Evolving experience with thoracic aortic stent graft repair

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Purpose: We reviewed our initial thoracic aorta (TA) stent graft experience in 28 patients from the perspective of treatment with homemade devices (Dacron over Gianturco Z stents; 14 cases) and a commercial device (Excluder; W.L. Gore Co, Flagstaff, Ariz; 14 cases).

Methods: From November 1996 to August 2001, 28 patients with a spectrum of disease (degenerative aneurysm, n = 18; chronic dissection, n = 4; pseudoaneurysm, n = 3, with 1 trauma and 2 anastomotic; intramural hematoma, n = 2; and coarctation, n = 1) underwent TA stent grafting. Clinical parameters included a mean age of 71 years, 12 female (43%) and 16 male (57%) patients, 14 of 28 patients (50%) with major comorbidities that prohibited open repair, and nine of 28 patients (32%) with urgent or ruptured conditions. Seven patients (25%) needed open surgical access to the aorta or iliac artery for either concomitant abdominal aortic aneurysm repair (n = 3) or device deployment (n = 4), and six of 28 patients (21%) needed left subclavian-carotid transposition to provide for an adequate proximal fixation site. Focal (<15 cm) grafts were used in 19 patients, and the remaining patients had at least two thirds of their descending aorta excluded.

Results: The procedural mortality rate was 3.5% (1/28 patients); three additional deaths, (1 device-related) occurred during the mean follow-up period of 17 months. Access artery complications occurred in six of 28 patients (21%), with one fatal. No immediate or late open conversions were performed. One patient needed urgent dilation and stenting of a collapsed stent graft 3 weeks after deployment. Serious systemic complications included temporary dialysis (n = 1), congestive heart failure (n = 1), and unstable angina (n = 1). Complete exclusion of the TA lesion was noted in 27 of 28 cases (96%). No cases of spinal cord ischemia were noted. Ease and accuracy of deployment was superior for the second generation (commercial) device.

Conclusion: TA stent graft repair, although in evolution, appears to be a safe and effective alternative to open repair for many patients with a spectrum of TA disease. Prospective trials for individual diseases will be necessary to define its ultimate role. (J Vasc Surg 2002;35:1129-36.)

Stent graft repair of thoracic aortic (TA) aneurysm, first reported by Dake et al., has progressed more slowly than the corresponding experience with infrarenal aneurysm. The much lower incidence rate of degenerative aneurysm in the TA and the device design constraints imposed by the need for proportionally larger devices inserted from more remote access sites are plausible explanations for this trend. However, the perspective of offering a less invasive form of treatment for lesions that affect the descending TA is an appropriate one because conventional repair thereof remains a major surgical undertaking with mortality and serious morbidity rates in the 5% to 10% range, even in centers with considerable experience. In addition, the spectrum of TA disease, including degenerative aneurysm, acute and chronic dissection, penetrating ulcer, intramural hematoma, and traumatic aortic tear, is potentially amenable to stent graft repair and will likely increase demands for this technology in the future.

Both device evolution and clinical experience with different diseases in TA stent graft repair remain at an early stage. Only a single large clinical series has been reported, with the acknowledged limitation imposed by first generation devices wherein device-related problems and complications were common. Herein, we report our initial experience with TA stent graft repair with a perspective gained from use of both custom-made constructs and a commercially made device (Excluder; W.L. Gore Co, Flagstaff, Ariz) currently in phase II clinical trials.

PATIENTS AND METHODS

During the interval from November 1996 to August 2001, 28 patients underwent stent graft repair of TA lesions. Use of custom-made devices (see subsequent) was originally sanctioned on a case-by-case basis by the Massachusetts General Hospital Institutional Review Board (IRB); subsequent use of this construct as standard of care was approved. Fourteen patients underwent treatment with a commercially manufactured device (Excluder) with two separate clinical circumstances. Eleven patients were enrolled in a US Food and Drug Administration-approved, industry-sponsored phase II clinical trial (with informed...
consent) approved by the IRB. This trial compares the Gore Excluder to open repair, and for eligibility, patients had to be candidates for either procedure. Three patients who underwent treatment with the Excluder device had conditions managed on a “compassionate use” basis because they did not meet clinical or anatomic criteria for the phase II trial. Such use was sanctioned on an individual case basis by the hospital IRB.

