

Anesthetic Management of Awake Craniotomy for Cortical Mapping Near Broca's Area Using the Asleep-Awake-Asleep Technique: A Case Report

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Abstract

Introduction: Awake craniotomy is a brain surgery technique performed while the patient is conscious, aimed at maximizing tumor resection while preserving neurological function, particularly when the lesion is located in eloquent areas such as the speech center or motor cortex. This technique combines regional anesthesia, selective sedation, and real-time intraoperative neurological monitoring.

Case: A 35-year-old male presented with recurrent focal motor seizures in the right upper limb and mild cognitive disturbances. MRI revealed a lesion in the left frontal lobe near Broca's area, suspected to be a low-grade glioma. The patient underwent awake craniotomy using the asleep–awake–asleep anesthesia technique, with a combination of propofol and dexmedetomidine, and a scalp block. During the awake phase, the patient was conscious, cooperative, and able to follow instructions for direct cortical mapping. No intraoperative complications such as seizures or airway obstruction occurred. Tumor resection was successfully completed with preservation of neurological function.

Discussion: The combination of propofol and dexmedetomidine provided stable and cooperative sedation throughout the procedure, while the scalp block effectively reduced pain during cranial manipulation. Airway management with LMA and nasal oxygen maintained optimal oxygenation. Coordinated anesthetic strategy and precise neurological monitoring were key to the success of this awake craniotomy procedure.

Conclusion: This case report presents the success of awake craniotomy at the cortical mapping location near Broca's area using the asleep–awake–asleep technique. The success of this approach depends on appropriate anesthetic techniques, cooperative sedation, and intraoperative neurophysiological monitoring.

Keywords: Awake craniotomy, glioma, asleep–awake–asleep, scalp block, dexmedetomidine, cortical mapping

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Introduction

Primary brain tumors are a leading cause of neurological morbidity and mortality worldwide. According to 2020 data from the Global Observatory of Cancer (GLOBOCAN), the global incidence of central nervous system tumors reached more than 308,000 new cases per year, with a reported death rate of approximately 251,000.^{1,2} Although brain

tumors are not among the top five most common cancers, they pose a significant burden of disease due to their strategic location and potential for widespread neurological dysfunction.² In Indonesia, data on the prevalence and incidence of brain tumors are still limited due to the lack of national registries. However, various hospital-based studies provide a picture of local epidemiology. A retrospective study at Cipto Mangunkusumo General Hospital (2014–2016)

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revealed 316 patients with intracranial tumors, of which 68% were female and the average age was 43.8 years.³ At Kariadi Hospital in Semarang (2015–2018), as many as 175 cases of primary tumors were identified, with a female predominance (61.7%) and a peak incidence in the 41–50 age group.⁴ A study in Bali (2020–2022) also concluded that most patients were women aged 50–59 years, with nearly 82% of primary tumors, primarily meningiomas and low-grade gliomas, predominantly located supratentorial. Local perceptions indicate a higher prevalence of these tumors in coastal areas, partly influenced by environmental conditions or varying medical access.⁵

Surgical treatment remains the primary treatment option for brain tumor management, especially for locally resectable tumors. However, for tumors located in functional areas of the brain (eloquent area), such as the motor cortex, sensory cortex, and speech centres, conventional surgical approaches carry a high risk of causing postoperative neurological deficits. In this context, awake craniotomy is the method of choice, allowing for direct, real-time evaluation of the patient's neurological function during the tumor resection procedure. Awake craniotomy is a surgical craniotomy technique performed while the patient is awake, allowing the surgical team to perform cortical mapping and monitor sensorimotor and language functions during brain lesion resection, thus minimizing the risk of neurological complications without compromising the extent of resection.⁶

The use of awake craniotomy is expanding as scientific evidence demonstrates its safety, effectiveness in increasing the degree of tumor resection, and low incidence of postoperative neurological deficits. A meta-analysis in 2021 demonstrated that awake craniotomy for gliomas located in the eloquent area significantly reduced the rate of permanent neurological complications compared with conventional craniotomy under general anesthesia. The study also highlighted that awake craniotomy contributed to an increase in gross total resection rates without compromising long-term functional outcomes.⁷

