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001 Peripheral Aneurysm Coiling Using Large-Volume Ruby™ Coils: Results from the Multicenter Aneurysm Coiling Efficiency Trial


Purpose: The Aneurysm Coiling Efficiency (ACE) trial aimed to demonstrate the safety and efficacy of soft, large-volume, bare platinum Ruby Coils (Penumbra Inc, Alameda, CA) in achieving high packing density, leading to complete aneurysm obliteration and stable vessel embolization.

Materials and Methods: The ACE trial was a prospective, multicenter study designed to capture data on the safety and efficacy of large volume coils in the peripheral vascular embolizations. Patients were identified from 15 centers between March 2012 and December 2016. Patients within the ACE registry were categorized into aneurysm embolization or vessel sacrifice subgroups. Primary outcomes included packing density with the number of coils implanted, time of fluoroscopic exposure, procedural device-related serious adverse events (SAEs), and occlusion status at 6 months with an optional 1-year outcome.

Results: A total of 78 cases were treated in 67 patients with peripheral aneurysms or malformations. The median age was 59 years (Interquartile Range (IQR) 48–71); 44.8% were female. In cases involving aneurysms (n = 26), a median of 6.5 coils (IQR 4–14) was deployed, achieving a median packing density of 26.8% (IQR 18.6–33.0) per case. Median fluoroscopy time was 29.0 minutes (IQR 21–36). At the 6-month follow-up, 90.9% (20 of 22) of cases had achieved stable or better occlusion grade compared with postprocedure and 100.0% (15 of 15) at the 1-year follow-up. No aneurysms were retreated during the follow-up period.

In 52 procedures, vessel sacrifice or treatment of miscellaneous malformations was performed. A median of three coils (IQR 2-5) were placed in a median of 21.5 minutes (IQR 15–29) under fluoroscopy. At 6-month and 1-year follow-up, a total of 91.7% (22 of 24) and 100.0% (3 of 3) cases have demonstrated stable or better occlusion grade than postprocedure, respectively. Two lesions were retreated at 1-year follow-up.
Common sites for embolization of this trial included were pulmonary \((n = 5)\), splenic \((n = 18)\), and gastroduodenal artery \((GDA, n = 10)\). Compared with GDA patients in Maleux’s study \((1)\) wherein fibered \((n = 15; \text{mean } \pm \text{ standard deviation [SD] } = 13.3 \pm 5.2; P = <0.0001)\) and Hydrogel-coated coil technology \((n = 13; \text{mean } \pm \text{ SD } = 3.9 \pm 1.5; P = 0.0134)\) were used, significantly fewer Ruby Coils were required to embolize the GDA. Only, \(4.5\% \ (3/67)\) of patients reported serious adverse events within 24 hours postprocedure; none were device related.

**Conclusions:** The Ruby Coil System efficiently achieves high packing density and stable occlusion in peripheral aneurysm embolization and vessel sacrifice. The six month and one-year follow-up supported the long-term embolization stability in both cohorts.
Submassive and Massive Pulmonary Embolus: Catheter-Directed Intervention versus Medical Management?

C. T. Hennemeyer, G. J. Woodhead, A. H. Shah, S. Sakla, C. Q. Moffett, S. Black

**Purpose:** To use retrospective analysis of right heart strain measures before and after catheter-directed intervention in massive and submassive pulmonary embolus (PE) and compare outcomes with matched control participants

New tools for catheter intervention allow for combination mechanical and chemical lytic therapy for massive and submassive PE. The authors hypothesize that when used in combination, clot aspiration devices and catheter-directed lytics substantially improve measures of right heart strain compared with standard medical management. Furthermore, timely catheter-based intervention on massive and submassive PE may provide a foundation for altering the course of pulmonary thromboembolic disease.

**Materials and Methods:** A retrospective study was approved by the institutional review board to investigate patient outcomes after catheter-based therapies comparing them with control participants. In the treatment group were 25 patients who underwent catheter-based therapy consisting of single or combination mechanical and chemical lytic therapy. A control group of 25 patients who were diagnosed with PE during the same time period was matched for relative clot burden, similar severity of disease (right ventricular–to–left ventricular [RV-to-LV] ratios), age, preexisting chronic obstructive pulmonary disease, and other pertinent risk factors. Control patients received standard of care medical management, including systemic anticoagulation only. All available pre- and postprocedural cardiac imaging, including CTA, and echocardiography were gathered and used to assess RV-to-LV ratios, as an indirect measure of right ventricular strain. Two blinded, fellowship-trained Cardiothoracic Imaging physicians (each with greater than 7 years of experience) evaluated the pre- and posttreatment computed tomography angiography (CTA) and echocardiography images. These blinded physicians acquired RV-to-LV measurements from diagnostic CTA and echocardiographic images at all time points according to established methods. Measurements of RV and LV diameters pre- and posttherapy, as well as assessment of clot burden and location were recorded in an anonymized data table.

**Results:** Over a period of approximately 1 year, 25 patients at a single institution underwent catheter-based thrombolysis of submassive and massive PE. Two devices were used, either alone or in combination: (1) Indigo Mechanical Thrombectomy System (Penumbra, Alameda, CA) and (2) EKOS Acoustic Pulse
Thrombolysis (BTG, London, United Kingdom). The total dose of administered tissue plasminogen activator was roughly uniform in both catheter-directed treatment groups, averaging 28 mg, and was administered either as a single bolus or as 12- to 24-hour infusion (average, 22 hours). Average preprocedure diagnosis was 1 day. Postprocedure imaging was performed at 48 hours after the initiation of medical management and systemic anticoagulation or after IR catheter-directed therapy (average postprocedure follow-up time-point, 1.8 days). Measurements of RV-to-LV ratios between the catheter-directed thrombolysis and medical management groups before and after therapy demonstrated a statistically significant reduction in RV strain, as measured by a change in RV-to-LV ratio. Specifically, the catheter-based group demonstrated an improvement in average RV-to-LV ratio of 25% at 48 hours ($P <0.05$) versus the medical management group, which showed a slight average increase in this ratio (7%; $P <0.1$). No adverse events were reported in either group.

**Conclusions:** Catheter-based management of massive and submassive PE shows improved RV-to-LV ratio, an indirect measurement of right heart strain, compared with medical management alone. A combination of widely available catheter-based devices, either mechanical aspiration or ultrasound-enhanced thrombolysis may be used in management of intermediate- and high-risk PE patients safely. If widely available, catheter-based therapy stands also to change the practices of interventional radiology physicians. The importance of catheter treatment could approach that of other cardiac emergencies such as ST elevation myocardial infarction, creating the expectation to provide emergent or semi-emergent response.

Although RV-to-LV ratios are a useful and a widely available indicators of short-term right heart strain, better measures of cardiac strain and total pulmonary vascular reserve are needed to more precisely measure the long-term impact invasive therapy and to understand the impact on disease progression to chronic pulmonary hypertension.
XTRACT as a Potential Frontline Treatment in Peripheral Arterial Thromboembolism: Results from the PRISM Trial


Purpose: The purpose of the trial was to examine the safety and clinical efficacy of XTRACT in a patient population with peripheral arterial occlusion. We report the outcome of the PRISM trial on the use of Penumbra/Indigo System as an initial and secondary approach for peripheral revascularization.

Materials and Methods: The PRISM trial is a single-arm, multicenter, and retrospective analysis of enrolled consecutive patients meeting the inclusion criteria of peripheral arterial occlusion (Thrombolysis in Myocardial Infarction [TIMI] 0–1) before treatment with the Penumbra/Indigo System. The primary endpoints were vessel patency immediately postprocedure as measured by TIMI scores, and the rate of serious adverse events (SAEs) within 24 hours of treatment with the study device.

Results: PRISM concluded with 79 patients enrolled. XTRACT was the primary treatment modality for 39 patients (49.4%); the remaining 40 patients (50.6%) were treated with XTRACT secondary to failure from CDT, other endovascular therapies, and distal emboli from preceding interventions. As the primary intervention, XTRACT was successful in 79.5% (31 of 39) of patients; as secondary therapy, 92.5% (37 of 40) of patients were successfully revascularized with XTRACT to TIMI 2–3. Overall, vessel patency (TIMI 2–3) was achieved in 87.2% (68/78) immediately after XTRACT and in 96.2% (76/79) of patients after additional adjunctive interventions. Procedural SAEs were reported in five patients (6.3%); none were device related.

Conclusions: Thrombectomy using XTRACT was safe and effective as both primary and secondary intervention in patients with peripheral arterial occlusions.
M. D. Dake, MD

**Purpose:** The safety and effectiveness of this bioconvertible Sentry inferior vena cava filters (IVCFs) were assessed in patients requiring temporary protection against pulmonary embolism (PE). The Sentry filter is designed to provide filtration for a 60-day period of transient PE risk and then open (bioconvert) to a nonfiltering configuration, obviating typical filter-related complications and with no requirement to retrieve the device.

**Materials and Methods:** At 23 clinical sites, 129 patients were enrolled with documented deep vein thrombosis (DVT) or PE or at temporary risk of developing DVT or PE and unable to use anticoagulation. The primary endpoint was clinical success at 6 months, including technical success of filter deployment, freedom from symptomatic PE through 60 days before filter bioconversion, and 6-month freedom from filter-related complications. Patients were extensively monitored by radiography, computed tomography (CT), and CT venography at prespecified time points, including filtering configuration through 60 days, filter bioconversion after 60 days, and PE and filter-related complications through 6 and 12-months.

**Results:** The primary endpoint of clinical success at 6 months was achieved in 111 of 114 evaluable patients (97.4%, 95% confidence interval 92.5%–99.1%). A Sentry device was successfully deployed in all patients. The rate of symptomatic PE was 0% through 60 days (0 of 129), 6 months (0 of 126), and 12 months (0 of 117). The rate of symptomatic filter-related complications was 1.6% (2 of 129) through 12 months. During the first month, 2 patients developed symptomatic caval thrombosis, experiencing no recurrence after successful interventions. Through 12 months, there were no instances of filter tilting, migration, embolization, fracture, or perforation, and there were no filter-related deaths. The rates of successful filter bioconversion were 95.7% (110 of 115) at 6 months and 96.4% (106 of 110) at 12 months.

**Conclusions:** The results of this pivotal multicenter trial demonstrate that this next-generation, bioconvertible IVCF provided safe and effective protection against PE during the 60-day period of risk. The Sentry device had a very high rate of intended bioconversion, an unprecedentedly low rate of device-related complications through 12 months of imaging-intensive follow-up, and a noteworthy 0% symptomatic PE rate at every follow-up time point to 1 year.
Clinical Outcomes and Debris Capture Analysis Using a Novel Filter During Atherectomy: WISE LE Study


Purpose: The WISE LE study was designed to demonstrate the performance of the WIRION Embolic Protection System (EPS) in subjects undergoing lower extremity atherectomy for the treatment of peripheral arterial disease (PAD). The study includes a histopathologic analysis of debris captured by the filter during the procedures.

Materials and Methods: WIRION is a distal EPS consisting of an independent modular filter unit with a proprietary locking mechanism mounted on a rapid exchange delivery system that can be attached in any location along any 0.014-inch guidewire through a 6-Fr or larger guiding catheter. The filter is compatible with arterial diameters of 3.5 to 6 mm.

The WISE LE is a multicenter study, performed in the United States and Germany, on patients with PAD who are undergoing atherectomy with the use of the WIRION EPS in the femoropopliteal arteries. The primary endpoint is a composite of MAEs occurring within 30 days postprocedure, which is compared with an objective performance goal derived from historical atherectomy data. The secondary endpoints include device and clinical success and evaluation of the debris in the filter.

Adverse events were adjudicated by an independent Clinical Event Committee. All filters were sent to an independent lab (NAMSA) for quantification and histology analysis of any captured debris.

Results: The study protocol specified enrollment of 153 patients with the primary endpoint successfully met if 18 (12.0%) or fewer MAEs occurred according to CEC adjudication. An interim analysis was performed in 103 patients, and the study was stopped for success at the interim given a single MAE.

The histopathologic analysis showed that the WIRION captured small-sized thrombi (<1 mm) in 97% of patients analyzed. Larger thrombi ranged 1 to 2 mm (20% of patients) or even larger (>2 mm) were captured in 14% of patients as well. In general, the thrombi exhibited presence fibrin material admixed with fibrous fragments along with some red blood cells and leukocytes. From 66% of patients, signs of microcalcification of the thrombi were detected.
**Conclusions:** The study was designed to demonstrate the successful and effective use of the WIRION filter with all atherectomy systems used in the study including directional, rotational, orbital, and LASER systems. The WIRION was demonstrated to be safe, easy-to-use device that can be used with all atherectomy system. Debris was captured in 97% of cases with larger than 1-mm debris in 20% of cases, demonstrating the highly clinical importance of using EPS during atherectomy in PAD.
007 Atherectomy Devices for Peripheral Arterial Disease: Review of Current Device Data

M. Liao, C. Molloy, C. Lam

Purpose: Understand atherectomy indications and contraindications in peripheral artery disease (PAD). Review current data regarding atherectomy devices.

Materials and Methods: PAD affects more than 2 million Americans. Atherectomy is an adjunctive endovascular technique to reduce plaque burden in PAD patients. This review discusses current data available for atherectomy devices.

Results: Current designs include directional, rotational, laser, and orbital atherectomy devices. Directional atherectomy devices (SilverHawk, TurboHawk, and HawkOne) enable different excisional planes by rotating the device. The DEFINITIVE LE study demonstrated 78% primary 1-year patency using SilverHawk; 33% received postatherectomy percutaneous transluminal angioplasty (PTA) and 3.2% stenting. The newest HawkOne device targets lesions with different morphologies, including thrombus. Neointimal hyperplasia and restenosis from arterial wall injury inspired development of Pantheris, a directional device with optical coherence tomography, currently undergoing the VISION trial.

Rotational devices (Rotablator, Jetstream, and Phoenix) require no distal embolic protection because debris is small. The ERBAC study demonstrated higher target lesion revascularization rates with rotational atherectomy (42.4%) and excimer laser (46.0%) when compared with angioplasty (31.9%). Excimer laser devices (Turbo Elite, Turbo-Tandem, and Turbo-Booster) use high-energy, monochromatic light to dissolve plaque. EXCITE ISR demonstrated that 6-month patency rates are higher with laser and PTA (73.5%) versus PTA only (51.8%). Orbital atherectomy systems (OAS) (Diamondback 360 and CSI Stealth 360) eccentrically sand plaque. New low-profile models (4 Fr) are more flexible, navigating highly tortuous calcified lesions. The CONFIRM registry reports lowered stenosis from 88% to ~10% with PTA and OAS. LIBERTY 360 (30-day results) demonstrated 90.7% freedom from major adverse events.

Conclusions: A wide array of atherectomy devices are available for the treatment of PAD patients. This review provides data supported guidance regarding which specific atherectomy devices are best equipped based on lesion specific morphology and characteristics.
Eighteen-Month Personnel Monitoring Dosimetry Results Using a Suspended Radiation Protection System with Face Shield

A. Lichliter, B. Yoder, C. Rees

Purpose: To determine the radiation doses at the waist and eye for an interventionalist performing a wide variety of procedures over an extended period using the suspended protection system (SPS) (Zero-Gravity™, TIDI Products, Neenah, WI)

Materials and Methods: One interventionalist wore two personnel monitoring dosimeter badges (optical stimulating luminescence, Luxel+, Landauer, Glenwood, IL), one at the front waist and one on the cap near the left eye, when performing procedures using SPS. The SPS includes a 0.5-mm Pb-acrylic face shield encompassing an arc in the front and to the sides of the operator and a 1-mm Pb apron. Reports for 18 consecutive months were retrospectively reviewed, along with corresponding technical information for same procedures, including fluoroscopy minutes, total patient dose-area-product (DAP), and fluoroscopic DAP. Background controls were subtracted out by the manufacturer using standard industry method. Data for the substantially fewer procedures in which the operator used a standard lead apron and different dosimeters is not included in this study.

Results: A total of 299 procedures were performed, including vascular and nonvascular interventions of the chest, abdomen, pelvis, and extremities (e.g., chemo- and radioembolization, transjugular intrahepatic portosystemic shunt, genitourinary and biliary interventions, others). The total deep dose equivalent (DDE) over 18 months were 0 mRem for the waist and 11 mRem (0.11 mSv) for the eye. The lens dose equivalent (LDE) was 11 mRem (0.11 mSv). Eye DDE is relevant to the brain. The average annual background exposure is 320 mRem (3200 μSv) or 80 mRem (800 μSv) without radon. This is compared with annualized left eye exposure of a practicing interventionalist using SPS in this study of 7.33 mRem (73.3 μSv). The annual occupational exposure limits to the lens of the eye are 15,000 mRem in the United States and 2000 mRem in Europe.

Conclusions: Eye exposures during clinical practice using the SPS were exceedingly low in this study, far lower than reports of mobile shields, and represent a 9% increase above background without radon. Waist dose was not detectable.
009 Early Clinical Results Using the FLEX Scoring Catheter in 100 Femoropopliteal Chronic Total Occlusions

T. Zeller, L. Lopez, J. Pigott

Purpose: Current methods in the treatment of chronic total occlusions (CTO) present numerous clinical and technical limitations. There is strong unmet need for treatment methods that are cost-effective and lead to improved patient outcomes. Initial clinical results using the FLEX Scoring Catheter (VentureMed Group, Toledo, OH) as a vessel preparation device to treat femoropopliteal chronic total occlusions were evaluated.

Materials and Methods: The Flex Scoring Catheter is a 6-Fr, 0.18-inch guidewire-compatible device. The FLEX has three atherotomes that modify plaque during pull-back with Dynamic Scoring technology. FLEX can be rotationally controlled to create multiple linear scores preparing the vessel for treatment. The present study analyzed voluntarily provided case reports (24 operators in 15 hospital systems) of 100 patients presenting between December 2015 and September 2017 with femoropopliteal CTOs. After successfully crossing the CTO, the lesion was treated with the FLEX Scoring Catheter before a drug-coated balloon (DCB) or plain old balloon angioplasty (POBA). Luminal gain after administration of the FLEX and postprocedure was calculated, as well as the average opening and maximal balloon pressures.

Results: The average lesion length was 191 mm (range, 30–350 mm). The average luminal gain after FLEX was 31%. Residual stenosis after FLEX plus DCB or POBA was 7.9%. Technical success was 99%; one patient required predilation to allow for the FLEX catheter to pass. The FLEX catheter allowed for recanalization of the CTO before angioplasty in 99% of the cases. There were no vessel perforations or emboli. Ninety-six percent of the cases had no dissection; 4% of cases had minimal dissections. Provisional stent use was 19%. Moderate or severe calcification was recorded in 46% of the cases. DCB was used in 70% of the cases, at operator discretion. The balloon-opening pressures (defined as the lowest pressure allowing for complete lesion effacement) averaged at 4.1 atm (range, 2–10 atm), and maximal balloon inflation pressures averaged at 9.4 atm (range, 4–16 atm).

Conclusions: The FLEX catheter performed safely with a high degree of technical success. It is effective in recanalizing CTOs with low rates of vessel dissection. Provisional stent use is low, and there were no flow-limiting dissections. Low (subnominal) balloon-opening pressures suggest significant change in vessel wall compliance after vessel prep with FLEX. The FLEX is used by interventionalists as a vessel preparation device, especially before DCB.
010 One-Year Results of The BioMimics 3D Stent System in the MIMICS-2 Study.

T. M. Sullivan, T. Zeller, M. Nakamura

**Purpose:** Endovascular treatment of femoropopliteal artery (FPA) disease is challenging because of high rates of restenosis and multiple forces in this vascular segment that present complex problems for stent design. The BioMimics 3D (three-dimensional) stent (Veryan, Horsham, UK) is a self-expanding Nitinol stent designed with unique 3D helical centerline geometry to generate swirling blood flow. Preclinical studies and an earlier clinical study (Mimics) have indicated that the introduction of swirling blood flow leads to elevated wall shear in the stented segment and reduced neointimal formation. The unique design offers biomechanical compatibility through its ability to accommodate longitudinal shortening during knee and hip flexion. This study is designed to demonstrate the safety and efficacy of the BioMimics 3D Vascular Stent System in the treatment of FPA disease.

**Materials and Methods:** This prospective, single-arm, multicenter trial enrolled patients with symptomatic de novo occlusive disease of the native FPA. An independent angiographic core laboratory reviewed all angiograms and endpoint events were independently adjudicated. The primary safety endpoint is a composite of major adverse events (MAE) comprising death, any target limb major amputation, or clinically driven target lesion revascularization (TLR) at 30 days. Primary efficacy is stent patency at 12 months. We present procedural, in-hospital clinical and 1-year primary patency and clinically driven target lesion revascularization (CDTLR) outcomes.

**Results:** A total of 271 subjects were enrolled, with a mean age of 68 years, 66% male, 81% smokers, and 45% with diabetes. The core laboratory–reported mean lesion length was 81.2 ± 38.4 mm, and vessel diameter was 5.2 ± 0.9 mm; 46% had moderate to severe calcification, and 30% were total occlusions. The baseline diameter stenosis was 77.4%, and at procedure conclusion, 11.5%. Lesion success (successful stent implantation without device-related complications) and procedure success (lesion success without MAE) were 100%. There were no procedural or in-hospital stent fractures, abrupt closure, spasm, distal embolization, or perforation. Dissections greater than type C occurred in 1% of cases. One-year primary patency and CDTLR data will be available at the time of presentation.

**Conclusions:** The unique design of the BioMimics 3D stent for treatment of FPA was safe and achieved excellent procedure success without procedural complications or stent fracture. The 1-year results will confirm whether these results are associated with sustained safety and efficacy.
All Other Abstracts

011 A New Closure Device: How to Close Large-Bore Sheaths, Leaving Nothing Behind

R. Teeslink

Purpose: EnSite Medical has designed a large-bore closure device, SiteSeal, that simulates external compression but removes the associated variables, leaving nothing behind. It applies invariant pressure to the vessel wall access site by using internal stainless steel springs, which function as shock absorbers to dampen blood vessel pressure fluctuations.

Materials and Methods: SiteSeal uses a no. 2 Vicryl suture to make a Z stitch, which holds the SiteSeal device in place and closes the arteriotomy site in a linear fashion. The Z stitch is placed by entering the soft tissue at the skin insertion site of the sheath. If the operator is right handed, the first entrance is 1 cm east of the sheath, passing under the sheath, and exits 1 cm west of the sheath. The second entrance is 1 cm above the skin insertion of the sheath and 1 cm to the east. The needle then crosses up and over the sheath and back down into the soft tissue and exits 1 cm west of the sheath. The two ends of the Z stitch form a double half knot, which when closed, creates an “X” over the arteriotomy site.

Bioseal powder is placed around the sheath and half knot. The device is cocked by turning the cross-bar horizontally and applying pressure, which loads the springs. It is then centered over the sheath at the arteriotomy site with the incline plane facing north. The dilator is removed from the sheath. The two suture ends are pulled tight against the sheath as pressure is applied to the device, closing the Z stitch into an “X” over the arteriotomy site, and the sheath is removed. The suture ends are pulled up through the designed slots and tied into the notched slot of the cross-bar. The loaded springs are released by turning the cross-bar back to a vertical position. After the device is activated, the pressure created by the Z stitch continues to elevate the artery and folds in the soft tissues surrounding the arteriotomy site, closing the site in a linear fashion. The roof is placed, and Tegaderm is applied for stabilization.

Results: Forty-five endovascular aneurysm repair (EVAR) and 23 Impella procedures have been performed using SiteSeal without any hematoma formation at discharge and 24-hour, 7-day and 30-day, follow-up.

Conclusions: SiteSeal has the ability to close large-bore sheaths with a single device, leaving nothing behind. Associated advantages are:
• Not limited by sheath size, including EVAR, thoracic endovascular aneurysm repair (TEVAR), or TAVAR

• No patient limitation: size, anticoagulation, calcification, and so on

• Simple and rapid deployment

• Allows immediate reaccess

• Minimizes patient discomfort, allowing immediate head elevation to 30 degrees with no restriction in leg movement

• Early ambulation

• Nothing left behind: the potential of minimal risk of vessel wall injury, infection, and embolization
012 Brachial Artery Hemostasis: Steps to Success with the Angio-Seal™ Closure Device

S. Mafed, S. F. Frossi Stella, K. Tan, G. Annamalai

Purpose: Brachial artery access can be a useful endovascular approach for peripheral and visceral artery intervention. It is, however, associated with higher complication rates compared with transfemoral access, particularly hematoma and thrombosis requiring surgical intervention. Hemostasis of the brachial artery has traditionally involved manual compression, but the off-label use of vascular closure devices has been suggested as an alternative.

We aim to:

1. Describe the safe principles of brachial arterial access.

2. Understand the potential risks of brachial artery access.

3. Describe patient selection and steps for safe deployment of an Angio-Seal in the brachial artery.

Materials and Methods: This is a retrospective study of patients who had an Angio-Seal deployed in the brachial artery after endovascular intervention. The picture archiving and communication system and electronic medical record were reviewed for the details of device deployment and any subsequent complications.

Results: At our institution, 14 6-Fr Angio-Seals were deployed into the brachial artery in 13 patients (10 men, 3 women; mean age, 77 years [range, 59–89 years]) using the steps above over a 3-year period. All were successful except for one pseudoaneurysm because of Angio-Seal maldeployment. No long-term adverse sequelae were identified.

The following steps are suggested for safe access and hemostasis of the brachial artery with off-label use of the Angio-Seal device:

1. Ultrasound evaluation of the brachial artery, including measurement of luminal diameter (<3 mm deemed unsuitable).

2. Ultrasound-guided access of the brachial artery overlying the distal humerus should be performed using a micropuncture set.
3. For hemostasis, before considering use of the Angio-Seal, brachial angiography should be performed to ensure the vessel can accommodate the 6-Fr Angio-Seal device; if the sheath is occlusive (no flow beyond sheath), either because of small vessel caliber or spasm, the closure device should not be used.

**Conclusions:** Brachial artery access is an important access site for endovascular intervention. With careful patient selection and the use of brachial angiography, off-label use of the Angio-Seal device can be a valuable tool for effective hemostasis. This technique provides an alternative to manual compression with no long-term adverse sequelae identified in our patient cohort.
013 Evenmore and Glidepath Hemodialysis Catheters: Is There a Difference?

V. Gustainyte, G. Hoots

**Purpose:** To evaluate the difference in incidence and time to first repeat intervention with Evenmore and Glidepath hemodialysis catheters

**Materials and Methods:** Our original study population included all Evenmore and Glidepath hemodialysis catheters placed from July 1, 2016, through June 30, 2017, at Tampa General Hospital, Tampa, Florida. This consisted of a total of 271 Evenmore and 188 Glidepath catheters. These were then screened for indication and vein used for access. Only right internal jugular vein catheters used for hemodialysis were included in the study. This reduced the number of catheters to a total of 182 and 126 for Evenmore and Glidepath catheters, respectively. After this, the incidence and time to first repeat intervention were calculated. The reason for catheter failure was noted when known. The time of normal function was calculated for catheters that were both placed and requested to be removed by interventional radiology (IR).

**Results:** The incidence of catheter failure requiring IR repeat intervention was 19.8% for Evenmore and 16.7% for Glidepath catheters. The average days to intervention was 60.1 (standard deviation [SD], 65.0 days) versus 55.5 (SD, 48.1 days) for Evenmore and Glidepath catheters, respectively. Malfunction of unclear etiology was most frequently found on IR repeat intervention (8.2% vs 7.1%) followed by vein stenosis or fibrin sheath formation (4.4% vs 4.0%) and infection (3.3% vs 2.4%).

**Conclusions:** In our study, there was a slightly smaller incidence rate of catheter failure seen with Glidepath catheters (19.8% vs 16.7%). When failure did occur, the average time to first IR repeat intervention was, however, shorter for Glidepath catheters (60.1 vs 55.5 days). Infection rates and catheter malfunction unable to be diagnosed by imaging were both higher with Evenmore catheters. There was also a slightly higher overall incidence of venous stenosis or fibrin sheath formation (4.4% vs 4%) with Evenmore catheters. Therefore, our study supports that Glidepath catheters may be more effective in maintaining patency and function when long-term hemodialysis access is required.
014 New Technologies in Access Needles

R. Teeslink

**Purpose:** The American Nurses Association created 10 golden rules of safety that they recommended to follow in designing a safety needle. InjectiMed has designed and developed an endovascular guidewire introducer needle, SafetyNet, that encompasses all 10 of these golden rules.

**Materials and Methods:** InjectiMed technology is based on a design in which a safety guard, with a movable trap, biased against the needle, slides along the needle and stops on a slight bulge at the distal end of the needle, capturing the tip. The blood containment chamber slides alongside the needle as it is positioned between the rear of the safety guard and the movable trap that closes the distal end of the chamber. The SafetyNet has an access control grip at the housing–hub interface, giving improved control for penetrating tough scar tissue and more consistently obtaining a one-wall stick. Two bevel-up indicators, one on a notch on the hub, and three raised chevrons on top of the Hi-Vis housing, help to determine the bevel orientation without the operator needing to take her or his eyes off the monitor. There is an echogenic tip located at the distal end of the bevel, which extends to the needle tip.

**Results:** Multiple sites have evaluated the SafetyNet and have rated the needle with a 100% acceptance of the unique concept, safety aspects, and user friendliness.

**Conclusions:** Features and benefits include:

1. Allows access with no change in technique
2. Designed to be activated with a single hand
3. Manipulate guidewire and control bleeding with the free hand
4. Brightly colored housing, allowing high visibility
5. Grip at the housing–hub interface gives improved control
6. Two bevel-up indicators, one is a notch on the hub and three raised chevrons on top of the Hi-Vis housing
7. Echogenic tip located at the distal end of the needle
8. Patented dual feature safety guard designed to:
• Instantly shield the sharp needle tip
• Contain blood in needle tip
• Protect caregivers from cross-contamination
015 Radial Artery Spasm During Radial Access: A Case and Review of the Literature

G. MehChu, J. Huang, R. Fabrizio, B. Hammelman

**Purpose:** To describe a case of severe radial artery spasm during a transradial intervention, the interventions that led to release of the catheter, and a review the literature related to artery spasm in transradial interventions.

**Material and Methods:** Radial artery spasm is the most common complication of the transradial approach to arterial interventions. Familiarity with its management is crucial as transradial access becomes more mainstream in interventional radiology. Herein we describe a case of severe radial artery spasm during uterine artery embolization (UAE) that required multiple interventions to release the guiding catheter. We then review the related literature.

**Results:** A 32-year-old woman presented for UAE. Her left radial artery demonstrated a Barbeau type A waveform. Access was gained to the left radial artery, and a 5-Fr radial access sheath was placed. Verapamil 2.5 mg, nitroglycerine 100 mcg, and heparin 3000 units were infused into the radial artery. The left uterine artery was cannulated using a 4-Fr catheter and embolized. At this time, the catheter could not be withdrawn.

