



# Anaesthesiologist's Approach to Awake Craniotomy

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Awake craniotomy, which was initially used for the surgical treatment of epilepsy, is performed for the resection of tumours in the vicinity of some eloquent areas of the cerebral cortex which is essential for language and motor functions. It is also performed for stereotactic brain biopsy, ventriculostomy, and supratentorial tumour resections. In some institutions, avoiding risks of general anaesthesia, shortened hospitalization and reduced use of hospital resources may be the other indications for awake craniotomy. Anaesthesiologists aim to provide safe and effective surgical status, maintaining a comfortable and pain-free condition for the patient during surgical procedure and prolonged stationary position and maintaining patient cooperation during intradural interventions. Providing anaesthesia for awake craniotomy require scalp blockage, specific sedation protocols and airway management. Long-acting local anaesthetic agents like bupivacaine or levobupivacaine are preferred. More commonly, propofol, dexmedetomidine and remifentanyl are used as sedative agents. A successful anaesthesia for awake craniotomy depends on the personal experience and detailed planning of the anaesthetic procedure. The aim of this review was to present an anaesthetic technique for awake craniotomy under the light of the literature.

**Keywords:** Awake craniotomy, anaesthesia, local

## Introduction

Awake craniotomy (AC) was first performed by Sir Victor Horsley in 1886 to localise the epileptic focus with cortical electrical stimulation (1). Dr Wilder Penfield, a brain surgeon and researcher, made mappings in conscious patients with severe epilepsy under local anaesthesia (LA) by directly observing the brain and assessing the responses to electrical stimuli. He prepared detailed reports on brain physiology, speech cortex, interpreting cortex and brain regions controlling body movements (2).

Awake craniotomy is most commonly performed in the resection of brain tumours near the sensitive cortex areas and in epilepsy surgery, allowing functional mapping (3). The sensitive areas of the cortex represent the brain regions that control motor, sensory or speech functions. It is performed by minimising the interaction with anaesthetic drugs while performing electrocorticography to determine the epileptic focus. In addition to these indications, stereotactic brain biopsy, ventriculostomy and resection of small brain lesions are other areas of application. It is routinely performed in some centres because it reduces the postoperative recovery period in supratentorial craniotomies and the duration of hospital stay in intensive care units, saving hospital resources (1, 4-6). In addition, selected patients can be discharged on the same day after AC (7). General anaesthesia (GA) can be used in patients who are unable to tolerate the risks of induction and awakening period (8).

**Functional cortical mapping of the brain:** The main aim of AC is to minimise the risk of neurological damage while maximising tumour resection by providing patient-specific resection of brain lesions close to the sensitive areas of the cerebral cortex. It is usually suitable for mapping of speech and sensorimotor functions. Individual changes in the cortical areas related to these functions may be observed, and brain topography may change depending on tumour infiltration, radiotherapy or previous surgeries (9-11).

The surgeon stimulates the relevant cortical areas with bipolar or monopolar probes and evaluates the patient's response to the stimuli in craniotomies related to brain mapping (12).

During motor mapping, abnormal involuntary movements or movement deficits are observed in the contralateral face, arm and/or leg. During sensory mapping, whether or not the patient has abnormal sensations, such as paraesthesia, is questioned (9, 11).

Language mapping includes tests, such as names of objects, counting numbers, reading single words and/or repeating complex sentences. During cortical stimulation, the patient is observed in terms of speech deficits, such as cessation of speech and expressive or repressive aphasia (2, 11).

Visual mapping involves abnormal visual phenomena (visual hallucinations or phosphene) or visual field interruption monitoring.

The resection area and institutional practices determine how the anaesthesiologist will be involved in motor and sensory mapping. Neurophysiologists or speech therapists are needed for a complete mapping of the brain's speech and visual fields (2).

**Electrophysiological mapping and electrocorticographic recording:** Electrocorticography is an invasive electrophysiological technique in which cortical potentials are recorded directly from the brain surface in order to localise seizure foci. Electrocardiographic recording is performed for intraoperative localisation of the epileptic centre in patients in whom epilepsy surgery will be performed. Electrodes are placed on the brain surface above or near the suspected epileptic focus. Cortical or subcortical signals are easily obliterated by the drugs used for anaesthesia or sedation. AC minimises pharmacological interferences on recordings performed under GA (2, 3).

