptured thoracic aortic aneurysms is admitted alive to the emergency department.[1] The prognosis of patients with ruptured thoracic aortic aneurysms that make it to the hospital and undergo intervention is thought to be more realistic; however, mortality and morbidity rates in this subgroup remain substantial.[6-8]

The traditional treatment for ruptured descending thoracic aortic aneurysm (rDTAA), which account for approximately 30% of all ruptured aneurysms of the thoracic aorta,[1] has been for decades open surgical resection followed by interposition of a Dacron graft.[6,7] Open surgical repair of rDTAA is associated with high mortality rates, and a considerable number of surviving patients suffer from disabling complications such as permanent paraplegia or stroke.[6-9] Thoracic endovascular aortic repair (TEVAR) recently offers a less invasive alternative for the management of descending thoracic aortic pathologies.[10-12] Although TEVAR is increasingly being used for the management of acute thoracic aortic disease,[13-16] it remains unclear if endovascular repair reduces the mortality and morbidity of rDTAA, due to the low incidence of this emergency. The purpose of this multicenter study is to compare the mortality, stroke, and paraplegia rates between patients with rDTAA treated with open surgery and TEVAR.

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METHODS

Study population. The following referral centers participated in this project: Yale New Haven Hospital (New Haven, Conn), Baylor College of Medicine (Houston, Tex), Christine E. Lynn Heart and Vascular Institute (Boca Raton, Fla), Policlinico San Donato, Istituto Di Ricovero e Cura a Carattere Scientifico (San Donato Milanese, Italy), St. Antonius Hospital (Nieuwegein, The Netherlands), Erasmus University Medical Center (Rotterdam, The Netherlands), and the University Medical Center Utrecht (Utrecht, The Netherlands). The study was approved by the institutional review committee at all participating institutions. Patients with rDTAA treated with TEVAR or open surgery between 1995 and 2010 were identified and included for analysis. Ruptured aneurysm was defined as any disruption of the aneurysmal aortic wall with an extravascular collection of blood. The anatomic extent of the aneurysm was located between the left subclavian artery and the celiac axis in all cases.

Surgical techniques. At present, the participating hospitals have established a protocol for admitted patients with rDTAA in which endovascular repair has become the preferred treatment. All endovascular procedures were performed in the operating room under general anesthesia by vascular and/or cardiothoracic surgeons. The following endovascular devices were used: Gore TAG (Gore Medical, Flagstaff, Ariz), Medtronic Talent (Medtronic, Santa Rosa, Calif), or Medtronic Valiant (Medtronic). The endograft diameter was oversized compared with the native aortic landing zone diameter by 10% to 20%, as recommended by the manufacturer. To ensure an adequate landing zone, overstenting of the left subclavian and/or celiac artery was required in some cases. Routine revascularization of the left subclavian artery was not performed; this depended on the preference of the surgeon, the vertebrobasilar circulation, and the condition of the patient. Contraindications for TEVAR have changed over the years and may differ between the different participating institutions and physicians. Current contraindications typically include no proximal or distal aortic neck, or an aortic diameter that is too wide for commercially available thoracic endografts.

Open surgical procedures were typically performed by cardiothoracic surgeons through a posterolateral thoracotomy in the fourth to sixth intercostal space using extracorporeal perfusion support, with a simple clamp technique or hypothermic circulatory arrest. Indications for hypothermic circulatory arrest included the need to extend the resection into the distal aortic arch or the entire descending thoracic aorta, or if the aortic pathology precluded the use of aortic cross-clamping. Reimplantation of intercostal arteries depended on the surgeon's preference. Prophylactic cerebrospinal fluid drainage during open surgery or TEVAR was only performed if the patient was stable enough and was thought to have an increased risk for spinal cord ischemia.

End points and statistical analysis. The primary end point of the study was a composite end point of death, permanent paraplegia, and/or stroke within 30 days after the intervention. We defined stroke as a new central neurologic deficit within 30 days after the aortic intervention, confirmed as an ischemic or hemorrhagic lesion on computed tomography or magnetic resonance imaging of the brain.

