Self-Expandable Aortic Stent-Grafts For Treatment of Descending Aortic Dissections

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Background. Acute aortic dissection is a life-threatening medical condition that is associated with high morbidity and mortality.

Methods. Of 198 patients treated with a self-expanding polyester-covered stent-graft for various pathologic aortic conditions in our institution, we selected 70 consecutive patients with type B aortic dissection who were undergoing treatment. The stent-graft was introduced through the femoral artery in the angiography suite, under general anesthesia with systemic heparinization and induced hypotension.

Results. The procedure was performed in 70 patients; of these, 58 had descending aortic dissection and 12 had atypical dissections. The procedure was successful in 65 patients (92.9%), as documented by exclusion of the false lumen of the thoracic aorta. Eleven patients (18.9%) had persistent blood flow in the false lumen of the abdominal aorta due to distal reentries. Five patients (7.1%) underwent conversion to surgery. Insertion of additional stent-grafts was required in 34 patients (48.6%). At 29 months of follow-up, 91.4% of the patients were alive.

Conclusions. Stent-grafts are an important means of treating aortic dissections, which may replace conventional medical treatment of this condition for the majority of patients.

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Aortic dissections are associated with high morbidity and mortality rates, especially in elderly patients with multiple comorbidities such as ischemic heart disease, previous aortic pathology, chronic obstructive pulmonary disease, or renal dysfunction [1]. Indications for operative intervention have been reserved for complications of the dissection [2]. The natural history of aortic dissection is well known, and surgery is indicated only when there are signs of eminent rupture or ischemia. Despite advances in diagnostic imaging and the development of new surgical approaches, mortality rates can be as high as 50%, especially when patients undergo operation on an urgent basis [3–8].

The introduction of stent-grafts into clinical practice by Parodi [9] in 1995, as an alternative treatment for abdominal aortic aneurysms, led to new perspectives in the treatment of aneurysms and dissections at other aortic sites. Dake and colleagues [10] were the first to use stent-grafts in the thoracic aorta. Since then, many groups have reported success in treating various pathologic aortic conditions with different types of endoprosthesis, resulting in reduced rates of morbidity and mortality in selected group of patients [11–13].

Clinical use of polyester-covered stent-grafts was pioneered at our institution for the treatment of type B dissections as a modification of the “elephant trunk” procedure [6]. The initial success in earlier phases of our experience encouraged us to develop new prostheses and catheters that could be deployed by means of a peripheral artery approach in the treatment of thoracic and abdominal aortic diseases. We report here the results and complications observed in a series of 70 consecutive, nonselected patients who presented with type B dissection, in whom a self-expanding endovascular prosthesis was used.

Patients and Methods

From December 1996 to June 2001, a total of 198 patients with either descending thoracic aortic dissection or aneurysm and abdominal aortic aneurysm were treated with endoprostheses at our institution. From this group, we selected 70 patients who were treated for aortic dissection, whose results are reported here. The mean age of the group was 57.6 ± 13.3 years and 73% were men. Of the 70 patients, 58 had classic type B dissection (n = 35 ± 60.3%, were acute dissections, with symptoms of ≤15 days), whereas 12 patients had atypical dissections (6 patients had intramural hematomas and 6 had aortic wall ulcers). All patients presented with a complex clinical picture that included persistent pain, decreasing hematocrit levels, mediastinal hematoma, hemothorax, or hemoptysis. Comorbid conditions such as chronic obstructive pulmonary disease, aortic insufficiency due to annuloaortasis, renal failure, cancer, heart failure, and coronary artery disease were commonly observed in this
group. Diagnostic confirmation as well as the size and length of the required prosthesis were based on aortography, computed tomography (CT), and transesophageal echocardiography (TEE). Anatomical criteria required for stent-grafting were intimal tear in the descending aorta, proximal and distal landing zones up to 32 mm in diameter, and ilio-femoral segment able to accept a 20F device. The distance of the left subclavian artery from the entry tear was not a contraindication for the procedure. Seven patients underwent the procedure in critical condition. Two patients had had cardiopulmonary arrest upon admission to the hospital, resulting from hemothorax due to bronchial aspiration. The other 5 patients had large hemothoraces secondary to leaks or rupture. Systemic hypertension was present on admission in 70% of the patients. Aortography revealed that in 18 patients (51.4%) the intimal tear was located less than 2 cm from the origin of the left subclavian artery. In 10 patients (28.9%) it was located 2 to 6 cm from the origin of the subclavian artery; in 7 patients (20%) the tear was present more distally in the descending portion of the thoracic aorta (Fig 1).