Nitroglycerine paste on the arm over the radial artery, ultrasound-guided tumescent nitroglycerine, and lidocaine around the radial artery and intravenous (IV) verapamil were attempted to no avail. Ultrasound demonstrated a high take-off of the left radial artery. The right common femoral artery was accessed, and a 5-Fr catheter was used to cannulate the left axillary artery. A Progreat microcatheter (Terumo) was advanced into the proximal radial artery alongside the immobile radial artery catheter. Verapamil 2.5 mg and nitroglycerine 100 mcg were infused through the microcatheter after which the radial catheter was dislodged. A left upper extremity arteriogram demonstrated diffuse vasospasm throughout the radial artery course and confirmed high take-off. A reverse Barbeau test demonstrated good perfusion of the hand with pressure occluding the ulnar artery.

**Conclusions:** High radial take-off and female gender are known risk factors for radial artery spasm. Other factors include small radial artery diameter, atherosclerotic lesions, cannulation of side branches, vessel tortuosity, larger sheath diameters, longer procedure duration, younger age, lower body mass index, diabetes, number of catheter exchanges, volume of contrast medium used, and repeated radial artery access attempts. IV vasodilator administration, intraarterial vasodilator infusion, axillary nerve blocks, and general anesthesia have been shown to be effective.
016 Brachiofemoral Access as an Adjunctive Technique for Thoracic Endovascular Aneurysm Repair of a Severely Tortuous Thoracoabdominal Aorta

C. Burk, R. Sharma, S. Patel

**Purpose:** The adjunctive technique of brachiofemoral access for thoracic endovascular aortic repair with severely tortuous anatomy is presented using a case in which the patient experienced severe postprocedural complications. Relative contraindications, appropriate perioperative imaging analysis, and potential complications are presented.

**Materials and Methods:** Endovascular repair of descending thoracic aortic aneurysms is thought to reduce perioperative mortality and morbidity compared with open surgery. However, therapeutic success is reliant on safe endoluminal delivery of the stent-graft device across the aortic aneurysm using a remote arterial access site. Aortic tortuosity can create hostile anatomy, making device delivery difficult. Even with the development of stiffer guidewires, adjunctive techniques, including brachiofemoral access and traction, are sometimes needed for improving endograft trackability and delivery. However, these supportive techniques are not without unique additional risks and must therefore be used with discretion.

**Results:**

1. Emergent thoracic endovascular aneurysm repair for a patient with a severely tortuous type II thoracoabdominal aortic aneurysm and associated complications is presented to highlight important clinical and technical considerations.

2. Techniques for obtaining through-and-through right or left brachiofemoral access are illustrated with review of important contraindications and associated risks.

3. Methods for analyzing aneurysm dimensions perpendicular to the aortic lumen center line using multiplanar reformatted images are presented with an overview of the methodology for calculating the tortuosity index.

4. A review of the literature will demonstrate the postoperative risks, long-term outcomes, and mortality rate associated with endovascular repair of low tortuosity and high tortuosity thoracic aortic aneurysmal anatomy.

**Conclusions:** Thoracic aortic aneurysmal tortuosity can create a hostile anatomy that increases the technical difficulty of endovascular repair and creates a need for adjunctive brachiofemoral access, which carries additional risk. Data suggests that even with technical success, in patients with a high degree of aortic tortuosity, there is increased risk for endoleaks and decreased overall survival that may necessitate vigilant postoperative surveillance imaging.
017 Complex Endovascular Aneurysm Repair of a Type IV Thoracoabdominal Aortic Aneurysm and Management of Gutter Endoleak

M. Roca, B. Zwiebel, L. Grundy, S. Murray, G. Hoots

**Purpose:** Presentation of a 73-year-old man who presented with a type IV thoracoabdominal aortic aneurysm (TAAA) measuring 6.9 cm in greatest diameter. An alternative technique to fenestrated endograft approach for treatment of a type IV TAAA using the bifurcated Gore excluder stent graft system (Gore Medical, Flagstaff, AZ) with the “octopus technique” for individual Viabahn stent graft placements (Gore Medica) into the renal arteries and superior mesenteric artery (SMA), and a separate Viabahn stent into the celiac artery. Additionally, postprocedural complication of a Gutter endoleak treated via a Perigraft approach is discussed.

**Materials and Methods:** Intraoperative aortography confirmed a type IV TAA. Through a right groin sheath, a 35-mm Gore excluder branch endograft was introduced while from a left axillary artery approach, a 9 mm x 10 cm Viabahn stent graft was positioned into the celiac artery. Simultaneous deployment of the endograft and Viabahn stent graft was successfully performed. This was followed by access into the contralateral gate of the bifurcated endograft from the left axillary artery with advancement of a 7-Fr sheath in which bilateral renal arteries were accessed, and two 7 mm x 10 cm Viabahn stent grafts were positioned on each side, respectively. Through the same sheath, the SMA was accessed, and a 9 mm x 10 cm Viabahn stent was positioned into the SMA. Deployment of the stents in an “octopus technique” was performed simultaneously. Further extension of the endograft with an additional bifurcated Gore excluder graft was deployed and extended into the proximal right common iliac artery with additional left iliac limb extension performed.

**Results:** Postprocedure aortography demonstrated successful complex TAA repair without evidence of endoleak. On postoperative day 1, computed tomography aortography was suspicious for a Gutter “endoleak” alongside the celiac stent without enlargement of the aneurysm sac. The patient elected for endoleak repair. Aortography confirmed a proximal gutter endoleak alongside the celiac stent. Using the Perigraft approach, the aneurysm sac was accessed, and the flow channel was embolized using a mixture of flowable D-stat and contrast until stasis within the aneurysm sac was confirmed.

**Conclusions:** The endovascular treatment of type IV TAAs can be challenging. An alternative to fenestrated stent grafts is the placement of excluder bifurcated endograft system with separate stent graft to the celiac artery and a feasible simultaneous deployment of the SMA and renal artery stents using the “octopus”
technique as described. Careful follow-up with imaging is important because gutter endoleak can be a common complication
018 Good Long-Term Result for Endovascular Aneurysm Repair: Conversion After 20 Years and 9 Months

T. Cohnert, S. Koter, A. Baumann

**Purpose:** Endovascular aneurysm repair (EVAR) is the treatment of choice in anatomically suited patients and high operating risk. There is still an ongoing debate whether EVAR should be offered to patients younger than 70 years of age because of the lack of long-term results. We report a case of successful treatment with EVAR by second-generation implant and follow-up of 20 years and 9 months.

**Materials and Methods:** A 60-year-old man underwent standard EVAR using a second-generation device for exclusion of a symptomatic inflammatory 6.3-cm abdominal aortic aneurysm (AAA) in November 1996. Implantation was carried out within IFU. Follow-up investigations were performed according to the institutional protocol.

**Results:** In 1997, 8 months after EVAR, laparotomy was performed because of abdominal pain and increasing aneurysm Diameter following arteriography without evidence for endoleak. A surgery a large inflammatory AAA was opened, no endoleak of structural defect of the prosthesis was detected, and the aneurysm sac was resected and closed. During follow-up with annual computed tomography (CT) scans, the maximum diameter of the aneurysm stayed at 4.5 cm from 1999 to 2003. In 2003, the AAA started growing, with a rate of 1 to 2 mm/year. The radiologic reports stated that there was no increase in diameter over a period of 8 years during which the AAA grew from 5.0 cm in 2004 to 6.9 cm in 2015. A possible explanation is that the computed tomography angiography (CTA) controls were performed in three different institutions. In 2015, a 6.9-cm a type I endoleak was visible on CTA but was not described. In August 2017, the patient developed abdominal pain. CTA revealed an AAA of 8.4 cm and a type I endoleak. Open conversion in the now 81-year-old man was performed with subtotal resection of the graft (bare springs at renal artery level left in situ). After transabdominal placement of an aorto-bifemoral graft, the patient was discharged home on postoperative day 13.

**Conclusions:** Standard EVAR within IFU can achieve good long-term results (>20 years). The follow-up after EVAR requires a lifelong strategy because complications such as aneurysm sac growth and endoleaks can appear after more than 10 years of follow-up.
019 Less Invasive Endovascular Aneurysm Repair Procedure Using a Repositionable Aortic Stent Graft Assisted by Intravascular Ultrasound Imaging


Purpose: Contrast medium, normally used for lowest renal artery visualization during endovascular aneurysm repair (EVAR), can be responsible for potential renal function impairment. Intravascular ultrasonography (IVUS) has been proposed as real-time alternative imaging diagnostic technique. However, there is no clear indication on the basic information IVUS can provide in EVAR. In this study, we evaluated the feasibility of EVAR using repositionable IVUS-assisted aortic stent grafts during vascular navigation without contrast medium injection.

Materials and Methods: From January 2015 to December 2016, 25 patients with infrarenal abdominal aortic aneurysms (AAAs) identified through anatomical inclusion criteria underwent EVAR using an Anaconda repositionable aortic stent graft (Vascutek, Terumo, Inchinnan, Scotland) assisted by IVUS (Volcano Visions PV, Philips, Amsterdam, Netherlands) during intraluminal navigation. Preoperative angio-computed tomography (CT) and intraoperative IVUS imaging findings, aimed at visualizing the most important reference arteries and sizing parameters, were compared. The accuracy of IVUS vs angio-CT was analyzed using a 2 x 2 table, Student t-test, Pearson correlation coefficient, and χ2 computation.

All patients had an arteriogram at the end of the EVAR procedure to confirm aortic stent graft patency and exclude type 1 endoleaks. The primary objective was intraprocedural and postoperative technical and clinical success in terms of avoiding type 1 endoleak and assuring adequate distal perfusion. Follow-up was performed using angio-CT, duplex scan, or contrast-enhanced ultrasonography at 6, 12, and 24 months.

Results: A total of 150 target vessels were evaluated. The IVUS versus angio-CT matching rate for vessel visualization was 100% for visceral arteries. The left renal artery, the lowest renal artery, and the hypogastric artery showed an 84%, 88%, and 96% matching rate, respectively. IVUS versus angio-CT had a 97.3% and 100% sensitivity and specificity rate, respectively. There were no type 1 endoleaks, and one patient had a type 2 endoleak (4%). As a primary objective, 100% technical and clinical success was obtained. During the follow-up, all the patients were alive without complications.

Conclusions: A full EVAR procedure is feasible using only IVUS vascular navigation without contrast medium injection and intraprocedural drawbacks. Anatomical inclusion criteria must be adopted for the best IVUS imaging during EVAR.
020 Novel Diagnostic and Therapeutic Approach to Delayed Type IIIb Endoleak After Fenestrated Endovascular Aortic Repair

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**Purpose:** To report the successful treatment of a delayed type IIIb endoleak after fenestrated endovascular aortic repair (FEVAR) of a juxtarenal abdominal aortic aneurysm (AAA). A novel approach using microbubble contrast-enhanced ultrasonography (CEUS) for characterization and follow-up of this patient's endoleak as well as off label utilization of Amplatzer Vascular Plug (AVP) (St. Jude Medical, St. Paul, MN) to treat the endoleak will be discussed.

**Materials and Methods:** A 69-year-old man with a known history of chronic kidney disease and hypertension underwent a four-vessel FEVAR of his 7.7-cm AAA. A type IIIb endoleak in the proximal body component of the fenestrated Anaconda graft was diagnosed approximately 30 months after the original procedure; the leak was associated with rapid aneurysm growth. The leak was characterized using a combination of catheter angiography and CEUS (local institutional practice) and felt secondary to a localized graft perforation. Endovascular relining of the fenestrated graft was not feasible because of the location of the endoleak immediately below the SMA fenestration. The patient was also not a candidate for open surgical conversion. Hence, the fabric defect was treated using an AVP with an intent to promote early mechanical occlusion of the graft defect with subsequent endothelialization to achieve complete endoseal.

**Results:** After plug deployment, immediate intraprocedural angiography showed a persistent but markedly decreased endoleak. Follow-up CEUS studies at 6 weeks and 6 months postprocedure confirmed adequate endoseal with no residual aneurysm sac perfusion, especially along the graft perforation site. The most recent noncontrast computed tomography (CT) performed 6 months after AVP deployment confirmed interval shrinkage of the native aneurysm sac. The patient remains asymptomatic.

**Conclusions:** Type IIIb endoleaks caused by fabric holes have been reported with multiple endografts. Typical options of endovascular relining of the endograft were not feasible in our case. We report a novel successful treatment of this leak with AVP, which has been durable out to 6 months postprocedure. Additionally, we demonstrate the value of CEUS in diagnosis, characterization and follow-up of endoleaks, especially in patients who cannot receive iodinated contrast enhanced CT studies because of poor renal function.
021 Outcomes Following Thoracic Endovascular Aortic Repair for Acute Aortic Syndromes


**Purpose:** Thoracic aortic endografts were initially indicated for and most studied in the treatment of thoracic aortic aneurysms followed by traumatic aortic transection. However, there has been increasing use of thoracic aortic endografts in acute aortic syndromes, including aortic dissection, penetrating atherosclerotic ulcer, and intramural hematoma. For this single, tertiary care institution with a large volume of thoracic endovascular aortic repairs (TEVAR), over the past 5 years, more endovascular repairs have been performed for acute aortic syndrome than for aneurysm. This study examines the outcomes of TEVAR in these patients.

**Materials and Methods:** From July 2012 through September 2017, 31 patients underwent TEVAR for acute aortic syndrome. Retrospective analysis of the preprocedure cross-sectional imaging; type and size endograft used; and postprocedure outcomes, including clinical outcomes and follow-up imaging results, was performed.

**Results:** Of the 31 patients who underwent TEVAR for acute aortic syndrome, 8 (26%) required additional intervention, 4 (13%) endovascular and 4 (13%) open surgical intervention. Twenty-one (68%) demonstrated positive aortic remodeling on follow-up imaging, 5 (16%) had negative aortic remodeling, and 4 (13%) demonstrated an endoleak. Two (6%) patients developed spinal ischemia with permanent lower extremity weakness, and 1 (3%) had a CVA with residual upper extremity weakness. There were 3 (10%) deaths unrelated to the procedure.

**Conclusions:** TEVAR is a safe and effective option for the treatment of acute aortic syndrome, with the majority showing positive aortic remodeling in follow-up imaging. The overall morbidity is lower than that seen with open aortic repair, and the rate of spinal cord ischemia is similar to that seen in other studies looking at both endovascular and open repair.
022 Role of Serum Biomarkers in the Evaluation of Acute Aortic Dissection

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**Purpose:** Aortic dissection is a potentially fatal condition that can demonstrate rapid deterioration from the onset of symptoms. The rapidly fatal nature of aortic dissection makes timely diagnosis critical. Physical examination findings can be nonspecific, and confirmation of aortic dissection using modalities such as computed tomography angiography, magnetic resonance angiography, or echocardiography is often required; however, these studies can be time consuming and limited for unstable patients. Rapidly available blood tests to help rule in or rule out aortic dissection would be extremely beneficial in the management of this time-sensitive disease process.

**Materials and Methods:** This educational exhibit reviews the current literature on biomarkers associated with aortic dissection and provides:

1. A review of extracellular matrix proteins found in the aortic wall and their alterations during aortic dissection
2. A summary of current data on biomarkers that are elevated during acute aortic dissection and their sensitivity and specificity
3. A discussion on the role of proteomics in creating future specific biomarker assays to help diagnose aortic dissection

**Results:** Meta-analysis reviews have shown d-dimer to have a high sensitivity for ruling out acute aortic dissection in patients with a low clinical suspicion of the disease. Prospective data from the International Registry of Acute Aortic Dissection Substudy on Biomarkers demonstrated a negative predictive value of 95% for d-dimer values less than 500 ng/mL within 24 hours of symptom onset. Biomarkers such as smooth muscle myosin heavy chain and calponin have also been shown to be elevated during acute aortic dissection. These markers, however, all show a low specificity on their own for diagnosing aortic dissection. Future study designs are aimed at finding an optimal combination of biomarkers to help diagnose aortic dissection based on the extracellular matrix remodeling that occurs.

**Conclusions:** Current data show that certain biomarkers have high sensitivity in ruling out acute aortic dissection; however, no single marker has demonstrated a clinically significant high specificity. Ongoing data are necessary to determine cost-effective and rapidly available bioassays that are sensitive and specific for diagnosing acute aortic dissection. Interventional radiologists involved in the management of aortic dissection...
should be familiar with the role of biomarkers in diagnosing this disease process and take an active role in ongoing research related to aortic disease biomarkers.
023 Seatbelt Aorta: Considerations in the Management of Pediatric Blunt Traumatic Abdominal Aortic Injury

C. Burk, R. Sharma, S. Patel

**Purpose:** A case of blunt traumatic abdominal aortic injury is presented to illustrate important clinical factors involved in managing these complex injuries. A review of multiple retrospective studies and case reports highlights important long-term outcomes after nonoperative management and technical considerations involved in endovascular and open surgical therapies.

**Materials and Methods:** Blunt abdominal aortic injuries account for 3.3% of reported injuries in the National Trauma Database. The frequently associated seatbelt syndrome, which includes visceral organ injury, can preclude open surgical placement of a synthetic aortic graft. In the pediatric population, clinicians are therefore often left deciding between conservative or endovascular management of these injuries. However, circumferential intimal transection, a common pattern of intimal injury in these patients, often necessitates urgent repair because of the increased risk of mesenteric and spinal cord ischemia.

**Results:**
1. A case of blunt traumatic abdominal aortic injury is presented to demonstrate important clinical considerations in the management of these patients.
2. The constellation of findings composing seatbelt syndrome and the classification of traumatic aortic injury is reviewed.
3. Special attention is paid to the mechanism by which intimo-intimal intussusception of circumferential intimal injuries increases the risk for mesenteric and spinal cord ischemia.
4. Rates of failure and reported complications of nonoperative management are presented.
5. Selection of bare-metal stents or stent grafts can be limited by vessel caliber and can limit the ability to sequentially dilate a device to maintain adequate wall opposition over time as the patient grows.
6. The use of intraoperative ultrasound can assist in the primary open repair of intimal injuries.

**Conclusions:** Nonoperative, endovascular, and open surgical management strategies have all been described for the treatment of blunt traumatic aortic injury in pediatric populations. However, such injuries are often associated with a constellation of findings that can necessitate endovascular repair. The selection of
bare-metal stents or stent grafts is an important consideration to minimize complications and ensure therapeutic longevity in a growing pediatric population.
024 Spontaneous Superficial Femoral Artery Dissection in a 25-Year-Old Woman: Case Report

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**Purpose:** Spontaneous dissection of peripheral arteries is a rare condition. Patients with arterial dissections commonly have risk factors, such as atherosclerosis, hypertension, or iatrogenic causes such as instrumentation or surgery. When these conditions are not present, the case warrants further investigation.

**Materials and Methods:** We present a healthy 25-year-old white female law enforcement agent with a spontaneous superficial femoral artery (SFA) dissection that was successfully treated with endovascular stenting. The patient initially sought medical treatment for right leg pain and cramping worsened by activity and relieved by rest. She reported recently starting a rigorous training regimen in preparation for her first marathon; however, the subsequent development of her symptoms was hindering her progress. She denied any significant familial history, past medical history, or prior surgery. Her only medications were oral contraceptives. She stated that before presenting to our clinic, she had been treated at multiple institutions for the same complaint without resolution.

**Results:** Her initial workup revealed no laboratory abnormalities, but an arterial ultrasound demonstrated right SFA and right anterior tibial artery (ATA) occlusion. Computed tomography angiography (CTA) of her lower extremities revealed a completely occluded right SFA. She was started on medical therapy with acetylsalicylic acid (aspirin) 81mg every day and cilostazol (Pletal) 100 mg twice a day, but her symptoms continued. Thus, a decision was made to perform angiography that demonstrated a completely occluded, dissected proximal right SFA with thrombus formation. The SFA exhibited retrograde filling with no evidence of atherosclerotic disease. The decision was made to pass the lesion in a retrograde fashion via the right dorsalis pedis artery. After balloon angioplasty and placement of a stent, the right SFA showed no acute intraluminal filling defects.

**Conclusions:** Although multiple cases of spontaneous rupture of the common iliac, external iliac, and common femoral arteries have been described, there are only two documented cases of spontaneous SFA dissections, both of which were treated with open vascular repairs. This case illustrates a need to pay close attention to patient presentation, history, and laboratory and study results in cases of dissection when there is no immediate identifiable cause or risk factor. Workup should also include assessment for hypercoagulability, fibromuscular dysplasia, Marfan syndrome, and Ehlers-Danlos syndrome type IV.
025 Use of D-Stat® Flowable as an Alternative to Traditional Liquid Embolic Agents for Endoleak Repair

K. Kuppler, L. Rachakonda, R. Gnesda, G. Hoots, B. Zwiebel

Purpose: The prevalence of abdominal aortic aneurysm in people older than 80 years of age is 5.9% (Uflacker and Robison, 2001), with endovascular aneurysm repair (EVAR) having emerged as the operative treatment of choice. Subsequently, management of endoleaks, the most commonly encountered delayed sequela of EVAR, is paramount to ensuring long-term stability (Sirignano et al, 2016). The embolic agents available to treat endoleaks are diverse and include coils, particles, and liquid embolics. A less expensive alternative embolic that functions similarly to some liquid embolics is the D-Stat Flowable.

The D-Stat Flowable is marketed for hematoma prevention in patients at high risk for bleeding after femoral access or prepectoral tissue tract formation. There is one case documented in the literature of its intravascular use for treatment of endoleak (Jones et al, 2017). Thrombin, the active ingredient in a D-Stat Flowable, allows for rapid hemostasis by converting soluble fibrinogen into insoluble fibrin and accelerates platelet activation (Ward et al, 2009). The viscosity of the D-Stat Flowable is favorable for preventing nontarget embolization, it is a fraction of the cost of other liquid embolic agents, and it can be used in higher volumes in cases when the endoleak cavity is large or poorly defined. The purpose of our study is to demonstrate the effectiveness of the D-Stat Flowable as a safe and economical alternative to traditional liquid embolic agents for endoleak repair.

Materials and Methods: We performed a retrospective review of all five patients who have been treated at our institution since 2016 with D-Stat Flowable as the primary embolic agent for endoleak repair.

Results: Since 2016, five patients with endoleaks have been treated at our institution with D-Stat Flowable as the primary embolic agent. The treated endoleaks included types 1 (gutter leak), 2, and 3. Only one of the treated endoleaks had residual flow into the aneurysm sac on postembolization angiogram. All patients had an uncomplicated postprocedural course. Three of the five patients have already had follow-up imaging with no residual endoleak and stability of the aneurysm sac. The other two patients will receive their follow-up imaging within the next 2 months.

Conclusions: D-Stat Flowable is a safe, effective, and economical alternative to the traditional embolic agents used in endoleak repair. D-Stat Flowable is optimally used for aneurysm sacs that are ill-defined and large volume and would otherwise necessitate use of a large volume of liquid embolic.
Clinical Trends of Aortic Valve Replacement: An Endovascular Revolution


**Purpose:** Transcatheter aortic valve replacement (TAVR) and surgical aortic valve replacement (SAVR) represent treatment options for severe aortic stenosis (AS), but their impact on clinical practice remain incompletely described. The goal of this study is to describe clinical trends over time between TAVR and SAVR.

**Materials and Methods:** A multicenter retrospective review of 1872 patients who underwent aortic valve replacement from 2011 to 2014 was performed among three high-volume academic centers. Of these patients, 842 patients had SAVR, and 1030 underwent TAVR. Both transfemoral (TF, \( n = 727 \)) and transapical (TA, \( n = 303 \)) TAVR approaches were included. Patients were then stratified by risk profile using the Society of Thoracic Surgery (STS) risk score: less than 4% as low risk, 4% to 8% as intermediate risk, and greater than 8% as high risk.

**Results:** Over the course of 3 years, the overall volume of TF approach TAVR (TF-TAVR) increased exponentially (+595%), but that of SAVR increased only by 23%. During the last year in particular, TF-TAVR increased by 28%, and SAVR and TA-TVR decreased by -15% and -49% respectively. When stratified by STS risk score, TF-TAVR was the preferred approach for high-risk patients. SAVR remained the predominate modality for intermediate-risk patients, but there was a notable downtrend in SAVR with an exponential growth TAVR.

**Conclusions:** The emergence of TAVR has resulted in a paradigm shift for the treatment of severe AS. This transformative technology surpassed SAVR for treating high-risk patients with clinical trends suggesting the same for intermediate risk patients. This study confirms the current endovascular revolution for the treatment of AS.
027 Case Presentation and Management Review of a Giant Serpentine Aneurysm

M. B. Hyatt, G. M. Snowden

Purpose: The purpose is to discuss the management and treatment of giant serpentine aneurysms (GSAs) involving the posterior cerebral artery (PCA). In doing so, we provide a case in which one of our patients received initial treatment 4 years prior with close interval follow-up to serve as an example.

Materials and Methods: GSAs of the PCA are a rare and serious condition with a poor natural history. GSAs are technically defined as measuring at least 25 mm in diameter with a partial thrombosis while maintaining a patent, serpiginous vascular channel with separate inflow and outflow tracts. Although the pathogenesis is not completely understood, the foremost theory suggests this entity stems from repeated dissections of an intrinsic abnormal vessel wall with intramural hemorrhages. Commonly misdiagnosed on initial computed tomography imaging as a neoplasm, GSAs commonly have a heterogenous mass-like appearance that causes adjacent edema and mass effect. The clinical presentation is variable depending on the location of the lesion; however, progressive neurologic defects represent the most common clinical findings.

Results: Conservative options typically fail with continued progressive deterioration of the patient. If tolerable, the primary course of action is permanent embolization of the parent artery. This is performed via endovascular deployment of either detachable coils, n-butyl cyanoacrylate, and/or ethylene vinyl alcohol copolymer (Onyx). A precise knowledge of the segmental anatomy of the PCA and its branches is imperative. In our presented case, the patient initially presented with a thalamic stroke and a small temporal hemorrhage. Clinically, she exhibited left foot drop and left leg paresthesia. The patient underwent successful treatment with coil embolization of both the outflow and inflow tracts to the aneurysm, thus trapping it from receiving any further flow. Initial results were excellent with no complications. On a follow-up cerebral angiogram performed 18 months posttreatment, two additional coils were placed at the inflow to ensure durable occlusion. Original presenting neurologic symptoms have nearly resolved. Regular, yearly follow-up is maintained.

Conclusions: GSAs of the PCA represent a rare subset of intracranial aneurysms that require vigilant recognition with aggressive management. Parental artery occlusion is the standard of treatment if tolerable. The patient in our presented case has demonstrated steady improvement and durable aneurysm occlusion since initial treatment 4 years ago.
028 Transcarotid Artery Revascularization: An Option for Patients at High Risk for Endarterectomy and Transfemoral Stenting

M. Jarmakani, F. Maqbool

Purpose: The purpose is to discuss indications for transcarotid artery revascularization (TCAR) and to describe our experience treating two patients with TCAR.

Materials and Methods: TCAR is a new technique briefly discussed in the vascular surgery literature now offered at our institution. Two patients have been treated: a 66-year-old man with greater than 90% right internal carotid artery (ICA) stenosis and a 69-year-old man with greater than 80% stenosis of the left ICA. Both patients were not candidates for CEA or transfemoral stenting secondary to tortuous ICAs, making it difficult or impossible to place a shunt for endarterectomy or an embolic protection device for transfemoral stenting.

The common femoral vein on the contralateral side was cannulated with an 8-Fr Silk Road venous sheath. A transverse incision was made between the heads of the sternocleidomastoid muscle on the ipsilateral side of the diseased ICA to isolate the common carotid artery (CCA). A superficial purse-string suture was placed in the anterior wall of the CCA, which was accessed in the middle of the purse string. An 8-Fr Silk Road arterial sheath was secured 2 cm into the proximal CCA. Angiography confirmed adequate placement, and flow reversal was established with the ENROUTE NPS system from the CCA to the femoral vein. The stenotic ICA lesion was traversed with a 0.014-inch stiff wire, and angioplasty was performed with a 4 mm x 30 mm balloon. An 8 mm x 40 mm ENROUTE self-expanding stent was placed over the stiff guidewire with the proximal aspect extending into the distal CCA. Angioplasty was done with a 5 mm x 40 mm balloon, and arteriography showed minimal residual stenosis in both patients. Antegrade blood flow was reestablished.

Results: Both patients were discharged 1 or 2 days after the procedure without major complications. At initial follow-up, one patient remained asymptomatic, and the other had restenosis from noncompliance with anticoagulation.

Conclusions: Carotid endarterectomy and transfemoral carotid artery stenting (TF-CAS) have been the mainstays of treatment. However, patients are not always appropriate candidates for either procedure. Research shows that patients undergoing CEA are at increased risk for cardiovascular events and cranial nerve injury. TF-CAS has shown higher incidences of cerebrovascular accidents relative to CEA and is not technically feasible in patients with angulated aortic arch anatomy. Both procedures are limited in patients with
anatomic challenges, including tortuous ICAs, restenosis post-CEA, radical neck dissection, radiation therapy, or cervical spine immobility. TCAR is a new technique not precluded by these limitations, offering these patients a solution.
029 Utility of 4D Computed Tomography Angiography in Predicting Internal Carotid Artery Patency for Preinterventional Stroke Therapy Planning

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Purpose: New large-bore computed tomography (CT) scanners are capable of whole-brain volumetric imaging with high temporal resolution. When used in conjunction with perfusion, the time-resolved sequence can be used in the construction of a time resolved (4D) CTA. In comparison, a single-phase CTA is a single spiral imaging technique performed from the aortic arch to the skull vertex. Determining the patency of the extracranial ICA in the setting of carotid terminus occlusions is challenging with modern single-phase CT angiography because of the slow contrast opacification of distally occluded vessels. Accurately determining the patency of extra- and intracranial vascular is crucial in preintervention planning for stroke therapy. Our purpose is to highlight the utility of 4D CTA in the preprocedural planning for neurointerventional stroke therapy.

Materials and Methods: We present a small case series (n = 3) in which 4D CTA imaging processed from perfusion more accurately delineates internal carotid artery (ICA) occlusions compared with single-phase CTA. Two board-certified interventional neuroradiologists reviewed the 4D CTA imaging and compared it with the single-phase CTA for each patient, who had all undergone subsequent cerebral angiography and stroke therapy. The 4D CTA volumetric perfusion technique (VPCT) protocol consisted of 19 consecutive volumetric acquisitions of the brain (160 mm in the z-axis; 7-second delay after start of contrast medium injection; 55-second total imaging duration; 80 kV; 150–300 mAs; rotation time, 0.3 seconds). A 50-mL bolus of contrast medium (Isovue 370) was used at a flow rate of 4 mL/sec. For spCTA (120 kV; 120 mAs; rotation time, 0.3 s; pitch, 0.6; collimation 2 × 64 × 0.6 mm), 50- to 70-mL contrast medium was injected at a flow rate of 4 mL/sec followed by a 30-mL saline chaser at 3 mL/sec.

