Current Problems in Procuring Mo-99/Tc-99m Generators

**Tc-99m and the Current Problems in Procuring Mo-99/Tc-99m Generators.**

Zuckier LS:
-Special Presentation: ()

Current shortages of Tc-99m are due to an unanticipated shut-down of a nuclear reactor in Canada.

**Discussion:** This month I would like to discuss the preeminent position of Tc-99m in the pantheon of radiopharmaceuticals used in nuclear medicine and segue to the current problems being encountered with production of molybdenum/technetium 99m generators. One of the take-off points for this discussion is an excellent review of Technetium 99m which appears in the March 2009 volume of *JACC Cardiovasc Imaging*, authored by Dr William C. Eckelman, a pioneer in the development of radiopharmaceuticals in nuclear medicine. The majority of Mo-99 produced for Tc-99m medical use comes from fission of highly enriched uranium which occurs in only 5 reactors around the world. In mid-May, operators at the Canadian plant found a small leak at the base of the reactor vessel and corrosion on the outside wall. Atomic Energy of Canada Ltd initially estimated that the problem, which isn't considered a safety concern, would keep the plant down for more than a month while the estimate was later revised to "at least 3 months." An update of that estimate is still pending. The worst-case scenario is that the 52-year-old plant in Ontario could be down for a prolonged stretch or may never restart. To add to this problem, one of the other main reactors, the HFR reactor in the Netherlands, has 2 upcoming scheduled maintenance shut-downs--for 4 weeks beginning in mid-July 2009 and for several months starting in the first quarter of 2010. Based on the limited availability of Molybdenum, one can readily understand how the emergency shut-down of the Canadian reactor has thrown the supply chain into chaos. In summary, the medical community has come to rely on Tc-99m as an excellent radionuclide for labeling of diagnostic radiopharmaceuticals. Unfortunately, we have not been proactive in ensuring a robust and redundant source of molybdenum, leading to the present unprecedented disruption in supply.

**Reviewer's Comments:** I am hopeful we will be able to limp through this crisis; however, we need to build a future reliable domestic source of radionuclide if we hope to sustain nuclear medicine in the future.

**print tag:** ()
MR Enteroclysis Is an Accurate Modality in Detecting Small-Bowel Neoplasms

Masselli G, Polettini E, et al:
Radiology; 251 (June): 743-750

MR enteroclysis is both specific and accurate in detecting small-bowel neoplasms in symptomatic patients.

**Objective:** To evaluate the performance of MR enteroclysis in detecting small-bowel neoplasms in symptomatic patients.

**Design:** Prospective analysis.

**Methods:** The study was comprised of 150 patients clinically suspected of having small-bowel neoplasms who underwent MR enteroclysis. Previous upper and lower GI endoscopy studies were normal in all patients. Clinical indications included recurrent abdominal pain, intermittent intestinal obstruction, GI bleeding, refractory celiac sprue, carcinoïd syndrome, and family history of small bowel neoplasm. Nasojejunal intubation was performed under fluoroscopic guidance prior to being transferred to the MR suite. MR examinations were performed on a 1.5T system. Approximately 1600 to 2000 mL of a polyethylene glycol-water solution was infused as the intraluminal contrast agent. MR fluoroscopy using dynamic 2D T2-weighted fast spin-echo images were acquired until the solution reached the ascending colon. Subsequently, single shot fast spin-echo and FIESTA sequences were performed. Contrast-enhanced 3D T1-weighted images were obtained 180 seconds after initiation of the contrast bolus. Images were reviewed by 2 radiologists. The presence of focal bowel wall thickening, small bowel stenosis, and small bowel masses was recorded. Histopathologic findings obtained at surgery or enteroscopy were used as the reference standard. Video capsule endoscopy and conventional enteroclysis were used to confirm the absence of small-bowel neoplasms.

**Results:** There were 21 lesions found at MR enteroclysis, with 19 confirmed surgically. These included carcinoid tumor, adenocarcinoma, stromal tumor, lymphoma, angiomatous mass, metastasis, leiomyoma, adenoma, and lipoma. There was 100% concordance between the diseased small bowel segment identified at MR and the one encountered at surgery. Eleven of the 19 masses had an associated partial small-bowel obstruction. MR enteroclysis was negative in 129 patients. Video capsule endoscopy, conventional enteroclysis, or conventional enteroscopy was subsequently performed. There were 3 false-negatives due to ileal polyps <10 mm and small-bowel wall thickening due to lymphoma. MR enteroclysis was shown to have 86% sensitivity, 98% specificity, and 97% accuracy in the detection of small bowel neoplasms.

**Conclusions:** MR enteroclysis is an accurate modality for detecting small-bowel neoplasms in symptomatic patients.

**Reviewer's Comments:** This study demonstrates that MR enteroclysis can be used in the detection of small bowel neoplasms in symptomatic patients. It cannot only detect abnormalities intrinsic to the small bowel, such as masses and wall thickening, but also functional information similar to a conventional enteroclysis study as well as extraluminal manifestations of disease afforded by cross-sectional imaging. One of the limitations reported in the study was that it was a single-center trial and consequently the disease prevalence in other patient populations may influence the overall accuracy of MR enteroclysis.

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Are There Certain CT and MRI Features of Successfully Ablated Renal Masses?

MRI and CT Characteristics of Successfully Ablated Renal Masses: Imaging Surveillance After Radiofrequency Ablation.

Davenport MS, Caoili EM, et al;
AJR Am J Roentgenol; 192 (June): 1571-1578

In this study, common findings of successfully ablated renal masses included initial increase in volume followed by decreasing volume as well as lack of central enhancement.

**Objective:** To determine if there are common CT and MRI imaging features of renal masses following radiofrequency ablation (RFA).

