Penn Thoracic Aortic Surgery Program

DIVISION OF CARDIOTHORACIC SURGERY

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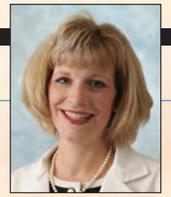

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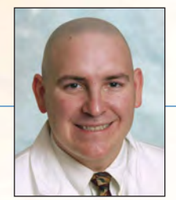

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Penn Thoracic Aortic Surgery

WELCOME

Joseph E. Bavaria, MD
Founder and Director
Penn Thoracic Aortic Surgery Program

Dear Colleague:

Ours is the battle against deadly and debilitating aortic disease. Approaching its 15th year in this effort, the Penn Thoracic Aortic Surgery Program continues to grow in value as a regional resource.

Our multidisciplinary structure and comprehensive staffing and facilities make us a center of choice for patients and physicians seeking the foremost in care for aortic events and conditions. The research in our program is tied closely to the clinical care that we offer for all levels of need.

Unfortunately, when it comes to conditions of the aorta, most patients receive care under emergent or acute status. But today, practitioners can screen for risk and evaluate signs of these conditions, often confirming abnormalities with inexpensive tests, such as echocardiography. Increasingly, we can manage and monitor to either help spare patients surgery or at least offer surgical care before an urgent aortic event takes place.

Our program is dedicated to advancing techniques and protocols to reduce risks at all phases of disease. And with a dynamic group such as the one we've built over these years, there's always relentless advancement in the battle against aortic disease. We want to continue to spread this news to our colleagues.

In this issue, we report on:

- ***Valve-sparing aortic surgery.*** Re-implanting a patient's native valves — in surgery for Type A (ascending aortic) dissections — allows patients to retain the advantages of their natural valve tissue. Repairing rather than completely replacing the aortic base and valves is an important new construct that we are extending to older patients as well.
- ***Preventing paraplegia.*** By working to prevent and treat spinal cord infarction before and after surgery, we've made progress against a devastating complication of aortic operations. We are actively preventing and treating it during and after surgery. We receive inquires from other centers on how to set up ICU protocols for this purpose.
- ***Stent grafting high-risk patients with Type B dissections.*** We were the first program to place stent grafts in patients with thoracic abdominal dissections and ruptures, and we've now treated about 250 patients in this manner. This paradigm shift in surgery for the abdominal aorta takes advantage of interventional vascular access and has led us to conclude that hospitals without an endovascular program should refer these types of patients to centers that do. As one of the few GORE training centers, we instruct specialists far and wide on the technique.
- ***Family history and aortic conditions.*** Our knowledge about the heritability and genetics of risk for aortic dissection or aneurysm, and specifically about conditions such as Marfan syndrome, continues to grow. We can identify and manage risk within families.
- ***Next generation of grafts.*** Newer customizable stent grafts appear to offer better safety and success, and may become the standard.

We perform hundreds of aortic surgeries each year and more thoracic aortic procedures than any other hospital in the Philadelphia area. Excellent emergency services, including the PennSTAR 24-hour emergency air medical service, allow us to get care to patients in the golden hours in which treatment is still possible and effective. These and many other factors help us to maintain quality outcomes that exceed the national averages. We appreciate the many years of support from our referrers and colleagues that have helped us to achieve the quality of care that we can now offer.

Sincerely,

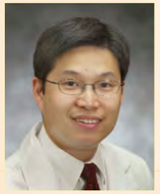
Joseph E. Bavaria, MD

Inside this ISSUE:

"We appreciate the many years of support that have helped us to achieve the quality of care that we can now offer."

