

creased chemotaxis is likely due to LPA. These data indicate a possible mechanism of dyslipidemia associated accelerated IH.

#### Computer Modeling for the Prediction of Thoracic Aortic Stent Graft Collapse

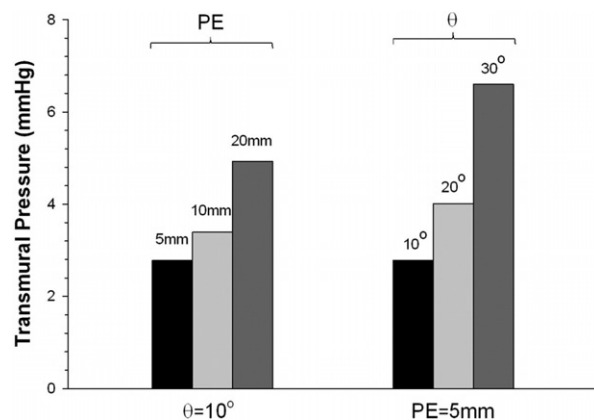
Salvatore Pasta, PhD, Onur Dur, PhD, Kerem Pekkan, PhD, David A. Vorp, PhD, Jae S. Cho, University of Pittsburgh, Pittsburgh, Pa

**Objective(s):** Thoracic aortic stent graft (TASG) collapse is a complication of thoracic endovascular aortic repair, occurring most commonly after treatment of traumatic aortic transection, and may cause reperfusion of the injured aortic segment or malperfusion of distal organs, or both. We used computational modeling to explore the hypothesis that poor apposition of the proximal end of the TASG to the lesser curvature of the aortic arch and associated proximal TASG protrusion can result in increased transmural pressure of sufficient magnitude to cause graft collapse and occlusion. Quantification of transmural pressure may help to identify patients with malapposition of the endograft who will eventually develop collapse.

**Methods:** One-way coupled fluid-solid interaction analyses were performed to investigate the flow-induced hemodynamic and structural loads exerted on the TASG protrusion. Three-dimensional geometries of the aortic arch and graft were reconstructed from computed tomography images of a representative patient after TASG repair. TASG geometry was characterized by the protrusion extension (PE), defined as the length of the TASG not in contact with the aortic wall and by the angle ( $\theta$ ) between the aortic wall and the protruded segment of the TASG. To explore the effect of  $\theta$ , we evaluated three models with PE fixed at a value of 5 mm:  $\theta = 10^\circ$ ,  $20^\circ$ , and  $30^\circ$ . The effect of PE was explored with three models with  $\theta$  fixed at  $10^\circ$ : PE = 5, 10, and 20 mm.

**Results:** The transmural pressure across the TASG wall protrusion increases as both PE and  $\theta$  increase (Fig. 1). A reduced pressure was found near the TASG protrusion (eg, 85 mm Hg for the PE = 20 mm and  $\theta = 10^\circ$  model), which could result in malperfusion of the distal organs. In general, for higher  $\theta$  or PE values, the blood flow loses its parallel pattern and enters between the aortic wall and the TASG, possibly leading to endoleak or collapse. In all cases, TASG wall stress did not change markedly.

**Conclusions:** Excessive endograft angle (PE = 20 mm and  $\theta = 10^\circ$ ) markedly increases the transmural pressure across the TASG wall, a load that would portend TASG collapse. Computational modeling may allow for identification of patients with high probability of TASG collapse and preventative intervention, and may aid in design and development of next generation TASG.



#### Standard Versus Prolonged Inflation Time in Balloon Angioplasty of Atherosclerotic Rat Aortas

John C. Lantis, II, Deva Boone, St Luke's Roosevelt Hospital, New York, NY

**Objective(s):** The ideal balloon inflation time in balloon angioplasty remains unknown. There are theoretic benefits for a prolonged inflation time in peripheral vessels, including reduced intimal trauma and recoil, but studies have been inconclusive. Our research compared the arterial response to prolonged inflation time (3 minutes) and standard inflation time (30 seconds) in a rat aortic angioplasty model.

**Methods:** Male Wistar rats were given vitamin D<sub>3</sub>, nicotine, and an atherogenic diet with added cholesterol and cholate. After 2 months, each rat received angioplasty of its distal aorta held for 30 seconds or 3 minutes. The rats were euthanized at 24 hours or 30 days, and aortas were assessed for comparison of intimal disruption in the 24-hour group or amount of intimal hyperplasia and medial thickening in the 30-day group.