The study protocol was approved by the local Ethics Committee and informed consent was obtained from each patient.

Endovascular Prosthesis
The aortic stent-grafts were individually manufactured with self-expanding stainless steel stents covered with polyester (Braile Biomedica, São Paulo, Brazil). These devices are highly resistant to radial collapse and maintain their ability to return to their original diameter. The prostheses were deployed through a 20F catheter-based delivery system. Length and diameter varied according to the extension and size of the diseased segment to be treated. The stent-grafts were available in lengths of 7.5 cm and 9.0 cm; when fully expanded, their diameter ranged from 20 to 34 mm.

Operative Procedure
The procedures were performed in the angiography suite under general anesthesia with endotracheal intubation and monitoring of vital signs. Transesophageal echocardiography (which is especially useful in cases of penetrating ulcers and intramural hematomas) was used as an important adjunct whenever possible. Aortography was performed in two views (ie, postero-anterior and left anterior oblique) using marked catheters to confirm preoperative CT-based measurements. After aortography, the least tortuous ilio-femoral artery was used to introduce the delivery catheter with the stent-graft. Surgical cut-down was used to expose the appropriate femoral artery. A dose of 5,000 U of heparin was used for anticoagulation. Under radiographic visualization, the catheter with the stent-graft was inserted over an extra-stiff guidewire through the femoral artery and slowly advanced toward the chosen deployment site in the thoracic aorta. The deployment site was marked by a radiopaque ruler placed under the patient’s back before the start of the procedure. Immediately before stent-graft deployment, sodium nitroprusside was administered intravenously to lower the mean aortic pressure to between 50 and 60 mm Hg, to decrease the risk of stent-graft migration during deployment. To confirm exclusion of the dissection, aortography was carried out a few minutes after the stent-graft was deployed and after blood pressure had returned to control values. After the procedure, patients were monitored in the postoperative care unit and kept under observation for 24 hours. The patients were discharged home after a postprocedural CT scan had been performed.

Results
The mean operative time for this procedure was 125 minutes. All patients were carefully followed up. In addition to aortography performed during the procedure, CT or TEE was also performed to document results and complications during hospitalization. The follow-up period ranged from 1 to 55 months, with a mean of 29 months.

The procedure was technically successful in 65 patients (92.9%), as documented by exclusion of the false lumen or ulcer/hematoma in the thoracic aorta (Fig 2). There were 5 (7.1%) conversions to surgery, all due to leakage at the proximal end of the stent-graft. Two patients required emergent conversion due to expansion of the aneurysm. Three patients underwent elective operations due to large flow of blood in the false lumen of the aneurysm. In 11 patients (18.9%) with classic type B dissection, residual blood flow in the false lumen per-

Fig 1. Intimal tear in acute type B aortic dissection.
sisted in the abdominal aorta due to a more distal tear, which could not be treated percutaneously because of the proximity of visceral vessels.

There were 2 deaths related to the procedure: 1 patient sustained a cardiac arrest before deployment of the stent-graft due to hypovolemic shock, and the other died in cardiogenic shock after successful deployment of the stent-graft while recovering in the intensive care unit. There were 2 in-hospital deaths from causes unrelated to the procedure. One patient developed multiorgan failure due to cardiac arrest before stent-graft implantation. The other patient experienced a pulmonary embolism. The in-hospital survival rate was 97.2%.

For adequate repair, insertion of additional stent-grafts was required in 34 patients (48.6%). Additional stent-grafts were needed in some patients either because of multiple tears or because the first stent-graft was malpositioned in relation to the origin of the dissection or the intimal tear. To that end, 17 patients received two stent-grafts, 10 received three, 4 received four, 2 received five, and 1 received six (Fig 3). Indications for additional stent-graft implantation were multiple entry tears or stent-graft malposition.

There was no in-hospital symptomatic branch vessel occlusion despite the fact that 14 patients (20%) had the left subclavian artery origin occluded by the stent-graft. Nevertheless, in 1 patient, 8 months after stent-graft implantation, a left carotid-to-left subclavian bypass was performed because of arm weakness. Stroke occurred in 2 patients (2.9%) and was due to cerebral embolization during stent-graft deployment. There were no instances of paraplegia in this group despite the fact that 34 patients received more than one stent-graft covering a greater portion of their thoracic aorta.

