



Intraoperative Basal Temporal Language Maps

by

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ABSTRACT

This paper reports two cases using a procedure which revealed a basal temporal language area (BTLA) in fusiform gyrus of language dominant hemisphere (L) by employing electrical stimulation and recording of the cortex, with grid electrodes, during computerized speech and object naming tasks. The procedure reduced the time necessary to map the inferior temporal, fusiform, and parahippocampal gyri by identifying the existence of and margins for BTLA during a single craniotomy for planned resection of the anterior temporal lobe in patients with medically intractable complex partial epileptic seizures. Both patients underwent intraoperative mapping for language while awake using low current, biphasic, bipolar electrical stimulation of adjacent pairs of subdural electrodes. During stimulation in the region of the fusiform gyrus, language deficits including speech arrest, dysnomia, and jargon aphasia were elicited. No interictal hot spots were observed within this region. Temporal lobe resection was immediately carried out using knowledge of the location of these language areas to guide resection. Prior reports of temporal lobe (including BTLA) mapping used chronically implanted electrodes (10-14 days), while our procedure considerably reduced mapping time, reduced from two to one the number of invasive surgical procedures and attempted to preserve this language area.

INTRODUCTION

Intraoperative mapping of the basal temporal language area (BTLA) is an efficacious procedure that locates requisite language and memory functions. This mapping procedure served multiple purposes: to localize more specifically those gyri producing interictal epileptiform EEG activity (hot spots); to identify the margins of language/memory functions in lateral neocortex; to identify any basal temporal language areas and their associated margins prior to resection; and to reduce from two to one, the number of craniotomies necessary for anterior temporal lobectomy within language dominant hemisphere. Reports have agreed that BTLA is a language area that can be localized through chronic grid implantation (Luders, Lesser et al., 1986). However, the consequences of removing BTLA remain controversial, with some reports suggesting no lasting language effects although there are often reports of short term deficits (Kluin, Abou-Khalil, et al., 1988; Burnstine, Lesser, et al., 1990; Luders, Lesser, et al., 1991; Suzuki, Shimizu, et al., 1992; Abou-Khalil, Welch, et al., 1994) or of mild deficits (Krauss, Fisher et al., 1996). No definitive body of extant literature highlights the importance of removing this area. In a regional epilepsy center, over six years of observations, we developed several concerns: 1) that with

BTLA removal immediate post-op naming deficits are more severe than reported, even when these deficits are relatively short-lived (

