Top 100 Most Cited Articles on Awake Glioma Surgery: A Bibliometric Analysis

Mary Angeline Luz U. Hernandez, MD,[1] Almira Doreen Abigail O. Apor, MD,[2]
Kevin Ivan P. Chan, MD[1] and Kathleen Joy O. Khu, MD[1]

[1]*Division of Neurosurgery, Department of Neurosciences, College of Medicine and Philippine General Hospital, University of the Philippines Manila*
[2]*Division of Adult Neurology, Department of Neurosciences, College of Medicine and Philippine General Hospital, University of the Philippines Manila*

ABSTRACT

Background and Objective. Awake craniotomy is often used in the surgery of glioma, the most common primary brain tumor. It has been proven to maximize the extent of tumor resection while minimizing post-operative neurologic deficits. Extensive research has been conducted on this topic, and we would like to perform a bibliometric analysis to identify the top 100 most cited articles in awake glioma surgery. Knowing the relevant and most impactful studies in the field would help clinicians streamline the evidence and determine its application in their practice.

Methods. In October 2023, we performed a title-specific search on the Scopus and PubMed databases using ("glioma*" OR "astrocytoma*" OR "glioblastoma" OR "low grade glioma" OR "high grade glioma") and ("awake craniotomy" OR "awake surgery" OR "awake brain surgery" OR "awake neurosurgery") as our query term without any restriction criteria. The top 100 most cited articles were identified, reviewed, and analyzed.

Results. Our search yielded a total of 5557 articles published. The top article had a citation count of 834 and reported on functional outcome after language mapping in glioma resection. *Journal of Neurosurgery* had the most number of publications. Neurosurgeons (n=81) were the primary author in most publications, followed by anesthesiologists (n=22) and neurologists (n=6). Three countries (USA, France, Italy) contributed to 74% of the articles. Most of the articles were reviews and case reports/series.

Conclusion. This study identified the top 100 most cited articles on awake glioma surgery. The content dealt with several aspects of awake craniotomy such as brain mapping, intraoperative techniques and adjuncts, and practice recommendations. This analysis can help identify knowledge gaps and potential areas of research in glioma surgery.

Keywords: awake craniotomy, awake surgery, glioma, glioblastoma, astrocytoma, bibliometric analysis, scientometric analysis

Paper presentation - Academy of Filipino Neurosurgeons Annual Research Contest 2023, November 30, 2023, Manila, Philippines.

eISSN 2094-9278 (Online)
Published: September 15, 2025
https://doi.org/10.47895/amp.v59i13.11080

Corresponding author: Mary Angeline Luz U. Hernandez, MD
Division of Neurosurgery
Department of Neurosciences
Philippine General Hospital
University of the Philippines Manila
Taft Avenue, Ermita, Manila 1000, Philippines
Email: muhernandez@up.edu.ph
ORCiD: https://orcid.org/0000-0002-0429-8866

INTRODUCTION

Glioma is the most common primary central nervous system (CNS) tumor, accounting for 30% and 80% of all primary and malignant primary brain tumors, respectively.[1,2] They are classified as either low grade or high grade based on histology and expected clinical behavior. Low grade gliomas are slow-growing primary brain tumors that are treated with maximal safe resection, as well as chemotherapy and radiotherapy (RT) in cases of residual tumors.[1] Its median overall survival rate is approximately 10 years.[1] On the other hand, high grade gliomas are aggressive tumors with an overall survival rate ranging from 14 months to 5 years despite surgery and adjuvant treatment.[2]

It has been established that greater extent of resection confers survival benefit and better quality of life.[3] Intraoperative adjuncts such as awake craniotomy play an important role in increasing safety in glioma surgery.

Awake craniotomy allows brain mapping on eloquent cortex such as the motor and language areas. It also plays a role in determining negative motor response and integrating movement control in multitasking evaluation.[3,4] Its impact and use in maximal safe tumor resection has been extensively described in the literature.[3] This technique is one of the adjuncts used in maintaining onco-functional balance in the surgical treatment of glioma, resulting in a better prognosis and quality of life.[3,4]

There has been an exponential growth in the literature on awake glioma surgery due to its increasingly widespread use, especially in high-resource countries, with only a few articles from low- and middle-income countries.[5,6] Knowing the relevant and most impactful studies in this field would help clinicians streamline the evidence and determine its application in their practice. Furthermore, identifying the key articles and mapping out the use of awake craniotomy in glioma surgery would help neurosurgeons and other physicians make evidence-based clinical decisions. The purpose of this bibliometric analysis is to identify and analyze the characteristics of the top 100 most cited articles on awake craniotomy for glioma surgery that has been published to date. We also aim to identify key areas and knowledge gaps, not only in the neurosurgical operative technique, but also the impact of awake surgery in glioma treatment and research.

MATERIALS AND METHODS

Search Strategy

We performed a citation analysis of awake craniotomy for treatment of high grade and low grade gliomas. A title-specific search of the SCOPUS and PubMed databases were used to identify highly cited articles from inception until October 12, 2023. Search strategies were developed using medical subject headings (MeSH). We used ("glioma*" OR "astrocytoma*" OR "glioblastoma" OR "low grade glioma" OR "high grade glioma") and ("awake craniotomy" OR "awake surgery" OR "awake brain surgery" OR "awake neurosurgery") as our query term without any restriction criteria. The results were arranged in descending order according to the citation count. Articles not related to the search terms were excluded from our study. Articles that were conference proceedings or book chapters were excluded. The top 100 most cited articles were obtained and reviewed by the authors. When multiple articles were tied with the same citation count, two or more articles occupied the similar rank. Reviewers screened all studies based on study titles and abstracts available. The studies were evaluated independently by two of the investigators.

