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1021144 Case Study

Systemic Arterial Emboli Resulting From Large Aortic Valve Vegetation

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Introduction: Cardiac valve vegetation is a primary characteristic of infective endocarditis. Systemic arterial embolization often occurs silently before the diagnosis of endocarditis has been made. This case study describes systemic emboli to the upper and lower extremity in a patient with a large aortic valve vegetation.

Patient Description: A 17-year-old male patient was referred to the vascular laboratory for a recent history of lower extremity claudication. Noninvasive studies included lower extremity physiologic testing and treadmill exercise. Magnetic resonance angiography of the lower extremity was performed and popliteal entrapment syndrome was suspected. The patient was admitted for duplex vein mapping and pre-surgical testing. Physiologic testing and vein mapping results prompted an echocardiogram referral.

Results: Physiologic testing noted normal right ankle-brachial index (ABI) and abnormal left ABI: Right posterior tibial (PT) 1.00, DP 1.01; Left PT 0.83, DP 0.74. Left ABI dropped to 0.48 following treadmill exercise. The right brachial pressure was significantly less than the left, 81 mm Hg and 119 mm Hg, respectively. Duplex examination of the right upper extremity revealed an axillary artery occlusion with hypoechoic intraluminal material. A similar intraluminal appearance was noted in the left popliteal artery and tibioperoneal trunk during duplex vein mapping. Echocardiography showed moderate aortic valve insufficiency and a 1.2-cm mobile vegetation localized underneath the bicuspid aortic valve leaflets. Infective endocarditis of unknown source was diagnosed. Heparin therapy was initiated and the patient was scheduled for emergency surgery. Excision of the aortic valve vegetation with aortic root replacement, modified Ross procedure, and Hemashield graft was successfully performed.

Conclusion: Cardiac valve vegetation is the hallmark of infective endocarditis. Size and mobility are predictors of embolic events and higher mortality. Awareness of systemic embolization and early diagnosis of infective endocarditis are key to

improved clinical outcomes and survival. Indications of systemic embolism in vascular patients should prompt echocardiography with cardiac consultation.

1021782 Case Study

An Iatrogenic Pseudoaneurysm of the Common Carotid Artery

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Introduction and Patient Description: Common carotid artery pseudoaneurysm (PSA) is a rare iatrogenic complication of an internal jugular venous dialysis catheter insertion. Described is a 73-year-old man who underwent right internal jugular catheterization for dialysis. After 2 days, the internal jugular line was pulled out accidentally. During the attempt to insert a new catheter into the right internal jugular vein, the focused ultrasound showed some vascular flow in the neck tissue, and upon further evaluation with color flow duplex imaging (CFI) and spectral Doppler, the patient was found to have a right common carotid artery PSA.

Methods: The patient was referred to the vascular laboratory for an arterial CFI to rule out a PSA of the right common carotid artery. Color flow duplex imaging and spectral Doppler were performed, using a Toshiba Aplio 500 with an 11 MHz linear probe.

Results: Color flow duplex imaging and spectral Doppler revealed a right common carotid artery PSA. The active chamber of the PSA had a “yin-yang” flow pattern with a size of 2.0 cm × 1.4 cm. The connecting neck from the mid-common carotid artery to the PSA measured 1.7 cm in length and 4.0 mm in diameter with a peak systolic velocity of 87 cm/s. Spectral Doppler demonstrated “to-fro” waveform. The common carotid artery distal and proximal to the PSA showed normal waveforms and peak systolic velocities. Based on these ultrasound test results, the patient underwent successful carotid artery reconstruction with an open repair of the PSA.

Conclusion: Color flow duplex imaging and spectral Doppler are valuable tools for the diagnosis and follow-up of a common carotid artery PSA due to jugular venous catheter insertion or other causes.