The AC requirement for epileptic focus resection has been reduced by improvements in presurgical imaging techniques. In some cases, AC protects language function and provides seizure-free results. Intraoperative electrocorticography can provide guidance for the required width and as a whole during resection.

**Improvement of perioperative outcome:** It reduces the need for intensive care and the duration of hospital stay. Complications due to GA are lower (8).

### Preoperative evaluation

Careful patient selection and patient preparation are important for successful awake procedures and should be coordinated between the surgeon and the anaesthetist. The patient should be evaluated in the anaesthesia clinic for AC (13). History should be obtained, and anaesthesiological examination should be performed in all patients before anaesthesia. In addition to physiological evaluation, psychiatric evaluation should also be performed to serve as a guide for patient selection. Airway evaluation is especially important (1, 9).

### Patient selection

The criteria for patient selection vary according to surgeons and institutions. In some institutions, absolute contraindications to AC are unwillingness of the patient and claustro-

phobia. Relative contraindications include conditions that increase the risk of sedation failure, prevent the cooperative effort required for the test or introduce a risk to the airway. Contraindications are anxiety disorders, apparent dysphagia, confusion or somnolence, alcohol or drug dependence, chronic pain disorders, restless legs syndrome, low pain tolerance, morbid obesity, obstructive sleep apnoea, expected difficult airway and uncontrolled cough. It is not performed in cases, such as vascular tumours and tumours close to the cerebral venous sinuses, in which a high volume of blood loss is expected (>750 mL-1000 mL) (9).

Routine antiepileptic drugs used for seizure prophylaxis are not administered because they affect the tests by causing sedation. In some centres, patients using preoperative antiepileptic drugs are allowed to use them until the operation day and also on the day of operation.

### Preoperative patient preparation

Patients (morbid obesity and obstructive sleep apnoea syndrome) who are at risk in terms of the development of airway obstruction due to sedation in the preoperative period are determined, and elective or emergency airway management is evaluated.

Medical preparation should also include psychological preparation. Patients who are well motivated, who have accepted the procedure, who can tolerate lying for hours and who may be cooperative during the test are the best candidates for AC (1).

The anaesthesiologist should inform the patient about the reasons for AC, the processes of the intervention, the degree of pain and discomfort, the procedures required for the tests during the operation and the likelihood of adverse effects (9, 14).

Even if preoperative anxiolytic agents are administered, they are not as effective as a proper preparation. Anxiety decreases if the patient feels as a member of the operative team and knows that anaesthesia can be performed when he/she cannot tolerate the procedure (13, 15). It is explained to the patient that the special clinic nurse will help if he/she reports any discomfort (e.g. pruritus and leg pain) (15).

It is recommended that sterile transparent surgical covers should be used in order for the patient not to be bored during surgery and not to feel airless, as well as for the surgeon to be able to observe the patient's movements (10).

### Anaesthesia management

**Premedication:** It is performed according to anxiety, baseline neurological status, comorbidity and patient-specific anaesthesia plan. Although not routine, midazolam can be administered in the operation room while anaesthesia is started. Benzodiazepines should not be used in patients undergoing electrocorticography because they will suppress seizure foci (1, 3, 15).

**Monitoring:** Standard American Society of Anesthesiologists monitors (electrocardiogram, blood pressure, pulse oximetry,

oxygen analyser and end-tidal CO<sub>2</sub> (ETCO<sub>2</sub>) are sufficient. Intra-arterial catheter is used according to the venous air embolism monitor, surgical procedure and features of the patient. Arterial catheter allows blood gas analysis when the level of sedation deepens. In addition, invasive pressure monitoring with arterial catheter should be preferred because the cuff, which is frequently inflated for non-invasive measurement of blood pressure, can often cause discomfort to the patient.

Electroencephalography (EEG) monitors (bispectral index (BIS), Entropy or SedLine) provide anaesthetic dose adjustment and a rapid wake-up for intraoperative speech testing. The BIS has been suggested to be useful in AC trials for the determination of sedation level. The target BIS values are 65-85. The Ramsay sedation scale should be at 2-3 (1, 6, 16).

