Hi, this is Dr. Jeff Klein, editor of RadioGraphics and welcome to the RadioGraphics audio summary podcast. Each issue, I will be highlighting a few of our articles that I think are important.

Expected and Unexpected Imaging Findings after ⁹⁰Y Transarterial Radioembolization for Liver Tumors
Juan C. Spina, MD • Isabel Hume, MD • Ana Pelaez, MD • Oscar Peralta, MD • Marcos Quadrelli, MD • Ricardo Garcia Monaco, MD

In this article from the Department of Radiology of the Hospital Italiano in Buenos Aires, Argentina, Dr. Juan Spina and colleagues review the expected and unexpected imaging of patients that have undergone transcatheter radioembolization or TARE for primary or metastatic liver malignancy. The article’s introduction begins with a review of the basic physics of yttrium-90 microspheres, patient selection, goals of treatment, and brief description of post-treatment imaging findings. Treatment planning and mapping is geared towards delivering the treatment “in the right dose to the right location with the right intent”. This begins with a quantification of the hepatopulmonary shunt fraction using technetium-99m-MAA to determine the lung shunt fraction and thereby adjust the treatment dose accordingly. The use of Tc-99m-MAA SPECT-CT is useful to determine extra-vascular sites at risk for post-radioembolization complications. The authors review the empiric, body surface area, and dosimetric methods for determining treatment dose. The authors stress the utility of cone-beam CT in modifying treatment plans in the majority of patients when used in the angiography suite. The article then proceeds to address the evaluation of treatment response, reviewing the response criteria for TARE treatment of hepatocellular carcinoma and hypervascular metastases and for hypovascular tumors and liver metastases. The use of tri-phasic CT and MR with diffusion-weighted imaging in the early functional assessment of tumor response is highlighted; PET-CT is used for problem-solving in selected cases. The tumoral and perilesional findings expected following treatment include edema and inflammation, ring enhancement, hepatic fibrosis, portal hypertension, and capsular contraction. The final section reviews potential hepatic and extrahepatic complications of TARE. Hepatic complications include biliary necrosis and biloma, hepatic abscess formation, and radioembolization-induced liver disease. Extrahepatic complications include radiation-induced cholecystitis, perihilar fluid and pleural effusion, gastrointestinal complications, and radiation pneumonitis and dermatitis.

High-Value Multidetector CT Angiography of the Superior Mesenteric Artery: What Emergency Medicine Physicians and Interventional Radiologists Need to Know
Nevil Ghodasara, MD • Robert Liddell, MD • Elliot K. Fishman, MD • Pamela T. Johnson, MD