All patients underwent preoperative evaluation with a combination of fine-cut (3-mm) computed abdominal tomographic (CAT) scans that encompassed the entire TA and abdominal aorta; helical three-dimensional reconstructions were used to supplement graft length measurements. Transfemoral angiography with a 100-cm marker catheter was used in all patients for optimal visualization of arch anatomy, as the principle guide to device length, and for evaluation of the iliofemoral access arteries. Aortic diameters at the proximal and distal fixation sites were assessed on an outer wall to outer wall basis from the axial and reconstructed CAT scan images. Two centimeters of proximal and distal (proximal to the celiac axis) fixation sites with diameters therein not exceeding 37 mm were the minimum anatomic criteria to permit stent grafting. Proximal fixation length could be increased with subclavian transposition. Graft diameter was selected with oversizing 10% to 15% of the fixation site diameter. Qualitative assessment of the stent graft landing sites (aortic wall calcification or atherothrombotic debris) was assessed from precontrast and postcontrast CAT scan results.

**Stent graft designs.** Two different graft constructs were used. The first was a custom-made device comprised of an endoskeleton of self-expanding Gianturco Z stents (W.A. Cook, Inc, Bloomington, Ind) covered with an ironed (to eliminate graft crimping) woven Dacron graft (Cooley Veri-soft, Meadox Medicals, Inc, Oakland, NJ) as originally described by Dake et al.1 Graft material extended to the ends of the endoskeleton from which the attachment barbs were removed. The interlocking 2.5-cm lengths of the Z stents were affixed to each other with 4-0 nylon sutures, and the graft material was attached to the endoskeleton with 5-0 polypropylene sutures placed through the stent eyelets. Graft diameters for this construct ranged from 20 mm (for a focal pseudoaneurysm at the site of a prior coarctation repair) to a maximum of 34 mm (constrained by stent size and the delivery system.) Custom-made grafts were gas sterilized the day before use and loaded into the delivery system in the operating room. The delivery system consisted of a 65 cm-long or 90 cm-long 24F Keller-Timmerman sheath (W.A. Cook, Inc), sufficiently long to be positioned across the deployment site. The device was manually loaded into a 24F peel-away sheath, which was used to introduce the device into the delivery sheath. With fluoroscopic observation, the device was advanced inside the sheath and positioned across the aneurysm. The device was deployed with fixing it in place with the sheath obturator and simultaneously retracting the sheath to release the self-expanding device. The other stent graft construct was a commercially manufactured (W.L. Gore, Co) device composed of a thin-walled polytetrafluoroethylene graft and a nitinol exoskeleton. The stent graft is self-expanding to a maximum diameter of 40 mm and is delivered through a sheath (22F or 24F) into the abdominal aorta to prevent both trauma to and premature deployment of the construct in passage through the iliofemoral access arteries. Thereafter, the stent graft is advanced “bareback” over a guidewire and is deployed essentially instantaneously from its midportion to either end with release of an enveloping thin membrane.

**Operative technique.** Procedures were performed either in the operating room or in an operating room compatible suite in the vascular radiology department. General anesthesia with arterial line monitoring was used in all cases and, in cases in which the stent graft was carried to the distal aortic arch, patients were positioned with shoulders rotated in right lateral decubitus position with the hips flat facilitating imaging in a steep left anterior oblique projection. Twenty patients (71%) could be approached with open femoral artery access, and in these cases, contralateral percutaneous femoral access was used for control and angiographic catheter access. Intraoperative imaging guidance was with standard catheter angiography performed after the stent grafts had been positioned in the approximate area of deployment. Four patients underwent open access via the abdominal aorta; three of these underwent simultaneous open repair of abdominal aortic aneurysm (AAA). In these circumstances, graft repair of infrarenal (1 case) or suprarenal (2 cases) AAA were performed in standard fashion, and thereafter, a 10-mm Dacron sidearm graft was anastomosed to the abdominal aortic graft for the stent graft delivery system access. Similarly, four patients underwent access with an initial iliac “chimney” graft (10-mm Dacron) performed through a lower abdominal retroperitoneal incision. Pharmacologic afterload reduction to a systolic blood pressure in the 80 mm Hg range was used before graft deployment only in circumstances in which the proximal deployment site was located in the aortic arch. Six patients (21%) needed a preliminary left subclavian to common carotid transposition proximal to the internal mammary artery to provide an adequate (2-cm minimum) proximal neck for stent graft fixation in the mid to distal aortic arch. This procedure was performed through a supraclavicular incision as an initial staged approach 2 days before stent graft implantation. Nine patients (32%) were cared for perioperatively in an intensive care unit, although three of these needed such care because of simultaneous open AAA repair; the remaining six patients had planned intensive care unit stays because of comorbidities. Mean operative time (exclusive of concomitant AAA repair) was 160 minutes (range, 70 to 490 minutes), and blood loss in cases without open AAA repair averaged 600 mL (range, 50 to 4500 mL).

