MSI HELPS SURGICAL PLANNING OF BRAIN TUMOR PATIENTS

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This paper has been prepared specifically for:

American Epilepsy Society Annual Meeting
Washington, DC
December 2 – 6, 2005

Please consider this information to be preliminary findings.

Abstract published: *Epilepsia 46(8);328[3.153]2005*

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ABSTRACT

RATIONALE: Presurgical evaluation of brain tumor patients is challenging, especially when the tumor is adjacent to eloquent cortex, such as language, somatosensory, and motor areas. Previously, functional mapping has relied on invasive methods, such as intraoperative cortical stimulation or stimulation via a grid implant. Neuroimaging methods have been used for presurgical evaluation in recent years, including functional MRI, PET, and magnetoencephalography/magnetic source imaging. MSI has distinct advantages to the other imaging techniques in that it directly maps neuronal activity. This report describes our early experience with MSI in presurgical decision making with brain tumor patients at Minnesota Epilepsy Group, PA.

METHODS: Four adult patients diagnosed with primary brain tumors underwent functional brain mapping with MSI (148-channel Magnes 2500 WH System, 4-D Neuroimaging, San Diego, CA) preoperatively using standard protocols for localization of language, somatosensory, and primary motor cortex. Data were analyzed using the single equivalent dipole model. Case 1 and Case 2 involved intra-axial, infiltrating tumors of the left frontal lobe, while Case 3 involved a similar lesion in the right frontal lobe. Case 4 had an extra-axial tumor originating from the midline, which appeared to be distorting the cortex.

RESULTS: In Cases 1 and 2, MSI identified language cortex in close proximity to the tumor, including (for one patient) deep cortical areas not identified on cortical surface stimulation. In both cases, resection of the tumor was accomplished without creating a post-operative language deficit. In Case 3, a right frontal tumor was encroaching on primary motor cortex. MSI identified the margin of the motor area in relation to the tumor, allowing for maximal resection without causing any deficit. In Case 4, the somatosensory cortex was displaced by the tumor. The surgical approach was guided by MSI data, and confirmed by intra-operative somatosensory mapping. Following tumor resection, the patient recovered without deficit.

CONCLUSION: MSI detects and maps the functional cortex in the sulcus. Cortical mapping delineates the superficial functional cortex. MSI plus cortical mapping can provide more accurate and complete functional information for surgical planning. This suggests the potential for practical clinical application of this new non-invasive technology to the presurgical evaluation of brain tumor cases on a routine basis.

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Introduction

Presurgical evaluation of brain tumor patients is challenging, especially when the tumor is adjacent to eloquent cortex, such as language, somatosensory, and motor areas. Previously, functional mapping has relied on invasive methods, such as intraoperative cortical stimulation or stimulation via a grid implant. Neuroimaging methods have been used for presurgical evaluation in recent years, including functional MRI, PET, and magnetic source imaging (MSI). MSI has distinct advantages to the other imaging techniques in that it directly maps neuronal activity. This report describes our early experience with MSI in presurgical decision making of brain tumor patients here at Minnesota Epilepsy Group, PA.

Methods

Four adult patients diagnosed with primary brain tumors underwent functional brain mapping with MSI (148-channel Magnes 2500 WH System, 4-D Neuroimaging, San Diego, CA) preoperatively using standard protocols for localization of language, somatosensory, and primary motor cortex. Data were analyzed using the single equivalent dipole model. Patient JN and DC involved intra-axial, infiltrating tumors of the left frontal lobe, while patient PZ involved a similar lesion in the right frontal lobe. Patient LP had an extra-axial tumor originating from the midline, which appeared to be distorting the cortex.

