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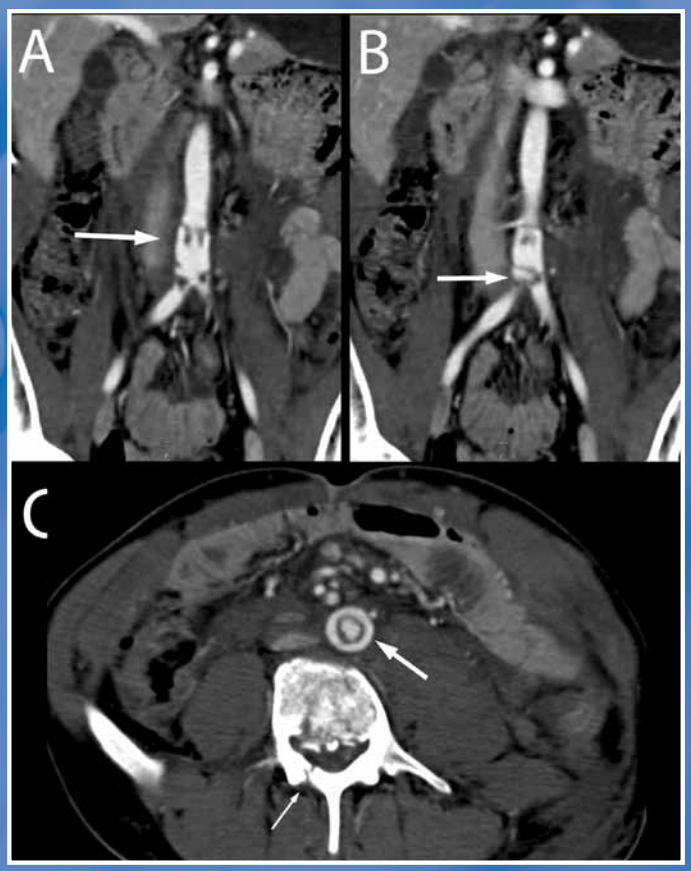

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ELG Repair Provides Alternative Intervention in Complex Vascular Trauma Case

By Scott Seidel, MD, FACS

Since its introduction by Juan Parodi in 1991, endoluminal stent graft repair of the aorta has revolutionized the treatment of various abdominal aortic pathologies, primarily aneurysmal disease. Four FDA-approved devices are now available in the United States for the repair of abdominal aortic aneurysms.

Treatment of the thoracic aorta with a commercially available device became possible with the approval of the Gore TAG stent graft in March 2005 (see Figure 1). More recently, thoracic grafts from Medtronic and Cook have been approved for the treatment of thoracic aortic aneurysms and penetrating aortic ulcers. Although approved for aneurysmal disease, centers with significant experience using the devices have been able to extend this potentially life-saving technology to the treatment of other aortic pathologies, including aortic dissection and traumatic aortic injuries, when open surgery may carry a higher risk.

A recent case at the University Medical Center Brackenridge highlights the issues surrounding the application of this evolving technology.

Figure 1. Stent grafts for abdominal aortic aneurysms (top – GORE Excluder) and for thoracic aneurysms or penetrating ulcers (bottom – GORE TAG).

Case Study

The patient was a 32-year-old otherwise healthy male who was the driver in a high-speed motor vehicle accident that resulted in one death. He was wearing his seatbelt and experienced no loss of consciousness.

During transport to the UMCB Emergency Department, the patient was hemodynamically stable with a GCS of 15 and, upon arrival, was promptly evaluated by the trauma team. His main complaint was of severe abdominal pain, although he had multiple other obvious injuries. Initial blood pressure was 115/60, which remained stable throughout the ED stay. Heart rate was elevated at 110 and the physical exam was significant for easily palpable femoral and pedal pulses and neurologically intact lower extremities. Initial lab results were unremarkable except for a hematocrit of 33.