Foley catheter is not routinely used due to patient discomfort (1, 3, 17). However, it can be considered in surgeries lasting >4 h, and when intraoperative mannitol is administered (9). In order to prevent the feeling of miction during the operation, 50-100 mL h<sup>-1</sup> crystalloid is administered (17).

**Position:** The supine, half-sitting or lateral positions are most commonly preferred. The head of the patient is fixed with a Mayfield head clamp or placed in gel rings.

The anaesthetist must actively participate in the positioning process. The 'sniffing' position should be applied as far as possible before the head is fixed. Thus, a wider area will be provided for intervention in the patient who breathes spontaneously during sedation and whose airway is open. Care should be taken that the patient's face can be seen continuously by the anaesthetist. During motor mapping, the face must be visible in order for the facial motor responses to be identified and for the shapes shown during the speech test to be recognised (18).

Over-flexion or rotation of the head should be avoided to reduce airway obstruction and difficulty in airway management. The neck veins should not be curled in order to prevent brain swelling. If the trunk is in the supine position, and the

head is in the lateral side, the risk of airway obstruction increases.

Comfort should be provided for the patient during procedures that last for hours. Discomfort caused by remaining in the same position for a long time is the most common complaint. Soft pads should be placed on the operation table and contact points in order to reduce position-related discomfort. The patient should be warmed with a blanket or an air blown blanket.

The operation room should be as quiet as possible, and there must be signs to warn the team that the patient is awake. Figure 1 shows the schematic view of an appropriately designed surgery room (1, 5).

**Selection of anaesthesia technique**

Throughout the procedure, GA can be performed with intraoperative awakening for conscious sedation or brain mapping. The technique is determined according to the institution's and the clinician's preference. Airway management is determined according to the anaesthesia technique.

Although the anaesthesiologist is responsible for patient comfort, for painful parts of the procedure and for tolerance to prolonged immobilisation, he/she should not fall into the trap of thinking that providing a situation equal to GA is solely under his/her responsibility in a patient who is spontaneously breathing and has an unprotected airway opening, but in whom access to the airway is difficult (3, 18).

**1. Sleeping-awake-sleeping**

It begins with GA and continues with positioning, fixation of the head, scalp incision, craniotomy and opening of the dura. The airway is secured with endotracheal tube or supraglottic airway (SGA) devices. When the dura is opened, the covering on the face of the patient is opened, the anaesthesia is stopped and the patient is awakened. After the airway is removed, the patient's participation is ensured during cortical mapping. This is an important moment. The entire team should pay attention to the anaesthesia team, and unnecessary activities should be stopped. When the patient first wakes up, he/she experiences a confusion period. There is no pain if the block has been successful. If there is a discomfort, LA is then added. The intradural period of the operation is specific to pathology and is evaluated according to the patient. Once mapping is complete, GA is started, airway tools are placed again, and GA is used until the procedure is completed (9, 14).

**2. Awake-awake-awake**

Conscious sedation is applied throughout the entire procedure. Sedation is applied at the beginning of the process in which the stimuli are provided, reduced or cut off during cortical mapping and repeated during the closure period. Moderate level conscious sedation should be the target. The patient should give meaningful response to verbal or tactile stimuli, airway should continue without any need for in-

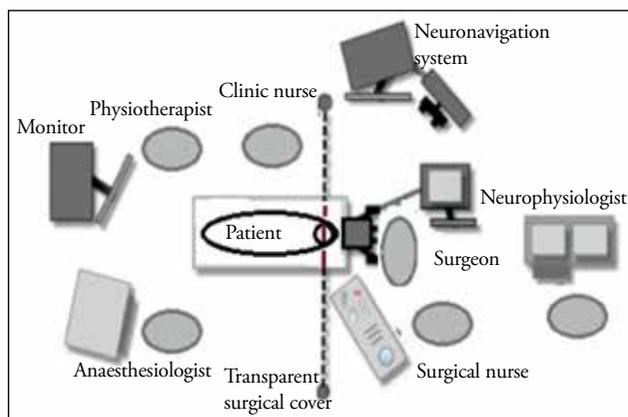


Figure 1. Arrangement of the operating room for good communication and teamwork in AC. The whole team should see the surgery field

tervention, and ventilation should be adequate. Haemodynamics should be stable without support. Excessive sedation should be avoided.

