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Anesthesia Management of Awake Craniotomy for Excision of a Supratentorial Hemorrhagic Brain Tumor Affecting Speech and Memory

Authors' Contribution:

Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABDEF 1 **Alex Hugues**
DEF 2 **Taylor Rechter**
DEF 1 **Aldo Poblete**
ADE 1 **Imani Thornton**

1 Department of Anesthesiology, HCA Westside/Northwest Hospital, Plantation, FL, USA
2 Dr. Kiran C Patel College of Osteopathic Medicine, Nova Southeastern University, Fort Lauderdale, FL, USA

Corresponding Author: Alex Hugues, 8201 W Broward Blvd, Plantation, FL 33324, USA, Phone: 561-537-9053, e-mail: Hugues.alex@hcahealthcare.com

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Patient: Female, 30-year-old
Final Diagnosis: Supratentorial meningioma
Symptoms: Behavioral disturbance • headache • memory changes • memory loss • seizure • speech disorders
Clinical Procedure: —
Specialty: Anesthesiology • Neurosurgery

Objective: Unusual clinical course


Background: Awake craniotomy is a neurosurgical approach used for resecting brain tumors in eloquent areas, where real-time neurological monitoring is critical to preserving function. Selecting the appropriate anesthesia approach is essential when preoperative language deficits or patient anxiety may limit intraoperative participation. While motor mapping is an established component of awake craniotomy, the use of a speech-language pathologist for real-time intraoperative monitoring remains underutilized.

Case Report: A 31-year-old woman presented with a 1-year history of seizures, headaches, and progressive speech disturbances. Imaging revealed a left-sided supratentorial hemorrhagic brain tumor measuring 4.1×3.8×3.6 cm located near language centers. Given the proximity to the eloquent cortex and the patient's significant preoperative speech and memory deficits, a sleep-awake-sleep (SAS) anesthesia technique was chosen for awake craniotomy with intraoperative speech mapping. Uniquely, a speech-language pathologist (SLP) was integrated into the surgical team to conduct real-time assessments of language function. After induction with propofol and remifentanyl, the patient was awakened during resection for real-time speech testing, allowing maximal tumor removal without compromising language function. She was then re-sedated for surgical closure. Postoperatively, there were no new deficits, speech remained at baseline, and magnetic resonance imaging (MRI) confirmed gross total resection.

Conclusions: This case report highlights the importance of individualized anesthesia planning and the under-recognized role of intraoperative SLP integration in awake craniotomy, which offers a more responsive approach to functional preservation than standard practice alone. For select patients, the SAS method provides a balance between patient comfort, surgical access, and preservation of neurological function.


Keywords: Awareness • Craniotomy • Language Disorders • Neurosurgical Procedures • Speech Therapy • Supratentorial Neoplasms

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Introduction

Awake craniotomy is a highly specialized neurosurgical procedure that facilitates maximal tumor resection in eloquent brain regions while preserving critical neurological functions. This approach is especially vital when tumors are located near speech or motor areas where standard imaging modalities cannot precisely predict functional boundaries. In this case, Stealth Technology, a 3D computed tomography (CT)-based imaging system, was utilized intraoperatively to facilitate precise tumor mapping. This imaging modality was chosen because cortical mapping is particularly sensitive to patient movement. Given the overlap between the language and memory networks, surgery in these regions carries the dual risk of post-operative language and memory deficits. The eloquent cortex refers not only to discrete language areas, such as Broca's and Wernicke's areas, but also to structures that are involved in memory encoding and retrieval, such as the hippocampus and parahippocampal gyrus. Thus, comprehensive intraoperative monitoring of both domains is imperative.

The anesthesia strategy used during awake craniotomy is chosen based on the patient's level of consciousness during key surgical stages: exposure, resection, and closure. The 3 primary methods are awake-awake-awake (AAA), awake-awake-sleep (AAS), and sleep-awake-sleep (SAS). The AAA approach maintains full patient consciousness throughout the procedure and is typically best suited for highly cooperative patients who have strong baseline neurological function and minimal procedural anxiety. While the AAA approach offers the best continuous mapping reliability, it also demands the greatest patient tolerance. The AAS approach allows the patient to remain awake during the period of resection before they are sedated for closure. This approach offers more of a middle-ground but also requires sustained wakefulness during the more demanding surgical phases in the beginning. Lastly, the SAS approach provides general anesthesia during both exposure and closing, which are typically the most physically demanding, while only requiring the patient to be awake during the mapping and resection phase. Therefore, SAS is particularly advantageous when patients present with preoperative neurological defects or deficits, anxiety, or when more controlled management of airways is required during non-mapping phases. Inadequate ventilation during the awake portion of the procedure carries significant risk, further emphasizing the necessity of an experienced anesthesia team. In the present case, all 3 factors were present, making SAS the most appropriate technique.