**Design:** Retrospective analysis.

**Participants/Methods:** This study was comprised of 25 patients with 28 lesions who had CT or MR examination prior to ablation therapy with a minimum of 1 year follow-up. CT examinations were performed on MDCT scanners. Unenhanced images were obtained followed by enhanced images acquired at 100 seconds during the nephrographic phase following the initiation of the contrast injection. MRI examinations were performed on a 1.5T or 3T system. Imaging sequences included T1-weighted gradient-recalled echo in-phase and opposed-phase, T2-weighted fast spin-echo, T1-weighted gradient-recalled echo in-phase with a water-saturation pulse, and T1-weighted dynamic contrast-enhanced images during the arterial, venous, and delayed phases. Images were reviewed by 3 radiologists. Pre-ablation studies were used to characterize the percentage of the mass that extended beyond the confines of the renal parenchyma. Post-ablation images were assessed for the following features: size of the ablated tumor, tumor volume, and enhancement characteristics. The presence or absence of perinephric stranding, periablational halo, and fat invagination were also assessed.

**Results:** Lesions measuring up to 3 cm³ showed an increase in tumor volume 1 to 2 months following ablation, and subsequently showed a gradual decrease at 12 to 24 months to a volume equal to or less than that of the original lesion. Lesions measuring >3 cm³ decreased in tumor volume 1 to 2 months following ablation, and at 12 to 24 months they were approximately half the original tumor volume. CT showed that the ablated lesions showed higher attenuation than the renal parenchyma on unenhanced images, and the attenuation remained relatively stable on follow-up. The ablated lesions had lower attenuation than the renal parenchyma on the nephrographic phase-enhanced images and without enhancement on follow-up studies. MRI demonstrated that the ablated lesions were heterogeneously hyperintense on T1- and heterogeneously hypointense on T2-weighted images compared to the renal parenchyma. There was no enhancement in the ablation zone, although there was a thin rim of peripheral enhancement commonly about the ablation bed. Perinephric stranding was seen in all patients on nearly all follow-up studies. A periablational halo was also seen frequently on CT and MRI and was more common with renal lesions that were predominantly exophytic. Fat invagination was less common, although when present, was seen more frequently on CT.

**Conclusions/Reviewer’s Comments:** The results of this study are useful in illustrating the relatively predictable findings of perinephric stranding, periablational halo, and fat invagination commonly encountered on CT and MRI following RFA of renal lesions. One of the limitations reported in the study was that the CT protocol did not include an arterial phase, which might have had a better sensitivity for the detection of residual or recurrent neoplasm.
Papillary and Clear Cell RCCs Can Be Differentiated Based on Signal Intensities

Renal Cell Carcinoma: T1 and T2 Signal Intensity Characteristics of Papillary and Clear Cell Types Correlated With Pathology.

Oliva MR, Glickman JN, et al:
AJR Am J Roentgenol; 192 (June): 1524-1530

Papillary RCCs tend to be hypointense on T2-weighted images while clear cell RCCs are typically hyperintense.

**Objective:** To determine if there are distinguishing T1 and T2 signal intensities of papillary renal cell carcinomas (RCCs) and clear cell RCCs.

**Design:** Retrospective analysis.

**Methods:** This study was comprised of 49 renal cell carcinomas, 21 papillary and 28 clear cell, in 45 patients who had undergone MRI. Overall, 37 of the 49 RCCs had pathological confirmation either via surgical resection, percutaneous fine-needle aspiration biopsy, or percutaneous large-needle biopsy. MRI examinations were performed on a 1.5T system. Sequences included T1-weighted spoiled gradient fat-suppressed or 3D fast-acquisition multiple excitation spoiled gradient-echo, and T2-weighted single-shot fast spin-echo. Images were reviewed by 2 radiologists. Qualitatively, they each classified the masses by visual inspection as homogeneous or heterogeneous and as hypointense, isointense, or hyperintense relative to the renal cortex on the T1- and T2-weighted images. Quantitative assessment was performed by calculating the tumor signal intensity ratio obtained by dividing tumor signal intensity by the renal cortex signal intensity. Pathological classification of the masses was performed by evaluating tumor cellularity, nucleus-to-cytoplasm ratio, and tumor cell architecture. The presence or absence of blood products, calcification, necrosis, and fibrosis was also recorded.

**Results:** There was variable signal intensity on T1-weighted images of both tumor types on visual inspection. There was no significant difference between the mean T1 tumor signal intensity ratios of papillary and clear cell RCCs on T1-weighted images. Both papillary and clear cell RCCs were either homogeneous or heterogeneous on T2-weighted images. Papillary RCCs were found to be hypointense and clear cell RCCs were hyperintense on T2-weighted images. Similarly, papillary RCCs had a lower T2 tumor signal intensity ratio than clear cell RCCs. A T2 tumor signal intensity ratio <0.93 was 86% specific and 96% sensitive for papillary RCC, while a ratio <0.66 was 100% specific and 54% sensitive for papillary RCC. Pathologically, there was no statistically significant difference between the 2 cell types regarding the presence or absence of blood products, calcification, necrosis, and fibrosis. Papillary RCCs had a predominance of papillary architecture, while clear cell RCCs had a nested architecture.

**Conclusions:** On T2-weighted images, most papillary RCCs are hypointense and clear cell RCCs, hyperintense. The T2 hypointense appearance of papillary RCCs correlated with a predominant papillary architecture at pathology.

**Reviewer’s Comments:** The results of this study are useful in demonstrating that MRI may aid in differentiating between the 2 more common cell types of RCCs. One of the limitations reported in the study was that the tumor signal intensity may vary depending on the MRI parameters used and consequently would need further investigation to determine its usefulness with other pulse sequences.

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Negative Coronary CTA Saves Time and Money

Low-Risk Patients With Chest Pain in the Emergency Department: Negative 64-MDCT Coronary Angiography May Reduce Length of Stay and Hospital Charges.

May JM, Shuman WP, et al:
AJR Am J Roentgenol; 193 (July): 150-154

In low-risk patients with chest pain, discharge from the ED based on negative cardiac CT, enzyme tests, and ECG may significantly decrease both length of stay and hospital charges compared with the standard of care.

Objective: To evaluate whether a negative coronary CT angiogram (CTA) performed in the ED setting would lead to a shorter length of stay and reduced cost.

Participants: 53 patients who presented to the ED with chest pain and had a low thrombolysis in myocardial infarction (TIMI) risk score of 0-2. All patients consented for a 64-MDCT coronary CTA. Exclusion criteria included positive initial cardiac enzymes and ECG findings suggesting ischemia. Patients who had a non-sinus rhythm, were unable to achieve a heart rate <75 bpm, or with a BMI >40 were also excluded.