FOR MORE INFORMATION OR TO REFER A PATIENT CALL PENNLINE: 1-800-635-7780

Joseph E. Bavaria, MD
Founder and Director
Penn Thoracic Aortic
Surgery Program

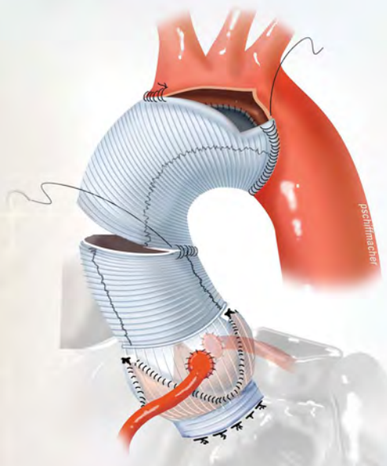


Wilson Y. Szeto, MD
Cardiovascular Surgeon

Valve-Sparing
Aortic Root Replacement

Until recently, patients with aneurysms of the aortic root and ascending aorta have had to undergo replacement of their entire aortic root apparatus as part of the surgical repair of their aneurysms. This has been true regardless of whether their aortic valve leaflets were normal or diseased. That meant patients were subjected to either life-long anticoagulation therapy (in those receiving a mechanical composite valve conduit) or limited durability (in those receiving a biologic valve replacement).

At the University of Pennsylvania Health System, we have been performing valve-sparing aortic root replacement for patients with aortic root and ascending aorta aneurysms. The advantage of this operation is the replacement of the aneurysm with *preservation* of the patient's native aortic valve. The procedure is successful and safe. In our series at the Penn, we have had no deaths and no reoperations for failure of repair.



Criteria for Surgery

To us, this advance has emphasized the need to evaluate and intervene with aortic-aneurysm patients early, before their aortic valve leaflets are irreversibly damaged. At present, our decision for surgical intervention is based primarily on the patient's maximum aortic diameter and the severity of the aortic valve insufficiency.

Surgery is indicated for patients who have:
- an aortic diameter of 5.5 cm or greater;
- an aortic diameter of 5.0 cm or greater with concomitant severe aortic valve insufficiency;
- an aortic diameter of 4.5 cm or greater, with either a connective-tissue disorder such as Marfan syndrome or a strong family history of aortic catastrophe,

Aortic insufficiency is not an absolute contraindication for valve-sparing aortic root replacement, providing the aortic valves are functionally normal. Often, aneurysmal dilatation and displacement of the commissures lead to aortic valve insufficiency. Pre-operative echocardiography often demonstrates normal leaflets with poor coaptation, resulting in a central regurgitant jet. Particularly in younger patients (typically those with Marfan syndrome) whose aortic leaflets are often normal, preservation of the native aortic valves is ideal.

Restoring the Sinuses of Valsalva and Normal Anatomy

In valve-sparing aortic root replacement, we reconstruct the aortic root apparatus while preserving the native aortic valve leaflets. First described in 1995, the original procedure involved the reconstruction of the aortic root apparatus with the use of a straight Dacron® graft. However, the sinuses of Valsalva is believed to be an important anatomic component of the aortic root apparatus. Recent data has suggested that coronary flow is improved and leaflet stress is reduced with the recreation of the sinuses of Valsalva. Therefore, to reconstruct the native aortic root with the optimal hemodynamics and leaflet durability, we have been using a Dacron graft conduit with pre-constructed sinus segments ("Valsalva" graft, Sulzer Vascutek, Refrewshire, Scotland). Preliminary results with this modification of the standard technique have been encouraging.

In the past, bicuspid aortic valve was considered a contra-indication for valve-sparing aortic root replacement. However, preliminary data has suggested that even patients with a bicuspid valve (that is otherwise functionally normal) may be candidates for the valve-sparing procedure. We are evaluating the durability of this type of repair for such patients.

Thus, valve-sparing aortic root replacement allows patients to avoid life-long anti-coagulation therapy and retain the durability of their native valves. Physicians should consider it for any patient who meets the appropriate criteria.

— Wilson Y. Szeto, MD
— Joseph E. Bavaria, MD

Valve-sparing aortic root replacement allows patients to avoid life-long anti-coagulation therapy and retain the durability of their native valves.