### 3. Sleeping-awake-awake

Scalp block, Mayfield application, craniotomy and opening of the dura are performed while the patient is sleeping. The patient should be awake during intradural operation and during closure period.

#### Airway management

A plan should be made preoperatively for elective or emergency airway management. Patients with the risk of airway obstruction (morbid obesity and obstructive sleep apnoea) should be identified.

Various airway management techniques can be used in the sleeping part of AC, such as endotracheal tube, SGA, O<sub>2</sub> support with face mask, nasal cannula or nasopharyngeal airway. SGAs are most commonly preferred. The proseal laryngeal mask is selected because it is easier to be positioned. Controlled ventilation can be performed, airway obstruction is avoided and the transition to awake status is achieved more comfortably.

Laryngospasm and cough that develop during airway manoeuvring between sleeping and awake periods may lead to surgical bleeding, increased intracranial pressure or injury because the head has been fixed.

It may be difficult to control the airway again during the induction of anaesthesia in the closure period. Since the head is fixed, the approach to airway is limited, and direct laryngoscopy cannot be performed. Spontaneous ventilation options, such as SGA placement with videolaryngoscope, flexible bronchoscope or intubation laryngeal mask and endotracheal intubation (ETI) with face mask or nasopharyngeal airway, can be used.

Securing the airway and the follow-up of ET<sub>CO</sub><sub>2</sub> are difficult with nasal cannulas and face masks in patients with obesity and sleep apnoea. When flammable skin preparation materials are used, there may be inflammation when O<sub>2</sub> accumulates under the cover. Bilateral nasopharyngeal airways are connected to the anaesthesia circuit with double lumen tube connectors. While providing a smooth transition between the sleeping and awake periods with bilateral nasopharyngeal airway, airway manipulation is not necessary. Obstruction in the upper respiratory tract due to snoring and the vibration generated in the surgical field are reduced, and continuous positive pressure can be applied with anaesthesia circuit. ET<sub>CO</sub><sub>2</sub> also allows continuous monitoring of pressure and spontaneous ventilation with spirometry. Ventilation can be supported manually in the case of deep sedation and hypercarbia (14).

#### Drug selection in conscious sedation

The choice of anaesthetic agent in AC changes depending on functional cortical mapping and intraoperative electrocorti-

cography. Propofol, remifentanyl, fentanyl and dexmedetomidine may be used for conscious sedation. These drug combinations may be administered as continuous infusion, bolus injection, target-controlled infusion or patient-controlled bolus. Benzodiazepines should not be administered in ACs in which electrocorticography is performed (19, 20).

Propofol is administered at a dose of 50-150 µg kg<sup>-1</sup> min<sup>-1</sup>. It should be stopped at least 15 min before EEG recording. Although it provides a rapid awakening, it leaves residual EEG traces characterised by high-frequency and high-amplitude beta activity, which covers abnormal activity (1, 19-21).

While dexmedetomidine provides sedation, anxiolysis and analgesia, the effect of respiratory depression is minimal (18). Dexmedetomidine is preferred because it does not cause respiratory depression and does not interact with electrocorticography. After dexmedetomidine bolus 1 µg kg<sup>-1</sup> is administered for 10 min, it is maintained with 0.4-0.8 µg kg<sup>-1</sup> h<sup>-1</sup> infusion. It can be used in combination with propofol, midazolam and opioids or alone. Dose titration should be measured carefully. Sedation may be prolonged in extended applications after drug cessation (19).

Dexmedetomidine infusion (0.1-0.5 µg kg<sup>-1</sup> h<sup>-1</sup>) during brain stimulation provides appropriate conditions for functional tests (speech mapping and electrocorticography). Even if it may delay patient responses during neurocognitive tests, it is advised that moderate infusion rates be administered (0.1-0.3 µg kg<sup>-1</sup> h<sup>-1</sup>) (18).

Remifentanyl 0.1-0.05 µg kg<sup>-1</sup> h<sup>-1</sup> infusion is used. Rapid onset and short duration of action facilitate the titration of sedation depth. Other opioids, such as fentanyl, alfentanil and sufentanil, can be used (19).