Methods: CTAs were performed either with retrospective ECG gating and tube-current modulation or with prospective ECG triggering. Findings of no greater than 30% stenosis in any coronary artery territory were considered a negative exam. After the exam, all patients were transferred back to the ED and standard of care (SOC) testing was resumed, including serial cardiac enzyme tests and ECGs. Following negative results of these serial tests, follow-up stress testing with either a 99mTc-tetrofosmin SPECT or stress echocardiography was performed as soon as scheduling allowed during regular business hours. The majority of patients had 3- and/or 6-month telephone follow-up regarding any interim cardiovascular events. Length of stay was recorded from the medical record and hospital charges were recorded from the hospital electronic billing program. Professional fee charges were also recorded.

Results: 3 of 53 patients had positive findings on CTA and were excluded from subsequent analyses. The remaining 50 patients who had negative CTAs also all had negative serial cardiac enzymes and no signs of ischemia on serial ECGs. All of their follow-up stress tests were also negative. Of the patients able to be contacted on follow-up at 3 and/or 6 months, none reported adverse events. The SOC mean length of stay (serial enzymes, serial ECGs, and follow-up stress test) was 25.4 hours. If a negative CTA was followed by observation (CTA within 90 minutes of admission, serial enzymes, and serial ECGS without follow-up stress test), the mean length of stay was 14.3 hours. If a negative CTA was followed by discharge (CTA within 90 minutes of admission and 1 hour after negative CTA results were submitted to ED physician), the mean length of stay was 5.0 hours. SOC mean charges were $7597. Negative CTA followed by observation mean charges were $6153. Negative CTA followed by discharge mean charges were $4251.

Conclusions: If a negative coronary CTA following initial negative cardiac enzyme tests and ECG were to used as criteria for discharge, length of stay and hospital charges would likely be significantly reduced.

Reviewer’s Comments: The authors have nicely demonstrated with numbers some of the potential benefits of performing coronary CTA in the ED setting.

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CT Tracheomalacia Diagnosis Called into Question

Tracheal Collapsibility in Healthy Volunteers During Forced Expiration: Assessment With Multidetector CT.

Boiselle PM, O'Donnell CR, et al:
Radiology; 252 (July): 255-262

Volunteers with no respiratory symptoms or known respiratory disease very often demonstrate significant tracheal luminal narrowing upon forced expiration which exceeds the previous CT diagnostic threshold for declaring tracheomalacia.

Objective: To evaluate normal range of forced tracheal collapsibility in healthy adults and compare this with the current CT standard of diagnosing tracheomalacia.

Design: Prospective analysis.

Participants: Adults with no respiratory symptoms and no history of respiratory disease, no history of smoking, and no history of prolonged intubation.

Methods: Patients consented for CT and pulmonary function tests (PFTs). Only patients with normal PFTs were included in the analysis. CT was performed using a low-dose technique, a 10-cm field of view centered on the trachea, and an area of coverage extending from 2 cm above the aortic arch to 2 cm below the carina. Imaging was performed at end-inspiration and during forced exhalation (dynamic expiratory phase). Spirometric monitoring of CTs was performed to verify that imaging was performed during the correct respiratory phase. Images were reconstructed with 2.5-mm thickness and 1.25-mm reconstruction interval. Images of the trachea were analyzed 1 cm above the aortic arch and 1 cm above the carina. Coronal and sagittal diameters of the tracheal lumen were obtained and the cross-sectional area of the lumen was obtained by tracing the inner wall of the trachea using an electronic tracing tool. The percentage of tracheal luminal collapse between the 2 respiratory phases was calculated and the shape of the trachea during the 2 respiratory phases was assessed.

Results: The average cross-sectional luminal area of the upper trachea decreased from 255.80 mm² +/- 61.81 to 112.57 mm² +/- 49.32 from end-inspiration to during forced exhalation. The average cross-sectional luminal area of the lower trachea decreased from 270.57 mm² +/- 56.91 to 117.04 mm² +/- 55.91 from end-inspiration to during forced exhalation. The average percentage decrease in cross-sectional luminal area of the trachea was 54.34% +/- 18.6 and 56.14% +/- 19.3 for the upper and lower tracheas from end-inspiration to during forced expiration. Using the current CT diagnostic criteria for tracheomalacia as >50% decrease in cross-sectional luminal area of the trachea from end-inspiration to during forced exhalation, 40 of 51 (78%) normal volunteers met the criteria. During forced exhalation, only 1 patient had a trachea which had the visual appearance of a frown. An expiratory frown-like appearance of the trachea was closely associated with tracheomalacia in a prior study.

Conclusions: Volunteers with no known respiratory disease very often demonstrate significant tracheal luminal narrowing upon forced expiration which exceeds the previous CT diagnostic threshold for declaring tracheomalacia.

Reviewer's Comments: The authors have demonstrated that the previous CT criteria for diagnosing tracheomalacia need to be updated in order to prevent overdiagnosis.

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Computer-Aided CT NSCLC Measurements Are Reproducible

Evaluating Variability in Tumor Measurements From Same-Day Repeat CT Scans of Patients With Non-Small Cell Lung Cancer.
Zhao B, James LP, et al:
Radiology; 252 (July): 263-272

Changes in the unidimensional diameter of >=8% of a non-small cell lung cancer nodule are larger than the measurement variability of the computer-aided method, and therefore can be considered to be a real change in tumor size.

