Femoral Crossover in Peripheral Vascular Interventions Initiated via a Transradial Approach: Incidence and Outcomes


Purpose: Transradial access (TRA) has been shown to lower morbidity and bleeding complications compared to transfemoral access (TFA) in percutaneous coronary interventions. Transfemoral crossover has been used to describe instances where interventions are initiated via the radial artery but require a secondary access site for completion. In this study, we evaluate the incidence and outcomes of transfemoral crossover in peripheral vascular interventions.

Material and Methods: A retrospective review was performed for all peripheral interventions for which the initial attempt at vascular access was the radial artery and either ipsilateral or contralateral femoral artery access was obtained prior to completion. A Barbeau test was first performed in all cases. Following this, access to the left radial artery was attempted under ultrasound guidance using a microcatheter with placement of a hydrophilic-coated sheath (5F, 6F). Following sheath placement, a standard solution of heparin (3000 units), verapamil (2.5 mg), and nitroglycerin (200 mcg) was administered intravenously. Upon completion, a TR-band (Terumo, Somerset, New Jersey) was used for hemostasis. Incidence of femoral crossover, reason for femoral crossover, secondary access site used, and major and minor adverse events were recorded.

Results: From April 2012 to July 2014, a total of 960 procedures were performed in 633 patients for which the radial artery was intended as the primary access site. Of these, there were 18 procedures in 18 patients (66 ± 13 years, 10 female, 8 male) completed with femoral access yield being an overall femoral crossover rate of 1.9%. Procedures performed were peripheral embolization (n = 7), radioembolization (n = 5), chemotherapy (n = 3), and peripheral vascular stent placement (n = 3). Causes of femoral crossover included vessel spasm/small vessel diameter (n = 7; 38%), radial loops (n = 5; 28%), proximal occlusion (n = 3; 17%), and catheter length limitations (n = 3; 17%). There were no complications in 14 of the 18 procedures. Other outcomes in transfemoral crossover cases occurred in 1 patient each included Grade 2 hematoma in an endoleak repair performed at the contralateral site due to vessel spasm, bruising in a radioembolization performed at the ipsilateral site due to radial loop and bruising in an other patient in a renal stent performed at the contralateral site due to vessel spasm, and radial spasm in a radioembolization performed at the ipsilateral site due to vessel spasm.

Conclusions: In our experience, incidence of transfemoral crossover in peripheral vascular interventions initiated via a transradial approach is extremely low. Recognizing anatomical and experience-related factors contributing to femoral crossover may be helpful in lowering access site complications while analysis of technical limitations may contribute to future product development.

Safety and Feasibility of Transradial Access for Visceral Interventions in Patients with Thrombocytopenia


Purpose: Transradial access (TRA) has shown lower morbidity and decreased bleeding complications compared with transfemoral access (TFA). This study evaluates the safety and feasibility of TRA in patients with a platelet count [lt,e] 50,000/µL on the day of procedure.

Material and Methods: Patients who underwent visceral interventions via the radial artery with a platelet count [lt,e] 50,000/µL on the day of procedure were retrospectively reviewed. In all cases, a Barbeau test was performed. A SF Gildeshread (Tenero Medical Corporation, Somerset, New Jersey) was placed in the left radial artery using ultrasound guidance. Following sheath placement, a combination of 3000 U heparin, 2.5 mg verapamil, and 200 mg nitroglycerin was administered intravenously. A TR band (Terumo Medical Corporation, Somerset, New Jersey) was used for hemostasis upon completion of each procedure. Technical success, major and minor adverse events, and procedural details were recorded.

Results: From July 1, 2012, to September 1, 2014, a total of 960 peripheral interventions via TRA were performed, of which 51 procedures were performed in 44 patients (Age: 63.8 ± 10.2 years, 11 female, 33 male) with a platelet count [lt,e] 50,000/µL (median [interquartile range]: 39 [34 to 44.5])/µL. Interventions included chemotherapy (n = 30), radioembolization mapping (n = 15), radioembolization (n = 2), splenic embolization (n = 3), and renal embolization (n = 1). Technical success was achieved in 95.1% (96%) cases. There was one case of severe vessel spasm requiring ipsilateral femoral crossover. There were no major adverse events at 30 days. Minor access site bruising occurred in 2 patients (6%) and was treated conservatively in all cases.

Conclusions: Transradial visceral interventions in patients with thrombocytopenia are both feasible and safe.

Endoleak Outcomes of Suprarenal vs. Infrarenal Endovascular Aneurysm Repairs Outside Instructions for Use Standards

R. Alexander, M. Rizer, R. Beasley

Purpose: To determine if there are any differences in outcomes between infrarenal fixation (IF) and suprarenal fixation (SF) for the endovascular treatment of abdominal aortic aneurysms (AAA) with aortic neck lengths (<15 mm) outside instructions for use (IFU) standards.

Material and Methods: A retrospective review of 561 endovascular aneurysm repairs (EVAR) procedures performed from 2004 to 2011 at a single institution. The charts and radiographic images of all patients were reviewed. Patients who underwent EVAR with AAA with short proximal neck lengths were stratified into 2 groups of IF (Gore Excluder) and SF (Cook Zenith). The primary end point of the study was the presence of endoleaks. The secondary end points were graft migration, postoperative rupture, and death.

Results: A total of 561 EVARs were performed during this study period with 52 identified as having a short proximal aortic neck. Seventeen patients were in the IF group and 34 in the SF group. The mean follow-up period was 33.9 months for the IF group and 23.4 months for the SF group. There was no difference in the average proximal neck length (8.8 mm IF vs. 9.9 mm SF; p = not significant [NS]) or the prostatic AAA size (23.7 mm IF vs. 25.2 mm SF; p = NS). There were no significant differences in age (74.7 years IF vs. 78.2 years SF; p = NS), gender (IF 49% male vs. SF 88% male; p = NS) or length of stay (2.2 days IF vs. 3.3 days SF; p = NS). There was one type II endoleak in both the IF and SF groups at 90-day follow-up. At 1 year, the type II endoleak in the IF group persisted while the 1 patient with a type II endoleak in the SF group died. There were no migrations noted in either group. There were no ruptures in the IF group and 1 rupture in the SF group (p = NS). There were 5 deaths in the IF group and 5 deaths in the SF group (p = NS).

Conclusions: There was no significant difference in endoleak rates between SF and IF for patients with short aortic neck lengths outside IFU standards.

Experience using the Penumbra Ruby Coil in the Peripheral Vascular: ACE Multicenter Study Preliminary Results


Purpose: The Penumbra RubyTM Coil system (Penumbra Inc., Alameda, California) is a new generation of larger (0.020 inch) platinum detachable coils that are designed for arterial and venous embolization in the peripheral vasculature. Recent literature has been published indicating the importance of higher packing density and its impact on occlusion stability and decreased recanalization rates. (1) The Aneurysm Coiling Efficiency (ACE) registry offers a unique opportunity to study the demographics and long-term outcomes of a multicenter cohort of patients with peripheral vascular embolizations, reported herein.
Material and Methods: Between March 2012 and September 2014, data were collected at 12 centers. There were 63 cases of peripheral aneurysms/malformations or vessel sacrifices (11 splenic artery aneurysms, 9 renal artery aneurysms, 1 hepatic artery aneurysm, and 1 mesenteric artery aneurysm, 7 AVMs, 6 fistulas, 3 varices, and 23 vessel sacrifices) treated with the Ruby Coils. The follow-up period was 6 months. Results: The mean number of coils placed per aneurysm was 9 with mean packing density of 26% in the aneurysms/malformations cases (N=39). Aneurysms identified at the splenic and renal arteries had volumes from 110 to 21,500 mm³ and neck diameters ranging from 4 to 16 mm. Mean fluoroscopy time was 29 minutes. No procedural serious adverse events (SAEs) were noted. Among the cases of aneurysms with posttreatment data, 21/24 (100%) were treated as posttreatment Scale Class I occlusion. Of the 10 patients with 6-month follow up data, 10 (100%) displayed stable complete Class I occlusion with 0% recanalization. Of the peripheral vessel sacrifices, 23/25 patients (100%) were reported to have had successful coil embolization by the treating physician. The mean number of coils placed was 4 with a mean fluoroscopy time of 22 minutes. No procedural SAEs were recorded. All of the 11 patients with 6-month followup data displayed stable occlusion.

Conclusions: Using Ruby in the peripheral vasculature resulted in a high mean packing density and complete occlusion post-procedure which remained stable at 6-month follow-up. The long lengths and large volume of the coil allowed the use of fewer devices to achieve high packing densities. Due to the small cohort of cases, a larger sample size is needed to validate these data.


Impact of Type-II Endoleak on Aneurysm Sac Growth and Preoperative Predictors of Type-II Endoleak

R. Kawaguchi, M. Ezure, Y. Miyaiishi, H. Kan, T. Kaneko, S. Oshima

Purpose: Type-II endoleak (T-II-EL) after endovascular abdominal aneurysm repair (EVAR) is an unresolved problem. Our purpose was to investigate the impact of T-II-EL on aneurysm sac growth and to identify potential preoperative T-II-EL predictors.

Material and Methods: We enrolled 162 consecutive patients (Zenith: 61, EXCLUDER: 57, ENDURANT: 44) who underwent successful EVAR without Type-I or Type-III endoleak and had at least 1-year follow-up. Computed tomography (CT) before and after EVAR (1 week, 6 month, and 1 year) were reviewed to estimate T-II-EL and measure sac diameter. Three-dimensional volume analyses were performed during CT for measuring sac volume. Vessel number and diameter of the patent lumbar artery (LA) and inferior mesenteric artery (IMA) were determined. Various anatomical parameters and patient characteristics were investigated as possible T-II-EL predictors.

Results: T-II-EL was 35.8%, 15.4%, and 12.3% at 1 week, 6 months, and 1 year after EVAR, respectively. The mean preoperative maximum sac diameter and volume were 50.1 ± 8.2 mm and 153.8 ± 75.5 mL, respectively, without differences between T-II-EL cases (T-II-group) and absence of T-II-EL cases (non-T-II-group). Significant differences in the reduction of sac diameter (T-II-group: −0.11 ± 3.4 mm vs. non-T-II-group: −7.3 ± 6.0 mm; p < 0.0001) and volume (T-II-group: −0.07 ± 14.6 mL vs. non-T-II-group: −24.2 ± 30.7 mL; p = 0.0007) was observed between 2 groups at 1 year after EVAR. Sac volume growth was observed in 47.6% of cases in the T-II-group. EXCLUDER use, patent LA, patent IMA, and IMA diameter were significantly associated with T-II-EL at 1 week after EVAR in univariate analysis. Dual antiplatelet therapy (DAPT), EXCLUDER use, number of LA, and patent IMA were significantly associated with THI at 1 year after EVAR. Multivariate analysis revealed that DAPT and EXCLUDER use were independent predictors of T-II-EL at 1 year after EVAR. Patent IMA was the only significant correlative factor of sac enlargement in patients with persistent T-II-EL.

Conclusions: Persistent T-II-EL after EVAR was observed in 12% of patients in the current stent graft system. DAPT and EXCLUDER use were independent predictors of persistent T-II-EL. Sac growth was observed in half of the patients with persistent T-II-EL. Because T-II-EL with patent IMA was significantly associated with sac growth, careful observation and additional intervention may be considered.

Blood Flow Changes Induced by Flow Diverting Stent in a Large Wide-Neck Intracranial Aneurysm

A. Chien, F. Vinuela, G. Duckwiler

Purpose: Intracranial aneurysm flow diverting stents (FDS) have been used for endovascular treatment. Experience with FDS has shown encouraging results for difficult to treat aneurysms. To further understand the influence of FDS and help treatment planning, many researchers have proposed using computer software to examine and compare aneurysm flow changes before and after FDS treatment. We implemented an intracranial stent flow mapping (IS FlowMap) program to study a large wide neck aneurysm and to compare the blood flow characteristics before and after treatment. Material and Methods: A 19 mm large ICA aneurysm (15.7 mm neck) was treated by FDS. Angiogram images before and after stent implantation were evaluated. The IS FlowMap program was used to evaluate stent-induced blood flow changes in a series of images. Motion-tracking algorithms were utilized to analyze blood flow patterns within the aneurysm and blood flow impingement on the aneurysm wall. Angiogram images with contrast injection before and after the FDS treatment were used as input.

Results: The large aneurysm treated with the Pipeline FDS had a decrease in flow impingement on the aneurysm wall, especially at the proximal wall. After FDS treatment, blood flow impingement along the reconstructed vessel and stent was observed. Distinct differences in the aneurysmal inflow circulation were found by flow vector analysis. We observed that the origin highimpingement at the proximal end of the aneurysm changed to the redirected slow inflow penetrating the FDS stent. This suggests that in the large wide neck aneurysm, although the improvement of blood inflow decreases, a larger area of blood inflow from the parent vessel is created due to blood flow penetrating the FDS.

Conclusions: By analyzing a series of angiogram images, we observed the detailed changes in blood flow induced by FDS treatment. Distinct flow changes after the placement of FDS can be found using regular angiogram images. Further understanding flow changes induced by stents and studying the relationship between such changes and treatment outcome will be helpful to advance treatment strategy.

Safety and Efficacy of Prostate Artery Embolization in Small-Volume Benign Prostatic Hyperplasia

S. Bagla, J. Smimiotopoulos, J. Orlando, A. van Breda

Purpose: Traditional urologic surgery of small-volume benign prostatic hyperplasia (BPH) is associated with high failure rates and complications such as bladder neck strictures and contractures. While prostate artery embolization (PAE) is postulated to be effective secondary to gland size reduction, we hypothesize that it may be equally effective in patients with small volume glands. We present our experience of PAE in prostate sizes < 50 cc.

Material and Methods: An Institutional Review Board approved a retrospective study of 78 consecutive PAE patients from January 2011 to July 2014. Patients were evaluated at baseline, 1, 3, and 6 months after intervention. We calculated the American Urological Association (AUA-SI) symptom index including quality of life-related symptoms (Qol), International Index of Erectile Function (IIEF), and prostate imaging (magnetic resonance imaging, ultrasound, or computed tomography at baseline). Analysis was performed for each stratified group (Group 1, prostate volume < 50 cc, Group 2, prostate volume > 50 cc) individually from baseline to 1, 3, and 6 months and between groups at each follow-up to assess for differences in outcome.

Results: There were no significant differences in baseline age, AUA score, Qol., or IIEF between groups (mean age 65.2 years, 26.4 AUA, 4.9 Qol, 14 IIEF; n = 78). Baseline volumes were: group 1 (37.5 cc, 25.9 to 48.0 cc, n = 16) and group 2 (108.5 cc, 52.0 to 274.0 cc, n = 62). Technical success was achieved in 16/16 patients in Group 1 and 59/62 in Group 2, with 2 unilateral embolizations and 1 unilateral secondary to bilateral atherosclerotic occlusion in the latter group. A statistically significant reduction in AUA was achieved in both groups from baseline to 1, 3 and 6 months (n = 77): Group 1: Baseline 27.2 to 12.7, 12.0, and 11.2 ± 1.3, and 6 mp < 0.006), respectively; Group 2: Baseline 26.1 ± 15.3, 14.4, and 14.9 (p < 0.0001), respectively.

Conclusions: PAE appears to offer similar positive clinical benefits to 6 months in patients with small-volume BPH. This may offer crucial benefit to those patients with limited surgical options. Future study aimed at evaluating recurrence rates is suggested.

Analysis of Distal Protection Debris to Identify High Risk Peripheral Interventions

L. R. Wilkins, M. Ugas, J. West, S. Sabri, J. Angle

Purpose: Distal embolization (DE) of plaque or thrombus is a well-recognized cause of intrageneric injury during percutaneous peripheral interventions. Several devices are available to help mitigate this and prevent potential distal ischemia. This study evaluated the incidence of DE during interventions involving use of intravascular delivery devices. The objective of this study was to evaluate the incidence of DE during a random 2012 study performed at a single academic tertiary care hospital.

Material and Methods: The NAV-6 was used over a 46-month period in 69 patients undergoing lower extremity arterial intervention. A database was generated through utilization of the Hi-IQ inventory management system. A retrospective analysis of this database was performed reviewing both the intervention notes stored in the EMR and the case images stored in PACS. The relative incidence of DE during chemical thrombolysis (intra-arterial TPA), atherectomy, and treatment of in-stent restenosis (ISR) was analyzed.

Results: The NAV-6 was available to help mitigate this and prevent potential distal ischemia. This study evaluated the incidence of DE during interventions involving use of intravascular delivery devices. The objective of this study was to evaluate the incidence of DE during a random 2012 study performed at a single academic tertiary care hospital.

Conclusions: PAE appears to offer similar positive clinical benefits to 6 months in patients with small-volume BPH. This may offer crucial benefit to those patients with limited surgical options. Future study aimed at evaluating recurrence rates is suggested.

Analysis of Distal Protection Debris to Identify High Risk Peripheral Interventions
use of NAV-6. There was 1 device malfunction where the NAV-6 fractured during retrieval. All but 1 patient had preserved or improved runoff at the end of the case.

Conclusions: The overall incidence of DE during lower extremity arterial intervention was 30%. Treatment of ISR, treatment with atherecomy, or use of intra-arterial TPA was associated with an increased incidence of DE (47%, 50%, and 50%, respectively) when compared with treatment not involving one of these techniques (19%). The incidence of DE despite use of NAV-6 was 12%. These findings validated the continued use of NAV-6 during lower extremity arterial interventions particularly in the settings of ISR, atherecomy, or use of intra-arterial TPA.

Mechanical Thrombectomy to Treat Intra-Procedural Distal Embolization Caused During Percutaneous Revascularization

R. Gandini, C. Del Giudice, S. Merolla, F. Chegai, M. Stefanini

Purpose: Periprocedural acute distal embolization is a complication that occurs during percutaneous revascularization of the femoro-popliteal and below-the-knee arteries. To date, limited research has been done and no standard of treatment has been established.

Material and Methods: Three cases using mechanical thrombo-aspiration to treat distal embolization complications from limb salvage treatment are reported. Each case was treated using a novel mechanical thrombectomy device, the Penumbra System (Penumbra Inc., Alameda, California), traditionally used during acute ischemic-stroke therapy. It involves a trackable catheter connected to a dedicated aspiration pump (Penumbra MAX Pump, Penumbra, Inc.). In addition, the Penumbra Separator wire technology was available to help prevent the catheter tip from clogging for the duration of the thrombectomy procedure. Thrombectomy debris and blood collected from the suction, and could be drained for visual confirmation and further clot analyses at the end of the procedure.