Further studies have also shown that AC reduces medium-term neurological deficits and improves overall survival and disease-free progression.⁸ In clinical practice, there are two main anesthetic approaches used for awake craniotomy: monitored anesthesia care (MAC) and the asleep-awake-asleep technique. The asleep-awake-asleep technique is more widely used because it offers greater flexibility in airway management and better hemodynamic control, particularly in the early and late phases of the procedure. During the awake phase, the patient is awakened from sedation to allow active participation in the neurological examination. The success of the procedure depends heavily on the selection of an anesthetic agent that provides mild to moderate sedation, anxiolysis, and analgesia, while maintaining airway patency and patient cooperation.⁶ In the past two decades, agents such as propofol, remifentanyl, and dexmedetomidine have become the backbone of sedation in awake craniotomy. Propofol is widely used due to its rapid onset and short duration, but its use can interfere with electrocorticography interpretation due to the beta wave activity it induces.⁹

On the other hand, dexmedetomidine, a selective α_2 -adrenergic agonist, is increasingly used because it produces cooperative sedation without respiratory depression, and provides sufficient analgesia and anxiolysis to maintain patient comfort during cranial manipulation.¹⁰ A systematic review in 2024 concluded that dexmedetomidine has a superior safety and efficacy profile compared to propofol in the context of awake craniotomy sedation, particularly in reducing the risk of agitation, intraoperative seizures, and respiratory complications.¹¹

In addition to sedation, regional anesthetic techniques such as scalp blocks also play a crucial role in patient comfort. Scalp blocks utilize local anesthetic infiltration into the six sensory nerve branches of the head and have been shown to significantly reduce pain during head pin fixation and craniotomy. Successful anesthesia in awake craniotomy is largely determined by a combination of optimal sedation techniques, effective nerve blocks, appropriate

intraoperative neurological monitoring, and the preparedness of the anesthesia and surgical teams in managing potential complications such as seizures, nausea, and airway compromise.¹² Therefore, awake craniotomy is a neurosurgical procedure that relies heavily on careful and collaborative anaesthetic management. This case report aims to describe the experience of anesthetic management in awake craniotomy using the asleep-awake-asleep approach, the use of a combination of propofol and dexmedetomidine, and the application of scalp blocks as a regional anesthetic strategy to support successful brain tumor resection in functional areas with optimal neurological outcomes.

Case

Anamnesis

A 35-year-old male patient presented to the neurosurgery facility with complaints of recurrent focal seizures that did not improve with standard anticonvulsant therapy. The first seizures occurred six months prior to admission, consisting of motor spasms of the right arm without loss of consciousness, lasting approximately one to two minutes. In the past two months, the frequency of seizures had increased to two to three times per week. The patient also complained of difficulty concentrating, fatigue during prolonged speech, and occasional mild articulation problems. There was no history of loss of consciousness, projectile vomiting, severe headaches, or behavioral changes. Head trauma, central nervous system infection, or radiation exposure was denied. The patient had no history of systemic diseases such as hypertension, diabetes mellitus, or heart disease. A family history of epilepsy or brain tumor was also denied.

Physical Examination

Physical examination revealed a *compos mentis* level of consciousness with a GCS score of 15. Vital signs were within normal limits: blood pressure 120/80 mmHg, pulse 78 beats per minute, respiratory rate 18 breaths per minute, temperature 36.8°C, and oxygen saturation 98% without oxygen support. Neurological examination revealed mild weakness (4+/5)

in the right upper extremity, without spasticity or pathological reflexes. Speech and cognitive function examinations were within normal limits. There were no signs of meningeal irritation or increased intracranial pressure. Cardiopulmonary, gastrointestinal, and nutritional examinations showed no significant abnormalities. The patient was then scheduled for an awake craniotomy using the asleep-awake-asleep technique to allow real-time mapping of the speech and motor areas during tumor resection. A thorough preoperative evaluation was performed. Detailed preoperative education was provided, including information on the procedure's stages, the importance of patient cooperation during the awake phase, and potential discomfort during

Supporting examination

Table 1. Supporting examination

Magnetic resonance imaging (MRI)	Magnetic resonance imaging (MRI) of the head revealed a 1.8 x 1.0 cm hyperdense lesion in the left frontal lobe, immediately adjacent to Broca's area. The provisional diagnosis was a low-grade glioma involving the eloquence area
Electrocardiography	Within normal limits.
Pulmonary function tests	Within normal limits.
Routine laboratory tests	Within normal limits.
Wada test and video EEG	The patient also underwent a Wada test and video EEG to determine dominant brain laterality and identify potential epileptiform activity.

head pin placement and cortical stimulation. The patient was cooperative and had no history of psychiatric disorders, making the patient suitable candidate for an awake craniotomy.

