International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Research Article

Surgical Outcome Following Awake Craniotomy for Eloquent Supratentorial Tumour- A Single Centre Experience

Dr Vikrant Keshri[1], Dr Jotdeep S. Bamrah[2], Dr Supriya Keshri[3]

[1] *Assistant Professor, Department of Neurosurgery, SBKS Medical institute and Research Centre, Vadodara, Gujarat, India.*
[2] *Senior resident, Department of Neurosurgery, SBKS Medical institute and Research Centre, Vadodara, Gujarat, India*
[3] *Assistant Professor, Department of General Surgery, SBKS Medical institute and Research Centre, Vadodara, Gujarat, India.*

Corresponding Author:

Dr Vikrant Keshri
Assistant Professor, Department of Neurosurgery, SBKS Medical institute and Research Centre, Vadodara, Gujarat, India

Received: 16-08-2025
Accepted: 05-09-2025
Available online: 25-09-2025

ABSTRACT

Background: Maximal resection improves survival in glioma patients, but tumours in eloquent areas risk neurological deficits. Awake craniotomy with intraoperative mapping enables safe tumour removal while preserving motor, language, and cognitive functions. This study evaluates functional and cognitive outcomes in patients undergoing this approach.
Material and Methods: This retrospective single-centre study (study period 2021 to march 2025) included adult patients with gliomas situated in eloquent brain regions. All participants underwent awake craniotomy with maximal tumour resection guided by intraoperative cortico-subcortical mapping according to functional boundaries. "Asleep-awake-asleep anaesthesia" technique using combination of propofol and fentanyl was used in all patients with functional outcomes evaluated included neurological status, cognitive and language function, and work capacity. Oncological outcomes comprised extent of resection (EOR) and survival.
Results: The series included 25 awake surgeries (12 low-grade gliomas, 5 grade III gliomas, 5 grade IV glioblastomas and 3 dermoid cyst). 10 patients had tumour located in left frontal lobe, 5 in left insular lobe, 6 in left temporal lobe, 3 in right premotor area an 1 in left post central gyrus. Preoperatively, 5 patients (20%) had focal neurological deficits, 10 patients 40%) exhibited neuropsychological disturbances, and 05 patients (20%) were unable to work. Maximal resection (>90%) was achieved in 10/12 low-grade gliomas (83%), 4/5 grade III gliomas (80%), 4/5 glioblastomas (80%) and 3/3 (100 %) dermoid cyst. Intraoperative stimulation induced seizures occurred in 2/25(8%) patients. Postoperatively, 02 patients (8%) experienced transient worsening of neurological and/or cognitive status which recovered gradually. At 6-month follow-up, 20 (80%) patients had excellent outcome and were symptom free .Survival outcomes correlated significantly with both tumour grade and extent of resection.
Conclusion: Functional mapping during awake craniotomy enables aggressive glioma resection without compromising neurological or cognitive outcomes in tumours located in eloquent area. Temporary postoperative deficits typically improve with individualized rehabilitation, allowing patients to regain daily functioning. Achieving a greater extent of resection remains critical for improving survival

***Keywords**: Awake craniotomy, Glioma, Glioblastoma, Intraoperative brain mapping, Neurological deficits*

INTRODUCTION

Maximal safe resection is a cornerstone of surgical management for diffuse gliomas because increasing the extent of resection (EOR) has been consistently associated with prolonged progression-free and overall survival across tumour grades when it can be achieved without causing unacceptable functional harm. Recent expert and consensus reviews emphasize that EOR should be considered and reported systematically when assessing the oncological benefit of surgery in adult diffuse gliomas [1,2].

Tumours that abut or invade eloquent cortical and subcortical regions (motor cortex, Broca/Wernicke language areas, insula, supplementary motor area and major white-matter tracts) pose a therapeutic dilemma: aggressive resection improves oncological outcomes but increases the risk of new or worsened neurological, language, or cognitive deficits that markedly impair quality of life. Consequently, the modern neurosurgical objective is "maximal safe resection" — that is, removing as much tumour as possible while preserving essential function [1,3].