Results: In all of the cases presented, the single-phase CTA demonstrated varying degrees of non-opacification of the right ICA from its cervical segment to the level of the terminus. Only the 4D CTA was able to reveal segments of patency of the cervical ICA and proximal intracranial segments, as well as distal arterial filling, more accurately delineating areas of occlusion.

Conclusions: 4D perfusion imaging has high utility in ruling in cervical carotid artery patency in patients with ICA occlusions and is useful for preprocedural planning for interventional neuroradiology stroke therapy.
030 Recanalization of Embolized Pulmonary Arteriovenous Malformations in Patients with Hereditary Hemorrhagic Telangiectasia Based on Tobacco Use

M. Haddad, E. Bendel, A. Stockland, I. McPhail, V. Iyer, S. Misra

**Purpose:** To determine whether patients with hereditary hemorrhagic telangiectasia (HHT) who smoke tobacco are more prone to have pulmonary arteriovenous malformations (pAVMs) that recanalize.

**Materials and Methods:** We retrospectively identified all patients with HHT treated for pulmonary AVMs between January 2000 and August 2017. All patients’ smoking status was checked, and those who reported a 20-pack-year smoking history or more were placed in the smoking group. Only pulmonary AVMs with no prior treatment and patients with both clinical and imaging follow-up were included.

**Results:** A total of 102 patients with HHT were identified who had 372 pulmonary AVMs (pAVMs) embolized in 151 procedures. Thirty-nine of the patients were male, and 63 were female with an average age of 52 years (range, 11–90 years). Twenty-five patients reported a smoking history of at least 20 years who had 59 pAVMs embolized, and 77 patients denied a smoking history and had 313 pAVMs embolized. Embolization was performed with either coils or plugs. Technical success was achieved in all but two cases (98.7%). The average follow-up period was 6.2 years (range, 0.02–14.9). Recanalization occurred in 14 of 59 pAVMs (23.7%) in the smoking group versus 47 of 313 (15%) in the nonsmoking group. The 5-year cumulative probabilities of recanalization were 25.1% in smoking group and 16.2% in the nonsmoking group; this risk was significantly greater in the smoking relative to the nonsmoking group (hazards ratio [HR], 2.2 [1.2–4.1]; \( P = 0.008 \)). Eleven of the 14 (78.6%) recanalized pAVMs in the smoking group required a repeat embolization in 8 procedures, and 28 of the 47 (59.5%) pAVMs in the nonsmoking group required a repeat embolization in 19 procedures. Univariate statistical analysis demonstrated this to be significant (\( P = 0.004 \)). Furthermore, repeat (secondary) recanalization occurred in 5 of the 11 (45.5%) reembolized pAVMs in the smoking group versus 2 of 28 (7.1%) in the nonsmoking group. The 5-year cumulative probabilities of secondary recanalization were 11.1% in smoking group and 4.0% in the nonsmoking group; this risk was again significantly greater in the smoking relative to the nonsmoking group (HR, 6.2 [1.1–34.5]; \( P = 0.036 \)).

**Conclusions:** pAVMs in HHT patients with a smoking history have significantly higher rates of recanalization as well as significantly higher rates of needing another embolization procedure. These findings, if confirmed in larger studies, raise the possibility that smoking may play a significant role in vascular remodeling and angiogenesis in patients with HHT.
031 A Case of Spontaneous Uterine Artery Pseudoaneurysm in a Primigravid Woman at 16 Weeks’ Gestation

G. Hoots, S. Shube, C. Davis, K. Kuppler, R. Gnesda, B. Zwiebel

Purpose: 1. Discuss the incidence of uterine artery pseudoaneurysm

2. Causes of uterine artery pseudoaneurysms

3. Review considerations in Interventional management of a woman at 16 weeks’ gestation

4. Case of uterine artery pseudoaneurysm treated with percutaneous thrombin injection and subsequently coil embolization

5. Suggestions for observation and treatment of this rare but significant entity usually related to prior cesarean section

Materials and Methods: Uterine artery pseudoaneurysm is a rare entity usually reported in the postpartum setting after cesarean section but has also been reported in septic abortion. It is a significant cause of hemorrhage previously only documented in the postpartum period.

Results: We present a case of a G1P0 woman at 16 weeks’ gestation who presented with severe left lower quadrant pain and was found to have a large left adnexal pseudoaneurysm arising from the left uterine artery. It was initially treated with percutaneous ultrasound-guided thrombin injection. Postprocedure ultrasonography documented complete thrombosis and no injury to the fetus. Two days later, the patient had recurrent pain, and ultrasonography demonstrated recanalization of the pseudoaneurysm. Angiography and embolization were then performed. Magnetic resonance imaging of the pelvis performed 1 month later confirmed persistent thrombosis.

Conclusions: Uterine artery pseudoaneurysm is a rare cause of postpartum hemorrhage and has not previously been reported antepartum. Treatment decisions, especially at this stage of gestation, are complex given possibly injury to or loss of the fetus during surgery or when treated with thrombin injection or embolization.
032 A Classic Hepatocellular Carcinoma with an Uncommon Arterial Supply

N. Monfore, S. Saleem

Purpose: Review the most common vascular supply for hepatocellular carcinomas. Review extrahepatic arterial supplies for hepatocellular carcinoma (HCC) and provide an example.

Materials and Methods: HCC is the sixth most common cancer in the world and the third leading cause of death after colorectal and lung cancer. Treatment of HCC is multifactorial with chemoembolization being the recommended therapy for the intermediary stage. Evaluation of the vascular supply to the tumor is imperative because treatment efficacy depends on injecting the antineoplastic agent directly into the artery supplying the tumor. HCCs normally receive vascular supply from the left or right hepatic artery; however, tumor location and advanced stage of disease can facilitate the development of extrahepatic (EH) collateral pathways. For example, peripheral tumors often have EH vessels compared with those located centrally. The most common EH arterial vessel is the right inferior phrenic artery, which often involves lesions in the dome and posterior liver. Dome lesions may also be supplied by intercostal arteries with posteriorly located tumors supplied by the lower intercostal arteries and lateral tumors by the upper intercostal arteries. As tumors are treated with subsequent transarterial chemoembolizations (TACEs), they can become more aggressive in their recruitment of EH collaterals. For example, the right gonadal artery can be recruited in tumors found in segment 6 or tumors invading the right kidney. Although this is rare, other branches such as the superior right renal capsular artery, lumbar arteries, and omental branches have also been identified in the literature.

Results: An example of gonadal arterial supply is a 62-year-old man who presented for repeat TACE of a 3.5-cm segment 6 HCC. Initially, the patient had both a segment 3 lesion supplied by the left hepatic artery and a segment 6 lesion supplied by the right hepatic artery. After three TACEs, follow-up imaging demonstrated successful treatment of the segment 3 lesion with residual disease in segment 6. Repeat angiography demonstrated recruitment of the right gonadal artery by the segment 6 lesion, which was subsequently treated with 35 mg of doxorubicin,

Conclusions: HCC typically receives its arterial supply from the left and right hepatic arteries. However, depending on the location, advanced stages of disease, and increasing number of TACE procedures, HCC can recruit extrahepatic arterial supply from the most common inferior phrenic artery or the more rare right gonadal artery.
033 Bilateral Uterine Artery Embolization for Management of Uterine Vascular Malformations: Two Embolic Agents Technique

T. Al-Hazmi, A. Khankan, N. Bagabas

Purpose: To report our experience with bilateral uterine artery embolization (UAE) with consecutive using of two embolic agents, polyvinyl alcohol (PVA) particles, and a gelatin sponge (GS) slurry for the emergency treatment of vaginal bleeding related to uterine arteriovenous malformations (UAVMs)

Materials and Methods: Five women (mean age, 35.7 years) with acquired UAVMs were referred to interventional radiology on an emergency basis for bilateral UAE after presenting heavy and uncontrolled vaginal bleeding after different obstetric matters. Four patients had pervious obstetric manipulations, and one patient had incomplete abortion with no obstetric intervention.

Confirmatory diagnosis of UAVM was based on pelvic ultrasound or magnetic resonance imaging findings (or both). After obtaining confirmatory angiogram via femoral arterial approach, bilateral UAE was performed with using PVA particles followed by GS slurry until flow stasis in the uterine arteries. Technical success (bilateral embolization) and clinical success (absence of bleeding at 1 month after embolization) and complications were evaluated.

Results: Bilateral UAE of UAVMs was technically successful in all cases. All patients had confirmatory angiographic findings of UAVM. The rate of technical and clinical success was 100%. All patients have mild to moderate postembolization pain that was controlled conservatively and discharged from the hospital within the first 3 three days after the procedure. After follow-up, two women became pregnant with deliveries.

Conclusions: UAE is an effective emergency therapy for UAVMs with the potential to maintain fertility. Experience from these cases suggests that combination of PVA particles and GS slurry provides predictable and effective embolization.
034 Does Use of a Microcatheter During Pulmonary Arteriovenous Malformation Embolization in Patients with Hereditary Hemorrhagic Telangiectasia Decrease Recanalization?

M. Haddad, E, Bendel, A. Parvinian, A. Stockland, I. McPhail, V. Iyer, S. Misra

**Purpose:** To identify whether recanalization after coil embolization in patients with hereditary hemorrhagic telangiectasia (HHT) is less likely with the use of a microcatheter

**Materials and Methods:** We retrospectively identified all HHT patients treated with coils for pulmonary arteriovenous malformation (AVM) embolization between January 2000 and August 2017. Only cases with both clinical and imaging follow-up were included. Rates of primary recanalization and repeat embolization were evaluated.

**Results:** A total of 338 pulmonary AVMs (pAVMs) were embolized with coils in 85 patients with HHT in 131 separate cases. The patients consisted of 37 men (44%) and 48 women (56%) with an average age of 52 years (range, 11–90 years). The coils used were Nester only in 185 out of the 338 (55%) pAVMs embolized, Tornado only in 78 (23%), combination of Nester and Tornado in 61 (18%), Ruby only in 8 (2.4%), and combinations of other coils (Fiber, Hilal, and Ruby) in 6 (1.6%). A total of 180 of the 338 (53%) pAVMs were treated using a microcatheter, and 158 (47%) did not require use of a microcatheter. Technical success was achieved in all but two cases (99.4%), one in each group. The average follow-up time was 6.6 years (range, 0.1–13.5 years). There were 35 (19%) pAVMs that demonstrated primary recanalization in the microcatheter group of which 20 (11%) required a second embolization in 15 procedures. Statistical analysis using univariate analysis demonstrated that this was not significantly different in terms of primary recanalization ($P = 0.161$) and cases requiring a second embolization ($P = 0.920$) compared with the nonmicrocatheter group because there were 24 (15%) pAVMs that demonstrated primary recanalization of which 17 (11%) required a second embolization in 14 procedures. The 5-year cumulative probability of recanalization was 21.2% in microcatheter group and 13.0% in the nonmicrocatheter group; this risk was not significantly greater in the microcatheter relative to the nonmicrocatheter group hazards ratio, 1.224 [0.721–2.077]; $P = 0.454$).

**Conclusions:** In this cohort of patients with HHT undergoing coil embolization of pAVMs, microcatheter use did not confer an advantage in decreasing the incidence of primary recanalization or the need for a second embolization. These data suggest that coiling of the distalmost aspect of an arterial feeder of a pAVM using a microcatheter may not be necessary for satisfactory embolization. Further prospective investigation is warranted to validate these results.
Embolization of a Congenital Intrahepatic Portosystemic Shunt for the Treatment of Hepatic Encephalopathy

K. Singh, B. Goodman

**Purpose:** Intrahepatic portosystemic venous shunts are rare in noncirrhotic patients. The majority of the shunts appear to be congenital in origin; others are caused by rupture of a portal vein aneurysm into the hepatic vein. Patients with congenital intrahepatic portosystemic venous shunts are often asymptomatic, but some develop hepatic encephalopathy, either spontaneously or with precipitating events such as infections or gastrointestinal bleeding. Encephalopathy does not occur with a shunt ratio of less than 30%, but there are substantial risks for encephalopathy with shunt ratios in excess of 60%. In symptomatic patients, shunts can be reduced or closed with interventional radiological procedures that access the shunt transhepatically or through the hepatic vein.

**Materials and Methods:** This is a case report and review of the literature.

**Results:** A 58-year-old woman with no history of liver disease was evaluated for chronically elevated ammonia and altered mental status. Computed tomography demonstrated a large shunt between the right portal vein and the right hepatic vein. After management with lactulose, her symptoms persisted, and the decision was made for embolization of the shunt. The embolization was performed by a transjugular approach with an Amplatzer vascular plug and coils. After embolization, the patient’s symptoms improved, and her ammonia levels normalized. There were no procedure-related complications at 2 months’ follow-up.

**Conclusions:** Hepatic encephalopathy caused by portal-systemic shunt in patients without underlying liver disease is a well described and potentially reversible cause of encephalopathy. Embolization of congenital portosystemic shunt has good prognosis and can result in resolution of symptoms.
036 Emergent Embolization of a Tracheoinnominate Fistula

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Purpose: Tracheoinnominate fistula (TIF) is a fatal condition and complication of radiation necrosis. Patients can rapidly exsanguinate if not immediately treated. We report a case of emergent embolization of a TIF.

Materials and Methods: A 61-year-old female patient had a history of recurrent squamous cell laryngeal cancer status after chemoradiation and pharyngolaryngectomy with an ulnar forearm flap. She was found at home, unconscious and bleeding from her stoma. The patient was intubated by emergency medical services and transported to the emergency department, where she received blood transfusions for hemorrhagic shock. The endovascular team was then consulted.

Results: The patient was brought to the interventional radiology suite. Digital subtracted angiography aortogram was performed with and without manual compression of the stoma, demonstrating brisk extravasation from the distal innominate artery upon releasing pressure. The right common carotid artery did not opacify. The right subclavian artery was patent with a prominent right internal mammary artery (IMA) and thyrocervical trunk. Because of the emergent nature of the procedure and available supplies, we decided to occlude the innominate artery to take the pressure head off of the fistula. First, 12- and 10-mm AVP2 plugs were deployed proximal to the takeoff of the IMA to preserve right arm collateral supply. Next, we performed a sandwich technique embolization with tightly packed coils ranging from 8 to 16 mm followed by two more 10-mm AVP2 plugs. Flush aortogram demonstrated an occluded innominate artery without antegrade extravasation but with residual retrograde bleeding via cervical branches. Right subclavian artery opacification was delayed, but remained patent because of retrograde collaterals. The stoma was packed with V+Pad hydrophilic wound dressing to promote clotting. A final flush aortogram demonstrated no retrograde bleeding. There were palpable right upper extremity pulses and good oximetry waveform. The patient was then transferred to the intensive care unit in stable condition. She was extubated the next day and was able to follow commands. She had no further bleeding episodes in the hospital and was discharged to home hospice the following week.

Conclusions: In the setting of an exsanguinating TIF, rapid diagnosis and treatment are paramount. Embolization can be performed with the use of many different agents such as coils, plugs, and covered stents. In patients with robust collateral supply via contralateral internal and external carotid arteries, the innominate artery can be sacrificed with preservation of the distal upper extremity branches.
037 Juvenile Nasopharyngeal Angiofibroma: A Unique Case with Interventional and Coblator Endoscopic Surgical Treatment

M. Mulatre, V. Kadakia, G. M. Snowden, G. Digoy

Purpose: Juvenile nasopharyngeal angiofibroma is a rare head and neck tumor of adolescence whose diagnosis and management have changed over the past 2 decades. Patients often present after progressive tumor growth with symptoms of nasal or sinus obstruction. This tumor is markedly vascular, and surgery is often complicated by extensive blood loss, often necessitating transfusion. This is a report of a case with unique diagnostic features, an unexpected surgical course, and positive treatment outcome.

Materials and Methods: A 16-year-old male patient with history of nasal congestion developed the inability to breathe through his nose. Computed tomography of the sinuses demonstrated a large enhancing nasopharyngeal mass. Subsequent magnetic resonance imaging evaluation demonstrated a mass arising from the left nasal cavity with, interestingly, minimal invasion of the left sphenoid sinus. was is involvement of the right nasopharynx, including septum deviation. Of note, the preoperative platelet count was 108 k/mL, and this thrombocytopenia was perhaps caused by Kasabach-Merritt–like consumptive coagulopathy by the vascular mass. Given the tumor’s size and bilateral involvement, it was believed that angiography and embolization would be of value to map the blood supply and reduce operative blood loss.

Results: Angiography via right femoral artery access demonstrated that the tumor was supplied by the left sphenopalatine artery, artery of the pterygoid canal, and right sphenopalatine artery. Embolization was performed with polyvinyl alcohol followed by coils.

On postoperative day (POD) 2, the patient was taken for surgical removal of the tumor via the left nares. The Coblator device (Smith and Nephew, London, United Kingdom) is used to debride and simultaneously cauterize the tissue, in the hopes of further decreasing procedural blood loss. Despite thrombocytopenia, the estimated intraprocedural blood loss was only 300 mL, and transfusion was not deemed necessary. The patient was discharged on POD 6 without complication.

Conclusions: This case report describes a combined neurointerventional and otorhinolaryngologic approach to a rare head and neck tumor. This case is unique given the minimal involvement of the sphenoid sinus despite relative large tumor elsewhere. This case is also unique because of its combined use of presurgical embolization and a Coblator device, which reduced blood loss to 300 mL. The average loss in the literature ranges from 1000 to 5000 mL, and this patient did not require blood transfusion.
038 Ovarian Vein Embolization as Treatment for Postural Orthostatic Tachycardia Syndrome and Pelvic Congestion Syndrome


**Purpose:** Pelvic congestion syndrome (PCS) is an important cause of chronic pelvic pain in women arising from dilated and refluxing ovarian and pelvic veins. Postural orthostatic tachycardia syndrome (POTS) is characterized by exaggerated tachycardia during orthostasis accompanied by symptoms of cerebral hypoperfusion such as dizziness, cognitive difficulties, and weakness. The link between POTS and PCS might be due to excess venous pooling in the pelvis, leading to a reduction in effective circulating volume. This study aims to elucidate the effect of ovarian vein coil embolization on clinical symptoms and quality of life in patients with PCS and POTS.

**Materials and Methods:** Retrospective analysis was done from September 2012 to June 2017. Inclusion criteria were as follows: diagnoses of PCS and POTS, successful ovarian vein coil embolization, and a follow-up duration of at least 12 months. Pelvic pain and dyspareunia were assessed using a numeric pain rating scale questionnaire to compare severity at baseline versus the 1-, 3-, 6-, and 12-month time periods postembolization. The Orthostatic Hypotension Questionnaire (OHQ) was used to determine changes in orthostatic symptoms at similar time intervals. The Short Form 36 (SF-36) Health Survey was used to assess change in quality of life at 12 months postembolization.

**Results:** Fourteen of 21 patients who met the inclusion criteria participated in this study. All were women (100%) with a mean age of 38.0 ± 8.1 years.

Pelvic pain and dyspareunia showed significant improvement. Mean changes in pelvic pain scores were as follows: 1.7 ± 2.8 (P <0.010), 2.3 ± 3.0 (P <0.002), 2.7 ± 2.8 (P <0.001), and 3.0 ± 2.7 (P <0.001) at 1, 3, 6, and 12 months postembolization, respectively. Reduction in dyspareunia was observed for each time interval postembolization with the following values: 2.0 ± 3.9 (P <0.025), 2.7 ± 3.7 (P <0.006), 2.9 ± 3.7 (P <0.004), and 3.0 ± 3.7 (P <0.004).

The average pre-embolization OHQ score was 5.9 ± 1.6. Significant improvement in OHQ scores across 1, 3, 6, and 12 months postembolization are shown as follows: 1.1 ± 2.5 (P <0.066), 1.7 ± 2.6 (P <0.011), 2.2 ± 2.7 (P <0.004), and 2.5 ± 2.9 (P <0.003), respectively.
Mean total SF-36 scores were compared at baseline versus 12 months postembolization with a mean change of 23.8 ± 27.3 (P <0.003), revealing significant improvement in quality of life.

**Conclusions:** Ovarian vein embolization potentially improves clinical symptoms and quality of life in patients with both PCS and POTS.
039 Overview of Methods Available to Facilitate Outpatient Uterine Fibroid Embolization

S. N. Weber, M. Chehab, M. M. Zaki

**Purpose:** To provide a review of adjuvant techniques to uterine fibroid embolization (UFE) aimed at improving patient comfort and satisfaction, as well as facilitating patient discharge. This includes brief background, technique and outcome of transradial approach, superior hypogastric nerve block (SHNB), and intraarterial lidocaine injection. Corresponding outcome measures relating to each method are also discussed.

**Materials and Methods:** Transradial approach: A left radial approach is preferred. A Barbeau test and preprocedure ultrasound are performed to confirm adequate radial artery diameter (>3 mm is preferable) and patency. Plethysmography is monitored on the ipsilateral thumb. A 4-Fr hydrophilic sheath is placed in the radial artery followed by administration of 3000 to 5000 U of heparin, 2.5 mg of verapamil, and 200 mcg of nitroglycerine. A 120-cm, 4-Fr hydrophilic catheter plus a microcatheter are used for UFE. Hemostasis is achieved with a compression band worn for 2 to 4 hours.

SHNB: The goal of SHNB is to temporarily inhibit pain receptors thought to contribute toward pain experienced after UFE. The location of the aortic bifurcation is outlined via a catheter placed “up and over” from a femoral approach. A 21-gauge needle is advanced under fluoroscopic guidance through the anterior abdominal wall until the L5 vertebral body or sacral promontory is reached. A test injection is used to confirm needle tip location. After the extravascular position is confirmed, 20 mL of 0.75% ropivacaine or 0.25% of bupivacaine is injected. A translumbar approach may also be used if the uterus is large or if identification of the aortic bifurcation is difficult.

Intrauterine lidocaine injection: With a microcatheter positioned in the horizontal segment of the uterine artery, 2 mL of 1% lidocaine mixed with 4 mL of saline is injected followed by one or two Gelfoam pledgets immediately after UFE. Other protocols include injection of 100 mg of lidocaine (10 mL of 1% lidocaine) either during or after UFE. It is important not to inject lidocaine before embolization because it can cause moderate to severe vasospasm, which can negatively affect the procedure.

**Results:** The transradial approach has been shown to reduce procedure duration time, reduce radiation exposure rates, and improve all-procedural comfort compared with traditional transfemoral approach. The technical success rate of UAE using the transradial approach has been shown to be high, even when the radial artery is larger than 2 mm, with one study reporting 100% success rate. Other advantages include lower
overnight admission rates, mitigation of bladder catheterization, and lower vascular complications. However, no significant change in UFE related pain versus the transfemoral approach has been seen.

SHNB has been shown to obviate the need for narcotic pain control altogether in some studies. Consequential reduced opioid related nausea was also noted. The time to perform SNHB procedure was only 4.5 minutes on average (range, 2.5–9.5 minutes).

Results of intraarterial lidocaine injection have been variable but overall beneficial. One study showed that lidocaine injection after UFE improved subjective pain scores but did not affect opioid requirements. Others have shown improved pain control with reduction in pain medication requirements in the first 4 to 48 hours after embolization. Findings in patients who underwent lidocaine injection after embolization suggested synergistic effects in causing fibroid infarction.

Conclusions: The option for same-day or outpatient UFE increases its attractiveness versus other procedures such as myomectomy and hysterectomy. These techniques may help facilitate this, with no compromise in treatment efficacy.
040  Prostate Artery Embolization: Prospective Single-Center Trial Evaluating Prostate Artery Embolization Outcomes for Benign Prostatic Hypertrophy (Prostates Over 90 cc)

K. Kuppler, R. Gnesda, L. Rachakonda, G. Hoots, C. Davis

**Purpose:** Prostate artery embolization (PAE) for treatment of lower urinary tract symptoms caused by benign prostatic hypertrophy (BPH) may be an alternative to traditional surgery. There is scant prospective data from the United States on PAE.

Patients with large prostates (>90 cc) from BPH have higher complication rates with surgical resection and TURP because of bleeding, risk of impotence or incontinence, and longer indwelling urinary catheter times. Patients with larger prostates tend to be older with more comorbidities, making surgical techniques more risky. The primary intent of this study was to evaluate patient symptoms scores before and after PAE by the International Prostate Symptom Score (IPSS 0 = no symptoms, 35 = worst symptoms), International Index of Erectile Function (IIEF <10 = severe erectile dysfunction, 75 = no ED symptoms) and quality of life (QoL) measures (0 = delighted, 6 = miserable). Secondary outcomes include prostate size by transrectal ultrasound (TRUS) at 6 and 12 months after PAE.

**Materials and Methods:** More than 100 patients have had PAE at our institution, but only 11 met criteria for the prospective study. All patients underwent preprocedure IPSS, IIEF, urodynamics (UDS), transrectal ultrasound (TRUS), PSA, digital rectal examination, and cystoscopy before the procedure. Postprocedure IPSS were performed at 1, 3, 6, 12, and 24 months. Postprocedure UDS and TRUS were performed at 6 and 12 months. The results include three patients 24 months after the procedure; eight patients are more than 6 months after PAE.

**Results:** Prostate volume (in cc) averaged 126 before PAE, 89 at 6 months, and 80 at 12 months after PAE. IPSS markedly improved postprocedure for 6 months (average drop from 25 to 8) before increasing at 12 and 24 months (10 and 13, respectively). QoL improved from baseline 4.5 (between “unhappy” and "mostly dissatisfied") to 2 ("mostly satisfied") at 24 month follow-up. Average IIEF scores improved from 21 to 42 at 24-month follow-up.

**Conclusions:** Patients undergoing PAE with prostate sizes larger than 90 g had significant improvement in symptoms at 24 months postprocedure. The average IPSS symptom score was reduced by 15 points at 12 months and 12 points at 24 months. QoL dropped 2.8 points at 12 months and 2.5 points at 24 months after PAE. In the urology community, an improvement in QoL by 1 point is considered significant. IIEF improved...
after PAE with no cases of worsening erectile dysfunction or incontinence. By 12 months, the average prostate had decreased to 63% of pre-PAE volume. Continued enrollment and follow-up are still being performed.
041 Radiation Dose Comparisons in Left Radial Artery Versus Right Common Femoral Artery Access for Transarterial Chemoembolism

C. Molloy, E. Nguyen, I. Lekht

Purpose: Transradial artery (TRA) access has rapidly gained popularity for hepatic transarterial chemoembolism (TACE). Multiple studies favor radial access for patient comfort, faster times to ambulation, and decreased access-related complications. Our goal was to identify if there are differences in radiation exposure to the operators between TRA access and traditional common femoral artery (CFA) access for TACE. Ergonomically lead shielding provides more effective radiation protection during TRA approach to TACE. We expected to find significant reduction in radiation exposure to the primary operator (PO) during TRA versus the right CFA approach to TACE.

Materials and Methods: We dedicated one day to study radiation exposure in three consecutive patients scheduled for treatment of hepatocellular carcinoma via TACE. Two patients underwent the TRA approach, and the third patient underwent the right CFA approach. The shielding was set up in a standard fashion used in our institution for every transradial case. The PO wore chest and waist dosimeters. At the same time, radiation dosimeters were set up in a simulated location of the operator for the right CFA approach and the shielding was also set up to simulate routine standard shielding used for every right CFA approach at our institution. During the right CFA case, the measurements and dosimeter setup were reversed. Radiation shielding included mobile lead shields (0.8 mm Pb eq and 0.5Pb eq) and Rad Pads (0.25 mm Pb eq). Routine lead curtain shields for scatter below the waist were attached on both sides of the angiography table.

Results: During the left TRA case, the simulated CFA operator dosimeters were removed from the suite during digital subtracted angiography (DSA) runs when the PO left the room. The simulation radiation dose to the right CFA PO was 37.6 times higher than the dose exposed to the left TRA PO. During the right CFA case, the simulated left TRA PO dosimeters were left in the suite the entire time (even when the right CFA PO left the room for DSA), and the right CFA PO dose was still 4.6 times higher than the simulated left TRA PO radiation dose. We also identified significant radiation dose heterogeneity.

Conclusions: The radiation dose to the left TRA PO was demonstrated to be markedly less than the radiation dose to the right CFA. The decreased left TRA operator radiation dose is likely due to several factors, including increased distance from the radiation source and ergonomic advantages allowing for optimization of lead shielding with left TRA access.
042 Recanalization of Pulmonary Arteriovenous Malformations in Patients with Hereditary Hemorrhagic Telangiectasia Based on Embolization Agent

M. Haddad, E. Bendel, A. Stockland, I. McPhail, V. Iyer, S. Misra

**Purpose:** To determine whether embolization agents are more effective than others in preventing recanalization of pulmonary arteriovenous malformations (pAVMs) in patients with hereditary hemorrhagic telangiectasia (HHT)

**Materials and Methods:** We retrospectively identified all patients with HHT treated for pAVMs between January 2000 and August 2017. Only pAVMs with no prior treatment and patients with both clinical and imaging follow-up were included. Embolization agents were grouped as Nester/Tornado coils, Amplatzer plugs, Ruby coils, and other (Hilal-Silver, Fiber, Helical, and MVP).

**Results:** A total of 117 patients with HHT were identified with 102 meeting the follow-up criteria. These patients had 372 pAVMs embolized in 151 procedures consisting of 39 men and 63 women with an average age of 52 years (range, 11–90 years). The average follow-up time was 8.5 years (range, 0.3–14.9 years). Technical success was achieved in all but two pAVMs (99%). Seventy-seven patients had 324 (87%) pAVMs embolized by Nester/Tornado coils, 24 patients had 33 (9%) pAVMs embolized by Amplatzer plugs, 8 patients had 9 (3%) pAVMs embolized with Ruby coils, and 5 patients had 6 (1%) pAVMs coiled by other agents. In the Nester/Tornado group, 57 of the 324 (17.6%) embolized pAVMs recanalized, with 37 requiring a second re-embolization in 25 procedures. Seven of the 37 pAVMs that required a second re-embolization went on to again recanalize with 5 requiring a third embolization. Although not statistically significant ($P = 0.0907$) based on statistical analysis using univariate analysis, the rate of recanalization was less in the Amplatzer group as 2 out of the 33 (6.1%) recanalized, none of which underwent a second embolization procedure for a variety of reasons. The 5 year cumulative probability of recanalization was 17.4% in the Nestor/Tornado group and 8.0% in the Amplatzer group; this risk was not significantly greater in Nestor/Tornado group relative to Amplatzer group (hazards ratio, 1.5 [0.4–6.4]; $P = 0.55$). For the Ruby group, 2 of the 9 (22.2%) pAVMs recanalized, and no recanalization occurred in the 6 pAVMs in the other group.