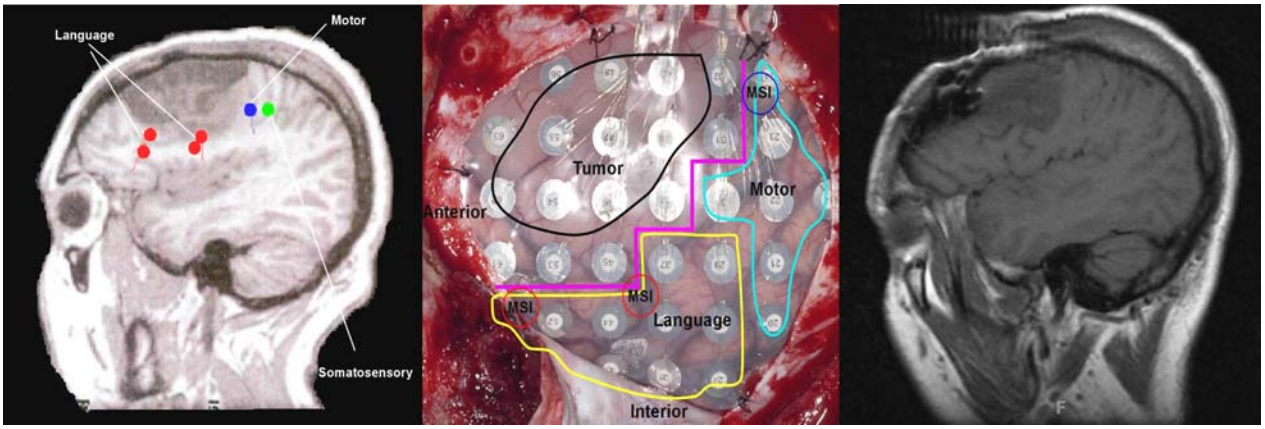
Results

In Patient 1 (JN), MSI identified language and motor cortex in close proximity to the tumor. In JN, deep language cortical areas defined by MSI were not identified on cortical surface stimulation. Resection of the tumor was accomplished without creating a post-operative language and other neurological deficit. In Patient 2 (DC), left frontal tumor displaced and split the expressive language area. Invasive cortical mapping was not acquired for DC, his surgery was based on the MSI mapping, and there was no language deficit. In Patient 3 (PZ), a right frontal tumor was encroaching on primary motor cortex. MSI identified the margin of the motor area in relation to the tumor, allowing for maximal resection without causing any deficit. In Patient 4(LP), the somatosensory cortex was displaced by the tumor. Central sulcus was mapped out with MSI. The surgical approach was guided by MSI data, and confirmed by intra-operative mapping. Following tumor resection, the patient recovered without neurological deficit.

Conclusion

MSI detects and maps the functional cortex in the sulcus. Cortical mapping delineates the superficial functional cortex. MSI plus cortical mapping can provide more accurate and complete functional information for surgical planning. This suggests the potential for practical clinical application of this new non-invasive technology to the presurgical evaluation of brain tumor cases on a routine basis.

Patient JN

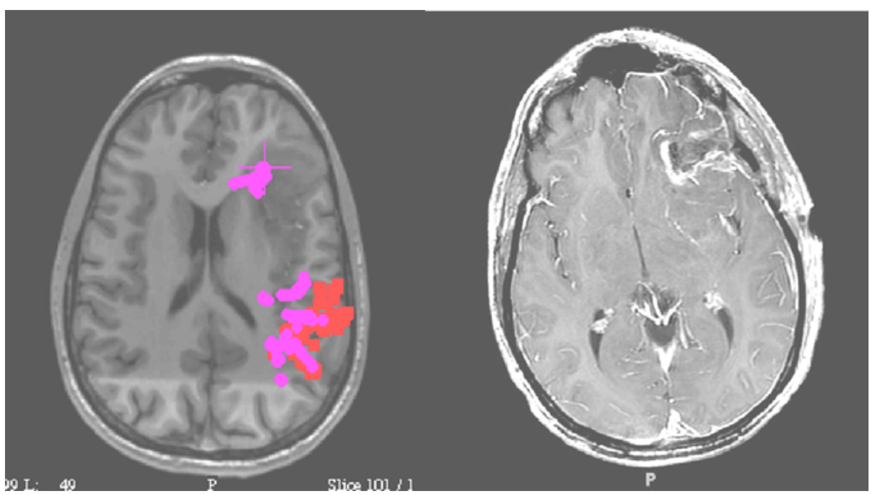


Left image shows the MSI localization of language, motor and sensory.

The middle figure illustrates cortical mapping of language and motor area compared with the regions defined by MSI The blue circle represents right hand movement as defined by MSI. MSI activities are 0.5-1.3 cm deep in sulci. The black outline represents the brain tumor. The purple line delineates the resection margin.