**Results:** After 24 hours, both inflation time groups showed mild intimal disruption, but the difference in wall disruption scores was not significant. At 30 days, lumen and outer wall diameters showed no significant differences between groups. There were no significant differences in intimal wall areas. The intimal and medial wall area as a percentage of overall vessel area was  $35.0\% \pm 5.2\%$  in the 30-second group and  $36.8\% \pm 6.6\%$  in the 3-minute group, which was not significant.

**Conclusions:** Prolonged balloon inflation time failed to produce significant changes in intimal disruption after 24 hours. At 30 days, there was no difference in the amount of intimal hyperplasia, medial wall thickening, or lumen diameter compared with standard inflation times.

#### Evaluating Changes in Regional Tissue Perfusion Following Percutaneous Lower Extremity Revascularization Procedures With a Hyperspectral Image-Based Tissue Oxygenation Mapping System

Dipankar Mukherjee, MD, Cardiovascular and Thoracic, Falls Church, Va

**Objective(s):** This study established the feasibility of using applied imaging spectroscopy to replace or supplement existing adjuncts in the evaluation and follow-up of patients with chronic limb ischemia undergoing percutaneous revascularizations.

**Methods:** This is an ongoing prospective investigation studying the use of a commercially available hyperspectral-imaging camera in patients undergoing endovascular procedures for chronic limb ischemia. Images of the dorsal surface of the foot were obtained across various wavelengths of light before and after intervention. Spectroscopic measures were used to assess capillary oxyhemoglobin, deoxyhemoglobin, and oxygen saturation values at each pixel in the image. The data are displayed as interactive digital color maps, demonstrating heterogeneous perfusion throughout the entire foot and allowing morphologic and quantitative analysis. Periprocedural changes were compared against existing noninvasive tests, such as ankle-brachial indices and the Rutherford classification. Revascularized patients were reimaged after the procedure and at 6 weeks, and 3, 6, and 12 months.

**Results:** Of 46 enrolled patients having lower extremity limbs amenable to endovascular treatment (Rutherford grades 1-3), 17 completed all preprocedure and postprocedure visits. For deoxyhemoglobin there was statistically significant overall decrease from visits 1-6 ( $P = .04$ ), and between visit 6 and baseline ( $P = .02$ ). For oxyhemoglobin and oxygen saturation, there was a clinically suggestive increase from visits 1-6, but neither the overall trend nor the difference between visit 6 and baseline were statistically significant. ABI did not prove to be a sensitive enough indicator to detect a change over the 1-year period ( $P = .97$ ).

**Conclusions:** Although our results lack adequate statistical power, they suggest that hyperspectral imaging may be a useful, noninvasive imaging modality to aid in the assessment of peripheral perfusion after percutaneous lower extremity revascularization procedures. We will continue to accrue patients to examine whether hyperspectral imaging can demonstrate clinically important and statistically significant findings of improved tissue oxygenation and decreased deoxygenation, and reliably replace ankle-brachial index to assess the success of lower extremity intervention for chronic limb ischemia.

#### Persistent Abdominal Pain Caused by an Inferior Vena Cava Filter Protruding into the Duodenum and the Aorta

Rafael Malgor, MD, George Hines, MD, Lisa Terrana, MS, Nicos Labropoulos, RVT, DIC, PhD, Stony Brook University Medical Center, Stony Brook, NY

**Objective(s):** We report a case of persistent atypical right upper quadrant abdominal pain secondary to duodenal and aortic wall perforation by an inferior vena cava (IVC) filter. We review a patient with duodenal and aortic perforation by an IVC filter treated with open removal of the filter and repair of the duodenum. Similar cases were identified through different health science libraries/databases and a detailed analysis performed.

**Case report:** A 61-year-old woman underwent placement of a prophylactic Bard G2 filter before a pericardiectomy for constrictive pericarditis. She complained of right upper quadrant abdominal pain 1 month after the procedure. She had had an episode of deep vein thrombosis and pulmonary embolus 30 years before pericardial resection and had limited cardiopulmonary reserve due to severe chronic obstructive pulmonary disease. A computed tomographic scan (CT) showed the IVC filter in a tilted position, with prongs abutting the duodenum. Nonoperative treatment was initially attempted and successful, but 1 year later, the patient returned with worsening of abdominal pain and weight loss.

A CT scan showed the filter prongs outside the IVC protruding into duodenum and aorta. Esophagogastroduodenoscopy also visualized the prongs in the second duodenal portion. During surgical exploration, several prongs were noted to have perforated the duodenum and aorta, and the head of the filter had also perforated the vena cava with 5-mm of filter head in the retroperitoneum. The venotomy was closed with a pericardial patch. The patient tolerated the procedure well being and was discharged to home on postoperative day 3. Duodenal perforation by IVC filters has been reported in 21 cases, and patients frequently present with abdominal pain or gastrointestinal bleeding. Endovascular filter retrieval is seldom an alternative. Filter extraction with or without IVC patch angioplasty or trimming the strut in selected cases are options reported with high success rate and no complication.

