Science Forecast
A digital science library
Review Article
Published: 11 Feb, 2019

Journal of Surgery Forecast

Anesthetic Management and Psychological Approaches for Excision in Awake Craniotomy of Lesions Located within or Near Eloquent Language Areas

Carbone D[1], Lubrano G[2], Muzio MR[3], Cuomo GF[3], Di Sauro A[4] and Cascella M[4]*

[1]Department of Emergency Medicine, Umberto I Hospital, Nocera Inferiore, Salerno, Italy

[2]Department of Anaesthesia, Resuscitation and Postoperative Intensive Care, "S. Francesco d'Assisi" Hospital, Oliveto Citra, Salerno, Italy

[3]Division of Infantile Neuropsychiatry, UOMI-Maternal and Infant Health, ASL NA3 SUD Torre del Greco, Naples 80059, Italy

[4]Division of Anesthesia and Pain Management, Department of Supportive Care, Istituto Nazionale Tumori Fondazione G. Pascale - IRCSS, Naples, Italy

Abstract

Gliomas are one of the most common types of primary brain tumors. Neurosurgical approaches are usually the first step in treating most types of gliomas as complete resection of high- or low-grade gliomas is of paramount importance for improving patient's survival. Gliomas may be also located in eloquent language areas of the brain and aggressive resection in the Broca's area or in adjacent cortex involved in language processing may increase the occurrence of neurosurgical complications. As a consequence, in order to avoid damage to these areas, resections are commonly performed through direct cortical stimulation and functional monitoring during awake craniotomy. This paper is aimed to present a multidisciplinary approach for excision in awake surgery of lesions located within or near eloquent language areas, underlying the features of the anesthetic management and the pivotal role of the psychological interventions during the whole perioperative course.

Keywords: Glioma; Brain Neoplasm; Awake Craniotomy; Procedural Sedation; Electrocorticography; Speech Mapping

OPEN ACCESS

***Correspondence:**
Cascella M, Division of Anesthesia and Pain Management, Department of Supportive Care, Istituto Nazionale Tumori Fondazione G. Pascale - IRCSS, Naples, Italy.
***Tel:** +39 081 5903221*
***E-mail:** m.cascella@istitutotumori.na.it*
***Received Date:** 02 Jan 2019*
***Accepted Date:** 07 Feb 2019*
***Published Date:** 11 Feb 2019*

***Citation:** Carbone D, Lubrano G, Muzio MR, Cuomo GF, Di Sauro A, Cascella M. Anesthetic Management and Psychological Approaches for Excision in Awake Craniotomy of Lesions Located within or Near Eloquent Language Areas. J Surg Forecast. 2019; 2(1): 1019.*

Introduction

The term awake craniotomy (AC) refers to a neurosurgical approach performed with the patient awake during the procedure. Historically, procedures of AC have been developed since the nineteenth century for removal epileptic foci under local anesthesia [1]. More recently, however, thanks to the improvement of monitoring methods and the availability of new anesthetic agents [2], indications of this operative modality have been extended to the execution of stereotactic biopsies, treatment of vascular lesions [3], resection of tumor lesions interesting the areas of language [4], and excision of supratentorial lesions located in different cortical areas [5].

Gliomas, including astrocytomas, ependymomas, and oligodendrogliomas are one of the most common types of primary brain tumors accounting for approximately 40% of all intracranial tumors [6]. Surgical resection of gliomas in the Broca's area, or in adjacent cortex involved in language processing such as the third part of the inferior frontal gyrus [7], is one of the main indications to the AC [8]. Complete resection of high- or low-grade gliomas, indeed, is of paramount importance for improving patient's survival. On the other hand, aggressive resection near eloquent language areas may increase the occurrence of neurosurgical complications. The neurosurgical interventions performed for this purpose provide, in the intraoperative phase, the carrying out of the functional mapping of the language domains (intraoperative speech mapping, SM), which can be performed with direct electrical cortical stimulation combined with the administration of test for language assessment, while the patient is fully awake and collaborating. Several clinical investigations demonstrated that AC is the optimal way to intraoperatively verify the preservation of language function and, in turn, to obtain the better neurosurgical result [9].

