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Self Assessment Module on Neuroradiology: Neuroimaging

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Advances of CT in Neuroimaging: Pearls and Pitfalls

Question 1: Which ONE of the following technical options is NOT recommended to reduce radiation dose in CT perfusion exams?

a. Reduce MA to 200 or less
b. Reduce KVP to 80
c. Use automatic dose modulation (variable MA) settings
d. Consider reduced temporal sampling rate
e. Consider 'toggling table' or 'shuttle' modes

Correct Response: Choice c is correct

Rationale: Automatic dose modulation is an important technique to reduce dose in many CT protocols. However since CT perfusion is a time series of images used to make parameter maps (not used as individual diagnostic images) it is preferred to keep dose in an individual slice constant. Use of dose modulation driven by image quality and stringent noise criteria may paradoxically actually increase overall dose in CT perfusion applications.

References:

1. Wintermark, M. and M.H. Lev; *FDA* Investigates the Safety of Brain Perfusion CT. AJNR Am J Neuroradiol, 2009 10.3174/ajnr.A1967

2. Website of the American Association of Physicists in Medicine, accessed on line 12/18/09: http://www.aapm.org/publicgeneral/CTDoseResponse.asp

Question 2: The 'spot sign' in neuro CTA exams:

a. Indicates increased likelihood of hematoma expansion
b. Is only seen in benign hematomas
c. Suggests a relatively dense, likely older blood clot
d. May be seen with dystrophic calcification
e. Is usually due to a detector artifact

Correct Response: Choice a is correct

Rationale: The spot sign reflect extravasation of contrast due to active bleeding or an abnormal blood-brain barrier. The odds of clot expansion are 10-20 times greater than when a spot sign is absent. However differential possibilities include underlying tumor, AVM, and other pathologies.

Reference:
Wada, R., et al., CT angiography "spot sign" predicts hematoma expansion in acute intracerebral hemorrhage. Stroke 2007 38(4):1257-62.

CNS Vascular Disease/Vascular Malformation

Question 3: Which of these lesions is least likely to present clinically with hemorrhage?

a. Pontine telangiectasia
b. Frontal lobe developmental venous anomaly
c. Temporal lobe cerebral cavernous malformation
d. Thalamic arteriovenous malformation

Correct response: Choice a is correct.

Rationale: Telangiectasias are most often identified as “incidental” findings on MR or at autopsy. They very rarely present with clinical signs and/or symptoms. Arteriovenous malformations are most likely to present with a hemorrhage. Cerebral cavernous malformations (CCM) are very common incidental lesions, but may present with seizures or other symptoms. Developmental venous anomalies are also common “incidentalomas” – but may be associated with CCM, and a hemorrhage is likely related to the CCM.

References:
Crawford, PM, West, CR, Chadwick, DW and Shaw, MD; .Arteriovenous malformations of the brain: natural history in unoperated patients. J Neurol Neurosurg Psychiatry 1986; 49:1-10

Costa, L, Wallace, MC, ter Brugge, KG, O'Kelly, C, Willinsky, RA, and Tymianski, M; The Natural History and Predictive Features of Hemorrhage From Brain Arteriovenous Malformations. Stroke 2009 40:100-105

Question 4: Which of these may predispose to development of a cerebral cavernous malformation (CCM)?

a. Developmental venous anomaly
b. KRIT 1 mutation
c. Radiation therapy
d. a and c
e. a, b, and c

Correct response: Choice e is correct.

Rationale: CCM may develop, in some cases, from increased venous pressure that may also be caused by a developmental venous anomaly. Radiation therapy is well known to cause both telangiectasias and cerebral cavernous malformations. The KRIT 1 mutation has been identified in families with autosomal dominant inheritance of multiple cerebral cavernous malformations.

References:
Laurans MS, et al; Mutational analysis of 206 families with cavernous malformations. J Neurosurg 2003 99:38-43

Jain, R, Robertson, PL, Gandhi, D, Gujar, SK, Muraszko, KM, and Gebarski, S; Radiation-Induced Cavernomas of the Brain.. AJNR Am. J. Neuroradiol., May 2005**;** 26**:** 1158 **-** 1162.

Chong VFH, Fan YF, Mukherji SK Chong et al; Radiation-Induced Temporal Lobe Changes: CT and MR Imaging Characteristics. AJR Am J Roentgen 2000175(2):431-36

Question 5: When treating a cerebral cavernous malformation (CCM) that is associated with a developmental venous anomaly (DVA):

a. the DVA should also be resected or occluded with the CCM
b. the DVA should be left alone
c. the DVA can be safely removed only after the CCM is dissected free
d. the DVA should be removed, and the CCM will resolve spontaneously.

Correct Response: Choice b is correct.

Rationale: A DVA is usually the only venous drainage for the normal functioning brain tissue around the CCM. Removal or occlusion of the associated DVA, therefore, creates a risk for venous infarction –which is often hemorrhagic and could be catastrophic for the patient.

Reference:
Buhl, R, Hempelmann, RG, Stark, AM, and Mehdorn H. M; Therapeutic considerations in patients with intracranial venous angiomas. European Journal of Neurology 2002 9:165-169

Venous Sinus Imaging

Question 6: Hemorrhagic infarction in the posterior temporal lobe suggests possible occlusion of which structure?

a. Recurrent artery of Heubner
b. Anterior choroidal artery
c. Occipital sinus
d. Vein of Trolard
e. Vein of Labbe

Correct Response: Choice e is correct

Rationale: The vein of Labbe drains the posterior temporal lobe. The most common predisposing factor is transverse sinus occlusion with secondary propagation of clot into the vein of Labbe (which normally drains into the transverse sinus).

Reference:
Lee, S.K. and K.G. terBrugge; Cerebral venous thrombosis in adults: the role of imaging evaluation and management. Neuroimaging Clin N Am 2003 **13**(1): 139-52.

Question 7: You are called to check an MR scan in progress and observe hyperintense signal in the sagital sinus on T1-weighted images. What pulse sequence would you prescribe to help confirm or exclude the diagnosis of sinus thrombosis?

a. Proton-density fat-saturated axial
b. 3D time of flight MRA
c. Phase contrast MR venogram
d. Time of flight MR venogram
e. Susceptibility-weighted MRI

Correct Response: Choice c is correct

Rationale: With inherently bright signal, phase contrast methods are preferred since methemoglobin can mimic flow on TOF exams. Acute clot which contains deoxyhemoglobin or intracellular methemoglobin can show dark signal mimicking flow voids on proton density, T2, and SWI images, so these routine sequences can appear falsely normal.

Reference:
Haage, P., T. Krings, and T. Schmitz-Rode; Nontraumatic vascular emergencies: imaging and intervention in acute venous occlusion. Eur Radiol, 2002 12(11):2627-43.