1022882 Case Study

A Rare Case of Ruptured Common Iliac Artery Aneurysm

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Introduction: IgG4-related retroperitoneal fibrosis (RPF) is a rare condition mostly affecting glandular tissue in elderly men. It is characterized by inflammatory and sclerotic tissues that encase adjacent structures. We present a case of IgG4-related RPF involving the right common iliac artery (RCIA) leading to aneurysmal degeneration, contained rupture, and presenting as acute limb ischemia (ALI).

Patient Description: A 71-year-old otherwise healthy man presented with 24 hours of right lower extremity ALI. On computed tomography (CT) angiogram, he was found to have a 15 × 10 × 13 cm right retroperitoneal mass with suspected invasion into the RCIA and right common iliac vein (RCIV). In addition, there was a 95% stenosis of the RCIA and associated thrombus—the likely source of embolism and ALI. On examination, he had a nonsalvageable foot. The patient underwent multi-disciplinary evaluation for suspected invasive retroperitoneal sarcoma.

Methods and Results: Imaging work up included ultrasound using a GE Logic 9 with curved 1 to 6 MHz gray-scale imaging with pulsed-wave Doppler, color Doppler, and B-flow imaging. Imaging was concerning for an RCIA contained ruptured aneurysm, although the patient was stable and without back pain. Magnetic resonance imaging and biopsies were performed, and the latter were indeterminate with necrotic tissue. Given high concern for an invasive oncologic process, he ultimately underwent a series of staged operations to revascularize his right leg, salvage a below-knee amputation, and resect the tumor/RCIA/RCIV en bloc. He additionally required inferior vena cava ligation. Pathology revealed a benign mass composed of fibrous tissue with chronic inflammation, scattered IgG4 positive cells, and organized hematoma.

Discussion and Conclusion: Acute limb ischemia in patients without atherosclerotic disease is usually secondary to embolism. Dedicated imaging can aid in the identification of embolic sources. In this case, RCIA aneurysmal degeneration with contained rupture and thrombus due to invasive IgG4-related RPF was the source of embolism. This rare condition is often treated surgically and can be challenging to diagnose, particularly in the acute setting.

1022980 Case Study

Vascular Abnormality Found Associated With CLOVES Syndrome

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Introduction: The CLOVES syndrome—Congenital Lipomatous Overgrowth, Vascular malformations, Epidermal nevi, and Scoliosis and/or Skeletal abnormalities—is a rare disease that is

an overgrowth syndrome that affects approximately 300 people worldwide. It is usually characterized as tissue overgrowth and vascular abnormalities. These abnormalities are caused by the mutation of the PIK3CA gene. It can affect the soft tissue, blood vessels, bone, and internal organs.

Patient Description and Methods: A 25-year-old patient presented with hematuria, abdominal pain, and a history of CLOVES syndrome. He also had a history of multiple pulmonary emboli. A computed tomography (CT) of the abdomen, urogram, and a venous duplex were ordered. The duplex ultrasound was performed on a GE Logic 9 with linear 2 to 9 MHz and curvilinear 1 to 6 MHz transducers. Gray-scale imaging, color Doppler, and pulsed-wave Doppler with spectral imaging were used.

Results: The CT showed two small masses within the abdomen and a markedly enlarged left iliac vein measuring up to 4.8 cm. The urogram noted a duplicated left inferior vena cava which was dilated, measuring up to 4.6 cm AP × 5.6 cm transverse, and a dilated left iliac vein measuring up to 3.6 cm in diameter. The venous ultrasound showed the same markedly enlarged or aneurysmal left iliac vein measuring up to 5 cm in diameter with a flow pattern noted.

Discussion and Conclusion: Vascular malformations are very common in patients with CLOVES syndrome. These usually involve low flow malformations like the venous abnormalities in this case. Dilated veins may promote thrombus formation and occasionally pulmonary embolism. These vascular abnormalities often go undetected until complications arise. Awareness may help reduce these occurrences and maintain the patient's quality of life.

