Intraoperative SEEG Guided Resection in Patients with Rolandic Epilepsy: An Expansion of SEEG Methodology

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Methods

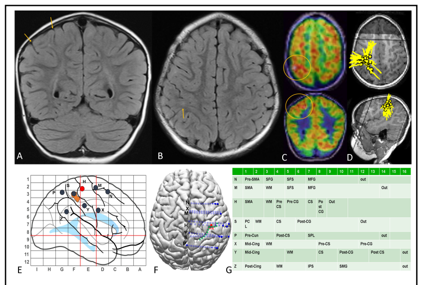
We retrospectively studied the surgical technique, intraoperative findings, pathology and outcomes of patients with intractable RE, as suspected on preoperative evaluation and confirmed on preoperative SEEG monitoring.

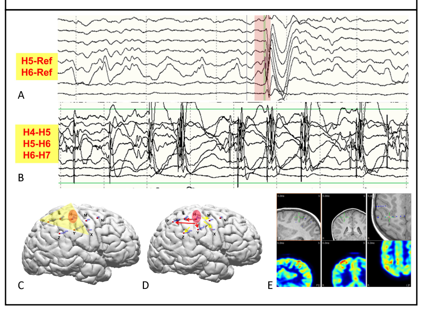
Results

Five patients were identified as having intractable RE based on analysis of preoperative SEEG. Preoperative magnetic resonance imaging was nonlesional in four patients. All patients underwent pre-resection imaging with stereo CT to determine the location of active electrode contacts and their related anatomy. CT was fused to pre-SEEG MRI. Intraoperative SEEG was performed to determine the exact location of the contacts showing epileptogenic activity, and once localized, tissue resection, around these electrode contacts, was performed until disappearance of spikes, while avoiding motor rcortex. Interestingly, all spikes coming from the rolandic areas disappeared after resection of peripheral active regions involving the SMA in three patients, and cingulate gyrus and pre-motor areas in another. In one patient, hand sensory area was resected, sparing motor cortex. Three out of five patients did not have any motor weakness. Pathology analysis showed focal cortical dysplasia type (IB, IIA, and IIB) and a possible vascular malformation in another. Three patients had mild motor weakness with one being transient. All patients were reported to be seizure free during the follow up period of 2 to 28 months (Table 1). Figures show a representative case.

Figure 1. MRI FLAIR was considered non-lesional. Retrospective review showed possible deep anomalous sulcus (gyrus in between arrows in coronal view, A) in right centroparietal region, with subcortical hyperintense T2 signal change in the sensory cortex (single arrow, axial view, B), congruent with area of hypermetabolism (circles) on PET scan (C), concerning for malformation of cortical development. MEG demonstrated interictal dipoles with tight clusters around the right perirolandic (hand) area (D). Pre-operative SEEG evaluation generated right post-central gyrus and right parietal hypotheses, represented in pre-op map (E) and post-op 3D MR / CT scan reconstruction and coregistration (F). Table shows the anatomical location of SEEG contacts (G).

Objective: To evaluate the feasibility of extending extraoperative stereoelectroencephalography (SEEG) monitoring into the intraoperative setting in cases of medically intractable rolandic epilepsy (RE) to better guide tissue resection based on real time monitoring.





Activity spread to P8-9/Y8-9, corresponding to superior parietal lobule and central sulcus. Ictal (B) activity was demonstrated in motor hand area with rapid spread to postcentral gyrus, superior parietal lobule and cingulate sulcus, and less frequently to superior frontal gyrus (M9-11), inferior parietal sulcus, supramarginal gyrus (Z7-10), mid cingulate and pre-central gyrus (X). Figures C and D indicate inter-ictal and ictal patterns respectively. Most frequent population epileptiform activities are indicated by red. Q-PET showed significant hypermetabolism occurring around the hand area, in close proximity to contact H5-6 (E).

Figure 2. Representative SEEG interictal (A) activity most pronounced on H6 (70% of discharges) corresponding to hand area.

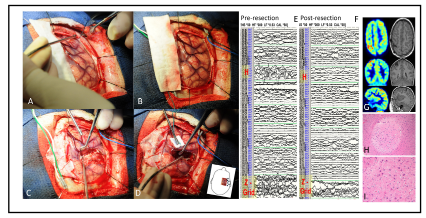


Figure 3. Surgical approach. SEEG electrodes are left in place and craniotomy carried out medial to insertion sites (A). A grid electrode array (4 x 4) is used to localize the central sulcus (phase reversal) (B). SEPs are used to locate the hand sensory area (not shown). Resection starts behind suspected primary focus (H5-6, hand motor) to minimize risk of motor deficit (C). Continuous intra-op SEEG monitoring is performed during resection to assess for epileptogenic activity (spikes). Note the pre-resection SEEG activity (E) on H electrode contacts and the disappearance of SEEG activity immediately after subpial resection of the sensory cortex/gyrus (F). Resection continues until SEEG epileptiform activity stops. Post-op MRI (G) shows tailored resection of the post-central gyrus and its anatomical relationship to preop-PET. Pathological analysis showed nodular heterotopia and focal cortical dysplasia type 2A with horizontal disorganization and dysmorphic neurons (H, I respectively).

	SZ onset yr	Age at evaluation	Failed AED (No.)	SZ freq	Regions of interest	Type of intracranial Monitoring	Location of resection	Tailored resection sparing	SZ outcome	Complication	Pathology
#1	1.75	2.9	6	1-2/week	Rolandic hand	SEEG+subdural EcoG	Postcentral hand knob	Hand motor cortex	17 m SZ free	None	FCD Type II A + Nodular heterotopia
#2	13	15	6	10-30/day	Paracentral lobule	SEEG+awake craniotomy	Posterior part of SMA+Part of Leg motor	Whole leg motor cortex	18 m SZ free	Mild foot drop	Concerned Vascular Malformation
#3	8	18	2	10-15/day	Rolandic hand	SEEG+subdural EcoG	Premotor cortex and SMA	Hand sensory cortex	28 m SZ free	None	FCD Type 1B
#4	3	15	3	EPC	Paracentral lobule	SEEG+subdural EcoG	Posterior part of SMA	Leg motor cortex	4 m SZ free	Mild leg weakness	Path pending
#5	2	5	5	3-5/day	Paracentral lobule	SEEG+subdural EcoG	Posterior part of SMA	Leg motor cortex	2 m SZ free	Transient right side weakness	FCD Type II B

Conclusions

The present study shows the feasibility and safety of extending SEEG evaluation into the intraoperative setting in order to better guide the surgeon for a more accurately tailored resection of epileptic tissue, especially operating around the central lobe.

Learning Objectives

1. To understand the feasibility of expanding SEEG into the intraoperative setting and understand the importance of real time intraoperative feedback for improved tailor resection.

References

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