**Conclusions:** Duodenal perforation with involvement of the aortic wall by an IVC filter is a rare complication that physicians should be aware of. Endovascular removal can occasionally be successful even with caval perforation. However, open removal of the offending filter and repair of the duodenum is a challenging operation that can be safely accomplished.

#### Endovascular Treatment of Stenoses in a Pediatric Patient With Incomplete Aortic Duplication, Mesenteric Ischemia, and Renovascular Hypertension

Harry Ma, MD, PhD, Abdullah Kandil, BA, Omar P. Haqqani, MD, Steven P. Maloney, MD, Neil Halin, MD, DO, Massr D. Iafrazi, MD, Tufts Medical Center, Boston, Mass

**Objective(s):** Anatomic variations in visceral and lower extremity circulation may be a predisposing factor to the development of symptoms such as chronic mesenteric ischemia, renovascular hypertension, and lower extremity claudication. Few reports exist of complete or incomplete duplications of the abdominal aorta. We present a pediatric patient with symptoms of chronic mesenteric ischemia, labile hypertension, and lower extremity claudication who had congenital stenoses within an incompletely duplicated abdominal aorta that was successfully treated by balloon angioplasty.

**Case report:** A 13-year-old girl with no significant medical history presented with a 1-month history of labile hypertension and a variety of symptoms that included epigastric pain after meals that began about 20 minutes after eating and lasted about an hour. She noticed that her legs felt heavy and fatigued after strenuous activity. Her workup with magnetic resonance angiography and abdominal aortography demonstrated an aorta that bifurcated into anterior and posterior branches shortly after entering the abdomen. The anterior branch supplied the celiac axis, bilateral renal arteries, and superior mesenteric artery. The posterior branch supplied multiple lumbar arteries and bifurcated into the common iliac vessels to supply the lower extremities. Within her anterior aorta there were focal stenoses of the proximal segment and her left renal artery, which were associated with pressure gradients. The posterior aorta was hypoplastic and measured only 6.4 mm proximally, tapering to 5.7 mm at the iliac bifurcation. The lesions in the anterior aorta were successfully treated with balloon angioplasty. The patient's abdominal symptoms and hypertension have resolved and she was without recurrent stenosis at the 1-year follow-up.

**Conclusions:** As demonstrated by this case, the evaluation of pediatric patients with symptoms of mesenteric ischemia and hypertension may alert the vascular surgeon to the possibility of developmental pathology associated with variations in abdominal aortic anatomy. To our knowledge, this is the first report of a successful endovascular intervention for mesenteric ischemia and renovascular hypertension in a partially duplicated aorta.

#### Acute Mesenteric Venous Thrombosis after Laparoscopic Duodenal Switch: Successful Treatment Using Percutaneous Transhepatic Mechanical Thrombectomy With Stenting

Ryan Suplee, MD, Naiem Nassiri, MD, Robert Sung, MD, Alfio Carroccio, MD, Robert Rosen, MD, Mitchell Roslin, MD, Lenox Hill Hospital, New York, NY

**Objective(s):** Acute mesenteric venous thrombosis is an established but rare postoperative complication. Prior case reports discuss treatment with anticoagulation with or without surgery to relieve symptoms and treat or prevent bowel ischemia or long-term sequelae such as varices. We present a case of percutaneous mechanical thrombectomy with stenting of the portal vein for acute mesenteric venous thrombosis after laparoscopic duodenal switch and describe an endovascular approach to treatment.

**Case report:** A 47-year-old morbidly obese woman (body mass index, 54 kg/m<sup>2</sup>) presented to the emergency department 20 days after a single-stage duodenal switch. She had a 24-hour history of right upper quadrant abdominal pain and nausea. Her medical and surgical history was significant for hypothyroidism, psoriasis, and remote bilateral breast augmentation and panniculectomy. A computed tomography (CT) scan showed thrombus within the splenic vein, superior mesenteric vein, and extending into the most proximal portion of the portal vein. She was anticoagulated with intravenous heparin. Symptoms persisted for 24 hours, and the decision was

made to intervene. Portal phase images and transhepatic direct portography confirmed the CT findings. Angio-jet thrombectomy was performed and a 10- × 68-mm Wallstent® was deployed in the extrahepatic portal vein. The patient's symptoms resolved. She tolerated a diet and had bowel movements. A transient increase occurred in liver function enzymes. She had a negative hypercoagulable workup. She transitioned from a heparin drip to Coumadin, and was discharged postoperative day 6 with a therapeutic international normalized ratio.