Anesthesia Management

On the day of surgery, the patient was positioned supine with the head secured with a Mayfield

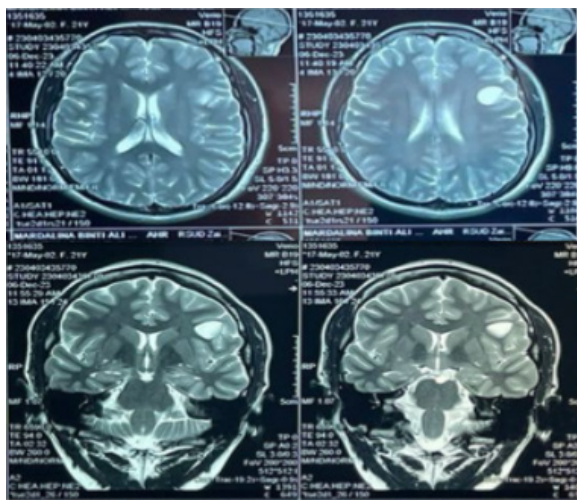


Figure 1. MRI slices the patient's head before awake craniotomy with an arachnoid cyst measuring 1.8 x 1.0 cm.

clamp. Premedication was not administered to avoid sedation that could interfere with the evaluation of brain function. Initial induction was performed using a mild titration of propofol (target-controlled infusion/TCI) and a low dose of fentanyl. After head fixation, a scalp block using 0.5% bupivacaine was performed on six sensory nerve branches of the head: the supraorbital, supratrochlear, auriculotemporal, zygomaticotemporal, occipital major, and minor

nerves. Local infiltration with 2% lidocaine was also administered around the craniotomy incision. During the asleep phase, the patient was maintained on spontaneous ventilation via the LMA and lightly sedated with propofol. After the cranial flap was opened and the dura mater was exposed, sedation was gradually discontinued and the LMA was removed. The patient was awake, had adequate verbal and motor responses, and was able to follow commands. Light sedation was continued using dexmedetomidine (0.2–0.3 mcg/kg/h) to maintain comfort without compromising patient cooperation. Cortical mapping was performed using direct electrical stimulation of the brain surface to identify speech and motor areas, assisted by intraoperative neurophysiological monitoring.

No seizures occurred during the stimulation. However, the patient complained of a dull pain sensation during subtemporal dural traction, which quickly improved with warm NaCl irrigation. Speech remained intact, no articulation impairment was found, and all areas of eloquent were identified and avoided during resection. Tumor resection was performed in stages until safe margins were achieved. After the brain tumor resection procedure