Results: Of the 3 cases, pre-procedural angiography showed indications of proximal steno-occlusions in the tibial artery in 2 and obstruction of the proximal third of the superficial femoral-popliteal artery in the other. After percutaneous transcutaneous angioplasty with a balloon catheter was performed, post-angiography imaging revealed distal embolization caused by the angioplasty procedure. Mechanical thrombectomy was used with Penumbra System (3MAX was used in 2 cases, and 4MAX in 1 case) connected to the aspiration pump. Final angiographic imaging showed complete recanalization and occluded arteries were restored to normal flow. A healing ulcer was observed at the 4- to 6-month follow-up, and all 3 patients were asymptomatic at the 12-month follow-up.

Conclusions: Our initial experience using the Penumbra System in the peripheral vasculature demonstrates a rapid and effective approach to address intra-procedural distal embolization and avoid possible grave clinical sequelae. Follow up in a larger cohort is warranted with this system.

Novel Thrombectomy System for Below-the-Knee and Visceral Arterial Interventions: PRISM Retrospective Interim Results

R. R. Saxon, C. Teigen

Purpose: Existing endovascular options in the treatment of peripheral and visceral arterial thromboembolism face the challenges of incomplete recanalization and significant bleeding risk (among other complications). The Penumbra/Indigo Systems (Alameda, California) are designed to address these challenges by providing a novel approach to mechanical thrombo-embolectomy in the periphery using a trackable, relatively small diameter aspiration system that has a proven track record in the treatment of ischemic stroke. The PRISM trial is the first multicenter study designed to obtain important safety and effectiveness data as well as to define optimal technical use for these systems in patients with confirmed peripheral or visceral artery occlusions. This abstract outlines the current status of the trial and discusses its preliminary findings.

Material and Methods: To date, 38 patients have been enrolled in this retrospective, single-arm, multicenter trial (total planned enrollment = 100). Mechanical thrombo-embolectomy using the Penumbra/Indigo Systems was performed in cases of failed thrombolysis, acute ischemia without adequate time for thrombolysis, or in patients with emboli as a complication of an endovascular intervention. The primary site of occlusion was located in the popliteal (17/38 patients, 44.7%), peroneal (5/38, 13.2%), superficial femoral (4/38, 10.5%), posterior tibial (4/38, 10.5%), profunda femoris (2/38, 5.3%), superior mesenteric (2/38, 5.3%), anterior tibial (2/38, 5.3%), renal (1/38, 2.6%), or brachial (1/38, 2.6%) arteries. Baseline characteristics were obtained and an angiographic assessment of vessel patency was recorded using the Thrombolysis in Myocardial Infarction (TIMI) score classifications both before and after use of the device in order to assess technical effectiveness. A review of procedural complications and adverse events was conducted to monitor safety.

Results: Mean patient age was 71.6 (standard deviation [SD] 14.8) years and 44.4% (16/38) were female. Procedural information presented in the following analyses was available for 24 patients and final revascularization data was available for 22 patients at the time of this abstract (data collection ongoing). A baseline angiographic TIMI score of 0 or 1 was reported for all 24 patients. Prior to intervention with the Penumbra/Indigo Systems, 41.7% of patients had no prior treatment and 45.8% received provisional thrombectomy therapy alone, 4.2% received mechanical intervention alone, and 8.3% received both. The mean time from symptom onset to procedure was 5.3 days (SD 7.4). Following mechanical thrombo-embolectomy, 86.4% of patients were successfully recanalized to TIMI 3 and 13.6% to TIMI 2 flow. Four adverse events were reported, 1 of which was classified as serious (cardiac arrest, not related to use of the study device). Three cases were noted in which distal branch occlusion occurred secondary to emboli during the procedure. None of these 3 events were clinically significant.

Conclusions: Early experience with the Penumbra/Indigo Systems shows promising results with safe and effective mechanical thrombo-embolectomy in the peripheral arterial vasculature. Its successful use across a broad range of clinical applications including acute ischemia, removal of embolus that occurred during other endovascular procedures, and after failed thrombolysis is encouraging. Optimal technique will be discussed.

Drug-Coated Balloons vs Standard Percutaneous Transluminal Angioplasty for the Treatment of Superficial Femoral Artery (SFA) and/or Proximal Popliteal Artery Disease: New Insights from the IN.PACT SFA Randomized Trial

J. R. Laird

Purpose: Drug-coated balloons (DCB) have shown promise in improving outcomes for patients with peripheral artery disease (PAD). Twelve-month outcomes following treatment of symptomatic femoro-popliteal disease with a paclitaxel-coated balloon versus treatment with percutaneous transluminal angioplasty (PTA) were compared.

Material and Methods: The IN.PACT Superfemoral Artery (SFA) Trial is a prospective, multicenter, single-blinded, randomized trial in which 331 patients with intermittent claudication or ischemic rest pain due to femoro-popliteal PAD were randomly assigned in a 2:1 ratio to treatment with DCB or PTA. The primary efficacy endpoint was primary patency, defined as freedom from restenosis or clinically driven target lesion revascularization at 12 months.

Results: Baseline characteristics were similar between the 2 groups. The mean lesion length and percent of total occlusions for the DCB and PTA arms were 8.94 ± 4.89 cm and 8.81 ± 5.12 cm (p = 0.89) and 19.0% ± 25.8% vs. 16.3% ± 25.8% (p = 0.24), respectively. DCB resulted in higher primary patency vs. PTA (82.2% vs. 52.4%; p < 0.001). The rate of clinically driven target-lesion revascularization was 2.4% in the DCB arm compared with 20.6% in the PTA arm (p < 0.001). There was a low rate of vessel thrombosis in both arms (1.4% after DCB and 3.7% after PTA (p = 0.10). There were no device- or procedure-related deaths and no major amputations. A prespecified gender subgroup analysis was performed and showed consistent results in male and female gender, with no significant treatment-by-gender interactions on the primary endpoints (p > 0.15). Primary patency (75.7% vs. 43.8%; p = 0.004) and clinically driven TLR (4.1% vs. 25.7%; p < 0.001) results were statistically superior in female subjects treated with the DCB.

Conclusions: In this prospective, multicenter, randomized trial, DCB was superior to PTA and had a favorable safety profile for the treatment of patients with symptomatic femoro-popliteal PAD. The DCB response was consistent between genders and showed favorable results in females.

New Insights From Real-world Femoral-POPliteal Drug-Coated Balloon Treatment: 1-year Results from IN.PACT Global Study, Including Long Lesions

G. Tepe

Purpose: Randomized trial data have demonstrated superior safety and efficacy of IN.PACT Admiral Drug-coated Balloon (CAB; Medtronic, Santa Rosa, California) vs. PTA for the revascularization of mostly TransAtlantic InterSociety Consensus (TASC) A-B femoro-popliteal lesions. The IN.PACT Global Study is a prospective, single-arm study, the IN.PACT global study, was conceived to expand the appraisal of DCB towards the real-world treatment of patients with the same peripheral artery disease symptoms, including those patients with lesions > 15 cm in length.

Material and Methods: The IN.PACT global study is a rigorous, independently adjudicated and monitored multicenter, international, 1500 patient, single-arm study of DCB revascularization of femoro-popliteal stenosis and occlusions with a minimum length of 2 cm. One-year results from the first 655 patients enrolled are presented. The majority had severe (58.2%) or moderate (27.3%) claudication or ischemic rest pain (10.9%) at baseline, and 41.2% were diabetic. The mean lesion length was 12.23 cm, 35.8% of lesions were total occlusions, and 21.4% of lesions represented in-stent restenosis. The primary endpoint was clinically driven target lesion revascularization at 12 months.

Results: At 12 months, the rate of clinically driven target lesion revascularization was 8.7%. An analysis by lesion length on the subset of subjects (N = 514) with unilateral limb treatment of single lesion was also performed. The clinically driven target lesion revascularization rate in lesion lengths greater than 15 cm was 11.5% (22/191), confirming the performance of the IN.PACT Admiral DCB in long lesions.

Conclusions: Preliminary results from the IN.PACT Global Study indicate that the IN.PACT Admiral DCB is safe and efficacious in the treatment of real-world femoro-popliteal lesions, and continues to perform well in long lesions.

Transarterial Chemoembolization Outcomes in Downstaging Hepatocellular Carcinoma Patients Beyond the Milan Criteria


Purpose: In this study, we evaluated outcomes of transarterial chemoembolization (TACE) for tumor downstaging in patients with hepatocellular carcinoma (HCC) beyond Milan criteria.
Material and Methods: From 1 January 2008 to 1 January 2013, a total of 564 patients with a diagnosis of HCC were listed for liver transplantation. Patients included in the study were determined to be outside of the Milan criteria but within the University of California-San Francisco (UCSF) downstaging criteria at 1 point in time and subsequently underwent either conventional transarterial chemoembolization (c-TACE) or deblunting bead TACE (DEB-TACE). Patients who underwent previous therapy at the time of intervention were excluded. The primary outcome variable was overall survival. Secondary outcome variables included effectiveness of TACE at tumor downstaging, progression-free survival prior to transplant, and disease recurrence after transplant.

Results: Seventeen patients (median age 58 years; 5 female, 12 male) met the criteria for inclusion in this study. Patients underwent a median (range of 3 to 1) TACE procedures (c-TACE 17; DEB-TACE 20). Downstaging to within the Milan criteria was successful in 13 patients (76%). Of the 13 patients who were successfully downstaged, 9 underwent liver transplantation (orthotopic 7; living donor 2), 1 remained on the transplant list within Milan criteria, 2 re-progressed beyond Milan criteria (79, 624 days), and 1 died without disease progression of septicemia after one day. None of the patients died with disease progression. Of the 13 patients who were downstaged, 11 remained on the transplant list within Milan criteria with favorable post-transplant disease free survival.

Percutaneous Thrombectomy with the AngioVac Aspiration Device: A Single-Center Experience

D. C. Stevens, D. Garbett, T. Casciani, S. Butty

Purpose: To describe a single-center experience with the AngioVac device (Angio-dynamics, Latham, New York), a 22 Fr percutaneous aspiration thrombectomy device designed for venous aspiration, extra-corporal filtration, and venous re-inflation.

Material and Methods: Institutional Review Board exemption was obtained for retrospective analysis of the medical records from 13 consecutive cases using the AngioVac device 1 January 2012 through 1 September 2014.

Results: Mean patient age was 49 years (range 24 to 71 years). Nine patients had thrombus located in the inferior vena cava (IVC), 3 in the right heart, and 1 in the pulmonary artery. Cardiac or peripheral vascular surgical services evaluated the patients and deemed them ineligible for surgery. Nine cases were clinically and angiographically successful. No adjunctive therapy, such as venous stent placement, was required. One patient experienced hyperkalemic cardiac arrest after successful thrombectomy and survived after 5 minutes of advanced cardiovascular life support. Four cases were unsuccessful. One patient with enlarging high volume pulmonary embolism (PE) and right atrial mass, later found to be a tumor thrombus, died due to iatrogenic PE, 1 patient with pulmonary artery thrombus experienced early cardiacogenic shock after her tricuspid valve was damaged by the advancing cannula. The patient survived open tricuspid valve repair and pulmonary artery thrombectomy. One case was abandoned prior to thrombectomy because sufficient bypass flow could not be established, and 1 case was abandoned after the cleared IVC immediately re-ocluded with thrombus.

Conclusions: In our experience, aspiration thrombectomy using the AngioVac device is safe and effective in removing central caval thromboses. The use of the AngioVac device to remove thrombus in the right heart is effective but may carry a higher risk of severe complication. Pulmonary artery thrombectomy is the most challenging because of the complexity of advancing the cannula through the heart and the high likelihood of an unstable patient.

Safer Is Better: Transradial Access for Liver-Directed Therapy

D. Klass, M. T. A. Al-Shammari, J. Chung, D. Liu

Purpose: Transradial access (TRA) is well described in the literature for coronary intervention. This approach has not been described in the radiology literature. This paper describes our initial experience using the left radial artery for hepatic arterial angiography and liver-directed therapy.

Materials and Methods: Twenty-seven TRA procedures were performed in 21 patients (18 male, 3 female; mean age 64) between April and August of 2014 for the purpose of liver-directed therapy. Bland embolization (n=4), chemoembolization (n=10), selective internal radiation therapy (n=6), and hepatic arterial mapping (n=7) were performed. The integrity of the palmar arch circulation was assessed using the Barbeau test (plethysmography and pulse oximetry). The artery was accessed under ultrasound guidance and using a proprietary 5 French radial access set. Following sheath placement, a combination of 200 mcg nitroglycerin, 2.5 mg verapamil, and 200 mcg nifedipine was used in 16 of patient’s blood was administered. A variety of diagnostic catheters ranging from 100 cm to 125 cm were used to access the hepatic arterial vasculature with or without the use of a microcatheter. Following the procedure, a proprietary hemostatic device was used to obtain hemostasis. Patients were allowed to ambulate immediately after the procedure. Patients were recalled to evaluate the access site to exclude complications such as occlusion, pseudoaneurysm, or distal embolic phenomena using Doppler ultrasound and clinical examination.

Results: All TRA procedures were technically successful (100%) with no immediate complications or major morbidity related to the approach on the follow-up ultrasound scan and clinical examination. The radial artery was accessed subsequently twice in 5 patients (9%).

Conclusions: Transradial access is a safe and feasible approach for mesenteric artery catheterization with a low complication rate. This procedure is preferred by many patients over transvenous access due to the improved recovery and comfort after the procedure.

Uncommon Solutions to a Common Problem: Endovascular Treatment of Access and Closure Complications

K. Gieserlind, G. Frey, S. David

Purpose: With the increase in percutaneous endovascular procedures, an interventionalist may be called upon to treat complex complications at a puncture site distant from the current access point without knowledge of what led to the complication. A variety of endovascular techniques may need to be employed to adequately address these complications. Here we review both common and novel methods to treat access complications through a series of cases.

Materials and Methods: A case series of complications related to arterial access and closure is presented and includes common femoral artery/iliac dissection, through-and-through puncture into the retroperitoneum, arteriovenous fistula formation, pseudoaneurysm, arterial graft thrombosis, and uncontrollable hemorrhage from distant puncture site.

Results: Many of the access complications can be attributed to inaccurate puncture site or technique. The closure complications usually arise from closure device malfunction or inappropriate manual pressure. A variety of treatment options exist depending on the complication encountered and range from commonly used techniques such as a covered stent or embolization to novel methods such as antegrade wiring of distant puncture site and subsequent retrograde closure device deployment. We review the indications, benefits, and risks of each approach.

Conclusions: Complications related to arterial access can occur, especially in patients with severe peripheral vascular disease. Use of bony landmarks and ultrasound guidance can be helpful in difficult cases. Care must be taken when applying manual pressure, especially in cases of arterial bypass grafts with tenuous inflow, as not to occlude the graft. Use of a closure device should be considered in these cases. Inappropriate puncture site can lead to a variety of complications that may require deployment of a covered stent or embolization to treat. Antegrade wiring of distant puncture site and subsequent retrograde closure device deployment is a safe and effective means to achieve hemostasis, even in extra-anatomic bypass grafts, and should be in the interventionalist’s repertoire.

Combined Transcatheter Aortic Valve Replacement and Endovascular Aortic Repair Via Transfemoral Approach

W. C. Oreyola, E. Elmarin, M. Wilderman, P. Vaidya, G. Simonian

Purpose: We report the applicability of transfemoral access for transcatheter aortic valve replacement (TAVR) in a patient with infrarenal abdominal aortic aneurysm.

Materials and Methods: A 63-year-old candidate for TAVR with a 5.5-cm infrarenal abdominal aortic aneurysm and past medical history of severe aortic stenosis after coronary artery bypass graft and mitral valve repair, automatic implantable cardioverter defibrillator implant, Society of Thoracic Surgeons operative high-risk score, and New York Heart Association class III received a Sapien XT #26 bioprosthesis (Edwards Lifesciences, Irvine, CA) via the transfemoral approach. This was followed through the same access with deployment of Gore Excluder® #31 endoprosthesis and Gore #23 (Gore Medical, Flagstaff, AZ) iliac limb to exclude the infrarenal abdominal aortic aneurysm (AAA).

Results: There were no intraoperative complications from the combined TAVR and endovascular repair procedures. Postoperatively, the patient had a brief gastrointestinal bleed that resolved and endoscopic retrograde cholangio-pancreatographic (ERCP) restenting of common bile duct he had from previous surgery. There were no cardiovascular events postoperatively. He was discharged home on postoperative day 13.

Conclusions: A TAVR candidate with suitable iliac anatomy does not need to be deferred because of the presence of an AAA. He could still benefit from a transfemoral approach, which is less invasive than transapical and transaortic.

Consequences of Worse Endovascular Aneurysm Repair

S. R. A. J. Pandey

Purpose: To identify the complications of worse endovascular aneurysm repair (EVAR).

Materials and Methods: A 78-year-old man with diabetes and hypertension with a history of coronary artery bypass graft, poor ejection fraction (15%-20%), chronic obstructive pulmonary disease, and a partially infected left kidney presented with complaints of 16 ml of patient’s blood was administered. A variety of diagnostic catheters ranging from 100 cm to 125 cm were used to access the hepatic arterial vasculature with or without the use of a microcatheter. Following the procedure, a proprietary hemostatic device was used to obtain hemostasis. Patients were allowed to ambulate immediately after the procedure. Patients were recalled to evaluate the access site to exclude complications such as occlusion, pseudoaneurysm, or distal embolic phenomena using Doppler ultrasound and clinical examination.

Results: All TRA procedures were technically successful (100%) with no immediate complications or major morbidity related to the approach on the follow-up ultrasound scan and clinical examination. The radial artery was accessed subsequently twice in 5 patients (9%).

Conclusions: Transradial access is a safe and feasible approach for mesenteric artery catheterization with a low complication rate. This procedure is preferred by many patients over transvenous access due to the improved recovery and comfort after the procedure.
Results: Postoperative day 1: Decreased urinary output (Doppler shows renal perfusion with increased resistive index and contrast-induced nephropathy). Postoperative day 3: Renal shutdown, metabolic acidosis, black tarry stools, signs of bowel ischemia, and need of shock late night.

Conclusions: We concluded that we should not cross the instructions for use. We had a lack of experience with chimney/fenestration. We should try to do the first few cases with a proctor.

Covered Stents in Visceral Aneurysm: Are They Effective and Safe in Long Term?

G. Orgera, M. Cappucci, F. Laurino, G. M. Varano, M. Rossi

Purpose: To evaluate midterm and long-term results of endovascular exclusion of visceral aneurysms using covered stents.

