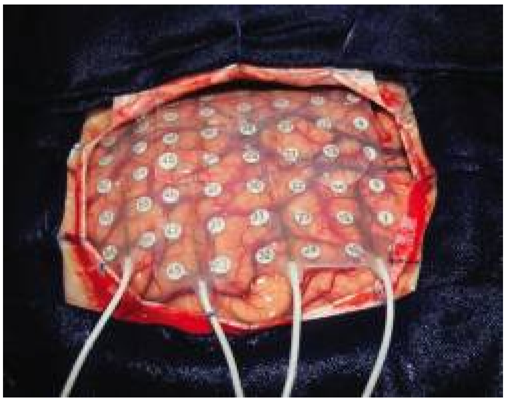
Subdural grid monitoring



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Indications

A useful technique for intra-operative functional mapping, for the surgical treatment of epilepsy.

○ Grids are frequently used for extra-operative functional mapping (helpful in children or in the mentally retarded). Subdural grid electrodes are placed with a craniotomy.

○ Surface strip electrodes may be placed through a burr hole.

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https://adtechmedical.com/subdural-electrodes.

Disadvantages

Subdural grid monitoring (SDG) has the advantage to provide continuous coverage over a larger area of cortex, direct visualization of electrode location and functional mapping. However, SDG can cause direct irritation of the cortex or postoperative headaches due to cerebrospinal fluid fistula. Epidural grid monitoring (EDG) without opening the dura is thought to reduce the possibility of these complications. Park et al. reported the experience with Epidural grid monitoring.

see Epidural grid monitoring.

Placement

Traditionally, for subdural grid electrode placement, large craniotomies have been applied for optimal electrode placement. Nowadays, microneurosurgeons prefer patient-tailored minimally invasive approaches. Absolute figures on craniotomy size have never been reported. To elucidate the craniotomy size necessary for successful diagnostics, Schneider et al. reviewed there single-center experience in the Charité.

Within 3 years, 58 patients with focal epilepsies underwent subdural grid implantation using patient-tailored navigation-based craniotomies. Craniotomy sizes were measured retrospectively. The number of electrodes and the feasibility of the resection were evaluated. Sixteen historical patients served as controls.

In all 58 patients, subdural electrodes were implanted as planned through tailored craniotomies. The mean craniotomy size was 28 ± 15 cm2 via which 55 ± 16 electrodes were implanted. In temporal lobe diagnostics, even smaller craniotomies were applied (21 ± 11 cm2). Craniotomies were significantly smaller than in historical controls (65 ± 23 cm2, $p < 0.05$), while the mean number of electrodes was comparable. The mean operation time was shorter and complications were reduced in tailored craniotomies.

Craniotomy size for subdural electrode implantation is controversial. Some surgeons favor large craniotomies, while others strive for minimally invasive approaches. For the first time, they measured the actual craniotomy size for subdural grid electrode implantation. All procedures were straightforward. They therefore advocate for patient-tailored minimally invasive approaches - standard in modern microneurosurgery - in epilepsy surgery as well [1)].

Subdural strip and grid electrode (SDE) implantations have long been used as the mainstay of intracranial seizure localization in the United States. Stereoelectroencephalography (SEEG) is an alternative approach in which depth electrodes are placed through percutaneous drill holes to stereotactically defined coordinates in the brain. Long used in certain centers in Europe, SEEG is gaining wider popularity in North America, bolstered by the advent of stereotactic robotic assistance and mounting evidence of safety, without the need for catheter-based angiography. Rates of clinically significant hemorrhage, infection, and other complications appear lower with SEEG than with SDE implants. SEEG also avoids unnecessary craniotomies when seizures are localized to unresectable eloquent cortex, found to be multifocal or nonfocal, or ultimately treated with stereotactic procedures such as laser interstitial thermal therapy (LITT), radiofrequency thermocoagulation (RF-TC), responsive neurostimulation (RNS), or deep brain stimulation (DBS). While SDE allows for excellent localization and functional mapping on the cortical surface, SEEG offers a less invasive option for sampling disparate brain areas, bilateral investigations, and deep or medial targets. SEEG has shown efficacy for seizure localization in the temporal lobe, the insula, lesional and nonlesional extra-temporal epilepsy, hypothalamic hamartomas, nodular periventricular heterotopias, and patients who have had prior craniotomies for resections or grids. SEEG offers a valuable opportunity for cognitive neurophysiology research and may have an important role in the study of dysfunctional networks in psychiatric disease and understanding the effects of neuromodulation [2)].

Case series

Hamer et al retrospectively reviewed the records of all patients who underwent invasive monitoring with subdural grid electrodes (n = 198 monitoring sessions on 187 patients; median age: 24 years; range: 1 to 50 years) at the Cleveland Clinic Foundation from 1980 to 1997.

From 1980 to 1997, the complication rate decreased ($p = 0.003$). In the last 5 years, 19/99 patients (19%) had complications, including two patients (2%) with permanent sequelae. In the last 3 years, the complication rate was 13.5% (n = 5/37) without permanent deficits. Overall, complications occurred during 52 monitoring sessions (26.3%): infection (n = 24; 12.1%), transient neurologic deficit (n = 22; 11.1%), epidural hematoma (n = 5; 2.5%), increased intracranial pressure (n = 5; 2.5%), and infarction (n = 3; 1.5%). One patient (0.5%) died during grid insertion. Complication occurrence was associated with greater number of grids/electrodes (p = 0.021/p = 0.052; especially >60 electrodes), longer duration of monitoring (p = 0.004; especially >10 days), older age of the patient (p = 0.005), left-sided grid insertion (p = 0.01), and burr holes in addition to the craniotomy (p = 0.022). No association with complications was found for number of seizures, IQ, anticonvulsants, or grid localization.

Invasive monitoring with grid electrodes was associated with significant complications. Most of them were transient. Increased complication rates were related to left-sided grid insertion and longer monitoring with a greater number of electrodes (especially more than 60 electrodes). Improvements in grid technology, surgical technique, and postoperative care resulted in significant reductions in the complication rate [3].

From 1987 to 1992, invasive EEG studies using subdural strips, subdural grids or depth electrodes were performed in a total of 160 patients with medically intractable epilepsy, in whom scalp EEG was insufficient to localize the epileptogenic focus. Dependent on the individual requirements, these different electrode types were used alone or in combination. Multiple strip electrodes with 4 to 16 contacts were implanted in 157 cases through burrholes, grids with up to 64 contacts in 15 cases via boneflaps, and intrahippocampal depth electrodes in 36 cases using stereotactic procedures. In every case, localization of the electrodes with respect to brain structures was controlled by CT scan and MRI. Visual and computerized analysis of extra-operative recordings allowed the localization of a resectable epileptogenic focus in 143 patients (89%), who subsequently were referred for surgery, whereas surgery had to be denied to 17 patients (11%). We did not encounter any permanent morbidity or mortality in our series. In our experience, EEG-monitoring with chronically implanted electrodes is a feasible technique which contributes essentially to the exact localization of the epileptogenic focus, since it allows nearly artefact-free recording of the ictal and interictal activity. Moreover, grid electrodes can be used for extra-operative functional topographic mapping of eloquent brain areas [4].

References

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