One case of brachial artery thrombosis (1.4%) was observed at an access site. This patient required endarterectomy repair. It was believed that this complication was due to the Seldinger technique used for insertion of the device. Another patient required endarterectomy repair of the femoral artery after the procedure. Another patient experienced deep vein thrombosis. Other complications were mild and transient renal failure (15 patients, 21.4%), surgical wound infection (2 patients, 2.9%), and peritoneal dialysis catheter infection (1 patient, 1.4%). Fever was common (15 patients, 21.4%); in most patients it appeared not to be related to an infective process and was considered to be due to an inflammatory reaction to the prosthesis. These patients were treated with antiinflammatory agents. Four patients (5.7%) died after hospital discharge. Two patients had sudden unexplained death. A third patient died in a car accident. The fourth patient died from hepatic failure. At mean follow-up of 29 months, 91.4% of the patients are alive and well.

Comment

The concept of aneurysm repair by the percutaneous insertion of an endovascular prosthesis was first suggested by Dotter [8] in 1969. However, it was Parodi [9] who, in 1995, successfully pioneered the treatment of abdominal aortic aneurysms with an endovascular prosthesis. These investigators used a balloon-expandable endovascular prosthesis and showed that the procedure was feasible and carried low risk. In 1994, Dake and colleagues [10] showed for the first time the feasibility of treating descending thoracic aortic aneurysms with an expandable endovascular prosthesis introduced through the femoral artery.
In our series of patients, there were low mortality and surgical conversion rates. The two sudden deaths that were observed were likely related to aortic disease, demonstrating that these patients require very close follow-up. The presence of intimal tears in the abdominal aorta, maintaining blood flow between the lumens, was frequently not diagnosed until occlusion of the thoracic tears. Accurate diagnosis of abdominal intimal tears can only be made after proximal occlusion of the true and false lumens, thereby decreasing the pressure in the false lumen distally. During TEE it was evident that immediate thrombosis of the false lumen of the thoracic aorta had occurred, as also documented by predischarge CT.

Absence of paraplegia in this series of patients, despite the facts that some of them had multiple stent-grafts and some had more than two thirds of their descending thoracic aorta covered by stent-grafts, is very encouraging. The low incidence of paraplegia after stent-graft treatment of aortic disease has been reported by others [14].

Cerebral vascular accidents are potential complications and can be associated with stent-graft insertion, as the aorta is usually severely diseased. Minimizing manipulation of the catheters during the procedure may decrease the incidence of these complications.

Other complications occurring in our series of patients were minor. Fever, not related to infection, was frequent and responded to therapy with nonsteroidal anti-inflammatory drugs. It was postulated that fever was due to an immune-mediated process in patients presenting with low-grade fever and mild leukocytosis. The use of antibiotics must be judiciously used in this group of patients.

In conclusion, our successful initial experience in the treatment of complicated and uncomplicated type B dissection of the aorta with stent-grafts provides a less invasive and lower-risk approach than does conventional open surgery. The latter is associated with significant morbidity and mortality rates. We have demonstrated that it is possible to insert stent-grafts in the angiography suite with a low complication rate. However, experience with larger series of patients and longer follow-up periods, as well as refinements in stent-grafts and their delivery systems, are required before this new modality of therapy can be recommended for widespread use treating thoracic aortic dissections.

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References

 INVITED COMMENTARY

Doctor Palma and his associates have provided a remarkable presentation of their 5-year experience with interventional management of aneurysms of the descending aorta. Within this timeframe, the authors have developed and adopted technical approaches that have helped them generate excellent clinical results.

Although great improvements have been made during past years by new surgical approaches, mortality and morbidity related to surgical repair of descending aortic aneurysms remains substantial. The role of catheter-based intraluminal stent grafting in descending aortic aneurysms is currently undergoing active clinical investigation [1]. In the high-risk, clinical setting of endoluminal stent repair of aortic dissection, this new therapeutic approach is yielding extremely promising results. In a recent review of 464 patients with aortic dissection, 30-day mortality in Type B dissection was 11% and 31% for medical or surgical therapy, respectively [2]. Long-term survival with medical therapy ranges around 70% and persistent false lumen patency turns out to be among the most important predictors of late mortality [3]. By noninvasive stent placement the intimal flap is covered and the entry site into the false lumen is obliterated, which results in thrombosis of the false lumen.