RESULTS

Pt. 148 Electrodes 9 and 10: These electrodes were stimulated for 5 seconds beginning at 4.0 mA with 2.0 mA steps increased until 15.0 mA was reached without an afterdischarge. Testing was performed at 15.0 mA for 10 seconds. First, the reading task was performed. The patient began to read and as soon as the electrodes were stimulated, there was total speech arrest. This was repeated at 15.0 mA and speech arrest occurred again. There was no afterdischarge. The next task was object naming. The patient could not name any objects (1/sec randomized continuous presentation) during the time of the stimulation of electrodes 9 and 10, exhibiting complete anomia. Electrodes 2 and 3: These electrodes were stimulated in the exact manner that was used for 9 and 10. Here the patient had speech hesitation at 15.0 mA but no speech arrest. Testing was repeated and the patient again had significant speech hesitations. The patient performed the object naming task next and could name the objects before and directly after the stimulation, however experienced complete anomia during the time of stimulation. Electrodes 3 and 4: These electrodes were tested at 15.0 mA and the tasks were performed satisfactorily. Electrodes 10 and 11: These electrodes were stimulated in the same fashion and testing was performed at 15.0 mA. When the electrodes were stimulated, the patient had very halting, hesitating speech. This was repeated and the patient had the same halting, hesitating speech. During the object naming task, the patient could not name any of the objects while being stimulated. Electrodes 11 and 12: These electrodes were stimulated in the same fashion and testing was performed at 15.0 mA. Here the patient could read fluently while being stimulated. However, during the object naming task, he could only name four out of eight objects presented. Pt. 149 Electrodes 1 and 9: These electrodes were stimulated for 5 seconds beginning at 4.0 mA and increasing until 7.5 mA was reached without an afterdischarge. The patient was feeling tingling in her face that began to become painful. Testing was performed at 7.5 mA for 10 seconds. The tasks were performed satisfactorily. However, the patient reported a feeling of *dejà vu*. Electrodes 2 and 10: These electrodes were stimulated in the exact manner that was used for 1 and 9. The pt. reported tingling in her bottom lip at 7.0 mA. When stimulated at 8.0 mA, the pt. had a "far away" feeling like before a spell. At a second stimulation at 8.0 mA, stimulation made the pt. laugh out loud. At 9.0 mA, the pt. heard a tune during stimulation. The pt. could not name the tune but moved her lips and tongue. At a second stimulation at 9.0 mA, the pt. again heard the tune but could not say the name when asked for it. At 9.5 mA, the pt.'s mouth drew to the left. At a second stimulation at 9.5 mA, there was no drawing of the mouth. Testing was performed at 9.5 mA. During the reading task, the pt. experienced speech arrest followed by jargon aphasia. During the object naming task, the pt. experienced complete anomia during stimulation. Electrodes 2 and 3: These electrodes were stimulated in the same fashion and an afterdischarge was seen at 11.0 mA. Testing was performed at 10.5 mA. When the electrodes were stimulated during the reading task, the patient had jargon aphasia. During the object naming task, the patient could not name any of the objects while being stimulated. There was an afterdischarge during this task so it was performed again. The pt. could not name the objects the second time with no afterdischarge. Electrodes 10 and 11: These electrodes were stimulated in the same fashion and testing was performed at 15.0 mA. The reading task was performed twice. Here the patient read slowly once and read fluently once while being stimulated. The object naming task was performed twice. She missed two objects the first time and one object the second time. Electrodes 3 and 4: These electrodes were stimulated in the same fashion and at 2.0 mA, the pt.

experienced shooting pain in her head. Testing was performed at 1.0 mA. The tasks were performed satisfactorily. Electrodes 11 and 12: These electrodes were stimulated in the same fashion and at 1.5 mA, the pt. experienced pain behind her ear. Testing was performed at 1.0 mA. The tasks were performed satisfactorily. Memory Scores The patients were given the BMAB 3.0 before and one month following the surgery. Their scores on language and memory functions did not decline significantly following the surgery. A comparison of these scores revealed no general decline in either recognition or recall functions; and only one specific deficit, in paired associates. No deficits were observed in object recognition (object anomia as seen during intraoperative stimulation). Procedural irregularities led to unreliable variability in paired associate data. These data will not be presented here.

----- Insert Table 1 about here -----

DISCUSSION

This intraoperative mapping procedure may represent a more efficient way of locating a BTLA in cooperative patients who are candidates for temporal lobe resection. These patients may also be the higher functioning patients who can cooperate during this procedure and may benefit from it most. During this procedure, the patient is awake while grid or strip electrodes are placed and subsequently electrically stimulated as memory and language functions are tested. In our patients, BTLA was demonstrated through replicated total speech arrest and complete object anomia. BTLA was surgically preserved in these patients and their testing scores reflect the consistency of their object naming scores before and after surgery. We found high individual variability of results to be the norm. Bipolar stimulation of sites separated by only 1 cm could produce entirely different deficits in different patients. (Krauss et al. 1996). We concur that intraoperative procedures are useful for a limited number of patients such as those who are able to withstand the ordeal. However, these patients are usually the very patients in whom sparing the BTLA may make a significant difference, as they may be individuals who rely more on these visual/verbal recognition skills. These patients were admitted to the hospital for 4 days and experienced only one surgical procedure which was significantly more efficacious and less costly than the other reported procedures. Craniotomy and implantation of a grid, 10-14 days of electrical stimulation, combined with the lobectomy and several days of recovery is a much more arduous pathway. Considering the inconsistency and variance of reports concerning the recoverability of function following resection of BTLA, our procedure would help ensure the preservation of a BTLA with a shortened hospital stay and a single surgical procedure with reduced costs. This procedure has several possible disadvantages. Electrode sites are usually tested during a single phase, rather than over several days. As cortical resistance, impedance, and afterdischarge thresholds are known to change over time, it is possible that these results are highly variable. It was always the case, however, that when we found complete speech arrest or total dysnomia, in BTLA, it was dramatic, replicable, and easily noticed and recorded. This suggests that it gives reliable indication of the regions certain involvement in language functions.