Data Collection and Analysis

The article title, primary author, primary author's specialty, institution, country of origin, journal of publication, citation count, and study category for the top 100 most cited articles were obtained. Study categories included prospective or retrospective cohort, systematic review, meta-analysis, randomized controlled trials, technical notes, or laboratory studies. Furthermore, the authors' Source Normalised Impact per Paper (SNIP) and SCImago Journal Rank (SJR) were obtained as well. SJR is a parameter that determines the importance of a journal for the scientific community, a value calculated based on the number of listed citations that this journal receives, as well as the scientific reputation of the journal from which the citation came from.[7] When the authors of an article had more than one affiliation, the department, institution, and country of origin were defined by the affiliation of the first author of the said study. Network analysis of related keywords was also conducted to determine clustering tendencies. Data were presented using descriptive statistics, and no tests of statistical significance were performed.

RESULTS

A total of 5557 bibliographic records on awake glioma surgery were retrieved from the electronic database. From this list, the top 100 cited articles with the highest citation counts were obtained. All the articles with the same number of citation counts shared a corresponding rank. Table 1 shows the top 20 most cited articles on awake glioma surgery. A supplementary table (Appendix) is provided for the complete list.

We identified a total of 124 articles with the top 100 highest citations, garnering a cumulative citation count of 27,226. The mean citation count was 220 (SD=126), and the median was 178 (IQR 136 – 256). The most cited article, with a total of 834 citations, was published in 2008 in New England Journal of Medicine by Sanai et al. It was entitled "Functional outcome after language mapping for glioma resection."

The articles were published across 59 unique journals, of which eight are considered high impact (IF ≥10). The median IF was 4.1 (IQR 2.895–6.595). Most articles were published in the Journal of Neurosurgery (n=16), followed by Neurosurgery (n=14), Acta Neurochirurgica (n=6), Brain (n=6), and Journal of Neuro-Oncology (n=6) (Table 2).

Most studies were reviews (n=50), followed by cohort studies (n=42), and case series or case reports (n=16) (Figure 1). Most articles dealt with neurosurgical treatment and outcomes (n=43), anesthesia (n=20), and anatomy and physiology of awake craniotomy (n=16) (Figure 2).

Majority of primary authors were neurosurgeons (n=81), followed by anesthesiologists (n=22), and neurologists (n=6) (Table 3). Among them, H. Duffau authored 40 articles, 21 of which he was the primary author, followed by M. S. Berger (n=17), S. Moritz-Gasser (n=10), and L. Capelle (n=10). The country with the most highly cited publications was the USA (n=51), followed by France (n=32), and Italy (n=7) (Table 4). Gui de Chauliac Hospital, Montpellier University Medical Center, France, and University of California - San Francisco, USA both had the greatest number of publications (n=13), followed by Hôspital Salpêtrière, France (n=11), and Harvard Medical School, USA (n=7) (Table 5).

Table 1. Top 20 Cited Articles

Rank	Title	First Author	Journal	Type of Article
1	Functional outcome after language mapping for glioma resection	Sanai N	New England Journal of Medicine	Retrospective study
2	Impact of intraoperative stimulation brain mapping on glioma surgery outcome: a meta-analysis	De Witt Hamer PC	Journal of Clinical Oncology	Meta-analysis
3	Survival following surgery and prognostic factors for recently diagnosed malignant glioma: data from the glioma outcomes project	Laws ER	Journal of Neurosurgery	Prospective study
4	Clinical Pharmacokinetics and Pharmacodynamics of Dexmedetomidine	Weerink MAS	Clinical Pharmacokinetics	Review
5	Movement intention after parietal cortex stimulation in humans	Desmurget M	Science	Case series
6	Lessons from brain mapping in surgery for low-grade glioma: insights into associations between tumour and brain plasticity	Duffau H	Lancet Neurology	Review
7	Contribution of intraoperative electrical stimulations in surgery of low grade gliomas: A comparative study between two series without (1985-96) and with (1996-2003) functional mapping in the same institution	Duffau H	Journal of Neurology, Neurosurgery and Psychiatry	Retrospective study
8	Intraoperative mapping of the subcortical language pathways using direct stimulations. An anatomo-functional study	Duffau H	Brain	Retrospective study
9	Usefulness of intraoperative electrical subcortical mapping during surgery for low-grade gliomas located within eloquent brain regions: functional results in a consecutive series of 103 patients	Duffau H	Journal of Neurosurgery	Retrospective study
10	Emerging insights into the molecular and cellular basis of glioblastoma	Dunn GP	Genes and Development	Review
11	Intraoperative subcortical stimulation mapping of language pathways in a consecutive series of 115 patients with Grade II glioma in the left dominant hemisphere	Duffau H	Journal of Neurosurgery	Retrospective study
12	Survival in glioblastoma: a review on the impact of treatment modalities	Delgado-Lopez PD	Clinical and Translational Oncology	Review
13	Cortical localization of temporal lobe language sites in patients with gliomas	Haglund MM	Neurosurgery	Retrospective study
14	Beyond the arcuate fasciculus: consensus and controversy in the connectional anatomy of language	Dick AS	Brain	Review
15	Does the left inferior longitudinal fasciculus play a role in language? A brain stimulation study	Mandonnet E	Brain	Retrospective study
16	Awake craniotomy with brain mapping as the routine surgical approach to treating patients with supratentorial intraaxial tumors: a prospective trial of 200 cases	Taylor MD	Journal of Neurosurgery	Prospective study
17	Propofol: an update of its use in anaesthesia and conscious sedation	Bryson HM	Drugs	Review
18	Intraoperative subcortical stimulation mapping for hemispherical perirolandic gliomas located within or adjacent to the descending motor pathways: evaluation of morbidity and assessment of functional outcome in 294 patients	Keles GE	Journal of Neurosurgery	Retrospective study
19	Dexmedetomidine: a review of clinical applications	Carollo DS	Current Opinion in Anaesthesiology	Review
20	Awake surgery for WHO grade II gliomas within "noneloquent" areas in the left dominant hemisphere: toward a "supratotal" resection - Clinical article	Yordanova YN	Journal of Neurosurgery	Retrospective study