**Conclusions:** Although not statistically significant, rates of recanalization were less with Amplatzer plugs than traditional Nester/Tornado coils. pAVMs requiring another embolization procedure and again recanalizing were also less with the Amplatzer group. Further investigation of plugs and newer coils such as the Ruby coil will be required to determine whether they are more effective at embolization of pAVMs in patients with HHT.
043 Transradial Stent-Assisted Coil Embolization for Acute Gastroduodenal Artery Stump Hemorrhage Postpancreatoduodenectomy

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**Purpose:** Acute hemorrhage from a gastroduodenal artery (GDA) stump hemorrhage after pancreatectoduodenectomy (Whipple procedure) may be technically challenging because of the residual GDA stump being short. Primary coil placement carries the risk of prolapse into the proper hepatic artery and may necessitate sacrificing hepatic arterial flow for adequate control of hemorrhage. Low-profile bare-metal stent deployment followed by stent-assisted packing of the GDA stump may offer rapid, sustained control of hemorrhage with preservation of the hepatic artery. We evaluate the safety and efficacy of stent-assisted embolization of GDA stump performed via a transradial approach.

**Materials and Methods:** Between October 2014 and October 2017, 5 patients (all male; median age, 66 years [range, 51–72 years]) underwent six attempted transradial stent-assisted embolization procedures of the common or proper hepatic artery across a GDA stump because of active hemorrhage after Whipple procedures, which was confirmed by CTA. The procedures were performed between 6 to 27 days after the Whipple procedure. Demographics, treatment approach, angiography, outcomes, and adverse events were reviewed. Technical success was defined as control of target lesion hemorrhage with preservation of hepatic artery flow. Clinical success was defined as absence of recurrent hemorrhage requiring reintervention or transfusion for 30 days.

**Results:** All cases were performed via a left transradial approach with a 6-Fr Glidesheath Slender (Terumo, Somerset, NJ). All stenting was performed with the RX Herculink Elite (Abbott, Abbott Park, IL) balloon-expandable bare-metal stent (diameter range, 4.5–6 mm) deployed via a 6-Fr guide catheter. Microcoils were deployed through stent struts in 4 of 6 (66%) cases and glue in 1 of 6 (17%). In one case, overlapping bare-metal stents alone were sufficient for hemostasis. The technical success rate was 100%. The clinical success rate was 83% (5 of 6). The single clinical failure required reintervention at 2 days for stent-assisted glue embolization of a hepatic bifurcation blister aneurysm with durable result. No procedure-related adverse events or repeat bleeding occurred up to 30 days postprocedure.

**Conclusions:** Stent-assisted embolization is a safe and effective technique for hepatic artery preservation in the setting of acute GDA stump hemorrhage. This procedure can be successfully performed via a transradial approach.
044 Tumor Necrosis in Conventional versus Drug-Eluting Bead Transarterial Chemoembolization for Hepatocellular Carcinoma

E. Fayazzadeh, A. H. Amer, F. Aucejo, G. McLennan

**Purpose:** To compare pathological tumor necrosis after transarterial chemoembolization (TACE) using drug-eluting beads (DEBs) or the conventional method (cTACE) in patients with hepatocellular carcinoma (HCC) undergoing liver transplantation

**Materials and Methods:** Eighty-four patients with HCC receiving one episode of TACE (April 2004–March 2017) as the sole bridging therapy before liver transplantation were retrospectively studied based on the type of modality (cTACE, $n = 47$; DEB-TACE, $n = 37$). Patients’ background characteristics, including age, gender, primary tumor diameter, Child-Pugh classification, and Model for End-Stage Liver Disease (MELD) score, as well as doxorubicin dosage were nearly similar among the two groups. In the cTACE group, injection of lipiodol–doxorubicin emulsion was followed by administration of microspheres. Treatment endpoint in both groups was stagnation of flow or reflux in segmental or subsegmental arteries feeding the tumor. Index tumor necrosis was evaluated based on the pathological examination of liver after transplant and was classified into complete response (CR, 100% necrosis), partial response (PR, 30%–99% necrosis), and no response (NR, <30% necrosis). The percentage of tumor necrosis and treatment response (CR or PR) were compared between the groups using Student’s t-test and Fisher’s exact test, respectively.

**Results:** Tumor necrosis rates were $78\% \pm 32\%$ in the cTACE group and $71\% \pm 36\%$ in the DEB-TACE group ($P = 0.34$). Treatment response was complete, partial, or absent in 40%, 47%, and 13% of the patients in the cTACE group and in 38%, 43%, and 19% of the patients in the DEB-TACE group, respectively. There was no significant difference in treatment response between the cTACE (87%) and DEB-TACE groups (81%) ($P = 0.55$).

**Conclusions:** The present study showed similar outcomes between cTACE and DEB-TACE with regards to HCC tumor necrosis in patients undergoing liver transplantation.
045 Acute Gouty Arthritis Following Percutaneous Cryoablation of Renal Cell Carcinoma

G. Hoots, S. Lu, A. Hussain, K. Massis, C. Davis, B. Zwiebel

Purpose:

1. Review the incidence of renal cell carcinoma (RCC)
2. Review the treatment options in RCC
3. Review the complications of percutaneous and laparoscopic cryoablation of renal tumors
4. Present a case of acute gouty arthritis caused by tumor lysis after percutaneous cryoablation
5. Review tumor lysis syndrome and previously reported case of tumor lysis after hepatic radiofrequency ablation
6. Suggestions for observation and treatment of this rare but significant complication of percutaneous ablation

Materials and Methods: Percutaneous cryoablation of RCC is an increasingly popular method for treating lesions in patients needing nephron-sparing treatment with complication rates of less than 7% (Hines-Peralta et al., 2015; 6). We report a case of acute gouty monoarthritis in a 58-year-old woman with chronic renal insufficiency after cryoablation of a 3.8-cm left RCC lesion.

Results: The patient was not a candidate for partial nephrectomy (the mass was too large) nor nephrectomy (risk of dialysis dependence). The patient underwent three-probe cryoablation with hydrodissection for adjacent colon, which was immediately complicated by intercostal or retroperitoneal hematoma. After the cryoablation, on postprocedural day 5, the patient developed acute left ankle pain and bilateral leg edema. Her uric acid was elevated at this time, and her symptoms resolved after intravenous solumedrol. The patient's pain resolved completely by her 1-month follow-up visit at the interventional radiology clinic.

Conclusions: To the best of our knowledge, this is the first reported case of acute gouty monoarthritis after cryoablation of a RCC lesion in a patient with underlying chronic renal insufficiency. Clinicians should be vigilant of the potential for this complication in at-risk patient populations. Although rare, tumor lysis syndrome can result from percutaneous ablation treatments. The commonality between our patient and the previously presented case was severe chronic renal impairment resulting in impaired clearance of tumor lysis byproducts.
Evaluation of Potential Racial Disparities in Conscious Sedation Dose and Time During Chest Port Placement

J. Giesler, R. Abboud, S. Abboud, I. Patel

Purpose: In regards to management of acute and chronic pain, racial and ethnic disparities related to access and quality of care have been documented (1,2). In the orthopedic literature, differences in acute pain management among racial groups have been examined for closed fracture reduction (3). However, similar evaluation of racial disparities for pain control during interventional radiology procedures have not been conducted; the purpose of this study is to evaluate any racial disparities in pain medication administration during chest port placement at a single large academic medical center.

Materials and Methods: Institutional review board approval for this retrospective study was obtained. Conscious sedation time, fluoroscopy time, and Versed and fentanyl dose during port placement were documented and compared between 99 white and 36 African American patients using between-groups one-way analysis of variance. Rates of potential confounding variables such as recent chronic painful conditions, home narcotic use, and history of prior central venous access procedures were compared between groups using two-sided chi-square analysis after coding histories as binary yes/no events. Adverse outcomes between groups in the first 30 days after port placement (including non–ST elevation myocardial infarction, ST-elevation myocardial infarction, stroke, pulmonary embolism, deep vein thrombosis, port infection) were also compared using chi-square analysis. A P value less than 0.05 was considered statistically significant.

Results: There was no statistically significant difference between racial groups in terms of conscious sedation time, fluoroscopic times, or fentanyl and Versed dose during port placement (P = 0.39, 0.93, 0.60, and 0.97, respectively). There was also no significant difference between racial groups regarding prior venous access, prior outpatient narcotic use, history of chronic painful condition, or occurrence of postprocedure negative outcomes within 30 days (P = 0.83, 0.051, 0.080, 0.35, respectively).

Conclusions: Our study reveals no significant difference in conscious sedation time, fluoroscopy time, and Versed and fentanyl dose during port placement between white and African American patients. Potential health care disparities must be guarded against and addressed in all equitable, high-quality medical systems.
047 Novel Treatment of Functional Popliteal Artery Entrapment Syndrome with Ultrasound-Guided Botox Injection

A. Wadhwani, A. Mirakhur, M. Nutley, D. Bakshi

Purpose: To report a case of ultrasound-guided injection of botulinum toxin type A (BTX-A) as a viable option for treating functional popliteal artery entrapment syndrome (PAES)

Materials and Methods: A 19-year-old elite basketball player was referred to the department of vascular surgery with claudication symptoms in the left leg with pain brought on by climbing one flight of stairs. She did not complain of night pain, rest pain, or ulcerations. On examination, plantar flexion of the left ankle resulted in near complete occlusion of blood flow to her left leg, which resumed with dorsiflexion. She was further evaluated with ultrasound and magnetic resonance angiography (MRA).

Results: Ultrasonography and MRA were performed with the ankles in dorsiflexion and plantar flexion. Passive plantar flexion resulted in segmental occlusion of the popliteal artery in the left leg over a length of 5 cm. This segmental occlusion was relieved by dorsiflexion on both modalities. As suspected on clinical examination, her ultrasound and MRA findings were consistent with a type 6 PAES. Under ultrasound guidance, 22-gauge needles were used to access the belly of the lateral and medial gastrocnemius in the region of maximal occlusion of the adjacent popliteal artery. A total of 100 units of reconstituted BTX-A was injected. The patient tolerated the procedure well with no immediate complications. On 3-week follow-up, the patient reported a significant improvement in symptoms and function in the left leg. Sonographic evaluation of the popliteal artery in the neutral and passive plantar flexed position showed no evidence of significant arterial occlusion and a much improved appearance compared with pre-Botox injection study.

Conclusions: Functional PAES is a complex and poorly understood cause of exertional leg pain amongst young athletes. Knowledge about the correct diagnostic modality protocol and a multidisciplinary approach are critical in diagnosing it and treating it. Ultrasound-guided BTX-A injection is a novel and experimental treatment option that offers a viable alternative to muscle debulking surgery. To address the expected recurrence of symptoms, more studies are required to identify the optimal dosage and frequency of repeat Botox injections.

J.J. Klobuka, S. Warhadpande, M. Krosin

**Purpose:** To review the management of contrast reactions (including anaphylaxis), cardiac arrest, hemorrhagic shock, symptomatic bradycardia, tachyarrhythmias, difficult airways, and oversedation

**Materials and Methods:** Interventional physicians often treat the most unstable patients in the hospital. Although the clinical scenarios we list here do not occur every day, they can all be potentially life threatening and thereby warrant periodic review.

**Results:** Anaphylaxis is the most severe manifestation of iodinated contrast allergies and may present as laryngeal edema, angioedema, and cardiovascular collapse. Anaphylaxis *with* hypotension is treated with 0.1 mg (which is 1.0 mL) of intravenous (IV) epinephrine 1:10,000 dilution. Anaphylaxis *without* hypotension is treated with 0.3 mg (which is 0.3 mL) of intramuscular (IM) epinephrine 1:1000 dilution. These are contrasted with epinephrine dosing for cardiac arrest, which is 1.0 mg (or 10 mL) of 1:10,000 dilution, IV.

Hemorrhagic shock is treated by crystalloid volume resuscitation to a mean arterial pressure (MAP) goal of 65 mm Hg. If this goal is not reached, blood products will be necessary. The decision to administer blood products should be made early. Two units of packed red blood cells (O blood type) should be administered initially. If there is an anticipated need for more than 3 or 4 units of packed red blood cells, the massive transfusion protocol (MTP) should be activated. MTP involves transfusing red blood cells, platelets, and fresh-frozen plasma in a 1:1:1 ratio to prevent the dilutional coagulopathic effects seen when transfusing a significant volume of packed red blood cells and isotonic fluids.

Bradycardia with hypotension is treated with 0.5 mg of atropine IV, repeated every 3 to 5 minutes, to a maximum of 3 mg.

Unstable ventricular tachycardia should be treated by synchronized cardioversion or 6.0 mg adenosine IV.

Mallampati class greater than 2, atlanto-occipital angle less than 35 degrees, and thyromental distance less than 6 cm indicates a difficult airway.

Oversedation can manifest as stridor, hypoxemia, and hypercarbia. Treatment is with 0.2 mg of flumazenil and/or 40 ug naloxone depending on the type of sedation used.
Conclusions: Familiarity with the low-frequency but high acuity events we present here is vital for ensuring patient safety. Recognizing the signs of clinical emergencies and remembering the correct treatment dosing is the responsibility of all physicians in the angiography suite. We hope this review will serve as a handy reference for all who see it.
049 Novel Strategies for Alleviating Orthopedic Injuries Associated With X-ray Protective Aprons

G. Waterman, P. Jain, O. Milstein, B. Zwiebel

**Purpose:** Interventional radiologists, cardiologists, and vascular surgeons frequently conduct lengthy procedures that require the use of x-ray protective aprons. Unfortunately, this puts them at increased risk of orthopedic injury associated with the prolonged use of this equipment, including missed days of work, surgery, and shortened careers. Some efforts have been made in the field to reduce the discomfort and weight associated with the aprons, but this is often to the detriment of the protective value of the equipment, especially at higher x-ray beam qualities. Our use of novel design strategies, advanced material composition, and weight distribution provides significant relief without compromising protection over the entire diagnostic range.

**Material and Methods:** We address the problem using three compatible strategies in parallel:

1. Development of an architecture that shifts the apron load distribution away from the shoulders and lower back, thereby relieving pressure on the intervertebral disks

2. Development of novel design concepts that allow for the reduction of filler mass, which is used to provide structural support for the x-ray attenuating materials

3. Development of composite radiation attenuating material compositions that offer Pb-equivalent protection at a reduced weight even at the highest x-ray quality used in practice (150 kVp). The radiation attenuation of these composites has been modelled using Monte Carlo n-Particle code (MCNP) in an inverted broad-beam geometry in accordance with ASTM and IEC standards and compared with conventional alternatives.

**Results:** Four materials were compared with 0.5-mm Pb for x-ray attenuation at 100 and 150 kVp and mass reduction. They are StemRad Pb Composite A, StemRad Non-Pb Composite B, StemRad Non-Pb Composite C, and Sb 40%-Bi 60% Bilayer. At 100 kVp, all materials had greater than 98% x-ray attenuation, ranging from 98% to 98.6%. At 150kVp, Composite A and B were equally attenuating compared with 0.5-mm Pb (94.8%). Composite C was 91.4%, and the Bilayer 93.8%.

Composite A and B reduced the mass compared with 0.5-mm Pb by 10%, Composite C by 30%, and Bilayer was equal.
Conclusions: Our results show a tangible improvement over the state of the art in terms of weight reduction even at the highest relevant energy spectra. This innovation combined with design concepts that reduce the amount of filler mass in the equipment and improved weight distribution architecture will greatly alleviate the orthopedic issues associated with x-ray protective aprons.
**050 Products to Improve Safety in Interventional Radiology: Devices, Safety Applications, and Relevant Literature Review**

J. Hoffmann, D. Kim, D. Szafarski, F. Khan, M. Hon, N. Georgiou

**Purpose:** The goal of this exhibit is to review a variety of interventional radiology (IR) products that claim to have a safety component, describe their use, and educate readers on the level of evidence and amount of data that support or refute the use of each product.

**Materials and Methods:** A variety of products are available for use in the IR suite that have a safety component. Some involve radiation safety, and others improve procedure safety in other ways. Although some of these products have substantial scientific literature or data supporting their use, others have minimal, if any, data to support certain safety claims. IR physicians and trainees must develop an understanding of these devices, which ones are supported by scientific data, and how one can cost-effectively incorporate their use into practice.

**Results:** This educational exhibit reviews concepts of how specific devices may improve procedural safety, relating to overall patient safety, procedural efficiency, operator safety, and radiation safety. We present a detailed review of IR products that claim to have a safety component, including description of each product, indication for use, cost analysis, potential safety benefits to patients or operators, and analysis of the available literature that may support or refute the use of such devices. Products discussed include (but are not limited to) distal embolic protection devices, antireflux microcatheters, steerable microcatheters, disposable radiation absorbing drapes, ultrasound-accelerated catheter-directed thrombolysis, ultrasound guidance and micropuncture kit use for vascular access, various techniques for track embolization when performing image-guided percutaneous biopsy, computer-assisted biopsy technology, centesis kits with safety or retractable needles, and the use of blunt-tip trocar technique to access difficult intraabdominal locations for percutaneous biopsy or drain placement.

**Conclusions:** Awareness of the various safety-related products available in the IR suite is important for interventional radiologists to be able to safely and cost effectively incorporate their use in appropriate clinical scenarios.
051 Experience with Combined Lymphangiography and Adjunctive Glue Embolization for Treating Refractory ChylousLeaks

A. Pillutla, J. Elbich, G. Morano, S. Krause

Purpose: Lymphatic obstruction from surgical disruption or adhesions can manifest as ascites, pleural effusions, or lymphoceles and result in abdominal distension, dyspnea, steatorrhea, and malnutrition. Among nonsurgical treatments for chylous leaks, lymphangiography with lipiodol has demonstrated a therapeutic effect in approximately 50% to 70% of cases. In refractory cases, adjunctive N-butyl cyanoacrylate (NBCA) glue embolization has shown promising results. Glue delivery methods include direct lymphocele puncture, upstream lymph node embolization, and upstream lymphatic vessel embolization.

Material and Methods: This educational exhibit reviews the current literature on chylous leak interventions and provides the following:

1. Review the causes and sequela of chylous effusions.

2. Discuss the medical, minimally invasive, and surgical management for chylous leaks.

3. Describe two cases of refractory postsurgical chylous leaks treated successfully with combination lymphangiography and NBCA glue embolization.

Results: From September 2015 to September 2016, chylous leak interventions were performed in a 60-year-old woman who underwent resection of a retroperitoneal sarcoma and a 44-year-old man who underwent retroperitoneal lymph node dissection after testicular cancer. Lymphoceles were confirmed by disrupted lymphatic channels and lipiodol extravasation on lymphangiography. The female patient initially underwent lymphangiography and computed tomography (CT)–guided percutaneous sclerotherapy with Gelfoam and doxycycline. The male patient initially underwent lymphangiography and direct fluoroscopy-guided lymphocele puncture and injection of NBCA glue. Neither case showed a therapeutic effect with lymphangiography alone, and initial treatment in both cases failed. Because of multiple inflow channels, upstream lymphatic vessel NBCA embolization was not feasible. Therefore, fluoroscopy-guided percutaneous NBCA embolization of upstream lymph nodes was performed. The female patient achieved clinical symptom resolution, and 8-month follow-up CT showed no evidence of lymphocele recurrence. The male patient also achieved symptom resolution and underwent drainage catheter removal 1 month after treatment.
Conclusions: Combination treatment with lymphangiography and glue embolization proved effective in successfully treating two cases of refractory postsurgical chylous leaks.
052 Intersocietal Accreditation Commission Carotid Artery Facility Survey Results: Accreditation Improves Quality

M. B. Farrell, N. Merrill, M. Lally, D. Sacks

Purpose: In 2005, the Centers for Medicare and Medicaid Services (CMS) instituted National Coverage Determination for carotid artery stenting (CAS) in high-risk patients. The requirements for CMS certification narrowly focus on staff qualifications, infrastructure, and system support.

The Intersocietal Accreditation Commission (IAC) began accrediting CAS facilities in 2011. The IAC accreditation program is a rigorous evaluation of staff qualifications, facility operation, equipment quality control, safety, appropriate patient selection, procedure performance, clinical outcomes, and quality improvement. IAC-accredited facilities must meet benchmarks for quality and outcome.

This survey aims to assess the effect of IAC CAS facility accreditation on quality among those who have successfully completed the process.

Materials and Methods: In October 2016, an 11-question electronic survey was sent to all IAC-accredited CAS facilities to assess perception of the effect of IAC accreditation on quality. The number and percentage of respondents that agreed or strongly agreed with accepted quality indicators were combined and presented.

Results: Sixty-six percent of the facilities responded to the survey. Most facilities (75%) were hospitals with more than 500 beds. The number of physicians performing CAS ranged from 5 to 10, and the of procedures performed annually ranged from 10 to 75.

Of respondents, 100% believed IAC accreditation improved the quality of their CAS program, increased definition and documentation of appropriate clinical indications, distinguished their facility as a quality provider, improved documentation of neurologic assessment within 24 hours postprocedure and at follow-up, and provided sufficient value in view of the effort and cost required to achieve accreditation. Three quarters of the respondents believed IAC accreditation improved procedure standardization and benchmarking and increased participation in formal quality programs.

All respondents believed IAC accreditation was helpful in increasing resources for data tracking and documentation. Also, 25% believed the process increased resources for staffing and equipment.
Conclusions: Although the volume of IAC-accredited facilities is low, IAC-accredited CAS facilities believe accreditation improves quality and clinical outcomes and believed achieving accreditation to be of value.
053 Mentorship in Interventional Radiology

J. Hoffmann, A. Eweka, F. Khan, I. Ahmed, D. Katz

Purpose: To review the current status of mentorship in interventional radiology (IR), discuss the importance of mentoring programs at various levels, describe the benefits of these relationships for mentees and mentors, highlight techniques for conflict resolution, and provide a framework for creating a successful mentoring program.

Materials and Methods: With the development and implementation of the IR residency, medical students need to determine whether to pursue a career in IR by the end of their third year of medical school. Because this shifts the career-selection process earlier by up to 4 years, substantial curricula changes and mentoring initiatives are needed to ensure that students have adequate IR exposure and can make appropriate career choices. As the concept of mentorship becomes more embraced in IR, it is equally important to recognize its role for the specialty as whole, including students, residents, fellows, junior attendings, and senior leadership.

Results: Mentoring is an important component of academic medicine, including IR, yet it is not specifically emphasized in most training curricula, and many academic departments across North America do not have formal mentoring programs for medical students, residents, fellows, and faculty. We review the concept of mentorship; explain the meaning of a "mentor"; review the relevant available literature on mentoring programs in IR; highlight the development of the SIR mentoring program; review the difference between a mentor and a teacher; discuss key differences among mentoring students, residents, fellows, and faculty; discuss how to find a mentor; and describe how to develop a successful IR mentoring relationship.

Conclusions: IR training pathway changes have resulted in a need for increased medical student outreach and mentoring by interventional radiologists, helping students to adequately evaluate IR as a potential career choice. This increased focus on mentorship highlights the role that interventional radiologists play in connecting with students, increasing exposure to IR, and impacting IR recruitment but also should stimulate development and implementation of mentoring programs for IR residents, fellows, and attending physicians.
054 Minimally Invasive Isolated Limb Perfusion: A First Report of a New Technique


Purpose: Isolated limb perfusion (ILP) enables administration of very high doses of chemotherapeutics regionally with low systemic toxicity. The most common indications are melanoma in-transit metastases and sarcomas. An alternative method is isolated limb infusion (ILI), which have the advantage of a percutaneous placement of the catheters. The toxicity profile is similar, but the response rates are inferior. A new technique that combines the benefits of each method is this newly developed minimally invasive ILP (MI-ILP) technique.

Materials and Methods: An 8-10Ch arterial and 12-14Ch venous Bio-Medicus NextGen catheter was placed percutaneously in the ipsilateral vessels using ultrasound guidance and then connected to an oxygenated perfusion system. The perfusion was performed during 60 to 90 minutes using melphalan alone \( (n = 5) \) or melphalan plus tumor necrosis factor alpha \( (n = 1) \). Response (World Health Organization criteria) and the worst local toxicity (Wieberdink scale) were evaluated at 3 months.

Results: Six patients were treated (melanoma in transit, \( n = 5 \); squamous cell carcinoma, \( n = 1 \)). The median number of tumors were 3, with a largest size of median 15 mm. There were five femoral and one brachial approach. The median perfusion flow was 555 mL/min (range, 110–711 mL/min), the leakage during perfusion was 0.1% (range, 0.0%–3.2%). The response rates at 3 months were 67% CR and 33% SD. The local toxicities were 67% grade II and 33% grade III.

Conclusions: MI-ILP is a new minimally invasive technique for tumor treatment. All procedures were successful, without any need for conversion to open surgery and with similar perfusion characteristics as for standard open surgery ILP. Further studies are needed to establish the role of MI-ILP in future cancer care.
055 Political Action Committee Funding: Where Interventional Radiology Lags Behind

J. Huang, B. Hyatt, M. Cedillo, S. Belmustakov, M. Makary, D. Huynh, H. Yu, K. Patel

Purpose: To compare funding of the Society of Interventional Radiology Political Action Committee (SIRPAC) with other physician political action committees (PACs) over the past 10 years.

Materials and Methods: The number of practicing physicians per specialty was garnered via the 2015 AAMC workforce survey. Contributions to physician society PACs was acquired on opensecrets.org from 2006 to 2016. Data were analyzed using Excel (Microsoft) and SPSS (IBM).

Results: A total of 28 PACs bearing physician specialties were identified through the AAMC workforce survey and opensecrets.org. The number of physicians per specialty ranged from 2967 (interventional radiology [IR]) to 114089 (internal medicine). Contributions to PACs were evaluated from 2006 to 2016. The contributions ranged from as low as $6975 to as high as $3,032,451 over a 2-year cycle. When normalized for the number of practicing physicians, the average per capita contribution per cycle (2 years) ranged from $1.36 to $104.36, $2.20 to $123.05, $2.17 to $158.29, $2.67 to $148, $2.93 to $135.68, and $2.25 to $137.80 in 2006, 2008, 2010, 2012, 2014, and 2016, respectively. SIRPAC performance during this time period was between $26.54 and $37.79, placing it 8th of 28.

When comparing SIRPAC with PACs of societies with fewer than 10,000 physicians, it place 8th of 11. Vascular surgery, with its 3358 members compared with IR's 2967, place 6th. However, the average contribution to the vascular surgery PAC over the past 12 years averages $45.70 compared with SIR'AC's $34.84, a difference of $300,845. SIRPAC has only collected $623,188 during this time period, so the difference accounts for nearly 50% of SIR'AC's total donation value. Of note, the total dollar amount SIRPAC has raised from 2006 to 2016 ranks 6th of 28 PACs. Cardiology PAC has a total contribution of $5,318,810 during this time period with similar average per-physician donation as SIRPAC but with nearly nine times the members.

Conclusions: IR has prided itself in being innovators and ahead of the curve in health care delivery. However, our society PAC is sorely underfunded compared with other specialties. The downstream effects of this are uncertain but troubling considering most of our colleagues are way ahead in terms of buying power on Capitol Hill. Policy drives practice; therefore, awareness and support for SIRPAC are critical if IR is to have a voice where it matters most.
056 Portosystemic Gradients as a Predictive Factor for Development of New Hepatic Encephalopathy Following Transjugular Intrahepatic Portosystemic Shunt Placement


**Purpose:** To evaluate the predictive value of portosystemic gradients (PSG) for new-onset hepatic encephalopathy after transjugular intrahepatic portosystemic shunt (TIPS)

**Materials and Methods:** This single-center retrospective study included 215 patients who underwent de novo TIPS placement between June 2011 and August 2017. Patients were grouped into those requiring subsequent narrowing or occlusion because of new-onset encephalopathy refractory to medical management and those requiring dilation because of continuation of symptoms from portal hypertension. Periprocedural variables from the original TIPS placement were recorded for all cases, including change in PSG pre- and post-TIPS placement as well as post-TIPS PSG. Independent samples t-test, chi-squared analysis, Fisher’s exact test, and receiver operating characteristic (ROC) curve were used for analysis with \( P > 0.05 \) regarded as significant. SPSS v23.0 (IBM) was used for analysis.

**Results:** Of the patients undergoing de novo TIPS placement at our institution, 5.6% (12 of 215) required narrowing or occlusion because of refractory hepatic encephalopathy, 10.2% (22 of 215) required dilation(s) because of recurrent symptoms of portal hypertension, and 84.2% (181 of 215) did not require subsequent revision within our follow-up period. Comparing patients who underwent subsequent revision with those who did not, no significance was found in post-TIPS PSG (narrowing or occlusion: \(-10.9\) vs \(-11.2, P = 0.880\); dilation: \(-11.7\) vs \(-11.2, P = 0.684\)) and change in PSG (narrowing or occlusion: \(5.1\) vs \(6.2, P = 0.098\); dilation: \(6.8\) vs \(6.2, P = 0.333\)). The ROC curve for evaluating post-TIPS PSG as a determinant for narrowing or occlusion had a nonsignificant area under the curve of \(0.643 (P = 0.096)\).

**Conclusions:** No significant association was found between the change in PSG after TIPS placement and the need for subsequent revision defined by this study. Furthermore, post-TIPS PSG does not appear to have predictive utility for new-onset hepatic encephalopathy. Clinically, this is in contrast to recommended critical post-TIPS PSG threshold of greater than 5 mm Hg to avoid complications from a low-pressure gradient. This study may be limited by a small sample size of TIPS narrowing or occlusions \(n = 12\); Model for End-Stage Liver Disease [MELD] score: range = 5.5–14.3, mean = 10.2) and dilations \(n = 22\), given the rarity of post-TIPS narrowing or occlusion procedures.
057 Preoperative Angiography and Embolization of Giant Solitary Fibrous Tumor

P. V. Rana, R. Hieb

Purpose: Solitary fibrous tumors (SFTs) are highly vascular rare neoplasms accounting for fewer than 2% of all soft tissue tumors. SFTs often reach massive proportion before becoming symptomatic. The large size and high vascularity make resection of these neoplasms very challenging. Interventionalists may perform preoperative embolization to decrease morbidity during surgical removal. Teaching points will include identification of the target vessels that should be interrogated during angiographic evaluation for SFT feeding vessels. We also report a unique case of a giant pleural SFT with an unusual dual vascular supply from both the bronchial and pulmonary artery systems, demonstrating the importance of preoperative angiography and embolotherapy.

Materials and Methods: A 55-year-old male construction manager was referred to our hospital for evaluation of large left lung mass noted on chest radiography after complaints of shortness of breath and persistent cough. Chest computed tomography demonstrated large mass filling left hemithorax, compressing the left lung, with chest wall invasion and bony destruction. The tumor compressed the left superior pulmonary vein and left lower lobe bronchus and encircled but did not invade or extrinsically compress the left pulmonary artery. After multidisciplinary evaluation, because of the hypervascularity of this lesion, preoperative embolization followed by surgical resection was planned.