**Patient clinical and anatomic profile.** Twenty-eight patients (12 female and 16 male) with an average 71 years of age (range, 36 to 91 years) underwent treatment. Pathologic characteristics of the TA lesions are displayed in the Table. Fourteen of 28 patients had major comorbidities (all
Thoracic aortic pathology disease treated with stent grafts

<table>
<thead>
<tr>
<th>Condition</th>
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<td><strong>Total</strong></td>
<td><strong>28</strong></td>
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Cardiopulmonary) believed to preclude open repair. Nine patients had undergone prior AAA graft repair. Nine patients (32%) underwent treatment in urgent circumstances, with documented symptomatic expansion in four patients, bronchopulmonary erosion in two patients, and contained rupture in three patients. Treatment size threshold for degenerative aneurysms was 6 cm.5,6 Twenty patients (71%) had relatively focal disease amenable (in 19 of 20 cases) to single stent grafts not exceeding 15 cm in length. The remaining eight patients had more extensive disease that necessitated at least two interlocking stent grafts covering most or all of the descending aorta. One patient with a type II thoracoabdominal aneurysm had combined open abdominal and stent graft repair extending from the distal arch to the aortic bifurcation, with the caudal end of the stent graft deployed into the suture line of a suprarenal AAA repair. Stent graft diameter requirements varied with individual disease, with a minimum of 20 mm for unusual disease, such as anastomotic pseudoaneurysm at the site of prior coarctation repair. Sixteen patients (60%) needed stent graft 34 mm or more in diameter, with two patients needing 40-mm grafts (Fig).

RESULTS

Endografts were successfully deployed in all patients with complete exclusion of the TA disease in 27 of 28 patients (96%). The single initial technical failure resulted when proximal retrograde and distal aortic dissection occurred during the course of stent graft repair of a symptomatic intramural hematoma of the proximal descending aorta. This dissection channel has sealed on follow-up examination between commercial grafts and custom-made constraints.

Mortality. A single periprocedural death (3.5%) occurred in a 91-year-old patient treated for a symptomatic contained rupture of a focal degenerative aneurysm. Disruption of the iliofemoral access anatomy (from a transfemoral approach) caused substantial hemorrhage and needed immediate open aortofemoral reconstruction. This patient died of multisystem failure on postoperative day 12. Three additional deaths have occurred during a mean follow-up period of 17.8 months (range, 1 to 53 months). One of these deaths was device related. An apparently successful (commercial device) stent graft exclusion of a contained rupture of a distal arch aneurysm failed when the patient was seen in 10 months with massive hematemesis and an aortoesophageal erosion was confirmed with endoscopy. CAT scan results showed aortic rupture at both ends of the stent graft, and enteric erosion/infection of the original aneurysm sac was suspected. One patient died of myocardial infarction at 10 months after surgery; the final death (aspiration pneumonia) occurred 4 months after combined open/stent graft repair of a symptomatic type II TA aneurysm. Crude survival rate was accordingly 86% at a mean follow-up interval of 18 months after stent graft repair.

Morbidity. No complications specifically related to surgical transposition of the left subclavian artery occurred. Stent graft procedural-related complications were classified as either local or systemic. Local complications occurred in eight patients (28%) and were usually (75%) related to the iliofemoral access anatomy; such access anatomy complications are related to bulky introducer sheaths and occurred with equal frequency throughout the study period and irrespective of stent graft design. Three patients needed either pelvic laparotomy or retroperitoneal exposure of the iliac artery for repair; three repairs could be accomplished with extension of the original groin incision, and two postoperative groin hematomas were managed conservatively. White et al7 noted that 27% of their patients needed iliofemoral reconstructions for access artery complications. Two device-related complications (both with custom-made grafts) occurred and necessitated endovascular rescue procedures. One was the intraprocedural dissection detailed previously, and a second patient had sudden kinking of a custom stent graft originally placed for recurrent coarctation and suture line false aneurysm. This resulted in bilateral lower extremity ischemia and was successfully managed with placement of an uncovered stent within the original stent graft. No significant groin wound infections were noted.

