The combination of stereotactic EEG and grid electrode placement

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Introduction

Stereotactic electroencephalography (SEEG) was first introduced by Talairach and Bancaud (1962) in the early 60's and has become one of the standard invasive procedures in Europe for exploring epileptic foci, especially deeper epileptic foci, such as limbic network, because of the low rate of surgical complications and the capability of a three dimensional mapping of the epileptogenic zone. This methodology is also beneficial to elucidate the precise seizure spread pattern as well as the ictal onset zone.

However, this technique can just demonstrate points of brain and is limited by the location or number of implanted electrodes. This spatial limitation of recordings may cause the difficulty of interpretation.

We use the combined technique of SEEG and grid placement in order to compensate these disadvantages.

Methods

The patient's head was fixed in a standard stereotactic frame (Leksell Stereotactic System®, Elekta, Stockholm, Sweden) and then targets were determined by MRI based on a pre-implantation hypothesis regarding the possible location of the epileptogenic zone. The depth and grid electrodes targeting and trajectory were determined on the robotic system (ROSA™, Medtech, Montpellier, France)(Fig. 1). Preoperative MRI with scalp-based fiducial markers were performed and the images were loaded onto ROSA™. The planned trajectory was reviewed to verify that no vessels or other important structures would be at risk for injury, and modified if necessary. The depth electrodes consisted of 10 cylindrical 2.3-mm-long platinum contacts with a diameter of 0.89 mm (Ad-tech, Racine, WI, USA). The grid electrodes consisted of 11 contacts(4 mm diameter) with center-to-center distances of 1cm (Ad-tech, Racine, WI). Under general anesthesia, the electrodes were inserted one by one (Fig.2).

Fig. 1 ROSA™

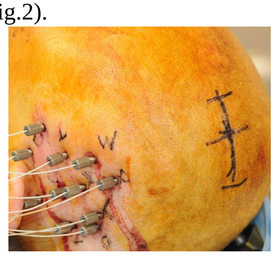
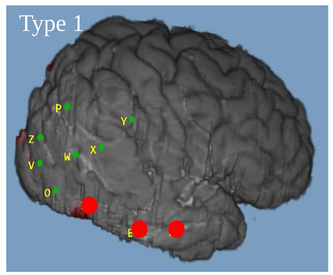


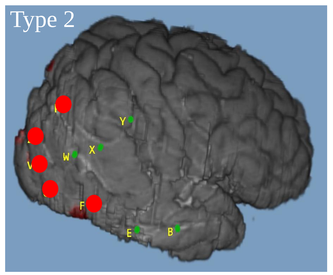
Fig. 2 Skin incision

Results

Case 1: 40 y.o. RH male Rt. T-PLE

Two different seizure patterns were recorded in SEEG evaluation.

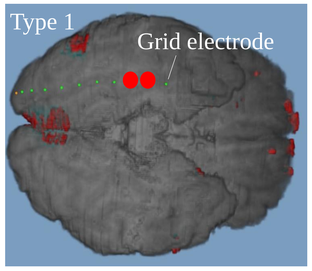


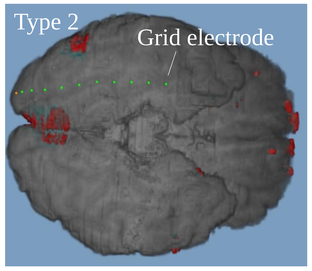


Sz onset

10 days later

Grid electrode was inserted to rule out the seizure propagation from the basal temporal region.

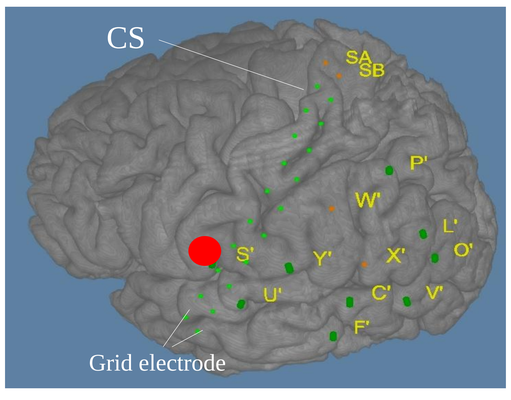




We concluded that the patient had multifocal epilepsy.