1024601 Scientific

Nutcracker Phenomenon-Syndrome: Literature Review Related to Duplex Doppler Ultrasonography

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Introduction: Left renal vein (LRV) compression has anatomic and physiologic variances. Asymptomatic or symptomatic findings have been described as nutcracker phenomenon or syndrome. This challenging topic has been investigated.

Methods: Approximately 100 pubmed.gov free articles and SVU publications have been reviewed to comply with educational goals related to a vascular laboratory founded in 1991 and ISO certified since 2000.

Results: Duplex ultrasonography (DUS) incidental findings are as follows: (1) varicose veins at the posterior, lateral, or anterior upper thigh; pelvic varices caused by increased pressure/dilatation of an LRV "ovarian" tributary and (2) LRV dilatation, thrombosis, collateralization, tributary reflux, and flow disturbances noted during abdominal tests with findings of tumors, aneurysms, nephroptosis, different kidney sizes, and duodenal or venous anomalies.

Case reports: Left inferior vena cava (IVC) joining LRV toward a right IVC, dual LRVs, and retro aortic LRV detected thrombosis delaying diagnosis of compression, venous

aneurysm, extended median arcuate ligament compression, spinal cord injury, displaced kidney, duodenal compression, and low body mass index (BMI).

Transabdominal-pelvic, transvaginal DUS, and/or intravascular ultrasound (IVUS) may be indicated based on direct signs and symptoms (hematuria, proteinuria, flank pain, orthostatic intolerance, anemia).

Pelvic Congestion Syndrome test for differential diagnoses: menstruation pain, urination, post-coital ache (dysmenorrhea, dysuria, dyspareunia).

Duplex Doppler ultrasonography criteria: LRV velocity, diameter ratios >5 , velocity >100 cm/s, standing versus sitting changes.

Treatment: conservative, surgical, laparoscopic, and/or endovascular, including transpositions, venous patches, bypasses, balloon or self-expandable intra- or extra-venous stenting, even robot procedures have been performed. Restenosis and stent migration have been described.

Conclusion: Duplex ultrasonography has been useful for incidental findings, screening, diagnosis, and follow-up of nutcracker or similar venous compression conditions. Long-term reports on clinical and procedural treatment outcomes are needed.

1025222 Case Study

Fibromuscular Dysplasia: Webbing—A Sonographic Finding to Be Aware of

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Introduction: Historically, catheter-angiography has been the criterion standard for the diagnosis and imaging of fibromuscular dysplasia (FMD). Advances in ultrasound improved the visualization of this disease. The implementation of high-frequency probes and B-flow imaging has allowed us to identify the medial fibroplasia, or fibrous webbing, associated with the “string of beads” appearance of multifocal FMD.

Methods: The GE Logiq 10 with the linear 2 to 9 MHz, curvilinear 1 to 6 MHz, and intraoperative linear 8 to 18i MHz transducers were used. Imaging was reviewed from a patient with known FMD. Gray-scale, color Doppler, color power angio, and B-flow imaging were directed to regions of the vessels identified with increased velocities and turbulence on spectral Doppler. When intraluminal abnormalities were identified, these studies were correlated with computed tomography angiography (CTA), magnetic resonance angiography (MRA), catheter-angiography, and prior history.

Results: The imaging of webbing is much easier to identify in superficial vessels and vessels without imaging limitations. Imaging of “webbing” is best seen in the brachial arteries but can be visualized in the carotid arteries with accuracy through image optimization techniques. These techniques include modifying the frequency, gray-scale color map, adjusting the gain and field of view. A side-by-side comparison of gray-scale imaging, and color Doppler can make imaging of gray-scale

abnormalities more evident. B-flow imaging correlation enhances the value of these images.

