TECHNOLOGY SUMMARY

"Method for determining locations of implanted electrodes with medical images"

MCW #1608

MEDICAL COLLEGE OF WISCONSIN
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Background

Epileptic patients with medically intractable disease are subject to implantation of subdural electrodes for the purpose of seizure localization and mapping of eloquent cortex. Resective surgical planning of chronic epilepsy patients provides a challenging problem for clinicians due to the uncertainty associated with subdural electrode position. The complex, variable surface of the brain makes surgical planning difficult without knowing the specific architecture of the cortex in each patient and the location of electrodes monitoring each unique brain. Inaccurate labor-intensive projection techniques in localization are currently the standard at some research institutes, but the algorithms needed are so complex that general adoption in the medical field will not likely take place. Subsequently, surgical planning of resective margins prior to operation is impossible and surgeons generally are forced to make key resective margin decisions at the time of the craniotomy reopening and removal of electrodes. This imprecision in resection margins can lead to less accurate surgeries and decreased surgical success rates.

Description

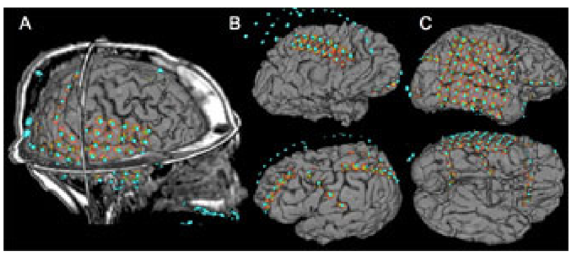

Figure 1. Cortical surface models illustrating location of the cortical electrodes and their corresponding projected shadows. **A.** Lateral view showing left hemisphere and subsequent coronal, axial, and saggital MRI slices. **B.** Cortical surfaces alone showing medial grid placed, as well as lateral electrode strips, some of which are placed on hemisphere not shown. **C.** Further illustration of the versatility of the method.

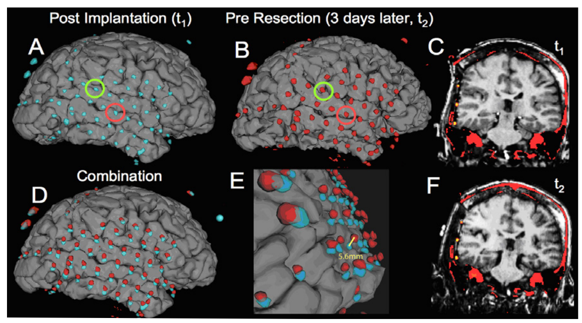

Figure 2. Displacement of electrodes over the duration of three days. **A.** Post surgical (t_1) implantation of subdural grid electrodes MRI+CT. **B.** Pre-resection MRI+CT data collected three days later (t_2). Highlighted with a green and red circle are two electrodes that between time-points have shifted gyri. **C.** Coronal slice showing electrode position (t_1). **D.** Combination of both time-points, overlaid on the t_1 surface. **E.** 3D view of cortical displacement with an example of an electrode that has been displaced 5.6mm. **F.** Same coronal slice as C at t_2.

This invention relies on the collection of CT and MRI data after the patient has electrodes placed on their brain. The images are co-registered to each other. Accurate 3D models of electrodes and specially reconstructed brain models are then generated and combined to produce one simultaneously viewable model (Figure 1). This gives clinicians an accurate 3D representation of electrode positions overlaid on the patient's brain.

This visualization method offers several advantages to a clinical team. It uses the patient's own MRI data, which allows assessment of cortical architecture underneath the electrodes, and allows assessment of cortical compression caused by the electrodes themselves. These images can be utilized in the planning of resection boundaries of epileptic zones causing seizures. If multiple sets of images are gathered at different time points in the duration of the patient monitoring, they can be combined to reveal shifts in electrode position (Figure 2). Measurement of electrode shift gives clinicians the ability to provide minimally invasive procedures and enhance the success rate of surgical intervention.

Stage of Development

Clinical data. In clinical use.

US Patent 8,666,478: "Method for determining locations of implanted electrodes with medical images"

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