A total of 1268 keywords were identified from the included articles, 402 of which were unique. Each article had between 2 and 36 keywords, with a median keyword count of 6 (IQR 5–14.25)(Table 6). Network analysis revealed multiple thematic clusters with high-degree nodes corresponding to frequently studied topics such as "glioma," "brain mapping," and "awake craniotomy." “Glioma,” being the primary tumor type involved in awake craniotomy, had strong links to keywords about surgery techniques, imaging, treatment, and brain processes. “Brain mapping” directly linked to language mapping, direct electrical stimulation, cortical mapping, neurosurgery, and brain plasticity. “Awake craniotomy” strongly connected to glioma, extent of resection, brain mapping, neuronavigation, direct electrical stimulation, and conscious sedation, emphasizing its role in tumor resection and function preservation. Other central keywords included: “magnetic resonance imaging,” “language,” “extent of resection,” “sedation,” “neurosurgery,” and “connectivity.” (Figures 3 and 4)

DISCUSSION

Awake craniotomy has a long history that can be traced back to archeological records of the successful practice of trephination.[6] It spans from trephinations performed in ancient times, to the first concept of brain mapping by Batholow in the 19th century, and to the first application of awake craniotomy for intractable epilepsy in the 1920's by Wilder Penfield.[5,6] It is an essential tool in modern neurosurgery, particularly in glioma surgery, with the goal of maximizing tumor resection while minimizing the postoperative deficits.[6] Awake glioma surgery allows aggressive resection of the tumor in eloquent areas of the brain.[7] Furthermore, with the continuous development and intensive research in brain mapping and the search for the best anesthetic technique for awake craniotomy, the future of integrated cerebral localization techniques and maximal tumor resection may significantly impact the prognosis of glioma patients.

To the best of the authors' knowledge, this is the first bibliometric analysis to focus on articles on awake glioma

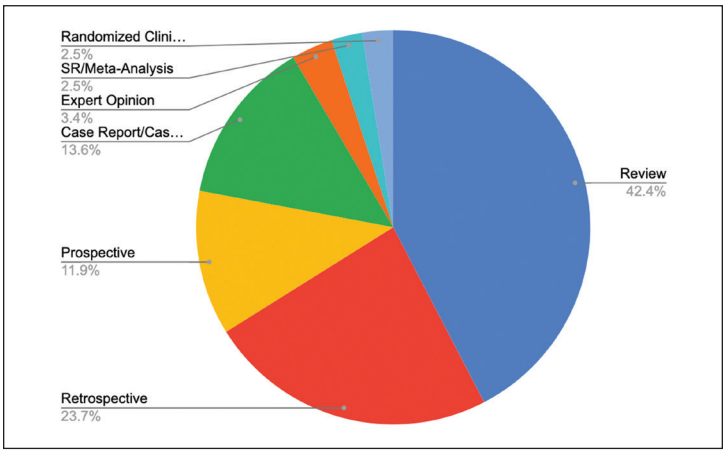

Figure 1. Types of articles published in the top 100 most cited articles.

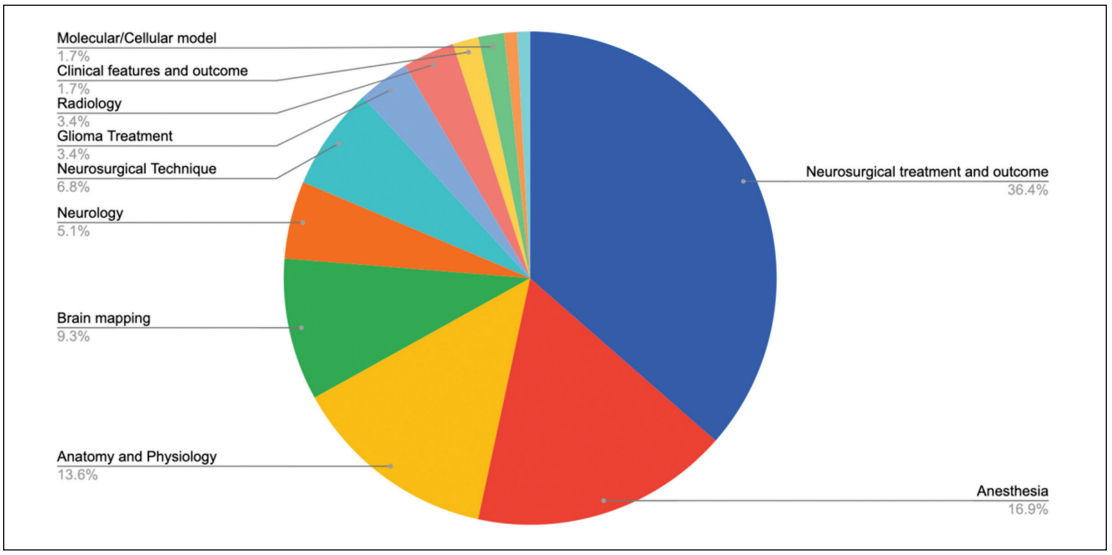

Figure 2. Content of articles published in the top 100 most cited articles.