Results: The patient was brought into the angiography suite. During angiography, extensive vascularity arising from the pulmonary artery and bronchial artery systems was visualized. Feeding vessels from the left internal mammary artery, two left bronchial arteries, and branches of the left pulmonary artery were identified and embolized with coils, PVA particles, and glue. Upon resection, the resected mass was found to be 4477 g, measuring 29.0 x 20.0 x 13.0 cm.

Conclusions: We believe this is the first time that an SFT has been reported with dual vascular supply from both the pulmonary and bronchial artery systems. This emphasizes the need for careful preoperative angiographic evaluation to identify the major vascular supply to the tumor, which may be extremely variable. The use of preoperative embolization decreases intraoperative bleeding, reduces the need for perioperative transfusions, and improves the safety of surgical resection of SFT.
058 Successful Implementation of A New Interventional Radiology Emergency Response in a Level 1 Trauma Hospital


Purpose: Prompt treatment is necessary for critically injured trauma patients who require immediate interventional radiology (IR) procedures for hemorrhage control. The American College of Surgeons requires arrival time of the IR team within 30 minutes of notification for this low-volume but high-risk patient population for level 1 and 2 trauma facilities. Before this intervention, the monthly compliance to response within 30 minutes of notification was roughly 54.5%. The purpose of this project is to develop a new response system that will increase IR compliance to 100%.

Materials and Methods: A multidisciplinary team met and identified current challenges to meeting this requirement. The first goal was to identify criteria that met the definition of an emergent trauma case. The criteria included patients with a REBOA (resuscitative endovascular balloon occlusion of the aorta) without immediate need for operative intervention (typically hemodynamically stabilized patients with zone 3 REBOA and active extravasation in the pelvis), active vascular extravasation with transfusion requirement, as well as if the need for IR was determined in the operating room (typically damage control laparotomy patients with high grade liver injuries).

A flow chart was established to identify the steps anticipated to streamline and expedite a process for consistency in notification, preparation, and transportation of the patient.

The team discussed the existing notification process and determined that notification of the residents and IR staff was also necessary but that it needed to be a specific stat trauma page and required some changing of assigned pagers.

Education was provided to the team with a focus on the new process, including chain of communication, notification of IR, and subsequent confirmation of notification by pagers.

Results: The pager captured the notification time, and the IR nurses logged the physician arrival time into the paging system, establishing a means of monitoring this metric. A total of 17 cases were included for evaluation from May 2017 to August 2017 with a trial period beginning June 1, 2017. The preintervention response time was 54.5%. The postintervention response rate increased to 75% with a 100% response rate in August 2017.
Conclusions: Implementation of a new response system has increased IR's response time from 54.5% to 75% with the goal of obtaining a consistent 100% 30-minute response time for critically injured patients. By achieving this goal, our department hopes to improve patient outcomes.
059 The Role of the Critical Care Experience in Early Specialization in Interventional Radiology

Z. Masi, S. Amin

**Purpose:** As interventional radiology (IR) moves toward a categorical residency and a more comprehensive clinical model, the role of resident education in managing critically ill patients is rapidly increasing in importance. The testing grounds for this paradigm shift within the field is the intensive care unit (ICU) rotation within the early specialization in interventional radiology (ESIR) tract. The aim of this presentation is to evaluate both the immense potential and the possible limitations of this experience in resident education.

**Materials and Methods:** After the completion of a month-long critical care rotation at Cooper University Hospital, a level I trauma center and stroke center in Southern New Jersey, we evaluated the impact of the experience on resident education within the context of the ESIR program. Resident evaluations from critical care faculty, procedural logs, and participation in multidisciplinary conferences were assessed. Skill sets developed in the ICU setting, which are not part of the traditional radiology curriculum, were documented. Subsequently, their importance to successful management of IR patients was discussed with IR faculty, and relative values were assigned based on the frequency and importance of using the specific skill.

**Results:** Functioning as a resident in the ICU provided experience in managing patients with unstable hemodynamics and airway issues, both of which are advantageous to interventionalists in practice. The ICU experience allowed for performing procedures on the medical floors, such as peripheral arterial lines, placing central venous access with ultrasound guidance, and bedside thoracentesis. Ultrasonographic assessment of cardiac function was likewise performed with much higher frequency, mastery of which can be essential for determining prognosis and treatment in massive and submissive pulmonary embolism, as well as intraprocedural evaluation of patients at high risk of coronary events.

**Conclusions:** Rotating through the ICU offers clear subjective advantages to a resident preparing to be an exceptional interventional radiologist. Objectively quantifying the benefits of this experience will require further assessment involving testing of residents’ didactic knowledge and clinical performance before and after the critical care requirement is completed. The more accurately the educational benefits can be detailed, the more the resident experience can be specifically tailored to the needs of the interventional radiologist in training.
060 The Steerable Microcatheter: Impact on Superselective Angiography Procedural Efficiency and Radiation Safety

J. Hoffmann, D. Kim, A. Eweka, S. Mittal

Purpose: To study steerable microcatheter (SM) use in moderate and highly difficult vessel selection compared with conventional preshaped microcatheter (CM) use, including ease of vessel selection, time to target vessel selection (TTVS), procedure time, and radiation exposure index

Materials and Methods: An institutional review board–approved single-institution, prospective analysis of 40 complex angiographic procedures with superselective microcatheter use during a 3-month period in 2017 was performed. Target vessels were deemed moderate or highly difficult to select based on vessel size, tortuosity, or angulation during nonselective initial angiography. Data collected included type of microcatheter used (SM or CM), number of microcatheters and microwires used, procedure time, radiation exposure index (dose area product [DAP]), target vessel location, and TTVS (time from device placement to vessel selection). The relative difficulty of vessel selection perceived by the operator before and after each procedure was recorded using a 10-point Likert scale. Comparison between the SM and CM groups was performed using Wilcoxon test.

Results: A SM (SwiftNinja, Merit Medical, South Jordan, UT) was used to select 46 vessels in 20 patients. One or more CMs were used in 20 patients to select 34 vessels. Median TTVSs were 12 seconds (range, 4–155 seconds) in the SM group and 47.5 seconds (range, 12–480 seconds) in the CM group (P <0.001). No guidewire was used when selecting 33 SM vessels, with median guidewire use of 0 in the SM group and 2 in the CM group (P <0.001). The median total procedure times were 75 minutes in the SM group and 112 minutes in the CM group (P = 0.03). The median DAPs (microGray.m²) were 26,948 in the SM group and 30,904 in the CM group (P = 0.29). Despite the SM’s group being perceived to have more difficult vessels to cannulate (median Likert score of 7 in the SM group vs 5 in the CM group; P <0.001), the actual ease of vessel cannulation perceived by the operator was easier in the SM group (median Likert score of 3 in the SM group vs 5.5 in the CM group; P <0.001).

Conclusions: Use of a steerable microcatheter, without or with a guidewire, leads to easier and faster target vessel selection with shorter procedure times in appropriately selected cases.
061 The Sunshine Act: Development, Implementation, and Current Controversies

D. Kim, A. Eweka, F. Khan, A. Baadh

Purpose: The goal of this exhibit is to review the development of the physician Open Payments Program (OPP), describe its current use and implications for interventional radiologists, and detail a variety of current controversies that exist surrounding this program.

Materials and Methods: The physician OPP (Sunshine Act) requires medical product manufacturers and group purchasing organizations to disclose to Centers for Medicare and Medicaid Services via the National Physician Payment Transparency Program any payments or transfers of value to physicians or teaching hospitals. It was designed to increase transparency of the financial relationships between industry and physicians and hospitals. An understanding of the OPP program, what interactions are reported, how to access and dispute this information when needed, and current controversies surrounding the OPP will help interventional radiologists make informed decisions regarding their interactions with industry based on what is best for their practice from both an educational and patient care perspective.

Results: This educational exhibit reviews the OPP: what it is, why it was developed, when it was implemented, and who is affected. We discuss the current status of the OPP and review literature about potential impacts on interventional radiologists. We review the importance for physicians to monitor what has been reported about them and how to access the information and initiate a claim dispute in a timely manner, if needed. A variety of OPP system controversies are discussed, including (but not limited to) overall goal of providing transparency to patients but no context is given to the general public or patients, the cumbersome process and timeline for interventional radiologists to dispute data, misperception among public that such relationships are illegal, analysis of various reporting loopholes that exist, the role of Medical Communications Companies in these relationships, and what happens to the OPP if the Affordable Care Act is replaced.

Conclusions: It is critical for interventional radiologists to understand the OPP, what is reported, and how to dispute claims so they can make appropriate choices in terms of how to interact with industry to meet both their professional educational and patient care needs.
062 Ultrasound-Guided Percutaneous Periarterial Thrombin Injection for Paracentesis-Related Hemoperitoneum

D. P. Duncan, B. Abudu, G. Rivera-Sanfeliz, E. Deyoung

Purpose: To present a case of periarterial injection of thrombin for the treatment of paracentesis-related hemoperitoneum after failure of conservative and conventional therapy.

Materials and Methods: A 50-year-old man presented to the emergency department with a 2- to 3-day history of progressively worsening unsteady gait, weakness, and somnolence. He underwent a diagnostic and therapeutic paracentesis without image guidance performed by the critical care team using a 5-Fr digital subtracted angiography needle and subsequently became hemodynamically unstable. Computed tomography (CT) of the abdomen and pelvis with and without contrast demonstrated intraperitoneal active extravasation at the right lateral abdomen, presumably at the site of prior paracentesis. He was not a surgical candidate. He was taken to the angiographic suite, where there was extravasation at the right T11 and T12 intercostal arteries. Transcatheter transarterial Gelfoam embolization was performed; however, his hemoglobin continued to trend down, and he required multiple transfusions to maintain his hemodynamics. Repeat CT showed continued bleeding. Repeat interventional radiographic and surgery were deemed unsafe or unlikely to be successful. Evaluation of the paracentesis site by Doppler ultrasound demonstrated a color jet extending into the distended peritoneum. Under ultrasound guidance using a linear 12-3 MHz transducer, approximately 3000 U of thrombin was injected in a slow pulsatile fashion adjacent to the origin of the vascular jet. After approximately 3.5 mL of the thrombin–saline mixture was injected, an approximate dose of 3000 to 3500 U, the vascular jet was no longer visualized.

Results: The patient’s hemoglobin remained stable, and the patient’s hemodynamics improved over the 72 hours after the procedure.

Conclusions: The reported case shows the efficacy of ultrasound-guided percutaneous thrombin injection in the setting of arterial hemorrhage after paracentesis when performed by a well-trained interventional radiologist. Although transcatheter embolization and surgery remain the first-line therapies because of their proven efficacy and safety, ultrasound-guided thrombin injection could be considered as an alternative, particularly when traditional therapies fail or are prohibited by comorbidities.
063 Use of the FLEX Scoring Catheter as a New Arteriovenous Access Management Device

J. Ross, J. vale, J. Pigott

**Purpose:** End-stage renal disease, treated by hemodialysis, affects more than 2 million people worldwide. There is a growing clinical requirement for arteriovenous (AV) access management advancements that are cost-effective, reduce AV complications (including thrombosis), and improve patient outcomes. The FLEX Scoring Catheter (VentureMed Group, Toledo, OH) was evaluated in the treatment of AV access stenosis.

**Materials and Methods:** The Flex Scoring Catheter is a 6-Fr, 0.18-inch guidewire-compatible device. Recently, a 40-cm useable catheter length has been commercialized. The FLEX has three atherotomes that modify AV stenosis during pull-back with Dynamic Scoring technology. FLEX can be rotationally controlled to create multiple linear scores. Voluntarily provided case reports (18 operators in 10 hospital systems) from 59 patients treated for AV access complications between January 2017 and October 2017 were analyzed. The patients treated had mean age of 63 years (28 women, 31 men). The lesions were treated with the FLEX Scoring Catheter followed by the administration of a drug-coated balloon (DCB) or plain old balloon angioplasty (POBA). Luminal gain after treatment by the FLEX Scoring catheter was calculated followed by subsequent opening balloon pressure and the overall luminal gain achieved postprocedure.

**Results:** Of the 59 cases evaluated, 41 (70%) were AV fistulae, and 18 (30%) were AV grafts. The average lesion length was 33 mm (range, 2–80 mm). The average AV access stenosis was 83% (range, 50%–100%) before treatment. The average luminal gain after using the FLEX improved 25%. The average opening balloon pressure (defined as the pressure required for complete lesion effacement) was 6.5 atm (range, 3–16 atm), and the maximal balloon inflation pressure averaged 12.1 atm (range, 4–24 atm), significantly below most AV access procedures. Residual stenosis after FLEX plus angioplasty averaged 8.2% (range, 0%–40%). The most common balloon diameter was 8 mm (n = 26). Eleven patients were treated with DCB after FLEX.

**Conclusions:** The growing occurrence of renal disease and subsequent hemodialysis illustrates the need for advancements in AV access management. FLEX before angioplasty allows for significant luminal gain. Lesion effacement with angioplasty after FLEX occurs at subnominal pressures. Early experience with the FLEX Scoring catheter suggests it may offer benefits in the management of AV access, especially in the era of DCB. Further studies are warranted.
What's the Score?! A Review of Classification and Scoring Systems Used in Interventional Radiology

J. Hoffmann, A. Eweka, D. Kim, I. Ahmed, N. Georgiou, M. Hon

**Purpose:** The purpose of this exhibit is to thoroughly review a variety of classification and scoring systems that are relevant to interventional radiologists and trainees.

**Materials and Methods:** Classification and scoring systems are widely used in medicine to aid physicians in their clinical decision making and to guide medical care. Interventional radiologists must be aware of and be able to use classification and scoring systems in clinical practice, at tumor boards, and during interactions and discussions with referring physicians and must be able to provide longitudinal patient care.

**Results:** This educational exhibit provides interventional radiologists and trainees with a high-yield review of a wide array of classification and scoring systems that are used in interventional radiology. These include clinical and imaging examples, when appropriate, as well as relevant literature review. Topics will include (but are not limited to) tumor, node, metastasis (TNM) staging system; Barcelona Clinic Liver Cancer (BCLC) staging system for hepatocellular carcinoma; Well's criteria; Model for End-Stage Liver Disease (MELD) score; Childs-Pugh Score; Eastern Cooperative Oncology Group (ECOG) score; Visual Analogue Pain Scale; Uterine Fibroid Symptoms and Health-Related Quality of Life (UFS-QOL) score; multiple tumor response grading systems (including Response Evaluation Criteria in Solid Tumors [RECIST], European Association for Study of the Liver (EASL), and modified Response Evaluation Criteria in Solid Tumors [mRECIST]); International Prostate Symptom Score; Sexual Health Inventory for Men (SHIM) score; CEAP (Clinical, Etiology, Anatomy, Pathophysiology) system to classify chronic venous disorders; and Rutherford Classification system.

**Conclusions:** Interventional radiologists and trainees must be aware of and be able to use appropriate scoring and classification systems when evaluating their patients and following outcomes after procedures. Appropriate utilization demonstrates sound knowledge base and clinical acumen and helps clinicians to communicate effectively and efficiently about their patients.
065 AngioJet For Acutely Thrombosed Renal Fenestration Bridging Stent Grafts: Initial Experience

S. Mafeld, G. Annamalai, S. F. Stella, K. Tan

Purpose: We outline our experience with a previously unreported technique using AngioJet (Boston Scientific, Marlborough, MA) rheolytic thrombectomy in the management of acutely thrombosed renal fenestrated stent grafts. Fenestrated endovascular aneurysm repair (f-EVAR) is an evolving technique to treat abdominal aortic aneurysms in patients who are unsuitable for conventional infrarenal EVAR. The technique requires bridging stent grafts between the aortic graft main body and the visceral arteries. Visceral bridging stent graft patency with f-EVAR is high, approaching 90% at 4 years. Acute thrombosis of the visceral arteries after f-EVAR can have potentially catastrophic clinical outcomes, and there is limited consensus and experience in managing this presentation.

Materials and Methods: This is a retrospective study of patients who underwent AngioJet rheolytic thrombectomy for acutely thrombosed visceral stent grafts after f-EVAR. The picture archiving and communication system (PACS) and electronic medical record (EMR) were reviewed for case details and outcomes.

Results: Three patients (all male; mean age, 81 years) presented acutely at a mean of 49 days after f-EVAR with acute renal failure and confirmed renal fenestrated stent graft occlusion on computed tomography. Two of the patients had solitary kidneys. All patients underwent AngioJet rheolytic thrombectomy, two patients underwent additional localized infusion of tissue plasminogen activator, and one patient also required renal angioplasty and stent insertion. There was a 100% technical success rate defined as reestablishment of renal arterial flow. At mean follow-up of 14 days postprocedure, there were a mean creatinine reduction of 33% and a 30% recovery in estimated glomerular filtration rate.

Conclusions: In our experience, AngioJet rheolytic thrombectomy is safe and technically successful in the management of acutely thrombosed renal fenestration bridging stents. It provides an effective, endovascular management option in this difficult-to-treat patient cohort.
066 Single-Center Evaluation of Patients Undergoing Superficial Femoral Artery Thrombolysis with and without Distal Embolic Protection

E. Russell, D. Hechavarria, E. Dobrow, D. Mittleider

**Purpose:** To evaluate the differences in subjective and objective measures of pain in patients undergoing lower extremity thrombolysis with and without the use of a distal embolic protection (DEP) device. Additionally, to evaluate the safety profile of DEP use in this group of patients.

**Materials and Methods:** EMR and catheter angiography studies were reviewed for patients at our institution. Ten patients were identified who underwent successful catheter thrombolysis for angiographically proven acute or subacute long segment superficial femoral artery (SFA) occlusions between 2015 and 2017. Four of these procedures had DEP devices deployed before thrombolysis, and seven did not. One patient had two separate events and was included in each subgroup analysis. Patients were included regardless of existing SFA stents. Patients without angiographic evidence of active SFA involvement, patients who underwent endovascular therapy before thrombolysis, and patients with vascular grafts were excluded. Patient pain levels were reported on a standardized 10-point visual analog scale, and the range of pain values during thrombolysis was reviewed. Morphine equivalent dose of analgesia per hour of thrombolysis was calculated. Unpaired t-tests were performed.

**Results:** The average thrombolysis times for the DEP group and non-DEP group were 37.4 and 38.7 hours, respectively ($P = 0.86$). The morphine equivalent doses per hour of thrombolysis were 2.5 mg/hr in the DEP group and 3.7 mg/hr in the non-DEP group ($P = 0.49$). The difference in average subjective reported pain for non-DEP patients and DEP patients was not statistically significant ($P = 0.79$). One patient in the non-DEP group had a distal embolus into the anterior tibial artery as a complication. No patients in the DEP group had angiographic evidence of embolic complications. No patients in either group developed signs of local or systemic infection.

**Conclusions:** The clinical utility of DEP device deployment during lower extremity arterial thrombolysis remains controversial. This study demonstrates a trend toward decreased narcotic use in patients who underwent thrombolysis with DEP; however, this finding was limited by low statistical power and would benefit from a larger patient group. There was no statistically significant difference in the subjective reported pain between either group, nor was there increased infection risk secondary to the prolonged dwell time of the DEP.
catheter. There were no acute distal embolic events during thrombolysis in the DEP group, and there was one event in the non-DEP group.
067 Thinking Outside the Skull: Employing Cerebral Stent Retrievers for Distal Arterial Emboli

N. Thangaraj, G. Suarez Duran, A. Trebelev, B. Bianco

Purpose: Upper extremity distal embolization is a described complication of percutaneous dialysis fistula thrombectomy. Although the emboli are typically singular and self-limited or managed conservatively, acute limb ischemia is possible. Angiography followed by directed thrombolysis has been used in upper extremity ischemia secondary to emboli and surgical embolectomy is reserved for severe cases when limb viability is challenged. Mechanical interventions for upper extremity ischemia are less explored, especially in distal emboli. Using devices, such as clot retrievers typically used for cerebral emboli, may offer a novel form of intervention for upper extremity ischemia secondary to emboli.

Materials and Methods: We explore the case of a 57-year-old woman at our institution who complained of numbness and paresthesia in her left hand after a percutaneous thrombectomy of a left upper extremity fistula at an outside hospital. Acute occlusion on the left of the ulnar and interosseous arteries at their origin and the distal radial artery at the level of the metacarpals was identified on angiography. Directed alteplase therapy was sufficient to lyse the thrombus in the ulnar and interosseous arteries. Given the location of thrombus in the radial artery, the decision was made to use the Trevo XP ProVue (3 x 20 mm), a cerebral stent retriever, which was successful in restoring flow to the superficial and deep palmar arches of the radial artery. We also compare this method with other well-known techniques in retrieving emboli in declotting procedures such as backbleeding, manual thromboaspiration, and mechanical intervention devices such as this AngioJet Possis system.

Results: After the successful use of a cerebral stent retriever in our patient, we explored the possibility of using this device in other patients with distal arterial emboli. We explored several factors that can contribute to selecting the right patients in which to use this method.

Conclusions: If embolism retrieval devices used in the cerebral vasculature can be used in the distal extremities when conservative treatment and directed lysis are unsuccessful, the patient may be spared surgical intervention and the associated complications. Our successful use of the Trevo XP ProVue Retriever (3 x 20 mm) in the distal radial artery could encourage other interventionalists to explore its use for embolectomy in distal vasculature of the upper extremity and elsewhere.
068 Gait Analysis of Patients with Peripheral Arterial Disease Before and After Endovascular Therapy

T. Kakihana, O. Ito, MD, H. Goto, D. Akamatsu, Y. Sekiguchi, M. Akizuki, M. Kohzuki

Purpose: Patients with peripheral arterial disease (PAD) show slower walking speed and lower joint torque, which is the force attributed to muscle contraction across a joint of lower extremities such as the hip, knee, and ankle during walking. We reported the reduction in hip flexor moment may relatively increase the load of the calf muscles and induce calf claudication in patients with aortoiliac PAD. However, it is not clear how these parameters change before and after revascularization.

Materials and Methods: We recruited 10 PAD patients, who had 9 unilateral and 1 bilateral intermittent claudication (11 limbs), and performed endovascular therapy (EVT). Walking speed and each joint torque, including hip extensor and flexor, knee extensor and flexor, ankle plantar flexor, and dorsi flexor, were measured by three-dimensional motion analysis device during walking compared with 11 healthy control participants. Ankle-brachial index (ABI) and walking distance with a treadmill were assessed before and after EVT.

Results: The EVT using stents was performed for all of the limbs. The stents were placed in three common iliac arteries, five common plus external iliac arteries, and three external iliac arteries. The mean time between an EVT and an exercise test was 2.3 ± 1.7 days. After EVT, the ABI increased from 0.60 ± 0.17 to 0.98 ± 0.16 (P < 0.001). The pain-free and maximum walking distance also improved (420.4%, P = 0.008, 224.4%, P < 0.001 respectively). Before treatment, slower walking speed (75%, P < 0.01) and lower hip flexor torque (HFT, 66%, P < 0.01) and knee extensor torque (KET, 54%, P = 0.015) were observed in the PAD patients compared with the healthy control participants. There was no significantly difference in ankle plantar flexor torque (APT) between groups. EVT significantly increased walking speed by 15% (P = 0.013), HFT by 20% (P = 0.015), and KET by 41% (P = 0.008), but APT remained unchanged. However, walking speed and HFT were significantly lower in the PAD patients after EVT compared with the healthy control participants.

Conclusions: Although the walking speed and joint torque were improved early after EVT, the improvement of waking speed and HFT were insufficient. Our results suggest that hip flexor muscle training may have an effect on walking performance rather than ankle plantar flexor muscle in PAD patients after revascularization.
069 Occlusion Perfusion Catheter: A Universal Drug Delivery Device, Next Generation

R. Teeslink

**Purpose:** Advanced Catheter Therapies (ACT) has designed the Occlusion Perfusion Catheter (OPC) to function as a universal agent delivery system that will accommodate any therapeutic agent, including pharmaceuticals, biologics, and live cells.

**Materials and Methods:** The OPC is a five-lumen catheter designed with proximal and distal occlusion balloons, a center space-occupying balloon, an inflow port, an outflow port- and a guidewire lumen compatible with standard 0.014 wire. It is a 5-Fr catheter, compatible with a 6-Fr sheath. A fiberoptic pressure sensor is incorporated into the inflow lumen to monitor treatment chamber pressure. Occlusion balloons define the treatment region.

The proximal and distal occlusion balloons are inflated simultaneously to control blood flow and create a treatment chamber. In addition, they serve to prevent systemic distribution of the agent. The fourth and fifth lumens are for inflow and outflow ports located within the established treatment chamber. The trapped blood is removed from the treatment chamber by flushing with saline.

The space-occupying balloon can be inflated to minimize the amount of therapeutic agent required when indicated. This balloon never touches the vessel wall.

After the blood has been evacuated, the therapeutic agent is delivered. A sensor monitor controls and optimizes pressure within the chamber for penetration into the media of the vessel wall, longitudinally and circumferentially.

**Results:** Confocal analysis of the vessel wall demonstrated delivery of fluorescent paclitaxel within media and adventitia, circumferentially and longitudinally.

Pharmacokinetics analysis demonstrated a straight line of 0.1 mcg/mL for 72 hours. According to Axel et al (1), the effective range of paclitaxel is 0.0085 to 0.85 mcg/mL to effect a 90% to 99% inhibition of human arterial smooth muscle cells.

Seven-day specific electron microscopy demonstrated paclitaxel delayed healing effect. Twenty-eight-day histology demonstrated normal reendothelialization. Live cell testing demonstrated that the OPC can deliver live cells with minimal mechanical damage at a wide range of pressures.
Conclusions:

Preclinical testing conclusions include that the OPC:

1. Delivers an agent circumferentially and longitudinally into the vessel wall
2. Delivers the effective range of paclitaxel for 90% to 99% inhibition of human arterial smooth muscle cells, maintaining normal intimal endothelial function by noncoating
3. Delivers multiple agents
4. Supports multiple use in the same patient, above and below the knee
5. Controlled pressure within the chamber negates the requirement for accurate balloon to wall measurements
6. Delivers live cells with minimal mechanical damage to the cell membrane
7. Negates blood–agent admixture
8. Minimizes systemic effect via flushing
9. Decreases cost
070 Recanalization of Lower Limb Chronic Arterial Occlusions with Radiofrequency Wire

R. Yamada, K. Gillen, T. Kuhlman, C. Forsberg, C. Schonholz, M. Guimaraes

**Purpose:** To describe the use of radiofrequency (RF) wire as a crossing and reentry device for chronic arterial occlusions of the lower extremity

**Materials and Methods:** Three patients with chronic arterial occlusions of the lower extremities underwent recanalization assisted with RF wire after failure of conventional technique. In two patients with occlusion of the common iliac artery (CIA) and external iliac artery (EIA), the RF wire was used as a crossing device. The third patient had occlusion of the superficial femoral artery (SFA), and the RF wire was used as a reentry device. The RF wire used was the Powerwire RF Guidewire (Baylis Medical, Montreal, Canada). It is a 0.035” x 250 cm wire with different shapes of the tip, varying from straight to 40-degree angulation. The wire is connected to a 100- to 120-V generator that delivers 25 W of power and radiofrequency energy of 455 to 465 kHz.

In patients with CIA or EIA occlusions, retrograde access was gained in both common femoral arteries. Through the contralateral side, a 10-mm Amplatz GooseNeck Snare (Covidien, Minneapolis, MN) was placed in the distal aorta as a target. On the ipsilateral access, the RF wire was inserted through a 5-Fr directional catheter. Alignment between the RF wire and snare loop was checked in anteroposterior, right anterior oblique, and left anterior oblique views multiple times as the RF wire was being advanced.

For the SFA lesion, the occlusion was crossed with conventional technique, but distal reentry into the lumen could not be obtained. Under roadmap visualization, the RF wire was inserted through a directional catheter and advanced toward the lumen. The catheter was then advanced over the wire and intraluminal position confirmed. All lesions were primarily stented.

**Results:** All three patient were men with a mean age of 73.6 years. Symptoms included intermittent claudication, rest pain, and nonhealing ulcer. Mean lesion length was 16.3 mm (range, 18–7 cm). The technical success rate was 100%, and there were no minor or major complications associated. Mean follow-up time was 6.6 months.

**Conclusions:** RF wire can provide an alternative approach to cross the obstruction and to reenter the distal lumen, allowing endovascular arterial recanalization when conventional technique fails.
071 Drug-Eluting Stent Use in Femoropopliteal Disease: Results from a Retrospective, Single-Center, Real-World Study

M. Earle, R. Gullipalli, A. Major, G. Browne

Purpose: The use of drug-eluting stents in the treatment of femoropopliteal peripheral artery disease remains a relatively new approach to management. This retrospective, single-center study evaluates the efficacy of the Zilver-PTX drug-eluting stent in the management of femoropopliteal disease in real-world patients with complex vascular lesions.

Materials and Methods: The Zilver-PTX drug-eluting stent has been used at our institution since 2010. All patients with symptomatic femoropopliteal disease treated with the Zilver-PTX drug-eluting stents since 2010 were included in the study. Clinical outcomes were assessed for patients with 1-year of follow-up. The primary clinical outcome measured was freedom from target lesion revascularization (TLR), a measurement of the need for repeat percutaneous or surgical revascularization. Lesion characteristics, using both Trans-Atlantic Inter-Society Consensus II (TASC) and Rutherford classifications, as well as patient comorbidities were also collected.

Results: In total, 77 patients were included in the study. Of these, 62 patients had 1 year of follow-up. Patient characteristics included high incidences of smoking (42%), diabetes (65%), chronic kidney disease (16%), and hypertension (95%). Patients primarily had a single lesion (70%) versus multilevel disease (29%). Lesions were mostly TASC B (50%), with TASC C (29%) and TASC A (20%) making up a smaller percentage. By Rutherford classification, the majority of lesions were class 3 (35%) but also seen were class 4 (13%), class 5 (18%), and class 6 (16%). Freedom from TLR was 85% at 6 months and 79% at 12 months.

Conclusions: Despite increased incidence of patient comorbidities and complex lesions, clinical outcomes remain similar to those seen in clinical trials, confirming the effectiveness of the Zilver-PTX stent in a real-world population.
072 Unique Use of Intravascular Ultrasound to Identify Remnant Pacemaker Insulation within the Superior Vena Cava

J. Stoneburner, J. Hallsten, A. Chhabra

Purpose: Incomplete permanent pacemaker (PPM) hardware removal is strongly associated with cardiovascular implantable electronic device (CIED) infection relapse with rates as high as 50% to 100% compared with 0% to 4.2% when the whole system is removed. Although rare, patients with incomplete hardware removal have mortality rates ranging from 31% to 66%. To investigate the remnant hardware from prior incomplete hardware removal, current practice typically uses contrast-enhanced chest computed tomography (CT) and transesophageal echocardiogram (TEE) as first-line imaging modalities. However, we present a case in which intravascular ultrasound (IVUS) identified remnant hardware within the superior vena cava (SVC) after the two first-line imaging modalities had failed.

