MRI in Neuro-Oncology

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• Review Basics of Brain Imaging
  – Contrast agent
  – MRI choice

• Advanced MRI applications in neuro-oncology
  – Diffusion Imaging - microstructure brain or tumor
  – Perfusion Imaging – blood flow/blood volume
  – Spectroscopy – chemical signature
  – fMRI and tractography
Path dx = GBM
Gadolinium agents

- T1-shortening
  - Creates high signal
- Demonstrates enhancement due to blood brain barrier (BBB) breakdown
- DELAYED STATIC ENHANCEMENT
  - Inject IV contrast and then obtain T1 image
  - What type of T1, What type of contrast
- Gadolinium agent first approved in 1988
TIPS:
How to image – neuro-oncology

• 3T potential advantage over 1.5T
• What contrast agent to use
• T1 relaxivity - **ENHANCEMENT**
  – Multihance > Gadavist > others
  – Others= Magnevist, Prohance, Omniscan, Dotarem

• Volumetric imaging
  – 1 acquisition and can look at brain in many planes
    • Axial, sagittal, and coronal
Utility of Enhancement

• Lesion detection
  – Can perform contrast images with high resolution!

• Enhancement can help to indicate grade of tumor
  - but not perfect NEED PATHOLOGY

• Low grade Astrocytoma and Oligodendroglioma
  – No enhancement
    • (EXCEPTIONS – pilocytic astrocytoma, ganglioglioma, PXA, DNET)

• Anaplastic Astrocytoma and Oligodendroglioma
  – Enhancement

• Metastatic disease
  – Enhance
Ring Enhancing Lesions

- Tumors
  - primary brain tumor
  - metastatic tumor
- Abscess
  - single or multiple
- Multiple Sclerosis
- Subacute stroke
- Hematoma
- Radiation necrosis
- AIDS – toxoplasmosis, lymphoma
- Lymphoma – immunosuppressed (non-AIDS)
Utility of Enhancement

- 60 subjects, MRI exams with contrast
- Enhancement 1 - 3 days post-contrast
  - To avoid surgery induced enhancement
- 80% of tumor recurrences enlarged from enhancing masses

Markedly superior performance vs CT

CT good for:
- Hemorrhage
- Fractures
- Mass effect

Early Postoperative Magnetic Resonance Imaging after Resection of Malignant Glioma: Objective Evaluation of Residual Tumor and Its Influence on Regrowth and Prognosis
Albert, Friedrich K. M.D.; Forsting, Michael M.D.; Sartor, Klaus M.D.; Adams, Hans-Peter D.-I.M.; Kunze, Stefan M.D.
Neurosurgery 1994
Utility of Diffusion MRI

Many cells will cause slow water motion and restricted diffusion.

Few cells with non-restricted diffusion.

Diffusion analysis confounded:
- Hemorrhage
- Edema
- Necrosis
- Inflammation
Multiple abscesses with:
1) High diffusion centrally
2) No elevated perfusion

History: 35 y.o. male feeling poorly with fever, fatigue, and headaches for a couple of weeks.

Path: Abscess wall and microbiology demonstrated streptococcus viridans.
Utility of Perfusion MRI

- Evaluate angiogenesis
  - Increased perfusion ≠ enhancement
- Help determine etiology of a lesion
  - GBM/AA and MET high perfusion
  - Lymphoma, demyelination and to a lesser degree abscesses – have low perfusion
- Determine treatment effect vs tumor
  - Treatment necrosis has LOW perfusion
- Oligodendrogiomas can have high perfusion
• To quantitatively measure CBV or CBF, regional changes in signal intensity versus time must be converted into contrast agent concentration-time curves.

• for a given TE, T2 rate change ($\Delta(1/T2^*)=\Delta R2$) is proportional to brain tissue contrast concentration [conc.], i.e.

$$\Delta R2 = k[\text{conc.}]$$

Where k is a tissue-, pulse sequence-, and field strength-specific constant.

Leukemic infiltration at biopsy

CBF map – very low perfusion
• Is a lesion a tumor?
  - Strong use in necrosis vs tumor
  - Tumor vs necrosis is markedly different
  - Useful in tumor vs stroke

• Problems
  - Many pathologies have similar spectroscopy
  - Warning
    - Tumefactive MS and high grade tumor has same spectroscopic appearance
20 y.o. male developing left sided weakness, clumsiness and mild spasticity.
Brain Mapping

- fMRI
  - Vision
  - Sensory
  - Motor
  - Language
    - Word generation
      - yellow
    - Object naming
    - Word mapping
    - Verb generation
    - Passive listening

- White Matter Tracts
  - Optic radiation, vision
  - Thalamocortical, sensory
  - Corticospinal, motor
  - Arcuate fasciculus, language
• Thank You!
• Matthew L. White, MD
• Neuroradiology