This case illustrates the successful anesthesia management of an awake craniotomy using the SAS approach in a patient with a hemorrhagic supratentorial tumor adjacent to language areas. Notably, the intraoperative team included an SLP to assess real-time speech function, an integration that is non-standard

at most centers. More commonly, language assessment during awake craniotomy is performed by the surgical team without a dedicated speech-language expert. However, this was particularly important in the present case given the patient's preexisting language deficits and high personal motivation to preserve communication abilities. The SLP's role extended beyond speech assessment, as language tasks during awake mapping engage the working memory and semantic processing networks. Therefore, it is essential to consider the functional integrity of both systems during resection.

Case Report

A 31-year-old woman first began experiencing headaches, memory difficulties, and progressive speech abnormalities in March 2023. She had no significant medical comorbidities. She denied tobacco use, alcohol use, substance abuse, and had no occupational exposure to high-risk environmental hazards. A magnetic resonance imaging (MRI) scan was obtained in April 2023; however, the patient was subsequently lost to follow-up. In September 2023, she experienced her first seizure, which then prompted reevaluation the following month and the initiation of surgical planning. Although no further seizures occurred, her speech and memory deficits continued to worsen over this period. During this time, the patient also sought a second opinion, which further delayed surgical intervention. Surgery was ultimately performed in February 2024.

At the time of surgical evaluation, her symptoms significantly interfered with her daily function and communication. Additionally, social and family responsibilities had contributed to delays in care throughout her clinical course. MRI revealed a left-sided supratentorial hemorrhagic mass measuring 4.1×3.8×3.6 cm, with vasogenic edema and mass effect (Figure 1). The tumor's proximity to known language regions raised a concern about postoperative speech deficits. Although a definitive histologic diagnosis could only be made postoperatively, the imaging was suggestive of a high-grade glioma.

Given the imaging characteristics, several diagnoses were considered. Glioblastoma multiforme was the leading differential given the hemorrhagic nature of the mass, its size, the degree of vasogenic edema, and the significant mass effect. Meningioma was considered given the supratentorial location, but the intra-axial appearance and hemorrhagic components were less consistent with this diagnosis. Metastatic disease was also included in the differential, although the patient had no known primary malignancy and no systemic symptoms to suggest an extracranial source. Lastly, neurocysticercosis was considered because it can present as a hemorrhagic lesion with surrounding edema, particularly in the appropriate clinical and epidemiological context. However, our patient presented without

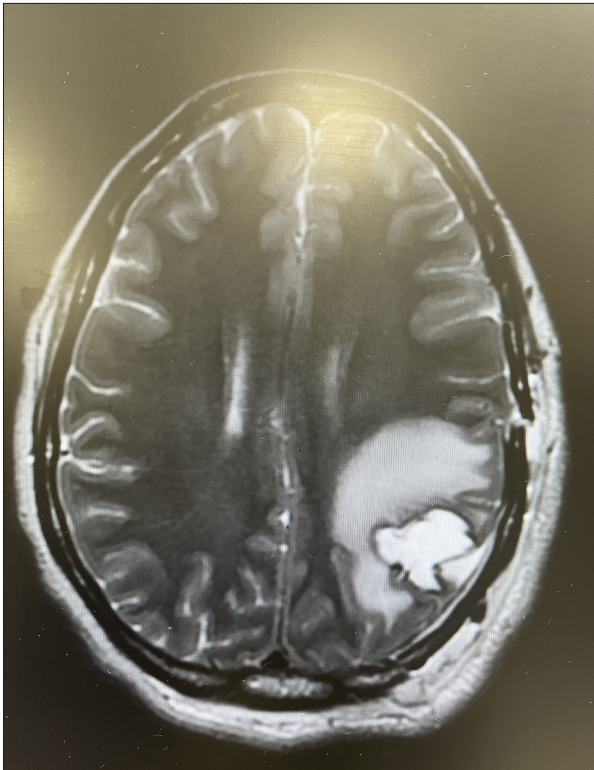


Figure 1. Contrast-enhanced magnetic resonance imaging brain demonstrating a left-sided supratentorial hemorrhagic brain tumor measuring 4.1×3.8×3.6 cm located near language center.

fever or elevated in white blood cell count, and imaging demonstrated a solitary lesion, thus making both infectious and metastatic etiologies less likely. The clinical and radiographic findings were more suggestive of a high-grade glioma, and surgical planning proceeded accordingly.