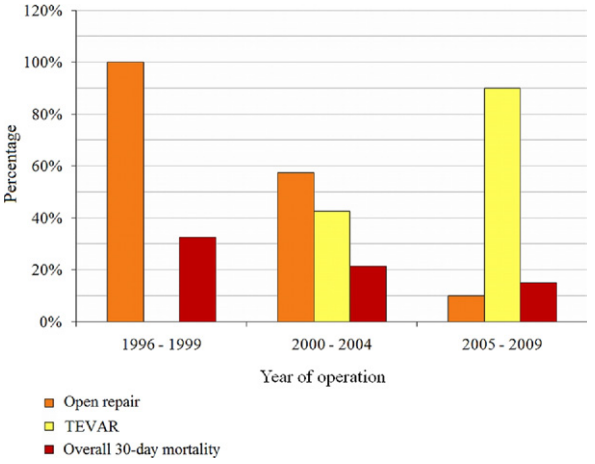

Fig 1. Trends in management and 30-day mortality of ruptured descending thoracic aortic aneurysm (rDTAA). The 30-day mortality of rDTAA decreased over the years from 32.4% before 2000 to 21.4% between 2000 and 2004, and 15.0% between 2005 and 2009 ($P = .109$). *TEVAR*, Thoracic endovascular aortic repair.

The individual components of the primary end point were analyzed as secondary end points. Secondary end points also included other complications, aortic reintervention within 30 days, hospital length of stay, and aneurysm-related survival during follow-up. Categorical variables were investigated using the χ^2 test or the Fisher's exact test and continuous variables using the Student *t* test or Mann-Whitney *U* test. Multivariate logistic regression analysis was used to investigate independent effects of baseline and operating characteristics on the primary composite end point and 30-day mortality. Variables with a *P* value $<.2$ in univariate analysis were integrated in the multivariate regression model. Kaplan-Meier survival analysis was used to investigate the aneurysm-related survival during follow-up after TEVAR and open surgical repair. Aneurysm-related death was defined as death within 30 days, or death after 30 days due to complications related to the aneurysm and/or intervention. Statistical analysis was performed using SPSS 15.0 software (SPSS, Inc, Chicago, Ill); a *P* value $<.05$ was considered statistically significant.

RESULTS

Overall, 161 patients with rDTAA between 1995 and 2009 were identified, of which 57.1% (n = 92) underwent TEVAR and 42.9% (n = 69) open surgical repair. Prior to 2000, all admitted patients underwent open surgery (Fig 1), compared with 57.4% of patients between 2000 and 2004, and 10% of patients admitted from 2005 ($P < .001$). After the first endovascular repair of rDTAA in 2001, the utilization of TEVAR for rDTAA rapidly increased (Fig 1).

Table I. Baseline characteristics

	Open repair (n = 69)		*TEVAR (n = 92)*		
	N	*(%)*	*N*	*(%)*	P *value*
Age (years)	64.8	(±12.8)	69.4	(±11.4)	.016
Male gender	51	(73.9)	62	(67.4)	.37
Comorbidities					
Hypertension	42	(60.9)	48	(55.8)	.53
Diabetes mellitus	15	(21.7)	13	(15.3)	.30
Coronary artery disease	29	(42.0)	38	(45.8)	.64
Chronic obstructive pulmonary disease	21	(30.4)	22	(25.0)	.45
Chronic renal insufficiency	12	(17.4)	13	(15.9)	.80
Carotid disease	8	(11.6)	13	(15.7)	.47
Hyperlipidemia	20	(29.0)	23	(27.7)	.86
Prior aortic repair	23	(33.3)	21	(23.1)	.15
Presentation					
Thoracic pain	47	(75.8)	62	(67.4)	.26
Hemothorax	36	(52.2)	39	(43.8)	.29
Hypovolemic shock	18	(26.1)	21	(23.1)	.66
Aneurysm diameter (mm)	69.5	(±17.4)	55.5	(±20.4)	<.001
Associated dissection	10	(14.5)	13	(14.3)	.97
Associated fistula	9	(13.0)	12	(13.2)	.98

TEVAR, Thoracic endovascular aortic repair.
Prior aortic repair consisted of 29 prior abdominal aortic interventions and 16 prior thoracic aortic interventions; one patient had undergone both a prior abdominal and thoracic aortic intervention.

The mean age of patients treated with TEVAR was 69.4 years, compared with 64.8 years for patients treated with open surgery ($P = .016$; Table I). There were no significant differences in gender or pre-existing comorbidities between the TEVAR and open repair groups. The mean aneurysm diameter of patients that received TEVAR was significantly smaller than those receiving open surgery (55.5 mm vs 69.5 mm; $P < .001$, Table I). Aneurysm repair was performed within 24 hours in 89.4% of the open repair group and in 85.4% of the TEVAR group ($P = .49$). Coverage of the left subclavian artery was needed in 34.1% after TEVAR and coverage of the celiac artery in 5.4%. Left carotid-subclavian bypass was performed in three of the patients in which the left subclavian artery was covered. Cerebrospinal fluid drainage was performed in similar rates in both treatment groups during the intervention (15.9% vs 18.7%; $P = .65$).