Materials and Methods: We present a rare case in which a 61-year-old man presented with fever, chills, and aches months after CIED removal prompted by gram-negative bacteremia. Despite subsequent hardware removals and replacements with courses of antibiotic therapy, the same gram-negative bacteremia continued to recur. Although contrast CT scan and TEE imaging techniques were used with no success, IVUS of the brachiocephalic vein and SVC successfully identified the remnant hardware. The insulation was noted as a ghost image visible only on IVUS.

Results: Upon surgical removal of the remnant insulation, a culture from the insulation grew out 4+ for the same gram-negative species. The patient was followed up for a total of 18 months and has remained infection free since the remnant insulation removal.

Conclusions: This case demonstrates that the use of peripheral IVUS catheter to visualize within the SVC was clinically effective in a patient with incomplete CIED hardware removal and recalcitrant bacteremia. Only one other published case involves IVUS to identify PPM leads in a vessel larger than a coronary artery. Our case is the first documented use of IVUS to pinpoint and acquire images of PPM lead insulation in the SVC (18–22 mm). This novel technique is relevant to the larger context of intravascular imaging and demands further study and inquiry into alternative diagnostic uses of IVUS.
073 Acquired Hemorrhagic Vascular Malformation After Elective Termination of a Cesarean Scar Ectopic Pregnancy

D, Kazimirko, A. M. Patel, K. Saleh, B. Kelly, D. Hofstede, G. Campbell

Purpose: To describe the diagnosis and treatment of an iatrogenic vascular malformation after elective abortion of a cesarean scar ectopic including illustrative sequence of events, diagnostic workup, treatment, and follow-up

Materials and Methods: A 24-year-old G5P3013 presented with heavy vaginal bleeding 4 weeks s/p ultrasound guided intragestational potassium chloride–methotrexate installation for a ~7 week cesarean scar ectopic pregnancy (CSP) after unsuccessful intrauterine compression balloon ablation attempt. The chronological beta-human chorionic gonadotropin (bHCG) trend was established.

Ultrasonography demonstrated a highly vascular lesion at the site of the previous CSP measuring up to 5 cm, with no residual embryonic or fetal cardiac activity or bladder invasion. Multiphasic computed tomography angiography further defined the lower uterine segment hypervascular mass, which was concerning for arteriovenous malformation (AVM). The patient continued with active bleeding from the cervical os (~600 mL) despite vaginal packing, requiring ongoing volume resuscitation, and thus was brought to angiography suite for emergent uterine artery embolization (UAE) to stop the bleeding and preserve the uterus. A 5-Fr RCFA sheath, 5-Fr angled base catheter, and 2.8-Fr microcatheter were used.

Pelvic and selective uterine arteriograms demonstrated hypertrophied bilateral uterine arteries supplying a hypervascular uterus and focal tangles of vessels infiltrating spherical area in the lower portion with transient contrast pooling and early venous opacification consistent with an acquired high-flow uterine AVM.

Bilateral UAE was performed with combination of 500 to 700 micron Embospheres and Gelfoam pledgets. Complete cessation of vaginal bleeding was achieved.

Follow-up: Magnetic resonance angiography at 1 week after UAE showed a residual or recurrent 3.5-cm uterine AVM with few internal tortuous vessels supplied from bilateral recanalized uterine arteries. Ultrasonography at 2 weeks after UAE demonstrated cesarean scar site with a 1.7 x 1.4 cm gap with partially involuted surrounding tissue that had not fully resolved. The patient reported mild continued bleeding lightened to 1 pad per day.
Ultrasonography at 2 months after UAE demonstrated relatively normal perfusion throughout the uterus, both laterally along the uterine arteries and throughout the myometrium including the midline. The cesarean scar defect further healed up to 5.3 mm in thickness. bHCG had normalized with no further evidence of bleeding. The obstetrician/gynecologist deemed the cesarean scar site to be reasonable in thickness and indicated that attempting conceptions would be within the standard of care, with low risk for recurrent CSP.

**Results:** CSP is a rare type of ectopic with incidence estimated 1 per ~2000 associated with high morbidity including infection, bleeding, recurrent ectopic pregnancy, uterine rupture, and death. Treatment of CSP carries significant reported complication rates of 47% to 62%, necessitating emergency hysterectomies, laparotomies, and UAEs (Timor-Tritsch).

Patients presenting with life-threatening hemorrhage after elective abortion carry an important differential diagnosis, including placenta accrete or percreta as remnant from pregnancy termination procedure (differentiate on imaging), gestational trophoblastic disease (high bHCG), or iatrogenic vascular malformations.

High-flow uterine AVMs have the classic features of enlarged feeding arteries supplying a complex of small vessels with early venous drainage. Pseudoaneurysms of the uterine artery may have one or multiple feeding branches. A nonarteriovenous uterine vascular malformation should be considered as subinvolution and failure of obliteration of the placental bed vessels in the absence of retained placental tissue after cessation of pregnancy. Angiographically, this type of uterine vascular malformation appears as hypertrophied uterine arteries, rapidly opacifying the uterine parenchyma and normally draining into large pelvic veins with no direct communication between the artery and vein (Salazar). An arteriovenous fistula would demonstrate a direct communication between an artery and vein.

We illustrate a case of an acquired vascular malformation after elective termination of ectopic pregnancy. Mechanical manipulation by cervical dilation with balloon compression followed by direct intragestational instillation of potassium chloride and methotrexate to induce fetal demise could have contributed to the development of such vascular lesion.

Endovascular treatment of uterine AVMs with UAE have been used both to prevent intraoperative bleeding and stop postoperative bleeding (Yang, Timor-Tritsch). Chou et al reported that use of nonresorbable microspheres may provide a more definitive devascularization both in duration and distal penetration as gestational sac at the cesarean scar site may require 3 to 4 months to complete resolution. A 2- to 4-week duration of vessel occlusion with absorbable Gelfoam particles may be insufficient because of extensive
neovascularization and thus may require repeat UAE. Even if there is no extravasation of contrast material, bilateral UAE is still effective in controlling bleeding.

**Conclusions:** Endovascular treatment with UAE is safe and effective in a patient with a potentially morbid uterine AVM at the site of a cesarean scar ectopic for preservation of fertility and uneventful recovery. Endovascular treatment of uterine AVM with UAE can be used to prevent intraoperative or control postoperative bleeding. Nonresorbable microspheres may provide a more definitive devascularization over Gelfoam to allow the lesion enough time to involute.
074 Fatal Outcome After Embolization of a Pulmonary Arteriovenous Malformation in a Child

D. A. Lopez, M. Mallon

**Purpose:** Case report of a 14-year-old male patient with a large pulmonary arteriovenous malformation (pAVM) and pulmonary arterial hypertension (PAH), likely caused by hereditary hemorrhagic telangiectasia, that was treated with Amplatzer occlusion, subsequently developed right cardiac failure and died 4 days after the procedure. The case report discusses the different clinical presentations in children with pAVM. It also describes imaging findings of pAVM in chest radiography, echocardiography, computed tomography angiography (CTA), and angiography. There is a discussion of treatment indications in pAVM according to size, symptoms, and associated conditions, specifically PAH. Last, the incidence of complications and mortality after pAVM occlusion are discussed.

**Material and Methods:** Literature review, pictorial review

**Results:** The initial symptoms in pAVM are dyspnea, cyanosis, and digital clubbing caused by hypoxemia secondary to a right-to-left shunt. The natural course is not benign and can be associated with life-threatening complications, such as cardiac failure, stroke, cerebral abscess, pulmonary hemorrhage, hemothorax, hemoptysis, and rupture of PAVM at any age, independent of lesion size.

The main imaging finding on chest radiography is a soft tissue mass and in CTA and angiography is a feeding artery, aneurysmal part, and draining vein.

pAVM occlusion by embolization is the first-line treatment; if successful, it leads to regression of the pAVM and reduces complications. Embolization complication rates in children are similar to those for adults.

Patients with PAH, large-caliber shunts, giant lesions covering an entire lobe, renal failure, and other special conditions (e.g., allergy to intravenous contrast, unsuccessful endovascular intervention) are excluded from embolization and are candidates for surgical excision. On the other hand, a retrospective study showed that embolization of pAVM did not lead to a consistent increase in pulmonary artery pressure (PAP) in a series which that individuals with severe PAH.

No periprocedural mortality had been reported with embolization of pAVM, and complications have in general been infrequent and self-limited.
Conclusions: Even when patients with higher PAP are more likely to report a symptomatic benefit if pAVM can be safely occluded, the fatal outcome in this patient indicates that severe PAH should be a contraindication because it can result in acute fatal increases in PAP and heart failure as in this case, in which surgical resection should have been considered.
075 Selective and Super-Selective Angiography for Frameless Radiosurgery Planning of Arteriovenous Malformations


Purpose: Radiosurgery (RS) for intracranial arteriovenous malformations (AVMs) requires accurate three-dimensional delineation of the nidus. Previously, we published on the integration of dynamic computed tomography angiograms (dCTAs) for AVM RS. Although this technique represented a significant improvement over existing methods, accurate delineation of the nidus can be challenging for select small AVMs. In selected micro-AVMs and poorly visible AVMs, we have used selective digital angiography to assist with nidus definition for RS planning.

Materials and Methods: Four patients who had AVMs inadequately visualized with magnetic resonance imaging (MRI), magnetic resonance angiography, computed tomography (CT), and computed tomography angiography, including dCTA were identified for selective angiography (two had super-selective angiography). The mean age at the time of treatment was 45 years (range, 22–71 years). All patients had prior hemorrhage and were deemed inoperable. Super-selective angiography was done under general anesthesia to minimize motion artefact and the risk of arterial dissection. Angiography was performed using a biplane angiographic suite. Volumetric data was acquired through rotation of the C-arm-mounted flat-panel detector cone-beam CT system. The data set was imported into the RS TPS and co-registered with the treatment planning CT, T2 MRI and dCTA. Delineation of the AVM nidus was performed by the multidisciplinary AVM team.

Results: There were no adverse events related to the selective angiography. Selective CTA clearly demonstrated feeding arteries, the nidus, and the draining veins. Selective CTAs were accurately co-registered with treatment planning scans in the RS TPS and used to define the nidus and develop RS plans in all four patients. The mean nidus size was 0.45 cc (range, 0.07–1.00 cc). To date there have been no acute or late side effects of RS. Efficacy of RS will be reported at a later date.

Conclusions: Selective and super-selective CTAs can be successfully imported into the robotic RS TPS to assist in nidus delineation for selected patients with small or poorly visible intracranial AVMs.
Cephalic Arch Anatomy and Fistula Access Dysfunction Following Cephalic Arch Stent Grafting

S. Abboud, V. Wu, J. Cui, Z. Irani

Purpose: Cephalic arch stenosis (CAS) is often implicated in brachiocephalic fistula dysfunction secondary to multiple anatomic factors. Although angioplasty (PTA) remains first-line treatment, stent graft (SG) placement is increasingly used in this setting. The relationship between the cephalic–axillary vein confluence angle (CAA) and fistula access dysfunction following SG for CAS has, to our knowledge, not been described. Here we report our experience with VIABAHN SG placements for CAS.

Materials and Methods: Retrospective review was performed to identify patients who received SG for treatment of CAS and received follow-up fistulograms for access dysfunction. CAA was categorized as less than 60 degrees (group A) or greater than 60 degrees (group B). The findings for dysfunction were noted on fistulogram. One-sided Student’s t-test compared time to access dysfunction between groups A and B.

Results: Thirty-seven patients were identified for this review between January 2014 and July 2017. Nineteen returned for fistulogram because of access dysfunction; 15 of them had stent edge stenosis. The average time to stent-edge stenosis was 192 days. Eleven of 19 patients had CAA less than 60 degrees (group A), and 8 of 19 had CAA greater than 60 degrees (group B). The average time to access dysfunction was 247 days and 137 days in groups A and B, respectively; there was a nonsignificant trend for longer time to access dysfunction in group A (P = 0.07).

Conclusions: Patients with a CAA less than 60 degrees demonstrated a nonsignificant trend toward greater time to brachiocephalic fistula access dysfunction after cephalic arch stent-graft placement versus those with a CAA greater than 60 degrees. Our study is limited by sample size; further investigation regarding the possible relationship between CAA and time to access dysfunction after cephalic arch stent grafting is warranted.
077 Endovascular Recanalization of Chronically Occluded Suprahepatic Inferior Vena Cava Anastomosis Status Post Liver Transplant

C. Molloy, E. Rosenthal, J. Van Rompaey, I. Lekht

Purpose: Inferior vena cava (IVC) occlusion may occur because of intraluminal thrombus, extrinsic compression, or rarely after orthotopic liver transplant (OLT) at the IVC anastomosis. This presentation discusses the clinical presentation, workup, and treatment of patients with IVC occlusion s/p OLT. We also present a case of chronic suprahepatic IVC occlusion.

Teaching points:
- Clinical presentation of IVC occlusion
- Imaging and laboratory workup of IVC occlusion
- Treatment options for IVC occlusion
- Techniques for endovascular recanalization for IVC occlusion

Materials and Methods: Patients with IVC occlusion may present with bilateral lower extremity (BLE) swelling, abdominal pain, and hepatosplenomegaly. In OLT patients, the workup should include liver function tests and ultrasonography, computed tomography, or magnetic resonance imaging to evaluate the vasculature and help guide treatment options.

A 53-year-old man with a history of OLT for treatment of hepatocellular carcinoma presented with BLE swelling and abdominal swelling. Prior imaging demonstrated chronic occlusion of the intrahepatic IVC. Despite serial venograms, venoplasties, and stenting of the middle hepatic vein–IVC junction to 20 mm, his symptoms recurred. Endovascular recanalization of the IVC was planned.

Results: In the angiography suite, right transjugular access and right common femoral vein access were obtained. Venogram from the inferior IVC demonstrated total occlusion of the suprahepatic IVC with extensive collateral flow via the azygous vein and abdominal collateral veins. Venogram from the right atrium also demonstrated no direct flow to the IVC. Sharp recanalization was performed from the right atrium into the IVC and extended into the middle hepatic vein stent using an introducer sheath and 16-gauge intrahepatic needle. Additional sharp recanalization was then performed from the right atrium into the intrahepatic IVC.
recannulated intrahepatic IVC was lined with 12-mm Viatorr stents. Venogram from the infrahepatic IVC demonstrated direct inline flow from the infrahepatic IVC to the right atrium with no residual stenosis.

**Conclusions:** It is important for interventional radiologists to recognize the clinical signs of IVC occlusion. Patients with chronic IVC occlusion secondary to IVC anastomotic stricture may benefit from endovascular recanalization. Interventional radiologists should understand the endovascular treatment options for chronic IVC occlusion to provide relief for patients with chronic IVC occlusion status after OLT.
078 Endovenous Laser Treatment of Small Saphenous Vein: Our Experience

C. Baraldi, F. Niutta

Purpose: In recent years, endovenous laser treatment (ELT) has been proposed to treat incompetent great saphenous veins (GSVs) as a gold standard procedure. This study reports the safety and clinical and anatomic effectiveness of ELT for treating small saphenous veins (SSVs).

Materials and Methods: From September 2011 to June 2017, ELT procedures were performed for incompetent SSV segments in 380 patients (217 women, 163 men) with a mean age of 57 years (range, 19–81 years). They were treated with intraluminal ELT using a 1470-nm diode laser (LASEmaR1500-Eufoton, Italy) with a kit that includes optical radial fibers of 600 microns (KIT RING, Eufoton, Italy). The SSV diameter was measured by Duplex examination in an upright position in two SSV segments (1.5 cm below the saphenopopliteal junction and sural segment). These measurements were used to determine the optimal linear endovenous energy density (LEED) for treatment. Patients were evaluated clinically and by duplex scanning at 1 and 8 days, 1 to 3 and 8 months, and 1 year to assess treatment efficacy and adverse reactions.

Results: A total of 380 SSVs were treated. The mean diameter was 6.5 mm (range, 4.0–10.0). The LEED was tuned as a function of the initial SSV diameter measured in the orthostatic position, from 40 J/cm (4.0 mm) to 80 J/cm (10 mm). At the 1-week follow-up, 11.4% of the patients reported mild pain. In the immediate postoperative period, the closure rate was 99.0% and remained constant during the 1-year follow-up (44.4% of all patients). After 1 year, a complete disappearance of the SSV or minimal residual fibrous cord was noted in the first 80 cases. Major complications have not been detected; in particular, there was no deep vein thrombosis. Ecchymosis were seen in 26%, and transitory paresthesia was observed in 2%. No permanent nerve injury occurred. Complementary phlebectomy was done in 79% of patients. No failures occurred.

Conclusions: ELT of the incompetent SSV with a 1470-nm diode laser and a radial fiber appears to be an extremely safe technique, particularly when the LEED applied is calculated as a function of the SSV diameter. It is associated with only minor effects. Currently, ELT has become the method of choice for treating SSV and has almost replaced the treatment of traditional ligation and stripping.
079 Hybrid Techniques for Treatment of Varicose Veins: Combined New and Conventional Technologies

C. Baraldi

**Purpose:** We assessed the safety and efficacy of combined endovenous laser treatment (ELT) and traditional techniques for treatment of the saphenous veins insufficiency, based on experience, increasing the endolaser procedure in patient often treated with stripping.

**Materials and Methods:** From September 2009 to July 2017, 2125 ELT procedures were performed (great and small saphenous vein) using a diode laser of 1470 nm wavelength (LASEmaR1500-Eufoton, Italy) with a kit that includes optical radial fibers of 600 microns (KIT RING, Eufoton, Italy). Local echo-guided anesthesia have performed in all cases. Laser power is variable regarding veins diameter from 4 to 8.5 watts settled in continuous mode, and the energy supplied is personalized to morphologic vein characteristics. Power is always personalized to echography vein patterns (diameter, wall thickness, anatomic deep). In 94% of all patients, other techniques were used: microphlebectomy (6%), varicectomy (2%), perforator vein closure (4%), sclerofoam (40%), stripping of lower extremity of great saphenous vein (GSV) (1%). This last procedure (stripping) or sclerofoam combined with ELT is performed when the tortuosity of the GSV prevents laser endovenous treatment and when a double GSV was selected for treatment (four cases).

**Results:** All cases (100%) have shown subjective diminishing of symptomatology, with an objective improvement of symptomatology at 1 month after the operation and of esthetic profile. At 3 months after the operation, in 99.9% of all cases, there was complete occlusion of vein treated. In 0.01% of cases, there was early recanalization of the saphenous vein (initial learning curve only). At 6 months after operation, recanalization of the saphenous vein was detected in 1.5% of the 145 operated patients. At 12 months after operation, a long regurgitation without usual relapses was detected in 1.75% of 32 operated patients. No major complications occurred. One deep vein thrombosis (0.05%) occurred. Local transient paresthesia at the ankle and midcalf level occurred in five patients (0.27%). In the 74% of patients, the vein treated disappeared after 6 months.

**Conclusions:** In all (100%) of patients treated with combined technique ELT, sclerofoam, and stripping, we assessed a total improvement of esthetic and functional aspects, especially with foam. ELT of saphenous veins is a minimally invasive surgical intervention that often can be combined with other techniques performable by a day surgery under ultrasound guidance and topical anesthesia. ELT with sclerofoam permits
and can ensure good clinical and esthetic results, avoiding invasive procedures such as stripping. Combined techniques personalized to the patient’s vein situation allow one to obtain the best results and the best satisfaction of all patients.
080 Inferior Vena Cava Filter Retrieval Initiatives: A 2008 to 2017 Systematic Review

D. Raissi, A. Goodin, Q. Han, J. Brown

Purpose: Inferior vena cava filters (IVCFs) are indicated for therapeutic and prophylactic treatment of venous thromboembolism in patients in whom anticoagulation has failed or is contraindicated. Retrieval of temporary IVCFs is rare despite clinical recommendations. The purpose of this review is to systematically compare results in the literature regarding interventions to improve IVCF retrieval rates.

Materials and Methods: Articles were identified via the search terms “vena cava filters” and “inferior vena cava filters” in conjunction with “retrieval.” Searches were repeated in MEDLINE/PubMed, Google Scholar, and Cochrane database. Exclusion and inclusion criteria were applied according to PRISMA guidelines. Two independent reviewers screened key elements in the identified manuscripts, including the targeted intervention population, study design, IVCF retrieval rates, and other outcomes. A third reviewer corroborated results and consolidated findings.

Results: Seventeen articles were identified for review. Of these, 12 were physician-targeted interventions, and 8 were patient-targeted interventions (n = 3 studies included both). IVCF retrieval rates varied substantially for each study, but all reviewed studies reported improvement in retrieval rate after intervention. Only 5 studies reported decreased IVCF indwell times in intervention groups. Reported complication rates from IVCF retrievals were low, ranging from 0% to 2%.

Conclusions: IVCF retrieval rates were improved by all interventions in the reviewed studies, but few improvements were statistically significant. Findings suggest that IVCF retrieval rates can be best improved by tracking patients typically lost to follow-up. Literature suggests successful tracking requires an individual or team of individuals who have been assigned dedicated clinical responsibility for coordinating care after IVCF placement.
081 Isolated Duodenal Varices Caused by Inferior Vena Cava Occlusion: A Rare Case with Endovascular Treatment

V. Kadakia, A. Molloy, J. Kothadia, J. Farag, C. Williamson

Purpose: Visceral varices are common in portal hypertension, in which they affect the stomach and esophagus with the duodenum being a much less common site. However, it is extremely rare for the etiology to be inferior vena cava (IVC) occlusion. A literature search shows two prominent case reports in 1973 and 1991, in the gastrointestinal and autopsy literature, respectively. More than 20 years later, we present the diagnosis and potentially first successful treatment of this rare clinical entity.

Materials and Methods: A 58-year-old woman with kidney transplant presented with a chief complaint of melena. She demonstrated pallor, tachycardia, anemia, and leukocytosis. These findings all raised concern for cirrhosis or portal hypertension. However, she had no stigmata of chronic liver disease, and her platelet count, liver profile, and ultrasound with Doppler are all normal. A three-phase liver protocol computed tomography scan showed the duodenal varices but also shows occlusion of the suprarenal IVC.

Interventional radiology (IR) was consulted for further diagnostic evaluation and possible treatment. Access of the right common femoral and internal jugular veins was obtained. Digital subtracted angiography evaluation of the superior vena and IVC was performed, confirming the presence of large collateral vessels, duodenal varices, and IVC stenosis. Multiple catheter and wire combinations from the femoral access site were necessary to traverse the occlusion. This wire was then snared from the IJ access site. Angioplasty was performed with 8- and 14-mm balloons. A 20-mm WALLSTENT (Boston Scientific Corporation, Watick, MA) was deployed with an inflated balloon to prevent right atrial migration, and the stent was dilated by 14- and 16-mm angioplasty balloons.

Results: Postprocedural DSA showed no filling of the varix. Embolization of the varix was foregone because of the risk of additional contrast in the setting of renal transplant dysfunction. Repeat angiographic evaluation 2 months later revealed an in-stent stenosis of the infrahepatic portion, which was treated with 18-mm angioplasty.

Of note, the patient’s baseline creatinine normalized to 1.2 mg/dL from 2.3 mg/dL. It is possible that the patient’s renal transplant function improved with adequate central venous drainage; however, the authors admit that resolution of anemia and cessation of a nephrotoxic fluoroquinolone likely also contributed.
Conclusions: Isolated, ectopic duodenal varices caused by IVC occlusion is a rare clinical entity, not reported in more than 20 years. This case highlights its diagnosis with computed tomography imaging and successful treatment by IR.
082 Splenic Vein Recanalization via Transhepatic and Transplenic Access

M. K. Singh, A. Birney, A. Fischman, R. Lookstein, R. Patel

**Purpose:** To describe a rare treatment for chronic segmental splenic vein occlusion in the setting of sinistral portal hypertension.

**Materials and Methods:** We describe a case of a 64-year-old woman with a history of multiple abdominal surgeries with complex enterocutaneous fistulas in the aftermath of necrotizing pancreatitis against a background of short bowel syndrome. Computed tomography (CT) demonstrated virtually absent splenic vein at the portomesenteric confluence caused by chronic segmental splenic vein thrombosis with a reasonable quality of splenic vein at the hilum. Large gastric varices were also identified. The patient was due for a complex multistage surgical intervention to repair her enterocutaneous fistulas. A significant confounding factor in consideration of her surgery was the finding of left-sided portal hypertension. Interventional radiology was consulted for possible percutaneous approach. We describe detail of the procedure and review of the literature in regards to treatment of splenic vein thrombosis.

**Results:** Technical success was obtained in recanalizing the chronic segmental splenic vein occlusion. Transhepatic and transplenic access was obtained, and initial venography demonstrated chronically occluded splenic vein with only a minuscule remnant lumen at the portomesenteric confluence. Using multiple wires, the splenic vein lumen was slowly recanalized until the catheters were approximated. Multiple attempts were made to snare a wire from the transhepatic access through to the transplenic access until through-and-through access was obtained. When access was obtained, the tract was predilated, and stents were placed. Final venograms and computed tomography scans demonstrated a patent splenic vein with in-line flow within the stent. The patient went on to successful surgery for enterocutaneous fistula repair.

**Conclusions:** Splenic vein recanalization can safely and effectively be performed via transhepatic and transplenic access in patients with sinistral portal hypertension.
083 Tired of Low Inferior Vena Cava Filter Retrieval Rates? Here is the Least You Can Do!

D. Raissi, Q. Han, M. Winkler, R. Pennington, J. Brown

**Purpose:** Recent attention into retrieval rates of inferior vena cava filters (IVCFs) elicited several institutional interventions aimed at improving IVCF retrieval rates. This has been spurred by reports of low retrieval rates as well as Food and Drug Administration safety communications calling for increased and earlier retrieval of IVCFs once clinically indicated. We present our own experience tackling this problem with a minimal intervention.

**Materials and Methods:** To help guide our intervention, we performed a literature review of IVCF retrieval interventions via database searches using Google Scholar, MEDLINE/PubMed, and the Cochrane Library Database. A total of 17 manuscripts met inclusion criteria. Cost, feasibility, outcomes, and limitations of these studies will be presented in a table format to guide future interventions. A retrospective review of retrieval of all IVCFs placed at our tertiary care center between October 2011 and February 2016 was performed. A letter mailing–based intervention was instituted to improve our IVCF retrieval rates.

**Results:** A total of 184 and 93 IVCFs were placed at our center in the pre- and postintervention periods. In the preintervention period, 7 of 174 (4%) had their IVCFs retrieved; 7 of 90 (7.8%) in the postintervention period were retrieved. In the time-to-event analysis, which accounted for death during follow-up, the retrieval rate before the intervention was 4.4%; in the postintervention period, it was 8.1%. The cumulative incidence between the two groups was significantly different ($P = 0.043$). The times to retrieval in the pre- and postintervention period were a mean (standard deviation [SD]) of 503 (207) days and a mean (SD) of 119 (83) days, respectively.

**Conclusions:** Using a minimal letter mailing intervention, IVCF retrieval rates at our institution were increased with decreased time to retrieval. All the reviewed interventions showed improved IVCF retrieval rates, which suggests that any intervention, including ours, would lead to significant improvement.
084 Transvariceal Embolization of Esophageal Varices: A Case Report and Discussion on Technique

B. Kelly, K. Saleh, D. Kazimirko, D. Hofstede, A. M. Patel

Purpose: Educate the observer on the clinical presentation, workup, and interventional technique in the setting of variceal embolization.

Materials and Methods: We present a case of a 62-year-old woman with nonalcoholic fatty liver disease (NASH) cirrhosis presenting with grade 3 bleeding esophageal varices noted on esophagogastroduodenoscopy refractory to endoscopic management.

Results: Workup before embolization revealed chronic thrombosis of the portal vein and splenic vein without patent or accessible retroperitoneal varices. Additionally, given the presence of moderate portal hypertension (PHT), the patient was not an ideal candidate for surgical mesocaval shunt. This presented a unique challenge for cannulation of the varices. Thus, through a percutaneous approach, a splenic varix was accessed, allowing for retrograde access of the coronary varix via the patent proximal splenic vein. Multiple Terumo Azur HydroCoil, Azur CX coils (Terumo Interventional Systems, Somerset, NJ) and Boston Scientific interlock coils (Boston Scientific, Marlborough, MA) were deployed in the varix. The access site was closed with Angio-Seal (Terumo Interventional Systems).

Conclusions: Variceal hemorrhage poses clinical concern because it is a potentially life-threatening complication in the setting of PHT. Emergent control of variceal bleeding is critical for optimal outcomes and prevention of future catastrophic variceal hemorrhage. Various techniques have been described for the endovascular management of varices, including coil embolization. Previously, decompressing pressure, such as in transjugular intrahepatic portosystemic shunt (TIPS) with or without embolization, was the mainstay of treatment. Development of transvenous obliteration techniques using antegrade or retrograde approaches, such as in balloon-assisted (BATO or BRTO), coil-assisted (CARTO), and plug-assisted (PARTO) approaches, have led to successful outcomes. These techniques are used in the setting of suboptimal or technically challenging candidates for TIPS, such as those with high Model for End-Stage Liver Disease (MELD) scores, encephalopathy, severe coagulopathy, or a recanalized portal vein. These clinical findings should weigh on the approach taken for embolization of varices. In cases of chronic thrombosis of portal and splenic veins, the authors propose retrograde treatment of varices through appropriately accessible varices themselves. Future considerations include evaluation of safety of direct variceal puncture for expectant management of gastric and esophageal varices through readily accessible varices.
085 Clinical Efficacy of Transjugular Intrahepatic Portosystemic Shunt Reduction and Occlusion for the Treatment of Post–Transjugular Intrahepatic Portosystemic Shunt Complications

G. Hoots, L. Rachakonda, R. Gnesda, K. Kuppler, B. Zwiebel

Purpose: To evaluate multiple indicators of hepatic function and degree of post–transjugular intrahepatic portosystemic shunt (TIPS) shunting in predicting the need for TIPS occlusion over reduction in post-TIPS patients with liver failure and encephalopathy

Materials and Methods: A total of 215 TIPS placements were done between June 2011 and August 2017. All were evaluated for follow-up interventions and respective indications. Pre- and postprocedure portal pressures, time from initial TIPS to subsequent intervention, serum ammonia, hepatic encephalopathy scores, and Model for End-Stage Liver Disease (MELD) score components were recorded. MELD and Na-MELD scores were calculated. These data were then compared among patients.