Preventing and Treating Paraplegia
After Thoracoabdominal Aortic Aneurysm Repair

Albert Cheung, MD
Cardiovascular Anesthesia

Thoracoabdominal aortic aneurysm repair is considered a definitive procedure. A successful operation results in a cure. However, thoracoabdominal aortic aneurysm repair is one the most complex surgical operations in contemporary medicine. A major challenge is preventing and treating complications associated with the operation. The most serious and devastating complication is paraplegia, caused by spinal cord ischemia or infarction from interruption of blood flow to the spinal cord. This complication occurs because many of the blood vessels that supply the spinal cord originate from the diseased segment of the aorta that has to be replaced. Despite advances in surgery and anesthesia, the problem of paraplegia persists.

Members of Penn's Aortic Surgery program recognized that a successful program depended on our ability to manage this complication. A team of surgeons, anesthesiologists, neurologists, and critical-care nurses undertook this effort. We focused on three strategies: 1) techniques to maintain blood supply to the spinal cord, 2) improved detection of spinal cord ischemia, and 3) emergency interventions to treat paraplegia caused by spinal cord ischemia.

Preventing Paraplegia During Surgery

To improve spinal cord perfusion during operation, a heart-lung machine is used to provide blood flow to the distal aorta beyond the aneurysm. Arterial blood pressure Is monitored in both the proximal and distal aorta and controlled precisely, often with potent vasopressor medications. A thin silastic catheter is inserted into the spinal canal before the operation to drain cerebrospinal fluid (CSF) to prevent build-up of CSF pressure that could impede spinal cord perfusion. By using intraoperative neurophysiologic monitoring to assess spinal cord function during anesthesia, we learned that controlling both the arterial pressure and CSF pressure was critical to preventing spinal cord ischemia.

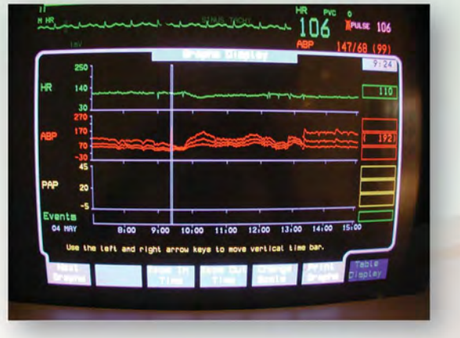
Treating Paraplegia After Surgery

The improved surgical care decreased the number of patients developing paraplegia during operation, but patients were still at risk for spinal cord ischemia after operation. To address this new problem, a "rapid response team" was created to treat delayed-onset paraplegia after operation using many of the same techniques, such as lumbar CSF drainage and arterial pressure augmentation.

For this approach to work, ICU nurses, other staff members, and even the patient had to be taught to recognize the first signs of spinal cord ischemia. The team could then intervene immediately, before the injury became permanent. Using this approach, we were able to reverse delayed-onset paraplegia completely in many patients, or decrease the severity of injury in those with incomplete responses. We reported our success in a paper presented at the annual meeting of the Society of Thoracic Surgeons.

Seeing a patient respond to treatment and recover from paraplegia has been one of the most gratifying experiences in medicine. It has also been rewarding to learn that other centers applying our techniques have experienced similar successes. However, we realize that the problem has not been solved. There are still some patients who do not respond to treatment and some of the interventions have inherent risks. We are involved in work to identify which patients are at greatest risk and to refine procedures and protocols to improve their safety. Nevertheless, progress has been made to prevent and address a tragic event associated with operations on the thoracic aorta – a complication previously thought unavoidable, unpredictable, and untreatable.

— Albert T. Cheung, MD



An episode of spinal cord ischemia after thoracic aortic aneurysm repair associated with hypotension (inset). Immediate treatment of hypotension resulted in recovery—the patient can now lift both legs off the bed.

Caring for the Patient
with a Type B Dissection of the Aorta

G. William Moser, MSN, RN
Clinical Practitioners

The Type B aortic dissection, unlike Type A, presents the clinician with a variety of possible treatment scenarios and the need to make challenging clinical decisions about the approach to care. With Type A dissection, time is of the essence, given that short-term mortality is very high: about one percent per hour. For these cases, emergency surgical intervention is imperative.