Direct electrical stimulation (DES) with intraoperative cortical and subcortical mapping performed during awake craniotomy is the most widely used technique to identify functional cortex and critical white-matter pathways in real time. Multiple institutional series and narrative reviews show that awake mapping allows tailored resections to functional boundaries and reduces the rate of permanent deficits while facilitating higher EOR in lesions within eloquent regions [4,5].

Anaesthetic approaches for awake mapping commonly employ an "asleep–awake–asleep" or a conscious-sedation regimen adapted to institutional practice; both strategies aim to provide patient comfort during painful portions of the procedure while enabling patient participation for language and motor testing during mapping. Careful patient selection, preoperative neuropsychological assessment, and a multidisciplinary team (neurosurgeon, neuroanesthesiologist, neuropsychologist/ speech-language therapist and nursing staff) are critical to success. Implementation of standardized awake craniotomy programs has also been associated with maintained or improved clinical outcomes and institutional efficiencies in larger cohort studies [6].

Despite growing evidence supporting awake mapping, outcome data remain heterogeneous because of differences in patient selection, mapping paradigms, tumour biology, and definitions of EOR and functional outcomes. Single-centre series remain important to expand knowledge about real-world functional, cognitive, and oncological outcomes following awake resections, particularly in centres adopting standardized protocols and asleep-awake-asleep anaesthetic workflows [4,5].

Accordingly, we performed a retrospective single-centre analysis of patients who underwent awake craniotomy with intraoperative cortico-subcortical mapping for supratentorial gliomas in eloquent regions between January 2021 and March 2025, to evaluate surgical safety, functional and cognitive outcomes, extent of resection, and the relationship between EOR, tumour grade and survival.

MATERIAL AND METHODS

Study Design and Setting: This was a retrospective, single-centre observational study conducted over a period of four years, from January 2021 to March 2025. The study was designed to evaluate surgical, functional, and cognitive outcomes in patients who underwent awake craniotomy for supratentorial gliomas located within eloquent cortical and subcortical regions.

Study Population: Adult patients (≥18 years) with radiologically and histopathologically confirmed supratentorial gliomas involving eloquent brain regions, such as the motor cortex, speech areas, insula, or supplementary motor area, were included. Patients with severe preoperative neurological impairment precluding cooperation, psychiatric illness, or contraindications to awake craniotomy were excluded. A total of 25 patients were included in the final analysis.

Preoperative Evaluation: All patients underwent detailed preoperative assessment, which included:

- **Neurological examination** to document motor, sensory, and cranial nerve functions.
- **Neuropsychological evaluation** assessing memory, executive function, language, and attention.
- **Neuroimaging:** MRI brain with contrast and diffusion tensor imaging (DTI) for tractography were obtained to delineate tumour location and relationship with eloquent pathways.
- **Functional imaging:** In selected patients, functional MRI (fMRI) was used to identify motor and language activation areas.

Anaesthetic Protocol: An "asleep–awake–asleep" anaesthesia technique was used for all cases. Induction was achieved with intravenous propofol and fentanyl, followed by placement of a laryngeal mask airway. Patients were awakened for intraoperative mapping and language/motor testing, with re-sedation after tumour resection. Standard intraoperative monitoring included ECG, SpO_2, invasive blood pressure, and end-tidal CO_2.

Surgical Technique: All procedures were performed under by single senior neurosurgeon. A tailored craniotomy was planned according to tumour location. Intraoperative cortical and subcortical mapping was performed using bipolar stimulation (current range: 1–5 mA). Patient participation was ensured during language and motor testing, and tumour resection was limited to functional boundaries as defined by positive stimulation sites.

Outcome Assessment:

- **Extent of Resection (EOR):** Postoperative MRI within 48 hours was used to calculate EOR, classified as gross total resection (>90%) or subtotal resection (<90%).
- **Neurological outcome:** Motor, sensory, and cranial nerve deficits were assessed at discharge and at 1- and 6-month follow-up.
- **Cognitive and language outcomes:** Evaluated by standardized neuropsychological testing preoperatively and at 6 months post-surgery.
- **Oncological outcome:** Survival analysis was correlated with tumour grade and EOR.
- **Return to work capacity:** Documented during follow-up.

Data Collection and Analysis: Data were retrieved from electronic medical records and operative logs. Descriptive statistics were used to summarize demographic, clinical, and surgical data. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages. Survival was analyzed in relation to tumour grade and extent of resection.