A variety of diagnostic imaging studies were performed after the patient's initial evaluation. The head CT, cervical spine CT, plain films of the pelvis and chest X-ray were normal. The chest CT showed a normal mediastinum, normal great vessels and thoracic aorta, but bilateral pulmonary hemorrhagic contusions.

Plain films of the right leg diagnosed a patellar fracture and a calcaneous fracture. Contrasted CT of the abdomen and pelvis was significant for multiple abdominal injuries with irregularity of the spleen, free abdominal fluid and an L4 burst fracture with retropulsion and mild impingement of the spinal canal.

Of significance was an infrarenal aortic injury at the level of the inferior mesenteric artery. There was circumfrential disruption of the intima, but no evidence of contrast extravasation. The intimal disruption extended into the right common iliac artery and there was a pseudoaneurysm of the aortic wall at the level of the tear with a small surrounding hematoma (see Figure 2).

Figure 2. The patient's admission abdominal CT showing aortic tear at the level of the IMA (A – arrow) extending into the iliac vessels (B – arrow). The tear exhibited a target sign indicating a 360° intimal tear (C – large arrow). Note lumbar vertebral fracture (C – small arrow).

Consultations were obtained from the neurosurgery, orthopedic and vascular surgery services. The patient continued to complain of severe abdominal pain and, therefore, was taken to the operating room by the trauma team for exploratory laparotomy. Intraoperatively, he was found to have a hemoperitoneum, transection of the rectus musculature just below the umbilicus, multiple small bowel wall tears, perforation of the descending colon with fecal soiling and multiple mesenteric tears with an associated section of nonviable small bowel. There was a small nonexpanding hematoma in Zone I of the retroperitoneum.

Figure 3. Intraoperative photograph after ELG repair. The stent graft was delivered through two small groin incisions. Note staples and colostomy from the abdominal exploration two days prior.

Given the lack of cardiovascular instability, palpable pedal pulses and the severity of the other injuries, the vascular surgical team elected to closely follow the aortic injury to expedite repair of the more imminently life threatening problems. The patient underwent splenectomy, segmental resection of a nonviable small bowel section, repair of multiple mesenteric rents and repair of the colon injury with a diverting colostomy. Closure of the transected abdominal wall was also performed.

The patient remained stable throughout the case, and the orthopedic service repaired the patellar fracture and splinted the right lower leg. He was placed in a lumbar spine brace and transported to the ICU in critical but stable condition, where he remained mechanically ventilated for several days and neurologically intact. The pulse exam was monitored closely and he was treated with IV beta blockade to avoid hypertension and minimize the chance of propagation of the aortic tear.

A follow-up CT of the abdomen was performed two days later to re-evaluate the aortic injury and plan repair. Given the nature of the other abdominal injuries, the abdominal fecal contamination and ongoing physiologic challenges, the patient was not an ideal candidate for open aortic repair, which typically would be performed using a synthetic graft. Other options considered included open repair using autogenous deep femoral vein that would avoid contamination of a synthetic graft, but would require a longer procedure including vein harvest. Therefore, ELG repair was recommended.

After sizing the aorta and iliac vessels, a commercially available stent graft was chosen (Gore Excluder, Flagstaff, Ariz.). Treatment of the aortic tear required extension of the graft into the iliac vessels, given the involvement of the right common iliac artery.

