Research Article

Optical topography as a noninvasive alternative to the WADA test in the presurgical evaluation of epilepsy surgery

Mohammad Ismail[*,], Nermin Hamdy**, Enas Hasen**, Mohamed Kilany**, Amal Khafagi** and Eiju Watanabe***

* Department of Neurosurgery, Jichi Medical University, Tochigi, Japan.
** Department of Neurology, El-Minia University, Egypt.

Abstract

Optical topography is a new alternative for noninvasive functional brain imaging. It has been successfully used for functional mapping. In this study we tested the value of optical topography as a noninvasive alternative to the Wada test in ٦ patients with drug resistant epilepsy prepared for surgery in Jichi Medical University. Results were identical in all these patients, reflecting the feasibility of optical topography.

Key words: Optical topography, Wada test, epilepsy surgery.

Introduction

Optical topography (OT) is a new alternative for noninvasive functional brain imaging. It uses near infrared light projected from the scalp into the brain. The reflected light carries the information of hemoglobin concentration change of the regional brain tissue. OT has been successfully used for functional mapping of the motor cortex, the somatosensory cortex, the visual cortex, the auditory cortex, and language areas (Watanabe et al., ١٩٩٦). It can be also utilized in the presurgical evaluation of epilepsy patients in the diagnosis of epilepsy focus (Watanabe et al., ٢٠٠٧).

Aim of the work

This study aims at studying the value of optical topography as a noninvasive alternative to the Wada test to identify the language dominant hemisphere in the presurgical evaluation of patients with drug resistant epilepsy.

Patients and Methods

Six patients were included in this study (٣ males and ٣ females) ranging in age - at time of the operation – from ٢١ to ٥٤ years. All were selected from patients admitted to the Department of Neurosurgery in Jichi Medical University Hospital (JMUH) for the presurgical evaluation of epilepsy surgery and operated in the period from (January, ٢٠٠٦) to (August, ٢٠١٠).

*Inclusion criteria:

The study included adult patients of both sexes with surgically remediable drug resistant epilepsy. Drug resistant epilepsy was defined as: failure of adequate trials of two tolerated and appropriately chosen and used AED schedules (whether as monotherapies or in combination) to achieve sustained seizure freedom. Seizure freedom was defined as: freedom from all types of seizures for ١٢ months or three times the preintervention interseizure interval, whichever is longer (Kwan et al., ٢٠٠٩).

*Exclusion criteria:

١) Children: as there was no special unit for video-EEG monitoring in Jichi Children's Medical Center Tochigi.
٢) Patients who did not fulfill the criteria to diagnose drug resistant epilepsy.
٣) Inoperable patients with drug resistant epilepsy due to any cause including patients with multiple independent epileptic foci.

All patients were subjected to clinical evaluation including history taking and neurological examination. They were also subjected to phase I evaluation including structural brain MR imaging and long term scalp video-EEG monitoring.

*The Wada test:

Baseline language was obtained by going through the entire protocol in the patient's

hospital room on a separate day before being subjected to the Wada test. The test was conducted in the angiography suite in the radiology department of JMUH. The angiogram aspects of the test were performed by the neuroradiologists, while the actual language and memory testing was performed by epilepsy neurosurgeons. Testing was performed immediately following cerebral angiography, and both hemispheres were studied on the same day. Patients begin counting repeatedly from ١-٢٠ with their hands held up and their palms turned rostrally and fingers spread. An injection of ١٥-٢٥ mg of secobarbital sodium was administered by hand over a ٣-٥ second interval via a percutaneous transfemoral catheter. Following demonstration of hemiplegia and evaluation of eye gaze deviation, the patient was requested for object naming, reading of words and sentences, as well as word and sentence repetition approximately ٣٠-٤٥ seconds following injection. At the completion of the first side, the patient was allowed to recover for ٢٠-٣٠ minutes before testing the contralateral side. Testing of the contralateral side was done using the same anesthetic and same dose as the initial side. Results were compared to determine hemispheric language representation. Comprehension deficits, paraphasias, and perseverations during the reading, repetition and naming tasks, as well as word-finding difficulties and prolonged speech arrest in the absence of vigilance alteration, or most commonly global aphasia were taken as indications of language representation in the injected hemisphere.