Standard preoperative laboratory testing was completed, including a complete blood cell count, basic metabolic panel, and type and screen, all of which were within normal limits. The patient's symptoms and MRI findings were the primary abnormalities guiding surgical decision-making. After interdisciplinary case review, the surgical team elected to proceed with awake craniotomy to maximize resection while preserving speech. Given the patient's anxiety, preexisting deficits, and the expected complexity of resection, an SAS anesthesia plan was selected to balance comfort and cooperation. Detailed preoperative counseling and simulation with the anesthesiologist, neurosurgeon, and SLP were provided. As part of the preoperative preparation, the patient met with the SLP on 2 separate occasions prior to surgery. During these sessions, a formal baseline assessment of speech and memory was established, providing a reference point against which intraoperative and postoperative function could be compared.

Intraoperative Steps

Induction and Exposure (Asleep)

The patient was induced with propofol and remifentanyl and a supraglottic airway device was placed. Anesthesia was maintained with propofol (80 µg/kg/min) and remifentanyl (0.1 µg/kg/min). Regional scalp nerve blocks were administered (supraorbital, supratrochlear, zygomaticotemporal, and auriculotemporal nerves) to reduce intraoperative discomfort. After Mayfield pins were placed, the scalp was incised and the dura was exposed.

Tumor Resection (Awake)

The anesthetic infusions were reduced (propofol paused, remifentanyl 0.02 µg/kg/min) and the patient was gently stimulated awake. This allowed for the supraglottic airway to be removed, while having the patient remain in surgical position. Once awakened and the supraglottic airway was removed, the SLP conducted continuous real-time speech assessments using a predetermined set of questions during tumor resection, focusing on naming, repetition, and sentence generation tasks. This real-time feedback loop between SLP and the neurosurgical team was central to achieving gross total resection while preserving language and memory function.

Closure (Asleep)

Following resection, sedation was re-initiated with propofol and remifentanyl. The airway was resecured, and the dura and scalp were closed without complication. The patient was repositioned and awakened after anesthesia discontinuation.

Postoperative Course

Following surgery, the patient was transferred to the intensive care unit (ICU), where she recovered over a period of 3 days under standard hemodynamic monitoring. Additionally, daily CT scans were obtained to surveil for postoperative hemorrhage, edema, or other complications. Continuous electroencephalogram monitoring was maintained throughout her ICU stay using a Cerebel monitor to assess for subclinical seizure activity. Speech and language function was also monitored at the bedside by nursing staff during this period. The patient's neurological status remained stable, with speech preserved at baseline and no new deficits identified. She was subsequently transferred to the general floor and discharged in satisfactory condition.

Following discharge, the patient had monthly follow-up appointments with the neurosurgery clinic. MRI confirmed gross total resection and histopathology confirmed a high-grade

glioma, for which the patient was referred for adjuvant therapy and continues to participate in neuro-oncological follow-up. Additionally, speech and memory function continued to be tracked at each monthly visit by the SLP, who maintained a detailed summary of the patient's communicative and cognitive progress.

Discussion

Awake craniotomy remains a cornerstone in functional neurosurgery when lesions involve eloquent cortical areas. The decision to use 1 of the 3 primary anesthetic approaches—AAA, AAS, or SAS—depends on multiple factors, including patient anxiety, preoperative deficits, anticipated surgical duration, and the need for airway management. The SAS technique is the oldest and most common technique in awake craniotomy, where general anesthesia is used both before and after brain mapping. Awake craniotomy has been used since the 1980s for the resection of tumors in higher functioning cortical areas, and has since expanded both in indication and geographic reach [1]. Anesthesia management has continued to evolve alongside innovations in total intravenous anesthesia and modern regional techniques such as scalp nerve blocks. The goal of this technique is to improve patient comfort during the non-mapping phases of surgery, thus addressing the limitations of fully awake approaches in patients who may not be able to tolerate prolonged wakefulness [2-5].

