Awake surgery

see Awake surgery in pediatric patient.

An awake craniotomy is a safe neurosurgical procedure that minimizes the risk of brain injury. During the course of this surgery, the patient is asked to perform motor or cognitive tasks, but some patients exhibit severe sleepiness.

For neurosurgery with an awake craniotomy, the critical issue is to set aside enough time to identify eloquent cortices by electrocortical stimulation (ECS). High gamma activity (HGA) ranging between 80 and 120 Hz on electrocorticogram (ECoG) is assumed to reflect localized cortical processing.

In recent years, there have been a number of reports on interventions in conscious patients with other neurosurgical pathologies, which may be regarded as a new emerging tendency in neurosurgery and neuroanesthesiology. Neurosurgery in conscious patients provides a special advantage because it enables highly functional neuromonitoring without use of complex devices 1).

Indications

Gross total removal of glioma is limited by proximity to eloquent brain. Awake surgery allows for intraoperative monitoring to safely identify eloquent regions.

For a long time, the right hemisphere (RH) was considered as “non-dominant”, especially in right-handers. In neurosurgical practice, this dogma resulted in the selection of awake craniotomy with language mapping only for lesions of the left dominant hemisphere. Conversely, surgery under general anesthesia (possibly with motor mapping) was usually proposed for right lesions. However, when objective neuropsychological tests were performed, they frequently revealed cognitive and behavioral deficits following brain surgery, even in the RH. Therefore, to preserve an optimal quality of life, especially in patients with a long survival expectancy (as in low-grade gliomas), awake surgery with cortical and axonal electrostimulation mapping has recently been proposed for right tumors resection. Here, we review new insights gained from intraoperative stimulation into the pivotal role of the RH in movement execution and control, visual processes and spatial cognition, language and non-verbal semantic processing, executive functions (e.g. attention), and social cognition (mentalizing and emotion recognition). Such original findings, that break with the myth of a “non-dominant” RH, may have important implications in cognitive neurosciences, by improving our knowledge of the functional connectivity of the RH, as well as for the clinical management of patients with a right lesion. Indeed, in brain surgery, awake mapping should be considered more systematically in the RH. Moreover, neuropsychological examination must be achieved in a more systematic manner before and after surgery within the RH, to optimize the care by predicting the likelihood of functional recovery and by elaborating specific programs of rehabilitation 2).

Operations in eloquent areas
Awake craniotomy was introduced for surgical treatment of epilepsy, and has subsequently been used in patients with supratentorial tumors, intracranial arteriovenous malformation, deep brain stimulation, and mycotic aneurysms near critical regions of brain.

Patients are selected for awake craniotomy when the planned procedure involves eloquent areas of the brain, necessitating an awake, cooperative patient capable of undergoing neurocognitive testing, especially speech area, (Broca’s area, Wernicke’s area) near motor strip, thalamus, removal of brainstem tumors, some seizure surgery.

The critical issue is to set aside enough time to identify eloquent cortices by electrocortical stimulation (ECS). High gamma activity (HGA) ranging between 80 and 120 Hz on electrocorticogram (ECoG) is assumed to reflect localized cortical processing. In this report, we used realtime HGA mapping and functional magnetic resonance imaging (fMRI) for rapid and reliable identification of motor and language functions. Three patients with intra-axial tumors in their dominant hemisphere underwent preoperative fMRI and lesion resection with an awake craniotomy. All patients showed significant fMRI activation evoked by motor and language tasks. After the craniotomy, we recorded ECoG activity by placing subdural grids directly on the exposed brain surface. Each patient performed motor and language tasks and demonstrated realtime HGA dynamics in hand motor areas and parts of the inferior frontal gyrus. Sensitivity and specificity of HGA mapping were 100% compared to ECS mapping in the frontal lobe, which suggested HGA mapping precisely indicated eloquent cortices. The investigation times of HGA mapping was significantly shorter than that of ECS mapping. Specificities of the motor and language-fMRI, however, did not reach 85%. The results of HGA mapping was mostly consistent with those of ECS mapping, although fMRI tended to overestimate functional areas. This novel technique enables rapid and accurate functional mapping.

Awake craniotomy for glioma

Craniotomies for glioma resection under conscious sedation (CS) have been well-documented in the literature for gliomas that are in or adjacent to eloquent areas.

Awake surgery for glioma aims to maximize resection to optimize prognosis while minimizing the risk of postoperative deficits.

The oncological and functional results of awake glioma surgery during the learning curve are comparable to results from established centers. The use and utility of resection probability maps are well demonstrated. The return to work level is high.

AC with the input of the speech and language therapist (SLT) and an experienced neurophysiotherapist (NP) is a key component in ensuring optimal functional outcomes for patients with gliomas in eloquently located areas.