RESULTS

A total of 25 patients underwent awake craniotomy for supratentorial lesions located in eloquent brain regions during the study period. Histopathological evaluation revealed 12 low-grade gliomas (48%), 5 grade III gliomas (20%), 5 glioblastomas (20%), and 3 dermoid cysts (12%) (Table 1).

The most common tumour location was the left frontal lobe (10 patients, 40%), followed by the left temporal lobe (6 patients, 24%), left insular lobe (5 patients, 20%), right premotor area (3 patients, 12%), and left post-central gyrus (1 patient, 4%) (Table 2).

Before surgery, 5 patients (20%) presented with focal neurological deficits, while 10 patients (40%) exhibited neuropsychological disturbances, including cognitive or language dysfunction. Five patients (20%) were unable to work due to tumour-related symptoms, whereas the remaining 5 (20%) were functionally intact (Table 3).

Postoperative MRI assessment demonstrated that maximal resection (>90%) was achieved in 10 of 12 patients (83.3%) with low-grade gliomas, 4 of 5 patients (80%) with grade III gliomas, 4 of 5 patients (80%) with glioblastomas, and all 3 patients (100%) with dermoid cysts. Overall, gross total resection was achieved in 84% of the study population (Table 4). Stimulation-induced seizures occurred intraoperatively in 2 patients (8%), both of which were controlled with cold Ringer's lactate irrigation and antiepileptic administration. Two patients (8%) experienced transient postoperative neurological or cognitive worsening, which gradually resolved with supportive therapy and rehabilitation. Importantly, no patient developed a permanent new neurological deficit (Table 5).

At 6-month follow-up, 20 patients (80%) achieved excellent functional recovery and were completely symptom-free, while 5 patients (20%) had minor residual deficits but remained independent in daily activities. Return to work was achieved in the majority of patients, including those who were preoperatively unable to work. Survival analysis demonstrated a significant correlation between outcome and both tumour grade and extent of resection, with higher EOR associated with improved prognosis (Table 6).

Table 1. Histological types of tumours (n = 25)

Tumour Type	Number of Cases	Percentage (%)
Low-grade glioma	12	48.0
Grade III glioma	5	20.0
Glioblastoma (Grade IV)	5	20.0
Dermoid cyst	3	12.0
Total	**25**	**100.0**

Table 2. Tumour location distribution

Location	Number of Cases	Percentage (%)
Left frontal lobe	10	40.0
Left insular lobe	5	20.0
Left temporal lobe	6	24.0
Right premotor area	3	12.0
Left post-central gyrus	1	4.0
Total	**25**	**100.0**

Table 3. Preoperative patient status

Parameter	Number of Patients	Percentage (%)
Neurological deficits	5	20.0
Neuropsychological disturbances	10	40.0
Unable to work	5	20.0
No significant deficits	5	20.0
Total	**25**	**100.0**

Table 4. Extent of resection (EOR) by tumour type

Tumour Type	Total Cases	EOR >90% (n)	Percentage (%)
Low-grade glioma	12	10	83.3
Grade III glioma	5	4	80.0
Glioblastoma	5	4	80.0
Dermoid cyst	3	3	100.0
Total	**25**	**21**	**84.0**

Table 5. Intraoperative and postoperative complications

Complication	Number of Cases	Percentage (%)
Intraoperative stimulation-induced seizures	2	8.0
Transient postoperative neurological/cognitive worsening	2	8.0
Permanent new neurological deficit	0	0.0

Table 6. Functional outcomes at 6 months

Outcome Category	Number of Cases	Percentage (%)
Excellent outcome (symptom-free)	20	80.0
Residual minor deficits	5	20.0
Total	**25**	**100.0**

CASE EXAMPLE:

A 30-year-old female presented with history of seizures since last one month. On MRI evaluation a low-grade glioma was found involving left insular lobe. She underwent Awake surgery and trans opercular excision of insular glioma under speech and motor mapping. Pre corticectomy area of speech arrest was noted by bipolar stimulation. Gross total excision was done. Postoperative period was uneventful, and she was discharged on postoperative day3. Postoperative MRI revealed gross total excision. (Figure 1)