Discussion and Conclusion: Duplex ultrasound is relatively inexpensive in comparison with CTA, MRA, or catheter-angiography. Patients with FMD often have multi-vessel involvement. Duplex ultrasound can identify the presence of multifocal FMD when care is taken to optimize the images. This recognition will help earlier diagnosis and treatment which can minimize exposure to contrast agents and radiation.

1025437 Case Study

Heard But Not Seen: When Doppler Waveforms Speak—An Innominate Steal Case Study

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Introduction: Innominate artery stenosis is an unusual finding when performing carotid duplex ultrasound (CDU). We report on a patient with greater than 80% innominate artery stenosis and a history of fibromuscular dysplasia and hypertension. The use of Doppler waveform analysis in diagnosing this patient will be discussed.

Patient Description and Methods: This patient was referred for CDU for evaluation of a known innominate artery stenosis. Imaging was performed and included Doppler interrogation of the carotid, subclavian, and vertebral arteries, as well as brachial blood pressures. Doppler waveform analysis was used to recommend angiographic imaging to treat severe innominate stenosis.

Results: The initial CDU revealed dampened post-stenotic waveforms in the right common carotid artery (CCA) and internal carotid artery (ICA), as well as pre-steal retrograde right vertebral artery waveforms. The patient was initially asymptomatic, but a year and a half later, CDU revealed the following on the right: pre-steal Doppler waveform in the CCA, bidirectional flow in the ICA, and retrograde vertebral artery flow. The patient now had right arm claudication and underwent placement of an innominate artery stent. Follow-up CDU demonstrated normal CCA and ICA waveforms and antegrade vertebral artery flow; however, when the patient presented with a right-sided stroke, a pre-steal vertebral artery Doppler waveform alerted the team that there was a stenosis in the innominate artery stent. Subsequent CDU examinations showed progression of disease with recurrence of pre-steal flow in the right CCA, complete subclavian steal, retrograde vertebral artery flow, and the right brachial pressure 41 mm Hg lower than the left brachial pressure. This prompted another surgical referral for recurrent innominate artery stenosis.

Discussion and Conclusion: Ultrasound was instrumental in the initial diagnosis and surveillance of this patient. Doppler waveform analysis was critical for detecting significant hemodynamic changes in the innominate artery, which is not well-visualized by gray-scale imaging alone. This case demonstrates the value and utility of performing spectral Doppler analysis of the cervical arteries during CDU to provide the most complete assessment.

1037512 Case Study

Interesting Sequelae in a Patient With Cystic Adventitial Disease of the Popliteal Artery

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Introduction: Cystic adventitial disease is an unusual pathology which most commonly presents in the popliteal artery. As the disease progresses, it may lead to the development of a hemodynamically significant stenosis and ultimately claudication. In this case, the expansion the popliteal cyst led to compression of the popliteal vein and subsequent deep venous thrombosis and later identification of arterial neovascularization within the thrombus.

Patient Description and Methods: A 48-year-old man presented for vascular consultation following an abnormal knee magnetic resonance imaging. Differential diagnosis of synovial cyst versus cystic adventitial disease was reported with 80% stenosis of the popliteal artery. The patient reported orthopedic knee pain without vascular calf claudication. Physical examination demonstrated a prominent left popliteal pulse and easily palpable pedal pulses. High-resolution duplex ultrasonography and physiologic testing were obtained to better evaluate the popliteal abnormality.

Results: Initial duplex examination demonstrated a hypoechoic fluid collection within the wall of the popliteal artery, consistent with cystic adventitial disease. Normal arterial hemodynamics were present. Of note, the popliteal vein showed extrinsic compression from the adjacent artery. Over the next year, an interesting sequela of pathology was uncovered by ultrasonography and computed tomography angiography, including deep venous thrombosis, followed by neovascularization of venous thrombus and progression of the cystic adventitial disease. This information ultimately led to successful surgical treatment of the affected popliteal artery.

