

Awake Craniotomy: Anaesthetic Guidelines and Recent Advances

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Introduction

While the debate continues over the advantages of regional anaesthesia versus general anaesthesia for many forms of surgery, there is an increasing number of indications in intracranial surgery for the patient to be awake during some or all of the operation.¹⁻³ This may be a daunting prospect for the neuroanaesthetist who is inexperienced in the technique of awake craniotomy. However, with a sound anatomical knowledge of the nerve blocks and the knowledge to anticipate certain predictable intraoperative events, this can be an extremely rewarding procedure for the neuroanaesthetist, whilst offering the patient the best possible outcome from the surgery.

The traditional indication for awake craniotomy has been epilepsy surgery and, in particular, temporal lobectomy where the excision occasionally encroaches on the eloquent cortex (motor and speech areas). Tumour or arteriovenous malformation surgery where the lesion abuts or invades the speech, motor, sensory or visual cortex may also involve intraoperative functional testing or cortical mapping, requiring the patient to be awake. Occasionally, avoidance of general anaesthesia is advisable for medical reasons and confidence with the awake craniotomy technique allows local anaesthesia with sedation to be considered as an option. Intraoperative corticography can be used to help define the epileptic focus and to confirm the resection, but is less useful than awake functional testing to define the limits of the resection and avoid postoperative deficits.⁴

Preoperative assessment

Patients presenting for awake craniotomy are often highly motivated and naturally eager to maximize the chance of cure and minimize the possibility of a postoperative neurological deficit. Those with epilepsy can be offered a reasonable expectation of seizure reduction or abolition⁵ and patients with an intracerebral tumour can be offered the best possible margin of resection. Occasionally, a patient may be considered to be unsuitable due to emotional or psychological reasons; however, this is unusual and teenagers have tolerated the procedure well.^{6,7} When children undergo awake functional testing during craniotomy, general anaesthesia is usually required for the first part of the procedure.^{8,9}

Airway assessment may affect decisions regarding intraoperative positioning, and

early communication with the surgical team is essential in this regard. It is our custom to premedicate our patients with oral clonidine 3 mcg/kg about an hour prior to the anaesthetic. This offers anxiolysis and blood pressure stability without compromising alertness during the testing phase.¹⁰ With accurately placed scalp blocks, most operations are painless and all patients can be reassured that the majority of the operation will be comfortable. Sometimes brief periods of discomfort may be experienced at certain stages, but it must be emphasized that this “headache” does not represent a problem. Properly prepared patients are aware of this and most are happy to accept it.

Preparation

The patient can be prepared as for a conventional craniotomy according to the custom of the anaesthetist. In the unlikely event of a conversion to general anaesthetic, or the more likely occurrence of an intraoperative seizure, full monitoring would be required. In addition, capnography can be attached to sample the expired gas. This is best used as a monitor of respiratory rate and to detect apnoea, as end tidal CO₂ concentrations are likely to considerably under-read. A dedicated intravenous line for the sedative drugs is advisable as an inadvertent bolus of potent sedative can cause apnoea or airway obstruction. A simple form of central line placed from the antecubital fossa is ideal as it allows rapid delivery of drugs into a central vein, while being resistant to dislodgement in the event of unexpected patient movement. A urinary catheter is avoided if possible.

Some sedation is usually necessary for the performance of the scalp blocks as this can be painful. We prefer to use the drugs intended for intraoperative sedation (remifentanyl and propofol). Remifentanyl should be prepared as a dilute solution of 10-20 micrograms/ml, to lessen the chance of inadvertent overdose. The sensitivity of the patient to these drugs can thus be assessed while he or she is being closely observed during performance of the blocks. In this way, the optimal dosage required to tolerate mild discomfort can be determined well prior to head pin placement and draping.

Performance of the scalp blocks

Six nerves need to be blocked bilaterally to completely anaesthetise the scalp: the supratrochlear, supraorbital, zygomaticotemporal, auriculotemporal, and the lesser and greater occipital nerves. Minor contributions from the greater auricular nerve and third occipital nerve rarely encroach into the surgical field. An exact knowledge of the craniotomy site and head pin position can allow more selective blockade. A full description of the blocks can be found in a recent review¹⁰ and a basic diagram has been included (Figure 1).