Early outcomes. Overall, the 30-day mortality of rDTAA decreased over the years from 32.4% before 2000 to 21.4% between 2000 and 2004, and 15.0% between 2005 and 2009 ($P = .109$; Fig 1). Among the patients treated with open repair, the 30-day mortality was 24.6% (n = 17), compared with 17.4% (n = 16) among patients treated with TEVAR (odds ratio [OR], 0.64; 95% confidence interval [CI], .30-1.39; $P = .260$). The composite outcome of death, stroke, or permanent paraplegia occurred in 36.2% (n = 25) of the open repair group, compared with 21.7% (n = 20) of the TEVAR group (OR, 0.49; 95% CI, 0.24-0.97; $P = .044$). Permanent paraplegia occurred in 8.7% after open surgery, compared with 2.2% after TEVAR ($P = .059$; Table II). The death, stroke, and/or paraplegia rates did not differ significantly between the participating institutions.

Postoperative pulmonary complications (31.9% vs 17.4%; $P = .032$) and acute renal failure (24.6% vs 8.7%; $P = .006$) were significantly increased in patients treated with open surgery compared with TEVAR (Table II). Endoleak was diagnosed in 17.4% within the first 30 days after TEVAR (type 1A in seven patients, type 1B in three patients, type 2 in five patients, and type three in one patient). The median hospital length of stay for surviving patients was 22 days (interquartile range, 26 days) in the open repair group, compared with 8 days (interquartile range, 10 days) in the TEVAR group ($P < .001$).

Multivariate analysis of end points. Independent risk factors for the primary end point of death, stroke, or permanent paraplegia in multivariate analysis were increasing age (OR, 1.04; 95% CI, 1.01-1.08; $P = .036$) and hypovolemic shock (OR, 2.47; 95% CI, 1.09-5.60; $P = .030$), while TEVAR was associated with a significantly lower risk of the composite end point (OR, 0.44; 95% CI, 0.20-0.95; $P = .039$). The risk of death, stroke, and/or permanent paraplegia tended to increase after prior aortic repair (OR, 2.15; 95% CI, 0.95-4.86; $P = .065$; Table III). Independent predictors of 30-day mortality were hypovolemic shock at admission (OR, 2.63; 95% CI, 1.03-6.70; $P = .044$) and a prior aortic repair (OR, 2.65; 95% CI, 1.08-6.47; $P = .033$; Table IV).

Aneurysm-related survival during follow-up. The median length of follow-up of patients that were alive at 30 days was 34.5 months in the open repair group and 13.5 months in the TEVAR group. After the first 30 days, seven additional patients in the open repair group died of complications related to the aneurysm and/or intervention, and five patients in the TEVAR group. Causes of death in the open repair group were poor general condition and/or congestive heart failure related to surgical intervention (n = 3), multi-organ failure (n = 2), sepsis (n = 1), and unable to be disconnected from the respirator (n = 1). Causes of

Table II. Early outcomes

	Open repair (n = 69)		*TEVAR (n = 92)*		
	N	*(%)*	*N*	*(%)*	P *value*
Death, stroke, or permanent paraplegia	25	(36.2)	20	(21.7)	.044
Death	17	(24.6)	16	(17.4)	.26
Stroke	7	(10.1)	7	(7.6)	.39
Permanent paraplegia	6	(8.7)	2	(2.2)	.059
Paraplegia/paraparesis	10	(14.5)	7	(7.6)	.16
Other complications					
Cardiac complications	9	(13.0)	5	(5.4)	.090
Pulmonary complications	22	(31.9)	16	(17.4)	.032
Acute renal failure	16	(24.6)	8	(8.7)	.006
Visceral ischemia	2	(2.9)	0	(0)	.18
Aortic reintervention within 30 days	2	(2.9)	7	(7.6)	.30
Median length of stay (days)	22	(26)	8	(10)	<.001

TEVAR, Thoracic endovascular aortic repair.
The median hospital length of stay is shown with the interquartile range and was calculated for patients that were discharged alive. Among the seven patients that suffered stroke after open surgery, six had an anterior circulation stroke and one patient had a stroke of the posterior circulation. Among the seven patients that developed a stroke after thoracic endovascular aortic repair, four had an anterior circulation stroke, while three patients had a posterior circulation stroke.

