Presurgical language mapping using Transcranial Magnetic Stimulation is effective in surgical planning and preserving language function in a predominately pediatric cohort with epilepsy or brain tumor

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Introduction

Transcranial Magnetic Stimulation (TMS) is an evolving technique that is increasingly being used in mapping the language cortex to facilitate surgical planning. TMS creates non-invasive "virtual lesions" and can provide a strong alternative to direct cortical stimulation mapping, which has a low efficacy rate in young children[1] and has a higher risk of complications[2]. In this study, we examined the utility of Transcranial Magnetic Stimulation (TMS) in the identification of critical language areas in patients undergoing epilepsy or brain tumor surgery.

Method

In a retrospective chart review, we identified 109 patients who underwent TMS language mapping prior to epilepsy or brain tumor surgery. Participants in whom surgery was performed solely in non-language areas were excluded, leaving 98 patients in the final analysis, 71% of whom were pediatric. Of the 98 patients, 40% were undergoing surgery for epilepsy, while 60% were having surgery for brain tumor.

Results

TMS identified language areas in all patients and assisted in surgical planning without post-operative language deficits in 82% of patients. Of these patients, 51 had surgery without resection of TMS-identified language areas. Twenty-eight patients had no post-operative language deficits despite the removal of TMS-identified areas; however, this was to be expected as additional language areas were also found in the same hemisphere (n = 18) or in the contra-lesional hemisphere (n = 10). One patient had no deficits despite the resection of a significant number of TMS-identified areas. The calculated sensitivity was 99%, while the accuracy was 85%.

For a breakdown of data regarding the 18 patients with language deficits, please see Table 1.

Table 1: Breakdown of data by parameters. *Numbers given are the total participants meeting the criteria for each item, unless otherwise stated.*

Parameter	Item	Number
Participants	Total cohort	98
	Pediatric cohort (age ≤ 18 years)	70
	Average age (years)	17.9 ± 11.08
	Age range (years)	5 – 64
	Males	53
	Females	45
TMS	Language dominance: left	38
	Language dominance: right	11
	Language balanced bilaterally	17
	Language dominance: inconclusive	12
	Tested only in lesioned hemisphere	20
Surgery	Resection in TMS-identified dominant hemisphere	31
	Resection in non-dominant hemisphere	18
	TMS-Identified areas removed: language deficits	4
	Identified areas removed: no deficits	29
	No identified areas removed: language deficits	14
	No identified areas removed: no deficits	51
Language Deficits	Total with deficits	18
	Deficits due to:	
	• Motor difficulties	4
	• Language areas not mapped by TMS	6
	• Surgical inclusion of white matter tracts	4
	• Removal of critical TMS-identified language areas	4

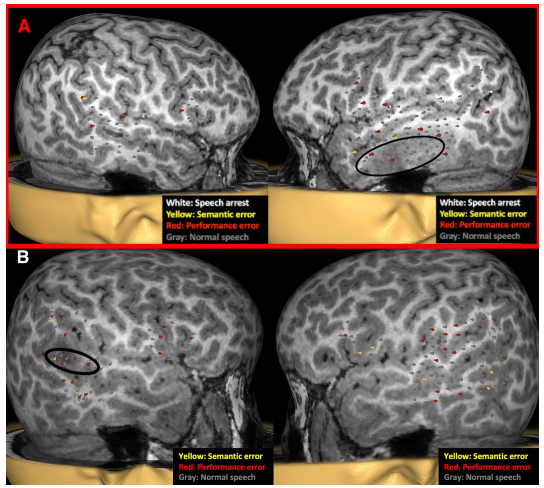

Figure 1: A: *16-year-old patient who had transient language deficits following resection in the TMS-determined left-dominant hemisphere. Few language areas were demonstrated in the right hemisphere. Black circle indicates approximate area of resection.* ***B:*** *9-year-old TMS left-dominant patient without post-surgical language deficits likely because of significant language representation in the right hemisphere.*

Conclusions

TMS successfully localized critical language areas in a predominately pediatric cohort with epilepsy or brain tumor. These data are the largest to show the efficacy of TMS in planning surgical resection and optimizing post-operative language outcome and indicate that TMS is a safe, highly effective language mapping technique.

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