If narcotics have been used, antiemetic drugs should be routine. Ondansetron, dexamethasone or both can be administered (18).

#### Local anaesthesia

The basic element of anaesthesia is the application of LA. Sedation cannot compensate for inadequate scalp anaesthesia provided with the infiltration of nerve blocks and pin sites (18).

Under conscious sedation, anaesthesia should be administered in the scalp during incision in order to prevent pain while awakening in the sleeping-awake-sleeping anaesthesia technique. The scalp is anaesthetised by regional nerve block provided with LA infiltration in the incision and pin sites or by scalp block (20-22).

The nerves to be blocked for scalp block are selected according to the incision and craniotomy area. For a complete scalp block, six nerves are blocked bilaterally; approximately 40 mL of LA is required. Long-acting LAs (0.25% bupivacaine, 0.2% ropivacaine and 0.25% levobupivacaine) should be ad-

ministered with 1:200,000 epinephrine to prolong duration of action and reduce systemic absorption. The application of high-volume LA assuming that it may be needed during the procedure increases the risk of LA systemic toxicity. The amount of LA that can be allowed should be discussed with the surgeon.

For scalp block, bupivacaine or levobupivacaine 2.5 mg kg<sup>-1</sup> (lean body mass) is administered. If an additional dose is required, it may be administered as ≤1/4 initial dose 2-4 h after the initial dose administration, as ≤1/2 initial dose 4-8 h after the initial dose and as a full dose >8 h after the initial dose.

Despite adequate scalp block, 30% of the patients may have complaints of significant pain, and opioids may be needed. The absence of complete coverage of the incision area with scalp block may be caused by pain originating from the other structures or by decreased effect of the block in prolonged surgeries.

Dura manipulation is painful, especially in dissections near the meningeal vessels. The surgeon should perform dural

infiltration in conscious sedation. LA infiltration into the temporalis muscle is necessary for analgesia during dissection in pterional craniotomy. Additional LA infiltration may be required to close the scalp at the end of the surgery.

**Scalp block (5, 20)**

Subcutaneous scalp infiltration with bupivacaine and epinephrine along the incision line is local infiltration, and it is not the scalp block which is provided with the injection into the target nerves. In LA of the scalp, the major step is the transition from the scalp infiltration to the block of the scalp nerves. The major advantage of the scalp block is that most of the nerves that innervate the scalp are superficial terminal sensory branches, and that the risk of nerve damage is less than the deeper motor nerves. The scalp block is a safe technique with rare complications.

In 1986, Girvin described the scalp block technique for AC use. However, this technique has not been widely used for years. In 1996, Pinosky et al. described the scalp block consisting of supraorbital and supratrochlear nerves and postauricular branches of the great auricular nerve, auriculotemporal nerves and greater and lesser occipital nerves.

Scalp and forehead sensory innervation occurs with trigeminal and spinal nerves (Figure 2). Ophthalmic (V1), maxillary (V2) and mandibular (V3) branches of the trigeminal nerve innervate the scalp and forehead regions. While the forehead and anterior scalp are innervated by supraorbital and supratrochlear nerves of the ophthalmic branch, zygomaticotemporal nerves of the maxillary branch and auriculotemporal nerves of the mandibular branch, the posterior scalp is innervated by the greater occipital nerve and lesser occipital nerve behind the ear. Six nerves are blocked bilaterally (Figure 3).

**Supraorbital nerve:** It is blocked in the place where it exits from the orbita. The needle is vertically inserted at the site 1 cm medial to the supraorbital incisura through the upper edge of the orbita.

**Supratrochlear nerve:** It exits from the superior medial angle of the orbita and proceeds in parallel to the supraorbital nerve 1 in. medial to the forehead. It is blocked in the place where it goes above the eyebrow or by extending the supraorbital block to the medial side.

**Auriculotemporal nerve:** It is blocked with the infiltration of the zygomatic protrusion at the level of the tragus in 1-5 cm anterior side. The superficial temporal artery is in front of the nerve at the level of the tragus, and the artery should be palpated before the block.

**Temporozygomatic nerve:** Infiltration is performed from the supraorbital edge to the posterior part of the zygomatic arch. It pierces the temporalis fascia when it reaches above the zygoma in the middle of the auriculotemporal and supraorbital nerve. Deep and superficial injections are recommended.