The anesthetic techniques proposed for AC are the Monitored Anesthesia Care (MAC) in which the patient is under sedation during the whole operation [10] or general anaesthesia approaches with intra-operative wake-up. These latter solutions include the Asleep-Awake-Asleep (AAA) technique, which involves a general anesthesia phase with orotracheal intubation, or laryngeal mask (LMA) insertion, followed by an awakening phase and, once the mapping is completed, by a conclusive step (i.e., surgical resection) performed under general anesthesia [11], and the Asleep-Awake (AA) technique which foresees a phase of general anesthesia followed by awakening for the mapping after which a subsequent sedation can be foreseen for the completion of the intervention [12].

In our experience we prefer the AA approach [13]. However, for its success a rigid protocol and a multidisciplinary cooperation is needed (Figure 1). Thus, several critical issues should be carefully addressed (Table 1).

Periopratіve Management

Preoperative assessment

In this phase, a multidisciplinary discussion of the case with the involvement of a neurosurgeon, an anesthesiologist and a psychologist is mandatory to verify the patient's eligibility. After the patient selection, a careful preoperative anesthesia evaluation is provided, obtaining risk evaluation and stratification as well as informed consent (Table 2).

Within the preoperative assessment, the neuropsychological framework is fundamental for: i) evaluating the degree of collaboration; ii) evaluating any deficit in word processing; iii) presenting the patient the language tests used in the operating room. Details of the procedure must be exhaustively explained, underlying the possible risks and complications of surgery, the potential cause for discomfort (e.g., probability of aphasia during stimulation and occurrence of vomiting and nausea) and the need to collaborate as well as to maintain immobilization.

Intraoperative management

The awake craniotomy technique provides general anesthesia and the need to obtain a rapid phase of anesthesia emergence [14,15]. The anesthetic strategy provides intravenous general anesthesia through target-controlled infusion (TCI) of remifentanil and propofol followed by the awakening phase. In this scenario it is mandatory to refer to a detailed anesthetic protocol, exploiting at best the pharmacokinetic/dynamic characteristics of the drugs used and the operative modalities of drug delivery systems as well as the modalities for monitoring of anesthesia.

After premedication with dexamethasone 8mg ev, ranitidine 50mg ev, and midazolam 0.03/mg/kg, when not contraindicated [16,17] the general anesthesia is performed by TCI Schneider's pharmacokinetic model with propofol (3.0-4.0 mcg/ml, under BIS guidance) and remifentanyl (5-15 ng/ml) [18]. The muscle relaxant rocuronium bromide (0.5 mg/kg) is used to facilitate laryngeal mask airway (LMA) and mechanical ventilation. The choice to curarize the patient is relative to the lateral position of the head (turned to the right after positioning the headboard) which may induce malposition of the LMA during the operation.

Intraoperative monitoring typically includes electrocardiogram, invasive blood pressure measurements, pulse oximetry (SpO_2), respiratory rate, capnography ($EtCO_2$). Again, the transition between the two anesthetic phases is guided by monitoring the depth of anesthesia with the bispectral index (BIS) and the drug concentrations in the biophase. Furthermore, neuromuscular monitoring is used as a guide to the administration of muscle relaxants and their antagonists (e.g., the cholinesterase inhibitor neostigmine) or reversal agent (i.e., sugammadex).