On post-injury day three, the patient was taken to the endovascular suite at UMCB where the procedure was completed without incident, implanting the device through two small groin incisions (see Figure 3). A 23 mm x 12 cm x 14 mm

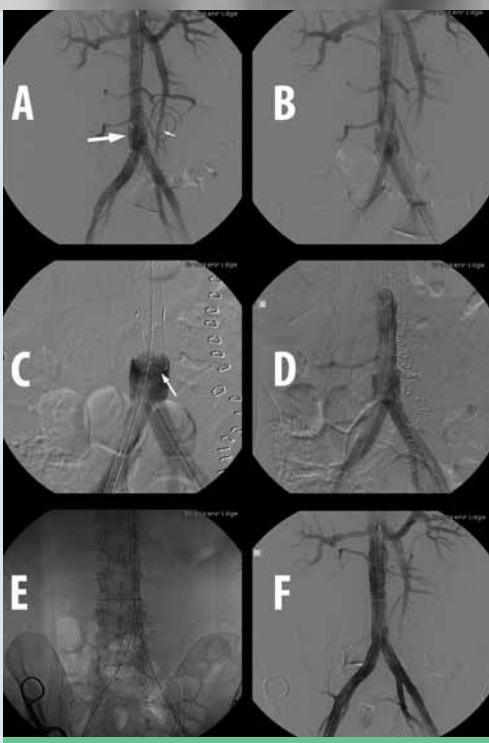

Figure 4. Angiographic images from ELG repair. A – Initial angiogram showing aortic tear (large arrow). B – main body device delivered. C – the contralateral graft gate (arrow) is positioned within the pseudoaneurysm for cannulation. D – Gate cannulated and contralateral limb ready for delivery. E – Final deployment of graft. F – Final angiographic result with excellent flow through ELG and exclusion of aortic tear and psuedoaneurysm.

Figure 5. Follow-up CT image at the level of the IMA two months later. The pseudoaneurysm has resolved and the IMA remains patent (arrow). Note colostomy (arrowhead) and spinal hardware. Inset – 3D CT image from the same study showing graft placement.

main body Gore Excluder device was chosen and we utilized a 7 cm x 14 mm contralateral iliac docking limb. There was complete exclusion of the aortic tear and pseudoaneurysm with preservation of flow into both iliac systems (see Figure 4).

The patient recovered uneventfully and eventually underwent successful lumbar fusion and calcaneal fracture repair. He was discharged from the hospital less than three weeks from initial presentation.

A follow-up CT scan of the aortic repair almost two months later showed the stent graft to be in good position with resolution of the pseudoaneurysmal area and no evidence of endoleak (see Figure 5). The patient has since undergone reversal of the colostomy and is doing well.

This case highlights the challenges of managing a multiply injured patient with vascular arterial trauma. His favorable outcome was a result of a multidisciplinary approach and the care he received from the trauma system at UMCB. Utilization of a minimally invasive endovascular repair of his aortic injury was also important in decreasing the repair risk of this life-threatening injury as well as minimizing the recovery time to allow continued aggressive rehabilitation and treatment of the other injuries.

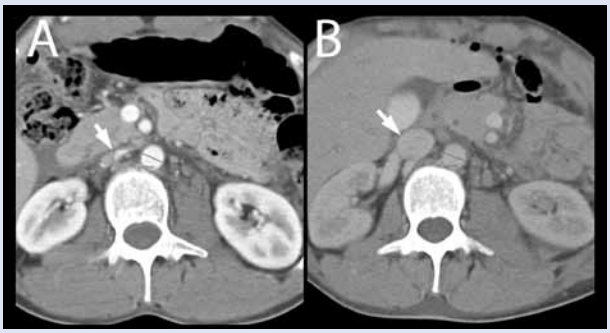

Figure 6. Pre-resuscitation (A) and post-resuscitation (B) CT scans demonstrating aortic size change. The aortic diameter was 14.8 mm and the IVC was collapsed (arrow) prior to volume repletion. Two days later, the measurement at the same aortic level was 16.4 mm. Note full IVC in panel B (arrow.)