Notes:

- *Neurosurgical technique – articles described different neurosurgical techniques in awake glioma surgery*
- *Neurosurgical treatment and outcome – articles focused on the use of awake glioma surgery and its outcomes*
- *Glioma treatment – articles employed a more comprehensive approach to glioma treatment, and not just awake surgery*
- *Clinical features and outcome – articles that described the demographics, clinical characteristics, surgical treatment, and outcomes of patients*
- *Neurology – these were mainly review articles on neurological concepts in brain mapping and awake surgery*
- *Brain mapping – articles that described different techniques of brain mapping (invasive or combination of invasive and non-invasive) in awake glioma surgery*

Table 2. Top Journals by Number of Most Cited Articles

Journal	Articles	SJR	Quartile	IF (2022)
Journal of Neurosurgery	16	1.138	Q1	2.90
Neurosurgery	14	1.221	Q1	2.41
Brain	6	4.437	Q1	8.68
Journal of Neuro-Oncology	6	1.178	Q1	3.68
Acta Neurochirurgica	6	0.718	Q1	2.26
Neurosurgical Focus	4	1.188	Q1	3.26
Anesthesia and Analgesia	4	1.365	Q1	3.29
Journal of Neurology Neurosurgery and Psychiatry	3	3.178	Q1	6.69
Brain and Language	3	0.766	Q1	2.51
Neuro-Oncology	3	4.833	Q1	9.53
British Journal of Anaesthesia	3	2.487	Q1	4.15
Brain Structure and Function	3	1.168	Q1	2.88
Current Opinion in Anaesthesiology	2	0.566	Q2	2.46
Neuropsychologia	2	0.995	Q1	2.64
Cortex	2	1.303	Q1	3.44
NeuroImage	2	2.512	Q1	5.68
Journal of Neurosurgical Anesthesiology	2	0.774	Q1	2.48
World Neurosurgery	2	0.591	Q2	1.68

Table 3. Specialties of the Primary Author Contributing to the Top 100 Cited Articles

Author Specialties	n
Neurosurgery	81
Anesthesiology	22
Neurology	6
Psychology	5
Neuro-oncology	3
Radiology	2
Neurocognitive	1
Neuroradiology	1
Pharmacology	1
Radiation Oncology	1
Neurobiology/ Basic Neuroscience	1

Table 4. Countries of Origin of Top 100 Cited Articles

Country	n
USA	51
France	32
Italy	7
Germany	6
Canada	4
Netherlands	4
Spain	4
Finland	2
Israel	2
UK	2
New Zealand	1
Portugal	1
Japan	1
China	1
Ireland	1
Russia	1
India	1
Norway	1
South Korea	1
Malaysia	1

Table 5. Institutions with more than One Article in the Top 100 Articles

Institution	Country	Articles
Gui de Chauliac Hospital, Montpellier University Medical Center	France	13
University of California, San Francisco	USA	13
Hôpital Salpêtrière	France	11
Brigham and Women's Hospital, Harvard Medical School	USA	7
New York University Medical Center	USA	3
Toronto Western Hospital	Canada	3
Mayo Clinic	USA	2
Tel Aviv Medical Center	Israel	2
University Hospital Schleswig-Holstein	Germany	2
University of Insubria	Italy	2
University of Washington	USA	2
VU University Medical Center	Netherlands	2
Florida International University	USA	2

Table 6. Top 10 most Common Keywords Found in the List of Top 100 Cited Articles

Keyword	n	%
brain neoplasms	103	8.12
glioma	99	7.81
brain mapping	59	4.65
humans	50	3.94
language	41	3.23
cerebral cortex	37	2.92
craniotomy	33	2.60
electric stimulation	33	2.60
dexmedetomidine	32	2.52
neurosurgical procedures	29	2.29

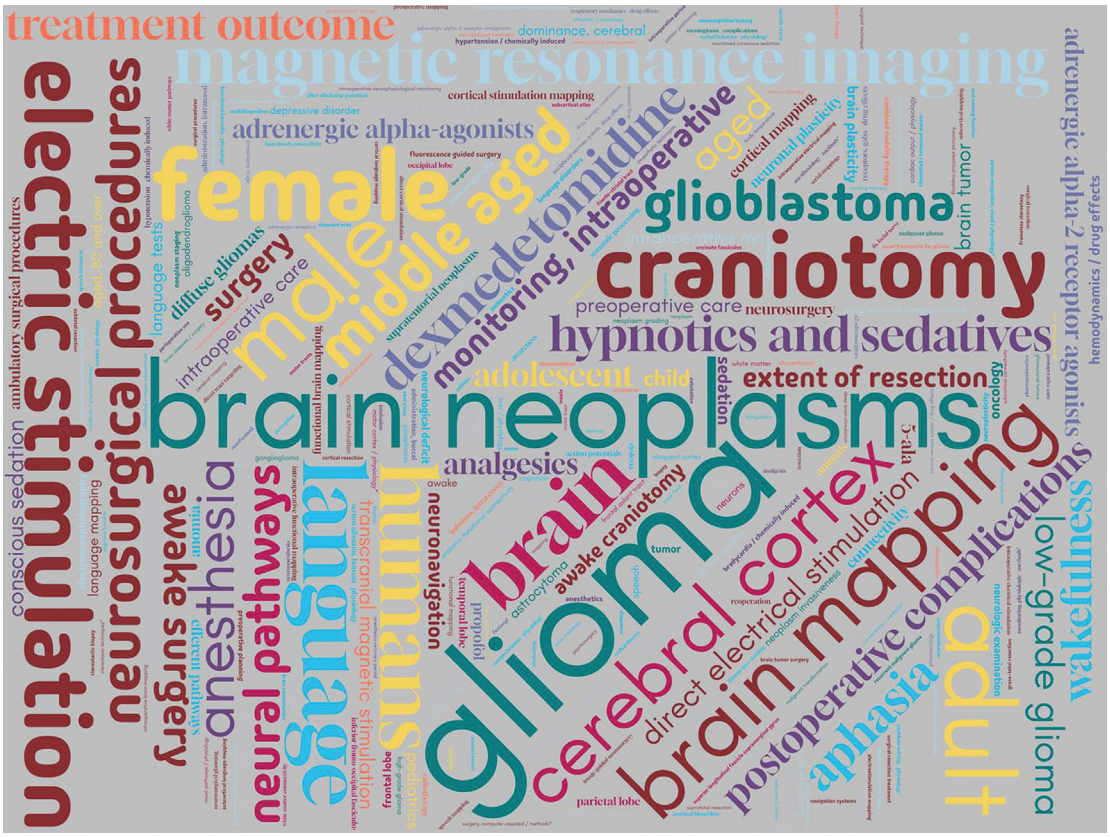

Figure 3. Word cloud representation of key words of the included literature.