Materials and Methods: From February 2006 to October 2011, we implanted 25 covered stents in 24 patients (13 female and 11 male; mean age, 58.2 years) affected by aneurysm of the splenic (n=15), hepatic (n=4), gastrocudodenal (n=1), and renal (n=4) arteries. Sac size ranged between 22 and 60 mm. All procedures were performed electively. The endpoints were technical success, stent patency, aneurysm rupture or modification, and target organ perfusion. Follow-up was based on clinical evaluation and computed tomography angiography at 1, 6, and 12 months and then once a year (range, 1-72 months).

Results: Immediate aneurysm exclusion was obtained in 21/24 aneurysms. In 1 patient there was intraoperative bleeding with subsequent splenectomy; in 1 renal aneurysm there was endoleak due to incomplete distal sealing; and in 1 patient implantation of 2 covered stents was ineffective, and proximal and distal embolization was necessary. Ischemic injuries to the distal organs were postoperatively observed in 6/24 patients. One patient died after 20 months for pancreatic tumor. Out of 21 successfully treated aneurysms, 18 stents (85.7%) remained patent from 24 to 72 months (mean, 48 months). Three stents were found occluded at 6 and 12 months; patients remained asymptomatic and aneurysms thrombosed.

Conclusions: Endovascular treatment of visceral aneurysms with covered stent, although not always technically feasible, seems safe and effective with a low complication and a high long-term patency rate. It allows vessel patency and outflow preservation. No significant clinical consequences have been observed in case of stent occlusion. It could be considered as first-line treatment whenever delivery devices can be safely advanced at the aneurysm site.

Endovascular Repair of the Migrated and Tilted Endograft With Type 1 Endoleak Using a Bifurcated Modular Graft

K. Rust III, S. B. Hancock, F. Maqbool, K. Campbell-Conner

Purpose: 1. To briefly explain relevant anatomy and complexities of the migrated and tilted endograft, as well as treatment options. 2. To describe the clinical progression of 2 patients who came to our institution with delayed type 1 endoleaks occurring secondary to significant endograft migration and tilting. 3. To explain clinical decision-making in these cases and describe the endovascular repair and follow-up on these patients.

Materials and Methods: Two patients came to our institution with significant proximal migration and tilting of their endograft. Pre-procedure computed tomography (CT) angiographic imaging confirmed the presence of proximal migration, tilting of the aorta, and a type 1 endoleak. Both were treated using the AneuRx bifurcated modular graft (Medtronic, Minneapolis, MN). Follow-up monitoring involved CT angiography imaging at intervals of 3 months, 6 months, and then annually.

Results: Two patients demonstrating significant proximal migration and tilting of their existing endografts, who subsequently developed type 1 endoleaks, were successfully treated with bifurcated modular grafts. One of the patients is more than 2 years post-repair, while the other is less than 1 year post-repair. No complications or recurrent endoleak have been observed in either case.

Conclusions: In an aging population, there is increasing incidence and identification of infrarenal abdominal aortic aneurysm. New complexities, such as tortuous iliac arteries, different types and angulation of the neck and their treatment with simple endografts, will become more prevalent, leading to increased incidence of delayed type 1 endoleaks. In some patients with significant proximal migration and tilted endograft who were previously strongly considered for surgical revision, we have found success using techniques such as those described in the aforementioned cases. The bifurcated modular AneuRx graft shows promise in these situations, thereby alleviating the risks of surgery.

New Endograft for Treatment of Reverse Tapered-Neck Infrarenal Aortic Aneurysm and Small-Caliber External Iliac

K. Rust III, S. B. Hancock, F. Maqbool, K. Campbell-Conner

Purpose: 1. To describe challenges of proximal aortic neck anatomy in endovascular treatment of abdominal aortic aneurysm (AAA). 2. To explain our experience with treating an AAA with a reverse tapered infrarenal aortic neck and small-caliber external iliac arteries using a novel Ovation Prime™ endograft from Trivascular (Santa Rosa, CA). 3. To provide an illustrated explanation as to the methodologies employed using this graft in these situations.

Materials and Methods: The reverse tapered and short infrarenal aortic neck is a challenging type of anatomy to treat via an endovascular approach, especially in the setting of small iliac arteries. We have successfully treated this type of AAA with a Trivascular endograft. The novel ring incorporated technology provides a better seal in this setting, allowing the aneurysm to re-model and stabilize.

Results: After identifying a patient at our institution with both the reverse tapered aortic aneurysm neck and small-caliber bilateral external iliac arteries, this new endograft device was used with success.

Conclusions: Continued innovations and advances in AAA endovascular repair are vital, given the delayed comorbidities involved with more invasive procedures. This new addition to the family of endografts has shown early success in the setting of the difficult reverse tapered AAA neck anatomy at our institution.

Novel Use of Conformable Guide to Avoid Brachial Artery Access in the Treatment of Complex Aorto-iliac Aneurysms

J. D. Adams

Purpose: To report the novel technique of selective catheterization of visceral and internal iliac arteries in the setting of complex endovascular aneurysm repair using the Aptus conformable sheath (Aptus Endosystems, Sunnyvale, CA).

Materials and Methods: The technical details of 5 cases of complex aorto-iliac endovascular aneurysm repair using the Aptus conformable guide catheter are reviewed, and technical considerations are discussed (Figure 1).

Figure 1. Aneurysm repair using the Aptus conformable sheath.
Results: Five patients underwent successful complex aorto-iliac endovascular aneurysm repair from a transfemoral approach using the Aptus conformable guide catheter (Figure 2), thus obviating the need for the usual brachial access.

Two Complex Cases of Transcatheter Aortic Valve Replacement

J.-K. Han, H.-M. Yang, B.-K. Koo, H.-S. Kim

Purpose: To present case reports demonstrating how to overcome complex anatomy in 'real world' transcatheter aortic valve replacement (TAVR) procedures.

Materials and Methods: Case 1: A 84-year-old female with severe aortic stenosis (AS) was referred to our hospital for dyspnea. Transcatheter aortic valve replacement with CoreValve® (Medtronic, Minneapolis, MN) was planned. Pre-procedural computed tomography revealed complete U-shape curvature of thoracic aorta, which may hinder successful transfemoral approach. Case 2: A 73-year-old female presented with severe AS complicated by bicuspid aortic valve. Transcatheter aortic valve replacement with CoreValve was planned. However, echocardiography showed a 0.9-0.6 cm-sized mobile fibroelastoma on aortic valve, which can be embolized during TAVR procedure.

Conclusions: The transfemoral use of the Aptus sheath is a safe and feasible technique to facilitate selective catheterization of the visceral vessels and internal iliac arteries in the setting of complex endovascular aneurysm repair, thus avoiding the need for brachial artery access.

Quantitative Analysis of Flow Diverter–Induced Blood Flow Reduction in Brain Aneurysm Treatment

G. Duckwiler

Purpose: Hemodynamics is thought to play an important role in the pathogenesis, progression, and rupture of aneurysms. Reports have suggested that ruptured aneurysms tend to have more irregular shapes, which induce incoming flow to form a prominent jet stream directed toward the aneurysm head. Over time, the localized collision of these high-velocity flow jets with the aneurysm wall is suspected to deteriorate endothelial function. The objective of this study was to gain insight into high-risk flow by analyzing ruptured aneurysm cases. Our aim was to find the effect of aneurysms shape on flow rates within aneurysms and identify high-risk shape-related flow properties in ruptured aneurysms. We used digital subtraction angiography images to perform patient-specific hemodynamic analysis and study the blood flow within each aneurysm. Quantitative hemodynamic variables were extracted from the simulation results. Blood flow through the aneurysm dome <7 mm, 7-12 mm, 12-24 mm, and >24 mm, respectively. Patients’ 3-dimensional digital subtraction angiography images were used to perform patient-specific hemodynamic analysis and study the blood flow through each aneurysm. Quantitative hemodynamic variables were extracted from the simulation results. Blood flow through the aneurysm neck, body, and dome were evaluated with respect to the cross-section size.

Results: All ruptured aneurysms generally experienced similar incoming systolic flow rates regardless of the inlet cross-section geometry. When flow entering aneurysms was compared with the arterial flow rate, aneurysms with smaller necks experienced greater flow rate changes than those with medium or large necks. The overall flow rate changes through the neck for small, medium, and large necks were 97.8±1.4%, 90.0±2.7%, and 41.1±22.4%, respectively. Blood flow through the aneu-
intestinal hemorrhage (Figure 1). In some instances, a variety of embolization options

Results: Regardless of the overall aneurysm shape, we found that the shape and area of the aneurysm neck may have a large influence on flow rate and flow im-
pingement at the aneurysm apex. By analyzing the hemodynamic characteristics of a

Conclusions: Regardless of the overall aneurysm shape, we found that the shape and area of the aneurysm neck may have a large influence on the risk of rupture. As endoleaks can be described and correlated with cross-sectional imaging and angiography. Interven-
tional radiologists play a critical role in the management of endoleaks, particularly in

Materials and Methods: Interventional eligibility for C2R will be determined by the

Methods to embolize/treat arterial hemorrhage and GI bleed

- Coiled embolization
  - Mechanically blocks/occludes the area of abnormality
  - Critical to treat both front and back door to prevent retrograde supply
to the pseudoaneurysm or area of contrast extravasation
- Glue/BCA (N-butyl cyanoacrylate)
  - Permanent, rapidly acting liquid embolic agent
  - Polymericizes immediately upon contact with tissue
- Covered stent
  - Deployed across/over area of abnormality and directly covers over and
  - Thrombin injection
  - Percutaneous or injected via microcatheter into area of concern
- Combination of techniques

Figure 3. Methods to treat arterial hemorrhage and gastrointestinal bleed.

Diagnosing and Managing Endoleak Complications After Endovascular Aneurysm Repair

A. Fadl, A. Baadh, N. Georgiou, M. Hon, S. W. Stavropoulos

Purpose: Endovascular aneurysm repair (EVAR) is a well-accepted method of abdomi-
nal aortic aneurysm (AAA) treatment. For a significant percentage of AAA patients, it is an

Materials and Methods: This exhibit will review the importance of cross-sectional

Methods to embolize/treat arterial hemorrhage and GI bleed

- Coiled embolization
- Glue/BCA (N-butyl cyanoacrylate)
- Covered stent
- Thrombin injection
- Combination of techniques

Figure 2. Several techniques are used to treat this pseudoan-

Conclusions: This exhibit will review a variety of complex arterial causes of acute
gastrointestinal hemorrhage and multiple interventional management options (Figure

Conclusions: Enrollment into the C2R has been recently approved to begin in 2014.
Enrollment into C2R can continue until publication of the primary results from CREST-2.

Purpose: To review and demonstrate the cross-sectional and angiographic appear-

A Review of Interventional Radiology Treatment Approaches for Unique Arterial Causes of Gastrointestinal Hemorrhage

J. C. Hoffmann, A. Fadl, A. Baadh, O. Shoaib, N. Georgiou, M. Hon, D. Danda

Purpose: The CREST-2 (carotid revascularization for primary prevention of stroke)
Companion Registry (C2R) was developed through multispecialty input and National
Institutes of Health collaboration. The objective of C2R is to promote the rapid initia-
tion and completion of enrollment in CREST-2.

Materials and Methods: Interventionist eligibility for C2R will be determined by the

Results: On September 17, 2014, the Centers for Medicare and Medicaid Services
(CMS) approved reimbursement for carotid artery stent patients enrolled in CREST-2
and in C2R. Because CREST-2 and the C2R are covered under a national coverage
determination, the process of C2R-patient coverage by CMS does not require study
sites to get approval from the CMS administrative contractors. Enrollment guidelines
include 1) at least 1 operator must receive credentialing into CREST-2 within the first
75 total C2R cases or 30 CREST-2 eligible cases at the operator’s site and 2) once the
first interventionist at a site is credentialed to randomize into CREST-2, other opera-
tors may work toward credentialing, but the site must maintain an overall enrollment
ratio of 1:1 into C2R versus CREST-2.

Conclusions: Enrollment into the C2R has been recently approved to begin in 2014.
Enrollment into C2R can continue until publication of the primary results from CREST-2.

In the abdomen. In complex cases, a combination of techniques may be needed for successful treatment (Figure 2). Correlation between angiographic findings/intervention and cross-sectional imaging will be provided.

Figure 1. Placement of a covered stent to exclude the area of hemorrhage.

Results: Based on the patient’s anatomy, etiology of hemorrhage, and cause of hem-
orrhage, a variety of embolization techniques can be used to treat acute arterial gastro-
intestinal hemorrhage (Figure 1). In some instances, a variety of embolization options
can be chosen. In other circumstances, patient anatomy may dictate a necessity to
perform a particular type of embolization or exclusion. This exhibit will review the
imaging findings of acute arterial gastrointestinal hemorrhage, with focus on nuclear
development of an endoleak. This exhibit will review the various types
of endoleaks, highlight the role of cross-sectional imaging in their diagnosis, and detail the
integral role of interventional radiology in treating certain types of endoleaks.

Materials and Methods: This exhibit will review the importance of cross-sectional
imaging in post-EVAR patient management. The endoleak classification system will be
described and correlated with cross-sectional imaging and angiography. Intervention-
tional radiologists play a critical role in the management of endoleaks, particularly in

Figure 2. Several techniques are used to treat this pseudoan-
eurysm.
Embolization of Renal Pseudoaneurysms Using n-Butyl Cyanoacrylate Glue: Initial Results and Technique


Purpose: To determine the safety and feasibility of renal pseudoaneurysm (PSA) embolization using n-butyl cyanoacrylate (n-BCA) liquid embolic.

Materials and Methods: A retrospective review was performed of all renal PSA embolizations in which n-BCA (TRUFILL®; Codman Neurovascular, Raynham, MA) was used as the sole embolic agent. N-butyl cyanoacrylate was delivered in a super-selective fashion using a microcatheter system. Patient demographics, lesion characteristics, pre- and post-procedure imaging and renal function, technical success, and major and minor adverse events were reviewed (Table).

Results: From 08/2007 to 09/2014, there were 16 renal PSAs in 14 patients (mean age, 58; range, 30-86). Lesion etiology included iatrogenic (n=8), traumatic (n=2), anticoagulation (n=1), tumor-related (n=2), and cryptogenic (n=3). Eleven patients had signs of hemodynamic instability before embolization (78%). Pre-procedure computed tomographic angiography was positive for acute renal hemorrhage with active extravasation and PSA formation in 100% of cases. One hundred percent technical success was noted (defined as cessation of active bleeding on angiography and hemodynamic stability post-procedure). Re-intervention rate was 0% with mean follow-up interval 388 days (range, 3-1915). There was no change in pre- and post-intervention glomerular filtration rate at 24 hours (p=0.52) or at ≥30 days (p=0.56). Three patients (18%) required hemodialysis within 3 days of embolization; all had pre-existing chronic renal failure (Table 1). One PSA was treated by coil embolization with rebleeding within 1 day prior to treatment with n-BCA. Thirty-day mortality was 7% (1 patient died from sequela of post-hypovolemic shock 3 days after procedure).

Table. Patient Demographics, Treatment, and Follow-Up Information

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Age (gender)</th>
<th>Cause</th>
<th># of PSA</th>
<th>PSA location/ Embolized branch</th>
<th>Preembolization GFR (mL/min/1.73 m²)</th>
<th>GFR at 24 hours (mL/min/1.73 m²)</th>
<th>GFR at ≥30 days (mL/min/1.73 m²)</th>
<th>Follow-up time (days)</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>42 (F)</td>
<td>AML</td>
<td>1</td>
<td>Right inferior</td>
<td>92</td>
<td>92</td>
<td>69</td>
<td>1924</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>59 (M)</td>
<td>Nephrostomy tube placement*</td>
<td>2</td>
<td>Right superior, right inferior</td>
<td>36</td>
<td>48</td>
<td>36</td>
<td>1663</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>56 (F)</td>
<td>Nephrostomy, stent placement*</td>
<td>1</td>
<td>Left superior</td>
<td>16</td>
<td>17</td>
<td>n/a</td>
<td>3</td>
<td>Death</td>
</tr>
<tr>
<td>4</td>
<td>48 (M)</td>
<td>Partial nephrectomy*</td>
<td>1</td>
<td>Right middle</td>
<td>46</td>
<td>50</td>
<td>59</td>
<td>194</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>30 (M)</td>
<td>Thoracentesis*</td>
<td>1</td>
<td>Right middle</td>
<td>51</td>
<td>60</td>
<td>99</td>
<td>49</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>54 (M)</td>
<td>Renal biopsy*</td>
<td>1</td>
<td>Right inferior</td>
<td>20</td>
<td>10</td>
<td>26</td>
<td>257</td>
<td>None</td>
</tr>
<tr>
<td>7</td>
<td>84 (M)</td>
<td>Ground-level fall*</td>
<td>1</td>
<td>Left inferior</td>
<td>29</td>
<td>22</td>
<td>16</td>
<td>865</td>
<td>AKI requiring dialysis</td>
</tr>
<tr>
<td>8</td>
<td>86 (F)</td>
<td>RCC*</td>
<td>1</td>
<td>Left interpolar</td>
<td>59</td>
<td>68</td>
<td>n/a</td>
<td>377</td>
<td>None</td>
</tr>
<tr>
<td>9</td>
<td>51 (F)</td>
<td>Cryptogenic</td>
<td>2</td>
<td>Left inferior, left interpolar</td>
<td>15</td>
<td>8</td>
<td>n/a</td>
<td>14</td>
<td>None</td>
</tr>
<tr>
<td>10</td>
<td>67 (F)</td>
<td>Cryptogenic*</td>
<td>1</td>
<td>Left superior</td>
<td>11</td>
<td>6</td>
<td>5</td>
<td>422</td>
<td>None</td>
</tr>
<tr>
<td>11</td>
<td>31 (M)</td>
<td>Renal biopsy*</td>
<td>1</td>
<td>Right middle</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>1251</td>
<td>AKI requiring dialysis</td>
</tr>
<tr>
<td>12</td>
<td>86 (F)</td>
<td>Anticoagulation</td>
<td>1</td>
<td>Right lower</td>
<td>47</td>
<td>n/a</td>
<td>53</td>
<td>74</td>
<td>AKI requiring dialysis</td>
</tr>
<tr>
<td>13</td>
<td>66 (M)</td>
<td>Dislodged nephrectomy*</td>
<td>1</td>
<td>Left arcuate</td>
<td>32</td>
<td>36</td>
<td>45</td>
<td>35</td>
<td>None</td>
</tr>
<tr>
<td>14</td>
<td>53 (F)</td>
<td>Renal biopsy*</td>
<td>1</td>
<td>Left lower</td>
<td>8</td>
<td>18</td>
<td>11</td>
<td>1121</td>
<td>None</td>
</tr>
</tbody>
</table>

AKI, acute kidney injury; AML, angiomyolipoma; GFR, glomerular filtration rate; PSA, pseudoaneurysm; RCC, renal cell carcinoma.

