Proton magnetic resonance spectroscopy (MRS) is unique among the clinical imaging techniques in its ability to noninvasively provide biochemical/metabolic information about an intracranial neoplastic lesion (ICNL) without the use of radiation. In a general sense, MRS will complement other MRI methods that image structural or hemodynamic properties of such lesions. For more than two decades there has been sustained interest in using MRS for the diagnosis and evaluation of ICNLs in human patients. This presentation will summarize recent studies and current opinion related to using MRS for the diagnosis and post-therapy evaluation of ICNLs in patients. It will focus on the traditional neuroradiologist responsibilities of 1) defining how to perform the MRS examination and 2) interpreting the results in a meaningful way for the referring physician (typically a neurosurgeon, a radiation oncologist or neuro-oncologist) and the patient.

An MRS component should be integrated into a well-planned and time efficient multiparametric MRI protocol. The protocol should include other types of imaging (e.g. T2w, FLAIR, DWI/ADC/DTI, pre- and post-contrast T1w, DSC-perfusion, DCE-Ktrans) that provide structural and biologic information. MRS works in synergy with these other types of imaging to form an integrated picture of the lesion’s biology.

For evaluation of ICNLs, Magnetic Resonance Spectroscopic Imaging (MRSI) is preferable to single voxel localized MRS for several practical reasons. MRSI provides greater efficiency for examination macroscopic heterogeneity. It efficiently delineates lesion margins and foci of intensely abnormal metabolism, which is of value in neurosurgical planning and in radiation therapy planning. While MRSI is incapable of achieving microscopic spatial resolution, its spatial resolution is about 1 cm³, which is comparable to the practical spatial resolution of neurosurgery and radiation therapy. Earlier MRSI limitations related to the commercial availability of MRSI pulse sequences, the inability of MRSI to practically operate at short TE, and the complexity of MRSI data have been largely relaxed in newer commercial MRI scanners.

The most important signals in the context of ICNLs are choline (Cho), N-acetylaspartate (NAA), lactate (lac) and mobile lipid (ML). Interpretation of MRS signal patterns should be based on the known metabolism of the signal-producing molecules. Interpretation must also take into account that several of the signal-producing molecules are intracellular (Cho and NAA) and therefore the signal levels reflect cell density, which can be highly variable within ICNLs, in addition to the intracellular metabolism. The possibility partial volume confounds (i.e. MRS voxels that contain a mixture of tumor, edematous non-neoplastic tissue and normal brain tissue) must also be taken into consideration.

While it is not possible to definitively diagnose new found ICNLs prior to biopsy and histopathology, knowledge of certain typical MRS characteristics of ICNLs can guide diagnostic interpretation. Two useful interpretive rules are 1) Cho, Lac and ML signal levels tend to increase with malignancy and 2) Volumes, which are free of partial volume confounds, that produce detectable NAA signal with normal to low Cho signal are benign or are not neoplastic. Exceptions to these rules exist and must be kept in mind. For reporting signal levels it is useful to develop a straightforward quantitative approach. Use of signal ratios is usually the most convenient approach. Beyond the use of general rules, one online database of spectra acquired from histopathologically confirmed intracranial mass lesions and several recent reports describing the utility of automated MRS pattern classification also can be helpful.

The most useful aspect of MRS in the context of ICNL diagnosis, is its ability to repeatedly and safely obtain post-therapy biologic information. MRS is useful for identifying therapeutic failure, progression and recurrence. Such work depends on developing a sense of what constitutes a significant between-study signal change for the MRS protocol that is being used. It is also important to consider that recurrence or progression of primary glial tumors may not necessarily result in the development of a dense cellular tumor mass. Progression by invasion is more probable in the modern era in which antiangiogenic agents and signaling inhibitors are commonly used therapeutics. Such invasive progression of primary ICNLs may be difficult to detect with MRS.