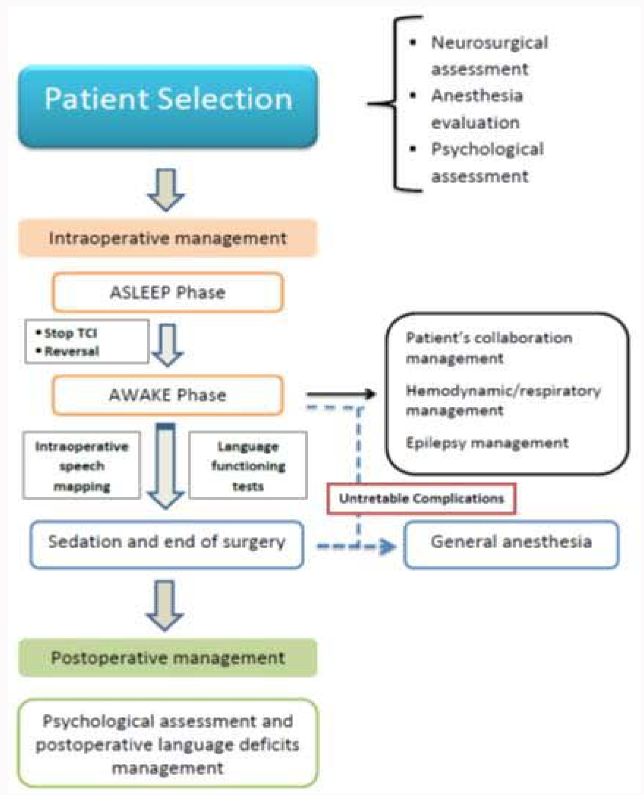

Figure 1: Algorithm for awake craniotomy. Modified from [13].

Under general anesthesia, the local anesthesia of the scalp nerves is performed before placing the Mayfield head clamp, in order to have the maximum patient's comfort once awakened. This scalp block is obtained by levobupivacaine 0.75% (20-30 ml) to anesthetize the big and small occipital nerves, the suprabitary, zygomatic-temporal, auriculo-temporal nerves, as well as the cutaneous points where the piercing cones of the headboard will be allocated.

Awake Craniotomy management: Once the craniotomy has been made, the dura mater is irrigated with 0.5% levobupivacaine and then opened and, in turn, it is awaited the patient's awakening.

Awakening procedure: The peculiarity of this type of intervention is the need of obtaining a rapid and complete recovery from the neuromuscular block and an equally rapid and complete recovery of the state of consciousness. Once the neuromuscular block has been evaluated, rocuronium bromide is reversed by sugammadex at a dosage of 2 mg/kg, in case of moderate block (T1-T2 present), and 4 mg/kg in the deep block. At the same time, the administration of propofol and remifentanil is turned off, and the TCI biophase is followed to assess the patient's awakening.

During surgical excision the patient is awake, in spontaneous breathing and fully collaborating. Oxygen delivery by nasal cannula at 4 lt/min and non-invasive end-tidal carbon dioxide ($EtCO_2$) monitoring are foreseen in the protocol.

Speech Mapping and evaluation of language function: Neurosurgeons usually perform these procedures by using intraoperative navigation systems which load magnetic resonance

Table 1: Anesthesia critical issues for awake craniotomy.

Patient selection
Fast and secure transition between the asleep and the awake phases:
• *Anesthetics pharmacokinetics and pharmacodynamics* • *Drug antagonists and reversal agents for curare*
Intraoperative hemodynamic stability
Early detection and effective management of any complications (e.g., intraoperative seizures)
Loss of airway control
Inability to control ventilation
Assurance of immobility for up to 2 hours
Management of nausea and vomiting

Table 2: Patient selection and preoperative anesthesia evaluation.

ASA status (≤ 3)
Airway assessment
Evaluation of the risk of sedation failure
Risk of intraoperative complications (e.g., risk of epilepsy)
Neurological disorders and their treatment
Psychological evaluation
Contraindications:
• *Patient's refusal*
• *Communication difficulties*
• *Abuse of alcohol, drugs and other psychotropic substances*
• *Sleep apnea and sleep apnea risk**
• *Chronic pain and opioid use/abuse for treatment*
• *Inability to lie still for a long period*
• *Psychic and/or psychiatric disorders^*
• *Confused patient*
Legend: *STOP BANG score; ^e.g., extreme anxiety

imaging (MRI) and computed tomography (CT) images obtained preoperatively to better distinguish between the lesion and normal tissues. The technique used for intraoperative functional brain mapping is based on electrical stimulation of the brain. The brain area covered with electrodes is determined by the neuronavigation system. For the electrocorticography high frequency stimuli (e.g., 50–60 Hz with intensity of stimuli increased up to 15 mA by increments of about 1 mA) are applied. This procedure provides two types of responses. The 'positive response' in which brain function is induced by electric stimulation and the 'negative response' that is suppressed by the stimulation.