Objective: To evaluate the variability of measurements of non-small cell lung cancer (NSCLC) on CT by comparing 2 same-day CT scans.
Participants: 32 patients with pathologically proven non-small cell lung cancer were evaluated. Inclusion criteria included having a measurable tumor which was at least 1 cm in size.
Methods: After finishing the clinically indicated CT scan, patients consented to an immediate repeat CT. Between the 2 CTs, patients left the scanner table and walked around the scanner site. The repeat CT was performed within 15 minutes of the initial CT. All CTs were performed without IV contrast and with a breath-hold. All CTs were performed on either a 16-detector or 64-detector row CT. Images of 1.25 mm were reconstructed with no overlap. Manually using electronic calipers on an axial plane, the largest diameter of the tumors was measured and the largest perpendicular diameter was measured. Three radiologists measured the lesions independently. Two of 3 radiologists also repeated all measurements 2 days later. In addition, a semi-automated 3D technique was also employed to measure the nodules.
Results: The concordance correlation coefficients (CCCs) were high (>=0.96), indicating high reproducibility and repeatability of the 3 radiologists. The reproducibility of the computer-aided measurements was even higher (CCCs = 1.00). The 95% limit of agreement for the computer-aided unidimensional measurements on the 2 CTs was -7.3% and 6.2%. For the computer-aided bi-dimensional measurements, it was -17.6% and 19.8%). For the computer-aided volumetric measurements, it was -12.1% and 13.4%.
Conclusions: Changes in the unidimensional diameter of >=8% of a non-small cell lung cancer nodule are larger than the measurement variability of the computer-aided method, and therefore can be considered to be a real change in tumor size.
Reviewer's Comments: It would be interesting to see if these results are applicable to CTs performed using 2 different CT scanners on the same patient.

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How Confident Are You in Diagnosing "Bunkbed" Fracture in Pediatric Patients?

Swischuk LE:
Emerg Radiol; 16 (May): 171-174

In children with a history of landing from height with pain and swelling over the medial forefoot, there is high likelihood of a "bunkbed" fracture.

Objective: To illustrate the subtlety of one of the so-called "bunkbed" fractures, which is often overlooked upon initial plain film imaging.

Design/Methods: This is a case-report presentation of a 4-year-old girl who presented to the ED with pain along the medial aspect of the right foot and swelling of the soft tissues surrounding the first metatarsal. Pertinent history included jumping from a non-defined height, specified only as from the level of a bed. A diagram from the clinician's notes was provided for clarification regarding the location of foot pain and swelling. Plain films of the feet upon initial presentation and follow-up were examined. In addition to presentation of the reported case, literature was referenced with regard to the various fractures of the foot and lower extremity commonly seen in the pediatric age group.

Results: Initial plain films demonstrated soft tissue swelling along the medial aspect of the right foot, particularly overlying the first metatarsal. Along the medial aspect of the first metatarsal base was an angulated buckle fracture through the cortex. The patient was casted and interval plain film evaluation demonstrated sclerosis at the fracture site consistent with healing.

Conclusions: In the pediatric literature, there are 2 types of "bunkbed" fractures. One is an impaction fracture of the cuboid bone and the other is a fracture involving the base of the first metatarsal. Both fractures are secondary to transmitted compressive forces upon the forefoot upon landing in a vertical direction. In practice, any of the metatarsals can fracture from this type of force. Due to the plastic nature or softness of children's bones, frank cortical breaks or fractures are often not seen. Instead, simple angulation, as in the described case, is all that is appreciated besides soft-tissue swelling. According to the author, with a clinical history of a child landing from height with pain over the medial forefoot, a first metatarsal buckle fracture should be highly suspected. In fact, comparative views of the feet may be obtained if the findings are equivocal.

Reviewer's Comments: Diagnosing fractures across all age groups can occasionally be challenging, even for the most skilled radiologist. The key to improving diagnostic accuracy sometimes involves recognizing a classic history and/or physical examination findings. In this article, Swischuk stresses the importance of identifying a particular type of fracture that is often very subtle, but in reality, is actually quite obvious once the clinical history is given due consideration. In a busy ED, a large percentage of patients have suffered trauma and invariably undergo radiographic evaluation. In children, some fractures can be ambiguous, especially a non-displaced buckle fracture. Being able to identify such injuries will only boost our diagnostic credibility and ensure prompt and appropriate medical care for our patients.

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Plain Films of the Pelvis Unnecessary in Initial Evaluation of Assault Patients

Are Pelvic Radiographs Needed in Assault Victims?
Mulligan M, Talmi D:
Emerg Radiol; 16 (July): 299-301

In assault patients, the AP view of the pelvis can be eliminated from the standard radiographic work-up if there are no findings suspicious for acute pelvic fracture.

Objective: To determine the effective utility of pelvic radiographs in the evaluation of assault patients.

Design: Retrospective study.

Participants/Methods: 357 patients with a history of assault who underwent anteroposterior (AP) imaging of the pelvis were evaluated. Overall, 267 patients also had concomitant pelvic computed tomography (CT) scans as part of body imaging work-up. A medical physicist was employed to estimate the total gonadal dose of radiation from a single AP view of the pelvis.

Results: After a consensus evaluation between 2 musculoskeletal radiologists, no acute pelvic fractures were identified. In addition, there were 6 cases in which pelvic CT scans actually negated positive findings suspected upon initial plain film evaluation. The only pertinent acute findings that were diagnosed included rib and transverse process fractures, all of which were made by CT scan, not the single AP view of the pelvis. The estimated gonadal dose conferred to females and males from an AP view of the pelvis was calculated to be 700 mSv and 500 mSv, respectively.

Conclusions: In their retrospective review of 357 patients, the authors concluded that the AP view of the pelvis can be eliminated from the standard radiographic work-up of assault patients. As they demonstrate by this study, not only would this be an effective cost-reduction strategy, but more importantly, it would significantly reduce the radiation conferred to this subgroup of patients. Despite the lower number of female patients in this study (49 females), all measures to lower levels of radiation exposure should be considered, especially in women with childbearing potential.

Reviewer’s Comments: In my opinion, Mulligan and Talmi have made a significant contribution toward an intelligent and mindful approach to the practice of Radiology. With our current state of inflating healthcare costs, it is perhaps best if radiologists can figure out means to decrease imaging utilization. Furthermore, we are all taught to abide by the ALARA principle of radiation exposure (as low as reasonably achievable). The estimated gonadal doses calculated by their medical physicists are impressive figures that are difficult to ignore. With respect to evaluating assault victims, it seems more than reasonable to eliminate the AP view of the pelvis from the standard radiographic evaluation. Just as in many other clinical scenarios, if there is justifiable reason to suspect focal injury in a particular location, then radiographic evaluation is the appropriate next step. In my practice, I would advocate for exclusion of the AP pelvis if there is no suspicion for acute pelvic fracture, especially if the patient is female and is scheduled for an abdominopelvic CT scan as part of the trauma evaluation.