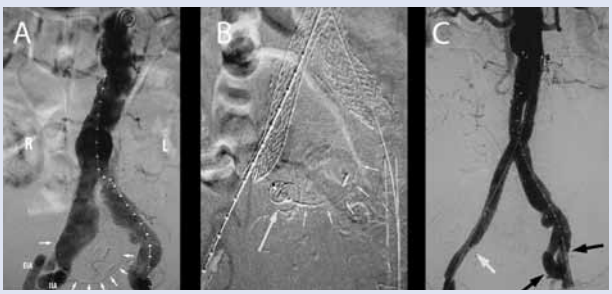

Figure 8. Angiograms from a patient with a large right common iliac aneurysm (A – small arrows) involving the origins of both the external iliac and internal iliac arteries. This required selective occlusion of the right internal iliac artery at its origin with a vascular plug (B – long arrow). Final image after ELG deployment shows complete exclusion of the iliac aneurysm (C – white arrow) with preservation of internal and external iliac flow on the left side (C – black arrows).

Discussion: Aortic Trauma

Although the repair of thoracic aortic transection with ELG repair has been widely reported and, in some centers, is the procedure of choice in stable patients, studies evaluating abdominal aortic injury and, therefore, its treatment are rare. The term "Seat Belt Aorta" has been used to describe the findings in blunt deceleration injuries to the abdominal aorta and surrounding structures first described in 1969 by Campbell et al.

Figure 7. Late images from the implantation angiogram showing filling of the lumbar artery pairs (white arrows) and collateral filling of the IMA (black arrow).

The patient in this case study exhibited many features typical of these injuries including trauma to the abdominal wall at the level of the seat belt, associated bowel injuries, lumbar spine fracture in addition to the aortic injury. Interestingly, the angiographic images generated during the ELG procedure demonstrated a limited dissection of the superior mesenteric artery seen at the level of the aortic injury (see Figure 4A).

Blunt abdominal aortic injuries are rare, accounting for less than 5 percent of traumatic blunt aortic injuries (the remainder being thoracic) and the majority of patients die at the scene. As in this case, patients surviving to presentation at the hospital have either a contained aortic tear with preserved flow through the area or more commonly thrombosis at the site of injury.

Although neurologic injury is common in the cases of aortic thrombosis, in preserved flow cases, it is less common assuming there is no neurologic compromise from the associated lumbar spine fracture. This factor is

important in treatment as aortic thrombosis or lumbar spinal cord injury would favor open surgical repair to ensure lumbar arterial flow. The non-operated mortality rate of blunt abdominal aortic injury is greater than 75 percent, and the overall mortality rate of these critically ill patients even when repair is successful is between 20-40 percent.

Treatment

The majority of blunt trauma aortic injuries have been treated with open surgical repair, while there are only a handful of reported endovascular repair. In the case of non-circumfrential aortic dissection, most endovascular repairs have utilized non-covered stents to restore the arterial flow lumen. In this patient's case, the presence of circumfrential disruption of the intima and associated pseudoaneurysm precluded non-covered stent placement. In addition, although injuries limited to the aorta can be treated with single-covered stents (usually aortic extension cuffs from devices used for aneurysm repair) the extension of the injury into this patient's right iliac system required a bifurcated device.

Accurate sizing of these devices is paramount to a successful outcome. In the treatment of thoracic aortic dissections, over-sizing has lead to acute stent collapse. Because the commercially available devices are designed for repair of degenerative aortic aneurysm, the smallest available sizes may be too large in younger trauma patients. This has certainly been an issue in the thoracic aorta.

In this patient, concern was initially based on his admission CT that the aorta above the intimal injury at the site of implantation would be too small. However, as has recently been demonstrated in the thoracic aorta by van Prehn and associates (2008), aortic sizes can vary significantly between non-resuscitated and resuscitated trauma patients. This situation was true here as the repeat CT scan on post-injury day two demonstrated an implantation zone that was more than 4 mm larger than his pre-resuscitated CT, making him an acceptable ELG candidate (see Figure 6).

Other issues include the long-term outcome of the stent graft in a young person. While longer-term follow up is available for older ELG aneurysm patients, the long-term results of the device have not been extensively studied in the trauma population, which is significantly younger.