Table III. Independent predictors of death, stroke, or permanent paraplegia

Variable	*Odds ratio*	*95% confidence interval*	P *value*
Age	1.04	1.01-1.08	.036
Female gender	0.91	0.40-2.08	.83
Prior aortic repair	2.15	0.95-4.86	.065
Hemothorax	1.29	0.58-2.89	.53
Hypovolemic shock	2.47	1.09-5.60	.030
TEVAR	0.44	0.20-0.95	.039

TEVAR, Thoracic endovascular aortic repair.

Table IV. Independent predictors of 30-day mortality

Variable	*Odds ratio*	*95% confidence interval*	P *value*
Age	1.01	0.97-1.05	.58
Female gender	0.94	0.36-2.44	.89
Diabetes mellitus	1.48	0.52-4.23	.47
Prior aortic repair	2.65	1.08-6.47	.033
Hemothorax	2.03	0.81-5.07	.13
Hypovolemic shock	2.63	1.03-6.70	.044
TEVAR	0.78	0.29-2.13	.40

TEVAR, Thoracic endovascular aortic repair.

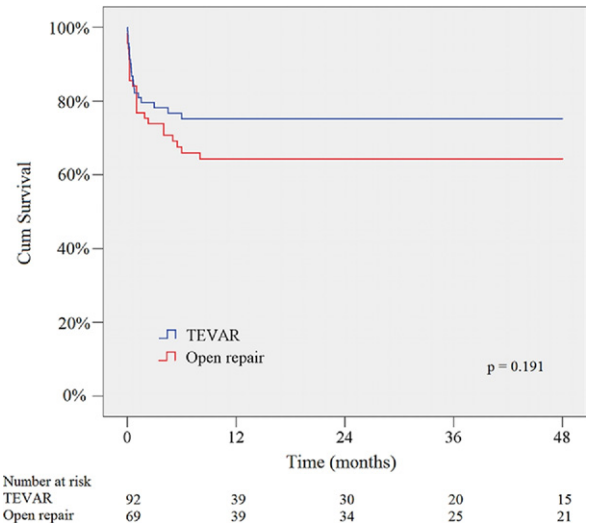

Fig 2. Aneurysm-related survival during follow-up after open repair and thoracic endovascular aortic repair (*TEVAR*). The aneurysm-related survival of patients treated with open repair was 64.3% at 4 years, compared with 75.2% for patients treated with TEVAR ($P = .191$).

death in the TEVAR group were an infected endograft and/or sepsis (n = 3), aortic rupture (n = 1), and a poor general condition (n = 1). The aneurysm-related survival of patients treated with open repair was 64.3% at 4 years, compared with 75.2% for patients treated with TEVAR ($P = .191$; Fig 2).

Reinterventions during follow-up. In the TEVAR group, aortic reinterventions were required in 11 patients during follow-up, because of type one endoleak in eight patients, an aortoesophageal fistula in one patient, and aneurysmal dilatation of the thoracic aorta without endoleak in two patients. Aortic reinterventions after TEVAR consisted of deployment of an additional endograft in nine patients, coiling in one patient, and surgical resection of a type III thoracoabdominal aortic aneurysm in one patient. In addition, a thorax drain was placed in 22 patients, an esophagostomy was performed in three patients, and one patient required a thoracotomy to release trapped lung tissue and evacuate a clotted hemothorax.

In the open surgery group, aortic reinterventions were required in three patients during follow-up, which consisted of repair of the distal anastomosis because of leakage in two patients and evacuation of an abscess around the aortic graft in one patient. Other reinterventions included a

tracheostomy because of respiratory insufficiency (n = 10), a pneumonectomy (n = 1), necrotectomy and debridement (n = 1), and a laparotomy because of visceral ischemia (n = 1).

DISCUSSION

TEVAR has revolutionized the management of thoracic aortic disease. Advantages of a minimally invasive endovascular approach are the avoiding of thoracotomy and aortic cross-clamping, reduced operating times, and minimal additional blood loss, which are particularly important in rDTAA patients in critical condition. TEVAR is emerging as the preferred treatment for patients with rDTAA at our institutions, although there is currently no strong evidence that an endovascular approach improves survival compared with traditional open surgery.