* indicates presentation with signs of hemodynamic instability.

Conclusions: While EVAR has become widely used to treat aortic aneurysms, radiologists must understand their role in diagnosing endoleaks, as they are the most common complications of the procedure. Knowledge about the imaging appearance and pathophysiology of the types of endoleaks is crucial for appropriate diagnosis. Interventional radiologists play a pivotal role in endoleak management, especially when treating type II endoleaks.

Case One: Digital subtraction angiographic image demonstrating a Type II endoleak via a lumbar artery, with collateralization to a right internal iliac artery branch vessel. This was successfully treated with transcatheter embolization via a microcatheter.

Case Two: CT guided transluminal percutaneous placement GFR: Glomerular filtration rate; PSA: Pseudoaneurysm.
Conclusions: Embolization of renal PSA with n-BCA liquid embolic is feasible, effective, and appears to be safe. Patients who present in extremis or have underlying severe chronic renal dysfunction are at greater risk for major complications.

Outcomes and Change of Splenic Volume and Platelet Count After Endovascular Treatment of Splenic Artery Aneurysm


Purpose: This study aimed to review outcomes of endovascular treatment of splenic artery aneurysm and to evaluate change of splenic volume and platelet count.

Materials and Methods: From March 2006 to December 2013, 22 patients (8 male; 14 female; median age ± standard deviation, 52±13 years) were retrospectively enrolled. Underlying disease and symptoms were reviewed. Size and location of aneurysm were analyzed with computed tomography and angiographic findings. Technical success, complication, and change of splenic volume and platelet count were investigated during the average follow-up period of 325 days.

Table 1. Location of Aneurysm in Patients Who Received the Sandwich Technique

<table>
<thead>
<tr>
<th>Location</th>
<th>Number (percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle</td>
<td>14/19 (74%)</td>
</tr>
<tr>
<td>Distal</td>
<td>3/19 (16%)</td>
</tr>
<tr>
<td>Ostial</td>
<td>1/19 (5%)</td>
</tr>
<tr>
<td>Segmental</td>
<td>1/19 (5%)</td>
</tr>
</tbody>
</table>

Results: Thirteen patients (13/22, 59.1%) had either hypertension or liver cirrhosis or malignancy. Eighteen patients (81.8%) had no symptom. Mean size of 21 true aneurysms (21/22, 95.5%) was 24.4 mm. The middle portion of the splenic artery was most commonly involved (14/22, 63.6%). The sandwich technique was performed in 86.4% (19/22; Table 1), followed by sack packing (n=1), stent graft insertion (n=1), and both isolation and packing (n=1). Technical success rate was 95.5% (21/22). Partial splenic infarction occurred in 8 patients (8/19, 42.1%) in the sandwich technique (Table 2). Splenic volume decreased more in patients with liver cirrhosis (357.4±325.3 ml vs. 48.1±62.8 ml; p=.028) during an average follow-up period of 456 days. Platelet count increased in 10 patients by an average of 95,000/μl while the platelet count decreased in the other 10 patients by an average of 21,400/μl during an average follow-up period of 32 days.

Conclusions: Endovascular treatment of splenic artery aneurysm is safe and effective, although self-limiting infarction and post-embolization syndrome can occur. After treatment with the sandwich technique, splenic volume tends to decrease more in liver cirrhosis patients, and platelet count can either increase or decrease with no clinical significance.

Peri-Procedural Pain Control for Uterine Fibroid Embolization Using Conscious Sedation and Neuraxial Analgesia


Purpose: Use of peri-procedural moderate (conscious) sedation and concurrent neuraxial analgesia (MS+NA) in patients undergoing elective uterine fibroid embolization (UFE) has been suggested as more effective in post-procedural pain control than moderate sedation alone (MS). This study quantifies the effectiveness of the universal application of MS+NA compared with a prior pain control regimen of MS alone for patients undergoing UFE at our institution.

Materials and Methods: A retrospective study was performed reviewing self-reported pain rating scales (1-10) after UFE during the 3-year period following the universal application of MS+NA in November 2011. Neuraxial analgesia was defined as the application of intrathecal or epidural anesthesia. Since that time, a total of 39 patients underwent elective UFE for symptomatic uterine fibroids. The mean value was assessed with 2-tailed student t-test and paired t-test, comparing post-procedure pain levels with patients having had MS alone during the 3-year period from November 2008 to November 2011 (18 patients). We assessed the effectiveness of the MS+NA protocol at 4 and 24 hours after the procedure.

Results: The mean pain score at the 4-hour time point was 1.65 (1.08-2.22) in the MS+NA group and 3.88 (2.74-5.03) in the MS-only group, which represents a significant difference (p=0.0002). The mean pain score at the 24-hour time point was 0.30 (0.06-0.608) in the MS+NA group and 2.44 (1.10-3.77) in the MS-only group, which represents a significant difference (p=0.0001). In the MS+NA group, the mean pain score at 24 hours was 0.30 (0.06-0.608), which is significantly lower than the mean pain score at 4 hours of 1.65 (1.08-2.22) (p=0.0001) [paired t-test].
However, in the MS-only group, the mean pain score was 3.88 (2.74-5.03) at 4 hours and 2.44 (1.10-3.77) at 24 hours, and these were not significantly different (p=0.10) [paired t-test].

**Conclusions:** The results of this retrospective study measuring the effectiveness of the universal application of MS+NA compared with MS alone at our institution show that simultaneous neuroaxial analgesia and moderate sedation at the time of UFE provides superior analgesia at both 4 and 24 hours post-procedure. Our findings were consistent with a previous retrospective analysis within our institution and demonstrate significantly lower post-procedure pain levels at 24 hours compared with 4 hours for patients who received MS+NA. In the MS-only group, however, there was no significant difference in pain control at 4 and 24 hours post-procedure. These findings suggest that patients undergoing UFE benefit from a pain management strategy that incorporates the peri-procedural application of neuroaxial analgesia. Improved peri-procedural patient comfort via this protocol may result in expedited time to discharge, reduced post-procedural narcotic use, lower readmission rates, and an improved overall UFE experience for patients.

**Preoperative Embolization of Giant Solitary Fibrous Tumor of Pleura: Case Report and Literature Review**

S. Iqbal, C. Molgaard, C. Williamson, B. Davison, H. Ahari, S. Flacke

**Purpose:** Solitary fibrous tumors (SFTs) are a heterogeneous group of rare spindle-cell tumors. Clinically, they are presented as a solitary pleural-based mass. Pulmonary parenchymal SFT is rare, and multiple bilateral lesions are extremely rare. We present the clinical report, imaging, and management of a giant pleural solitary fibrous tumor.

**Materials and Methods:** We present the case of a giant solitary fibrous tumor of pleura. The patient, a 56-year-old female, presented with chest discomfort. The patient was otherwise unremarkable. Chest x-ray showed a large tumor in the right hemithorax, almost completely obliterating the entire lung field, which was confirmed by computed tomography. On positron emission tomography imaging there was no metastasis. A decision was made to operate and excise the lesion. Because of the large size of the tumor, there was a high chance that the lesion may have parasitized blood supply from surrounding areas. To avoid massive loss of blood during surgery, embolization was performed.

**Results:** The tumor had parasitized arterial blood supply from multiple intercostal arteries, the right inferior phrenic artery, and the hepatic artery from the peritoneal space. All these arteries were embolized using particles and coils to good effect. Surgical resection was performed with minimal intra-operative bleeding, decreasing recovery time.

**Conclusions:** The giant solitary fibrous tumor of pleura was managed by surgical resection. Surgery had a high risk of intra-operative bleeding. Embolization is a safe and effective option for reducing bleeding during surgery for a giant solitary fibrous tumor of the lung.

**Use of SpiderFX™ Embolic Protection Device vs. Distal Embolic Event: A Health Economic Study**

E. Dippel, K. Wallace, N. Parikh

**Purpose:** Distal embolization (DE) is a potential complication of percutaneous atherectomy and other endovascular procedures that can lead to poor outcomes for the patient and escalated costs for hospitals. Embolic protection (EP) devices have been shown in several studies to have a low failure rate, and thus reduce the incidence of these events. This study compared inpatient and outpatient costs and resource utilization in 2 nonconcurrent (presumed lower extremity) atherectomy patient populations: (1) a DE event group and (2) a SpiderFX™ (CookMedical, Inc.) event group.

**Materials and Methods:** All inpatient and hospital outpatient discharges for atherectomy of nonconary vessels were selected via the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) or current procedural terminology (CPT) codes from a comprehensive hospital admissions database (Premier database 2008-Q3 2013). Of these, DE patients were identified using ICD-9-CM diagnosis codes. Patients receiving the SpiderFX device were identified using a protocol keyword search. Separate analyses were performed for the inpatient and hospital outpatient settings. Discharges in both the DE and event groups were matched 1:1 using propensity score methodology, adjusting for covariates. Hospital length of stay, operating room (OR) time, intensive care unit (ICU) utilization rate, and costs were compared between the groups for inpatient setting. Total and component costs were compared between the groups for hospital outpatient setting.

**Results:** A total of 1110 matched pairs were identified for the final analysis: 667 inpatients and 443 patients in the hospital outpatient subset. In the inpatient analysis, hospital stay averaged 1 day longer in the DE group compared with the SpiderFX device patients. Operating room time was 64 minutes longer for DE patients (p<0.0001). The ICU utilization rate was 54% in the DE group vs. 15% in the SpiderFX device patients (p=0.0001). Total costs were higher for the DE group ($23,815 vs. $21,378, p=0.0225).

In the hospital outpatient analysis, total costs were significantly higher in the DE group ($12,685 vs. $10,955) than in the SpiderFX device patients (p=0.0008).

**Conclusions:** The use of the SpiderFX device is strongly associated with lower costs, shorter inpatient hospital stays, lower ICU utilization rates, and shorter OR times. Cumulatively, these findings demonstrate EP devices such as the SpiderFX device may significantly reduce consumption of hospital resources.

** Nanoparticles as an Imaging Platform for Selective Localization of Lower Gastrointestinal Bleeding**

B. Khalsa, K. Nelson

**Purpose:** Lower gastrointestinal (GI) bleeding is often a treatment challenge for interventional radiologists. The intermittent nature of most clinically significant lower gastrointestinal bleeds and the need for selective localization for intervention pose a diagnostic and therapeutic challenge for the interventional radiologist. There is a need for a better diagnostic tool for the precise localization of lower GI bleeding for the purposes of intervention.

**Materials and Methods:** In addition to endoscopy, the advantages and disadvantages of existing diagnostic modalities, including radiouclide imaging, computed tomography angiography and interventional radiology angiography, are discussed. Based on the limitations of existing diagnostic modalities, a literature search is performed for an imaging platform that can be easily administered intravenously during a hemorrhagic event, is able to cross the pulmonary capillary bed into the mesenteric arterial vascular system, and is able to bind to intestinal mucosa when extravasated centrally.

**Results:** Each currently available diagnostic modality has selective advantages in sensitivity and specificity for diagnosing lower GI bleed. All modalities, however, are limited in their need for active bleeding during image acquisition and logistical factors that often result in image acquisition outside of the acute hemorrhagic episode. Nanoparticles are introduced as potential diagnostic tools for imaging and localization of lower GI bleeding due to select properties that enable them to be easily administered and imaged during the window of a hemorrhagic event.

**Conclusions:** Radiopaque nanoparticles may serve as an ideal imaging platform to enable the timely diagnosis and selective intervention of acute lower GI bleed due to properties that allow for intravenous delivery during an acute hemorrhagic episode. Further research needs to be performed to evaluate the toxicity profile, dosing, efficacy, and cost before its clinical application in interventional radiology.

**Endovascular Management of Fibromuscular Dysplasia Via a Transradial Approach: Feasibility and Technical Outcomes**


**Purpose:** Renal fibromuscular dysplasia (FMD) is a known cause of renovascular hypertension that has been shown to respond to percutaneous balloon angioplasty (PTA). In this study, we evaluate the safety and feasibility of transradial access (TRA) in endovascular management of FMD.

**Materials and Methods:** Patients with a diagnosis of FMD (confirmed by renal ultrasound and clinical symptoms) requiring intervention were retrospectively reviewed. All patients who underwent angiograms via the left radial artery (RA) were included in this analysis. A Barbeau test was performed using a pulse oximeter before all procedures. A 6F Gildeshsheath Slider™ (Terumo Medical Corporation, Somerset, NJ) was placed in the left RA using ultrasound guidance. Following sheath placement, a mixture of 3000 U heparin, 2.5 mg verapamil, and 200 mcg ni troglycerin was administered intra-arterially. Angiograms with hemodynamic measurements were performed using a pressure wire (PrimeWire; Volcano Corporation, San Diego, CA). Percutaneous balloon angioplasty was performed using 4-6 mm Sterling™ balloons (Boston Scientific, Marlborough, MA). A TR band™ (Terumo Medical Corporation, Somerset, NJ) was used for RA hemostasis upon completion. Access site complications, hemodynamics, technical success, fluoroscopy time (FT), post-procedure pain scores (0-10 verbal numerical rating scale), time to ambulation (TTA), time to discharge (TDD), and major and minor adverse events at 30 days were recorded.

**Results:** From April 1, 2010, to September 1, 2014, a total of 6 patients (median age: 38 [18-46] years; 4 female, 2 male) underwent diagnostic angiography of the renal arteries. Significant systolic pressure gradients were encountered in 50% (3/6) of patients (median: 20 [17-28] mmHg), all of whom underwent successful interventional treatment with PTA (Table). Median FT was 10.7 (6.3-17.4) minutes. Median post-procedure maximum pain score was 0 with a majority of patients reporting no pain. Median TTA following 6 procedure was 0. A single case required crossover from femoral access to TRA with TTA of 270 minutes. Median TTD was 235 (86-360) minutes.

**Conclusions:** In our experience, endovascular management of FMD via TRA is both technically feasible and safe with immediate ambulation post-procedure.
undergoing angioplasty and stenting received weight-based heparin before crossing the side with the arm extended on an arm board adjacent to the patient’s body. All patients determined using the Barbeau test. All procedures were performed from the patient’s left artery interventions via a left radial artery access. Eligibility for radial access was de-

our experience with transradial access in consecutive patients undergoing renal artery vascular events, and awkwardness of working on the patient’s left side. We report of the radial artery (RA) for access include the potential for RA thrombosis, cerebro-

Purpose: Radiofrequency ablation (RFA)-assisted osteoplasty (OP) and vertebro-

Table. Patient Demographics, Treatment, and Follow-Up Information

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Sex</th>
<th>Barbeau waveform</th>
<th>Guide catheter</th>
<th>Intervention</th>
<th>Pre-gradient (mmHg)</th>
<th>Post-gradient (mmHg)</th>
<th>Gradient reduction (mmHg)</th>
<th>Fluoroscopy time (min)</th>
<th>Complication</th>
<th>Post-procedure VNRS pain level</th>
<th>Time to ambulation (min)</th>
<th>Time to discharge (min)</th>
<th>Radial artery occlusion</th>
<th>Repeat intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>45</td>
<td>F</td>
<td>A</td>
<td>6F Envyo 100 cm</td>
<td>Renal PTA</td>
<td>30</td>
<td>0</td>
<td>30</td>
<td>NA</td>
<td>None</td>
<td>0</td>
<td>270</td>
<td>360</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>F</td>
<td>A</td>
<td>6F Runway 110 MP</td>
<td>Renal PTA</td>
<td>20</td>
<td>0</td>
<td>20</td>
<td>15.1</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>379</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>3</td>
<td>46</td>
<td>F</td>
<td>A</td>
<td>6F 110 JR4</td>
<td>Renal PTA</td>
<td>15</td>
<td>0</td>
<td>15</td>
<td>24.3</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>72</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>4</td>
<td>57</td>
<td>M</td>
<td>A</td>
<td>6F 110 MP1</td>
<td>Renal angiogram</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10.7</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>86</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>31</td>
<td>F</td>
<td>B</td>
<td>5F Sarah</td>
<td>Renal angiogram</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7.1</td>
<td>None</td>
<td>0</td>
<td>0</td>
<td>118</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>M</td>
<td>B</td>
<td>6F MAC 3.0 guide</td>
<td>Renal angiogram</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>None</td>
<td>8</td>
<td>0</td>
<td>346</td>
<td>No</td>
<td>None</td>
</tr>
</tbody>
</table>

PTA, percutaneous balloon angioplasty; VNRS, verbal numerical rating scale.

Left Transradial Access in Treating Atherosclerotic Renal Artery Stenosis

G. Sivananthan, R. S. Patel, E. Kim, F. Nowakowski, R. Lookstein, N. E. Tabori, A. Fischman

Purpose: Renal interventions are traditionally performed through common femoral artery access. However, left transradial access offers several theoretical advantages over femoral access. These include a cranio-caudal approach to the renal arteries, as well as a relatively lower risk of access site complications compared with femoral access in a cohort of high-risk patients who often have hypertension and require peri-procedural anticoagulation and antiplatelet therapy. Reported concerns regarding use access in a cohort of high-risk patients who often have hypertension and require peri-

Materials and Methods: We performed a retrospective review of 11 consecutive patients (5 male, 6 female; mean age, 64.5±20.8 years) undergoing 13 separate renal artery interventions via a left radial artery access. Eligibility for radial access was de-

Results: The transradial approach was successful in 12/13 (92.3%) attempts. The 1 failed case was due to a clinically silent occluded RA presumably from a prior cardiac catheterization. The mean FT was 21.45±10.9 minutes. Seven patients presented for the index intervention and were stented. Two of these patients required reintervention, both via repeat left RA access. Three patients did not have significant translesional pressure gradients and were not treated. There were no major adverse events. Minor access site bruising was seen in 1/13 cases (7.7%). There was no post-procedural left hand neurovascular compromise or cerebrovascular incidents. All patients had docu-

Conclusions: Our case series suggests that transradial renal intervention can be safely performed in patients suspected of renovascular hypertension.