Discussion and Conclusion: Cystic adventitial disease and arterial neovascularization of venous thrombus may be unusual findings on duplex ultrasonography, although both may be easily identified and monitored by a thorough and detailed examination for the specific pathologies. This case demonstrates the importance of communication between the vascular surgeon and sonographer, as well as an understanding of additional imaging modalities by the sonographer to better focus the duplex examination.

1040392 Case Study

Spontaneous Pseudoaneurysm of the Posterior Tibial Artery

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Introduction: True aneurysms involve dilation of the entire vessel wall while pseudoaneurysms form connective tissue around a localized hematoma. The risk of rupture or

thromboembolic events increases as the size of the aneurysm increases. We report an incidentally found posterior tibial artery pseudoaneurysm.

Patient Description: A 78-year-old man presented with swelling of his ankle and complaint of foot numbness when seated. His history included coronary artery disease, mechanical mitral and aortic valve replacements, paroxysmal atrial fibrillation, and a previous stroke when sub-therapeutic on warfarin. Noninvasive imaging showed a partially thrombosed pseudoaneurysm of the posterior tibial artery and normal ankle-brachial indices.

The decision was made to proceed with endovascular intervention to avoid stopping his anticoagulation due to previous events when sub-therapeutic. Angiography demonstrated patency of all named vessels of the leg. The right anterior tibial artery was the dominant flow to the foot, with slow filling of the posterior tibial artery that terminated in the pseudoaneurysm. Two Azur (Terumo; Somerset, NJ) coils were placed at the proximal neck. Completion angiography demonstrated resolution of flow into the pseudoaneurysm and preserved outflow into the foot via the anterior tibial artery. The patient had resolution of symptoms, and follow-up imaging has shown persistent thrombosis of the pseudoaneurysm at six months.

Discussion and Conclusion: Most cases of tibial artery pseudoaneurysm occur due to penetrating trauma, orthopedic procedures, calcaneal fractures, and iatrogenic injury. Risk factors include diabetes, immunosuppression, infection, and connective tissue disorders. Literature suggests open or endovascular interventions can be considered, depending on patient age, comorbidities, size of aneurysm, and severity of symptoms.

Our patient had no trauma or surgery to the area and had not tolerated being sub-therapeutic on his anticoagulation, complicating his treatment approach. Further investigation into the possible cause of spontaneous pseudoaneurysm formation as well as guidelines for treatment of pseudoaneurysm of the tibial vessels are needed.

1040418 Case Study

Claudication: The Role of Lifestyle Modifications and Assessing Their Efficacy Using Perfusion Markers

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Introduction and Patient Description: The patient is a medically complex 77-year-old man with a history of coronary artery disease, hypertension, hyperlipidemia, and a current 40 pack-year smoker. Surgical history includes an endovascular abdominal aortic repair and open bypass of his thrombosed right popliteal artery aneurysm. He continued to smoke, and his bypass graft occluded resulting in right calf short distance claudication. Because of his limited options anatomically for revascularization, we encouraged a trial of

medical nonoperative therapy, stressing smoking cessation and an exercise regimen.

Methods: Pedal Acceleration Time (PAT) is a novel technique that quantifies foot perfusion using duplex ultrasound. Prior to beginning the at-home exercise program, we obtained detailed claudication symptoms and perfusion testing which included resting ankle-brachial index (ABI), toe pressure, and PAT. Ten months later, the same perfusion tests were measured.

Results: Before lifestyle modifications, the patient reported less than one block claudication with resting ABI of 0.5, and absolute toe pressure of 30 mm Hg. Pedal Acceleration Time in the arcuate artery and lateral plantar artery was categorized as severe Class 4 ischemia. After consistently following his exercise regimen for 10 months, he returned for follow-up. At that time, he had quit smoking and exercised on average four times per week for one hour. He reported that his claudication had completely resolved. His ABI increased slightly to 0.6 and absolute toe pressure improved to 70 mm Hg. The PAT in the arcuate artery and lateral plantar artery improved significantly to Class I (normal).