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Combo MR and CT More Accurate than MR Alone in Differentiating TDL From Glioma

**Distinguishing Tumefactive Demyelinating Lesions From Glioma or Central Nervous System Lymphoma: Added Value of Unenhanced CT Compared With Conventional Contrast-Enhanced MR Imaging.**


In this study, CT hypoattenuation of MR-enhanced areas of lesions was highly specific for distinguishing TDL from glioma or CNS lymphoma and improved evaluation compared with MR imaging alone.

**Background:** Tumefactive demyelinating lesions (TDLs) are often indistinguishable from brain tumors.

**Objective:** To determine the additive value of non-contrast CT to contrast-enhanced MR in distinguishing TDLs from glioma or lymphoma.

**Design:** Retrospective study.

**Participants:** 15 patients with TDL and 48 with brain tumors, histologically proven. The tumors consisted of 10 with lymphoma and 48 with high- or low-grade glioma. All patients underwent preoperative CT and MRI.

**Methods:** Signal intensity, enhancement patterns, margins, and vasogenic edema were all evaluated on MRI. MR signal was categorized as hypointense, isointense, or hyperintense to white matter for T1 images and to gray matter for T2. CT attenuation of enhanced and non-enhanced portions of the mass (as determined by MR) was evaluated. Areas of necrosis, hemorrhage, or vasogenic edema as seen on MR were excluded. Visual grade of attenuation was categorized relative to cortical and basal ganglia gray matter: Grade 2 was isointense and Grades 1 and 3 hypo- and hyperintense, respectively.

**Results:** On CT evaluation, the most significant finding was that Grade 1 attenuation was always present in the enhancing portions (as seen on MR) of TDLs (93% sensitive for TDLs since 1 patient had no enhancement at all), and was found in only 6% of tumors (96% specificity; \( P <0.001 \)). On MR evaluation, incomplete rim enhancement and mixed iso- and hyperintense signal in enhancing areas of the mass were found exclusively in TDLs. Areas of necrosis, hemorrhage, or vasogenic edema as seen on MR were excluded. Visual grade of attenuation was categorized relative to cortical and basal ganglia gray matter: Grade 2 was isointense and Grades 1 and 3 hypo- and hyperintense, respectively.

**Conclusions:** CT hypoattenuation of MR-enhanced lesions was highly specific for distinguishing TDL from glioma or CNS lymphoma and improved evaluation compared with MR imaging alone.

**Reviewer’s Comments:** The data compiled, tables provided, and discussion are excellent. The textual presentation of the data was poor. Ideally, the authors should have provided an algorithm. For a patient and determined radiologist presented with the possibility of TDL, careful use of the data in this paper should be helpful.

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Is There a Difference Between Hypertensive, Normotensive Patients With PRES?

Posterior Reversible Encephalopathy Syndrome: Do Predisposing Risk Factors Make a Difference in MRI Appearance?

Neuroradiology; 51 (June): 373-383

No significant difference was found between normotensive and hypertensive patients with posterior reversible encephalopathy syndrome in extent and severity of MRI appearance, although eclamptic patients more likely had basal ganglia involvement.

Background: Posterior reversible encephalopathy syndrome (PRES) is an entity that is most commonly secondary to disease entities that include systemic hypertension, although not always.

Objective: To determine whether the MRI appearance of PRES may vary based on presence or absence of hypertension.

Design: Retrospective review.

Participants: 30 consecutive patients with PRES.

Methods: MRI was performed in all patients between 1 and 3 days of symptom onset.

Results: 24 patients (80%) presented with systemic hypertension; 10 of these presented with preeclampsia-eclampsia, 6 with renal failure, 5 with immunosuppressive agents, 1 in allergic shock, and 2 with hypertensive crisis. Of 6 patients without hypertension, 3 were receiving immunosuppressive agents: 1 with cyclophosphamide for treatment of lupus, and 2 from chemotherapy for treatment of cancer. No statistically significant difference was found in the pattern or severity of brain involvement or of the extent of brain edema between normotensive and hypertensive patients. Some tendencies between groups were observed, however. Basal ganglia was involved exclusively in patients with hypertension. Also, there was a tendency (P =0.66) toward involvement of basal ganglia in patients with eclampsia-preeclampsia as 60.0% of these patients had basal ganglia involvement, whereas only 18.2% without eclampsia had basal ganglia involvement. Only 3 patients had involvement of only 1 brain region. Patients with preeclampsia-eclampsia had a statistically significantly higher number of affected brain regions (P =0.046). Five hypertensive patients had parenchymal hemorrhage and 1 had subarachnoid hemorrhage. Seven hypertensive patients had areas of "T2 shine through" with high diffusion and high or isointense apparent diffusion coefficient maps. One patient had restricted diffusion consistent with infarct. The authors did not comment on whether these findings were statistically significant. Of all patients, only 5 had symmetric abnormalities in all brain regions. In the rest, at least 1 brain region was asymmetric. Follow-up was performed in 21 patients, and in 5, there was complete resolution. The remainder demonstrated improvement in PRES-related abnormal signal. Occipital lobes were the most commonly affected area and were involved in all but 2 patients. Next most commonly involved were the frontal (53%), cerebellar (43%), parietal (40%), temporal (33%), pons, (30%), and basal ganglia (30%) regions.

Conclusions: Among patients with PRES, those with eclampsia-preeclampsia were more likely to have basal ganglia involvement, and there were significantly more brain regions involved. Otherwise, no significant difference was seen between normotensive and hypertensive patients.

Reviewer's Comments: The authors' conclusion that there were no differences between normotensive and hypertensive patients is puzzling given that T2 shine though and hemorrhage were seen only in hypertensive patients; they did not comment on the statistical significance of these findings. The paper includes an extensive discussion about possible etiologies of PRES.

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How to Avoid Unnecessary Interventions in the Developing Breast

Breast Masses in Children and Adolescents: Radiologic-Pathologic Correlation.