As the lumbar arteries that supply the spinal cord are routinely covered by the stent graft, care must be taken to carefully select patients who can tolerate the loss of antegrade flow in the covered lumbar vessels. In addition, coverage of the inferior mesenteric artery must be tolerated.

In the current case, both of these arterial distributions were critical due to the lumbar spine fracture and the colectomy, which by necessity had interrupted collateral flow to the colon. Fortunately, as can be seen on the late images following implantation, there is opacification of the lumbar artery pairs as well as the IMA (see Figure 7). As mentioned previously, the patient has done well and a CT two months post implantation showed a good technical result. He will require lifetime follow-up, similar to that required for stents in other parts of the arterial tree.

Future Trends

As devices evolve, physicians will continue to apply this technology to appropriately selected patients to improve outcomes. Since the inception of our aortic endovascular stent graft program at Cardiothoracic and Vascular Surgeons, we have utilized ELG

Figure 9. CT postoperative image of a patient with bilateral large common iliac aneuysms involving both internal iliac arteries (outlined). The right internal iliac was chronically occluded (asterix) and therefore a left external iliac to internal iliac bypass was performed at the time of ELG implantation through a small left lower quadrant retroperitoneal exposure to maximize pelvic blood flow and allow exclusion of the aneurysm (arrow – bypass, arrowhead - internal iliac origin).

Figure 10. Follow-up CT from the first TAG endoluminal stent graft performed at Seton for a large, penetrating, thoracic aortic ulcer with associated aneurysm.

technology in hundreds of patients and have one of the largest experiences in Central Texas.

Combining open vascular surgical techniques with endovascular repair, expanded options are now available in the treatment of patients with more complex anatomy. For example, in the case of large iliac aneurysms with involvement of the internal iliac artery, selective embolization of the internal can be performed when the contralateral internal iliac is patent (see Figure 8). However, when the contralateral internal iliac is diseased or occluded, a bypass from the external iliac to the internal iliac can be performed at the time of ELG implantation to preserve pelvic blood flow (see Figure 9).

With the advent of stent grafts for pathology in the thoracic aorta, we have expanded treatment to this group of challenging patients as well (see Figure 10). The partnership among the peripheral vascular specialists and our cardiothoracic colleagues at CTVS has led to the seamless integration of the two disciplines to treat complex patients requiring both thoracic and abdominal approaches (see Figure 11). These combined open and endovascular repairs require hybrid operating rooms capable of handling complex open vascular operations in conjunction with high-resolution imaging for the image guided portion of the case.

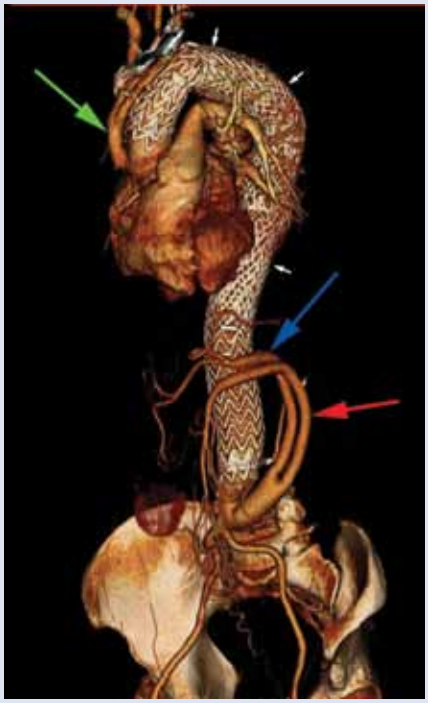

Figure 11. Complex debranching of the entire aorta for a thoracoabdominal aneurysm. Staged reconstruction consisted of abdominal debranching from the distal abdominal aorta to the celiac (blue arrow) and SMA (red arrow). The renal artery bypass is not shown. Subsequently, the thoracic aorta was debranched through a median sternotomy with a bypass from the ascending aorta to the great vessels (green arrow). This allowed multiple sequential TAG placements (white arrows) to exclude the thoracoabdominal aneurysm.