Bipolar Radiofrequency Ablation–Assisted Osteoplasty and Vertebroplasty

S. Kaduri, G. Annamalai, C. Tingerides, E. David

Purpose: Bipolar radiofrequency ablation (Bipolar RFA)–assisted vertebroplasty (VP) appear to be feasible and effective in the treatment of painful osteolytic bone metastases (1,2). Conventional monopolar RFA devices pose risks to adjacent tissues, particularly the spinal cord. In patients undergoing OP and VP, it is unclear if adding RFA changes the safety and outcome of the procedure or improves control of cement injection. Furthermore, it is unknown how impedanc varies based on tissue type. Our objectives are to assess safety and radiologic outcomes of bipolar RFA-as-

Materials and Methods: Patients referred for RFA-assisted VP from March 2013 to August 2014 were included. Bipolar RFA was performed (OsteoCool® RF Ablation System; Huyis Medical, Montreal, QC) reaching a temperature of 70°C, which was kept constant during ablation over 7 to 15 minutes, followed by cement injection. Radiologic outcomes and cement distribution were assessed using computed tomography scanning. Multiple impedance measurements were recorded. Average values were used to deter-

Results: There were 13 patients treated (8 male, 5 female; median age, 69) contribut-

Conclusions: Staged OP and VP for treatment of osteoporotic compression fracture appears to be a feasible treatment option. The results may be explained by the use of bipolar energy, which might result in less cement leakage and improved bone cement contact.

Figure. Average impedance values according to type of lesion.
Conclusions: Radiofrequency ablation-assisted OP and VP using a bipolar RF system is safe, allows controlled cement injection with a low rate of cement leak, and resulted in radiological stability of the treated bone. Impedance values in multiple myeloma were higher than other tissue types, perhaps due to their cellular nature.


Multimodality Approach to a Complex Pseudoaneurysm Repair and Its Complications

A. Z. Zuberi, S. Iqbal, M. Iqbal, K. Ali, D. Brake, S. Gonda, R. Berger

Purpose: Our complex case describes a subacute right common femoral artery (CFA) pseudoaneurysm (PSA) as a result of a femoral access for cardiac catheterization. A 42-year-old female presents for follow-up of a right CFA pseudoaneurysm that developed after cardiac catheterization. It was followed by computed tomography and ultrasound on an outpatient basis with no resolution (Figure 1).

Materials and Methods: Initial CT and duplex ultrasound demonstrate a 7×6.5×6.5-cm pseudoaneurysm along the anterior aspect of the right CFA. It was having mass effect on CFA resulting in monophasic tardus parvus waveforms in the femoropopliteal and runoff vessels of the right lower extremity (RLE). A total of 4 attempts were made to percutaneously thrombose the pseudoaneurysm using ultrasound guidance for thrombin injection using a total of 12,000 units of thrombin. The PSA was thromboased after the fourth attempt; however, the following day the patient had a cold extremity and absent pedal pulses. An angiography was performed, which demonstrated complete occlusion of CFA at the location of the PSA with additional acute thrombosis of the tibioperoneal arteries (Figure 2). A pseudoaneurysm fills after a leak from a collateral vessel, and an additional stent is placed to stop the leak. We successfully treated the PSA with a total of 12,000 units of thrombin and 2 Viabahn-covered stents.

Results: Angioplasty and a Viabahn-covered stent were placed in the CFA to cover the neck of the PSA, and tissue plasminogen activator was infused into the RLE arterial system for thrombolysis. Follow-up angiograms over the next several days demonstrated filling of the PSA through a collateral vessel from the profunda femoris artery. An additional Viabahn-covered stent was placed extending from CFA to the superficial femoral artery at the expense of the deep femoral artery (Figure 3). This resulted in recanalization of the RLE and occlusion and thrombosis of the pseudoaneurysm with no further filling.

Conclusions: We present a complex case of a subacute right CFA pseudoaneurysm as a result of a femoral access for cardiac catheterization. This case demonstrates the importance of using a multimodality approach for diagnosis and therapy of a complex pseudoaneurysm. We successfully treated the PSA with a total of 12,000 units of thrombin and 2 Viabahn-covered stents.

Novel Integration of Mobile Application for Interventional Radiology Consults

W. A. Fernandez, S. Krohmer

Purpose: Mobile phone applications (apps) have expanded clinician effectiveness and medical management by improving patient care with an infinite amount of accessible information. Residents/Fellows/Attending and interventional radiology (IR) departments have a greater potential for qualitative data mining. We have developed a mobile phone app that allows physicians to request and track consults on the go. The consult app notifies the IR team via pager, text message, or email. Consult information is categorized into minable data points: type of procedure, requesting service, coags, pertinent negatives, etc. Procedures and/or requirements can be changed in real time, allowing IR physicians and departments to tailor the app to local needs.

Materials and Methods: An Android/iPhone app was created that uses SSL (secure socket layering), an industrial standard in cryptographic protocol design for securely transmitting data over the Internet. All information and forms are HIPAA compliant with no identifying protected health information being transmitted. A dedicated website for housing and data mining is incorporated for exporting files and reports. Real-time consults were integrated into a RSS (rich site summary) feeder. Interventional radiology residents and faculty instituted a proof of concept usage of an IR TRAC app over the course of several months. Initial allocation of time was devoted to refining desired consult information and workflow scenarios. A prototype app was created and vetted through risk management, corporate compliance, information technology, safety, and intellectual property offices. Initial beta testing was performed by the IR resident fielding all consults using IR TRAC. Daily/Weekly/Monthly reports were generated, and systems analyses were performed. A limited rollout and implementation of IR TRAC was then instituted with select service providers. Providers were oriented and trained in app utility. Ongoing communication and feedback from referring services were incorporated throughout. Input from service providers was used to refine and customize the graphical user interface for relevant specialty information.

Results: The consult database was used to quantify/qualify consults. The performed and unperformed consults were analyzed for weak points in physician-physician interaction. Institution-wide knowledge of IR services and accessibility was increased. Productivity concerns were targeted and unnecessary consults identified as a need to educate health-care providers (resident, staff, and ancillary services). Reduction in unnecessary consults, improved allocation of resources, and faster turnaround response times were experienced.

Conclusions: Innovative application of a mobile phone app creates clinically effective opportunities to customize practices by tracking consults, consulting service trends, procedures, and information. The notification of the IR team with this
information allows a cohesive movement of resources for improved interaction between the referring physician and IR physician.

**Surgical Outcomes in Patients Who Underwent Transjugular Intrahepatic Portosystemic Shunt Prior to Liver Transplant**


**Purpose:** To evaluate postoperative outcomes of patients who had a transjugular intrahepatic portosystemic shunt (TIPS) placement prior to an orthotopic liver transplant (OLT) in a tertiary care institution over a 9-year period.

**Materials and Methods:** A retrospective analysis was conducted on 46 patients who underwent TIPS placement before OLT from 2004 to 2013. Patient demographics, clinical characteristics, preoperative laboratory values, and postoperative outcomes, including length of stay (LOS), surgical complications, and mortality, were obtained. Surgical complications were subdivided by hemodynamic instability requiring transfusion; infection; hyperglycemia; perihepatic hematoma; and pulmonary, renal, and biliary-complicated procedures.

**Results:** Forty-six patients had TIPS procedures with subsequent OLT; 29 patients (63%) were female with a mean age of 54.6 years (range, 33-71 years) and mean model for end-stage liver disease (MELD) score of 15.9. On average, patients had OLTs 274.6 days (range, 6-2127 days) after TIPS procedures and were hospitalized for 14.4 days (range, 3-56 days). Among the 26 patients (56.5%) who had surgical complications, the most common were hemodynamic instability requiring transfusion (30%), postoperative renal hematoma (30%), biliary-related (20%), and pleural effusion (20%). Six patients (13%) died an average of 875.3 days (range, 197-1694) after TIPS placement.

**Conclusions:** When compared with other patients who underwent OLT at our institution (n=588) with similar average MELD scores, patients with TIPS placement prior to OLT experienced a 1-day longer mean LOS (13.1 and 14.4 days, respectively). Theoretically, patients receiving TIPS before OLT may be technically more difficult to transplant due to the creation of hepatic and portal anastomoses adjacent to the stent. Conversely, by improving portal hypertension before transplant, patients could benefit from decreased postoperative complications and LOS. However, our data suggest there may be no significant difference in total LOS in patients with similar MELD scores who underwent TIPS placement before OLT compared with those who did not.

**The Effects of Transjugular Intrahepatic Portosystemic Shunt (TIPS) Placement on Outcomes in Cirrhotic Patients Undergoing Abdominal Surgery**

A. Kovalesski, B. Maertins, R. Myers, J. Peterson, K. Werth, J. Hill, P. Johnson, Z. Collins

**Purpose:** To determine if pre-surgical placement of transjugular intrahepatic portosystemic shunt (TIPS) has an effect on outcomes for abdominal surgery in cirrhotic patients.

**Materials and Methods:** Between 2003 and 2013, a retrospective analysis was conducted on 76 patients who underwent a TIPS procedure before abdominal surgery. Surgeries included were exploratory laparotomy (with associated interventions such as lysis of adhesions [LOA], partial gastroectomy, bowel resection, splenectomy, choledochojejunostomy, pingo-oopherectomy), umbilical hernia repair, and orthotopic liver transplant. Postoperative outcomes of intensive care unit (ICU) and hospital length of stay (LOS), surgical complications, and mortality were analyzed. Surgical complications were categorized as wound complications (AKW), altered mental status (AMS), hypertension, pneumonia, pleural empyema, hemodynamic instability, hemorrhagic shock requiring transfusion, or uncontrolled hemorrhage leading to death.

**Results:** A total of 82 surgeries were performed in the 76 patients who had cirrhosis with TIPS procedures and subsequent abdominal surgeries. Two-thirds (64%) were male with a mean age of 53.2 years (range, 26-70 years). After surgery, 73 patients (96%) were hospitalized with 78 of the 82 surgeries requiring hospitalization. Two patients’ hospital courses are unknown after surgery, while 1 patient died due to intraoperative complications. Of the hospitalized patients, 47 (64%) went to the ICU for an average stay of 3.5 days (range, 0-37 days) and a total mean hospital LOS of 16.8 days (range, 0-56 days). Thirty-nine patients (51%) had postoperative complications, with the most common being hypertension (8%), AKW (7%). Eighteen patients (24%) died an average of 529 days from surgery (range, 0-1694 days). Thirty-day and 90-day mortality were 4% and 8%, respectively.

**Conclusions:** Cirrhosis and portal hypertension are known contributors to high perioperative morbidity and mortality. For cirrhotic patients undergoing abdominal surgery, 30- and 90-day mortality rates are typically 20% and 30%, respectively (Neeff et al., 2013). Transjugular intrahepatic portosystemic shunt placement is a minimally invasive procedure useful for the management of portal hypertension. Although further investigation is warranted, this analysis found that preoperative TIPS placement may contribute to increased survival among cirrhotic patients undergoing abdominal surgery.

**The Newer Kids on the Block: An Update on Oral Anticoagulants for Proceduralists**

J. C. Hoffmann, A. Baadh, P. Cygan, A. Fadl

**Purpose:** For many years, traditional anticoagulants (warfarin, heparin, and analogues) have been used to prevent or treat thromboembolic disease and reduce the risk of stroke in atrial fibrillation. These agents do have limitations including a relatively narrow window to achieve therapeutic anticoagulation, dietary interactions, and a need for frequent laboratory testing due to significant variability in the dose-response relationship in each patient. As a result, multiple new oral anticoagulants have been developed to overcome these limitations. The purpose of this exhibit is to describe the key characteristics of these new medications and review their perioperative dosing and management.

**Materials and Methods:** This exhibit will review the mechanism of action and other key differences between warfarin, heparin (and analogues), and the newer oral anticoagulants. The reader will learn how to manage patients on these medications who need an interventional radiology procedure. Periprocedural management of patients on these newer oral anticoagulants will be discussed in the context of current Society of Interventional Radiology (SIR) guidelines.

**Results:** The current SIR practice guidelines do not include the newer oral anticoagulants now being used frequently in patients with atrial fibrillation, deep venous thrombosis, and/or pulmonary embolism. They differ from warfarin, as they are not vitamin K antagonists. Instead, dabigatran is a direct thrombin inhibitor, and rivaroxaban and apixaban are factor Xa inhibitors. These newer medications also differ from warfarin in that they have various percentages of renal clearance, thus renal dosing is important. In addition, the newer agents have faster onset of action and shorter offset of action compared with warfarin. As no SIR guidelines exist for these medications, an understanding of these drugs is critical for the interventional radiologist to determine when to perform procedures while continuing these medications versus postponing a procedure until the medication is cleared from the body. Equally as important is the safe resumption of therapy post procedure. These decisions are based on multiple factors including urgency of the procedure, level of bleeding risk, and timing of last dose.

**Conclusions:** An understanding of the various new oral anticoagulants used to prevent and treat thromboembolic disease and reduce the risk of stroke in atrial fibrillation is critical to physicians performing procedures. Knowledge of the mechanisms of action and half-lives of these agents, along with what medicine may potentially reverse their effects, is crucial to adequately manage these patients. Recently, the use of these newer oral anticoagulants has increased significantly. As such, physicians must be aware of how these medications differ from the more traditional heparin-based agents and warfarin.

**Drug-Elimuting Balloons Outcomes: Single-Center Experience**

H. M. Coffey, R. Gullipalli, A. Dalton

**Purpose:** The optimal endovascular treatment for peripheral vascular disease (PVD) has not yet been clearly defined. Conventional angioplasty and stenting are associated with unresolved problems of restenosis and high rates of target lesion revascularization (TLR). Drug-eluting balloons (DEBs) have recently shown promising results in European studies in treating PVD. The THUNDER trial reported decreased TLR at 24 months. Similar results were obtained in the FEMPAC trial, with a 6-month restenosis rate of 19% vs. 47% comparing DEB and conventional balloon angioplasty. LEVANT II found improved primary patency at 6 months and improved freedom from TLR at 12 months in the DEB group compared with the conventional angioplasty group.

**Materials and Methods:** We designed a retrospective, single-center study evaluating the efficacy of angioplasty with drug-eluting balloon. Our study included 78 DEB procedures, where 42 target lesions were 6 months post DEB angioplasty and 36 target lesions were 12 months post DEB angioplasty. Patients were divided based on lesion-specific characteristics including lesion location and type of lesion. The anatomic location was divided into iliac artery (9), superficial femoral artery (24), and infrapopliteal artery (10). The type of lesion was categorized into de novo lesion (44), in-stent stenosis (15), and restenosis (19). Patient baseline characteristics assessed included age, diabetes, smoking status, hypertension, and renal failure. The primary endpoint after intervention was defined as freedom from target lesion revascularization 6 and 12 months post DEB angioplasty. Rates of TLR, amputation, and death were also analyzed. Baseline patient, lesion-specific characteristics, and freedom from TLR will be compared with previous study cohorts.

**Results:** Pending

**Conclusions:** Pending

**Impact of Lesion Location on Procedural and Acute Outcomes in Patients With Critical Limb Ischemia Treated With Orbital Atherectomy: A CONFIRM Subanalysis**

M. S. Lee

**Purpose:** Orbital atherectomy is a feasible method of treating critical limb ischemia (CLI) in patients with peripheral artery disease (PAD). The specific location of the lesion in question affects the procedural outcomes and the chances of limb salvage in this population of patients. This analysis compares the procedural and acute angiographic outcomes of PAD patients with CLI treated with orbital atherectomy (OAT) or popliteal (POP) lesions versus below-the-knee (BTK) lesions. Orbital atherectomy (AK) is a technique that uses an atherectomy catheter to remove atheromatous material from the lesion. The reader will learn the mechanism of action and characteristics of these new medications and review their perioperative dosing and management.

**Materials and Methods:** The CONFIRM registry series with non-missing Rutherford classification and lesion location was analyzed and includes 1109 real-world PAD patients (1544 lesions) with CLI treated with orbital atherectomy. In all, 594 patients had AK and 530 patients had POP lesions (832 lesions) while 523 patients had BTK lesions (712 lesions). This analysis compared the acute procedural and angiographic outcomes after treatment with orbital atherectomy in patients with AK or POP lesions versus
patients with BTK lesions. The primary endpoint was the composite of dissection, perforation, slow flow, vessel closure, spasm, embolism, and thrombus formation.

**Results:** Patients with ATK or POP lesions had a higher proportion of females (47% vs. 37%, p<0.001) and current smokers (31% vs. 25%; p=0.002). Compared with patients with ATK or POP lesions, patients with BTK lesions had a higher prevalence of diabetes (76% vs. 64%, p<0.001). Lesion length and plaque morphology were similar between the 2 groups. Patients with ATK or POP lesions had a higher postprocedural percent stenosis (38% vs. 32%; p=0.01) that was accompanied by more adjunctive therapies (eg, balloons and stents; 1.3% vs. 1.1%; p<0.001) compared with patients with BTK lesions. Procedural outcomes including flow-limiting and non-flow-limiting dissections were similar between the 2 groups. Patients with BTK lesions had higher incidence of perforation (2% vs. 0%; p=0.008) and spasm (10% vs. 4%; p<0.001) but lower incidence of embolism (0% vs. 5%; p<0.001).

**Conclusions:** Plaque modification with orbital atherectomy provided similar clinical outcomes in the patients with ATK or POP lesions and patients with BTK lesions. The higher rates of perforation and spasm in BTK patients may be explained by more challenging procedural characteristics in these patients.

**Orbital Atherectomy in the Occluded Arm: A Case Presentation of Ulnar/Interosseous Artery Treatment**

D. A. Dishon

**Purpose:** Endovascular treatment of the arm is difficult due to small vessel size; however, this treatment option often carries fewer risks than surgical interventions. Here we present a challenging case using atherectomy of the ulnar/interosseous artery. A 69-year-old man presented with pain and gregarious changes of the right index and middle fingers. Angiography identified a total occlusion of the radial artery and an occlusion in the ulnar/interosseous artery. Endovascular intervention was performed in an effort to salvage the patient’s right hand and possibly his fingers.

**Materials and Methods:** Using the modified Seldinger technique, a 6-French endovascular wire (Abbott Vascular, Abbott Park, IL) was used to transverse the stenosis (Figure A). The Prowater wire was exchanged for a ViperWire™ and a 1.25-mm DIa mondback 360® Peripheral Orbital Atherectomy System (Cardiovascular Systems, Inc, St. Paul, MN) was advanced across the wire into the ulnar/interosseous artery (Figure B). Sequential atherectomy passes were performed, and the catheter was removed and exchanged for a tapering 2.5–210-mm NanoCross™ balloon (Covidien, Plymouth, MN). Following balloon angioplasty, there was an improved angiographic result with restoration of flow to the hand and less than 20% residual stenosis (Figure C).