*OT:
OT was done by the use of the same machine, technique and theoretical basis described above.

The language session consisted of ten repetitions of a word-generation task, each lasting ٢٠ seconds, followed by a resting period of ٣٠ seconds. During these task periods, subjects were instructed to generate as many words as they can, beginning with a letter mentioned by the examiner at the beginning of the task period, and to write down the words on a sheet of paper.

OT results were assessed and interpreted by the epilepsy neurosurgeons of JMUH. The language dominant hemisphere was defined as the hemisphere showing significantly higher increase in total hemoglobin concentration during the task periods mainly at the region of the inferior frontal gyrus including Broca's area.

Results
Six patients have been subjected to both the Wada test and OT investigation to determine the language dominant hemisphere as a part of the presurgical evaluation of epilepsy surgery. In all these patients the results of OT were identical to those of the Wada test; the left hemisphere was the language dominant hemisphere in all these patients as identified by both the Wada test and OT.

Discussion
Number of patients subjected to both OT and the Wada test was relatively small, but similar number of patients has been used by Watanabe et al., (١٩٩٨) who included in their study ١١ healthy volunteers and ٦ patients with drug resistant epilepsy. Also, Watson et al., (٢٠٠٤) included in their study ٨ healthy volunteers and ١٦ patients with drug resistant epilepsy; OT was performed preoperatively in only ٦ patients with drug resistant epilepsy. Moreover, Kennan et al., (٢٠٠٢) compared the diagnosis of OT with that of fMRI in lateralizing the language dominant hemisphere in only ٦ healthy volunteers.

Watanabe et al., (١٩٩٨) showed that agreement of OT with the Wada test was in all patients with drug resistant epilepsy. But, Watson et al., (٢٠٠٤) showed agreement in ٥ of ٦ patients studied preoperatively. That was in agreement with our results.

Conclusion
Optical topography can be used as feasible noninvasive alternative to the Wada test in the identification of the language dominant hemisphere as a part of the presurgical evaluation of epilepsy surgery.

Recommendations
- Optical topography is recommended in the presurgical evaluation of epilepsy surgery to determine the language dominant hemisphere as a noninvasive alternative to the Wada test.

- Further research with larger number of patients to be included to have more statistically significant results.

Reference

١. Kennan RP, Kim D, Maki A, Koizumi H, Constable RT. (٢٠٠٢) Non-invasive assessment of language lateralization by transcranial near infrared optical topography and functional MRI. Hum Brain Mapp.; ١٦: ١٨٣-٩.

٢. Kwan P, Arzimanoglou A, Berg AT, Brodie MJ, Hauser WA, Mathern G, Moshé SL, Perucca E, Wiebe S, French J. (٢٠٠٩) Definition of drug resistant epilepsy. Consensus proposal by the ad hoc Task Force of the ILAE Commission on Therapeutic Strategies. Epilepsia; DOI: ١٠.١١١١/j.١٥٢٨-١١٦٧.٠٢٣٩٧.x.

٣. Watanabe E. (٢٠٠٧) Applications of optical topography in neurosurgery Brain Nerve; ٥٩(٥): ٤٥٩-٦٦.

٤. Watanabe E, Maki A, Kawaguchi F, Takashiro K, Yamashita Y, Koizumi H. (١٩٩٨) Non-invasive assessment of language dominance with near-infrared spectroscopic mapping. Neurosci Lett.; ٢٥٦: ٤٩-٥٢.

٥. Watanabe E, Yamashita Y, Maki A, Ito Y, Koizumi H. (١٩٩٦) Non-invasive functional mapping with multi-channel near infrared spectroscopic topography in humans. Neurosci Lett.; ٢٠٥: ٤١-٤٤.

٦. Watson N, Dodrill C, Farrel D, Holmes MD, Miller JW. (٢٠٠٤) Determination of language dominance with near-infrared spectroscopy: comparison with the intracarotid amobarbital procedure. Seizure; ١٣: ٣٩٩-٤٠٢.