Chung EM, Cube R, et al:
Radiographics; 29 (May-June): 907-931

The majority of breast masses in children and adolescents are benign, although imaging findings may help guide appropriate management in cases that need further intervention.

Objective: To correlate radiologic and pathologic findings in order to aid characterization of breast masses in children and adolescents.

Design: Literature review.

Methods: These authors, at the Armed Forces Institute of Pathology, conducted a literature and case review of breast masses in children.

Results: The first category of breast masses to be reviewed is congenital and developmental abnormalities. One of these abnormalities is gynecomastia. At puberty, up to 75% of boys have some degree of breast enlargement that peaks in incidence at age 13 to 14 years. It is more often bilateral than unilateral. Sonographic evaluation generally demonstrates increased subareolar tissue without a discrete mass. The condition is self-limited. Juvenile hypertrophy, also called macromastia, is a second condition described as excessive female breast enlargement that occurs in a short period, generally <1 year. There is bilateral symmetric tenderness and enlargement of the breasts with no discrete mass. Sonographic findings are similar to gynecomastia. By far, the most common breast mass in girls aged <20 years is a fibroadenoma. Patients may present with a slowly enlarging, painless mass. These tumors are estrogen-sensitive and manifest as well-circumscribed, uniformly hypoechoic oval or round masses on ultrasound. The juvenile fibroadenoma subtype is an uncommon variant that may grow rapidly. This subtype typically has a multilobulated surface on ultrasound and is generally excised as it may be indistinguishable from a phyllodes tumor. Phyllodes tumors are the main consideration in the differential diagnosis of a fibroadenoma. They account for 1% of breast lesions in children and adolescents, generally presenting at >=6 cm in size. On sonography, the internal echotexture of these masses is heterogeneous and may contain anechoic cysts. Juvenile papillomatosis is a proliferative disorder of adolescents who present with a well-defined mobile mass in the breast that sonographically appears to have multiple small cysts at its periphery. The mass has internal cysts evident on T2-weighted MRI and markedly enhances on post-contrast images. Malignant masses are very rare in children. Among the more common of these rare masses is the secretory carcinoma subtype. Sonographically, these typically have irregular margins, are taller than they are wide, and have posterior acoustic shadowing.

Reviewer's Comments: Examining the pediatric breast is not an uncommon request in routine practice. Knowledge of the spectrum of pathology helps to avoid unnecessary interventions that should be avoided as much as possible in the developing breast.

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Micropapillary Carcinoma Imaging Findings Typically Linked to Malignancy

Invasive Micropapillary Carcinoma of the Breast: Mammographic, Sonographic, and MRI Features.
Adrada B, Arribas E, et al:
AJR Am J Roentgenol; 193 (July): W58-W63

Imaging characteristics of invasive micropapillary carcinoma are generally highly suspicious for malignancy.

**Background:** Invasive micropapillary carcinoma is a subtype of invasive ductal carcinoma that has recently been defined as a distinct entity pathologically. This highly aggressive subtype is rare, although there is an interest in defining its radiologic characteristics.

**Objective:** To attempt to correlate pathologic and clinical data with radiologic characteristics in order to help characterize invasive micropapillary carcinoma further.

**Design:** Retrospective study.

**Participants/Methods:** Over an 8-year retrospective period, patients who were diagnosed with invasive micropapillary carcinoma of the breast were identified in a surgical database. Those who had undergone imaging with mammography, sonography, and/or MRI were included in the study. Mammographic findings were noted including presence and location of the mass or masses, shape, margin, density, and distribution of calcifications. Sonographic findings that were noted included whether the lesion was solid, cystic, or complex cystic, shape, margins, posterior acoustic enhancement or shadowing, echogenicity, vascularity, and associated skin, nipple, or muscle involvement. When MRI was available, findings that were recorded included areas of abnormal enhancement, whether it was mass-like or non-mass-like, and enhancement kinetics. Histopathologic correlations were made.

**Results:** A total of 29 separate tumors were included in the study (28 patients). Median age of patients was 56 years. Clinical presentation was a palpable mass 61% of the time; the other 39% were identified on screening mammography. A total of 40% of cases had either nipple retraction, erythema, or skin retraction. On mammography, 45% of cancers presented as a mass with microcalcifications, 24% simply as a mass, and 17% as microcalcifications alone. Only 1 case presented simply as architectural distortion. Of masses, 80% were irregular in shape and 55% were spiculated. Most commonly, any associated microcalcifications were pleomorphic and clustered or grouped. Sonographically, a mass was seen 85% of the time, and architectural distortion was seen in only 4%. Of note, sonography failed to show 11% of cancers. Axillary lymphadenopathy as assessed sonographically was present in 48% of cases. The sensitivity and specificity for detection of metastasis to lymph nodes on sonography was 72% and 91%. For 5 tumors where MRI was performed, 3 enhancing masses were discovered, and non-mass-like enhancement was found in 2 cases. Most commonly, masses were irregular in shape and spiculated. All lesions demonstrated a type 3 enhancement curve, highly suggestive of malignancy.

**Reviewer’s Comments:** Early data show that findings for micropapillary carcinoma on imaging are generally findings associated with a high specificity for malignancy. An important result is that 11% of tumors were sonographically occult.

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Can DWI Aid in Determining Histopathologic Architecture of Certain Breast Tumors?


The greater the ratio of cellularity in mucinous carcinoma of the breast, the greater the degree of water diffusion, as characterized on diffusion-sensitive MRI.

Background: Mucinous carcinoma of the breast is a histopathologic type of breast cancer that is associated with varying degrees of cellularity in the setting of large amounts of extracellular mucin. Generally, 2 subtypes exist: 1 that is deemed the pure form where all tumor cells are surrounded by mucin, and 1 that is deemed the mixed type and contains components of invasive ductal carcinoma. Furthermore, characterization is also aided by the degree of cellularity of the tumor in relation to the degree of mucin.

Objective: To determine whether there is a correlation on MRI diffusion-weighted imaging (DWI) with histopathologic characteristics of these relatively rare tumors.

Design: Retrospective study.