No particular needle type is prescribed; however, if a needle larger than 25 Gauge is used, a small skin bleb may improve the comfort of the blocks. We use about 2-3 ml of 0.75% ropivacaine with adrenaline 5 mcg/ml at each site, giving a maximum volume of 35 ml. This results in a safe but rapid peak plasma level, which begins to drop after about 15 minutes; thus, a small 5-10 ml top up prior to surgery is safe if necessary.¹¹ The depth of needle insertion is critical and the efficacy of the blocks is maximized by depositing local anaesthetic in the correct layer of the scalp.

A brief description is included for each nerve:

1. The supraorbital nerve is blocked just above the supraorbital notch and local anaesthetic is deposited just superficial to the periosteum.

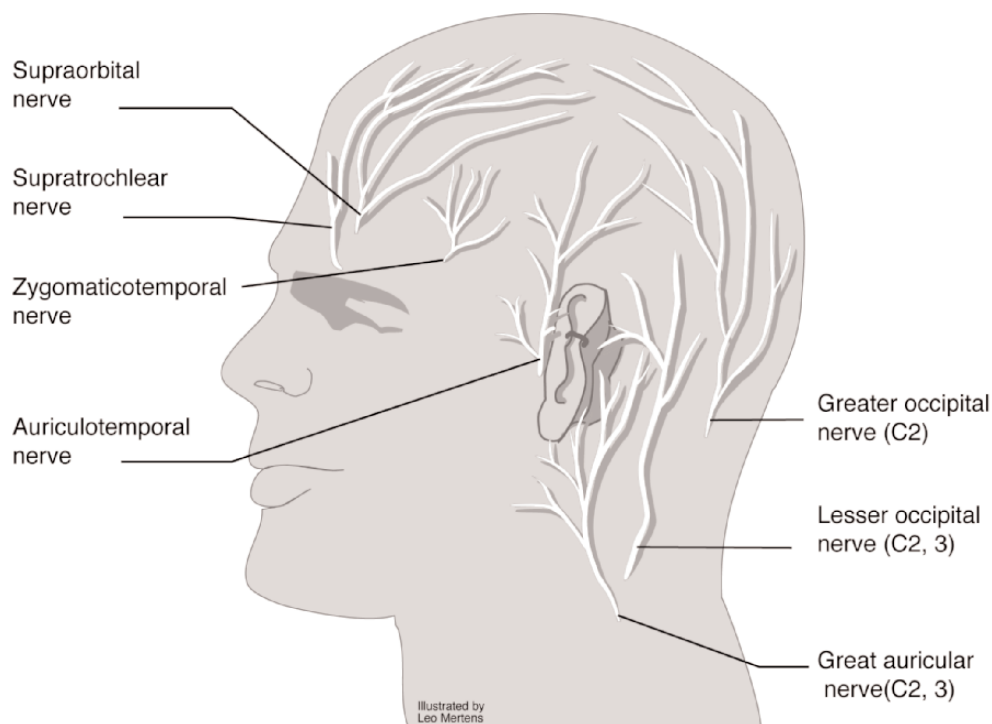


Figure 1. Innervation of the scalp (Reprinted from Ref 10; with permission of Elsevier and authors).

2. The temporal branch of the auriculotemporal nerve is blocked immediately posterior to the superficial temporal artery at the level of the auditory meatus. Injection is superficial and subcutaneous. Too deep an injection will produce facial nerve block.
3. The main branch of the zygomaticotemporal nerve emerges from the temporalis fascia near the lateral border of the orbit, although many smaller deep branches ramify within the temporalis muscle. These small branches are especially important to block so as to cover temporally based flap incisions. Field infiltration above the zygoma through the temporalis muscle and almost down to the periosteum of the temporal bone will give a good result, without causing a facial nerve block. Up to 5 ml can be used on the operative side.
4. The lesser occipital nerve can be blocked either deep or superficial to the fascia at the upper, posterior border of sternocleidomastoid.
5. The greater occipital nerve is blocked subcutaneously by injecting along the middle third of a line between the mastoid process and the external occipital protuberance along the superior nuchal ridge. This injection will also reinforce the lesser occipital nerve block as it becomes subcutaneous.

Positioning

The main objective of positioning is to maintain access to the airway and adopt a comfortable position for the patient, while avoiding airway obstruction if sedation is

necessary. To achieve this, a lateral or semi-lateral position is preferred with minimal rotation of the neck. Other (often competing) considerations are the visibility of the patient to the anaesthetist during intraoperative functional testing and allowing the surgeon and assistant adequate surgical access. One such set up is depicted in Figure 2.