Note: The size of each term corresponds to its frequency of occurrence. Prominent terms such as "gliomas," "craniotomy," "brain mapping," and "electric stimulation" emphasize critical aspects of tumor resection, functional preservation, and intraoperative monitoring.

surgery. Some of the identified knowledge gaps in the use of awake surgery in glioma treatment include the definition of cortical language areas, intraoperative brain mapping techniques, and the optimal anesthetic technique in awake craniotomy. We hope that our study identified the list of impactful articles that would answer these knowledge gaps, particularly those that are applicable to specific resource settings.

Most Cited Articles

The most cited article in our study was written by Sanai et al. in 2008, with a total of 836 citations. This paper highlighted the variation of cortical language organization among patients.[8] The most significant finding in this article was the low morbidity rate from resection of cortical areas that yielded a negative response during cortical stimulation. This was contrary to the classic belief that there was a need to identify the language area by positive mapping before safe glioma resection can be performed.[8]

The second most cited article was written by De Witt Hamer et al. in 2012, with 745 citations, followed by Laws et al. in 2003, which received 564 citations. Both articles discussed the functional outcome of intraoperative brain mapping on glioma surgery, and they both concluded that intraoperative mapping enabled maximal tumor resection involving eloquent cortex with fewer neurologic deficits.[4,9] In fact, De Witt Hamer et al. recommended that intraoperative brain mapping be the standard of care for all glioma surgery.[4]

Author Affiliation and Specialty

Seventy-four percent (74%) of the top 100 most cited articles were contributed by three countries: USA, France, and Italy. This finding demonstrated their significant contribution in the development of awake glioma surgery and its continuous advancement. The USA had the highest number of studies, producing 51 articles in the top 100 most cited articles. This was consistent with the finding of Elarjani et al. in their bibliometric analysis, wherein the USA was found to be number one in astrocytoma publications.[2] This was not surprising since the U.S. National Institutes of Health (NIH) is one of the largest funding sponsors in glioblastoma multiforme research.[10] Furthermore, the three top countries in this analysis are among the most well-equipped and advanced in scientific research.[1,2,10]

There were 124 publications in the top 100 most cited articles, and they were produced by more than 50 institutions. The centers with more than five articles included University