**Conclusions:** Technical success, clinical improvement, and prompt symptomatic relief was achieved in a unique case of symptomatic acute mesenteric venous thrombosis after a single-stage laparoscopic duodenal switch was successfully managed using a combination of Angio-jet thrombectomy and stenting of the portal vein after failure of systemic anticoagulation to relieve symptoms. We recommend consideration of endovascular approaches as a diagnostic and therapeutic option in these settings, with stenting as a viable adjunctive measure when indicated.

#### Repair of Innominate Artery Injuries with a Modified Endovascular Graft

Saadat Shariff, MD, Evan C. Lipsitz, William D. Suggs, MD, Larry A. Scher, MD, Nicholas G. Garguilo, MD, Omer J. Riaz, MD, Ashish Raju, MD, Amit R. Shah, MD, Montefiore Medical Center, Bronx, NY

**Objective(s):** Innominate artery injuries, including tracheoinnominate artery fistula (TIF) are rare but associated with significant morbidity and mortality. Traditionally, these and other arch branch vessel injuries have been treated with open surgical repair via a sternotomy, which can be challenging in emergency situations, redo sternotomy, or both. Endovascular techniques are now used to treat a variety of arterial injuries. However, no stent grafts are specifically designed for repair of the arch vessels. We describe two patients in which Zenith® Iliac limb extension stent grafts were modified for repair of innominate artery injuries.

**Case reports:** The first patient is a 46-year-old man who sustained an iatrogenic injury to the innominate artery during insertion of a port for chemotherapy. The second patient is a 64-year-old woman who suffered a cerebrovascular accident complicated by locked-in syndrome. A TIF developed 6 weeks after a tracheostomy was performed. Both patients had undergone prior sternotomy and were hemodynamically unstable. Challenges included the need for a midrange diameter, short-length, and non-tapered device. A Zenith® iliac leg extension (ESLE) was chosen and modified to the appropriate length by removing one of the three Z stents. The modified stent was deployed retrograde from the right common carotid artery to address delivery system length and tortuosity. In both cases a completion angiogram demonstrated exclusion of the injury and good flow to the carotid and subclavian vessels. The first patient had an uneventful postoperative course. A computed tomography (CT) angiogram on postoperative day 1 demonstrated no leak. The second patient underwent laryngoscopy, which demonstrated a tracheal ulceration distal to the vocal cords through which the stent graft was visualized. The tracheal defect was subsequently repaired with a sternocleidomastoid myocutaneous flap. The patient was ultimately discharged to a rehabilitation facility with a healed TIF and improved neurologic status.

**Conclusions:** Currently, there are no covered stents designed or labeled for the treatment of innominate artery injuries. We describe the successful repair of two innominate injuries in patients at high risk for open repair with an off-label modified endovascular graft.

#### Two-Stage Repair of a Complex Symptomatic Celiac Aneurysm

Reid A. Ravin, BS, In-Kyong Kim, MD, Rajeev Dayal, MD, Roman Nowygrod, MD, New York Presbyterian, Columbia University, Manhattan, NY

**Objective(s):** Aneurysms of the splanchnic arteries are uncommon, accounting for 5% of all intra-abdominal aneurysms. Celiac aneurysms are even less prevalent, comprising 4% to 6% of splanchnic aneurysms. We report a patient with a proximal celiac artery aneurysm, giving rise to separate right and left hepatic arterial branches associated with bilateral iliac artery aneurysms.

**Case report:** The patient was a 42-year-old man with no significant medical history until the current illness, when he presented with severe left abdominal pain. Imaging showed he had a splenic infarction, a 2-cm saccular aneurysm of the proximal celiac artery, and bilateral fusiform iliac aneurysms of 2 cm on the left and 2.8 cm on the right. The celiac artery aneurysm gave rise to a splenic, an aberrant left hepatic artery, and a common hepatic artery with patent gastroduodenal and left gastric branches. A two-stage repair was performed. First, an aortobihepatic bypass was performed with separate limbs to the common and left hepatic arteries. A bifurcated Dacron graft (12 × 6 × 6) was used to create a proximal anastomosis to the supraceliac aorta, which was grossly normal. Three months later, he underwent percutaneous coil embolization of the celiac aneurysm. A 10-mm Amplatzer® plug was deployed at the branch point of the splenic and hepatic arteries. The celiac aneurysm, proximal to the Amplatzer® plug, was then embolized with 8 Interlock® 0.018 coils. Completion angiograms demonstrated excellent