But, Type B dissections can present along a continuum of complexity: from the acute, uncomplicated event to the acute event complicated by malperfusion, ischemia, and even aortic rupture. With a wide variation in clinical presentations – and also a high level of acuity – Type B aortic dissections require the medical team to make swift and accurate decisions. Prompt and appropriate action is critically important and will directly affect the eventual outcome for the patient.

The Stanford classification system defines Type B aortic dissection as a tear in the aortic intima occurring distal to the left subclavian artery. This longitudinal dissection can present as a limited tear involving a short segment of the descending thoracic aorta or range up to a complete dissection extending through the abdominal aorta into the aortic bifurcation and iliofemoral system. As the tear extends distally, branch flow – to the spinal cord, mesentery, renals, and lower extremities – is disrupted. This effect may be mild with no clinical evidence of impaired perfusion or may present with mild to severe signs or symptoms, including lower-extremity paraparesis or paralysis, abdominal pain and ischemia, renal insufficiency with a rising blood urea nitrogen and creatinine, and lower extremities with diminished or no pulses.

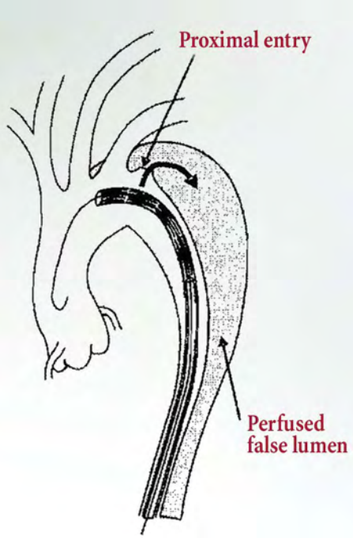
Being Systematic and Exhaustive

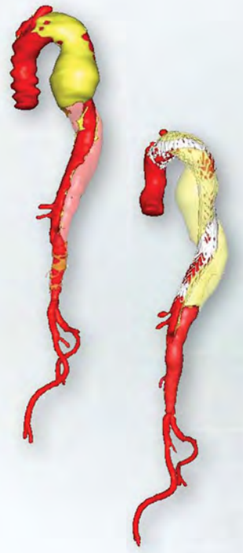
What to do? Algorithmic thinking within a defined protocol ultimately enables the clinician to obtain the best, most consistent outcomes. Regardless of presentation, a Type B aortic dissection is a life-changing event. Affected patients must incorporate new habits and recommendations into their daily lives. Many will need to break old lifestyle habits. Immediate, assertive management, followed by consistent, diligent, long-term monitoring and follow-up will improve the overall outcome for patients with these difficult circumstances.

In the acute phase of the event, defined as less than two weeks from the inciting episode, assessment of end organ perfusion, including lower extremities, takes priority. Simultaneously, the managing medical team will commonly institute strict hypertensive care for the patient, including admission to the ICU for intravenous pharmacotherapy.

Therapy should ideally incorporate beta blockade. Reducing the dp/dt (rate-pressure product) is a mainstay of treatment. Though target blood pressures are determined on a case-by-case basis, systolic blood pressures under 130 mmHg are generally desirable. The team will titrate this to patient response and recurrence of pain. Hypertension resulting in back pain is symptomology necessitating further decreases in blood pressure.

The medical team should, at the same time, address perfusion deficits. Frequent neurologic checks, both for mentation and extremity movement are mandatory. Continuous hemodynamic monitoring will enable careful titration of medications controlling blood pressure and heart rate. Deficits in perfusion will likely require an immediate response. Consultants in these circumstances commonly involve cardiac surgery, vascular surgery, and interventional radiology. The methods for treating malperfusion vary significantly. Thus, having access to experienced surgical and multidisciplinary staff for immediate consultation is vital.