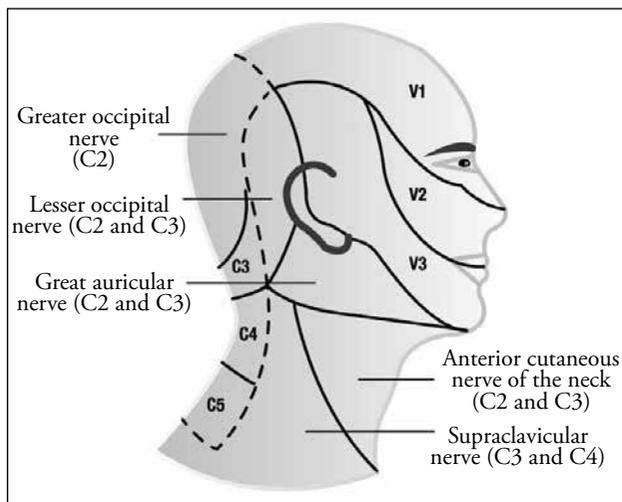


Figure 2. Head and neck sensory innervation

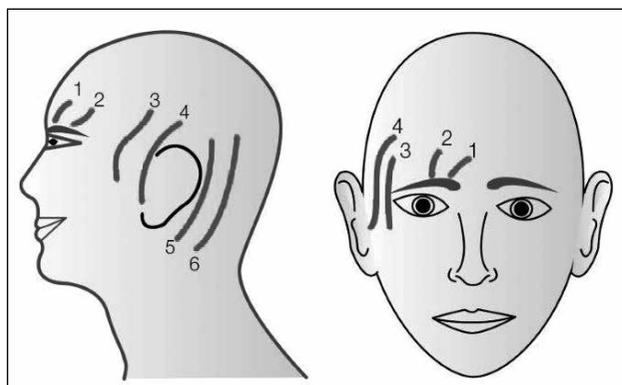


Figure 3. Peripheral nerves that were blocked: 1: supratrochlear nerve, 2: supraorbital nerve, 3: zygomaticotemporal nerve, 4: auriculotemporal nerve, 5: lesser occipital nerve, 6: greater occipital nerve

Table 1. Nerves to be blocked and their origins

Nerve to be blocked	Origin	Anterior craniotomy	Posterior craniotomy
Supraorbital	Ophthalmic branch (V1) N trigeminus	+	-
Supratrochlear	Ophthalmic branch (V1) N trigeminus	+	-
Auriculotemporal	Mandibular branch (V3) N trigeminus	+	-
Temporozygomatic	Maxillary branch (V2) N trigeminus	+	+
Greater occipital	C2 posterior ramus	-	+
Lesser occipital	C2 and C3 ventral rami	-	+

**Greater occipital nerve:** Infiltration is performed 2.5 cm lateral to the nuchal median line in the middle of the mastoid protrusion and occipital protuberance. The occipital artery is palpated, and injection is made into the medial side after careful aspiration.

**Lesser occipital nerve:** The block is made 2.5 cm lateral to the greater occipital nerve along the superior nuchal line.

In addition, the scalp block which involves the great auricular nerve block is made. It is the thickest ascending branch of the cervical plexus. It arises from C2 to C3, and the posterior branch innervates the skin areas behind the mastoid protrusion and the auricle. The postauricular branches of the great auricular nerve are blocked by injection between the skin and the bone 1.5 cm behind the ear at the level of the tragus.

In each region, 2-5 mL of LA (0.25%-0.5% bupivacaine) is administered. Table 1 shows the six nerve origins used in the scalp block and the nerves to be blocked in the anterior and posterior craniotomies (4, 5).

#### Adverse effects

LA injection may lead to an acute increase in anaesthetic plasma concentration and LA toxicity. Epinephrine is particularly recommended to increase the duration of the block and decrease the sudden increase in plasma concentration in areas with intense vascularisation, such as the scalp (4). Intravascular injection or systemic absorption when mixed with bupivacaine vasoconstrictor may lead to hypertension. With correct application, the combination of bupivacaine and epinephrine does not significantly change the mean arterial pressure and heart rate.