Remote or systemic nonfatal complications occurred in eight patients (28%) and included (all complications listed) respiratory failure (n = 3; two patients with major antecedent pulmonary comorbidity), temporary dialysis (n = 1), atrial fibrillation (n = 2), unexplained mental status changes (n = 2), septicemia (n = 2), and urinary inconti-
Stent graft repair of complex thoracic aortic pathology. Patient was frail 82-year-old woman who had recently undergone suprarenal open AAA repair complicated by retrograde intraoperative aortic dissection. Rapid enlargement of thoracic aorta with dissection superimposed on degenerative aneurysm was noted with significant back pain and documented expansion from 4 to 6.5 cm during 4-month interval. A, Axial computed tomographic (CT) images show dissection channel (arrow) in 6.5-cm aneurysm. B, Intraoperative angiogram shows proximal deployment site (large arrow) just distal to left subclavian artery (double arrows). C, Intraoperative angiogram shows distal deployment site (single arrow) into origin of celiac axis (double arrows). D, Postoperative axial CT scan (same level as A) documents aneurysm sac collapsed around stent graft. E, CT scan reconstruction shows two 40-mm interlocking stent grafts excluding entire thoracic aorta to level of celiac axis (arrow).
nence (n = 2). Notably, no strokes and no spinal cord ischemic complications were seen.

Anatomic follow-up examination. Among 19 patients treated for degenerative aneurysm (including one patient with dissection in a recognized antecedent degenerative aneurysm), CAT scan follow-up imaging data were available for a mean interval of 11 months after treatment. Aneurysm sac shrinkage was observed in nine patients (47%), and no aneurysms were noted to enlarge. Delayed development of endoleak or graft migration was not observed; stent graft extension either proximally or distally has not been necessitated.

DISCUSSION

Experience in the current modest-size series supports the feasibility, safety, and (with important qualifications about follow-up duration) efficacy of stent graft repair for degenerative descending TA aneurysm. Although far less common than degenerative aneurysm in the infrarenal position, both the proportionally higher risk of conventional operation for TA disease and the possibility of extending stent graft repair to the treatment of acute distal dissection is certain to increase demand for this technology. In contrast to other reported series, ours is a combined experience with the so-called first generation device (Dacron over Gianturco Z stent endoskeleton) and the W.L. Gore Excluder graft, affording an opportunity to assess the capabilities and limitations of each construct. We certainly agree that there are distinct disadvantages of the custom-made construct—large caliber delivery systems, lack of flexibility, segmented design prone to kinking in curved aortic segments, inaccuracy of proximal deployment—as emphasized elsewhere. The proprietary device we used in 14 patients is clearly a superior design. Yet the custom-made construct continues to have a role particularly in focal disease in the straight portion of the descending aorta and until such time as propriety devices have completed the cycle of clinical trial and eventual approval. Indeed, as of the writing of this report, the W.L. Gore Excluder device is “on hold” because of stent fractures (none were observed in our patients) leading in at least one case to device failure and TA rupture.