5 aminolevulinic acid guidance during awake craniotomy

Corns et al. describe the case of a patient with recurrent left frontal GBM encroaching on Broca’s area (eloquent brain). Gross total resection of the tumour was achieved by combining two techniques, awake resection to prevent damage to eloquent brain and 5-ALA fluorescence guidance to maximise the extent of tumour resection. This technique led to gross total resection of all T1-enhancing tumour with the avoidance of neurological deficit. The authors recommend this technique in patients when awake surgery can be tolerated and gross total resection is the aim of surgery.
Contraindications

Uncooperative (very young or too old patient).
Confusion.
Speech deficit
Language barrier

Brain mapping

Electrocortical stimulation (ECS) is the gold standard for functional brain mapping during an awake craniotomy.

Awake craniotomy could be challenging because of unsecured airway with risks of vomiting, epileptic attacks or unstable level of consciousness. It is considered that the patient monitoring becomes more difficult when iMRI is performed because the patient's face cannot be observed directly. We should remember that conscious level as well as respiration pattern may change during operation.

Awake craniotomy can be safely performed in a high-field (1.5 T) iMRI suite to maximize tumor resection in eloquent brain areas with an acceptable morbidity profile at 1 month.

The routine use of fMRI was not useful in identifying language sites as performed and, more importantly, practiced tasks failed to prevent neurological deficits following awake craniotomy procedures.

Management of anesthesia

The importance of minimizing pain and preparing patients thoroughly to reduce anxiety and maximize cooperation. Awake surgery is an excellent treatment modality for brain tumors with very positive perception by patients.

Different anesthetic combinations, including neurolept, propofol with or without opioid infusions, and asleep-awake-asleep techniques, have been reported for awake craniotomy. In all these techniques, respiratory depression has been reported as a complication.

see dexmedetomidine

Different protocols exist for anesthetic care during awake craniotomy based on monitored anesthesia care (MAC) or general anesthesia (asleep-awake-asleep technique). Nevertheless the administration of anesthetics, expectedly, is not without drawbacks, side effects and risks. A new approach for awake craniotomies emphasizes the need of adequate communication with patients.

Scalp block

see http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4236942/#ref11

Awake surgery with intraoperative brain mapping is highly recommended for patients with diffuse low
grade gliomas in language areas, to maximise the extent of resection while preserving the integrity of functional networks and thus quality of life.

The picture naming test DO 80 is the gold standard for language assessment before, during, and after surgery.

Cognitive functioning is correlated with quality of life, itself linked with return to work.

The objective was to evaluate the significance of measuring naming speed, and its correlation with the return to professional activities. Two complementary studies are reported. In the first retrospective study, eleven patients were examined post-operatively. Five patients were selected because they were not able to resume their professional activities (“no return group 1”). They were compared with a control group of six patients who are working normally after surgery (“return group 1”). The eleven patients performed a global language and neuropsychological assessment, with a post-operative median follow-up of 35 months. In a subsequent prospective study, twelve patients were examined pre-operatively and post-operatively. Six patients who were not able to return to work (“no return group 2”) were compared with a control group of six patients who were working normally after the surgery (“return group 2”). The twelve patients performed a pre and post-operative language assessment, with a median follow-up of 9 months. Our results show, for the first time, that naming speed is significantly correlated with a major criterion of quality of life: the return to professional activities. There were no differences between the two groups regarding other measures of cognition. Assessing naming times, and not only naming accuracy, is essential in the management of low-grade glioma patients, before, during, and after surgery, to preserve their quality of life by resuming their previous professional activity. Our results have fundamental implications concerning the comprehension of language processing and its relationship with cognitive functioning.

### Cost effectiveness

Retrospective analysis of a cohort of 17 patients with perirolandic gliomas who underwent an AC with DCS were case-control matched with 23 patients with perirolandic gliomas who underwent surgery under GA with neuromonitoring (ie, motor-evoked potentials, somatosensory-evoked potentials, phase reversal). Inpatient costs, quality-adjusted life years (QALY), extent of resection, and neurological outcome were compared between the groups.

Total inpatient expense per patient was $\$ 34 804 in the AC group and $\$ 46 798 in the GA group (P = .046). QALY score for the AC group was 0.97 and 0.47 for the GA group (P = .041). The incremental cost per QALY for the AC group was $\$ 82 720 less than the GA group. Postoperative Karnofsky performance status was 91.8 in the AC group and 81.3 in the GA group (P = .047). Length of hospitalization was 4.12 days in the AC group and 7.61 days in the GA group (P = .049).

The total inpatient costs for awake craniotomies were lower than surgery under GA. This study suggests better cost effectiveness and neurological outcome with awake craniotomies for perirolandic gliomas.

### Awake surgery for insular glioma

see Awake surgery for insular glioma.
Case series

see Awake surgery case series.