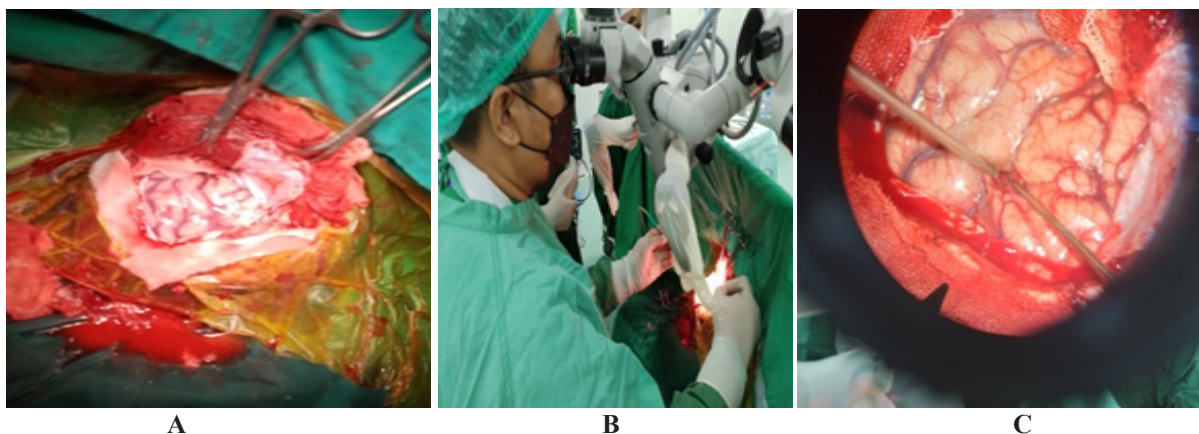


Figure 2. Initial visualization of the brain surface after craniotomy and dural opening, clearly exposing brain tissue and surface vascular structures, allowing identification of cortical topography for functional mapping, B. The resection process is performed using an operating microscope. The operator is seen carefully manipulating the brain tissue to remove the lesion with microscopic guidance, while still preserving neurological function, C. Close-up view through the operating microscope showing brain tissue with superficial blood vessels. The suspected lesion area is indicated by a probe, used as a guide when cortical stimulation is performed

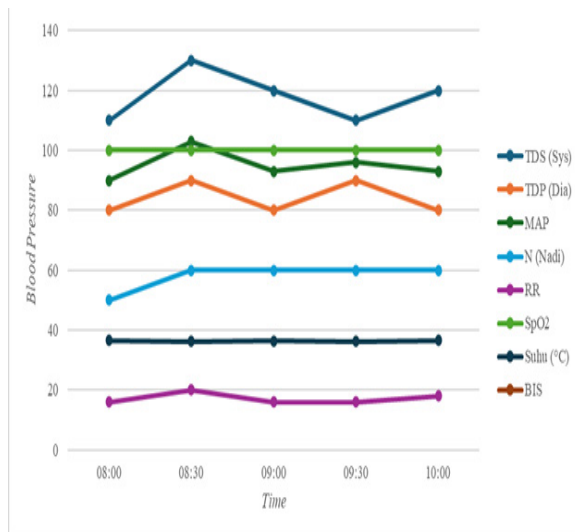


Figure 3. Neuro-anesthetic management in awake Craniotomy patients

using the awake craniotomy technique was completed, the patient received light sedation with dexmedetomidine 0.2 mcg/kg/hour and remifentanyl 2 ng/mL during wound closure. For postoperative pain management and prevention of moderate to severe pain, a multimodal analgesic combination of tramadol 100 mg, paracetamol 1000 mg, and ketorolac 30 mg was administered intravenously. For prophylaxis of post-anesthesia nausea and vomiting (PONV), the patient also received ondansetron 4 mg. The total duration of the operation was 1 hour and 45 minutes, with 1,000 cc of crystalloid administered, estimated blood loss of approximately 200 cc, and unmeasured diuresis. After wound closure and dressing were completed, the dexmedetomidine and remifentanyl infusions were discontinued.

Post-surgical Management

The patient was then transferred to the Recovery Room (RR) for further observation for 1 hour, with close monitoring of neurological, respiratory, and hemodynamic status. Once stabilized, the patient was transferred to the High Care Unit (HCU) for 24-hour intensive monitoring. During the postoperative period, there were no seizures, and neurological function remained intact. The patient was scheduled for further evaluation using electroencephalography (EEG) to assess brain electrical activity and anticipate the

possibility of residual epileptogenic foci or other pathological activity. These results demonstrate successful anesthetic and surgical management, with good pain control, hemodynamic stability, and preservation of postoperative neurological function.

Discussion

Awake craniotomy is a unique and complex brain surgery procedure because it is performed while the patient is awake. This technique is specifically applied to patients with brain lesions located in important functional areas (eloquent areas), such as the motor cortex and speech center. The primary goal is to identify and preserve neurological function during tumor resection, allowing the surgeon to perform maximal resection without causing permanent neurological deficits.¹³ In this case report, the patient had a low-grade glioma located in the left frontal lobe near Broca's area, so awake craniotomy was chosen as a strategic approach to maximize the safety and effectiveness of the procedure. The awake craniotomy procedure in this patient was performed using the asleep-awake-asleep approach, which consists of three anesthesiologic phases: an induction phase with deep sedation and spontaneous ventilation, an awake phase for neurological function mapping, and a re-sedation phase for completion of the surgery.