Although the cumulative experience with thoracic stent graft repair is limited, important distinctions from the parallel experience with AAA stent graft repair are apparent. First, periprocedural mortality rate with TA stent graft repair generally exceeds that reported for abdominal aortic stent grafting. The 3.5% operative mortality rate reported herein is significantly higher than our recently reported experience with 362 AAA stent graft repairs (operative mortality rate, 1.6%). Yet this 3.5% figure is at the lower range reported for TA stent graft repair, with other reports noting procedural mortality rate in the 9% and even up to the 20% range. These figures are influenced by the fact that most TA stent series contain small numbers of patients and many of these have been treated in truly desperate anatomic or clinical circumstances wherein conventional open operation was not a realistic option. Despite such mitigating factors, also clear is that direct device-related problems have contributed substantially to procedural mortality. Device migration with aneurysm rupture, device failure with immediate open conversion, massive distal embolization, fatal mesenteric ischemia from celiac occlusion, and stroke from device manipulation in the aortic arch have all been reported. Inaccurate proximal deployment (particularly when proximal fixation is at or near the aortic arch) caused by the “wind sock” effect of ventricular ejection figured prominently in the failures and complications reported with first generation devices. Superior design characteristics of second generation devices have already made intraoperative maneuvers, such as inducing ventricular asystole during graft deployment, obsolete. Despite this fact, we agree with the intuitively logical conclusions of other authors that careful preoperative anatomic assessment, including a qualitative assessment (for mural debris) of device landing zones, and ensuring adequate proximal and distal fixation lengths is essential in avoiding potentially fatal procedural mishaps. To achieve such adequate proximal fixation, no hesitation should be seen in initiation of the procedure with left subclavian artery transposition, a maneuver necessary in some 20% of our patients and in 8% to 43% in other reports. We strongly disagree with the posture of simply covering the left subclavian origin with the stent graft or deploying the same into the origin of the subclavian artery. Although sacrifice of the subclavian will be tolerated by most, if not all, patients, the concern for devastating proximal endoleak is too great to forego the simple expedient of left subclavian transposition.

Two additional procedural complications, namely access artery issues and spinal cord ischemia, are deserving of comment. Given that large-diameter introducer systems are typically necessitated and the higher relative (compared with AAA) proportion of female patients (with expected smaller iliofemoral arteries) with thoracic aneurysm, access artery constraints and potential complications can be anticipated in many candidates for TA stent grafting. The approximately 20% rate of something other than transfemoral access is in the range (16% to 66%) reported in other series, although these figures are influenced by inclusion of patients who have undergone simultaneous open AAA repair with use of the abdominal graft for TA stent graft access. Careful consideration of complete preoperative pelvic vessel imaging studies is necessary to develop an appropriate operative plan. There should be no hesitation to directly approach iliac vessels or the abdominal aorta when mismatch between delivery system size and femoral/external iliac artery size exists. Furthermore, intraprocedural maneuvers, such as preemptive placement of balloon occlusion catheters before sheath withdrawal, can be lifesaving in the circumstance of iliofemoral artery disruption, which typically occurs at the iliac bifurcation and is recognized only as the delivery sheath is removed at the conclusion of the procedure. Access artery complications, which occurred in some 20% of our patients and caused the only operative death, must be both anticipated and managed.
promptly. The potential for such complications constitutes a compelling argument for continued use of general anesthesia, arterial-line monitoring, and a fully equipped operating room as the appropriate environment for TA stent graft procedures.

As experience accumulates, a gratifying dearth of spinal cord ischemic complications accompanying TA stent grafting has been seen. Although such complications have been reported, experience to date permits the conclusion that the usual surgical paradigm relative to intercostal vessel sacrifice during open repair and its resultant increased risk of spinal cord ischemic complications does not pertain to stent graft repair. We observed no spinal cord complications despite the fact that many of our patients had the critical lower thoracic segment (ninth thoracic vertebrae to first lumbar vertebrae) completely covered with the stent graft. In addition, three patients underwent concomitant open AAA repair, a circumstance that apparently increases the risk of cord ischemia in the Stanford experience. Whether related to aortic crossclamp application or concomitant sacrifice of lumbar arteries, the Stanford group noted lower extremity neurologic deficit only when concomitant open AAA repair was performed; accordingly, they recommended against simultaneous repair. Not surprisingly, Greenberg et al correlated more extensive lengths of stent grafts as increasing cord ischemic complications, which they observed in 12% of their patients. This latter figure must be considered a maximum for spinal cord complications because most reports are similar to our own experience with cord ischemia in the 0 to 3% range. One group suggested a test deployment of a collapsible stent graft with evoked potential monitoring to assess the potential negative impact of stent graft exclusion of intercostal vessels. Also suggested is that patients at high risk for cord ischemia undergo management with protective adjuncts (cerebrospinal fluid [CSF] drainage, hypothermia, etc) as might be used during open repair. We did use CSF drainage in a single patient deemed at high risk for cord ischemia (Fig); the patient did well, but the impact of CSF drainage is, of course, unknown. Although no definitive statements about the comparative risks of spinal cord ischemia with open versus stent graft repair are possible, the available evidence, including the present experience, suggests that the risk of cord ischemia with stent graft repair is low.