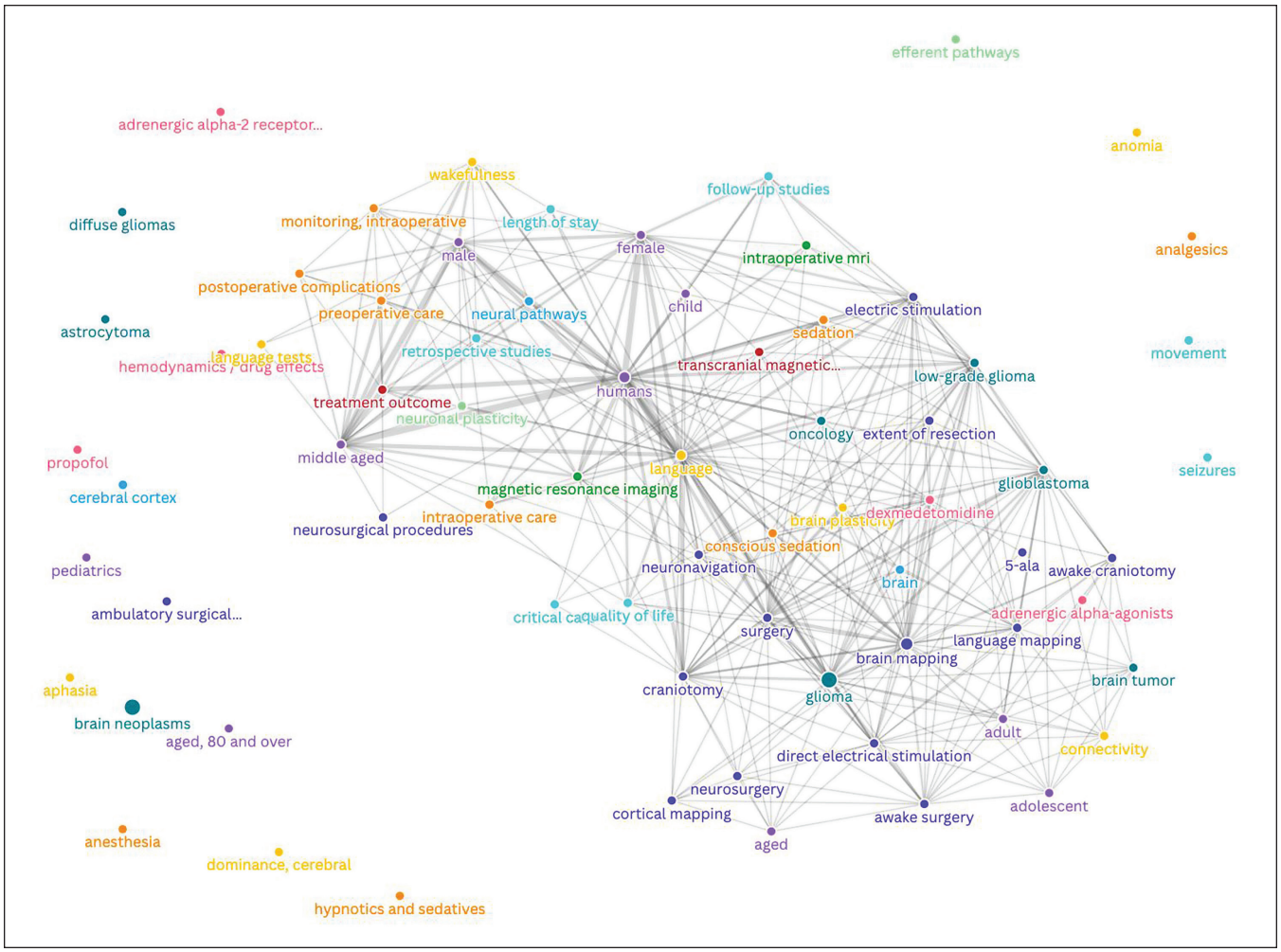

Figure 4. Network diagram of related keywords from the top 100 most cited articles on awake glioma surgery. Each node represents a keyword, while edges indicate co-occurrence relationships. Node colors correspond to distinct thematic clusters, highlighting key research topics in awake craniotomy.

of California San Francisco, USA and Gui de Chauliac Hospital, Montpellier University Medical Center, France, which were tied at first place in producing 13 articles each. Pitié-Salpêtrière University Hospital, France was second by contributing 11 articles. These top institutions have been continuously producing high-quality science and impactful research to improve the outcome of patients with glioma. In fact, University of California San Francisco was awarded as the number one public institution by the NIH in 2022.[11,12] Interestingly, there was only one publication identified from LMICs, which ranked 89th in citation analysis. It accounted for 0.8% of the total publications identified, reflecting the paucity of data from resource-limited settings. This lone article is from India, which reported the results of a prospective randomized study comparing awake craniotomy versus surgery under general anesthesia for tumor resection in eloquent cortex.

The top authors from this analysis also came from the top institutions identified, namely Dr. Hughes Duffau from Montepellier University and Dr. Mitchell Berger from University of California San Francisco. Dr. Duffau's work focused on the development of intraoperative monitoring in awake glioma surgery while Dr. Berger's work was more diverse, ranging from "bench to bedside" treatment for glioma. This included basic sciences studies, laboratory research, and their application in clinical settings.

Among the specialties, neurosurgery contributed the most articles, which is expected, and the journal that published the most number of articles in this analysis was Journal of Neurosurgery. Of the top 100 most cited articles, eight prospective studies discussed the impact of surgical management, particularly awake craniotomy, on the treatment of malignant glioma, and they all concluded that extent of resection was a significant prognostic factor for survival.[9,13-19] Several articles reported on the use of awake craniotomy with intraoperative brain mapping techniques and other adjuncts that allowed safe and maximal resection of tumors in eloquent areas and minimized postoperative neurologic complications.[13-15,18,19]

Anesthesia was the second most common specialty in this analysis, confirming its vital role in awake craniotomies. This exemplifies the need for an excellent multidisciplinary team to conduct successful awake glioma surgery.[20] The role of propofol and dexmedetomidine as anesthetic agents for awake craniotomy was also evident. In our list, these two anesthetic agents were the most studied and investigated in awake cranial surgery. Dexmedetomidine has a unique property that allows smooth transition from sleep to wakefulness, allowing the patient to be more cooperative during surgery.[21] Because of its unique sedative effect, two review studies also reported its application and feasibility in the pediatric population.[22,23] This opens avenues for research on the feasibility of awake cranial surgeries among pediatric patients. In fact, Ard et al. reported their experience on two pediatric patients who underwent awake craniotomy with dexmedetomidine. In their case series, the patients were able to complete neuro-psychological testing and brain mapping during the surgery.[22]

Aside from anesthesia, other non-neuroscience specialties such as radiology and psychology have produced articles as well.

Type of Study and Content

Almost 50% of the studies were literature reviews and case reports or series. There were very few randomized controlled trials and most of the prospective studies were from the top three institutions identified. Most of the articles were about neurosurgical treatment and its clinical outcome. They included literature reviews, case series, and cohort studies about intraoperative brain mapping and maximal tumor resection. There were also 11 articles in the top 100 that described non-invasive adjuncts to awake craniotomy, brain mapping, and cortical stimulation, such as functional MRI, tractography, transcranial magnetic stimulation, image guidance, and neuronavigation. They were included in this analysis because they were either used with or directly compared with awake craniotomy. One study concluded that presurgical mapping can improve the extent of tumor resection and the patient's clinical outcome.[24] This was a novel area for research since these methods are not yet standardized.[24] In a recently published report, Krieg et al. wrote that navigated transcranial magnetic stimulation showed excellent concurrence with direct cortical stimulation, at a level that is adequate for preoperative neurosurgical work-up and use as an adjunct for tumor surgery on eloquent areas. However, they cautioned that this should not replace the use of awake craniotomy in the resection of eloquent brain tumors.[25]

Trend of Publications

Our findings showed an increasing trend in the number of publications from 2001 to 2017, which comprised 87% of the articles on the list (Figure 5). This trend coincided with the start of the use of awake craniotomy for brain tumor resection in most centers.[5] However, there was a decline in the number of studies thereafter, especially during the COVID-19 pandemic. This decline can be attributed to a decrease in the number of elective surgery cases, as well as the hesitation of the surgical team to perform awake cranial surgery without a proper protocol in the early months of the pandemic.

Network Analysis

Analysis of keywords revealed an extensive range of terms. The number of unique keywords suggests a broad spectrum of research interests, encompassing various aspects of awake craniotomy, including neuro-oncology, intraoperative monitoring, and functional preservation.