> If the medical team successfully coordinates all of the elements of long-term management, it can often help spare the patient from having to undergo surgery to repair the aorta.

Many Patients Can Avoid Surgery

It is difficult to overemphasize the importance of follow-up management of patients with Type B aortic dissection. Given that most of these patients do not require immediate surgery, the managing medical team should focus its energy on reducing the likelihood of surgery in the long term. The main elements for achieving this goal include:

- tight blood pressure control within specific guidelines;
- routine serial imaging of the aorta and related vasculature;
- lifestyle modifications;
- and patient and family support.

If the medical team successfully coordinates all of these elements, it can often help spare the patient from undergoing surgery to repair the aorta. Current data suggests that about a third of patients sustaining a Type B aortic dissection will eventually require surgery to repair the aorta. The indication for this surgery will likely be expansion of the false lumen into an aneurysm. The medical team can gauge the likelihood of this event and the general prognosis within the first three months of therapy. Aggressive blood pressure management in the first few months after dissection can greatly impact the likelihood of surgery in the future.

Collaboration Makes for Good Care

The Penn Thoracic Aortic Surgery Program comprises an experienced, accomplished, cross-disciplinary group of experts who specialize in diseases of the aorta. This team has developed and refined a strict set of protocols for timely care of the acutely ill population of patients with Type B dissections. With a single telephone call to our program, patients and referring physicians can get quick access to our experts.

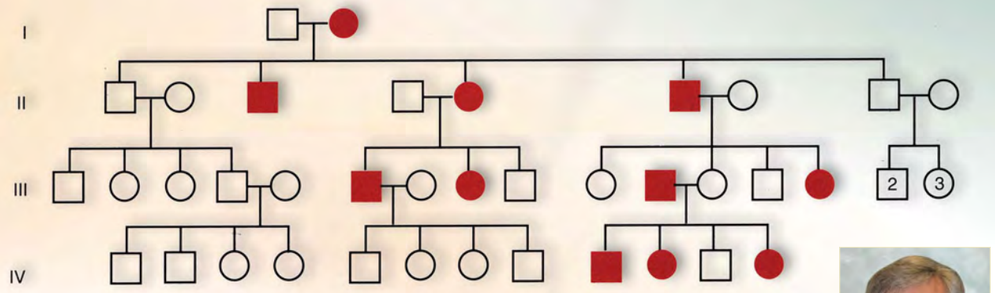
Once the acute phase of the patient's care has been managed, the team must then focus on long-term care. By incorporating the expertise of the patient's local cardiologist or internist for hemodynamic management, and taking advantage of Penn's surgical expertise to review serial imaging, the team can achieve the best outcomes in each case. This collaborative arrangement not only provides the patient with excellent medical and surgical care, it also gives the patient the assurance that his or her care is comprehensive, state-of-the-science, and detail oriented. Patients continue to work with their own physicians, who, in turn, trust the Penn team to lend first-rate surveillance of the patient's aortic anatomy at routine intervals.

The Penn Thoracic Aortic Surgery Program is one of the most active aortic programs in the region, and one of the foremost such programs in the nation. This group conducts extensive clinical trials and investigations on treatment advances and refinements comprising a variety of surgical and medical issues.

PennSTAR is the region's leading Level 1 flight service. This 24-hour emergency medical air service offers direct air transfer of acutely ill patients to Hospital of the University of Pennsylvania within 150 miles of Philadelphia. With our nationally recognized cardiac and vascular surgeons, entry into the University of Pennsylvania Heath System is a quick telephone call away. Once the patient is admitted, this expertise extends to the ICU intensivists, nurse practitioners and ICU nursing staff in the Surgical Intensive Care Unit (SICU). This well-orchestrated team immediately institutes the protocols, customized to each individual's presentation, which will lead the patient through this critical time.

A member of the program's team is available around the clock, to promptly consult with referring physicians and to immediately provide care for patients in acute or critical situations. Referring physicians can rest assured that one of our team members is on call for such consultations at all times.