Efficacy of TA stent graft repair will only be proven when sufficient numbers of treated patients are followed for long periods of time. Currently, intermediate range follow-up is available for small numbers of patients in this study and in other reports. We have assumed that the usual surgical paradigm relative to intercostal vessel sacrifice during open repair and its resultant increased risk of spinal cord ischemic complications does not pertain to stent graft repair. We observed no spinal cord complications despite the fact that many of our patients had the critical lower thoracic segment (ninth thoracic vertebrae to first lumbar vertebrae) completely covered with the stent graft. In addition, three patients underwent concomitant open AAA repair, a circumstance that apparently increases the risk of cord ischemia in the Stanford experience. Whether related to aortic crossclamp application or concomitant sacrifice of lumbar arteries, the Stanford group noted lower extremity neurologic deficit only when concomitant open AAA repair was performed; accordingly, they recommended against simultaneous repair. Not surprisingly, Greenberg et al correlated more extensive lengths of stent grafts as increasing cord ischemic complications, which they observed in 12% of their patients. This latter figure must be considered a maximum for spinal cord complications because most reports are similar to our own experience with cord ischemia in the 0 to 3% range. One group suggested a test deployment of a collapsible stent graft with evoked potential monitoring to assess the potential negative impact of stent graft exclusion of intercostal vessels. Also suggested is that patients at high risk for cord ischemia undergo management with protective adjuncts (cerebrospinal fluid [CSF] drainage, hypothermia, etc) as might be used during open repair. We did use CSF drainage in a single patient deemed at high risk for cord ischemia (Fig); the patient did well, but the impact of CSF drainage is, of course, unknown. Although no definitive statements about the comparative risks of spinal cord ischemia with open versus stent graft repair are possible, the available evidence, including the present experience, suggests that the risk of cord ischemia with stent graft repair is low.

II endoleak as a persistent problem. These authors also cautioned that sac shrinkage should be expected in successfully treated cases. Resch et al documented mean aneurysm shrinkage of just 4 mm at an 18-month mean follow-up period. We noted shrinkage on computed tomographic scans at 1 year in some 50% of patients. White et al noted aneurysm sac volume to be decreased or stable in most patients after stent graft repair, and this method may be the more sensitive and preferred method of follow-up examination. Late migration of the stent graft, particularly as the aneurysm morphology changes after exclusion, has been a cause of late failure and correlated with graft kinking by two groups. This phenomenon has been observed primarily with the first generation construct especially when graft kinking occurs. Late migration of the stent graft has not been observed in our patients, nor are endoleaks persistent in our patients currently under observation.

This series mirrors the experience of other investigators in terms of patient anatomic selection and device evolution. We attribute the favorable results reported herein to a reluctance to compromise on anatomic constraints (insisting on a minimum 2-cm fixation length and avoiding tortuous aortic segments as fixation points), particularly with the first generation construct. The accumulating experience with TA stent graft repair indicates that it will be an effective alternative to open repair for degenerative aneurysm in patients with suitable anatomy. Exciting developments with TA stent graft repair for acute distal dissections and chronic dissection with aneurysm have been reported. Prospective trials for each of these individual diseases will be necessary before the ultimate role of TA stent grafting is defined.

Note: Since the submission of this material, a recent case of extensive thoracic stent graft replacement has been complicated by paraplegia.

REFERENCES

DISCUSSION

Dr Robert Hopkins (Providence, RI). I greatly admire the study and its presentation. It seems almost miraculous. I have two questions. One is the question of how many patients you found unacceptable for this procedure and used the open technique by preference? Second, with respect to spinal cord ischemia, what proportion of your patients had very limited stents and how many actually covered most of the thoracic aorta with the intercostal vessels included?

Dr Richard Cambria. Thank you, Dr Hopkins, for your comments and questions. I will answer your second question first. You obviously made the sage observation that one of the available series in the literature has correlated, as you might expect, increasing lengths of the thoracic aorta covered with an increase in risk of spinal cord ischemia. We had nine patients who had most or all of the descending aorta covered in this experience. The remainder of the patients, 19, had relatively focal lesions that could be encompassed by a graft no longer than 15 cm.