The superior mesenteric artery may be involved in a variety of acute abdominal conditions that may present as life-threatening entities. This article from Johns Hopkins Hospital and Health System begins with a review of the multi-detector CT protocol to be used in the evaluation of SMA pathology, particularly the importance of 2-D coronal and sagittal and 3-D reconstructions to depict pathology. Familiarity of the normal and variant anatomy of the SMA is important for diagnosis and to plan surgical or endovascular procedures. The primary acute entity affecting the SMA is acute mesenteric ischemia due to embolus, arterial or venous thrombosis, and non-occlusive ischemia. The article describes and illustrates the vascular and intestinal CT findings including circumferential wall thickening, the target or halo sign, bowel dilatation, pneumatosis, and mesenteric or portal venous gas. The role of MDCT in conjunction with clinical evaluation in determining treatment options is discussed, particularly those findings that help determine if supportive, endovascular, or surgical management is indicated. Isolated SMA dissection or that associated with aortic dissection is readily assessed on MDCT; the presence of a mesenteric hematoma or hemorrhagic ascites should alert the ER physician to rapidly engage the interventional and surgical management teams. The interventional radiologist needs to review the MDCT findings to determine if endovascular treatment if requested is appropriate or feasible. Superior mesenteric artery aneurysms and pseudoaneurysms typically occur in men in their 40s and typically develop within the proximal 5 cm of the vessel. MDCT accurately depicts these as true or false aneurysms and must be identified and characterized to guide proper management. Vasculitides including Takayasu and giant cell arteritis, systemic lupus erythematosus, and segmental arterial medialiysis may affect the SMA; bowel inflammation or ischemia in a young patient should prompt consideration of this diagnosis. MDCT findings of vasculitis include arterial heading and narrowing with secondary ischemic bowel changes. Superior mesenteric artery hemorrhage encompasses a spectrum of pathologies; the final part of this review of SMA pathology on MDCT focuses on intraluminal gastrointestinal hemorrhage, which is the specific focus of a RadioGraphics article from July 2018 by Wells and colleagues. The article reinforces that colonic diverticulosis and angiodysplasia are readily distinguished on MDCT, and reviews the vascular anatomy as depicted on MDCT that is of importance for guiding endovascular treatment with embolic material.
Radiologists can play a central role in the evaluation of limb length discrepancy or limb overgrowth by recognizing imaging findings and recommending appropriate genetic testing in the appropriate clinical context. These disorders, which result predominantly from mutations in the PI3K/AKT/mTOR regulatory pathway, are associated with vascular anomalies such as PI3KCA Overgrowth Syndrome, Klippel-Trenaunay Syndrome, CLOVES, Fibro-Adipose Vascular Anomaly, and other syndromes. The paper reviews the diagnostic imaging of vascular anomalies, beginning with MRI and pre- and post-contrast MR angiography, which is the preferred imaging modality to evaluate vascular tumors and malformations. MR, along with ultrasound, are the preferred imaging methods to employ as many of the affected patients are young children and adolescents, and so CT is rarely used for evaluation. Digital subtraction angiography and venography is utilized for pre-treatment planning and dynamic evaluation and treatment of these vascular anomalies. The International Society for the Study of Vascular Anomalies or ISSVA updated its classification of vascular anomalies in 2014 and divided these entities into malformations and tumors; interested readers looking for a more thorough review of the ISSVA classification system are referred to the September 2016 RadioGraphics article by Merrow and colleagues on this topic. This article focuses on the anomalies associated with the PI3K/AKT/mTOR regulatory pathway. Klippel Trenaunay Syndrome involves capillary malformations, venous malformations, and bony/skin tissue overgrowth; a characteristic lesion depicted on MRA in KTS is a large lateral embryonic vein in the lower extremity named the marginal vein of Servelle. CLOVES syndrome reflects the clinical findings of congenital limb overgrowth (CLO), vascular anomalies (V), epidermal nevi (E) and scoliosis or spinal deformities (S). This syndrome can be mistaken for KTS and the authors provide a concept map in Figure 4 that provides key clinical findings that help in this distinction. Fibroadipose Vascular Anomaly or FAVA is characterized by a solid fibro-fatty intramuscular lesion with slow-flow vascular malformations. Ultrasound is the most appropriate first study given the focality of this lesion, with MRI/MRA imaging findings characteristic of a fibrofatty mass. PTEN mutation spectrum encompasses a multitude of clinical syndromes that are associated with hamartomatous overgrowth. Parkes-Weber Syndrome is distinguished from KTS as PWS is associated with high-flow arteriovenous malformations whereas KTS has slow-flow malformations. Figure 9 summarizes the phenotypic diagnostic criteria associated with Proteus Syndrome, named after the shape-shifting Greek god as a result of its tendency to progress with worsening phenotypic features over time.