Results: Nineteen patients required TIPS reduction or occlusion for encephalopathy, pulmonary hypertension, hepatic failure, or heart failure. Three TIPS reduction patients required occlusion because of encephalopathy. Of the 10 patients who had initial TIPS reduction, 6 had resolution of encephalopathy, 1 improved, and 3 patients had TIPS occlusion for persistent encephalopathy. Of the 9 patients who had TIPS occlusion without attempted TIPS reduction, 5 died, and the 4 surviving patients demonstrated improvement. Of the three 3 who had subsequent occlusion, 1 had improved encephalopathy but died of heart failure after myocardial infarction on PPD #7, 1 had improvement, and 1 had unchanged encephalopathy. No statistically significant differences were found in pre intervention variables, time from original TIPS, or portal pressures. All patients who had reduction only demonstrated resolution of hepatic encephalopathy and therefore did not have subsequent occlusion.

Conclusions: A 55% mortality rate in the patients who had initial TIPS occlusion without attempted reduction could be attributed to hemodynamic changes or post-TIPS hepatic vascular injury. Only 1 death was noted in the reduction group from postprocedural myocardial infarction. Although no differences were found in multiple variables to predict success of initial TIPS reduction, there were trends in ammonia, MELD score, and Na-MELD score, which may show significance with a larger sample. Further study may be difficult given the rarity of post-TIPS reduction or occlusion procedures.
Covered versus Bare-Metal Stents in Transjugular Intrahepatic Portosystemic Shunt: 10-Year Institutional Experience at a Rural Medical Center

J. Kingsbury II, M. Clark, M. Nagib, K. McCluskey, B. Steadman, L. Higgins

Purpose: We aim to discuss and evaluate the evolution of the transjugular intrahepatic portosystemic shunt (TIPS) technique and stent grafts used at our institution over the 10-year period from 2005 to 2015 in addition to reviewing the literature for the history and development of TIPS placement. The TIPS is a portosystemic shunt created for the management of complications related to sequela of portal hypertension. Bare-metal stents predominated as the primary stent used throughout the 1990s until the mid-2000s when a covered stent became commercially available in the United States.

Materials and Methods: We reviewed 157 TIPS procedures that were performed at our institution between 2005 and 2015. Of these, 127 (81%) were a successful first attempt. Thirty (18%) of the procedures were performed as revisions, either for TIPS that were performed at outside institutions or for TIPS we performed before 2005. Of the 128 TIPS conducted at our institution between 2005 and 2015, 18 (14%) were subsequently revised because of issues with graft patency. The type of stents used and incidence of revision were evaluated and compared. A corresponding literature review was also performed.

Results: The TIPS technique originated in the 1960s and was refined through animal experimentation until the 1980s when the first human clinical procedure was performed. Upon widespread use of the technique, self-expanding bare-metal stents were subsequently used throughout the 1990s, albeit with relatively poor patency rates. In 2003 to 2004, the Viatorr polytetrafluoroethylene (PTFE)-covered stent graft became commercially available. Bare-metal stents were exclusively used at our institution until 2009 to 2010 at which point covered stents were used in greater frequency. During this 10-year time frame, 44 bare-metal stents were placed. From 2009 to 2015, 48 Viatorr-covered stents were used. The incidence of TIPS revision was almost exclusive to patients receiving the bare-metal stents. To date, only one of the TIPS procedures in which a covered stent was used has undergone subsequent revision (2%).

Conclusions: TIPS technique and stents have evolved greatly over the past 2 decades. A majority of the patient population in the state of West Virginia undergo TIPS for end-stage liver disease secondary to nonalcoholic fatty liver disease and alcohol or viral hepatitis. At our institution, TIPS has been shown to be a viable option for refractory ascites and variceal bleeding. It has been established at our institution and
throughout the literature that covered stents lead to better control of portal hypertension with a decreased incidence of complications and need for revision.
Liver Transplant Scoring in Adults with Hepatocellular Carcinoma: What the Interventionalist Should Know

M. Brett Hyatt, V. D. Kadakia, A. J. R. Moore, R. J. Trojan

Purpose: The purpose is to review the current liver transplant criteria as outlined by the Organ Procurement and Transplantation Network (OPTN) with the goal of educating interventional radiology (IR) physicians on their important role of both reaching and maintaining patient transplant viability during the pretransplant waiting period.

Materials and Methods: Liver transplant candidacy is governed by the OPTN under the administration of the United Network for Organ Sharing (UNOS). The policies for liver transplantation are based on an objective list of qualifications to best allocate donated livers in the most fair and appropriate manner based on a scoring system. The assigned score is primarily generated from the Model for End-Stage Liver Disease (MELD). However, liver transplant candidates can acquire priority status if certain requirements are met, such as in specific cases of hepatocellular carcinoma (HCC).

Results: The pathway to gain priority or “exception points” for patients with HCC stems directly from the OPTN grading criteria, which is in accordance with the Milan criteria. These standards will be reviewed from the point of view of the IR physician. The rules are clear yet not necessarily obvious on how they can best be used for the benefit of the patient. For instance, locoregional therapy may or may not affect exception points because each case is unique. Nevertheless, we will discuss the role of IR in both downstaging tumor burden and in preventing patients from being dropped off the transplant list. The complete armamentarium will be systematically outlined, which will include chemoembolization and radioembolization and ablation techniques. Also, the importance of combating portal hypertension will be discussed because it, too, has been shown to compound the difficulty of getting patients to transplant without expedited action.

Conclusions: Liver transplantation requires a dedicated multidisciplinary team to achieve consistent success. IR physicians should understand the entire scope of the liver transplant process because they play an important role on that team. They can significantly impact outcomes of select patient populations waiting to acquire a transplant, particularly in cases of HCC.
088 Noninvasive Prediction of Hepatic Transplant Portal Vein Stenosis

G. Hoots, M. Vasher, R. Lababidi, K. Massis, B. Zwiebel

Purpose: To compare Doppler ultrasound to transhepatic catheter portal venogram in evaluating hepatic transplant main portal vein (MPV) stenosis to determine which Doppler ultrasound criteria are often the best for diagnosing MPV stenosis

Materials and Methods: Thirty-two hepatic transplant transhepatic catheter portal venograms were performed because of clinical, biochemical, ultrasonography, computed tomography, or magnetic resonance imaging abnormalities. Venograms and pre-venogram Doppler ultrasounds were retrospectively reviewed. Doppler ultrasound criteria of MPV peak velocity, velocity step-up ratio, and change in velocity across the anastomosis were correlated with venography. Our control group consisted of patients who underwent venography without finding of MPV stenosis, as well as 54 randomly chosen patients without suspicion of hepatic transplant MPV stenosis.

Results: MPV stenosis was identified on 25 venograms. Doppler ultrasound detection of MPV stenosis was achieved using the following criteria: velocity step-up ratio threshold of 2.4 (95% sensitive; 92% specific), threshold for change in velocity across the anastomosis of 69 cm/sec (95% sensitive; 72% specific), and threshold for peak velocity of 220 cm/sec (60% sensitive; 95% specific).

Conclusions: Using our Doppler ultrasound criteria, accurate detection of MPV anastomotic stenosis can be reliably diagnosed before transhepatic catheter portal venography.
089 Transcatheter Arterial Chemoembolization for the Treatment of Recurrent Extrahepatic Hepatocellular Carcinoma After Liver Transplantation

T. Graham, S. Saleem

**Purpose:** Liver transplantation is typically curative for intrahepatic hepatocellular carcinoma (HCC). However, the recurrence rate has been reported between 10% and 20%. Limited data exist as to the optimal therapy to combat recurrent HCC. This is a case presentation of an unusual location of recurrent HCC that recruited blood supply from two uncommon sources that can be challenging to access.

**Materials and Methods:** This presentation is to illustrate a unique case of a patient with hepatitis C virus and liver failure who had been originally diagnosed with HCC in July 2014. He had undergone prior transarterial chemoembolization (TACE) as well as microwave ablation to his native liver in September 2014. His treatments qualified him for an orthotopic liver transplant, which was performed in December 2014. Follow-up imaging in March 2015 demonstrated an enhancing right retroperitoneal nodule. Over the course of the next 2 years, the nodule significantly increased in size. This corresponded to an increase in his serum alpha-fetoprotein. Given the unique location, it was decided that TACE should be attempted in this lesion.

**Results:** Computed tomography angiography demonstrated arterial supply to this lesion from the right adrenal and inferior phrenic arteries, which was corroborated with conventional angiography. Conventional TACE with doxycyclin was delivered to the nodule from branches of the right adrenal and inferior phrenic arteries. Posttreatment angiography demonstrated diminished blood flow to the lesion.

**Conclusions:** TACE is one of the first line treatments in intrahepatic HCC. However, treatment for recurrent HCC after liver transplant remains poorly studied from a systematic approach. This case will hopefully contribute to the larger body of knowledge.
090 Traumatic Splenic Vein Pseudoaneurysm: A Unique Case with Interventional and Surgical Management

A. Moore, V. Kadakia, S. Lee

Purpose: Traumatic splenic vein pseudoaneurysm is an exceedingly rare condition, particularly when compared with its arterial counterpart. Even in the setting of portal hypertension, splenic origin is less common than portal origin. This report examines the presentation and diagnosis of a rare case of Isolated traumatic splenic vein pseudoaneurysm. It describes how angiography made the proper diagnosis and discusses how interventional radiologists may treat this entity in the future.

Materials and Methods: A 33-year-old male police officer presented to the emergency department with severe abdominal and back pain, raising initial concern for aortic dissection. Of note, the patient reported a physical altercation with a suspect 3 weeks before presentation. Computed tomography revealed hemoperitoneum, a large perisplenic hematoma and an area of enhancement near the splenic vasculature concerning for splenic artery aneurysm.

Interventional radiology was urgently consulted, and a visceral angiogram was planned. Access was obtained via the right common femoral artery. The celiac artery was selected by a Cobra catheter, and a 5-Fr sheath and Simmons 1 catheter were ultimately needed to select the splenic artery.

Results: Visceral angiography via right common femoral artery access revealed no obvious abnormality of the celiac axis or splenic artery. A repeat selective splenic angiogram was performed with delayed imaging to identify a possible smaller branch aneurysm. This revealed an aneurysmal structure arising from the splenic vein, consistent with splenic vein pseudoaneurysm.

Consideration was made to place a covered stent across the pseudoaneurysm via transplenic approach. However, there is no reported case of doing so in this rare clinical scenario, and given the patient’s active hemorrhage (hemoglobin of 13.6–9.2 g/dL) and increasing hemodynamic instability (blood pressure of 117/101 to 83/57 mm Hg), definitive surgical treatment was thought to be more appropriate. The patient underwent total splenectomy.

Conclusions: Traumatic splenic vein pseudoaneurysm is a very rare condition that is difficult to differentiate from arterial aneurysm on computed tomography, particularly when trauma suggests the latter. This case serves to raise awareness of this clinical entity and highlights the utility of delayed imaging to evaluate the
visceral venous drainage when arterial imaging does not correlate with cross-sectional diagnosis. Further investigation may demonstrate transplenic covered stent placement as a viable alternative to open surgery.
091 Inferior Vena Cava Filter Filter Type and Placement Approach: Effect on Tilt Angle and Retrieval


**Purpose:** The purpose of this study was to assess the influence of inferior vena cava filter (IVCF) placement approach, filter type, and filter dwell time on eventual filter tilt angle and ease of retrieval as measured by duration of fluoroscopy time.

**Materials and Methods:** Retrospective analysis was performed on all patients who had IVCFs inserted between June 2014 and August 2015 at a single community teaching hospital. Placement approach, filter type, and dwell time (if retrieval attempted) were recorded as predictor variables. The main outcome variable, tilt angle (the angle between centerline of the filter and center line of the IVC), was measured on the last available imaging study. For filters for which retrieval was attempted, additional outcome variables were success in retrieval and total fluoroscopy time during retrieval. The relationship between predictor and outcome variables was assessed using multiple linear regression models.

**Results:** A total of 159 filters were placed, 85 (53.5%) via right femoral, 50 (31.4%) via jugular, and 24 (15.1%) via left femoral approaches. Filters included 74 (46.5%) Meridian (Bard Peripheral Vascular, Tempe, AZ), 53 (33.3%) Denali (Bard, Tempe, AZ), 18 (11.3%) Option (Argon, Plano, TX), and 14 (8.8%) permanent Vena Tech (Braun, Evanston, IL) filters. Femoral approach filter tilt angles (mean, 6.6 degrees) were greater than jugular approach (mean, 4.3 degrees) by 2.3° (P = 0.005). Meridian and Option filters had 3.9-degree (P = 0.016) and 4.6-degree (P = 0.018) greater tilt angles, respectively, than Vena Tech filters. No significant tilt angle difference was found involving Denali filters. Retrieval (excluding exchanges) was attempted for a total of 56 filters, 54 of which were successful. The mean dwell time was 224 days, a variable that showed no significant association. Fluoroscopy time for retrieval of left femoral approach filters was 5.8 minutes longer than for the right femoral approach (P = 0.045).

**Conclusions:** Both filter type and placement approach predicted tilt angle with jugular approach having a smaller tilt angle compared with the femoral approach. The tilt angle is larger in Meridian and Option (but not Denali) filters compared with Vena Tech filters. The left femoral approach had longer retrieval fluoroscopy time than the right femoral approach.
092 An Automated Reminder System to Improve Inferior Vena Cava Filter Retrieval

B. Mikhael, M. Jaff, M. Albaghdadi, F. Abtahian, J. Borges, I. Weinberg

Purpose: Inferior vena cava filters (IVCFs) are associated with complications, which may be caused by delayed retrieval. However, retrieval rates remain low. Initiation of an automated reminder system may improve retrieval rates and reduce complications.

Materials and Methods: A computerized automated reminder system was implemented at a large academic medical center where physicians from multiple disciplines implant IVCFs. The reminder system provided performing attending physicians with interactive email reminders after implantation while collecting appropriate use data (defined as either retrieval or a clinician verified explanation for not retrieving an IVCF). For this analysis, we collected data regarding device implantation, retrieval, and complications both before (“pre” group) and after (“post” group) system implementation. A multivariate analysis was performed for a composite outcome of IVCF thrombosis, deep vein thrombosis, pulmonary embolism and death, controlling for age, malignancy status, implantation indication, medical service performing implantation, anticoagulation status, and presence of the reminder system.

Results: A total of 1070 IVCF insertions were included: 715 patients in the “pre” group and 355 in the “post” group. Patient age (61 vs 64 years; \( P = 0.95 \)) and sex (42% vs 40% female; \( P = 0.55 \)) were similar in the “pre” and “post” groups, respectively. More “post” patients had malignancy (48.7% vs 38.6%; \( P = 0.02 \)). The retrieval rate in the “post” group was higher than in the “pre” group (148 of 297 [49.8%] vs 223 of 715 [31.2%]; \( P = 0.0001 \)). The median time to retrieval was shorter in the “post” group (112 days vs 146 days; \( P = 0.01 \)). There were fewer complications in the “post” compared with the “pre” group (30 of 319 [9.4%] vs 115 of 715 [16.1%]; \( P = 0.05 \)). In multivariate analysis, the automated system was associated with increased odds of IVCF retrieval (odds ratio [OR], 2.56; 95% confidence interval [CI], 1.82–3.59; \( P < 0.0001 \)) as well as reduced odds of the composite clinical outcome (OR, 0.72; 95% CI: 0.60–0.80; \( P < 0.0001 \)). Data regarding appropriateness were available for 297 (83.7%) “post” patients; this could not be tested in the “pre” group without information on physician reasoning (only made available with the new system).

Conclusions: Implementing an automated email reminder system was associated with higher IVCF retrieval rates, shorter dwell times, fewer complications, and a reduction in a composite adverse outcome. Such systems should be implemented in all centers offering IVCF.
093 Catheter-Directed Thrombolysis and Thrombectomy in Submassive Pulmonary Embolism: Experience from an Inner-City Hospital

G. Upadhya, L. Yee, H. Kamran, R. Castillo, H. Chadow, A. Khan

Purpose: Acute pulmonary embolism (PE) is the third most common type of cardiovascular disease in the United States, accounting for 60,000 to 100,000 deaths annually. The goal in treating PE, whether it is with anticoagulation alone or with surgical or catheter-based interventions, is to prevent hemodynamic compromise. Catheter-directed thrombolysis (CDT) and catheter-directed mechanical thrombectomy (CDMT) for acute PE may result in more rapid resolution of right ventricular (RV) dysfunction compared with anticoagulation alone. The purpose of this study is to analyze the short-term clinical outcomes of patients diagnosed with submassive PE who received catheter-based treatments in an inner-city hospital.

Materials and Methods: In this retrospective cohort study, patients admitted to our hospital between April 2016 and June 2017 who underwent CDT and/or CDMT for acute PE were identified from the hospital’s electronic database. Patients were stratified according to classification of the PE (massive vs submassive vs low risk). Patients with submassive PE were further stratified according to their Pulmonary Embolism Severity Index (PESI) and included in our study.

The primary endpoint was the change in catheter-based pulmonary arterial pressures (CPAPs), a surrogate for RV strain. Secondary endpoint measures were echocardiographic pulmonary arterial pressures (EPAPs), change in alveolar–arterial gradient (A–a), major complications, in-hospital mortality, and 30 day all-cause morality. The results were analyzed using SPSS version 21.0.

Results: From April 2016 through June 2017, there were a total of 14 submassive PE cases: CDT (1 patient), CDMT (1 patient), and CDT with CDMT (12 patients). The total in-hospital mortality rate was 2 of 14 (14.3%), and 30-day all-cause mortality among survivors was 0 of 12 (0%). Of the survivors, 12 patients (85.7%) had successful cases defined by: decrease in baseline pulmonary arterial pressures measured by pulmonary catheter (9.6 ± 8.6 mm Hg; \(P < 0.05\)), echocardiography (5.8 ± 7.5 mm Hg; \(P = 0.12\)), and A–a gradient (-9.8 ± 134.4 mm Hg; \(P = 0.87\)). No major bleeding or strokes were reported.

Conclusions: CDT and CDMT may be a safe and effective alternative treatment for submassive PE. There were significant improvements in ventricular hemodynamics and subjective improvements in patient well-being postprocedure. Comparisons of long-term morbidity and mortality benefits of early catheter-based interventions in acute submassive PE will require further, larger prospective studies.
094 Initial in vivo Safety and Efficacy Testing of the Arrow ClearClot Mechanical Thrombectomy Device

G. Nadolski, A. Salute, T. Robinson

**Purpose:** To describe the initial in vivo testing of the ClearClot (CC) mechanical thrombectomy device in native ovine vein and a porcine model of iliocaval thrombosis

**Materials and Methods:** A prospective evaluation of the CC over the wire thrombectomy device (Teleflex, Reading, PA) was performed at an independent GLP-approved laboratory. To assess device-related injury to vessel wall and venous valves in vein segments between 6 to 8 mm in diameter, the CC was tested in native ovine saphenous veins without thrombus. After six back-and-forth passes with the maceration basket activated, animals were either sacrificed immediately \((n = 3)\) or 30 days later \((n = 3)\). To test efficacy of the CC, iliocaval thrombosis was created in three adult female swine by implanting an occlusion balloon in the inferior vena cava (IVC) inferior to the renal veins and injecting 2000 units of thrombin inferior to the inflated balloon. The wire and balloon ports of the catheter were capped and implanted in a subcutaneous pocket. A suprarenal IVC filter was placed at the time of clot creation. Seven days after clot creation, thrombectomy was performed. Gross pathology and histologic analysis were performed by an independent board-certified pathologist who examined vein segments for vessel wall injury, valvular damage, and degree of vessel occlusion.

**Results:** Histologic evaluation of the ovine vein segments showed rare minor intimal trauma with no evidence of structural damage to the vessel wall or valve leaflets. In patent vein segments from animals sacrificed 30 days after testing, there was no significant neointima formation compared with control vessels, and all valve leaflets were intact. In the iliocaval thrombus model, all animals had complete IVC occlusion before thrombectomy. Angiographically, CC restored venous flow in all animals with percent occlusion after thrombectomy of less than 10% in two animals and 25% in the other. Histologically, the mean vein occlusion score for the CC device indicated less than 25% luminal occlusion. No segmental pulmonary emboli were identified in the animals tested. No detectable tissue ischemia was seen in the lungs. No intraprocedural deaths occurred. Histologically, no clinically meaningful vascular trauma related to CC device use was observed in the iliocaval thrombus model.
**Conclusions:** Initial experience with the CC mechanical thrombectomy device demonstrated the ability to safely restore flow in completely occlusive iliocaval thrombosis in an animal model without significant vessel injury.
095 Comparison of Different Adjunctive Procedures to Reduce Intraoperative Blood Loss During Cesarean Hysterectomy


Purpose: To compare the efficacy of different adjunctive procedures to decrease estimated blood loss (EBL) during cesarean hysterectomy (C-hyst) in patients with invasive placenta

Materials and Methods: Retrospective analysis of the University of California registry for all patients with invasive placenta who underwent C-hyst between January 2011 until May 2016 was performed. Patient characteristics, surgical technique, laboratory parameters, and patient outcomes were reviewed.

Results: A total of 170 patients (median age, 34 years; range, 22–49 years) were identified. A total of 124 of 170 patients (72.9%) who did not undergo any adjunctive procedures during the C-hyst are were considered the control group. After cesarean delivery, 18 of 170 patients (10.6%) had internal iliac artery ligation, 16 of 170 patients (9.4%) had balloon occlusion of the internal iliac arteries, and 12 of 170 patients (7.1%) had occlusion of the infrarenal aorta before hysterectomy. The mean intraoperative EBL for patients with balloon occlusion of the internal iliac arteries and aorta was 1826 ± 584 mL compared with 2644 ± 1952 mL in the control group ($P = 0.002$) and compared with internal iliac artery ligation 3717 ± 3,156 mL ($P = 0.021$). There was no significant difference in intraoperative EBL for patients undergoing internal iliac artery ligation compared with controls ($P = 0.15$).

Conclusions: Aortic and internal iliac artery balloon occlusion resulted in significantly less intraoperative EBL compared with internal iliac artery ligation and supportive care. With the increase in the incidence of invasive placenta, such adjunctive interventions should be considered in the management of pregnant women with invasive placenta.
096 Evaluating the Frequency and Severity of Ovarian Venous Congestion on Adult Female Computed Tomography


Purpose: Abdomen and pelvic computed tomography (CT) is often used to evaluate pain in women. Although chronic pelvic pain is relatively common, no large- or medium-sized studies have been conducted to our knowledge to evaluate the frequency and severity of ovarian vein dilation, either incidentally discovered or when scanned specifically for unexplained pain. The purpose of our study was therefore to analyze a large number of consecutive body CT scans in women to determine gonadal varicosity incidence and severity.

Materials and Methods: An institutional review board–approved, single-institution retrospective analysis of 1042 consecutive body CT scans in women ages 25 to 65 years was performed. Scans were evaluated for the presence and severity of uni- or bilateral ovarian vein dilation (transverse measurement at the level of the iliac crests), association with "nutcracker" anatomy, and correlation with the history provided on the requisition. We used binomial proportion with a 95% confidence interval (CI) of gonadal vein dilation in this population, including analysis of right-side only, left-side only, and bilateral dilation. All analyses were performed using SAS 9.4.

Results: Of the 1042 scans reviewed, 9.3% had bilateral dilation (95% CI 7.5%–11.1%), 2.8% had left-side-only dilation (95% CI 1.8%–3.8%), and 1.7% had right-side-only dilation (95% CI 0.9%–2.5%), for a total of 144 positive cases (13.8%). Of the positive scans, 97 were bilateral (67.4%), 29 were left-side only (20.1%), and 18 were right-side only (12.5%). Eighteen patients had nutcracker-type left renal vein compression (14.3% of scans with dilated left or bilateral ovarian veins; 1.7% of all scans). In positive scans, the median right- and left-side dilations were both 7 mm (range, 5–14 mm). Based on our findings, the dilation grading scheme developed was mild (<6 mm), moderate (6–8 mm), and severe (>8 mm), with moderate including the middle 33% of cases.

Conclusions: Dilated ovarian veins were found in 13.8% of 1042 consecutive abdominal and pelvic CT scans. Moderate gonadal vein dilation is defined as a diameter of 6 to 8 mm at the iliac crests. Additional studies are needed to determine the clinical relevance of the degree of dilation.
097 Endovascular Aneurysm Repair in Women: Long-Term Results

T. Cohnert, S. Koter, P. Konstantiniuk, H. Portugaller

**Purpose:** The aim of this study was to evaluate operative results for endovascular aneurysm repair (EVAR) in female patients with special focus on long-term results.

**Materials and Methods:** Prospectively collected data of all consecutive patients undergoing abdominal aortic aneurysm (AAA) repair between October 1996 and June 2017 were analyzed retrospectively. Statistical analysis was performed using SPSS software.

**Results:** A total of 1699 patients (223 women, 1264 men) underwent AAA surgery: open repair (OR) in 1283 operations for 1067 men and 216 women. A total of 267 patients were operated because of rupture (267 of 1283; 20.8%). Emergency OR was performed in 46 women. (46 of 267; 17.2%). EVAR was performed strictly in an elective situation in 416 patients (416/1699; 24.5%). The percentage of women was higher in OR with 14.3% (178 of 1283 patients) compared with EVAR with 9.1% (38 of 416 patients). Thirty-eight women with (age 78.6 + 8.7 years [range, 69–94 years]) underwent EVAR without in-hospital mortality. Four female patients underwent conversion: 1 early and 3 late after 47, 50, and 54 months. Six patients died after 5 to 123 months (median, 9 years). Mean follow-up time in 28 women was 45.7 + 38.9 months (range, 2–144 months). No graft limb occlusion or secondary intervention was observed.

**Conclusions:** During a 21-year period with 1487 AAA operations, a total of 38 women were treated by EVAR. Very few women underwent EVAR (1.8%). Low operative mortality and very good long-term results justify wider use of EVAR in women. AAA screening programs for women, changes in treatment indications, and device modification need further investigation.
May-Thurner Syndrome as an Atypical Cause of Pelvic Congestion Syndrome: Diagnosis and Management Options

M. N. Maneevese, R. Zvavanjanja

**Purpose:** After reviewing this presentation, readers should understand the following:

- May-Thurner (MT) morphology and pelvic congestion on cross-sectional imaging
- Mechanism and clinical implications of MT morphology as a cause of pelvic congestion syndrome (PCS)
- Options available for treatment of PCS
- Which option is most beneficial for PCS depending on the underlying cause

**Materials and Methods:** Chronic pelvic pain affects as many as 26.6% of women worldwide. PCS is thought to be the cause in up to 31% of these patients. Typically, the gonadal vein drainage pathway is involved; however, there are variant venous pathologies that may contribute or have been associated with PCS. MT syndrome or morphology is one of the variants that can atypically present with symptoms of pelvic venous flow obstruction or congestion.

**Results:** This presentation reviews the presentation, physiology, and management options available for patients who present with PCS. We also review vascular anatomy of pelvic congestion and MT morphology and how the presence of both these entities greatly affects the options in management. We conclude with a case of concurrent pelvic congestion and MT morphology and discuss patient outcomes with the varying treatment procedures.

**Conclusions:** Chronic pelvic pain caused by PCS is a common and often debilitating condition in women. A thorough understanding of anatomy, physiology, and atypical variant venous drainage is important for radiologists, who often have a pivotal role in the diagnosis and therapy.
099 Spinal Osteomyelitis After Presacral Hematoma from Superior Hypogastric Nerve Block for Uterine Fibroid Embolization

M. Chorney, R. Fabrizio, B. Hammelman

**Purpose:** To describe a previously unreported complication following superior hypogastric nerve block for uterine artery embolization (UAE)

**Materials and Methods:** We perform transradial UAE combined with the superior hypogastric nerve block (SHNB). Here we report the course of a patient who developed a hematoma followed by spinal osteomyelitis secondary to the SHNB and review the relevant literature.

**Results:** Our 51-year-old patient underwent bilateral UAE for symptomatic fibroids. At the completion of the procedure, a 22-gauge needle was advanced using an anterior percutaneous approach into the retroperitoneal space anterior to the L5 vertebral body, and 20 mL of 0.5% bupivacaine was instilled. The patient received Ancef 2 g intravenous prophylaxis and was discharged on the same day.

Seven days later, the patient returned with atypical low back discomfort, notably worse while sitting. Pelvic magnetic resonance imaging (MRI) demonstrated a 2.4 x 4.3 x 9.1 cm presacral fluid collection with a small S1 epidural component, consistent with an uncomplicated hematoma. Her pain reached near resolution, but she returned with recurrent severe pain on postoperative day 35. MRI revealed resolution of the hematoma but new edema and enhancement of the inferior L5 and superior S1 endplates. There was also enhancing soft tissue anterior to L5 with new mild retrolisthesis of L5 on S1. The L5 to S1 disc was uninvolved, overall consistent with spinal osteomyelitis without discitis.

Fluoroscopic-guided culture of the tissue anterior to the inferior endplate of L5 yielded no microorganisms, nor did subsequent blood cultures. The patient was briefly admitted and began a 6-week course of antibiotics, during which her symptoms rapidly reached resolution. MRI 12 weeks later demonstrated improvement but not complete resolution of the endplate edema and enhancement, with stable mild retrolisthesis.

**Conclusions:** Although the SHNB has demonstrated impressive effectiveness in mitigating postprocedure pain and facilitating same-day discharge after UAE, concerns for bleeding and infectious complications may be barriers to widespread adoption. In this case, an iatrogenic presacral hematoma was likely seeded with either skin or gut flora, with spread to the adjacent bone. To our knowledge, this is the first major complication related to the SHNB that has been described. Although we still believe the benefits of the nerve block
outweigh the risks, patients should be informed of all possible complications when considering the nerve block in combination with UAE.
Characterization of the Effect of Statins on Patients Undergoing Transjugular Intrahepatic Portosystemic Shunt

M. K. Lazaga, H. Li, M. Albahhar, H. Vo, E. Rotem

Purpose: To report the preliminary clinical experience of patients using statins undergoing TIPS for recurrent ascites compared with those not using statins.

Materials and Methods: Over a 13-year period, patients undergoing TIPS for refractory ascites at a tertiary academic medical center were retrospectively analyzed. Patients were subcategorized into those using statins and those not using statins prior to the procedure. Patient demographics, medication history, presence and quantity of ascites on pre and post-procedure imaging (CT/MRI/ultrasound) were compared. Fisher’s exact test was used to analyze contingency tables.

Results: 28 patients with recurrent ascites on pre-procedure imaging (CT, MR, ultrasound) underwent TIPS at our institution (9 female, 19 males; age 33-70 years; mean age 53.79 years). Among patients examined, 5 statin users and 23 non-statin users were identified. Of this population, 0 patients using statins and 14 patients not using statins were found to have ascites post-procedure. In the study group, statin use at the time of TIPS was found to be a significant predictor of ascites resolution at 90 days (p = 0.04). Alcohol use (p = 1), MELD score (p = 0.47), age (p=0.71), BMI (p=0.13), Hepatitis C (p=1), Hepatitis B (p=1), or the presence of infection (i.e. Hepatitis C/Hepatitis B/HIV) (p=0.68) were not found to be significant predictors.