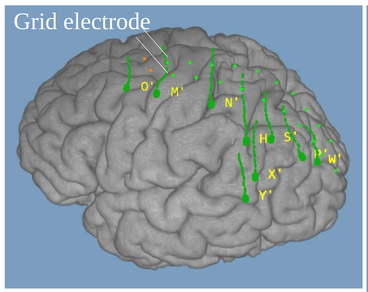
Case 2: 61 y.o. RH female Lt. PLE

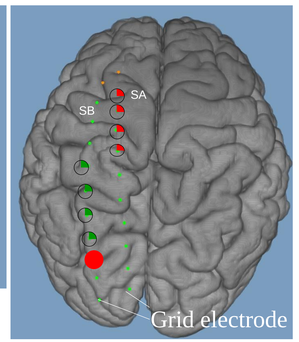
The semiology of a complex facial somatosensory aura would suggest a parietal onset.
The grid electrode was inserted to cover the sensory cortex.



Case 3: 51 y.o. RH female Lt. PLE

Grid electrode was inserted for sensorimotor mapping.

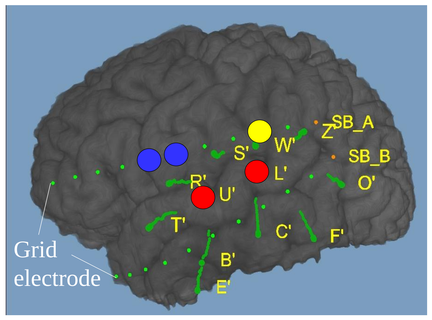




Motor Right Arm
Sensory Right Arm
Sz onset

Case 4: 19 y.o. ambidextrous female Lt. TLE

Grid electrode was inserted for language mapping.



Nagative motor
Language
Sz onset

Table 1 patient profile

No	Age/ Sex	Epilepsy	Scalp EEG	MRI	PET	MEG	iSPECT	ictal onset	Surgical outcome
1	40M	Rt T-PLE	Rt O	NL	Rt OF+T	Bil. T-O	Rt T-P	Rt basal T and lateral T-O	-
2	61F	Lt PLE	Lt H	NL	Lt P-O	NL	-	Left P Operculum	-
3	51F	Lt PLE	Lt H	Lt Th atrophy	Lt Th+F	-	-	Lt SPL	Ia (15 mos)
4	19F	Lt TLE	Non-Loc	NL	Lt F-T	Lt T-P	-	Left T Operculum	-

F: frontal, F-T: fronto-temporal, H: hemisphere, M: male, NL: non-lesion, Non-Loc: non-localizible, O: occipital, OF: orbitofrontal, P: parietal, PLE: parietal lobe epilepsy, P-O: parieto-occipital, SPL: superior parietal lobule, T: temporal, Th: thalamus, TLE: temporal lobe epilepsy, T-O: temporo-occipital, T-P: temporo-parietal, T-PLE: temporo-parietal lobe epilepsy

Discussion

We performed SEEG evaluation combined with grid electriode placement in four patients. SEEG cannot provide details of cortical extent of epileptogenic regions or functional areas.

In these patietns, grid electrode provided additional information regarding the following aspects.

1. Precise description of seizure spread
2. Identification of seizue onset
3. Functional cortical mapping

SEEG has advantage for exploring deeper epileptic foci and network-related seizure spread. On the other hand, grid electrode is advantageous for exploring cortical extent of epileptogenic regions or functional areas. These methods are complementary and the combination of these options provides better information to modify the treatment strategy.

Conclusion

The combination of SEEG and grid electrode provides additional information regarding functional mapping and detection of seizure onset. This technique suggests additional points of view in presurgical evaluation in patients with epilepsy.

Reference

Talairach J, Bancaud J, Bonis A, Szikla G, Tournoux P. Functional stereotaxic exploration of epilepsy. Confin Neurol 1962; 22: 328-31.