In this case, the SAS approach offered key advantages. Inducing anesthesia for exposure allowed for a stress-free start, which was critical for a patient already experiencing speech and cognitive difficulty. Awakening the patient during resection allowed real-time monitoring of language tasks, enhancing the surgeon's ability to differentiate tumor from functional tissue. The primary indications for the SAS approach over the AAA or AAS approaches included significant preoperative anxiety, existing neurological deficits that could impair cooperation, and the need for a secured or assisted airway during non-mapping stages of the operation.

Compared to AAA or AAS, the SAS approach is particularly beneficial for patients with significant anxiety or who may not tolerate prolonged wakefulness. In a similar case [6,7], AAA was used in a patient with strong baseline cognitive function and high procedural tolerance. Conversely, in our case, the patient's preoperative deficits and psychosocial context necessitated a hybrid approach. However, the SAS technique carries its own risks. The transition from the asleep to awake phase introduces the possibility of emergence agitation and carries complications with reintubation and intraoperative testing [2]. Additionally, during the awake phase, airway management requires careful monitoring to maintain patient responsiveness

without compromising their respiratory function or cooperation. Of particular concern in this case was patient movement during the awake phase, as the head and neck remain suspended in Mayfield pins throughout the procedure. Thus, any significant movement could have resulted in catastrophic injury. These risks collectively highlight the necessity of a highly experienced anesthesia team along with thorough preoperative patient preparation.

Beyond anesthesia, this case underscores the value of incorporating an SLP in the intraoperative team. While motor mapping is standard, real-time speech monitoring is less commonly emphasized in the literature, especially when patients present with existing language impairments. In many cases, language assessment during awake craniotomy is performed by the neurosurgical team without a dedicated SLP. However, a UK survey of SLPs working in awake craniotomy found that intraoperative practice involves sustained real-time assessment of speech, language, oromotor, and cognitive functions, with findings that are immediately communicated to the surgical team [8]. In fact, the survey showed that the SLPs' real-time assessments were able to support improved outcomes. Furthermore, the University of Texas MD Anderson Cancer Center employs an interdisciplinary awake craniotomy model that also integrates speech-language pathology. This model has shown that a team-based approach can improve care and quality of life for patients undergoing awake craniotomy [9]. In our case, this integration was critical given the patient's preexisting language difficulties. Preserving language was not only medically important but personally critical to the patient's identity and caregiving role.

Awake craniotomy also reduces exposure to general anesthesia, potentially minimizing complications such as postoperative delirium, especially in patients with neurological vulnerabilities. Early neurologic evaluation and faster recovery are additional benefits [10].

Finally, success in these cases depends on seamless teamwork. The anesthesiologist's role extends beyond sedation to ensuring patient engagement, managing airway transitions, and coordinating intraoperative timing with the surgical and speech teams [3].

In summary, awake craniotomy provides important benefits from the anesthesiologist's perspective, including the ability to support intraoperative mapping, minimize risks associated with general anesthesia, reduce postoperative complications, and enhance recovery. As surgical techniques advance and patient-centered care becomes increasingly emphasized, the anesthesiologist's role in awake craniotomy remains central to balancing safety, comfort, and neurological preservation.

Conclusions

This case report illustrates the effective use of a SAS anesthesia approach in an awake craniotomy for a hemorrhagic brain tumor near the eloquent cortex. Compared to fully awake approaches such as AAA and AAS, the SAS technique offered a clinically meaningful advantage in this patient by providing controlled airway management and patient comfort during the most demanding phases of surgery, while still enabling reliable cortical mapping during resection. The integration of a SLP proved to be significant, offering a level of real-time functional assessment that goes beyond standard practice and was particularly critical given the patient's preexisting language deficits. A particular strength of this case was the patient's active participation during the awake phase, which provided real-time confirmation of viable tissue boundaries and removed possible ambiguity from resection decisions. Future investigation should focus on prospective evaluation of intraoperative SLP involvement on language outcomes, standardized models for integrating SLPs across neurosurgical centers, and long-term comparative outcome across anesthesia techniques.

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Department and Institution Where Work Was Done

Department of Anesthesiology, HCA Westside/Northwest Hospital, Plantation, FL, USA.

Patient Permission/Consent

Written informed consent for publication of this case report and all associated images was obtained from the patient.

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