Of note is the closed circuit video monitoring, which allows the surgeon and neurologist to clearly see and hear the patient during testing.¹⁰ In addition to the video

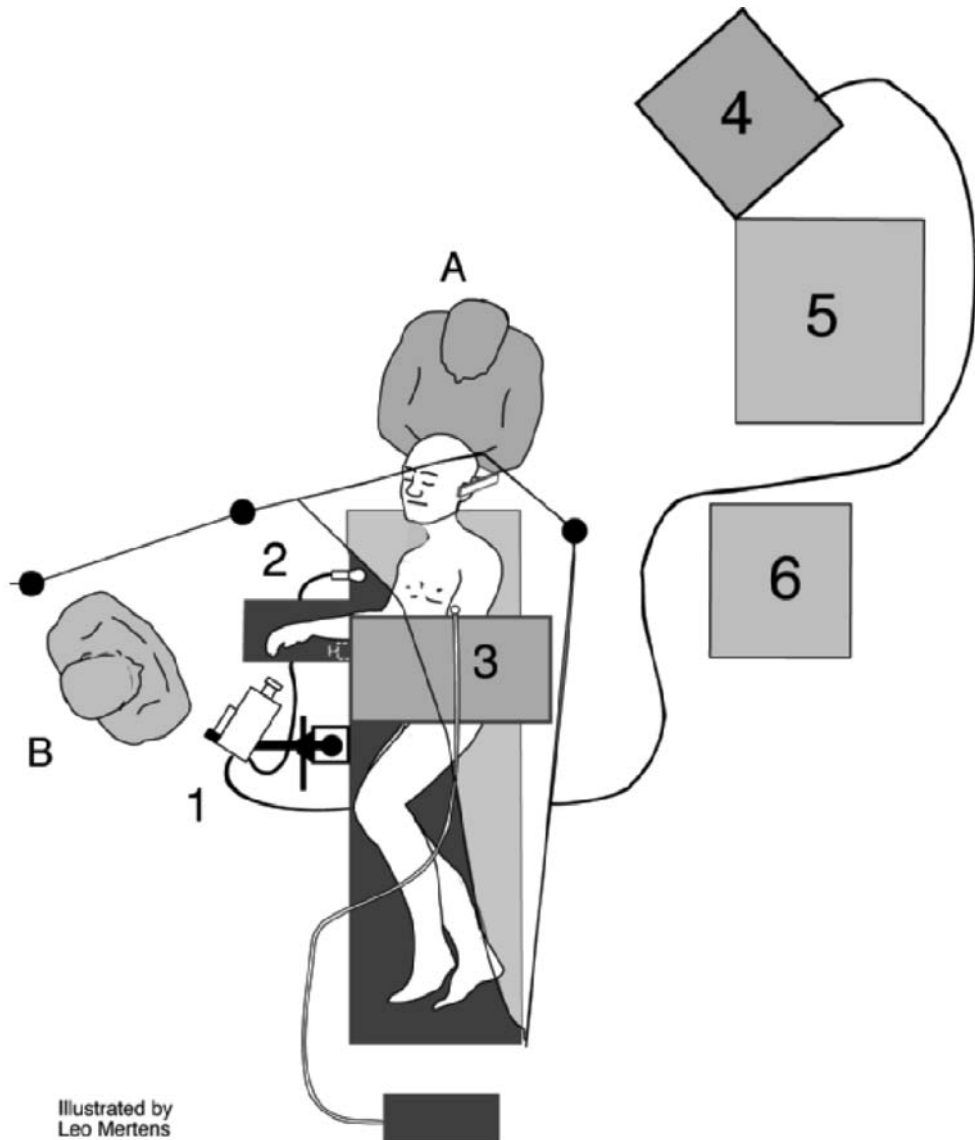


Figure 2. Suggested positioning for awake craniotomy. (Reprinted from Ref 10; with permission of Elsevier and authors). A: Surgeon; B: Anaesthetist; 1: Camera; 2: Microphone; 3: Fiberoptic light; 4: Television monitor; 5: Frameless stereotactic monitor; 6: Microscope base.

camera, design of a small LCD screen to be placed in the patient's field of vision is in progress. This screen will display images of ten or more familiar objects to the patient at regular intervals during electrical stimulation of the posterior speech centre. The same images will be visible to the surgeon simultaneously via a connection to the video monitor on that side of the drapes. A microphone placed near the patient's mouth will allow the surgeon to hear the patient's responses clearly and immediately. This "object naming" process has until now, been performed by the anaesthetist pulling objects from a bag and holding them one at a time in front of the patient.