— G. William Moser, MSN, RN



Family showing dominant inheritance of aortic aneurysm.

Family History and Aortic Aneurysms

Reed Pyeritz, MD
Medical Genetics

For nearly a century, physicians have observed that aortic aneurysms tend to cluster in some families. We know this to be true for aneurysms that occur in the abdominal aorta; however, recent research has also emphasized the importance of family history in aneurysms that occur in the ascending aorta. These aneurysms are especially serious, because a tear in the wall, known as a dissection, can result in sudden death. The newer findings complement our long-standing association of several genetic conditions – especially the Marfan syndrome – with an increased risk of aneurysm of the ascending aorta.

People with Marfan tend to grow tall and lean; have difficulties with their vision; develop skeletal deformity, such as curvature of the spine or indentation or protrusion of the breastbone; and have mitral valve prolapse. The syndrome affects men and women with equal prevalence, and a person who has the condition has a 50-50 chance of passing it to his or her child. This is termed autosomal dominant inheritance.

Testing Family Members

A number of other conditions also predispose to aortic aneurysm and are also inherited in an autosomal-dominant fashion. In the past year, researchers have described a new condition, termed Loeys-Dietz syndrome, which predisposes to dissections in blood vessels that are branches of the aorta. In other families, aortic aneurysm is associated with a common (one person in 200) deformity of the aortic valve, in which only two cusps are present rather than the usual three (bicuspid aortic valve). Finally, in some families, aneurysms in any part of the aorta are inherited in an autosomal-dominant fashion, although there is considerable variation among relatives.

The Penn cardiovascular team can treat these forms of disrupted aortic anatomy medically and, if necessary, surgically. The key lies in understanding who is at risk. Knowledge of the family history is essential, and those relatives who are at high risk can undergo simple screening and monitoring procedures, such as echocardiography or computed tomography (CT). Increasingly, testing of specific genes can identify those at risk, and, importantly, reassure those who are not at risk.

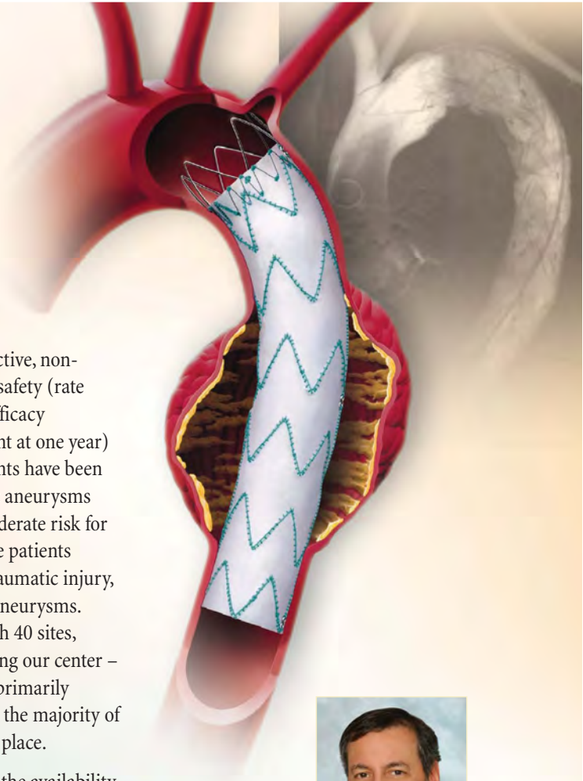
Excellence in Counseling and Management

Much of what we understand today about the medical and surgical therapy of aortic dissection or aneurysm in families was established by studies of Marfan syndrome. At the University of Pennsylvania School of Medicine, I direct a Center of Excellence for Heritable Disorders of Connective Tissue that focuses on this and other conditions that predispose to aneurysms. I am also proud to say that our team discovered the gene that causes Marfan syndrome. This team includes physician experts who provide clinical services for individuals, including evaluating risk, counseling about genetic testing, and coordinating care with cardiologists and with Penn's Thoracic Aortic Surgical Program.

