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ORIGINAL ARTICLE

**Functional magnetic resonance for the localization of eloquent areas in epilepsy surgery candidates: comparison to cortical electrostimulation mapping**

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**KEYWORDS**

Cortical mapping;  
fMRI;  
Epilepsy surgery;  
Eloquent areas

**Abstract**

**Introduction:** Surgical treatment for epilepsy comprises resective techniques in most patients.

In those with epilepsy of sites close to highly specialized or eloquent areas, very precise anatomic delimitation is required. So far the most reliable method for anatomic localization of function is direct cortical electrostimulation mapping (CEM). Functional magnetic resonance (fMRI) is a non-invasive method that could also be used for this purpose.

**Objective:** To determine the sensitivity and specificity of fMRI for the identification of eloquent areas compared to CEM in epilepsy surgery candidates.

**Methods:** Four patients who underwent presurgical fMRI and grid implantation in eloquent areas for epileptic focus localization with video-EEG were included in this study. Once the seizure onset site was identified, CEM was performed and a postsurgical structural magnetic resonance was reconstructed with Eclipse software to determine grid position. After correlating pre and postsurgical images, the site of the grid contacts where eloquent areas were identified was compared to localization by fMRI.

**Results:** One hundred and twenty electrodes in six eloquent areas were evaluated and compared to location by fMRI: five hand motor areas and one language area in the temporal lobe. We found a global sensitivity of 0.86, specificity of 0.96, positive predictive value of 0.89, negative predictive value of 0.95 and accuracy of 0.94 for fMRI.

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*Conclusion:* In this study fMRI showed high specificity and proved to be useful for language lateralization. It is necessary to study this technique further, especially for language areas.  
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**PALABRAS CLAVE**

Mapeo cortical;  
fMRI;  
Cirugía de epilepsia;  
Áreas elocuentes

**Resonancia magnética funcional para la localización de áreas elocuentes en candidatos a cirugía de epilepsia: comparación con el mapeo de electroestimulación cortical**

**Resumen**

*Introducción:* El tratamiento quirúrgico para Epilepsia comprende técnicas resectivas en la mayoría de los pacientes. En aquellos con epilepsia de sitios cercanos a áreas altamente especializadas (elocuentes o primarias) se requiere una delimitación anatómica muy precisa. Hasta ahora el método más confiable para identificación anatómica de una función es el mapeo cortical directo con estimulación de la corteza cerebral. La Resonancia magnética funcional (fMRI) es un método no invasivo que también pudiera ser usado para este fin.

*Objetivo:* Determinar la sensibilidad y especificidad de la fMRI para identificar áreas altamente especializadas en comparación con mapeo cortical por electroestimulación en pacientes candidatos a cirugía de epilepsia.

*Métodos:* En este estudio se incluyó a cuatro pacientes en los que se efectuó fMRI prequirúrgica e implantación de mallas de electrodos en áreas primarias para registro continuo de video EEG para localización del foco epiléptico. Una vez localizado el sitio de inicio de las crisis, se hizo mapeo cortical por estimulación eléctrica (MCEE) y Resonancia Magnética (RM) estructural que se reconstruyó con el software Eclipse para determinar la posición de la malla. Después de correlacionar las imágenes se comparó la localización de los contactos de la malla donde se identificó el área especializada por mapeo con su localización obtenida por fMRI.

*Resultados:* Se evaluó la estimulación de 120 electrodos en seis áreas elocuentes: cinco áreas motoras para la mano y un área de lenguaje en lóbulo temporal y se comparó con el área activada en la fMRI. Se encontró para la fMRI una sensibilidad global de 0.86, especificidad de 0.96, VPP de 0.89, VPN de 0.95 y exactitud de 0.94.

*Conclusión:* En este estudio la fMRI mostró alta especificidad y gran utilidad para lateralización del lenguaje con aplicación clínica. Es necesario continuar estudiando estas técnicas, en especial en áreas para el lenguaje.

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**Introduction**

Surgical treatment for epilepsy comprises resective or deep brain stimulation (DBS) techniques. Aspects like focus location and the feasibility of its total resection have great importance. Patients with an epileptic focus far from eloquent areas are candidates for resective surgery with very good results, especially in cases of temporal lobe epilepsy.<sup>1</sup>

One of the main factors that limit total resection of the epileptic focus is its location in or adjacent to an eloquent area. Patients with multiple foci or those in whom focus resection would cause important sequels require thorough presurgical study since it is very important to correctly identify the eloquent area and how distant it is from the epileptic focus. CEM is the method of choice to predict the functional outcome of epilepsy surgery<sup>3,4,5</sup> since it allows precise cortical location of the function being studied. At the Epilepsy Clinic of the General Hospital of Mexico CEM is performed

extraoperatory, through grid electrodes, at the telemetry room.

Functional magnetic resonance (fMRI) is a non-invasive method for delimitation of functional areas. It uses the magnetic properties of hemoglobin in order to detect increased blood flow in sites activated by specific tasks. After image processing, this zones are represented colored.

The most used tasks for motor fMRI include consecutive movements of contralateral hand, either two-finger tapping, multiple-finger tapping, opening and closing the hand or squeezing a ball.<sup>3,12</sup>

For language there are several tasks depending on the specific area of interest. There are image naming tasks or silently thinking of words.<sup>3</sup> The most used tasks to determine language dominance are those of generating words of a certain category, mainly verbs, from others represented with images.<sup>1,22</sup> Combining different tasks that activate the same area during fMRI acquisition has proved to increase its

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