Participants/Methods: Patients at a single institution who had undergone MRI of the breast within a 2.5-year retrospective period were identified. Only those who had undergone DWI as part of the MRI protocol were included. One radiologist with 6 years' experience (blinded to histopathologic results) obtained the apparent diffusion coefficient (ADC) by drawing a region of interest around MRI evident lesions. The mean results of malignant tumors, mucinous carcinomas, and benign lesions were compared. Pathologic correlation was performed on surgically excised masses. The diffusion-weighted signal characteristics were correlated with histopathologic structure, with the hypothesis that mucin-rich tumors would be associated with a lower diffusion-weighted signal than cellular tumors.

Results: Mean ADC, which is inversely proportional to the signal intensity on DWI, was highest for mucinous carcinoma of the breast. In other words, mucin-rich tumors had lower rates of diffusion than did cellular tumors. Accordingly, the mixed subtype (the subtype associated with a greater proportion of tumor cells) was associated with a relatively higher diffusion-weighted signal intensity than was the pure subtype. Statistical analysis showed that correlation between degree of cellularity as determined on histopathology and diffusion-weighted signal intensity as determined on MRI was directly proportional.

Reviewer’s Comments: Notably, the authors discuss the known overlap of findings on DWIs when comparing mucinous carcinoma of the breast with breast cysts. As breast MRI is researched further, it’s up to the practicing radiologist to determine what variables to apply to a particular lesion of interest. The utility of morphology and enhancement kinetics has been established, with the remaining variables such as diffusion behavior being an added characterization that may help to suggest, rather than define, a particular pathology.

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When Compared With Traditional Screen-Film Mammography, Does Digital Mammography Change the Rate of False-Positive Findings or Rates of Invasive Procedures?

Implementation of Digital Mammography in a Population-Based Breast Cancer Screening Program: Effect of Screening Round on Recall Rate and Cancer Detection.

Sala M, Comas M, et al:
Radiology; 252 (July): 31-39

This study found that digital mammography decreases overall screening recall rates with a lower false-positive rate as well.

**Objective:** To assess how the introduced use of digital mammography affects the recall rate, detection rate, false-positive rate, and rates of invasive procedures in a European population.

**Design:** Retrospective study.

**Participants/Methods:** From a specific patient population, women who had completed a screening cycle of screen-film mammography from 2002 to 2004 were selected. Accordingly, those who had completed a screening cycle of digital mammography from 2005 to 2007 were selected. The groups of women were independent of each other, and information gathered included menopausal status, use of hormone replacement therapy, history of first-degree familial breast cancer, and history of personal benign breast disease. All mammograms were double read with a third radiologist reading when the original double read resulted in a discrepancy. In the interest of eliminating interobserver variability, the same 3 radiologists participated in all screenings reviewed. Two types of results were considered, deemed normal or positive. The positive result was considered a true positive if, after subsequent workup, breast cancer was diagnosed at pathology. Otherwise, findings were considered false positives. Short-term interval follow-up was not considered in the analysis. Of note, breast cancer screening intervals in this European population are every 2 years, not every year as North American guidelines.

**Results:** Mean age of the screen-film mammography group was 59.6 years, and mean age of the digital mammography group was 59.5 years. More than twice as many screen-film mammograms were evaluated than digital mammograms. No statistically significant difference was found in age or menopausal status, whereas more women in the screen-film mammography group reported current use of hormone replacement therapy. Also, more women in the screen-film mammography group reported a personal history of benign breast disease. The overall recall rate of the digital mammography group was 4.2%, while the overall recall rate of the screen-film mammography group was 5.5%; a difference that was statistically significant. Overall, the false-positive rate was 3.8% in the digital mammography group and 5.1% in the screen-film group, a finding also calculated to be statistically significant. Percentages of women who underwent overall invasive tests in the screen-film mammography group and digital mammography group were 2.6% and 1.3%, respectively. This finding was also statistically significant. The statistically significant positive-predictive value for the digital screening group was 9.7%, and for the screen-film mammography group, it was 7.5%. The overall cancer detection rate between groups was not statistically significant.

**Reviewer’s Comments:** Whether the decrease in recall rate and subsequent invasive procedures for the digital group decreases overall costs is what is to be gleaned from these data. Findings suggest that digital mammography does, with no compromise in detection rate.

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Primary Stent Placement May Be Better Option After Lung Transplant

Endobronchial Dilation for the Management of Bronchial Stenosis in Patients After Lung Transplantation: Effect of Stent Placement on Survival.

Abi-Jaoudeh N, Francois RJ, et al:
J Vasc Interv Radiol; 20 (July): 912-920

Endobronchial stenting of stenosis in lung transplants improves survival more than bronchoplasty alone.

**Background:** New surgical techniques and medical therapies have improved the outcome of lung transplantation. Airway complications such as bronchial stricture still plague 7% to 40% of these patients, which decreases survival. There is some controversy about stent insertion for benign disease such as this.

**Objective:** To compare patients treated by bronchoplasty with or without stent placement in the authors' institution and to present the results of this experience.

**Design/Participants:** Retrospective review of 41 patients who underwent dilation or stent insertion.

**Methods:** 106 strictures were treated in these 41 patients, during 177 sessions. There were 38 stent insertions, and 205 bronchoplasties.

**Results:** Complete technical success was achieved in 80% of patients. Partial success was achieved in another 18%. Technical success of stent insertion occurred in 97% of patients. Of lesions stented, 38% were in the left main bronchus and 28% were in the bronchus intermedius. Primary patency was maintained in 37% of patients at last follow-up, with secondary patency (patency with repeat angioplasty or stent placement) remaining in 93% of patients. With bronchoplasty alone, there was a primary patency rate of 19% compared to primary stent placement, where the primary patency rate was 71%. Clinical success was seen in 73% of patients. Mean primary patency after the first intervention was 13.8 months, with mean primary patency for stented lesions being 39.0 months compared to 9.9 months patency in stenoses treated with bronchoplasty alone. This is a significant risk reduction. Symptomatically, all patients improved significantly after all treatments.