A patient in whom mepivacaine injection was administered in the subarachnoid space during lesser occipital nerve block has been reported. It was observed that sudden unrest, nausea, loss of consciousness and superficial respiration in this case are due to occipital bone defect depending on right retromastoid craniotomy that the patient underwent years ago (20).

Internal carotid artery with intra-arterial injection and respiratory arrest with retrograde cerebral circulation or brain stem anaesthesia causing apnoea or loss of consciousness, which developed in the other head and neck nerve blocks, were not reported in the scalp block (20).

**Cardiovascular system:** Haemodynamic fluctuations may develop with hypertension, hypotension and bradycardia.

Venous air embolism may develop in the supine and half-sitting positions during the 'burr hole' procedure (15). When hypertension and tachycardia develop, the level of sedation is increased, and pain is controlled. Vasodilators and beta blockers are used (1, 13). Esmolol, a short-acting cardioselective beta blocker, has been demonstrated in clinical studies to provide haemodynamic stability during intraoperative and extubation in craniotomy surgeries (23, 24).

**Respiratory system:** Airway obstruction, hypoventilation, hypercarbia and O<sub>2</sub> desaturation can be observed. Minor interventions, such as jaw thrust, nasopharyngeal airway, mask and ventilation, usually resolve the problem. ETI and SGA are occasionally required (6).

**Neurological effects:** *Brain swelling:* It is caused by airway obstruction, hypoventilation and hypercarbia. Sedation is reduced, and the patient is asked to take a deep breath. Mask-assisted ventilation, ETI, SGA and hyperventilation may be needed. If the patient is not cooperative, GA is initiated. By controlling the position, the head is raised by 30°. This ensured that the neck veins are not curled. Hyperosmotic therapy and low normocarbic respiration can be used. If the patient is awake, the respiratory rate increases (1, 6).

*Seizure:* It develops at a frequency of 2%-20% during stimulation for brain mapping. It is usually focal and short and recovers spontaneously. It can also be generalised. If the dura is open when seizure occurs, the first therapeutic intervention is brain irrigation with sterile icy saline or ringer lactate (1, 5). If necessary, propofol (10-20 mg intravenous (iv)) or midazolam (1-2 mg iv) should be administered as a bolus to terminate seizure. If electrocorticography will be performed, propofol should be selected instead of midazolam. If the patient has not been taking antiepileptic drugs, a single dose of 500 mg levetiracetam may be intravenously administered to reduce the risk of seizures (5, 10).

Generalised seizures should be treated urgently to prevent injury to the patient and to prevent deterioration of the airway. Airway control can be achieved with GA induction in resistant seizures and recurrent treatments.

**Shivering:** It must be treated with warm infusion and blankets. Clonidine, dexmedetomidine, tramadol and ondansetron can be used to prevent shivering (1, 6).

**Pain:** It arises from areas not adequately anaesthetised during surgery, especially from the temporal region and from the dura mater and veins. Additional LA infiltration should be applied. Pain which the patients suffer from and which is caused by the fixed position of the patient due to prolonged procedures may be treated with small movements and with analgesics, such as diclofenac and acetaminophen (1).

**Nausea and vomiting, aspiration:** Depending on opioid, anxiety and surgical stimuli, nausea may occur at a rate of 4% (18.4%). Nausea and vomiting may develop during the dissection and traction of the dura on the base of the temporal fossa and in the traction of the brain vessels (1, 3). Recovery is by antiemetic drugs, and vomiting is rare. Dexmedetomidine and propofol are synergistic antiemetic drugs. In the case of nausea, 4 mg ondansetron is administered. Ondansetron does not cause sedation similar to other antiemetic drugs. For nausea or vomiting prophylaxis, 4 mg ondansetron, 10 mg dexamethasone and 10 mg metoclopramide can be administered intravenously (4, 9, 18).

**Failed AC:** Unplanned shift to GA means the inability to make mapping.

### Postoperative care

Haemodynamic management, neurological monitoring and management of complications in the post-anaesthesia care units (PACUs) are the same as in AC and in craniotomies performed under GA. There is a lower frequency in postoperative analgesic requirement, nausea and vomiting. All patients can be monitored in the PACUs except for those with comorbidities and complications. After a minimum of 2 h of follow-up, the patient is transferred to the inpatient service.

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