Airway management

Oxygen is delivered continuously either by Hudson mask or a nasal catheter. Some centres prefer an asleep-awake-asleep technique with a variety of airway protection devices. The most popular of these is the laryngeal mask, which can be inserted and removed with minimal access and without causing laryngeal irritability.¹² In general, we prefer a less invasive approach, but occasionally a nasopharyngeal airway is required during heavy sedation.

Intraoperative events

Once positioned, the patient should experience no discomfort until the dura is reached. Dura close to the saggital sinus or the middle meningeal artery is particularly sensitive to traction. Attempts to topicalise these areas are used in some centres, but gentle surgical technique and a little sedation can overcome any brief discomfort quite easily. Some patients may be alarmed if a noisy osteotome is used; either warning or sedation can overcome this anxiety. Stimulation of the cortex deep to the insula and traction on blood vessels and dura with deep resection are other possible causes of discomfort. Fortunately, cortical mapping is usually complete by this stage and some analgesia can be given.

It is essential that the patient be fully awake and cooperative for the testing phase of the cortical mapping. This is particularly true if complex speech and language testing is performed. Dexmedetomidine was thought to allow some sedation without cognitive impairment during testing;¹³ however, it has a relatively slow offset and can cause oversedation.¹⁴ We avoid any form of sedation during this critical phase where possible. An Ojemann stimulator is used to map the functional areas of the cortex and it is during this phase, particularly in the vicinity of the motor cortex, that intraoperative seizures can occur (up to 15% in one series).¹⁵ These can usually be quickly stopped with cold saline irrigation of the brain. If this fails, a small dose of thiopentone or propofol can be added. Nausea and bradycardia may occur, usually associated with deep cortical resection close to the midline. Asking the surgeon to reduce traction and administration of anticholinergics will be more effective than antiemetics in these cases.

In the past, it has been the task of the anaesthetist to relay information back over the drapes to the surgeon,⁶ creating a delay between the surgeon initiating the test and receiving the response. Where possible, it is advisable to have the neurologist or neurophysiologist most familiar with the patient's preoperative deficits perform the testing. We also employ a closed circuit video monitor to provide the surgeon with a clear view of the patient and amplification of the verbal responses. Awake testing may be required throughout the resection, for example with a tumour close to the motor cortex and this can be exhausting for patient and anaesthetist alike. It is important to recognize this and allow rest if necessary.

Post operatively

The duration of the scalp blocks well exceeds any reasonable surgical time, so an additional benefit of this technique is a reduced requirement for opioid analgesia in the postoperative period and a more alert, cooperative patient for postoperative neurological testing. Emergence hypertension, often seen at the time of extubation with general anaesthesia, is also avoided. There have been some attempts to link awake craniotomy with early postoperative discharge and even day-stay craniotomy.^{2,16} We do not recommend this practice as there is a high readmission rate. Compared with general anaesthesia using short acting agents, there is unlikely to be a significant difference with regard to discharge timing.

In the recovery room, the patient will occasionally notice worsening of the preoperative neurological deficit due to oedema and retraction. The unprepared patient may become upset by this new deficit, not understanding it is likely to be temporary.

Related procedures

Other surgical procedures may require intraoperative “wake up” where similar sedation may be useful. For example, there is a variety of implantable epidural stimulators for the treatment of chronic pain; the efficacy of placement may need to be tested intraoperatively. The rapid offset of these drugs may also allow sedation for stereotactic neurosurgery for movement disorders, where sedation was previously contraindicated.

Other applications of scalp blocks

Scalp blocks have been used with conventional craniotomy under general anaesthesia. They may be done preoperatively to reduce the haemodynamic response to head pin holder application¹⁷ and post-operatively prior to emergence to reduce postoperative pain and improve postoperative assessment.¹⁸ Scalp blocks have been advocated for use before stereotactic frame placement for functional neurosurgery,¹⁹ being less painful than local infiltration.²⁰ Elderly patients having extensive plastic surgical procedures of the scalp, including grafting and rotation flaps, are another group where these blocks can be easily used to avoid general anaesthesia.

Summary

In conclusion, we believe that with:

- a sound knowledge of the anatomy of the nerves innervating the scalp,
- an understanding of the local anaesthetic dosage limitations in this group of patients, and
- an appreciation of the likely intraoperative events and possible interventions required,

awake craniotomy can be added to the repertoire of all neuroanaesthetists. It is likely that those who regularly anaesthetise for intracranial surgery will be faced with patients where this technique is the most suitable option. It is equally likely that, if modern worldwide trends in neurosurgery are followed, more surgeons will be requesting this technique in the future.

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