With respect to your first question, we do approximately 60 to 70 thoracic or thoracoabdominal aneurysm repairs on our service annually. This is an experience that began in late 1996. I do not have the exact comparative numbers for you, although I will tell you that in the course of the phase 2 clinical trial for the Gore excluder device, this was a protocol that basically mandated equal numbers of open conventional operation controls to stent grafts. So, for those 11 patients during this study interval, there were 11 open thoracotomy repairs of descending thoracic aneurysms. In terms of a numerator/denominator sort of equation, if you take the entire spectrum of thoracic thoracoabdominal aneurysm disease, the percentage of patients graftable with this technology is certainly going to be lower than the corresponding abdominal aneurysm numbers because as aneurysms extend into the visceral aortic segment they of course are not treatable with stent graft repair.

Dr Philip Allmendinger (Hartford, Conn). Congratulations to Dr Cambria on this wonderful exposure of what is going on with the stent grafts in the thoracic aorta.

We had one experience with a patient in her late 70s who had had an abdominal aneurysm repair, and we extended the thoracic excluder graft down to the celiac. She had transient ischemia, which was manifested simply by numbness and weakness intermittently for about 6 weeks. This subsequently resolved. My question is, in the chronic dissection, did you have any visceral vessels coming off the false lumen and what was the result of excluding the false lumen with the stent graft?

Dr Cambria. Thank you for your comment and observation. I do not mean to imply (although we had 28 patients here with no ischemic spinal cord complications) that spinal cord ischemia is solved, and it certainly has been reported with stent graft repair in the thoracic aorta. The incidence rate ranges from a low of 0 to a high of 9% in those few series available. The patient that you asked about with the chronic dissection aneurysm is a complicated one. Because all visceral vessels below had already been reconstructed with an open repair, there was no potential for eliminating perfusion of vessels perfused from a false lumen.

Dr Richard Powell (Lebanon, NH). Those results are quite impressive. I had two questions. One was that I know that the Gore balloon is lobulated to allow flow around the balloon while it is inflated to facilitate precise placement in the proximal portion of the graft. I was wondering what other techniques your group used to facilitate precise placement of the proximal portion of the graft.

The other question I had was related to the iliac perforations, whether you thought these perforations would be amenable to repair with a covered graft like a Wallgraft or one of the AneuRx limb grafts.

Dr Cambria. Thank you, Dr Powell, for your questions. With respect to the iliac artery disruptions, we have learned in the course of some pretty heated and uncomfortable moments how to get ready to anticipate that. Firstly, when you are introducing hardware going in, one develops a feel for just how tight that is, and even if you have a centimeter-wide external iliac artery in a nice size man, the 24F Keller Timmerman sheath fits pretty tight in just about everybody. If you have issues referable to the iliac arteries, we have gotten into the habit of placing a balloon in the very proximal common iliac artery as the sheath comes out so that you can be prepared to inflate that. Whether or not it would be reconstructible with a covered stent graft I think relates to the extent of the injury. We have not done that; we have simply opened the retroperitoneum and fixed it. The most common site of injury is at the iliac bifurcation where the common iliac gives off the external. That is usually where the disruption occurs, so it would at least in theory be possible to fix that with proximal balloon control and a covered stent graft from the common iliac to the more distal external iliac.

Your first question was about maneuvers with respect to proximal deployment accuracy, in particular with the second generation devices. The era of adenosine or fibrillation to arrest the bradycardia needed to arrest the fibrillation to arrest the

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then affix the graft to prevent foreshortening at the lesser curvature. We do drop the systolic blood pressure to the 70-mm, 80-mm range when we have to deploy in the transverse portion of the arch. As mentioned, the deployment mechanism of the Gore excluder device has pretty much eliminated many of those concerns about accuracy of proximal deployment.

Dr Jens Jorgensen (Portland, Me). I would like to add a very nice presentation on an elegant solution to a complex problem. Just a couple of questions.

Do you use any of the usual adjuncts for spinal cord protection, such as spinal cord drainage or barbiturates or whatever?

Secondly, would you mind speculating on why you think covering the intercostals does not lead to spinal cord ischemia?

Dr Cambria. Thank you for your questions. My speculation is that the usual surgical paradigm does not hold because, although you are eliminating intercostal vessels that are potentially contributing spinal cord blood supply, you are not doing all the other things like crossclamping the aorta, sacrificing potential collateral circulation, and so forth.