This technique provides the anesthesia team with advantages in airway control and patient comfort during the initial and final phases of surgery and allows for optimal neurocognitive evaluation during the awake phase. This approach is now standard in many functional neurosurgery centers because it is considered to provide an ideal balance between anesthetic control and intraoperative patient collaboration.¹⁴ In a retrospective study, the asleep-awake-asleep technique was shown to be safe and effective for use in over 100 awake craniotomy procedures, with a very low conversion rate to general anesthesia and high operator satisfaction with intraoperative patient control.¹⁵ The choice of sedative agent is a critical component of the success of this procedure. In this case, a combination of propofol and

dexmedetomidine was used as the primary regimen. Propofol has the advantages of rapid onset and short duration of action and can be easily titrated to the desired depth of sedation.

However, propofol also has the disadvantage of producing high-frequency beta activity artifacts on electroencephalography (EEG), which can interfere with the interpretation of brain activity during the mapping phase.⁹ Therefore, as explained, propofol should be discontinued approximately 10–15 minutes before the awake phase to minimize its residual effects on the surface EEG.¹⁶ Dexmedetomidine, on the other hand, offers an ideal pharmacological profile for awake craniotomy procedures. As a selective alpha-2 adrenergic receptor agonist, dexmedetomidine produces sedation that mimics physiological sleep, providing mild anxiolytic and analgesic effects without causing significant respiratory depression.¹⁷

Several previous studies and guidelines related to awake surgery have established that the use of dexmedetomidine in awake craniotomy significantly reduces the risk of intraoperative seizures, agitation, and respiratory distress compared with propofol. Furthermore, dexmedetomidine allows the patient to remain conscious and cooperative during the mapping phase without compromising comfort.¹⁸ Local pain management in awake craniotomy is crucial to ensure the patient can tolerate the procedure while awake. One technique that has been proven effective in this regard is the scalp block, a regional anesthetic technique that involves infiltrating six sensory nerve branches of the head with local anesthetic.¹⁹ In this case, the supraorbital, supratrochlear, auriculotemporal, zygomaticotemporal, occipital major, and occipital minor nerves were blocked using 0.5% bupivacaine. The scalp block technique has been shown to significantly reduce pain during Mayfield pin placement and craniotomy manipulation. A study has shown that scalp block not only reduces patient subjective pain scores but also reduces hemodynamic responses such as hypertension and tachycardia during cranial pain stimulation, as well as reducing intraoperative and

postoperative opioid requirements.²⁰ Neurological monitoring during the awake phase consists of two main components: surface EEG monitoring and direct cortical stimulation. This mapping aims to identify speech, motor, or sensory areas that should be preserved.¹⁸ In this case, the patient was able to awaken well and provide adequate verbal and motor responses, allowing for optimal cortical mapping. It is important for the anesthesiologist to prepare for potential complications such as seizures during this phase. A study reported that intraoperative seizures occur in approximately 16% of awake craniotomy cases, with a higher risk in patients with a history of seizures or frontal lobe lesions.¹⁰ Seizure management strategies include discontinuing cortical stimulation, irrigating the brain surface with cold saline, and administering a bolus of propofol if necessary.^{10,18} In this case, no intraoperative seizures occurred, but the patient did complain of dull pain during dural traction, which was successfully relieved with warm irrigation.

Throughout the procedure, airway management remains a key concern. During the early asleep phase, a laryngeal mask airway (LMA) was used with spontaneous ventilation. The LMA is then removed when the patient reaches the awake phase and replaced with nasal oxygen.^{19,20} Airway maneuvers such as the jaw-thrust should always be prepared in case of airway obstruction. A study has confirmed that the LMA approach with a planned transition to the awake phase results in good airway control without incidents of desaturation or aspiration, if the procedure is performed by an experienced team.¹³

Conclusion

This case report demonstrates that awake craniotomy is a safe and effective brain surgery approach, particularly in patients with lesions located in eloquent areas, such as the left frontal cortex near the speech center. Using the asleep-awake-asleep anesthesia technique, combining propofol and dexmedetomidine sedation, and adequate scalp block, the procedure was performed optimally without major complications.

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