In the present multi-center analysis, we observed a trend toward reduced 30-day mortality for patients treated with
TEVAR (17.4% vs 24.6%), in accordance with previous reports of experienced centers, in which early mortality rates typically range between 11.4% and 18.9% after TEVAR[16-18] and between 22.2% and 33.3% after surgical repair.[9,18-21] In the United States between 1988 and 2003, the overall in-hospital mortality after open surgical repair of rDTAA was 45%,[6] and the "real world" mortality rate after intervention for rDTAA may therefore be underestimated in the literature. The lower mortality rate after open repair in our evaluation, compared with this population-based study,[6] may be related to the fact that the participating institutions in our study were tertiary referral centers, and mortality rates of rDTAA may be reduced in referral and/or large-volume hospitals.[22,23] Furthermore, referred rDTAA patients that survived transport and received a surgical intervention may have been relatively more stable, which may have contributed to improved outcomes as well.

Improved survival after an endovascular approach compared with open surgery has been observed as well for other thoracic aortic catastrophes, including traumatic aortic injuries or complicated type B aortic dissections.[13,15,24,25] Although mortality is a very important outcome measure, the quality of life of surviving patients is also essential when determining the preferred treatment. In descending thoracic aortic interventions, the most feared nonfatal complication is postoperative paraplegia due to interruption of the blood supply to the spinal cord. In this study, the incidence of the composite primary end point of death, stroke, or paraplegia was significantly reduced after TEVAR, and we observed a trend toward a lower incidence of permanent paraplegia in this group. Previous studies have shown a reduced paraplegia rate after TEVAR for nonruptured DTAA compared with open surgery.[26,27] Theoretic explanations for reduced risks of paraplegia after an endovascular approach are no aortic cross-clamping during TEVAR, fewer periods of perioperative hypotension due to blood loss or hemodynamic shifts, and slow thrombosis of the aneurysm sac compared with acute occlusion of critical vessels during surgical repair.[27]

Hypovolemic shock at admission was an independent predictor of both 30-day mortality and the composite end point of death, stroke, and paraplegia. Hypovolemic shock is a strong predictor of death in most acute aortic syndromes,[16,28-30] and hypovolemia may also lead to inadequate perfusion of the spinal cord and brain, resulting in increased risks of neurologic deficits. Aneurysm rupture, long cross-clamp duration, and intraoperative hypotension have been previously correlated with increased risks of spinal cord ischemia and stroke during open thoracic aortic surgery.[8,31] Several reports have suggested a similar relation between emergency procedures, blood loss or perioperative hypotension, and the occurrence of spinal cord ischemia after TEVAR.[32-35] Prior aortic repair was associated with an increased risk of 30-day mortality as well. Patients that have undergone prior aortic repair may have had a long history of atherosclerotic disease, and a poor general condition, resulting in increased risks of postoperative mortality and morbidity. In addition, open or endovascular repair of rDTAA may be more difficult in a previously reconstructed aorta.

Although TEVAR was associated with improved outcomes, a cause for concern is the occurrence of endograft-related complications.[36,37] Endoleak was diagnosed in 17% within the first 30 days, and aortic reinterventions were required in about 8% of all patients during the first month. Furthermore, several patients expired due to infected endografts and/or aortic rupture during follow-up after TEVAR. These findings underline the need for close radiologic surveillance during follow-up after endovascular repair of rDTAA, which may be initiated already before discharge of the patient. Nevertheless, in the open repair group, a considerable number of patients died as well after the first 30 days, due to multi-organ failure or a poor general condition.

An important limitation of the present study was the retrospective observational study design. However, due to the rarity of this condition and its emergent nature, it will be very difficult to ever realize a large randomized study comparing the outcomes of TEVAR versus open surgery of rDTAA. Moreover, because of the superior results of TEVAR for the management of acute thoracic aortic disease in multiple observational studies, including the present evaluation, conducting such a randomized study may not be ethical. Due to the nonrandomized observational study design, baseline differences existed between the treatment groups, including an older mean age and a smaller aneurysm diameter in the TEVAR group. The older age of the TEVAR patients may be explained by the increasing life expectancy of the population, and surgical interventions may have been refused to very elderly patients with rDTAA prior to the endovascular era. There may be several theoretic explanations for the smaller mean aneurysm diameter in the TEVAR group. The proportion of patients with aneurysms >5.5 cm undergoing elective thoracic aortic repair has increased over the years, due to increased detec-