**Reviewer's Comments:** Airway disease occurs in up to 15% of patients after lung transplant, which is associated with a high morbidity rate (2% to 5%). The 3-year survival rate (63%) of patients in the stent group approaches that of transplant patients without airway disease. Better survival and bronchial patency were obtained after stent insertion according to this study. This study suggests that primary stent placement is a better option, because patency did not seem to improve after the second intervention between groups. Self-expanding covered stents were used because they are less prone to mechanical failure and some can be repositioned after deployment. Stents tended to be placed in left main bronchi because there was a lower tendency of the stent to cover side bronchi in this location. More stents were placed in patients with bronchomalacia and severe stenoses simply because these do not respond well to bronchoplasty only. This study demonstrates that endobronchial dilation and stent placement is safe and effective, resulting in significant improvement of patient symptoms.

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How NTE Happens, How to Avoid Complications

Analysis of Nontarget Embolization Mechanisms During Embolization and Chemoembolization Procedures.

Lopez-Benitez R, Richter GM, et al:
Cardiovasc Intervent Radiol; 32 (July): 615-622

Non-target embolization (NTE) occurs when embolic material is delivered to a tissue or organ that is not the intended target of the embolization, usually caused by particle reflux. Particle reflux occurs when embolic material flows from an embolized region into a capillary bed with less resistance. What influences the severity of complications?

**Total number of particles:** If the target area is maximally filled with particles, those particles can spill into other open vessels.

**Particle size:** Fewer larger particles are needed to produce the same ischemic effect in tissue, but there is a risk that larger particles can flow backwards if the occlusion occurs in a short time. More homogenous mixtures injected slowly may reduce NTE.

**Functional state of affected organ:** If the organ of concern has a high amount of reserve, there is usually little clinical relevance to NTE. If the organ has less reserve, such as a severely cirrhotic liver or a damaged spleen, then NTE may produce more complications such as ischemia or abscess.

**Microparticle material features:** Different particle materials produce different ischemic effects even if they are the same size. More elastic particles can compress and reach further, even through to the venous system via microscopic arteriovenous shunts. Fragmented particles can reach smaller vessels. Some particle types allow for reperfusion of a vessel, whereas other particles cause a permanent occlusion.

**Organ collateral perfusion:** Variants in anatomy and collaterals should be documented. A blood vessel that is close to the origin of a treated vessel is at risk for NTE. Collateral vessels that are normally low flow may increase flow once other vessels are slowed down. Occlusion balloons and coils can prevent this.

**Angiographic control:** The pressure of contrast injected into embolized vessels may be enough to dislodge and send particles into other vascular areas. The authors recommend waiting for 3 to 5 minutes before doing runs and reducing flows.

**Patient condition:** Immunocompromised patients, those with a bilioenteric anastomosis, cholestasis, portal vein thrombosis, and sepsis, are at risk for infection.

**Reviewer’s Comments:** According to the literature, the most frequently reported complications are liver infarction/abscess, acute cholecystitis, pulmonary embolism, splenic infarction, ischemic hepatitis, acute pancreatitis, gastrointestinal mucosal lesions, and spinal cord injury. The most frequent causes of death associated with embolizations were fulminant pancreatitis, spinal shock, liver necrosis, and ischemic hepatitis. NTE is a dynamic process and complications can be avoided with diligence, good patient selection, and careful attention to details. This will help to decrease complications and better treat patients.

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ACD of Femoral Vein Successfully Treated With Image-Guided Sclerosis

Percutaneous Image-Guided Aspiration and Sclerosis of Adventitial Cystic Disease of the Femoral Vein.

Johnson JM, Kiankhooy A, et al:
Cardiovasc Intervent Radiol; 32 (July): 812-816

Adventitial cystic disease of the veins is very rare but can also be treated with drainage and alcohol sclerosis.

Background: Adventitial cystic disease (ACD) is a rare condition usually seen in arteries characterized by a mucinous cystic lesion that is based in the vessel wall. Venous ACD is very rare, with only 17 cases documented in the world literature. Venous ACD causes compression of the vein and leads to deep vein thrombosis (DVT) and venous obstructive symptoms. Usual therapy for ACD is surgical resection or fenestration.

Objective: To present a rare case of venous ACD treated by image-guided aspiration and ethanol sclerosis.

Case Report: A 65-year-old man presented with a history of several months of right calf and ankle swelling. A venous duplex performed demonstrated a 2.9-cm cystic structure in the right groin compressing the femoral vein. This structure was then aspirated under ultrasound, which was sufficient to provide relief of symptoms. Two years later, the patient returned with recurrent calf swelling, pitting edema, and a DVT in the same leg. Imaging demonstrated that the cystic lesion adjacent to the femoral vein was now 4.3 cm in greatest dimension and multiloculated. Using ultrasound and fluoroscopic guidance, the lesion was accessed with a 21-gauge needle, and 1 mg of tissue plasminogen activator (TPA) was placed in the lesion to lyse the locules. This was followed by an injection of ethanol to cause sclerosis in the lesion. The patient's symptoms resolved, and he remains symptom free for 18 months.

Reviewer's Comments: A literature review of ACD involving the veins showed that now there are 18 cases reported. Venous ACD seems to occur in middle age, and in men slightly more often than in women. The veins affected were mainly in the femoral region, but also in the internal iliac, saphenous, and wrist regions. To compare, arterial ACD is seen in 1 in every 1200 patients with claudication. Venous ACD presents with extremity edema with or without DVT. It is seen on ultrasound as a fluid-filled structure in the vein wall. MR angiography and CT angiography can also better characterize the cyst and its relation to the vessel wall, which can be useful for surgical planning. Percutaneous treatment, with drainage and sclerosis, has been successful in arterial ACD, with most authors recommending aspiration as first-line therapy. If the cyst re-accumulates, alcohol sclerosis can be used to obliterate the mucin-secreting mesenchymal cells. TPA was used in this case prior to sclerosis because loculations were visualized, and it was felt to be necessary to ensure a good sclerosis. Surgical treatment of ACD carries the risk of general anesthesia, hemorrhage, risk of infection, and possible future stenosis, especially in a case where graft interpositions are used. Percutaneous drainage and sclerosis offer a relatively lower-risk procedure to treat these cysts.

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