

## **Clinical Proton MR Spectroscopy of Pediatric Brain Tumors**

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### **I. Pediatric brain tumors**

- Most common solid tumors of childhood, second only to leukemia and lymphoma in overall incidence of pediatric neoplasm
- Number one cause of deaths from cancer in childhood
- Wide variation in cytologic complexity, histology, treatment options, and clinical outcomes
- Six most common histologic types in descending order of incidence
  - Pilocytic astrocytoma
  - Medulloblastoma
  - Ependymoma
  - Brain stem glioma
  - Primitive neuroectodermal tumor (PNET)
  - Neuronal and mixed neuronal-glia tumors (ganglioglioma, dysembryoplastic neuroepithelial tumor)

### **II. Types of Proton MR spectroscopy (1H MRS)**

- Single voxel
- 2D CSI
- 3D CSI

### **III. Clinical use of 1H MRS in children with brain tumor**

- Characterizing a brain mass as a neoplasm
- Differentiating neoplasm and treatment related changes (e.g., radiation necrosis)
- Monitoring treatment response of the primary neoplasm

### **IV. Challenges associated with 1H MRS in children**

- Location of common pediatric brain tumor—the posterior fossa—increases the likelihood of susceptibility artifact and technical limited data acquisition
- Large tumor related cyst, often seen with common pediatric brain tumors such as pilocytic astrocytoma, may cause volume averaging

### **V. Characterization of a brain mass using 1H MRS**

- Specific histological diagnosis of a brain tumor is not possible based only on MRS findings

- Interpretation of MRS should ALWAYS be done in conjunction with anatomic MR images and relevant clinical history, such as prior radiation therapy or chemotherapy
- Several tumor-mimicking lesions—abscess, stroke, subacute hematoma, demyelinating lesion—can be misdiagnosed as brain tumor; use other imaging sequences such as diffusion-weighted imaging or perfusion-weighted imaging for further evaluation to improve diagnostic accuracy
- High choline suggests metabolically active process such as neoplasm but no SPECIFIC enough since acute demyelinating lesion or acute radiation related inflammatory changes can also show elevated choline

#### VI. Differentiating residual/recurrent neoplasm and treatment related changes

- Residual/recurrent neoplasm often shows high choline and variable decrease in NAA
- Radiation necrosis, which is composed mainly of necrotic nonviable tissue, demonstrates high levels of lipid metabolites with markedly decreased or absent other metabolites

#### VII. Monitoring treatment response of the primary neoplasm

- Useful in tumors where surgical biopsy is risky (e.g., brain stem gliomas)
- Contrast enhancement following therapy is nonspecific and cannot provide accurate and reliable assessment of therapeutic success or failure
- Increase in choline metabolites during treatment should be interpreted with caution since transient inflammatory response to therapy can raise choline levels.
- Serial MRS examination, at most 2 months apart, is more helpful in assessing treatment response during and after therapy
- Critical to establish baseline metabolite levels in both pre-treatment and early treatment to better interpret late changes in MRS after therapy

#### VIII. Clinical examples

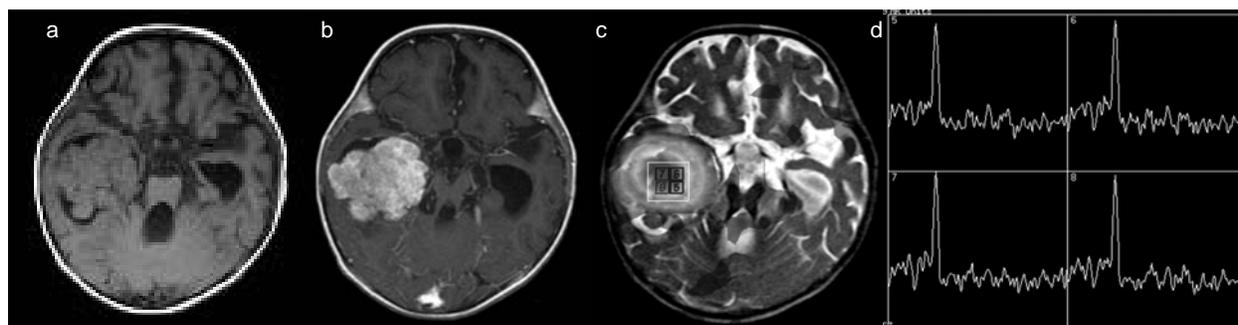


Figure 1. Five-year-old girl with right lateral ventricle choroid plexus papilloma. Axial pre- (a) and post-contrast (b) T1-weighted images demonstrate an avidly enhancing intraventricular mass within the right temporal horn. Axial T2-weighted image (c) is used to localize the 2D CSI box. Four spectra from the tumor demonstrates marked elevation of choline metabolite and absence of other metabolites consistent with metabolically active process.