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REFERENCES

- Abou-Khalil B, Welch L, Blumenkopf B, Newman K, Whetsell WO Jr. Global aphasia with seizure onset in the dominant basal temporal region. *Epilepsia* 1994; 35(5):1079-1084.
- Brockway JP, Follmer RL, Preuss LA, Prioleau CE, Burrows GS, Solsrud KA, Cooke CN, Greenhoot JH, Howard J. Memory, Simple and Complex Language and the Temporal Lobe. *Brain and Language* 1998, 29; 1-29.
- . Burnstine TH, Lesser RP, Hart J, et al. Characterization of BTLA in patients with left temporal lobe epilepsy. *Neurology* 1990;40:966-970. Fedio P, August A, Sato S, Kufta C. Neuropsychological characteristics of patients with basolateral temporal language. *Epilepsia* 1992;33(suppl 3):120-121.
- Kluin K, Abou-Khalil B, Hood T. Inferior speech area in patients with temporal lobe epilepsy [Abstract]. *Neurology* 1988;38(suppl 1):277.
- Krauss G, Fisher R, Plate C, Hart J, Uematsu S, Gordon B, Lesser RP. Cognitive effects of resecting basal temporal language areas. *Epilepsia* 1996;37:476-483.
- Lhermitte T, Gautier JC. Aphasia. In: Vinken PJ, Bruyn GW, eds. *Handbook of Clinical Neurology*. vol.4. Amsterdam: North Holland Publishing Company, 1969:84-104.
- Luders H, Lesser RP, Hahn J, et al. Basal temporal language area demonstrated by electrical stimulation. *Neurology* 1986;36:505-510.
- Luders H, Lesser RP, Hahn J, et al. Basal temporal language area. *Brain* 1991;114:743-754.
- Malow S, Bookheimer T, Blaxton W, et al. Lateral versus basal temporal electrical stimulation: dissociations in auditory and verbal language tasks. *Epilepsia* 1992;33(suppl 3): 21.
- Mills CK, Martin E. Aphasia and agraphia in some practical surgical relations. *JAMA* 1912;59:1513-1518.
- Mohr JP. Acquired language disorders. In: Asbury AK, McKhann GM, McDonald WI, eds. *Diseases of the nervous system: clinical neurobiology*. vol.1. Philadelphia: W.B. Saunders Company, 1992:729-740.
- Nielsen JM. Agnosia, apraxia, aphasia. Their value in cerebral localization. New York: Paul B. Hoeber, 1946.
- Schaffler L, Luders HO, Beck GJ. Quantitative comparisons of language deficits produced by extraoperative electrical stimulation of Broca's, Wernicke's, and Basal Temporal Language Areas. *Epilepsia* 1996;37(5):463-475.
- Suzuki I, Shimizu H, Ishijima B, Tanu K, Sugishita M, Adachi N. Aphasic seizure caused by focal epilepsy in the left fusiform gyrus. *Neurology* 1992;42:2207-2210.
- LEGEND TO THE FIGURE** Topotomological brain maps for Pts. 148 and 149 of lateral neocortex including inferior and fusiform gyrus showing existence of basal temporal language area

during intraoperative mapping. Subdural grids (2-4x5, 2x8) show localization of language effects during low current biphasic bipolar stimulation.

LEGEND TO THE TABLE Table 1. Memory and language performance scores (percentage correct for 26 specific tasks) for Pts. 148 and 149, prior and subsequent to tailored anterior temporal lobectomy (left--language dominant lobe) following intraoperative mapping of basal temporal language area. RUNNING

HEAD: Basal Temporal Language Area

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