The most commonly used terms identified aligns with the established focus with awake craniotomy optimizing oncologic and functional outcomes. There is a wide variation in keyword usage, which may highlight differences in how

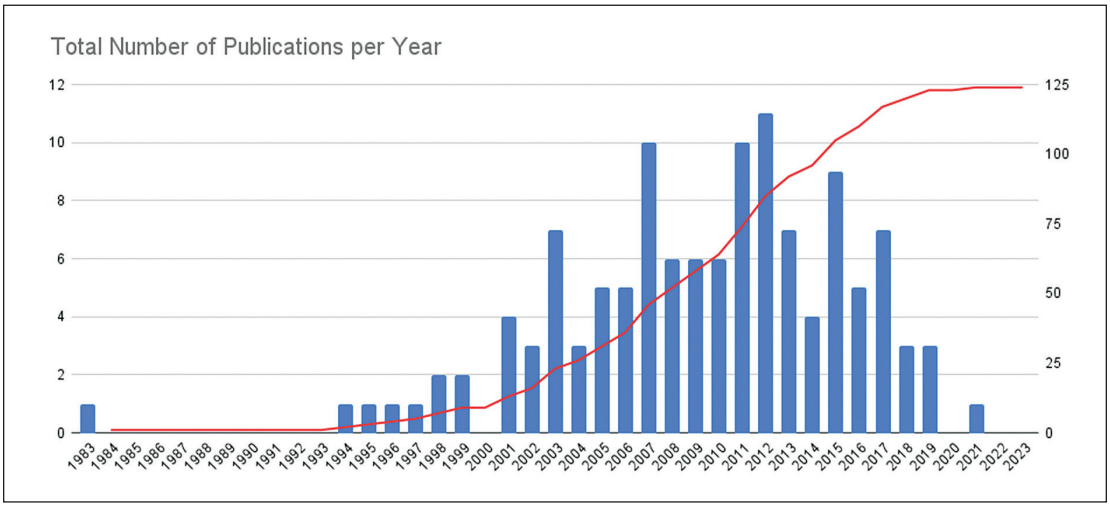

Figure 5. Distribution of top 100 most cited articles by year of publication.

authors prioritize descriptors, potentially influencing article discoverability in research databases (Figure 3).

In the network analysis of keywords, most were closely linked to the central keywords "glioma," "brain mapping," and "awake craniotomy," which correspond to the initial search query of the study (Figure 4). Tumor-related terms were found to be at the center of awake craniotomy discussions as well as surgical technique and functional outcomes. These keywords correlate with the general theme of awake craniotomy research – tumor resection, functional mapping, intraoperative imaging, patient safety, and treatment outcomes. These clusters reinforce the multidisciplinary nature of awake craniotomy, integrating neurosurgery, brain physiology, neuroimaging, neuro-oncology, and anesthesia for optimal patient care.

Future bibliometric studies could explore how keyword selection impacts citation rates and research visibility, providing further insight into the trends shaping the field of awake craniotomy.

Limitations

Our study included only English language articles, and a search was performed in only two databases. The list is also expected to change over time, as more articles are written. Furthermore, the citation count for each of the articles was influenced by factors such as journal accessibility and reputation. This count is only an indirect measure of its scientific impact and relevance.

CONCLUSION

The top 100 most cited articles highlighted the most relevant and influential articles in awake glioma surgery published to date. The content dealt with several aspects of awake craniotomy such as brain mapping, intraoperative techniques and adjuncts, and practice recommendations. This analysis illustrated the development of surgical treatment and approach to glioma throughout the years, and helped identify knowledge gaps and potential areas of research in glioma surgery.

Statement of Authorship

All authors certified fulfillment of ICMJE authorship criteria.

Author Disclosure

All authors declared no conflicts of interest.

Funding Source

None.