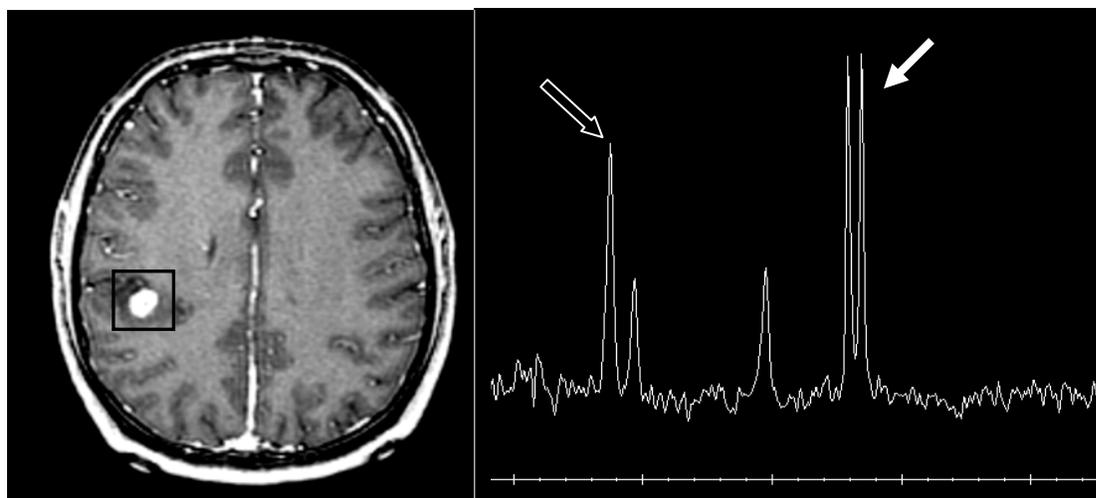


Figure 2. 17-year-old boy with right frontal grade II oligodendroglioma. Axial post-contrast T1-weighted image shows an enhancing nodule within the right posterior frontal lobe. A single voxel MR spectroscopy (TE=288 msec) of the enhancing nodule and the surrounding brain demonstrates abnormal elevation of choline (open arrow) and marked elevation of lactate (white arrow).

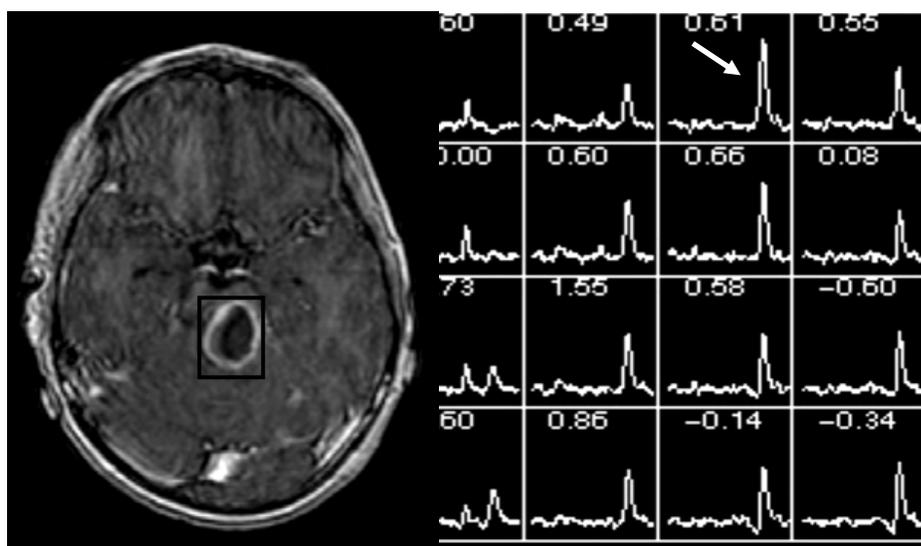


Figure 3. Six-year-old girl with brain stem gliomas treated with chemotherapy presenting with new ring enhancing lesion within the brain stem. Axial post-contrast T1-weighted image (left) shows a brain stem lesion with a thin rim of enhancement and a large area of necrosis. 3D-MR spectroscopic imaging (right) of the lesion shows marked elevation of lipid metabolite (arrow) and absence of other metabolites consistent with therapy related necrosis. This lesion decreased in size on a 2 month follow up examination.

### VIII. References

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