In our current issue readers can find the most recent contribution to our ongoing series of radiologic pathologic correlation articles from Drs. Kelly Koeller and Robert Shih of the AIRP, which addresses imaging of intradural extramedullary spinal neoplasms. As the authors stress, localization of spinal tumors to the intradural extramedullary space greatly narrows the differential diagnosis, as meningioma and schwannoma are the two most common entities, each associated with neurofibromatosis. Spinal meningiomas most often arise within the thoracic spine; a strong female pre-dilection suggests a hormonal association and ionizing radiation in childhood is a recognized risk factor. On MR, these tumors are situated lateral to the cord, with a dural tail seen in 60-70% of lesions on post-contrast MRI; specific features include the “ginkgo leaf sign” on MRI and the “arachnoid isolation sign” at CT myelography. Spinal schwannomas may be isolated or multiple, where they are associated with NF2. After reviewing the histopathology and immunocytochemistry of schwannomas, the article describes and illustrates the typical MR features of a T2-hyperintense nodular intradural mass along the lumbar dorsal nerve roots that enhances with contrast. When encountering an intradural mass that appears to reflect a nerve sheath tumor but shows a T1 hyperintensity and T2 hypointensity on MRI, a melanotic schwannoma, often associated with the Carney complex, should be considered. Neurofibromas either sporadic or associated with NF1 are most common in the cervical region; they show T1 isointensity and T2 hyperintensity with intense homogenous enhancement on MRI. Malignant peripheral nerve sheath tumors comprise < 1% of all peripheral nerve sheath tumors, with half of the cases associated with NF1. At imaging, these tumors manifest as heterogeneous masses at CT and MRI with variable enhancement post-contrast; the imaging appearance shows significant overlap with schwannomas and soft tissue sarcomas. Myxopapillary ependymomas, paragangliomas, and solitary fibrous tumors or hemangiopericytomas are all uncommon intradural tumors with nonspecific imaging findings. Finally, leptomeningeal metastasis is most often associated with solid tumors including melanoma, breast cancer, and small cell lung cancer. Table 1 provides a list of these intradural tumors with relative frequency, clinical correlates, typical location, and characteristic imaging features.
Pelvic venous congestion syndrome is an underdiagnosed cause of chronic pelvic pain in female patients. In their article of the imaging of this condition, the authors from the Mayo Clinic in Rochester, Minnesota review the normal female pelvic venous anatomy and detail those conditions associated with pelvic venous congestion, which are summarized in Table 1. Incompetent gonadal vein valves, either congenital or acquired, is the most common cause of pelvic venous congestion syndrome and is termed pelvic venous insufficiency or PVI. Nutcracker syndrome, or compression of the left renal vein between the aorta and SMA, May-Thurner configuration with right common iliac arterial compression of the left common iliac vein, and congenital absence of the IVC or acquired IVC obstruction are all additional causes of the syndrome. The paper reviews the imaging workup for PVCS due to PVI. Catheter venography is the gold standard for the diagnosis of PVI, and the Society of Interventional Radiology has published consensus diagnostic guidelines for the venographic diagnosis of PVI. Ultrasound, particularly transvaginal duplex US, can be useful for screening for PVCS as it can be performed in different patient positions and with provocative (i.e. Valsalva) maneuvers. MRI can provide pelvic anatomic and dynamic vascular evaluation; the authors share their MR imaging protocol for evaluation of PVCS in Table 2. CT is utilized when a structural abnormality is suspected as a cause of PVCS. Table 3 summarizes the diagnostic findings that suggest PVCS listed for each modality. For treatment, catheter-based embolization is more effective than medical or surgical therapies when PVCS is due to PVI. First reported by Edwards in 1993, gonadal and iliac vein embolization can provide symptomatic improvement in >93% of patients. The endovascular treatment procedure is detailed and use of sclerosing agents or vascular plugs is illustrated; patients found to have May-Thurner configuration may be successfully managed by stenting the left common iliac vein. Percutaneous vulvar variceal sclerosis can be employed when initial treatment has been ineffective. Despite its apparent effectiveness for PVI, reimbursement for the procedure from insurance companies can be challenging; the authors note that the SIR provides a standard letter for appealing denied preapproval claims.

Accompanying this month’s article on MRI of rectal cancer appearing in the GI section of the journal is this paper that details the MRI evaluation of treatment response to neoadjuvant chemoradiation therapy in patients with rectal cancer. Following a brief review of the TNM classification system and staging system for rectal cancer, the authors review treatment options which comprise surgery for small, well to moderately-differentiated T1 lesions within 8 cm of the rectal verge and involving <30% of the rectal circumference, and chemoradiation for those with stage II or stage III disease. The assessment of treatment response centers on MRI, and the authors share their MRI protocol for rectal cancer in Table 3. Posttreatment changes including decrease in tumor volume, the development of fibrosis and mucin production by recurrent/residual tumor, and morphologic changes are essential for assessing response to treatment. Primary tumor posttreatment restaging is evaluated using the same TNM and AJCC criteria used for pre-treatment evaluation of tumors, with a y prefix applied following neoadjuvant chemoradiation therapy. A semi-quantitative MRI-based tumor regression grade that correlates with histopathologic tumor regression grade has important prognostic implications; the grading schema is detailed in Table 4. Functional MRI imaging sequences including diffusion-weighted imaging and perfusion imaging are increasingly valuable in evaluating rectal cancer post chemoradiation; these and other emerging techniques are explored in greater depth in the article by Garcia-Figueiras in their May-June 2018 Radiology article on advanced imaging techniques in evaluation of colorectal cancer. In brief, tumor cellularity correlates inversely with ADC values which have value in assessing tumor aggressivity and therefore in predicting treatment response. DWI with ADC maps can assist in identifying residual tumor post therapy. Similarly, perfusion imaging with determination of the volume transfer constant Ktrans correlates with tumor vascular endothelial growth factor and tumor aggressiveness. Nodal assessment post-treatment, aside from a decrease in size, remains challenging on MRI, although PET shares similar limitations. The paper concludes with a brief discussion of the potential of PET/MRI in this clinical setting.

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