tion rates of thoracic aortic aneurysms, and improved treatment modalities and outcomes.[38,39] This may have resulted in a lower occurrence of rupture of very large aneurysms, and therefore a relative increase in the occurrence of aortic rupture of aneurysms smaller than 5.5 cm. In addition, very large aneurysms may be more often unsuitable for an endovascular approach, due to inadequate landing zones. In a recent comparative analysis of Patel and colleagues, patients treated with TEVAR for thoracic aortic rupture were significantly older and had a smaller mean aortic diameter as well, when compared with patients treated with open surgery.[16] Another limitation of the study is that most open surgical interventions were performed before 2000, while all endovascular procedures were performed after 2000 in our evaluation, and the outcomes of open surgery for rDTAA may have improved slightly over the years. However, due to the low incidence of rDTAA and the increasing utilization of TEVAR, it is very difficult to obtain a considerable number of rDTAA patients treated with open surgery in more recent years.

CONCLUSIONS

There has been a shift toward endovascular management of patients with rDTAA at our institutions. We observed a lower rate of the composite end point of death, stroke, and paraplegia, for the rDTAA patients treated with TEVAR compared with traditional open surgery. Furthermore, there was a trend toward lower risks of permanent paraplegia and improved aneurysm-related survival after TEVAR. In rDTAA patients, endovascular management appears the preferred treatment when this method is feasible.

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AUTHOR CONTRIBUTIONS

Conception and design: FJ, PL, BM
Analysis and interpretation: FJ, PL, ST, BM
Data collection: FJ, HV, PL, RH, ST, AL, FM, HA, VR
Writing the article: FJ, BM
Critical revision of the article: HV, PL, RH, ST, AL, FM, HA, VR
Final approval of the article: FJ, HV, PL, RH, ST, AL, FM, HA, VR, BM
Statistical analysis: FJ, ST
Obtained funding: BM
Overall responsibility: BM

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INVITED COMMENTARY

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Ruptured thoracic aortic aneurysms represent a formidable aortic catastrophe. A Swedish study from the pre-endovascular era found that 54% of patients died within the first 6 hours, 41% reached the hospital alive, and only 3% survived hospitalization.[1] Despite advances, open repair of ruptured descending thoracic aortic aneurysms (rDTAAs) continue to carry high mortality (45%) on a recent review of national outcomes.[2] Since the first report of a thoracic endovascular aneurysm repair (TEVAR) by Dake and colleagues in 1994, this technique has been shown to reduce early mortality, morbidity, length of stay, and spinal cord injury rates compared with open repair.[3-5] Currently, TEVAR has become the primary method of treatment in most centers for intact or ruptured thoracic aneurysms, penetrating ulcers, intramural hematomas, and traumatic transections.

In this issue of the *Journal*, Jonker and colleagues are to be congratulated for their report on the largest multicenter retrospective analysis of open versus endovascular techniques for treatment of rDTAAs.[6] The study has confirmed with "real world" data that the utilization of open repair was decreased from 100% prior to 2000 to 10% since 2005, when thoracic stent grafts became commercially available in the United States. The decreasing number of open repairs coincided with a trend toward decreased mortality: 32% prior to 2000 (open era), 21% between 2001 and 2004 (transitional era), and 15% after 2005 (endovascular era). The primary end point of the study was a composite of death, stroke, and paraplegia, and was significantly less frequent in the TEVAR (22%) compared with the open repair group (32%). The study had important limitations, namely the retrospective design, selection bias, lack of anatomical analysis of the extent of aneurysm, and relative small number of patients to allow analysis of factors associated with death, paraplegia, stroke, dialysis, and reinterventions. Nevertheless, these findings are in concert with other retrospective reviews, including reports of national datasets, single-center experiences, and a meta-analysis, all of which have confirmed the superiority of TEVAR for intact and ruptured thoracic aneurysms.[3-5]

Most would agree that TEVAR simplifies and expedites treatment of acute thoracic aortic emergencies. The advantages are numerous, including no thoracotomy, cardiopulmonary bypass, hypothermic cardiac arrest, or aortic cross-clamping, minimizing operative time, blood loss, and fluid requirements, with a minimally invasive approach. Still, there are limitations that impede the widespread use of TEVAR in some patients, because of anatomical constraints related to the quality of the landing zones, difficult iliac access, and need to carry a wide range of stent graft sizes off-the-shelf for emergent use. However, as aortic endograft technology evolves and becomes more available to the vascular community, TEVAR indications will continue to expand to patients with more challenging anatomy.

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