**Results:** Technical success was achieved in all but 3 patients who had short-term complications. Postoperative bleeding occurred in 2 patients, which responded to conservative measures. A large symptomatic retroperitoneal hematoma developed in 1 patient and required surgical evacuation. There was no procedure-related mortality in the group. The median follow-up duration was 15 months. The primary patency (90%) and assisted patency (59%) were achieved. There were no documented instances of stent fractures.

**Conclusions:** This summarizes our experience with a hybrid approach to the management of aortoiliac occlusive disease extending into the common femoral artery (CFA).

**Hybrid Approach in the Management of Aortoiliac Disease Extending Into the Common Femoral Artery**

S. Hanif, S. Brandon, W. Fan, A. Trebelev, B. Bianco

**Purpose:** A review of vascular disease affecting the hand, including traumatic, autoimmune, embolic, and smoking-related conditions that have unique imaging characteristics and patient demographics.

**Materials and Methods:** The introduction will include a basic anatomy review of the forearm and hand, including relevant musculoskeletal anatomy. Four vascular conditions will then be reviewed in a case-based format, including hypothenar ham- mer syndrome, Buerger disease, Raynaud’s disease, and thromboembolic disease. The common demographic for each patient will be described along with characteristic imaging findings (specifically catheter angiography images) to present each case. The presentation will be in poster format.

**Results:** A case-based review of unique vascular diseases affecting the hand will be presented in a case-based format.

**Conclusions:** The following diseases will be reviewed in a case-based format: hypothenar hammer syndrome, Buerger disease, Raynaud’s disease, and thromboembolic disease.
be considered for all patients with aortoiliac atherosclerotic occlusive disease regardless of the severity of TASC classification, particularly in those with high surgical risk.

**Urgent Management of a Secondary Aortoenteric Fistula**

**Author(s)**

**Co-Author(s)**

**Purpose:** To assess early diagnosis and management of hematemesis in patients who have a history of aortic reconstructive surgery.

**Materials and Methods:** A 70-year-old man presented with complaints of active hematemesis and melena for 2 days at the emergency department. He gave a history of aortic reconstructive surgery 9 years ago. Urgent computed tomography (CT) angiography was done and was suggestive of a large aortic anastomotic pseudoaneurysm with aortoenteric fistula (Figure 1). Urgent endovascular repair of the pseudoaneurysm with right femoral artery to left femoral artery crossover with ligation of left femoral artery, left common iliac artery, and left graft limb was done.

**Figure 1.** This computed tomography angiography image suggests a large pseudoaneurysm.

**Results:** The patient did well after the surgical management. Routine follow-up was done. Repeat CT angiography was done. No major complication was encountered (Figure 2).

**Figure 2.** Image shows surgical management of hematemesis.

**Conclusions:** Secondary aortoenteric fistula is a life-threatening complication of abdominal aortic reconstruction. The clinical manifestation of the aortoenteric fistula is always hematemesis. Treatment of the disease is an urgent hybrid surgical intervention.

**Inhibiting the Superficial Femoral Artery Sympathetic Nervous System to Treat Buerger’s Disease**

J. Tang

**Purpose:** To assess inhibiting the superficial femoral artery sympathetic nervous system to treat Buerger’s disease.

**Materials and Methods:** We observed the records of 30 cases of Buerger’s disease. The patients were treated by inhibiting the superficial femoral artery sympathetic nervous system by radiofrequency ablation. The ankle-brachial index (ABI), computed tomography angiography (CTA), and digital subtraction angiography (DSA) were analyzed.

**Results:** It was safe that all of the cases’ treatment was the inhibiting the superficial femoral artery sympathetic nerv-ous system by radiofrequency ablation. The ankle-brachial index (ABI), computed tomography angiography (CTA), and digital subtraction angiography (DSA) were analyzed.

**Conclusions:** This treatment is not only preventing the human body from the complication of lumbar sympathectomy, but also recovering Buerger’s arteries. However, we observed only a few cases with a short follow-up time, so we should have a lot of work to do.

**A Novel Use of the Viance™ Crossing Catheter: Retrograde Posterior Tibial Artery Approach for Chronic Total Occlusion Intervention**

S. Iqbal, M. Iqbal, A. Zuberi, S. Gonda

**Purpose:** We present a unique application of a novel tool in the treatment of chronic total occlusion (CTO). Our literature search reveals no prior reports of applications of the Viance™ Crossing Catheter (Covidien, Plymouth, MN) in a retrograde tibio-pedal approach for CTO intervention.

**Figure 1.** Chronic total occlusion.

**Materials and Methods:** The Viance crossing catheter provides a 0.037-inch profile, which can be placed over a 0.014-inch wire. The catheter also provides an atraumatic tip for decreased risk of vessel rupture. The catheter can be placed through a 5 Fr sheath. The crossing catheter is generally used in an antegrade manner to cross CTO. In our experience, we used this crossing catheter to successfully cross CTOs in the superficial femoral artery (SFA) and popliteal artery using the posterior tibial artery approach for retrograde intervention. We illustrate this technique using a series of 5 consecutive cases. We used ultrasound guidance to access the posterior tibial artery in each case, which was either followed by microsheath exchange for a 5 Fr sheath or direct over-the-wire exchange from microsheath to Viance crossing catheter. All patients had Trans-Atlantic Inter-Society Consensus Document on Management of Peripheral Arterial Disease (TASC) type B or C lesions in the affected extremity (Figure 1).

**Results:** Successful CTO was crossed in 5 out of 5 attempts through a retrograde approach; 3 in the SFA and 2 in the SFA/popliteal artery (Figure 2). These were followed by additional interventions such as atherectomy and angioplasty. The principal step...
in all cases was to initially cross the CTO through a retrograde approach and place a wire across it (Figures 3 and 4).

**Figure 2.** Crossing a chronic total occlusion.

**Figure 3.** Crossing the chronic total occlusion with a catheter wire.

**Figure 4.** Treatment of chronic total occlusion.

**Conclusions:** We demonstrate the efficacy of using the Viame crossing catheter for CTO intervention to be 100% in our experience. We also demonstrate the feasibility of adapting a new catheter into a well-established tibio-pedal retrograde approach for successful intervention of chronic total occlusion involving the posterior tibial artery and the superficial femoral artery.


**Acute Safety and Technical Success Results of the EverFlex™ Self-Expanding Stent With New Delivery System**

C. Wahlgren, M. Thieme, C. Paetzel, S. Nikol, S. Dietl, N. Dias

**Purpose:** This was a confirmatory study designed to evaluate technical success and acute safety of the EverFlex™ self-expanding peripheral stent with the new Entrust™ delivery system (Covidien, Plymouth, MN) for the treatment of symptomatic de novo or restenotic lesions in the native superficial femoral artery and/or proximal popliteal artery.

**Materials and Methods:** A prospective, multicenter, single-arm study enrolled 34 consecutive patients with symptomatic femoropopliteal lesions (ENTRUST study). The co-primary endpoints as assessed by an independent core laboratory were the following: 1) Absence of stent elongation, achieved when the implanted stent does not exceed the allowed stent length, which is the combined nominal stent length, 10% tolerance of nominal stent length and allowed measurement error, as assessed by the angiographic core laboratory and 2) Successful stent deployment was defined as the ability to deliver the stent catheter to the desired location and to provide coverage of the lesion as intended. The safety endpoint was the 30-day rate of device- and procedure-related adverse events.

**Results:** The mean age of enrolled patients was 71 years; 50% (17/34) were female. The most common pre-existing risk factors reported were hypertension (77%), history of smoking (65%), and hyperlipidemia (47%). Twenty-nine percent had diabetes and 15% had renal insufficiency. Non-healing ischemic ulcers in the lower extremities were present in 18% (6/34) of patients. Forty-five stents were successfully deployed to treat 39 target lesions. Per the angiographic core lab, the mean lesion treated was 87 mm, including 54% (21/39) moderately to severely calcified lesions and 54% totally occluded lesions. The co-primary endpoint of absence of stent elongation was achieved in 96% (43/45) of implanted stents, thus 2 of 45 implanted stents were deemed by the core lab to be elongated. The second co-primary endpoint, successful stent deployment, had a rate of 100%. One stent thrombosis at 14 days post procedure was the only adverse event and procedure-related adverse event (2.9%; 1/34) recorded through 30 days of follow-up.

**Conclusions:** The results of the ENTRUST study demonstrated successful deployment and safety of the EverFlex stent with Entrust delivery system for the treatment of symptomatic femoropopliteal lesions.

**Directional Atherectomy Is an Effective Treatment for In-Stent Restenosis After Femoropopliteal Stent Placement**

K. Nagarsheth, R. Aparajita, J. Schor, K. Singh, S. Zia, J. Deitch,

**Purpose:** In-stent restenosis (ISR) after femoropopliteal stent placement is an infrequent but challenging problem. We looked at the role of directional atherectomy (DA) in treating ISR in the femoropopliteal region.

**Materials and Methods:** A retrospective chart review was performed on all patients undergoing atherectomy after placement of a stent in the femoropopliteal area from the years 2011 to 2013. Demographic information, procedural data, and clinical follow-up data were collected and analyzed.

**Results:** Twenty-five patients who underwent DA for ISR were identified. The initial indication for intervention was claudication in 9 patients (36%), rest pain in 2 (8%), tissue loss in 7 (28%), and no data available for 7 (28%). The population was 32% male with a mean age of 69 years. After the first procedure, 100% were on antiplatelet agents; 24% were on aspirin alone, 16% clopidogrel alone, and 60% were on dual therapy. The 1-year primary patency was 70%. There were no distal embolization or device-related complications noted. Five patients required reintervention for restenosis after atherectomy. There was 1 postprocedural stent thrombosis requiring surgical bypass. There were 3 deaths and 2 amputations—all unrelated to the procedure and remote from the DA.

**Conclusions:** Directional atherectomy in-stent disease is a treatment option for recurrent disease. There is a low rate of complications, and DA has good patency rates. Further studies are needed to assess the long-term outcomes.

**Outside the Superficial Femoral Artery: The Role of Intravascular Ultrasound–Guided Reentry Devices in Complex Endovascular Procedures**

V. P. Krishnasamy, S. Sarin

**Purpose:** To review the use of an intravascular ultrasound (IVUS)-guided reentry catheter in complex arterial and venous endovascular procedures.

**Materials and Methods:** A retrospective review was performed of all cases that involved the use of the Pioneer® Plus Catheter (Volcano Corporation, San Diego, CA).
over a 10-year period at an academic tertiary medical center. Arterial and venous cases were reviewed and evaluated for the catheter’s role and effectiveness.

**Results:** During the period of review, it was found that the Pioneer Plus Catheter was used in a variety of complex endovascular procedures. These included superficial femoral artery (SFA) recanalizations, iliac artery recanalizations, aortic recanalizations, aortic dissection fenestration, transvenous punctures for arterial aneurysm coil embolization, and central venous recanalization.

**Conclusions:** Our experience shows that the Pioneer Plus Catheter can be used effectively for reentry in complex vascular cases beyond its original descriptions in the SFA. While several references have demonstrated its efficacy and safety in the peripheral vasculature, our review reinforces the use of this device elsewhere in the cardiovascular system. This case review exemplifies the use of this catheter in complex procedures that would have otherwise not been feasible or readily performed. Additionally, the use of this catheter likely improves the safety profile and operator confidence during these types of interventions.

### 3-Dimensional Image Fusion for Complex Aortic Interventions

**G. Koutouzi, O. Henrikson, H. Roos, M. Falkenberg**

**Purpose:** Traditionally, 3-dimensional (3D) imaging has been used for preoperative analysis and planning but not during the actual interventional procedures. With the advent of 3D image fusion and the development of flat-panel fluoroscopy systems with table integration, dynamic overlay visualization of critical anatomical structures from preoperative imaging is now possible. Our aim is to evaluate the feasibility of 3D fusion for guidance during complex endovascular procedures.

**Materials and Methods:** Important anatomical structures, such as target vessels and predicted optimal landing sites, were manually marked on preoperative computed tomography angiography (CTA) images before the procedures. Fusion of preoperative CTA with an intraoperative unenhanced cone beam CT (CBCT) was performed. Information from the fused CTA-CBCT dataset was overlaid on live fluoroscopy for intraoperative guidance.

**Results:** Target vessels to engage or to spare were effectively visualized during standard, fenestrated, branched, and chimney endovascular aneurysm repair (EVAR), thoracic endovascular aneurysm repair (TEVAR), and during aortic reinterventions. Specifically, localizations of vessels and positions not easily determined by conventional digital subtraction angiography were facilitated. Examples include vessels originating perpendicular to each other such as the renal arteries and the superior mesenteric artery (Figure 1) and optimal positions for parallel stent grafts in straight aortic segments (Figure 2). 3-Dimensional fusion was also used to localize false/true lumen and entries in a dissected aorta (Figure 3), to indicate positions of distal intercostal arteries to spare during TEVAR (Figure 4), and to guide percutaneous type 2 endoleak puncture (Figure 5). In cases where renoprotection was crucial, 3D fusion was used, and by confirming the correct position of the overlay with CO2 injections, advanced aortic interventions were performed with a minimum of iodinated contrast.

**Conclusions:** Intraoperative 3D image fusion is a valuable tool for guidance during endovascular procedures. Guidance based on fused CTA-CBCT datasets was feasible and allowed real-time 3D visualization of anatomy and pathology in complex aortic interventions. 3-Dimensional image guidance in combination with use of CO2 as contrast medium allows treatment of patients with reduced renal function in advanced endovascular procedures.
Endovascular Evaluation and Treatment of Patients With Peripheral Artery Disease Results in Lower Amputation Rate

J. Sanguily III

**Purpose:** Peripheral artery disease (PAD) is a prevalent disorder that affects almost 18 million Americans. Left untreated, PAD can lead to amputation. The number of amputations performed annually in the U.S. is estimated to be 160,000 to 180,000, and more than 50% of these patients never undergo an arterial evaluation before amputation. The purpose of this study is to prove that a community hospital could reduce major amputation rates by following a dedicated focus on (1) the implementation of advanced endovascular therapies, (2) PAD awareness programs, and (3) multidisciplinary wound care protocols.

**Materials and Methods:** The Martin Health Systems (MHS) amputation prevention initiative focused on 3 key areas: (1) Training—Physician-attended training programs teach the most advanced techniques in the rapidly evolving field of peripheral intervention. These programs focused on the latest advances in atherectomy treatment such as calcified plaque, angiome guided therapy, chronic total occlusion crossing techniques, and tibiopedal access; (2) PAD awareness—The Martin Memorial Medical Center implemented an aggressive PAD awareness program in his community in an effort to educate patients and referring physicians on the diagnosis and treatment of PAD; (3) Multidisciplinary wound care protocols—The interventionalist worked with the Martin Memorial Wound Care Center to develop protocols and treatments to help heal wounds to ultimately prevent amputations.

**Results:** The incidence of major amputations fell 87.5%, from 24 amputations in 2010 to 3 in 2014, with the increased use of angiography (Table). Increased use of angiography leads to reduced incidence of major amputations (Figure).

**Table.** Angiograms Reduce Amputations in Our Community

<table>
<thead>
<tr>
<th>Year</th>
<th>Angiograms</th>
<th>Amputations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>84</td>
<td>24</td>
</tr>
<tr>
<td>2011</td>
<td>146</td>
<td>18</td>
</tr>
<tr>
<td>2012</td>
<td>228</td>
<td>10</td>
</tr>
<tr>
<td>2013</td>
<td>249</td>
<td>6</td>
</tr>
<tr>
<td>2014</td>
<td>350+</td>
<td>3</td>
</tr>
</tbody>
</table>

**Conclusions:** A dedicated focus on the implementation of advanced endovascular therapies, PAD awareness programs, and multidisciplinary wound care protocols reduced the major amputation rates in a community hospital.
A Review of Transjugular Intrahepatic Portosystemic Shunt Dysfunction Causes and Revisions

M. H. Storace

Purpose: Portal hypertension is common in our patient population, and we are often faced with multiple options for transjugular intrahepatic portosystemic shunts (TIPS). This educational exhibit will explore cases of TIPS malfunction that we have managed at our institution. We will then review literature on complications of TIPS and discuss available treatment options.

Materials and Methods: Twenty-five cases of malfunctioning TIPS were evaluated. Most patients experienced recurrent symptoms of portal hypertension or had abnormal ultrasound findings. Nineteen patients were found to have stenotic TIPS at venography, either due to luminal irregularity, partial thrombosis, or a steep angle between the stent and portal or hepatic vein lumen. Five patients had complete thrombosis of the stent, four had a high portosystemic pressure gradient without gross evidence of stenosis, and three presented with progressive hepatic encephalopathy due to overshunting. The causes of malfunction, imaging findings, and techniques to remedy the problems were studied and evaluated.

Results: Angioplasty with or without additional stent placement was most commonly used to treat stent or adjacent venous stenosis. Presumably due to the use of potential included the filter (PTEF)-covered Viatorr® (Gore, Flagstaff, AZ). Most stenoses or irregularities were at the hepatic or, less commonly, portal venous portions. Both PTF and bare stents were used, depending on the location of the stenosis. Angioplasty alone was used in cases of high portosystemic pressure gradient without visible stenosis. In cases of complete stent thrombosis, a combination of mechanical and chemical thrombolysis was used to remove the stenosis. Several cases required transhepatic access to the TIPS due to inability to cross the thrombosis via transjugular access. Finally, side-by-side stent techniques were used to constrain TIPS in patients with hepatic insufficiency caused by overshunting of blood.

Conclusions: Stenosis and occlusion are common in the era before PTEF-covered stents. Nevertheless, these problems are still encountered, and a complete understanding of the complications and technical skills to fix them are required of interventionalists who treat patients with portal hypertension.

Catheter-Directed Thrombolysis Through Different Approaches for Lower Extremity Acute Deep Venous Thrombosis

P. Duan, C. Ni

Purpose: In our hospital, 106 patients with acute lower extremity deep venous thrombosis (DVT) were treated with catheter-directed thrombolysis through different access points including the small saphenous vein, great saphenous vein, and popliteal vein. The present study was conducted to investigate the feasibility, effectiveness, and complications of catheter-directed thrombolysis (CDT) through 3 different approaches for acute lower extremity DVT.

