# Technical Aspects of Awake Craniotomy with Mapping for Brain Tumors in a Limited Resource Setting

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■ BACKGROUND: **Brain tumor surgery near or within eloquent regions is increasingly common and is associated with a high risk of neurologic injury. Awake craniotomy with mapping has been shown to be a valid method to preserve neurologic function and increase the extent of resection. However, the technique used varies greatly among centers. Most count on professionals such as neuropsychologists, speech therapists, neurophysiologists, or neurologists to help in intraoperative patient evaluation. We describe our technique with the sole participation of neurosurgeons and anesthesiologists.**

■ METHODS: **A retrospective review of 19 patients who underwent awake craniotomies for brain tumors between January 2013 and February 2017 at a tertiary university hospital was performed. We sought to identify and describe the most critical stages involved in this surgery as well as show the complications associated with our technique.**

■ RESULTS: **Preoperative preparation, positioning, anesthesia, brain mapping, resection, and management of seizures and pain were stages deemed relevant to the accomplishment of an awake craniotomy. Sixteen percent of the patients developed new postoperative deficit. Seizures occurred in 24%. None led to awake craniotomy failure.**

■ CONCLUSIONS: **We provide a thorough description of the technique used in awake craniotomies with mapping used in our institution, where the intraoperative patient evaluation is carried out solely by neurosurgeons and anesthesiologists. The absence of other specialized personnel and equipment does not necessarily preclude successful mapping during awake craniotomy. We hope to provide helpful information for those who wish to offer function-guided tumor resection in their own centers.**

## INTRODUCTION

Surgery is an important treatment component for intra-axial brain tumors. However, resections that take place within or near presumably eloquent areas carry a greater risk of developing a neurologic deficit.[1-3] Literature regarding glioma surgery shows that there is increasing evidence that the extent of resection positively affects overall survival, progression-free survival, and malignant transformation (low grades) to a point that even supratotal resections have been advocated.[4-12] In metastatic disease, as a result of advances in systemic oncologic treatment and longer survival, the involvement of eloquent areas has become more frequent.[13] Therefore, given the indisputable role of surgery in the management of these diseases, surgeons treat more and more challenging cases, bearing in mind that an overly aggressive tumor resection may lead to undesirable deficit.

Awake craniotomy (AC) with brain mapping is considered the gold standard for intraoperative localization of eloquent brain. Because anatomic landmarks are not reliable in predicting function,[14] stimulation mapping is an outstanding tool for the identification of eloquence in real time. It allows a function-guided resection, reducing the incidence of neurologic deficit and increasing the resection.[15] In addition, AC has been shown to be safe and cost effective and to yield high levels of patient satisfaction.[16,17]

Despite brain mapping being well established, surgical, anesthesiologic, and stimulation techniques vary considerably among centers. Some institutions count on trained neuropsychologists, speech therapists, neurophysiologists, and neurologists to help

**Key words**
- Awake craniotomy
- Brain mapping
- Brain tumor
- Technical aspects

**Abbreviations and Acronyms**
**AC**: Awake craniotomy

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intraoperative evaluation of patients during awake surgery.[18] Conversely, many neuro-oncologic centers around the world (ours included) do not have access to these professionals or to the technology that they master.

The purpose of this study was to describe a tested AC protocol in a limited resource setting, with the sole participation of neurosurgeons and anesthesiologists.

## METHODS

A retrospective review of 19 patients who underwent AC for brain tumors between January 2013 and February 2017 at a tertiary university hospital was performed.

In our department, AC was performed in patients with supratentorial intrinsic brain tumor near or within presumed language and/or sensorimotor areas. Untreated psychiatric condition, claustrophobia, patient's refusal, and severely impaired preoperative function were considered contraindications to this method.

We sought to identify and describe the most critical stages involved in awake surgery with mapping. Complications such as intraoperative seizures, AC failure, and new postoperative deficits were also reviewed.

Demographic data such as age, gender, histology, tumor site, and type of mapping performed are shown in Table 1.

## RESULTS

The following stages were deemed relevant to the accomplishment of an AC. We provide a thorough description of the technique used in each and show complications related to this protocol.

### Preoperative Preparation

Every step of surgery such as head pinning, drilling, mapping, possibility of seizures, and closure is explained to patients. Nothing should be a surprise for them. During mapping, for instance, they should be spared the unnecessary concern of developing a deficit, because neurologic disturbances are reversible at this point. We instruct patients not to answer questions by nodding their heads, because we routinely apply rigid head fixation. During closure, we warn that pressure or pulling may be felt, but they should not feel pain.

We also show slides of pictures and words to remove those that could not be recognized or read from the database that is used later in intraoperative language testing.

### Positioning

Proper positioning is paramount for patients' comfort throughout surgery. All pressure points are generously padded and head flexion, extension, and rotation are kept within physiologic range. After positioning and head fixation, patients are asked whether they are comfortable and are able to see the computer screen (when language mapping is planned). We do not hesitate in making adjustments as many times as necessary until an optimal position is achieved.

We use an L-shaped metal bar attached to the surgical table to keep draping away from the patient's face. This strategy facilitates communication with the patient, allows visualization of the computer screen (used for language testing), and makes the airway easily accessible to the anesthesiologist. It is important that in addition to the face, the contralateral arm and leg are exposed, allowing visualization of muscle contraction triggered by stimulation during motor mapping. Venous and arterial lines as well as digital oximetry are also avoided in these limbs (Figure 1).

**Table 1.** Demographic Data

| Characteristic | Value |
|---|---|
| Age (years) | |
| Mean | 57 |
| Range | 25—78 |
| Gender (n) | |
| Male | 12 |
| Female | 7 |
| Histology (n) | |
| Low-grade glioma | 5 |
| High-grade glioma | 8 |
| Metastasis | 6 |
| Tumor site (n) | |
| Left frontal | 8 |
| Right frontal | 5 |
| Left insula | 1 |
| Left parietal | 1 |
| Right parietal | 1 |
| Left temporal | 2 |
| Right temporal | 1 |
| Mapping type (n) | |
| Language | 15 |
| Motor | 16 |
| Sensory | 2 |

### Anesthesia

***Local Anesthesia.*** Anesthesia is achieved by infiltration of the scalp both locally (at the planned incision line as well as at the head-holder pin insertion site) and regionally (at the emergence of the sensory nerves, i.e., supratrochlear, supraorbital, zygomaticotemporal, auriculotemporal, and greater and lesser occipital nerves).

The local anesthetic solution used included epinephrine, lidocaine, and bupivacaine.

***Conscious Sedation.*** We adopt a strictly awake anesthesiologic protocol, and thus, all patients undergo surgery with slight sedation. They are conscious throughout the operation. Hence, no airway instrumentation is required. Sedatives are carefully titrated, depending on the stage of the surgery, to achieve the desired level of consciousness. Cortical mapping is the most critical stage, when patients must be fully awake and responsive. During