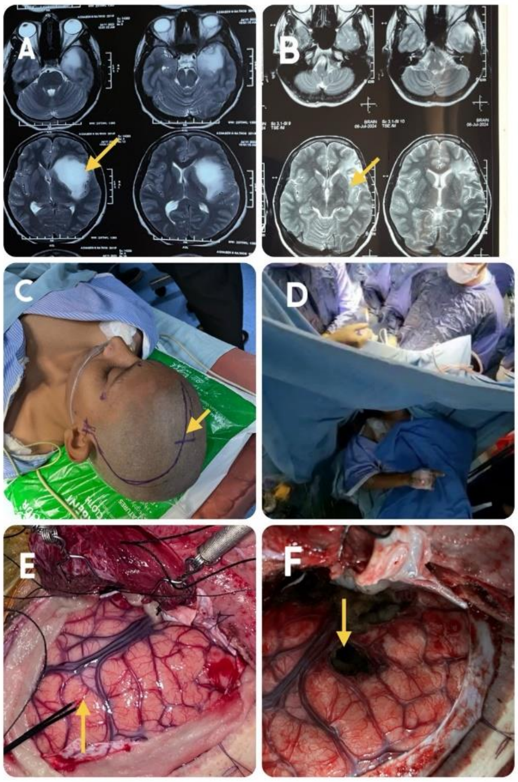

Figure 1: Case example

(A) Preoperative T2 weighted MRI suggestive of low-grade insular glioma. (marked by arrow). (B) Postoperative MRI image shows gross total excision. (C) Incision planning. (D) Operative setup. (E) Area of speech arrest on bipolar stimulation marked by yellow arrow. (F) Corticectomy and excision of tumor through inferior frontal gyrus preserving speech area.

DISCUSSION

Our study demonstrates that awake craniotomy with intraoperative cortical and subcortical mapping is a safe and effective approach for resecting gliomas located in eloquent brain regions. The procedure enabled maximal safe resection in 84% of patients, with a low incidence of transient neurological or cognitive deficits. These findings align with recent literature, which reports that awake mapping facilitates higher extent of resection (EOR) while preserving neurological function [7,8]. The high rate of gross total resection (GTR) achieved in our cohort, particularly in low-grade gliomas (83%) and dermoid cysts (100%), is consistent with studies indicating that awake craniotomy allows for more extensive tumour removal compared to standard techniques. This is especially pertinent in eloquent areas, where the risk of postoperative deficits is a significant concern [9,10].

Functional outcomes in our study were favorable, with 80% of patients being symptom-free at 6 months postoperatively. This is in line with findings from other centers that report high rates of functional independence following awake craniotomy [11,12]. The transient nature of the deficits observed in our cohort further supports the efficacy of awake mapping in minimizing permanent neurological impairments.

Our study also corroborates the significant association between EOR and survival outcomes. Patients achieving higher EOR had improved survival rates, a finding consistent with recent meta-analyses and systematic reviews [13]. This underscores the importance of striving for maximal safe resection in glioma surgery.

While our study adds to the growing body of evidence supporting awake craniotomy, it is not without limitations. The retrospective design and single-center nature of the study may introduce selection and observer biases. Additionally, the relatively small sample size limits the generalizability of our findings. Future multicenter, prospective studies with larger cohorts are needed to validate our results and further elucidate the long-term functional and oncological outcomes of awake craniotomy.

CONCLUSION

Awake craniotomy with intraoperative cortical and subcortical mapping provides a safe and effective strategy for resecting supratentorial gliomas located in eloquent brain regions. This approach enables maximal tumour removal while minimizing the risk of permanent neurological or cognitive deficits. Although a small proportion of patients may experience transient postoperative worsening, most recover with rehabilitation and return to normal daily activities. The extent of resection continues to be a critical determinant of survival, underscoring the importance of functional mapping-guided surgery in achieving optimal oncological and functional outcomes.

