Getting out of the Big BOX: Voxel Selection for Clinical SV/MRS

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Introduction: Primary and metastatic brain tumors do not read the textbooks, with sizes and morphologies which do not conform with the taught, standard 2x2x2 cm (8 cc) single voxel interrogation. We view MRS as a biochemical biopsy for classification of tissue, and voxel size should be chosen appropriately, and not a Procrustean bed. Over the past 25 years we have help to implement and perform clinical MR spectroscopy at 7 different institutions, 5 community and two university associated settings, none with departmental research infrastructure. Using acquisition and processing techniques available from the manufacturers, MRS has provided added value for referring physicians, neurosurgeons, and oncologists.

Methods: Available MRI studies of the patient are reviewed with the MR technologist prior to MRS acquisitions. Localizing series 3D FLAIR are obtained if prior imaging is available. If not, a complete MRI series with pre- and post contrast 3D T1 series are acquired. Supervised voxel placement is used in de novo cases. Two single voxel acquisitions PRESS (1) TE/TR 35/1500 ms (2,3,4,10) and 288/1500 ms (4-7) are obtained on the area(s) of concern with auto shimming and 128 avg. Most recently multivoxel sLASER acquisitions were available on the clinical 3T scanners. The single voxels are optimised to conform with the biochemical biopsy site in three dimensions; multivoxel acquisitions were optimised to sample the enhancing margins of a suspicious lesion. Spectra were processed using standard post processing packages, with the use of mono-exponential filtering prior to Fourier transform when appropriate. Spectra were interpreted on a PACS, using literature references (2-7).

Results: MR Spectroscopy can be easily implemented for clinical cases, differentiating high grade from low grade tumors(2-6); tumefactive multiple sclerosis from tumor (10); benign gliosis from low grade tumor, and in most cases radiation necrosis from tumor recurrence(8,9). Neurosurgeons have reported that knowing the grade of tumor before surgery assists in discussions with the patients and family. The more important cases are those where imaging findings are suspicious and MRS interrogation shows a benign etiology. The referring physicians choose to follow these lesions which can be safely followed with imaging and MRS.
Using MRS for evaluation of radiation necrosis is becoming a significant portion of our referred patients. In one recent case, both imaging and MRS were highly suspicious for recurrent tumor. Surgical resection followed with pathology consistent with radiation necrosis, to everyone's surprise.

Discussion: We approach MRS studies as non-invasive biopsies, supervising our technologists and planning the the voxel placement of tumor/lesion as clinically appropriate. In discussions with neurosurgeons and pathologists, non-enhancing tumors are best sampled in the core; higher grade WHO III-IV tumors, because of their heterogeneity are better sampled closer to the margins instead of necrotic areas. Just as one uses T1 and T2 weighted imaging for MRI acquisitions for evaluation of CNS pathologies, so is our approach in clinical MRS, using short echo (TE 35) a T1/PD weighted spectrum and long echo (TE 288) T2 weighted acquisition. We believe the short and long echo TE acquisitions improve the sensitivity and specificity of clinical MRS since one does not know, a priori what the pathology the tumor/lesion interrogated. Short echo acquisitions are better at differentiating MS from tumors (10) as well as CNS lymphoma, PML and pediatric tumors; long echo MRS gliosis from low grade and high grade gliomas (2-7). Radiation necrosis versus recurrent tumor (8,9) is still the most difficult of the diagnoses to make.

Conclusion: Clinical MRS can be utilized in community hospitals and centers, without research infrastructures, with appropriate interaction with the technologists. Voxel sizes do not have to be 2x2x2, and should be selected for the area being interrogated like a biopsy. Small voxel sizes, 1-5 cc, are attainable on 3T systems with high quality interpretable spectra. The literature provides excellent references for accurate interpretation, with appropriately chosen correlative parameters.

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