Conclusion

This case represents the application of endovascular technology in a situation where open repair would undoubtedly have carried higher risks. Although we continue to utilize the full spectrum of open vascular surgical techniques when indicated, expertise in minimally invasive vascular interventions is helping decrease morbidity and mortality in the treatment of appropriately selected patients with complex vascular problems.

Scott Seidel, MD, FACS, earned his medical degree from The University of Texas Southwestern Medical School in Dallas. His residency in General Surgery was completed at Vanderbilt University Medical Center in Nashville. Dr. Seidel completed his Vascular Surgery Fellowship at The University of Texas Southwestern Medical Center in Dallas and completed his Endovascular Surgery Fellowship at Stanford University Medical Center. He is an active member of the Society for Vascular Surgery, the Peripheral Vascular Surgery Society and the Society for Vascular Ultrasound. Dr. Seidel is a Fellow of the American College of Surgeons.

For more information about this case study or to refer a patient, please contact CTVS at (512) 459-8753, (800) 766-2365 or *doc@ctvstexas.com*. You can also visit their Web site at *www.ctvstexas.com.*

CASE STUDY

Single-Incision Laparoscopic Cholecystectomy

A New Technique with Fewer Scars, Less Pain

By John M. Uecker, MD

AC is a 24-year-old woman who presented with intermittent right upper quadrant abdominal pain for approximately one year.

The patient described having a dull aching pain that seemed to be related to food intake. The pain occasionally radiated to the mid-scapular area. She denied associated symptoms such as nausea or vomiting. She also denied any past medical or surgical history.

On physical exam, she was a pleasant woman with mild right upper quadrant abdominal pain. She showed no signs of peritonitis and there were no palpable masses on exam.

Diagnostic studies included a right upper quadrant abdominal ultrasound that showed a normal gallbladder without evidence of gallstones. A HIDA scan was then performed and showed a decreased ejection fraction of approximately 15 percent. She was diagnosed with biliary dyskenesia and scheduled for surgery.

She underwent a single-incision laparoscopic cholecystectomy. The operation was completed successfully without complication and she was discharged home the following day.

At her two-week post-operative visit, she reported that her pre-operative symptoms had resolved. She had no pain and was thrilled with her cosmetic result.

Intraoperative photo demonstrating three laparoscopic ports through one incision.

Immediate post-operative photo showing small infraumbilical incision.

Discussion

The laparoscopic approach for cholecystectomy has become the standard of care for treating gallbladder disease. Although traditionally done using a four-incision technique, a single incision can be used to perform the procedure.

The first single-port laparoscopic cholecystectomy in the United States was performed in 2007. Since that time, several academic institutions have reported small case series of the single-port technique. We have now performed the first 10 single-incision laparoscopic cholecystectomies in Central Texas. Our patients have been very satisfied with the cosmetic result and have reported less pain. Although further studies to evaluate patient satisfaction and post-operative pain are needed, this technique is both reasonable and safe. Most patients with symptomatic cholelithiasis, chronic cholecystitis or biliary dyskenesia are candidates for this procedure.

Dr. Uecker graduated with his MD from The University of Texas Medical Branch at Galveston in 1993 and completed his residency training at the Methodist Hospitals of Dallas. He then served as Ship Surgeon on the USS Enterprise followed by a tour as teaching staff at Portsmouth Naval Hospital.

Dr. Uecker has been in practice in Austin with Texas Surgical Group since 2003. His particular interests in advanced laparoscopic surgery, endocrine surgery and minimally invasive breast surgery. He is board certified with the American Board of Surgery.

For more information about this procedure, contact Dr. Uecker at:
Texas Surgical Group • 313 E 12th Street • Austin, Texas 78701 • (512) 324-7873