The evaluation of language function is performed by administering the patient the exercises already showed in the outpatient setting. According to guidelines for AC we use a combination of exercises which are able to test number counting (for evaluation of motion), visual naming (language expression), and auditory comprehension (for investigating perceiving and expression of language) [19]. In addition to the administration of the exercises, an overall neuropsychological evaluation is performed by the psychologist.

Management of complications: Epilepsy induced by the stimulation is usually focal and of short duration (due to cortical stimulation). However, episodes of myoclonic epilepsy may occur. These episodes may be treated with midazolam 2-5 mg in repeated boluses (may interfere with the mapping) or by cortical irrigation with cold solution of lactated Ringer. Dysphoric reactions and irritability are managed with the help of the psychologist. Nausea and vomiting are usually treated with ondansetron (8 mg e.v.) Severe respiratory depression and occurrence of airway obstruction involve quickly conversion to general anaesthesia.

Post-mapping phase: After the mapping, the neurosurgeon proceeds to close the craniotomy. Anesthesiological management involves conscious sedation (Ramsay score <5) under BIS guidance (>70), and $EtCO_2$ monitoring. For the procedural sedation we prefer dexmedetomidine (loading dose of 1μg/kg over 10 minutes, and then infused in a dose of 0.5–1.0 μg/kg/h) which has sedative and anxiolytic properties and is known for its analgesic potential owing to a reduction of sympathetic tone. Furthermore, this agent does not impair the respiratory drive per se, seldom causes apnea [20], and compared to midazolam may provide more comfort during the procedure for the patient and clinicians [21]. The neuropsychologist remains close to the patient until he/she is again sedated for the conclusion of the neurosurgical intervention.

In case of a patient who is not tolerant to surgery and/or due to the onset of complications, a new general anesthesia is performed (Asleep-Awake-Asleep technique). For the management of potential complication see (*Management of complications)* subparagraph. After the intervention the patient is sent to the neurosurgical postoperative intensive care unit.

Postoperative evaluations

A postoperative neuropsychological evaluation (generally conducted at 1 and 3 months after the operation), allows to monitor the results of the intervention. In particular, the comparison between pre- and post-operative data provides useful information to discern if a disorder has manifested itself ex-novo, that is, following the surgical removal, or is the expression of an aggravation of the preoperative symptomatology. Observed language deficits are evaluated and studied over time to verify if they are temporary or definitive. According to literature, indeed, permanent language deficits occurred in approximately 2.5%, whereas about 10% of postoperative language deficits become permanent [22].

Conclusions

The neurosurgical procedures performed with the AC approach applied to the treatment of gliomas located within or near eloquent language areas, allow to safeguard the patient's ability to preserve the language domains. However, the good result of the technique requires a close collaboration between the various professional figures involved including neurosurgeon, anesthetist, neuropsychologist and nurse. In regard to anesthetic management, the anesthesiologist's challenge is to develop a technique that allows obtaining, in safety, a rapid conversion from the state of surgical anesthesia to awake to ensure that the patient is awake and collaborative for the neurofunctional tests. Consequently, it is mandatory to refer to a detailed anesthetic protocol, exploiting at best the pharmacokinetic/dynamic characteristics of the drugs used and the operative modalities of drug delivery systems as well as the modalities for monitoring of anesthesia. The role of the psychologist is fundamental during the whole perioperative course. The preoperative assessment allows selection of patient and lays the foundations for his/her preparation to the intervention. Subsequently, the psychologist will remain in the operating room during the entire procedure, for the administration of neuropsychological tests and to manage any psychic destabilization.

Finally, the specialist will perform within the multidisciplinary team the postoperative evaluations.