As founder of the National Marfan Foundation, I was gratified that the foundation chose to recognize the importance of Philadelphia in this field by holding its 25th national meeting here in July 2006. The conference began with a workshop focused on research of eye problems caused by the condition. It also entailed a clinic for patients and their family members, sponsored by the Hospital of the University of Pennsylvania. Finally, the meeting concluded with two days of workshops devoted to medical and social issues that confront people with this condition. Penn's Thoracic Aorta Surgery Program was a major participant in and sponsor of this anniversary event.

— Reed Pyeritz, MD, PhD

The Next Generation of Thoracic Aortic Stent Grafts



Ronald Fairman, MD
Vascular Surgeon
National PI for Valor Phase I and II Clinical Trials

With enrollment recently completed for the Valor Trial (Evaluation of the Medtronic Vascular Talent Thoracic Stent Graft System for the Treatment of Thoracic Aortic Aneurysms), a new generation of endovascular graft has seen broader clinical use in the U.S. The Talent stent graft system has been used extensively outside the U.S. for many years, including in Europe, where it is widely accepted.

Specialists here have gained experience with the Talent stent graft since the Phase I trial in 1998. The evolution of the Talent stent graft to it the current "Valiant" design comes from feedback from thousands of implants worldwide. Engineers have enhanced the delivery system as well as the stent graft itself.

The original Talent stent graft was the first endovascular device available to treat thoracic aortic pathology when we began our thoracic endovascular program at the Hospital of the University of Pennsylvania in 1998. The customization features allowed us to offer novel options to patients whom we had previously had to manage with "watchful waiting."

Most Patients Enrolled at Handful of Centers

The device in the current trial is similar to the original. Today's version consists of a pre-loaded stent graft and a CoilTrac delivery system, with an endoprosthesis composed of a polyester graft fabric sewn to a self-expanding Nitinol wire frame.

The design is modular. Proximal and distal stent graft diameters range from 22 mm.-46 mm., and total length ranges from 112 mm.-116 mm. Configurations allow for crossing the great vessels of the arch as well as the celiac artery.

The Valor Trial is a prospective, non-randomized evaluation of the safety (rate of "all cause" mortality) and efficacy (successful aneurysm treatment at one year) of this system. Test-arm patients have been diagnosed with thoracic aortic aneurysms and are considered low-to-moderate risk for open surgical repair. These are patients diagnosed with dissections, traumatic injury, pseudoaneurysms, as well as aneurysms. Although the trial runs through 40 sites, eight sites in the U.S. – including our center – enrolled most of the patients, primarily because these centers perform the majority of stent grafting currently taking place.

The new design, as well as the availability of stents with diameters as large as 46 mm., has opened the door to endovascular thoracic aortic options for a broader range of patients. The preliminary results of the high-risk arm of the trial were presented in June 2005 at the Vascular Annual Meeting in Chicago.

Conforming Better to Anatomy

Although rigid stent grafts can function well in the abdominal aorta, flexible designs are paramount in the thoracic aorta. Thoracic devices need to conform to the aortic arch as well as to the tortuosity inherent in the atherosclerotic thoracic aorta. Controlled deployment in such areas has been difficult; but, a new delivery system — with a smaller profile, controlled ratcheting, and improved stabilization — addresses this challenge.

Furthermore, longer stent grafts are particularly desirable when treating most pathology in the thoracic aorta. The great majority of thoracic aortic conditions require stent graft coverage of up to 200 mm. Longer endograft devices result in fewer junctions and fewer passes of large delivery systems through small diseased iliac arteries. The new Valiant device has distinct "figure of eight" radiopaque markers proximally and "zero" markers distally, which provide enhanced visibility and result in more precise overlap.

Preliminary outcomes with the current grafts are encouraging and reveal high procedural success and lower operative mortality, stroke incidence, and paraplegia rates. The improved graft and system design allow more precise placement of endografts and should reduce complications.

– Ron Fairman, MD