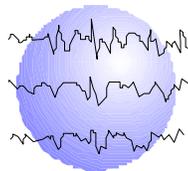


# CLINICAL UTILITY OF MAGNETIC SOURCE IMAGING FOR LANGUAGE LATERALIZATION IN YOUNG CHILDREN

Gretchen Weatherly, PhD  
Wenbo Zhang, MD, PhD  
Ann Hempel, PhD  
Frank J. Ritter, MD



This paper has been prepared specifically for:

American Epilepsy Society Annual Meeting  
Philadelphia, PA  
November 30 - December 4, 2007

Please consider this information to be preliminary findings.

Abstract available electronically at: [www.aesnet.org](http://www.aesnet.org) [2.277]

Minnesota Epilepsy Group, P.A.<sup>®</sup>  
225 Smith Avenue N., Suite 201  
St. Paul, MN 55102  
Phone: (651) 241-5290  
Fax: (651) 241-5248

## REVISED ABSTRACT

**RATIONALE:** Magnetic Source Imaging (MSI) is becoming more widely used for functional mapping of language cortex in individuals being considered for surgical resection for treatment of intractable epilepsy and brain tumors. However, studies investigating the convergent validity of MSI for language mapping have typically included data for adults only, and only a few articles report MSI language data in children 8 years or older (Breier et al. 2001, Papanicolaou et al. 2004). The current study aims to clarify the clinical utility of MSI for language localization in children under 8 years of age.

**METHODS:** A retrospective record review was conducted of 11 pediatric patients ages 4 to 7 years who had been referred for MSI at Minnesota Epilepsy Group between 11/04 and 6/07 preliminary to epilepsy or brain tumor surgery. MSI was performed using 148 magnetometers with single equivalent dipole modeling. Intracarotid Amytal Procedure (IAP) and cortical mapping data were reviewed when available.

**RESULTS:** The mean age of children referred for language mapping was 6 years 3 months (range = 4 years 0 months to 7 years 5 months). Two patients were unable to comprehend the task and were not recorded. Of the 9 children who participated in the language mapping task, recordings from 2 of these were contaminated by motion artifact and did not yield usable language data. Seven children produced clinically relevant data, although one of these did not follow instructions and the task was modified for another. Five were considered left hemisphere language dominant based on MSI activation, while 2 were reported to have bilateral language representation. Four of the children who completed the language protocol also underwent the IAP. There were no cases in which MSI and IAP were completely discordant, and there was a 75% concordance rate between IAP and MSI in identifying the presence or absence of language in the hemisphere of proposed surgery. One child who did not have an IAP underwent mapping with the electrical stimulation studies, which confirmed the presence of left hemisphere language as indicated by MSI. Taken together, the concordance rate between MSI and invasive methods in identifying language in the hemisphere of interest was 80%.

**CONCLUSION:** In this small sample, 7 of 9 (78%) young children ages 4 – 7 years produced usable language data with MSI. There were no cases in which MSI and IAP or stimulation study language data were completely discordant, and the concordance rate between MSI and traditional invasive techniques for identifying language in the hemisphere of interest was 80%. Results suggest MSI may be a valid method of determining language lateralization in young children. However, IAP and electrical stimulation studies should continue to play a role in clinical decision making for this population.

## **INTRODUCTION:**

Magnetic Source Imaging (MSI) is a noninvasive method of functional brain mapping that has been increasingly used in recent years for mapping of language cortex prior to epilepsy or brain tumor surgery. Studies investigating the convergent validity of MSI for language mapping typically have included data for adults only, and very few articles report MSI language data in children 8 years or older (Breier et al. 1999, Papanicolaou et al. 2004). Only one study was identified that focused solely on use of MSI for language dominance in children ages 8 –18 (Breier et al. 2001), with reported MSI and intracarotid amobarbital procedure (IAP) agreement regarding hemispheric language dominance in 17 of 19 cases. However, there are no known studies that have included children under 8 years, despite the importance of identifying noninvasive technology for functional mapping in this population. The current study aims to clarify the clinical utility of MSI for language lateralization in children under 8 years of age.

## **METHODS:**

### **Patients**

- A retrospective chart review was conducted of 11 patients ages 4 to 7 years who were referred for MSI with language mapping at Minnesota Epilepsy Group, PA between 11/04 and 6/07.
- Two patients could not understand task demands and were not recorded.

### **MSI Procedures**

- MSI was performed using 148 magnetometers with single equivalent dipole modeling.
- The MSI language task requires patients to listen to lists of abstract words and identify target words.
- Language laterality was determined based on the number of dipoles identified in the lateral superior temporal lobe, using the following formula to calculate a laterality index:
$$\frac{R - L}{R + L}$$
- Patients with a laterality index greater than 0.2 were considered right hemisphere dominant, less than -0.2 were considered left dominant, and between 0.2 and -0.2 were considered to have bilateral language representation.