Materials and Methods: Our study period was from September 2011 to November 2013. One hundred six patients in our department with extensive acute lower extremity DVT were enrolled in our study group. We collected patient information including age, gender, cause of DVT, duration of DVT before admission, and which extremity was affected. Contraindications to thrombolysis included the following: contraindications to decaocoagulant, thrombolytic drug, and heparin. Patients with acute lower extremity DVT were classified into 4 groups: group A—catheterization through the small saphenous vein, group B—catheterization through the great saphenous vein, and group C—catheterization through the popliteal vein. The presenting symptoms included incidental limb pain, plegia, and edema. All DVT patients were confirmed by conventional venography before CDT, and the patients included all types of extensive thrombosis including the femo-popliteal vein (Figure 1a) and iliac vein (Figure 1b). All DVT patients were evaluated by the same member of the operation team to determine their thrombolytic dosage. The inclusion criteria consisted of the following: acute lower extremity DVT (symptoms lasting <4 days); DVT involving iliac, femoral, and popliteal veins (extensive DVT); aged 15-75 years; status of the following: acute lower extremity DVT; and the presence of collateral circulation. Exclusion criteria included the following: contraindications to decaocoagulant, thrombolytic drug, and heparin. The exclusion criteria included the following: contraindications to decaocoagulant, thrombolytic drug, and heparin. A P value of less than 0.05 was used as a threshold for statistical significance. In the follow-up, we observed the symptom improvement of these patients and recorded the overall long-term thrombolytic patency rate with venography at 6, 12, and 24 months through venography performed by the same operator.

Results: There were no deaths or symptomatic pulmonary embolisms among our patients. In group A, there were 18 males and 23 females with a median age of 65 years (range, 28-75). There were a total of 35 cases of left-sided DVT and 62 right-sided DVT cases. The duration of DVT was from 12 hours to 10 days, with an average of 10-76 hours. In group B, there were 16 males and 16 females with a median age of 66 years (range, 21-71). There were 22 cases of left-sided DVT and 21 right-sided DVT. The duration of DVT ranged from 11 days to 12 hours, with an average of 107-66 hours. In these 106 patients, DVT developed after abdominal or pelvic operations in 23 cases and after bone or joint operations in 21. All these operations were performed at least 1 month before the patients underwent CDT. A total of 15 cases involved combined malignant tumour and other without obvious causes. Furthermore, the stenosis of common iliac veins with or without collateral circulation was found in 73 cases when we performed venography during CDT. Stenoses were all located at the iliacocaval junction. Catheter-directed thrombolysis was the technique used for 106 cases. Primary venous access sites used for CDT included the ipsilateral small saphenous vein in 41 patients (group A), the great saphenous vein in 35 patients (group B), and the popliteal vein in 30 cases (group C). In group C, 22 cases in group B, and 19 cases in group C, respectively). All of these procedures were performed at the left common iliac segments. Procedures were successful in all cases. The limb edema reduction rates between groups A, B, and C displayed no significant difference (82.3±7.6% vs 81.6±6.0% vs 83.9±6.1%, p>0.05). Likewise, the rates of thrombolysis (63.5±7.7% vs 66.9±8.4% vs 66.1±2.7%, p>0.05) displayed no significant difference. The mean time taken during the procedure was 11.5±1.2 min vs...
3.9±0.2 min and 4.6±0.6 min, respectively. The times taken in group B and C were significantly less than in group A (P values were 16.221 and 8.793, p<0.05). No significant difference was found between group B and C. There were no major bleeding complications in the 3 groups. In group A, minor bleeding events were recorded in 4 cases at the external ankle incisions, and the lowest level of fibrinogen was 0.3 g/L with a dose of urokinase of 0.8 million IU a day. These patients were treated with substituted urokinase and low-molecular heparin weight administration via a heparin saline (100 mg of heparin mixed with 500 ml of saline) continued infusion through the catheter at a rate of 2 ml/hour to prevent thrombosis in those catheters. Bleeding ceased within 24 hours with fibrinogen recovered above 1.0 g/L, and there was recurrence when we adjusted the dose of urokinase to 0.6 million IU a day. In addition, phlebitis was recorded in 1 patient after catheterization. The symptoms disappeared after regional hot fomentation with 50% salamamur for 5 days without catheter removal. Insensible feeling surrounding the incisions was recorded in 2 patients due to saphenous nerve injury during exposure of the small saphenous vein. In group B, no complications were recorded. In group C, swelling and pain were recorded in 2 patients at the puncture site after extubation. Hematoma fluid was confirmed by color ultrasonic, and these hematomas were self-absorbed by 2 months later. The complication rate of group B was lower than the other 2 groups (P<2.6-4.0, P<0.01 and P<2.5-0.6, P<0.025). Follow-up in 88 patients (88/100) performed with venography with a median duration of 11.1±1.3 months (range, 7-24). The primary patency rate was 87.1% at 6 months, and the secondary patency at 12 months was 77.3% and 71.2% at 24 months. There were 78 patients without symptoms (swelling, pain) at follow-up, and 6 patients had mild edema, but their symptoms could be relieved by rest, and there were 5 patients who had no symptom relief. Venography was used at follow-up, and complete patency was found in 70 patients with normal valve function. Partial patency was found in 15 patients, and rethrombosis was found in 6 patients. Furthermore, 4 of these 6 rethrombosis patients within 2-3 months after CDT had iliac vein stenoses but without stent placement, and the other 2 suffered rethrombosis 3-5 months after CDT due to their not taking warfarin for at least 6 months.

Conclusions: Cather-directed thrombolysis through 3 different approaches was an effective method in treatment of acute deep venous thrombosis. Catheterization via the great saphenous vein in CDT therapy for acute DVT is feasible and has fewer complications.

Characterization of the Cephalic Arch and Location of Stenosis

S. J. Bennett, M. Hammes, T. Blicharski, S. Watson, B. Funaki

Purpose: The purpose of this study is to accurately characterize the cephalic arch segments into 4 domains and to enable more specific evaluation of cephalic arch stenosis (CAS) and to determine the frequency of stenosis in each domain.

Materials and Methods: After Institutional Review Board (IRB) approval, a retrospective chart review was done to define a population of patients receiving hemodialysis who developed CAS as apparent on clinically indicated radiologic imaging. A standardized approach was devised to categorize 4 domains of the cephalic arch (Figure). Domain I was defined as the peripheral portion of the arch and Domain IV as the terminal portion.

Conclusions: Standardized domains have been defined; future work will validate these findings and determine the best intervention for each domain.

Mechanical Thrombectomy of Extensive Iliocaval Thrombosis Using AngioVac Device

J. White, N. Ghodasara, A. Trebelev

Purpose: 1. To show a case of extensive iliocaval thrombosis after inferior vena cava (IVC) filter placement. 2. To describe the procedure of percutaneous therapy for clot removal using the AngioVac mechanical thrombectomy device (Angiodynamics, Latham, NY) as well as more conventional pharmacologic and mechanical therapies.

Materials and Methods: A single case of venous thrombosis with multiple diagnostic and interventional images is presented.

Results: The majority of the clot burden was removed using multiple endovascular techniques including AngioVac thrombectomy, angioplasty, stent placement, tpa injection, and arrow-ferotiosa maceration (Figures 1-3).

Conclusions: Extensive venous thrombosis can be managed with multiple endovascular techniques to optimize clot retrieval.

Nonconventional Techniques for Adherent Inferior Vena Cava Filter Retrieval

D. Semaan, A. Vyas, M. Warren, B. Puzsar, A. Harb

Purpose: Inferior vena cava (IVC) filter placement is a common procedure in many interventional departments. While deployment is moderately straightforward for most skilled interventionalists, there are numerous inherent short- and long-term risks extensively cited in the literature. Complications include the possibility that the filter becomes unretrievable, symptomatic filter-related caval thrombosis, chronic IVC occlusion, and bowel penetration. The Food and Drug Administration (FDA) has drawn attention to the need to follow patients and remove IVC filters as soon as clinically feasible, including data demonstrating potentially debilitating complications with long-term indwelling IVC filters, novel techniques must be employed when one encounters an adherent filter. In review of the literature, various
techniques have been used in removing adherent IVC filters. Those include snare-over-guidewire loop technique, caval recanalization, venoplasty, and laser-assisted retrieval.

**Conclusions:** Interventional radiologists must be evermore cognizant of potential risks of filter deployment, including the dreaded risk of caval adherence and potential alternative methods of filter retrieval. Although often the only viable treatment for deep venous thrombosis, IVC filter placement is not always a benign procedure. It carries risk to the patient both pre- and post-procedure, and all attempts should be made to have the filter removed when clinically feasible.

**Percutaneous Recovery of Port-a-Cath Catheter From the Right Ventricle**

A. Spinazzola, N. Cionfoli, A. Farina, L. V. Cireni, E. Orlandelli, K. Petsos

**Purpose:** A Port-a-Cath® (Smiths Medical, Dublin, OH) is a completely implantable system; it consists of a reservoir or chamber and a catheter linked by a connector. This device is most frequently used to deliver drugs or parenteral nutrition. It is placed under radiological control, usually with local anesthesia, after puncture of the subclavian vein. The most common complications are iatrogenic, infectious, or thrombotic disorders; problems related to poor maintenance or cleaning of the system; and rupture or detachment of the catheter from the reservoir.

**Materials and Methods:** Two women, both over 60 years old and free of cardiologic symptoms and both with chemotherapy-sensitive neoplasias, underwent placement of a Port-a-Cath-type central venous catheter (CVC) at different times. The first case was referred to us after about 1 month of treatment because of a subcutaneous collection of drug after an infusion into the reservoir; the second case was referred because the catheter broke during removal of the port, after 5 years of not having used the system. Subsequent chest x-rays revealed that the catheter was in the right half of the heart. Given the visual evidence, the patients underwent a percutaneous endovascular procedure to recover the foreign bodies. Following local anesthesia and the placement of a 8-F introducer through the right jugular vein, an Entrio™ snare recovery system (9×15 mm in 1 case and 9×15 mm-12×20 mm in the other) was used to retrieve the catheters (Hard, Tempe, AZ). In the case of the whole CVC, repeated attempts to extract the catheter led to its displacement in the superior vena cava, making its retrieval easier because the 2 systems were in the same axis. In the case of the CVC remnant, its position in the right ventricle and its entanglement necessitated recovery from the distal extremity.

**Results:** Neither patient had significant complications following the procedure and were, therefore, discharged after 2 days to continue treatment at home; the period spent in the hospital was largely dependent on the age of the women.

**Conclusions:** If a catheter breaks or migrates, it may be necessary to use interventions under radiological control or a thoracotomy with cardiopulmonary bypassing to retrieve the foreign body. Endovascular recovery of remnants using a gooseneck snare under angiographic control was easy to perform with minimal periprocedural complications and is currently the first choice of management of this complication of CVC use.

**Redefining Virchow’s Triad: Time for a Quartet? Central Iliac Vein Occlusive Disease**

K. E. Olah, M. Kobiana

**Purpose:** We reviewed patients with a history of provoked or unprovoked lower extremity deep venous thrombosis for presence of factors related to Virchow’s triad.

**Materials and Methods:** All patients presenting at our lower extremity swelling and lymphedema clinic with or without a history of deep venous thrombosis underwent an in-depth history including cardiovascular risk factors, long travel, trauma, sedentary lifestyle, and medications, and they were also evaluated for conditions of stasis, vascular trauma, hypercoagulable states, and family history. They subsequently underwent venous Doppler, superficial venous study, and computed tomography venography. Those that met criteria underwent an invasive venography and intravascular ultrasonography of the superficial femoral vein, common femoral vein, iliac veins, and the inferior vena cava and subsequent endovascular intervention. Patients have been followed for up to 1 year since. Images including venography and intravascular ultrasound were obtained. These images and images of the lower extremities before and after intervention were compared with evidence of significant reduction in swelling by measurement with tape measure at the thigh, calf, and ankle.

**Results:** 1) All patients had at least 2 factors of Virchow’s triad. 2) All patients had varying degrees of the post-thrombotic state. 3) All patients had significant iliac vein obstructive or occlusive disease, which was more extensive in patients with a history of deep venous thrombosis. 4) Post-thrombotic syndrome completely resolved on endovascular intervention to the deep pelvis veins. 5) Common factors included long-distance travel including flights and long automobile trips of over 2 hours and medical problems including hypertension, tobacco abuse, and diabetes mellitus type 2. Images including venography and intravascular ultrasound were reviewed (Figure 1). The images of the lower extremities (Figure 2) before and after intervention were compared with evidence of significant reduction in swelling by measurement with tape measure at the thigh, calf, and ankle.

**Conclusions:** In a large majority of patients with history of deep venous thrombosis, evidence of central iliac vein compression, obstruction, and occlusions are noted. The presence of these lesions provide all the classical factors known as Virchow’s triad (ie, vascular injury due to external compression and subsequent fibrosis as shown on intravascular ultrasound images). Stasis is secondary to central pelvis vein compressions and hypercoagulable state in the vicinity of the iliac or central vein occlusive disease.
We propose that a congenital or acquired May-Thurner syndrome-like physiology and pathology should be added to Virchow’s triad. It is time to consider a quartet.

Outcomes of Drug-Eluting Stents in the Endovascular Treatment of Transplant Renal Artery Stenosis


Purpose: Transplant renal artery stenosis (TRAS) is an important cause of allograft dysfunction, refractory hypertension, and inferior allograft. In this study, we evaluate the short- and long-term outcomes of the use of drug-eluting stents (DES) in the endovascular treatment of TRAS.

Materials and Methods: From April 1, 2004, to April 1, 2014, 53 patients with TRAS underwent 64 endovascular interventions (EVIs), of which 18 patients (54±13 years; 12 male, 6 female) underwent a total of 19 EVIs (16 primary, 3 secondary) with 23 DES ([18 everolimus-eluting; 5 zotarolimus-eluting]), (mean width, 3.8 mm [range, 3.5–4 mm]; length, 12.2 mm [range, 8–22 mm]). Patients were stratified according to demographics, co-morbidities, graft characteristics (deceased donor, 16; living donor, 2), pre-EVI biopsy results, and time to presentation. Short-term outcome variables included technical success, safety, creatinine (Cr) at 3 months, mean arterial pressure (MAP), and number of blood pressure medications (meds). Long-term outcome variables included primary patency and allograft survival.

Results: Overall technical success was 95% (primary, 94%; secondary, 100%) with an intraprocedural systolic pressure gradient reduction of 45±24 mmHg. One technical failure occurred secondary to anastomotic stenosis with post-DES systolic pressure gradient of >80 mmHg requiring open surgical intervention. There were no adverse events 30 days post-EVI. There were no improvements in allograft function and blood pressure control in all patients (pre-Cr, 3.0±1.1 mg/dL; post-Cr, 2.2±0.7 mg/dL; p=0.01; pre-MAP, 120±14 mmHg; post-MAP, 111±13 mmHg; p=0.005). Blood pressure medication quantities were not significantly changed (pre-meds, 2.5±1.3; post-meds, 2.3±1.0; p=0.27). An analysis of covariance found no significant differences in short-term outcomes in primary vs. secondary intervention (p-Cr=0.34, p-MAP=0.9, p-meds=0.9). Patients remained free from re-intervention for a median of 21.4 (4.8–29.5) months (Figure). There was 1 case of restenosis (intra-stent systolic gradient, 15 mmHg) secondary to stent kinking, which was re-stented with a larger DES. The median allograft survival time post-EVI was 22.2 (12.4–29.2) months.

Figure. Patency of drug-eluting stents in transplant renal artery stenosis.

Conclusions: Drug-eluting stents are a safe and effective treatment option in both primary and secondary TRAS with low rates of re-intervention.

Percutaneous Renal Artery Stenting After Prolonged Ischemia From Blunt Injury: Case and Pooled Cohort Analysis

K. Farsad, Y. J. Noudezh, Z. Ashwell

Purpose: Guidelines for time to revascularization of blunt renal arterial trauma are lacking. We report a case of delayed stenting of an occluded left renal artery 24 hours after retroperitoneal lymph node dissection. At 37 months follow-up, the patient remains normotensive with patency of the left renal artery stent. A pooled cohort analysis of percutaneous renal artery intervention for blunt trauma was performed using all available published cases in the literature.

Materials and Methods: We searched PubMed and CINAHL databases using the keywords (“renal artery” AND (“injury” OR “trauma”) AND (“percutaneous” OR “stenst” OR “angioplasty” OR “transluminal”)). Thirty-six relevant publications with at least 1 case of blunt renal artery trauma treated by stenting, angioplasty, or both were identified. Of these, 31 were case reports and 5 were retrospective case series. Data regarding age, gender, mechanism of trauma, time-to-intervention, method of endovascular intervention, post-intervention management, and follow-up were extracted. Post-intervention hypertension, serum creatinine rise, stent restenosis, or <25% activity in the treated kidney by split renal function were considered clinical failures. Data from all technically successful cases were analyzed for clinical success using the Chi2 test and univariable Cox proportional hazard models. Two-tailed p-value ≤0.05 was considered significant.

Results: A total of 35 cases of percutaneous intervention for blunt renal artery injury were reported in 36 articles (male:female ratio=2:1; median age=21 years; median follow-up=6 months). Median reported time to revascularization was 8.0 hours (range, 2 hours-25 days). Technical success rate was 89.1%, and clinical success rate was 74.5%. The majority of clinical failures (67%) occurred in the first month after intervention. Renal artery occlusion was significantly associated with clinical failure (43.5% vs. 8.0% for nonocclusive injuries; p=0.005), and post-intervention antplatelet use was significantly associated with clinical success (89.5% vs. 56.2%, p=0.050). On Cox proportional hazard modeling, time-to-revascularization was not a predictor of clinical failure in technically successful cases (HR=0.51, p=0.403); renal artery occlusion predicted a 12-fold higher frequency of clinical failure (HR=12.3), and post-procedure antplatelet use predicted a nearly 80% lower frequency of clinical failure (HR=0.21).

Conclusions: Time-to-revascularization was not a predictor of clinical failure in patients with blunt renal artery injury who underwent percutaneous revascularization. Renal artery occlusion at the time of intervention was associated with higher rates of clinical failure, while post-intervention antplatelet therapy was associated with higher rates of clinical success. These findings could be important in designing future guidelines for percutaneous revascularization of blunt renal arterial injury.

The Role for Computed Tomography Angiography in the Workup of Lower Gastrointestinal Bleeding: Case Reports of Atypical Bleeding Sources

G. Rapp, B. Khalsa, C. Green, D. Fernando, M. Krishnam

Purpose: Acute lower gastrointestinal bleeding (LGIB) is a relatively common entity that frequently involves the diagnostic and interventional radiologist in the management of the disease. Radionuclide imaging, computed tomography (CT), and catheter angiography are the modalities available to the radiologist with variably reported sensitivities and specificities for identifying GI bleeding sources. Tagged red blood cell (RBC) radionuclide scans offer high sensitivity for detecting GI bleeding, and catheter angiography allows for both diagnosis and treatment; however, multi-phase CT angiography provides localization of GI bleeding in addition to important anatomical detail that the other 2 modalities lack. Given the high mortality that is associated with acute LGIB, a thorough, rapid, readily available test is paramount to the workup of this disease.