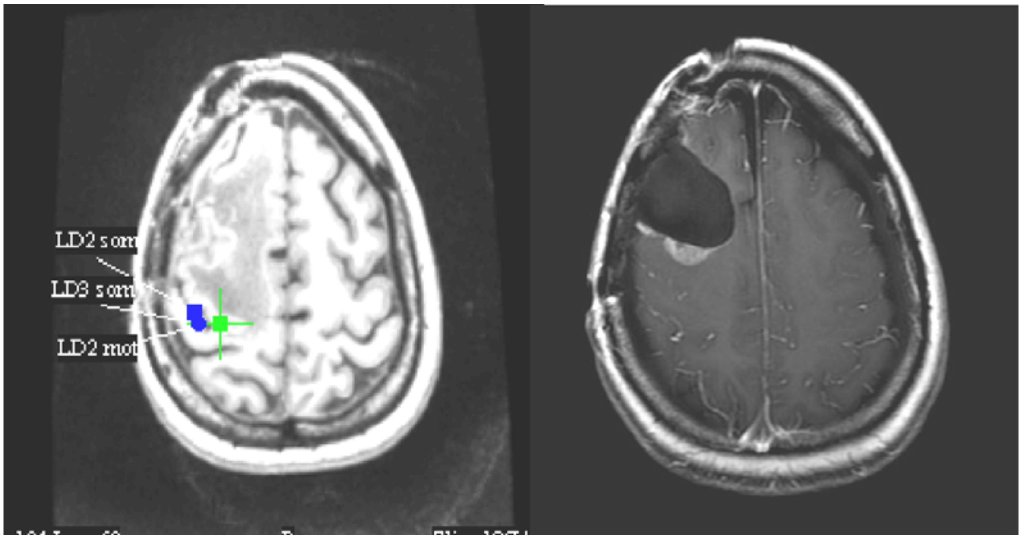
The right figure demonstrates the reserved language region (star) defined by cortical mapping and MSI on post-operative MR image.

Patient DC



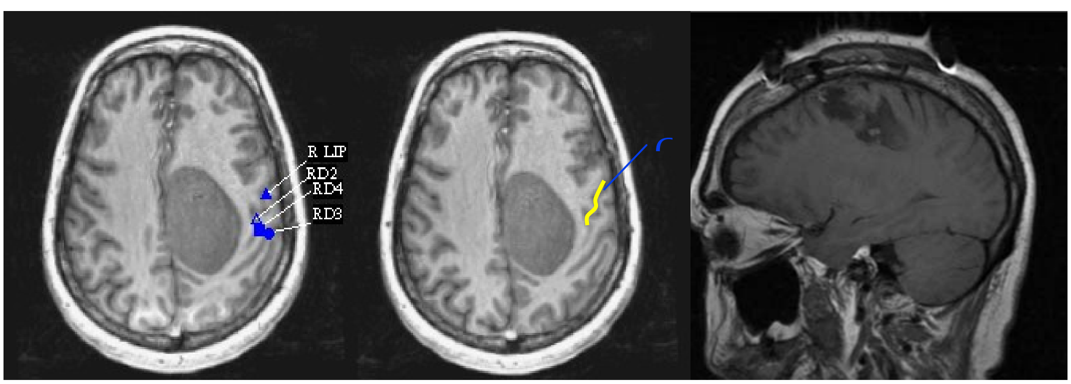
Left image demonstrates the receptive (red dots) and expressive (pink dots) language locations defined by MSI displaced by the left frontal temporal tumor. Surgery was performed based on the MSI function mapping information without language deficit. Right image shows the post-operative MR image after partial resection.

Patient PZ



MSI defined locations of sensory (left index finger --LD2 som, left middle finger – LD3 som) and motor (left index finger, LD2 mot) function and their relation to the right frontal tumor. Majority of the the tumor was resected based on the MSI and intra-operative mapping.

Patient LP



MSI defined central sulcus (CS) by mapping the primary somatosensory function of right lower lip (R Lip), right index finger (RD2), right middle finger (RD3) and right ring finger (RD4). The surgical approach of this meningioma was guided by MSI mapping. The third MR image demonstrates post-operative MR.