### **IAP and Cortical Mapping Procedures**

- Intracarotid amobarbital procedure (IAP) and/or cortical language mapping with a subdural electrode array (SEA) was conducted with 6 of the 9 patients. Two of the remaining children are currently being considered for additional testing prior to surgery, while one is no longer a surgical candidate due to seizure freedom with medication.
- The pediatric IAP protocol includes naming, comprehension, and repetition speech items, but may be modified for individual patients.
- The IAP was conducted via femoral catheterization and in most cases, both hemispheres were injected on the same day.
- Language functions of naming, automatic speech, auditory comprehension and repetition were evaluated, modifying the protocol as necessary for individual patients.

- Patients were considered to have language in the non-anesthetized hemisphere if they correctly performed any language task prior to motor recovery.
- Cortical mapping with electrical stimulation was assessed using a chronically implanted SEA. Interruption, hesitation, or errors in naming, automatic speech, and repetition were recorded over the surface of the temporal lobe and temporal-parietal junction, modifying the protocol as necessary for individual patients.

## **RESULTS**

- 7/9 (78%) children produced clinically relevant language data on MSI, although one did not follow task instructions and the task was modified for another.
- Of the 9 children who participated in the language mapping task, recordings from 2 were contaminated by motion artifact and did not yield usable data.

### **Concordance of MSI with IAP and electrical stimulation data:**

- 5 of the 7 successfully recorded children were left hemisphere dominant based on MSI, while 2 were classified as bilateral for language.
- 4 of the children who were recorded also underwent the IAP.
- There was a 75% concordance rate between MSI and IAP in identifying language in the hemisphere of interest.
- 1 child who was recorded underwent cortical language mapping with a SEA but not an IAP, and mapping results were consistent with MSI in identifying language cortex in the left temporal lobe.
- Taking IAP and cortical mapping results together, there was an 80% concordance rate between MSI and more invasive methods in identifying the presence of language in the hemisphere of proposed surgery.
- Table 1 details MSI, IAP, and cortical mapping results for all 9 children.

## **CONCLUSIONS:**

- In this small sample, 7 of 9 (78%) young children between the ages of 4 and 7 years produced usable language data with MSI. This is comparable to the 71% successful classification rate reported at our center in children ages 3 – 7 years with the IAP (Hempel et al., unpublished data).
- The concordance rate between MSI and traditional invasive methods for identifying the presence of language in the hemisphere of interest was 80%.
- Advantages of MSI in young children include reduced medical risk and reduced emotional distress.
- Disadvantages of MSI include a more complex language task and the necessity of remaining still for relatively long periods of time.
- Overall, results suggest MSI may be a valid method for determining language lateralization in young children, although IAP and electrical stimulation studies continue to have a role in clinical decision making for this population.

**References:**

1. Breier, J., Simos, P., Wheless, J., Constantinou, J., Baumgartner, J, et al.. Language dominance in children as determined by magnetic source imaging and the intracarotid amobarbital procedure: A comparison. *Journal of Child Neurology*, 2001, 16 (2), 124 – 130
2. Breier, J., Simos, P., Zouridakis, G., Wheless, J., Willmore, L., et al.. Language dominance determined by magnetic source imaging. *Neurology*, 1999, 53, 938 – 945.
3. Hempel, A., Risse, G., Ritter, F., Frost, M., Gates, J., et al. The Intracarotid amobarbital procedure (IAP): Factors in the assessment of hemispheric language and memory functions in children and adolescents. Manuscript in preparation.
4. Papanicolaou, A., Simos, P., Castillo, E., Breier, J., Sarkari, S., et al.. Magnetocephalography: a noninvasive alternative to the Wada procedure. *Journal of Neurosurgery*, 2004, 100, 867 – 876.

*Acknowledgements: Special thanks to Joel Landsteiner for his support with data collection and Dr. Gail Risse for her editorial assistance*

Table 1

**MSI Versus IAP and Cortical Mapping by Individual Patient**

Pt. #	Age (yr-mo)	Sex	IQ	Dx	Side of interest	MSI	IAP	SEA
1	4-0	F	113	Epilepsy	Left	Left	Left	Confirmed language on left w/ SEA
2	4-11	F	95	Epilepsy	Left	Bil.		Confirmed language on left w/ SEA
3	6-6	M	100	Tumor	Right	Bil.	Left	No language found on right with SEA
4	6-9	F	91	Epilepsy	Right	Left		
5	6-10	F	81	Tumor	Right	Left	Left	
6	7-0	F	93	Tumor	Left	Left	Bil.	Confirmed left language w/ SEA, right not tested
7	7-5	F	97	Epilepsy	Right	Left		
8	5-8	M	99	Epilepsy	Right	No data obtained	Left	
9	7-5	F	109	Hamartoma	Left	No data obtained		