Conclusions: Based on data from a single institution, statin use in patients undergoing TIPS significantly reduced recurrent ascites post-TIPS procedure. Though statins are not currently recommended for patients undergoing TIPS, their use may be considered. Our results suggest larger scale studies to characterize the effects of statins on patients undergoing TIPS are warranted.
101 Establishing a Regional Treatment Center for Abnormal Placentation: The Role of Interventional Radiology

M. K. Lazaga, M. Albahhar, N. Ohene-Baah, E. Rotem, J. Lee

Purpose: In this exhibit, we share our experience of developing a regional treatment center for abnormal placentation in a large teaching hospital. We outline our collaborative strategy with diagnostic radiology, high-risk obstetrics, urology, and anesthesiology that can serve as a template for other departments in a similar situation.

Materials and Methods: Abnormal placentation may result in potentially life-threatening hemorrhage with morbidity up to 60% and mortality up to 7%. Interventional radiology (IR) placement of preoperative balloon catheters in the internal iliac arteries or other arteries supplying the uterus for occlusion or embolization (or both) has grown to be part of the surgical plans to control intraoperative bleeding. For IR to prevail in this arena, a coordinated approach is essential.

Results: Traditionally, the management of abnormal placentation has primarily been in the realm of obstetrics or gynecology. To become more involved in providing comprehensive care for abnormal placentation, our team adopted a multifaceted approach. To recruit new patients, we made efforts to forge partnerships with obstetrics, gynecology oncology, diagnostic radiology, urology, and anesthesiology. This included organizing conferences on the role IR in prevention of peripartum bleeding and creating referral pathways to IR upon diagnosis of abnormal placentation. Patients were offered appointments in the IR clinic, where they were formally assessed before arranging procedures in conjunction with the other involved specialties. In addition, coordinated efforts to optimize scheduling the day of the procedure were made to minimize the impact on each service's daily workflow. These efforts resulted in high clinician and patient satisfaction as well as improved clinical outcomes. Implementation of these measures allowed us to establish a pathway of management of abnormal placentation and subsequently a smooth process of referrals and management on the day of procedure in our institution.

Conclusions: Establishing and a regional center for abnormal placentation provides IR the opportunity to collaborate and develop partnerships with other specialties and enables patients to receive safe and comprehensive multidisciplinary care.
The Efficacy of an Ultrasound Technique and Ultrasound Skills Lab in Increasing Procedural Skills Confidence

M. K. Lazaga, H. Li, S. Patel, N. Ohene-Baah, A. Wang, H. Vo

Purpose: The aim of our study is to determine if participation in an ultrasound technique and ultrasound basic skills lab increased students confidence in these techniques.

Materials and Methods: Study participants included a total of 22 first and second year medical students with minimal ultrasound training or experience. The medical student’s perception of pre-instruction skill was assessed using a rating scale of 0-100 in increments of 10 with 0 being no confidence, 50 being moderately confidence and 100 being very confident. Demographic questions including age, sex, gender, race and training level were also asked during the pre-instruction assessment. Location of ultrasound experience was also obtained. Verbal and hands on guided instruction about ultrasound technique and basic ultrasound skills principles was provided to the medical students by an attending interventional radiologist and several residents. A post-instruction assessment was provided using the same scale. Differences between pre- and post-instruction scores were analyzed using the wilcoxon signed rank test. The mean confidence gain was analyzed using a paired 2 sample t-test.

Results: The average age of medical student participant was 23.6+/− 1.6 years. 63.6% (N=14) of participants were male and 36.4% (N=8) were female. 50% (N=11) were first year medical students and 50% (N=11%) were second year medical students. Confidence in both ultrasound technique and ultrasound skills increased significantly between pre- and post-instruction skills assessment (p<.05).

Conclusions: Participation in ultrasound technique and basic ultrasound procedural skills labs increases students’ confidence to perform these types of procedures. Future studies can be performed to examine skill competency following such skills labs.
103 Predictive Effect of Liver Volume on Mortality for Transjugular Intrahepatic Portosystemic Shunt Patients

H. Li, M. Albahhar, M. Kellie, G. Lazaga, G. Sharma, J. Keshavamurthy, E. Rotem, H. Vo

Purpose: Given the clinical utility of liver volume (LV) established in the literature, it is hypothesized that LV or LV-related indexes may aid in predicting mortality following TIPS procedures.

Materials and Methods: This retrospective review examined 43 TIPS patients at a large academic institution who had preTIPS lab work, CT/MRI within 150 days prior to the procedure, and known 6-months survival status between 2004 and 2017. Estimated healthy LV (eLV) was calculated using an established formula (LV = -794.41 + 1267.28 * Body Surface Area). Actual LV was calculated from the CT/MRI using the Philips Liver Analysis software. Multiple logistic regression analysis was used to determine the predictive value of LV and LV-related indexes in relation to patient survival at 6 months.

Results: Of the 43 subjects, 35 patients were in the alive group while 8 were in the deceased group. The subjects’ mean age was 56 ± 9 and the Model for End-Stage Liver Disease (MELD) scores range from 7 to 27 (median of 13.5). Differences in age, sex, body mass index, alcohol use, hepatitis B status, HIV status, portosystemic gradient, LV, and LV normalized with BSA between the two groups were not statistically significant. With multiple logistic regression analysis, a larger deviation from eLV was significantly associated with mortality (p =0.0391) after adjusting for age and hepatitis C status. Incorporating the MELD score to the LV deviation model, both measures were no longer significant predictors, which suggests an interaction. In another multiple logistic regression analysis, mortality was significantly associated with a higher value of the interaction term of LV deviation with MELD score (p=0.0223) after adjusting for age and hepatitis C status.

Conclusions: We conclude that deviation of CT/MRI LV from estimated healthy LV can be a predictor of 6-month patient mortality in the setting of TIPS comparable to pre-TIPS MELD score. The interaction of LV deviation with MELD score appears to be potentially a more effective predictor of patient mortality at 6 months than MELD or LV deviation alone.
104 Arterioportal Fistulas: Etiology, Anatomy, and Clinical Outcomes Following Transcatheter Embolization

A. Swersky, J. Salsamendi, A. Sethi, P. Mohan

Purpose: Arterioportal fistulas (APFs) are rare communications between portal venous and systemic arterial vasculature. They can be congenital, traumatic, iatrogenic, malignant, infectious, or inflammatory in origin. They can present with portal hypertension manifesting as variceal bleeding or recalcitrant ascites or rarely with congestive heart failure. The aim of this study is to describe the etiology and anatomy of APFs and to assess the clinical outcomes after transcatheter arterial embolization (TAE).

Materials and Methods: Seven cases of APF that were endovascularly treated from 2011-17 from a single institution were included in the study. The clinical features and imaging characteristics were collected from electronic medical records and PACS.

Results: Seven patients (5 males, 2 females; mean age 35.5 years; SD 31.08) underwent TAE. Etiology included post liver transplant (n = 3), liver biopsy (1), trauma (2), and systemic lupus erythematosus (1). Clinical presentation included variceal bleeding (1), nonbleeding varices (1), ascites (2), splenomegaly (1), right heart failure (1), abdominal pain (1), and active intrahepatic bleeding (1).

On angiography, 6 cases showed APF between branches of the right hepatic artery and portal vein, and 1 case showed connection between a branch of the superior mesenteric artery and the superior mesenteric vein. All cases were performed via right common femoral artery access followed by use of microcatheter to select the fistula. Embolization was performed with coils (5), Gelfoam (1) and combination of vascular plug, coils, and Gelfoam (1). Five patients had successful embolization of the APF, 1 patient had partial embolization, and 1 patient showed persistent flow across the fistula after coiling, likely due to severe thrombocytopenia. There were no procedure related complications. Five patients showed symptomatic improvement on follow up, including ascites reduction (2), resolution of variceal bleeding (2), and pain relief (1).

Conclusions: TAE is an appropriate and effective procedure in the treatment and reduction of clinical sequelae of APFs.
Genetic Testing Helps Improve Familial Hypercholesterolemia–Associated High Lipid Management

R. Hendricks-Sturrup

Purpose: Familial hypercholesterolemia (FH) is an inherited cardiovascular condition that affects around 1/250 persons in the United States, depending on ethnicity, and is associated with high fasting or therapy-resistant low-density lipoprotein (LDL) blood cholesterol levels. Some serious symptoms include arterial plaques in the coronary arteries and proximal aorta, cardiovascular disease before 45 years in men and 55 years in women, and, if left untreated, heart attack. It has been argued that genetic profiling via genetic testing or genomic sequencing is needed to more precisely confirm or clinically characterize FH-associated mutations, which include genetic mutations in ApoB, LDLR, LDLRAP1 and PCSK9. To address these arguments, a systematic literature review was conducted to determine if genetic test results for FH-associated mutations help FH patients improve their high blood cholesterol management with help from their physicians.

Materials and Methods: A literature search was conducted in three databases - MEDLINE, TRIP Medical Database and PIER - using Boolean string “Diagnosis AND “Genetic Testing” AND “Hyperlipoproteinemia Type II.” The search yielded five relevant articles after applying the exclusion criteria.

Results: Key findings include: 1) Cascade screening for FH that uses genetic testing for FH-associated mutations leads to improved patient treatment initiation and adherence and case identification or genotype/phenotype characterization across families, 2) genetic testing helps clinicians detect known and/or identify new gene-variants associated with high LDL-C levels, 3) genomic sequencing can help clinicians identify first- or second-degree relationships among FH-associated mutation carriers within in given health system, and 4) genetic testing helps clinicians more accurately determine the presence of FH in patients with LDL-C levels at or over 160 milligrams per deciliter who otherwise fails to receive FH diagnosis using Simon Broome and Dutch Lipid Clinical Network clinical criteria.

Conclusions: Overall, genetic testing for FH-associated mutations led to improved lipid management and patient education. Recommendations to revise the most recent 2013 American College of Cardiology/American Heart Association (ACC/AHA) guidelines are made. Future research aims are also proposed, which include examining the clinical efficacy or utility of genetic testing for FH, the cost-effectiveness of genetic testing for FH for companion diagnosis to qualify patients for specialty prescription
treatment such as PCSK9 inhibitor treatment, and patient and provider perspectives or concerns about the use of genetic testing for FH.
Experience of the Use of Percutaneous Access Technique in Endovascular Aneurysm Repair (2016–2017)

S. Galego, D. Costa, D. Lucena, K. Santos, C. Araújo, M. Matar, L. Olinda, J. Corrêa

**Purpose:** To demonstrate the experience of a vascular surgery service with the use of PEVAR technique.

**Materials and Methods:** We performed a retrospective analysis of 26 cases of PEVAR in the years 2016-2017. 16 EVAR and 10 PEVAR. We used 108 devices just from Proglide Abbot in the purpose of closing vascular access.

**Results:** The prostheses used were the following: 11 Gore®, 1 Ovation®, 4 Medtronic® devices for EVAR. We also used 8 Gore® and 2 Medtronics® devices for the PEVAR. The sheaths ranged from 12 to 24F. In total of 26 cases, there was technical success in 24 patients (92.3%), requiring 2 surgical conversions. There were Proglide Abbot failure implantation in 4 devices. In relation to complications, there were important hematoma that needed surgical conversion. There were also 1 case of ischemia and 1 case of pseudo aneurysm (11.5%).

**Conclusions:** In this initial experience, the percutaneous approach method in this institution proved to be effective and with a low rate of complications in our institution. There is a need for more cases to prove these initial results.
A Retrospective Study of Postprocedure Intravenous Patient-Controlled Analgesia versus Epidural Patient-Controlled Analgesia Use After Uterine Fibroid Embolization

K. Tran-Harding, Q. Han, D. Raissi

Purpose: Patient-controlled analgesia (PCA) has been a major advance in the management of pain after procedures. The purpose of this study is to compare patient controlled epidural analgesia (PCEA) using an opioid in combination with a local anesthetic and patient controlled intravenous analgesia (IV-PCA) after uterine fibroid embolization. Our theory is that PCEA as compared to IV-PCA would decrease the overall opioid requirements, decrease systemic side effects such as nausea or pruritus, and decrease the required oral narcotics administered during hospital stay.

Materials and Methods: The subjects include 51 female patients between the ages of 27 and 55 that presented to the University of Kentucky for uterine fibroid embolization for symptomatic fibroids between March 2014 and January 2017. Of these patients, 20 received an IV-PCA for post embolization pain control and 31 received an epidural PCA. Both groups received either NSAID or acetaminophen as part of their pain control regimen. We performed a retrospective review of the electronic medical record for total hydromorphone administered during the patient’s stay, oral narcotics and other pain medications. Medication side effects such as nausea and pruritus were recorded as categorical events. Statistical analysis was completed in SAS 9.4 (SAS Institute Inc., Cary, NC, USA) using Fisher’s Exact, Chi-square test, and t-test. An Analysis of Covariance (ANCOVA) was also performed to determine if the treatment groups were significantly different after adjusting for age, race, and insurance status, history of opioid or NSAID use, smoking and alcohol use. Patient satisfaction with their pain regimen was recorded upon discharge.

Results: Total hydromorphone administered to a patient post uterine fibroid embolization using a PCEA was significantly less than patients that using an IV-PCA (p=0.0007). There was no significant difference in the NSAID, acetaminophen and oral opioid dose between the two groups. The frequency of nausea and pruritus between the two groups did not achieve statistical significance with (p=0.6628) and (p=0.6393) respectively. After adjusting for demographic variables, the treatments groups’ hydromorphone dose was still significantly different (p< 0.0001). PCEA group had a 90.3% satisfaction rate compared with 65% in the IV-PCA group (p= 0.0279). One patient remained hospitalized for 10 days after developing a CSF leak. None of the patients were re-admitted for pain management within the following 30 days.
**Conclusions:** Opioid requirements are significantly reduced with PCEA compared to IV-PCA. There was no difference in medication related side effects. PCEA group achieved a higher satisfaction rate. A double blinded prospective study is needed to evaluate the PCEA regimen in post UFE patients.
Temporal Trend of Aortic Aneurysm Mortality: A Brazilian Study


Purpose: To describe the temporal behavior of Aortic Aneurysm (AA) mortality in Brazil and its regions.

Materials and Methods: Descriptive analysis of secondary data taken from the DATASUS Mortality Information System (SIM / DATASUS) to calculate the death rate per AA (per 100,000 population) adjusted by the Ahmad coefficient. The distribution and variation of mortality by age, sex, age range (0 to 19 years, 20 to 59 years and> 60 years) and territorial mortality were also analyzed using the APC calculation in the periods 2000-2008, 2008-2015 and 2000-2015. Linear regression was used to measure the trend of AA mortality in the period studied. The statistical program used was Stata 11.0.

Results: Between 2000 and 2015 there was a 0.3% increase in mortality in Brazil ($\beta = 0.09$, $p = 0.047$), 86.2% in the Northeast ($\beta = 0.085$, $p <0.001$) and 61.7% ($\beta = 0.051$, $p <0.001$), but there was a decrease of 37.2% in the South region ($\beta = -0.096$, $p <0.001$) and a stability in the Southeast region ($\beta = -0.007$, $p = 0.252$). In the same period, there was an increase in mortality in females (12.2%), decrease in males (-5.5%). In parallel, there was an increase of 5.7% in the population over 60 years and a decrease of 16.6% in the population between 20 and 59 years.

Conclusions: Although mortality from AA varied only 0.3% in Brazil, there is a great inequality in the epidemiological reality of this disease, mainly in relation to sex and between brazilian regions, demonstrating that AA is still an expanding disease and of importance in public and private health in Brazil.
109 Iatrogenic Bilateral Renal Vein Thrombosis

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**Purpose:** Presentation of rare complication for IVC filter.

**Materials and Methods:** Inferior vena cava filter (IVCF) is widely used for patients with deep vein thrombosis (DVT) and pulmonary embolism (PE) who are not candidates for anticoagulation which is the preferred treatment. (1)

The application of IVC filters seems to have decreased over the years. Many complications are associated with IVCF including thrombosis and filter migration into the right atrium, pulmonary artery, right gonadal vein and lumbar veins. (4)

We present a case of anuric acute renal failure due to bilateral renal vein thrombosis from IVCF migration.

**Results:** 68 years old male with a past medical history of DVT, PE with IVCF 5 years ago, diabetes mellitus, hypertension, obstructive sleep apnea presented to the emergency department with severe back pain. Patient started to have severe lower back, present throughout the day, constant, non radiating and associated with nausea and vomiting. Patient was noted to have anuria and worsening azotemia. The patient was started on hemodialysis. Further work-up revealed extensive bilateral proximal DVT on Doppler ultrasound. Computerized axial tomography (CT) abdomen showed features of bilateral renal vein thrombosis in the context of IVCF transverse migration occluding both renal veins. Heparin drip was started. The patient underwent an angiogram with thrombectomy.

His kidney function and urine output started to improve and the patient was taken off dialysis.

**Conclusions:** Discussion:

IVCF migration is a rare complication and was reported in minimal number of case reports. A previous case report showed filter migrated to a suprarenal position inside IVC causing bilateral renal vein thrombosis causing acute renal failure. Our case showed migration of IVCF into a transverse position within the renal veins bilaterally resulting in renal shut down.
110 Effects of VIABAHN® Stent on Segmental Patency with Peripheral Obstructive Arterial Disease: A Retrospective Study

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Purpose: to describe the patency of the femoral-popliteal segments up to 24 months after the endovascular treatment using the VIABAHN® coated stent due to primary patency and limb salvage.

Materials and Methods: Retrospective study of the medical records of 65 patients submitted to endovascular surgery with VIABAHN® prosthesis and evaluated in up to 24 months, with a period of 6, 12, 18 and 24 months after the procedure. Sugery indications was performed due to stenosis intra-stent (ISR) in 32 cases (49,2%) and for primary indication in 33 cases (50,8%). We also observed the indication according to Rutherford’s classification.

Results: Patency rates were found in 6, 12, 18 and 24 months of 92%, 85.6%, 81% and 78.4%, respectively, and there was only 1 limb loss early follow-up (1,5%). Regarding indication according to Rutherford’s we observed: 15 pacients with Rutherford 2 and 3 (23,1%) and for Rutherford 4 and 5 were included 50 pacients (76,9%).

Conclusions: There were acceptable results in relation to the patency rate of the femoral-popliteal segments studied in the period, providing good surgical and clinical results with VIABAHN® stent use
111 Drug-Mechanical Revascularization of Stents of Renal Arteries of Branched Endoprosthesis

S. Galego, L. Olinda, D. Lucena, D. Costa, C. Araújo, M. Matar, K. Santos

Purpose: To present a strategy of endovascular treatment of visceral branch occlusion of fenestrated endoprosthesis.

Materials and Methods: The following case report is a 62-year-old male patient was treated for 2 years electively by a thoracoabdominal aortic aneurysm at another institution with aortic endoprosthesis and branching to the celiac trunk, superior mesenteric artery, and the two renal arteries.

Patient sought our emergency room for approximately 24 hours of acute bilateral low back pain, nausea, vomiting and anuria. For 10 days, the patient suspended clopidogrel 75mg / day and acetylsalicylic acid 100mg / day. The patient's serum creatinine was 3.45 mg / dL. Acute renal failure was diagnosed and hemodialysis was performed. Angiography showed bilateral renal artery occlusion and patency of celiac trunk and superior mesenteric artery. We performed drug-mechanical thrombectomy with AngioJet in the right kidney, followed by angioplasty with a 6x80mm Mustang balloon catheter. Renal angiography showing areas of stenosis. Released Viabahn stent 6x100mm. The same procedure was performed in the left renal artery. Final aortography with renal artery patency was performed.

Results: There was success in the percutaneous drug-mechanical treatment for thrombosis of visceral branches of fenestrated endoprosthesis.

Conclusions: Drug-mechanical thrombectomy proved to be a safe and effective treatment approach, despite the unusual indication as the rare case reported in the literature.
Use of the Hutson-Russell Pouch as an Access Point for Management of Recurrent Biliary Strictures

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**Purpose:** Common bile duct (CBD) injuries present a management challenge due to recurrent bile duct strictures and frequent need for biliary access. In Hutson-Russell pouch (HRP) procedure, a Roux-en-Y hepatico or choledocho-jejunostomy is used for treating CBD injuries. The afferent limb of jejunum adjacent to the biliary anastomosis is attached to the abdominal wall with metallic clips which can act as an access point for biliary interventions.

**Materials and Methods:** 142 HRP accesses (2.7/patient) performed in 51 patients (37 F, 14 M; mean age 52.5; SD 17.75) between 2008 and 2017 were included. HRP is accessed using fluoroscopy/US and the bile duct is cannulated in a retrograde fashion for intervention. Paired sample t-test was used for analysis.

**Results:** Reason for HRP creation included iatrogenic bile duct injury (n=42), recurrent cholangitis due to a choledochal cyst (n=5), primary sclerosing cholangitis (n=2), trauma (n=1), and congenital defect (n=1). Biliary enteric anastomosis was provided by hepaticojejunostomy (n=27), choledochojejunostomy (n=13), or hepaticodochojejunostomy (n=3). Indications for intervention included strictures of the bile duct or the anastomosis, and biliary leak.

Technical success was defined by the ability to access and intervene in the biliary system via HRP and it was achieved in 130/142 (91.5%) of procedures. There were significant improvements in LFTs post-intervention and the average decreases in AST, ALT, Total bilirubin, and Alkaline Phosphatase were 49.1 (p=0.02, SD 109.3), 36.7 (p=0.02, SD 74.8), 0.69 (p=0.001, SD 1.09), 53.2 (p=0.21, SD 233.8) respectively. Patency of the HRP was maintained in 94.1% of patients. 51% of patients had more than one procedure with an average time interval between procedures of 196 days and a mean follow-up of 739 days. The most common intervention performed was balloon cholangioplasty in 33/51 (64.7%) patients. Overall, there were only 3 complications.

**Conclusions:** HRP acts as an easy and efficient access point for biliary interventions in patients with complex biliary anastomosis with recurrent strictures. HRP avoids needle trauma to liver from repeated transhepatic access.
Improving the Efficiency of Interventional Techniques by Using Simulation and Deliberate Practice

S. Medarametla, A. Echenique

**Purpose:** To increase efficacy of various types of catheter exchange with the use of simulation technology and deliberate practice.

**Materials and Methods:** Tasks for catheter exchange were assigned to seven new Interventional Radiology fellows in training, without any practice. Four different modes of catheter exchange were performed. The total time for the procedures were taken and the number of errors were recorded pre and post procedure training. Initial training sessions were performed in the lab and deliberate practice was performed in the lab or at home.

**Results:** Improvement was observed in the performance of all participants for every catheter exchange task after simulation training and deliberate practice. The total procedure time for all participants decreased by 31.37% in average (range 4.4% - 80.86%) for Task A, B, C, and D. Number of errors associated with catheter exchange also reduced by 42.24% (range 0% - 100%) for all tasks.

**Conclusions:** This study confirms that competency of Interventional trainees in performing basic procedures of catheter exchange can be improved with simulation training and deliberate practice. In addition informal evaluation and feedback in a simulated clinical setting is highly appreciated and very beneficial for the trainees. Therefore, a curriculum featuring simulation and practice of various interventional techniques can be implemented in training programs to increase efficacy, decrease turnaround time, radiation exposure and post procedural complications in future populations treated.
114 Transvenous Biopsy in the Diagnosis of Suspected Intravascular or Perivascular Neoplasm

W. Sherk, M. Khaja, B. Majdalany, K. Cooper, D. Williams

Purpose: The purpose of this study is to describe patient presentation, techniques, outcomes, and complications of transvenous biopsy for suspected neoplasm.

Materials and Methods: Between 2008 and 2017, 36 patients (20M;16F) underwent transvenous forceps biopsy after venography (100%) and IVUS (23 patients, 64%), for diagnostic evaluation of suspected tumor thrombus or intravascular tumor extension. Tumor was suspected due to patient history, imaging appearance on IVUS and/or fluoroscopy, or inadequate response to thrombolysis. Symptoms related to venous occlusive disease were present in 26 of 36 patients (78%) prior to the procedure, and the remaining 10 patients had venous thrombus or tumor compression detected by cross-sectional imaging. A previous diagnosis of malignancy was available for 27 patients (75%) prior to the procedure. In 8 patients, there was no previous history of malignancy and the diagnosis was made from the transvenous biopsy; an additional patient was found to have a second primary malignancy.

Results: All 36 patients had adequate tissue sampling to provide a definitive microscopic diagnosis. Results were positive for malignancy in 27 patients (75%). Additional procedures such as recanalization, angioplasty, or stenting were performed following biopsy in 24 patients (67%). There were no minor or major complications related to the biopsy procedure.

Conclusions: Transvenous forceps biopsy is a safe and effective alternative method to percutaneous biopsy of suspected neoplasms with extension into or abutment of the vasculature.
115 Pain Management Differences in Central Venous Access in Patients with Sickle Cell Disease


Purpose: To examine trends in therapeutic analgesia for Central Venous Line (CVL) placement in patients with sickle cell disease (SCD) versus non-sickle cell disease (nSCD).

Materials and Methods: This IRB-approved retrospective study performed at a single large tertiary care hospital evaluated all patients who underwent CVL placement between 12/2016-03/2017. Patients were identified and procedure-related data (drug type/dose, sedation duration, and procedure and fluoroscopy times) was extracted from a prospectively created database of all IR procedures performed. This was linked to the institutional radiology data repository to extract patient age and gender. ANOVA was used to compare mean sedation duration and Chi-square was used to compare categorical variables.

Results: Of 126 patients (81/126, 64.3% female; mean age=45.7 Y, SD 19-93), SCD=45 (35.7%) and nSCD=81 (64.3%). Sedation duration in SCD patients (26.3min, 95% CI 21.3-31.2) was shorter than in nSCD patients (34.7min, 95% CI 31.0-38.4, p<0.01). SCD patients received fentanyl less frequently than nSCD (15 vs 50, p<0.01). Of the patients who received fentanyl, there was no significant difference in dose between SCD and nSCD patients (p=0.550). There was no significant difference in frequency of midazolam use or dose between SCD and nSCD patients (p=0.520 and p=0.330, respectively). SCD patients receive hydromorphone more frequently than nSCD (12 vs 7; p<0.01). Procedure duration was shorter in SCD patients than in nSCD (19.1min vs 25.5min; p=0.020). There was no significant difference in fluoroscopy time between SCD and nSCD patients undergoing CVL procedures (p=0.150).

Conclusions: Hydromorphone is used more frequently than fentanyl in SCD compared to nSCD patients. However, there is no significant difference in fentanyl dosage between SCD and nSCD patients. Additionally, sedation duration and procedure time are shorter in SCD compared to nSCD patients. These findings call into question the somewhat routine practice of using longer acting hydromorphone in SCD patients. This study serves as a platform for hypotheses in how to better provide for SCD patients by further understanding their pain and pathophysiology.
Purpose: To evaluate the technical evolution of native aortic sac access post endovascular abdominal aortic repair (EVAR) and outcome of embolization of type 2 endoleaks using ethylene vinyl alcohol copolymer (EVOH).

Materials and Methods: A retrospective review was performed of 34 patients (age 80.9 ± 6.9 years) who underwent 40 embolization procedures for type 2 endoleaks using EVOH. All patients demonstrated abdominal aortic aneurysm expansion of > 5mm within 6 months. Early in our experience, we employed the traditional modified transarterial (TA) and direct translumbar (DTL) approaches to access the endoleak nidus. Subsequently, we added novel techniques, including the direct transabdominal (DTA) and perigraft (PG) approaches. The DTA approach involved color-flow ultrasound-guided direct anterior abdominal access to the endoleak within the AAA sac, while the PG approach consisted of routine transfemoral access followed by direct catheterization of the AAA sac by undermining the iliac limb of the endograft. Endpoints included technical success, adverse events, endoleak persistence, endoleak recurrence, and AAA sac area change.

Results: The TA, DTL, DTA, and PG approaches were used in 20, 2, 10, and 14 cases, respectively, including a combination approaches in 6 cases. The TA approach was technically successful in 20 of 28 attempts (71%), including 10 of 10 (100%) for the IMA and 10 of 18 (56%) for lumbar arteries. The DTA approach was successful in all 12 attempted cases (100%). The PG approach was successful in 14 of 15 attempts (93%). No major adverse events were recorded. The primary technical success rate was 98%. The persistent endoleak rate at initial follow-up of 3 months was 35%. Three patients subsequently developed recurrent type II endoleaks while 1 patient developed a type 1 endoleak. At a mean follow-up of 12 months, 54% of patients demonstrated absence of a persistent or recurrent type 2 endoleak and 70% showed stability or decrease in the maximal cross-sectional sac area.

Conclusions: EVOH embolization is a safe and effective method for the prevention of aneurysm sac expansion in patients with type 2 endoleaks post EVAR. Over the course of the study, we were able to replace the cumbersome TA lumbar artery and DTL approaches with the more expedient DTA and PG approaches.
117 Unique Dialysis Access Pathway in a Patient with No Conventional Vascular Access

A. Desai, S. Shah, P. Riggs, R. Pyne

Purpose: Dialysis is essential for the survival of patients with end stage renal disease (ESRD). Interventional Radiology (IR) plays a pivotal role in maintaining dialysis access through routine interventions, but sometimes multidisciplinary collaboration and out-of-the-box thinking is required.

Materials and Methods: 77 year old vasculopathic patient with stage IV ESRD, multiple comorbidities, and central venous occlusion had no vascular access for dialysis. Multiple AV fistulas in both upper extremities had failed despite repeated interventions. In addition, the patient had a severely stenotic infrarenal inferior vena cava (IVC). The patient was temporarily being dialyzed via a left femoral access, which was failing. After discussion at Vascular Conference, a collaborative effort between IR and Vascular Surgery was planned, to create a unique dialysis access pathway in the form of an AV fistula between the right subclavian artery and the IVC, using a tunneled polytetrafluoroethylene (PTFE) HeRO graft.

Results: The procedure was performed in the Hybrid OR. The patient was positioned in a left lateral decubitus position, and the suprarenal IVC was accessed under fluoroscopic guidance using a translumbar approach. After bypassing a significant stenosis, access was secured using a wire. The IVC access was then exteriorized through a small subcutaneous tunnel in the right flank. Following this, a long PTFE graft was tunneled subcutaneously from the right flank to the right supraclavicular region. The proximal end of the PTFE graft was sutured to the right subclavian artery and the distal end of the graft was screwed onto the HeRO catheter, thus creating a unique AV graft with inflow from the right subclavian artery and outflow into the IVC. Postoperatively and at one month follow up, a strong palpable thrill was present throughout the AV graft, which will soon be ready to use.

Conclusions: Interdisciplinary collaboration can be utilized to devise novel innovative procedures that can greatly improve patient outcomes, and at times, save a patient’s life. In this case, a combined endovascular and surgical approach was used to create an AV graft between the subclavian artery and IVC for a patient with no other options.