Materials and Methods: We present 2 unique cases of acute LGIB at our institution for which the Interventional Radiology service was consulted for diagnosis and management and who underwent CT angiography as part of their workup. The pertinent clinical findings, imaging, and interventions were reviewed.

Results: The first patient is a 58-year-old female who presented with intermittent acute LGIB. Before consultation of the IR service, the patient underwent esophageogastroduodenoscopy (EGD), colonoscopy, and tagged RBC radionuclide scan, all of which demonstrated no active bleeding. Given the patient’s tenous hemodynamic status, she was taken for catheter angiography with selective angiography performed of the celiac artery, superior mesenteric artery, and inferior mesenteric artery with no bleeding source identified. A CT angiogram was then performed, which showed an atrophic pancreatic transplant with a pseudoaneurysm at the right common iliac artery anastomosis with extravasation into the bowel via the pancreatic duct anastomosis. A catheter angiogram of the right common iliac artery was performed, and the pseudoaneurysm was successfully excluded with no further LGIB. The second patient is a 32-year-old male who presented with acute LGIB. Tagged RBC radionuclide scan revealed active bleeding in the left upper quadrant consistent with a jejunal source. Colonoscopy and EGD were performed with no bleeding source identified. A CT angiogram was performed, which showed a vascular nidus/mass at the jejunum. The patient was taken to the operating department for resection with pathology returning a diagnosis of gastrointestinal stromal tumor. The patient had no further LGIB.

Conclusions: Multiphasic CT angiography is a useful tool in the workup of acute LGIB. In the cases in which we used this modality, a rapid and accurate diagnosis was obtained allowing appropriate and definitive management of the bleeding sources. Though the majority of acute lower GI bleeds can be attributed to diverticular disease and angiodyplasia, it is prudent for the radiologist to consider other sources, and CT angiography is a useful, readily available tool that should be considered in the workup and management of acute LGIB.

Inferior Vena Cava Filters That Give You Jitters

T. Rana

Purpose: In spite of the lack of any clear guidelines for the use of inferior vena cava (IVC) filters and only limited indications agreed upon universally, there is also
significant variation in the interpretation of the published literature by different professional groups. Use of IVC filters has increased over the years. There is also significant variation in the use as roughly more than 250,000 filters were expected to have been placed in the U.S. in 2012 as compared with 1255 filters in the British Society of Interventional Radiology registry in the U.K. Because of widespread use of optional IVC filters and lax indication, many patients’ IVC filters placed for temporary indications are lost to follow-up and not retrieved. In August 2010, the Food and Drug Administration issued a Medical Device Safety Alert, which noted an increasing number of reported device-related adverse events. Most of these were related to device migration and possibly delayed retrieval.

Materials and Methods: At the section of interventional radiology at King Faisal Specialist Hospital and Research Centre in Riyadh, Saudi Arabia, IVC filter placement has been a conservative process with filters being placed for very definite reasons. We have placed 270 filters in the last 3 years. In spite of not having a large number to follow-up, we have had our share of unfortunate events with IVC filters.

Results: We wish to present a pictorial review of problems and complications in relation to the IVC filters mostly placed for temporary indications. These include nonretrieval, thrombosis, mal-rotation, significant tilt, caval wall perforation, filter damage during retrieval, filter migration, and misplaced filters.

Conclusions: The purpose of this presentation is to highlight the problems associated with the apparently innocuous procedure having been performed to prevent a disaster. If properly understood, the indications may be reevaluated to prevent complications and to improve patient care.

Design of the Cook Inferior Vena Cava Filter Investigational Device Exemption Study

H. B. Smouse, R. J. Feezor, J. A. McCann-Brown

Purpose: The Cook inferior vena cava (IVC) study is intended to further evaluate the safety and effectiveness of Cook’s Günther Tulip® and Celect® filters (Cook Medical, Bloomington, IN) in patients in need of IVC filter placement for the prevention of pulmonary embolism (PE).

Materials and Methods: This prospective, global, single-arm study will enroll patients in 2 strata: 320 patients in the Celect filter stratum and up to 150 patients in the Günther Tulip filter stratum. Consistent with current clinical practice, patients at risk for PE for a variety of clinical reasons will receive IVC filters, and filters may be retrieved when clinically indicated. Following filter placement, patients will be followed until 3 months after filter retrieval or for 2 years while a filter is indwelling. During follow-up, patients will undergo duplex ultrasound, x-ray, and computed tomography imaging as part of the study assessments. The primary effectiveness endpoint is the rate of technical placement success and 12-month freedom from new symptomatic PE while a filter is indwelling. The primary safety endpoint is the rate of 12-month freedom from major adverse events, defined as clinical perforation, clinical migration, clinical fracture, embolization to the heart or lungs, IVC thrombotic occlusion, new deep vein thrombosis while a filter is indwelling, access site complications with clinical sequelae, and procedure-/device-related death.

Results: Study progress to date will be presented.

Conclusions: The IVC investigational device exemption study will further evaluate the Günther Tulip and Celect filters and will also provide additional safety and efficacy information to the Food and Drug Administration.

Use of Popliteal-Access Permanent retrievable Inferior Vena Cava Filters: Institutional Experience

G. J. O’Sullivan

Purpose: To describe a new technique of inferior vena cava (IVC) filter placement using a dedicated popliteal access filter. During venous thrombolysis procedures, if a filter is required, this means another venous puncture is needed to place it; either a 7-10F hole is made in the jugular/femoral/brachial vein (which then bleeds) or else a sheath is left in for the duration of thrombolysis. Neither are satisfactory; use of a popliteal route minimizes access-site issues.

Materials and Methods: Six patients undergoing venous thrombolysis/thrombectomy and considered at high risk of pulmonary embolism had a permanent retrievable IVC filter (popliteal ALN filter; ALN, Ghisonaccia, France) placed through the popliteal access site. Filter position and orientation at the time of insertion was assessed using standard anterior-posterior and lateral imaging. Subsequently, IVC filter removal through a jugular access at 6-8 weeks was performed; filter orientation and position were once again assessed.

Results: The filters showed no significant angulation nor movement when compared with the initial deployment. Removal was swift (skin to skin 248±81 s) and uneventful in each case.

Conclusions: Popliteal-route IVC filter placement is technically feasible and enables 1 fewer access site to be used, which is helpful when prolonged catheter-directed thrombolysis is being carried out.

Embolic Particle Volume as a Predictor of Post-Procedural Pain Following Uterine Fibroid Embolization

D. Semaan, M. Warren, A. Vyas, M. Hallemarian, L. Vance

Purpose: Uterine artery embolization (UAE) is a widely accepted, minimally invasive means of treating symptomatic uterine fibroids, often foregoing the need for a more invasive conventional hysterectomy. Post-procedural pelvic pain is the most commonly encountered, yet least predictable, complaint following UAE. There have been multiple attempts to correlate various technical factors with post-procedural pain; however, determinants of post-embolization pain remain mostly elusive. The purpose of this study is to evaluate the volume of embolic particles administered can be used to predict post-procedural pain reported by the patient.

Materials and Methods: This is a dual-center, retrospective analysis wherein medical records and imaging from all UAES performed from September 1, 2008, to July 1, 2014, were reviewed, totaling 147 patients. The overall amount of embolic particles (in cubic centimeters) and pain assessment by average numerical rating scale (NRS) during post-procedural hospitalization were recorded. A regression analysis was performed to assess the relationship between the volume of embolic particles and post-embolization pain.

Results: We found no statistical correlation between the volume of embolic particles used during the procedure and the average NRS pain score reported by the patient (p=0.74). The average NRS pain score reported by the patient markedly varied and was unpredictable.

Conclusions: Determining post-procedural pain following UAE based on various pre- and post-procedural factors has been elusive to many, as evidenced by this and multiple other studies. This study showed no statistical correlation between the volume of embolic particles used and post-procedural pain. This analysis strengthens similar conclusions from previously published studies.

Magnetic Resonance Imaging-Guided Breast Biopsy: Conceptual Overview

M. Iqbal, S. Iqbal, C. Muguire, L. May, A. Zuberi

Purpose: To review clinical indications for magnetic resonance imaging (MRI)-guided biopsy of ultrasound (US)-occult breast lesions and to present a pictorial step-by-step approach to performing this procedure.

Materials and Methods: We will present a pictorial step-by-step approach to performing MRI-guided breast biopsy. More specifically, the grid method approach will be discussed in detail. Advantages and disadvantages of the less popular pilar method are also included.

Results: Many US-occult lesions are often easily identified on MRI. An increased understanding and awareness of diagnostic tests such as various MRI-guided breast techniques can improve diagnostic yield and accuracy, particularly for lesions not easily identified on ultrasound. Precise targeting of breast lesions using MRI guidance can facilitate a timely diagnosis and treatment plan, thereby decreasing morbidity and hospital cost.

Conclusions: The MRI-guided breast biopsy technique is a relatively easy procedure to perform. Many indications exist for MRI breast imaging. The increasing use of MRI breast imaging has increased the frequency of lesions identifiable only using the MRI technique. Interventional radiologists and general radiologists alike should be aware of the various techniques targeting US-occult breast masses.

Pelvic Congestion Syndrome: Review of Treatment Success

M. Rizer, R. Alexander, R. Beasley

Purpose: Chronic pelvic pain may account for up to 15% of gynecologic outpatient visits in the United States. Over the last 60 years the association with pelvic varices has been established as a cause of what is now referred to as pelvic congestion syndrome (PCS). Pelvic congestion syndrome is a challenging condition to diagnose and involves a multidisciplinary approach. The condition can mimic a variety of pathology and requires an evaluation including pelvic and abdominal examination, pap smear test, ultrasound, and cross-sectional imaging. When other pathology is excluded, interventional radiology plays a pivotal role in diagnosis and treatment including the use of magnetic resonance imaging, diagnostic venograms, and varicose embolization. We review the literature concerning the use of venous embolization for treatment of PCS.

Materials and Methods: An extensive review of literature using PubMed, Google Scholar, and Florida International University Medical Library was performed. All published articles since 1974 were identified using the following key words: “pelvic congestion syndrome”, “pelvic varices”, “ovarian vein embolotherapy.”

Results: We identified more than 60 articles, 25 of which involved treatment of PCS for a total of 1002 patients. Twenty-one of these studies (for a total of 927 patients) involved interventional treatment including venous sclerotherapy and coil embolization. The remaining 4 studies involved surgical treatment including transeptal vein ligation or resection. Improvement of clinical symptoms after interventional or surgical treatment ranged from 48%-100% throughout the studies (Table), with a calculated overall success rate of 76.7% for interventional treatment. The rate of recurrence was calculated to be 0.014%. Complications included 9 incidents of clot/agent migration, 2 incidents of contrast media reaction, 1 groin hematoma, and 1 extravasation of contrast, for a total complication rate of 0.016%.

Conclusions: Treatment of PCS with pelvic venous embolization and sclerotherapy has been shown to be effective. Our extensive review of studies demonstrates
### Table. Data From 25 Studies Involving Treatment of Pelvic Congestion Syndrome

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>Patients</th>
<th>Procedure</th>
<th>Complications</th>
<th>Improvement of clinical symptoms (%)</th>
<th>Patients with improvement of clinical symptoms (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interventional procedure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Edwards (1993)</td>
<td>1</td>
<td>Coil embolization</td>
<td>None</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>Sichlau (1994)</td>
<td>3</td>
<td>Coil embolization</td>
<td>1 recurrence</td>
<td>67%</td>
<td>2</td>
</tr>
<tr>
<td>Chilla (1994)</td>
<td>1</td>
<td>Coil embolization and sclerotherapy</td>
<td>None</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>Capasso (1997)</td>
<td>19</td>
<td>Coil embolization</td>
<td>None</td>
<td>73.7%</td>
<td>14</td>
</tr>
<tr>
<td>Cordts (1998)</td>
<td>9</td>
<td>Coil embolization and gelatin sclerotherapy</td>
<td>2 recurrences</td>
<td>88.9%</td>
<td>8</td>
</tr>
<tr>
<td>Maleux (2000)</td>
<td>41</td>
<td>Sclerotherapy</td>
<td>Glue agent migration</td>
<td>58.5%</td>
<td>24</td>
</tr>
<tr>
<td>Venbrux (2002)</td>
<td>56</td>
<td>Sclerotherapy</td>
<td>Coil migration, 3 recurrences</td>
<td>65%</td>
<td>36.4</td>
</tr>
<tr>
<td>Scultetus (2002)</td>
<td>57</td>
<td>Coil embolization, sclerotherapy, phlebectomy</td>
<td>None</td>
<td>75.4%</td>
<td>43</td>
</tr>
<tr>
<td>Pieri (2003)</td>
<td>33</td>
<td>Sclerotherapy</td>
<td>None</td>
<td>61%</td>
<td>20</td>
</tr>
<tr>
<td>Chung (2003)</td>
<td>52</td>
<td>Coil embolization</td>
<td>2 coil embolizations, to pulmonary and renal vein</td>
<td>100%</td>
<td>52</td>
</tr>
<tr>
<td>Kim (2006)</td>
<td>127</td>
<td>Coil embolization and sclerotherapy</td>
<td>7 recurrences</td>
<td>83%</td>
<td>105.4</td>
</tr>
<tr>
<td>Mavili (2006)</td>
<td>1</td>
<td>Coil embolization</td>
<td>None</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>Kwon</td>
<td>64</td>
<td>Coil embolization</td>
<td>None</td>
<td>82%</td>
<td>52.5</td>
</tr>
<tr>
<td>Creton (2007)</td>
<td>24</td>
<td>Coil embolization and phlebectomy</td>
<td>1 recurrence, coil migration</td>
<td>76%</td>
<td>18.2</td>
</tr>
<tr>
<td>Asciutto (2009)</td>
<td>35</td>
<td>Coil embolization</td>
<td>None</td>
<td>47%</td>
<td>16.5</td>
</tr>
<tr>
<td>Castenmiller (2013)</td>
<td>43</td>
<td>Coil embolization</td>
<td>None</td>
<td>88%</td>
<td>32.8</td>
</tr>
<tr>
<td>Hoquelet (2013)</td>
<td>33</td>
<td>Coil embolization</td>
<td>Failure to catheterize</td>
<td>64%</td>
<td>21.12</td>
</tr>
<tr>
<td>Laborda (2013)</td>
<td>202</td>
<td>Coil embolization</td>
<td>Groin hematoma, coil migration, contrast media reaction</td>
<td>93.9%</td>
<td>189.7</td>
</tr>
<tr>
<td>Neimark (2012)</td>
<td>16</td>
<td>Coil embolization and sclerotherapy</td>
<td>None</td>
<td>86%</td>
<td>13.8</td>
</tr>
<tr>
<td>Meneses (2013)</td>
<td>10</td>
<td>Coil embolization and sclerotherapy</td>
<td>None</td>
<td>100%</td>
<td>1</td>
</tr>
<tr>
<td>Nasser (2014)</td>
<td>100</td>
<td>Coil embolization</td>
<td>4 cases of coil migration, 1 contrast allergy, 1 extravasation of contrast</td>
<td>53%</td>
<td>53</td>
</tr>
<tr>
<td><strong>Total number of patients</strong></td>
<td>927</td>
<td></td>
<td></td>
<td></td>
<td>711.42</td>
</tr>
<tr>
<td><strong>Surgical procedure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rundqvist (1984)</td>
<td>15</td>
<td>Extraperitoneal resection of left ovarian vein</td>
<td>Wound infection, bleeding</td>
<td>73.3%</td>
<td></td>
</tr>
<tr>
<td>Beard (1991)</td>
<td>36</td>
<td>Bilateral oophorectomy and hysterectomy</td>
<td>Infertility</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>Mathis (1995)</td>
<td>1</td>
<td>Transperitoneal laparoscopic ovarian vein ligation</td>
<td>None</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Gargiulo (2003)</td>
<td>23</td>
<td>Transperitoneal laparoscopic ovarian vein ligation</td>
<td>Hematoma</td>
<td>74%</td>
<td></td>
</tr>
</tbody>
</table>
significant resolution of symptoms with minor rates of recurrence and complications such as coil migration. Rates of recurrence or partial response to therapy may be related to patient anatomy, technique, severity of disease, as well as unaccounted multifactorial pathology.

Pancreaticoduodenal Artery Aneurysms: A Unique Cause of Retroperitoneal Hemorrhage

M. Bozza, A. Malamis

Purpose: Review of the current literature on pancreaticoduodenal arcade (PDA) aneurysms including anatomy, clinical presentation, diagnosis, pathophysiology, and treatment options.

Materials and Methods: Pancreaticoduodenal aneurysms are rare, accounting for only ~2% of visceral aneurysms. Although symptoms are often vague or nonexistent, spontaneous rupture can lead to hemorrhagic shock and death, most commonly due to retroperitoneal hemorrhage. We present 2 cases of PDA aneurysms at our institution that were emergently treated with an endovascular approach. Pancreaticoduodenal pseudoaneurysms are most common, while true aneurysms are rare and are often related to celiac artery stenosis. A hemodynamically significant stenosis of the celiac axis causes increased blood flow in the peripancreatic arterial network through the superior mesenteric artery (SMA). This provides collateral supply for revascularization of the celiac trunk, thereby dilating the vascular walls, promoting aneurysm formation. While these aneurysms are most often asymptomatic, they have a high propensity to rupture.

Results: We report 2 cases of sudden-onset abdominal pain and retroperitoneal hemorrhage. Mesenteric angiograms were performed demonstrating celiac trunk stenosis with a dense network of hypertrophied collaterals from the SMA supplying the ruptured aneurysms, as well as the collateral flow to the celiac trunk. One case was due to median arcuate ligament syndrome, and the other due to atherosclerosis. The patients were successfully treated with coil embolization, and their post-procedure courses were uneventful.

Conclusions: The current management of PDA aneurysms is multifactorial and ranges from no treatment to surgical repair. Interventional Radiology provides a minimally invasive endovascular therapy, which is the preferred treatment according to current literature, and in some cases, the only treatment. Treatment of the celiac artery stenosis depends on the etiology of the stenosis and has no formal guidelines. In 1 of our cases, surgical decompression of the median arcuate ligament could prove beneficial by preventing the risk for further aneurysm formation. Rapid diagnosis and treatment of PDA aneurysms can lead to decreased mortality and morbidity.