Discussion and Conclusion: This case illustrates that measurement of PAT reflects collateral flow and correlates with clinical symptoms. The patient's ABI improved by 0.1, which was not significant; however, his PAT did show marked improvement from Class 4 to Class I. This case exemplified the crucial role of motivation and adherence to lifestyle modifications when managing claudication. We also highlight the benefit of PAT over ABI in monitoring the changes in collateral flow that develop with exercise.

1040433 Case Study

Incidental Finding of a Circumaortic Left Renal Vein Aneurysm

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Introduction: *Vascular anomalies of the renal vein are rare.* Renal vein aneurysms (RVAs) are reported as 3% of all visceral abdominal aneurysms and are usually left-sided. They are usually found incidentally, but may present as abdominal pain, hematuria, pulmonary embolism, heart failure, or portal hypertension. Other variations of renal veins may include retroaortic and circumaortic anatomy. Circumaortic aneurysms are extremely rare. Here, we present an incidental finding of this rare anatomic anomaly.

Patient Description: A 59-year-old man was found to have a left renal hilar abnormality on a routine evaluation and surveillance chest computed tomography (CT). The patient denied any abdominal pain, hematuria, or cardiac issues. The patient was referred to vascular surgery.

Methods and Results: Initial evaluation by renal ultrasound showed a possible left renal vein fusiform versus saccular type dilation and a circumaortic renal vein. Subsequent CT scan demonstrated a left-sided circumaortic RVA measuring 2.2 cm

× 1.8 cm. Given the asymptomatic nature and size of the aneurysm, the patient was deemed appropriate for surveillance imaging.

Discussion and Conclusion: Renal vein aneurysms and circumaortic RVAs represent a rare variant of venous anomalies. There is only one case report of a circumaortic RVA which was managed conservatively. Review of the literature has shown management has been primarily based on presentation and complications attributed to the aneurysm. Presently, there is no consensus on the size of RVAs requiring intervention. Several published studies have managed RVAs nonoperatively with routine surveillance. More research is needed to better understand their pathophysiology, natural history, and possible treatment options.

1040438 Scientific

Correlation Between Toe Pressures and Pedal Acceleration Time—Why Do We Care?

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Introduction: Toe pressure (TP) has been described as a reliable noninvasive test in patients with diabetes or renal failure with noncompressible vessels. Duplex ultrasound of the pedal arch provides new data points in evaluating patients with arterial occlusive disease. Pedal Acceleration Time (PAT) is being used to quantify arterial blood flow to the foot. The PAT can be performed in patients without digits and those with wounds that are not conducive to pressure measurements. A previous publication reported high correlation between ankle-brachial index and PAT. We sought to compare the reliability of PAT with TP in patients with arterial occlusive disease.

Methods: A retrospective analysis in a prospectively kept database in a single institution for a 1-year period. Patients who did not have TPs or PAT performed were excluded from the study. A complete pedal arch duplex examination was performed in all limbs. The PAT of the dorsal metatarsal artery, leading directly to the first digit was analyzed in comparison with TP.

Results: Of the 182 limbs, 108 were diabetic. The majority of patients were men and over 70 years old. Other comorbidities included diabetes, smoking, hypertension, renal failure, coronary artery disease, and hypercholesterolemia. There was significant correlation between normal PAT and TP in nondiabetic patients ($R^2 = 0.85$). However, we found poor correlation between PAT and TP in diabetic patients ($R^2 = 0.44$).

Discussion and Conclusion: Our study showed that PAT correlates well with TP in nondiabetic patients. However, in patients with diabetes and presumed small vessel disease, TP may represent isolated small vessel disease of the digit compared with direct visualization of the feeding vessel. Recognizing that PAT allows direct visualization of arterial flow, this test may be a better indicator of overall foot perfusion compared with TP, given our ability to directly insonate the pedal arch. That is why we care.