References

1. Sahjpaul RL. Awake craniotomy: Controversies, indications and techniques in the surgical treatment of temporal lobe epilepsy. Can J Neurol Sci. 2000; 27: S55–63.
2. Bilotta F, Guerra C, Rosa G. Update on anesthesia for craniotomy. Curr Opin Anaesthesiol. 2013; 26: 517-522.
3. Gamble AJ, Schaffer SG, Nardi DJ, Chalif DJ, Katz J, Dehdashti AR. Awake Craniotomy in Arteriovenous Malformation Surgery: The Usefulness of Cortical and Subcortical Mapping of Language Function in Selected Patients. World Neurosurg. 2015; 84: 1394-1401.
4. Brown T, Shah AH, Bregy A, Shah NH, Thambuswamy M, Barbarite E, et al. Awake craniotomy for brain tumor resection: the rule rather than the exception? J Neurosurg Anesthesiol. 2013; 25: 240-247.
5. Blanshard HJ, Chung F, Manninen PH, Taylor MD, Bernstein M. Awake craniotomy for removal of intracranial tumor: Considerations for early discharge. Anesth Analg. 2001; 92: 89–94.
6. Schneider T, Mawrin C, Scherlach C, Skalej M, Firsching R. Gliomas in adults. Dtsch Arztebl Int. 2010; 107: 799-807.
7. Hagoort P. Nodes and networks in the neural architecture for language: Broca's region and beyond. Curr Opin Neurobiol. 2014; 28: 136-141.
8. Delion M, Terminassian A, Lehousse T, Aubin G, Malka J, N'Guyen S, et al. Specificities of Awake Craniotomy and Brain Mapping in Children for Resection of Supratentorial Tumors in the Language Area. World Neurosurg. 2015; 84: 1645-1652.
9. Paldor I, Drummond KJ, Awad M, Sufaro YZ, Kaye AH. Is a wake-up call in order? Review of the evidence for awake craniotomy. J Clin Neurosci. 2016; 23: 1-7.
10. Taylor MD, Bernstein M. Awake craniotomy with brain mapping as the routine surgical approach to treating patients with supratentorial intraaxial tumors: A prospective trial of 200 cases. J Neurosurg. 1999; 90: 35–41.
11. Huncke K, Van de Wiele B, Fried I, Rubinstein EH. The asleep-awake-asleep anesthetic technique for intraoperative language mapping. Neurosurgery. 1998; 42: 1312–1316.
12. Attari M, Salimi S. Awake craniotomy for tumor resection. Advanced Biomedical Research. 2013; 2: 63.
13. Carbone D, Cuomo A, Cascella M. Management anestesiologico per awake craniotomy applicata al trattamento neurochirurgico di lesioni tumorali della regione temporale sinistra. In: AAVV. Protocolli operativi in anestesia: l'impiego del sugammadex. Pazienti e procedure chirurgiche. MediMay. 2018. Pp. 30-37.
14. Cascella M, Bimonte S, Muzio MR. Towards a better understanding of anesthesia emergence mechanisms: Research and clinical implications. World J Methodol. 2018; 8: 9-16.
15. Cascella M. Emergence from anesthesia: a winding way back. Anaesthesiol Intensive Ther. 2018; 50: 168-169.
16. Cascella M. Anesthesia awareness. Can midazolam attenuate or prevent memory consolidation on intraoperative awakening during general anesthesia without increasing the risk of postoperative delirium? Korean J Anesthesiol. 2015; 68: 200-202.
17. Cascella M. What about Memory, Consciousness, Recall, and Awareness in Anesthesia? Iran J Med Sci. 2014; 39: 311-312.
18. Hans P, Bonhomme V, Born JD, Maertens de Noordhoudt A, Brichant JF, et al. Target-controlled infusion of propofol and remifentanil combined with bispectral index monitoring for awake craniotomy. Anaesthesia. 2000; 55: 255–259.
19. Kayama T, Guidelines committee of the Japan awake surgery conference. The guidelines for awake craniotomy guidelines committee of the Japan awake surgery conference. Neurol Med Chir (Tokyo). 2012; 52: 119-141.
20. Lodenius Å, Ebberyd A, Hårdemark Cedborg A, Hagel E, Mkrtchian S, Christensson E, et al. Sedation with Dexmedetomidine or Propofol Impairs Hypoxic Control of Breathing in Healthy Male Volunteers: A Nonblinded, Randomized Crossover Study. Anesthesiology. 2016; 125: 700-715.
21. Barends CR, Absalom A, van Minnen B, Vissink A, Visser A. Dexmedetomidine versus Midazolam in Procedural Sedation. A Systematic Review of Efficacy and Safety. PLoS One. 2017; 12: e0169525.
22. Kanno A, Mikuni N. Evaluation of Language Function under Awake Craniotomy. Neurol Med Chir (Tokyo). 2015; 55: 367-373.