As regards the patient with the complex pathology, combined dissection, and degenerative aneurysm, who was going to have her entire descending aorta covered to a prior graft that had been placed 3 months previously, I did use CSF drainage and kept her in an intensive care unit for 48 hours with CSF drainage. The patient had no problems. Of course we do not know if that adjunct was at all effective, but that we have used it in a single case is the answer to the question.

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22nd Annual William J. von Liebig Foundation Award for Excellence in Vascular Surgical Research for Residents, Fellows, and Mentors—
First Place: $5,000 (Author) and $10,000 (Supporting Mentor)

Additionally, an unlimited number of $2,500 awards will be given for each manuscript achieving a score within the 1.0 to 2.0 range, with $5,000 being awarded to each of their research mentors.

Purposes
- Motivate physicians early in their training to pursue their interest in research
- Recognize and support research professionals who supervise this critical function

Eligibility
- Author must be a Resident or Fellow on staff at an accredited vascular surgery program in the United States, Canada, or Mexico, with senior collaborators acting in a consultative capacity.
- Manuscripts must be postmarked no later than September 3, 2002. Selection results will be conveyed to all applicants by October 31, 2002.

Research Requirements
- The research may be experimental or clinical in nature, dealing with some fundamental or clinical aspect of vascular surgery. Both basic and clinical research papers are especially encouraged.
- The manuscript must be an original, unpublished work (not submitted elsewhere for publication, except to the ACS Surgical Forum).
- The submission must be in English and include 1 copy of the typed manuscript and 1 original copy of illustrations (photographic prints or original computer-generated images). The manuscript must also be submitted electronically in Microsoft Word or PDF format on a PC computer disk or e-mailed to liebigfoundation@draxgroup.com. All submissions must comply with the Information for Authors of the Journal of Vascular Surgery and include an abstract of 250 words or less.
- Accompanying each submission should also be the following: a cover letter from the Resident or Fellow indicating the manuscript is to be considered for “The 22nd Annual William J. von Liebig Foundation Award for Residents, Fellows, and Mentors”; the author’s full curriculum vitae; and a signed letter from the author’s mentor attesting that the author performed all the essential parts of the experimental work reported.

Selection Process
A select committee of vascular surgeons appointed by the Foundation will review the manuscripts submitted. 2002-2003 Committee Members include the following: Colleen M. Brophy, MD, Chairman; Ellior L. Chaikof, MD, PhD; Linda M. Graham, MD; William H. Pearce, MD; Michael Sobel, MD; Jean A. Goggins, PhD, Secretary; and Thomas C. Naslund, MD, SAVS Ex-Officio.

The first-prize winner will be a guest of The von Liebig Foundation, and the award will be presented at the annual meeting of the Southern Association for Vascular Surgery on January 15-18, 2003, at The Lowes Ventana Canyon Resort in Tucson, Arizona. Meeting expenses incurred by the winning author will be reimbursed according to the travel policy of the Foundation. The winning manuscript will be submitted to the Journal of Vascular Surgery or another publication of the author’s choosing for consideration for publication. The William J. von Liebig Foundation reserves the right to withhold the granting of the award at the sole discretion of the Award Committee, whose judgment with respect thereto shall be final and conclusive.

History
Since the award’s inception in 1982, 90% of previous award recipients have pursued careers in vascular or cardiothoracic surgical research. Thirteen recipients have become Fellows of the American College of Surgeons, three are associate members of the College, and one recipient is a Fellow of the American College of Cardiology. Two previous award winners are recipients of the von Liebig—supported Mentored Clinical Scientist Development Awards, and approximately 50% have become successful peer review funded researchers in vascular surgery. Past award winners include such well known researchers as Colleen Brophy, MD, Howard Greider, MD, Michael Marin, MD, and Kenneth Ourel, MD.

Conclusion
It is the desire of the Foundation to encourage the movement of technical innovation and relevant clinical findings from the laboratory to the vascular surgical community. It was Mr von Liebig’s hope that those who pursue this award and those who win it will contribute to the advancement of medical care.

Further inquiries may be directed to the Foundation as follows:

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FURTHER INQUIRIES:

Dr Jens Jorgensen (Portland, Me). I would like to add a very nice presentation on an elegant solution to a complex problem. Just a couple of questions.

Do you use any of the usual adjuncts for spinal cord protection, such as spinal cord drainage or barbiturates or whatever?

Secondly, would you mind speculating on why you think covering the intercostals does not lead to spinal cord ischemia?