REFERENCES

1. Karschnia P, Gerritsen JKW, Teske N, Cahill DP, Jakola AS, van den Bent M, et al. The oncological role of resection in newly diagnosed diffuse adult-type glioma defined by the WHO 2021 classification: a review by the RANO resect group. Lancet Oncol. 2024;25(9):e404–19. doi:10.1016/S1470-2045(24)00291-4
2. Jusue-Torres I, Lee J, Germanwala AV, Burns TC, Parney IF. Effect of Extent of Resection on Survival of Patients with Glioblastoma, IDH-Wild-Type, WHO Grade 4 (WHO 2021): Systematic Review and Meta-Analysis. World Neurosurg. 2023 Mar;171:e524-e532. doi: 10.1016/j.wneu.2022.12.052.
3. Young JS, Morshed RA, Hervey-Jumper SL, Berger MS. The surgical management of diffuse gliomas: Current state of neurosurgical management and future directions. Neuro Oncol. 2023 Dec 8;25(12):2117-2133. doi: 10.1093/neuonc/noad133. Erratum in: Neuro Oncol. 2024 Jun 3;26(6):1175. doi: 10.1093/neuonc/noae083.
4. Morshed RA, Young JS, Lee AT, Berger MS, Hervey-Jumper SL. Clinical Pearls and Methods for Intraoperative Awake Language Mapping. Neurosurgery. 2021 Jul 15;89(2):143-153. doi: 10.1093/neuros/nyaa440.
5. Masohood NS, Paquin-Lanthier G, Chui J, Lu N, Chowdhury T, Venkatraghavan L. Intraoperative stimulation mapping in neurosurgery for anesthesiologists, Part 2: The anesthetic considerations. J Neuroanaesth Crit Care. 2023;10:149-154. doi:10.1055/s-0043-1777443.
6. Singh K, Dua A. Anesthesia for Awake Craniotomy. [Updated 2023 Jul 6]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK572053/
7. Wang Y, Guo S, Wang N, Liu J, Chen F, Zhai Y, et al. The clinical and neurocognitive functional changes with awake brain mapping for gliomas invading eloquent areas: Institutional experience and the utility of The Montreal Cognitive Assessment. Front Oncol. 2023 Feb 22;13:1086118. doi: 10.3389/fonc.2023.1086118.
8. Mirza AB, Vastani A, Suvarna R, Rashed S, Al-Omarie A, Mthunzi E. Preoperative and intraoperative neuromonitoring and mapping techniques impact oncological and functional outcomes in supratentorial function-eloquent brain tumours: a systematic review and meta-analysis. eClinicalMedicine. 2025;80:103055. doi:10.1016/j.eclinm.2025.103055.

9. Abo-Elnour DE, Pichardo-Rojas PS, Abdalla YE, Salama MK, Elboraay T, Rizk MA, et al. Comparative efficacy of awake and asleep motor mapping in glioma surgery: A meta-analysis of 3011 patients. Neurosurg Rev. 2024 Nov 19;47(1):859. doi: 10.1007/s10143-024-03080-x.
10. Gerritsen JKW, Zwarthoed RH, Kilgallon JL, Nawabi NL, Jessurun CAC, Versyck G, et al. Effect of awake craniotomy in glioblastoma in eloquent areas (GLIOMAP): a propensity score-matched analysis of an international, multicentre, cohort study. Lancet Oncol. 2022 Jun;23(6):802-817. doi: 10.1016/S1470-2045(22)00213-3.
11. Nga S, Rigaud V, Moritz-Gasser S, Gozé C, Darlix A, Herbet G, et al. Long-term autonomy, professional activities, cognition, and overall survival after awake functional-based surgery in patients with IDH-mutant grade 2 gliomas: a retrospective cohort study. Lancet Reg Health Eur. 2024;46:101078. doi:10.1016/j.lanepe.2024.101078
12. Amores-Carrera L, Martín-Monzón I. Neuropsychological outcomes following awake surgery in adult glioma patients: a systematic review. Neuro-Oncol Pract. 2025 Jul 30. doi: 10.1093/nop/npaf075.
13. Staub-Bartelt F, Suresh Babu MP, Szelényi A, Rapp M, Sabel M. Establishment of Different Intraoperative Monitoring and Mapping Techniques and Their Impact on Survival, Extent of Resection, and Clinical Outcome in Patients with High-Grade Gliomas-A Series of 631 Patients in 14 Years. Cancers (Basel). 2024 Feb 25;16(5):926. doi: 10.3390/cancers16050926.