REFERENCES

1. Zhang Y, Lim D, Yao Y, Dong C, Feng Z. Global Research Trends in Radiotherapy for Gliomas: A Systematic Bibliometric Analysis. World neurosurgery, 161, e355–e362. https://doi.org/10.1016/j.wneu.2022.02.001
2. Elarjani T, Almutairi OT, Alhussinan M, Alzhrani G, Alotaibi FE, Bafaquh M. Bibliometric analysis of the top 100 most-cited articles on astrocytoma. Surgical neurology international, 12, 62. https://doi.org/10.25259/SNI_521_2020
3. Albuquerque LAF, Macêdo Filho LJM, Borges FS, Pessoa FC, Diógenes GS, Rocha CJ, et al. Awake Craniotomy for Diffuse Low Grade Gliomas in a Resource Limited Setting: Lessons Learned with a Consecutive Series of 51 Surgeries. World neurosurgery, S1878-8750(23)00879-3. Advance online publication. https://doi.org/10.1016/j.wneu.2023.06.096
4. De Witt Hamer PC, Robles SG, Zwinderman AH, Duffau H, Berger MS. Impact of intraoperative stimulation brain mapping on glioma surgery outcome: a meta-analysis. Journal of clinical oncology: official journal of the American Society of Clinical Oncology, 30(20), 2559–2565. https://doi.org/10.1200/JCO.2011.38.4818
5. July J, Manninen P, Lai J, Yao Z, Bernstein M. The history of awake craniotomy for brain tumor and its spread into Asia. Surgical neurology, 71(5), 621–625. https://doi.org/10.1016/j.surneu.2007.12.022
6. Bulsara KR, Johnson J, Villavicencio AT. Improvements in brain tumor surgery: the modern history of awake craniotomies. Neurosurgical focus, 18(4), e5. https://doi.org/10.3171/foc.2005.18.4.6
7. Panagopoulos D, Karydakis P, Giakoumettis D, Themistocleous M. The 100 Most Cited Papers About Brain Metastases. World neurosurgery, 138, 98–114. https://doi.org/10.1016/j.wneu.2020.02.156
8. Sanai N, Mirzadeh Z, Berger MS. Functional outcome after language mapping for glioma resection. The New England journal of medicine, 358(1), 18–27. https://doi.org/10.1056/NEJMoa067819
9. Laws ER, Parney IF, Huang W, Anderson F, Morris AM, Asher A, et al. Survival following surgery and prognostic factors for recently diagnosed malignant glioma: data from the Glioma Outcomes Project. Journal of neurosurgery, 99(3), 467–473. https://doi.org/10.3171/jns.2003.99.3.0467
10. Akmal M, Hasnain N, Rehan A, Iqbal U, Hashmi S, Fatima K, et al. Glioblastome Multiforme: A Bibliometric Analysis. World neurosurgery, 136, 270–282. https://doi.org/10.1016/j.wneu.2020.01.027
11. U.S. Department of Health and Human Services. (n.d.). Report ⟩ reporter. National Institutes of Health, Training Program in Translational Brain Tumor Research [Internet] 2022 [cited 2025 May]. Available from: https://reporter.nih.gov/search/9rbNLfGkjU--3je0VeNZtQ/project-details/10479153
12. UCSF News/Media, UCSF is No. 1 Public Recipient of National Institutes of Health Funding in 2022.[Internet]. 2023 (cited 2025 May]. Available from: https://www.ucsf.edu/news/2023/02/424826/ucsf-no-1-public-recipient-national-institutes-health-funding-2022#:~:text=1%20Public%20Recipient%20of%20National%20Institutes%20of%20Health%20Funding%20in%202022,-Share%20on%20Facebook&text=UC%20San%20Francisco%20received%20the,private%20institutions%20in%20the%20country.
13. 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. Journal of neurosurgery, 90(1), 35–41. https://doi.org/10.3171/jns.1999.90.1.0035
14. Meyer FB, Bates LM, Goerss SJ, Friedman JA, Windschitl WL, Duffy JR, et al. Awake craniotomy for aggressive resection of primary gliomas located in eloquent brain. Mayo Clinic proceedings, 76(7), 677–687. https://doi.org/10.4065/76.7.677
15. Serletis D, Bernstein M. Prospective study of awake craniotomy used routinely and nonselectively for supratentorial tumors. Journal of neurosurgery, 107(1), 1–6. https://doi.org/10.3171/JNS-07/07/0001

16. Chang SM, Parney IF, Huang W, Anderson FA Jr, Asher AL, Bernstein M, et al. Patterns of care for adults with newly diagnosed malignant glioma. JAMA, 293(5), 557–564. https://doi.org/10.1001/jama.293.5.557
17. Gupta DK, Chandra PS, Ojha BK, Sharma BS, Mahapatra AK, Mehta VS. Awake craniotomy versus surgery under general anesthesia for resection of intrinsic lesions of eloquent cortex--a prospective randomised study. Clinical neurology and neurosurgery, 109(4), 335–343. https://doi.org/10.1016/j.clineuro.2007.01.008
18. Duffau H. Long-term outcomes after supratotal resection of diffuse low-grade gliomas: a consecutive series with 11-year follow-up. Acta neurochirurgica, 158(1), 51–58. https://doi.org/10.1007/s00701-015-2621-3
19. Duffau H, Capelle L, Sichez J, Faillot T, Abdennour L, Law Koune JD, et al. Intra-operative direct electrical stimulations of the central nervous system: the Salpêtrière experience with 60 patients. Acta neurochirurgica, 141(11), 1157–1167. https://doi.org/10.1007/s007010050413
20. Sewell D, Smith M. Awake craniotomy: anesthetic considerations based on outcome evidence. Current opinion in anaesthesiology, 32(5), 546–552. https://doi.org/10.1097/ACO.0000000000000750
21. Lee S. Dexmedetomidine: present and future directions. Korean journal of anesthesiology, 72(4), 323–330. https://doi.org/10.4097/kja.19259
22. Ard J, Doyle W, Bekker A. Awake craniotomy with dexmedetomidine in pediatric patients. Journal of neurosurgical anesthesiology, 15(3), 263–266. https://doi.org/10.1097/00008506-200307000-00015
23. Tobias JD. Dexmedetomidine: applications in pediatric critical care and pediatric anesthesiology. Pediatric critical care medicine: a journal of the Society of Critical Care Medicine and the World Federation of Pediatric Intensive and Critical Care Societies, 8(2), 115–131. https://doi.org/10.1097/01.PCC.0000257100.31779.41
24. Sanai N, Berger MS. Surgical oncology for gliomas: the state of the art. Nature reviews. Clinical oncology, 15(2), 112–125. https://doi.org/10.1038/nrclinonc.2017.171
25. Krieg SM, Lioumis P, Mäkelä JP, Wilenius J, Karhu J, Hannula H, et al. Protocol for motor and language mapping by navigated TMS in patients and healthy volunteers; workshop report. Acta neurochirurgica, 159(7), 1187–1195. https://doi.org/10.1007/s00701-017-3187-z

SUPPLEMENTARY MATERIAL

Top 100 Most Cited Articles on Awake Glioma Surgery

Rank	Title	First Author	Journal	Citations
1	Functional outcome after language mapping for glioma resection	Sanai N	New England Journal of Medicine	834
2	Impact of intraoperative stimulation brain mapping on glioma surgery outcome: a meta-analysis	De Witt Hamer PC	Journal of Clinical Oncology	745
3	Survival following surgery and prognostic factors for recently diagnosed malignant glioma: data from the glioma outcomes project	Laws ER	Journal of Neurosurgery	564
4	Clinical pharmacokinetics and pharmacodynamics of dexmedetomidine	Weerink MAS	Clinical Pharmacokinetics	529
5	Movement intention after parietal cortex stimulation in humans	Desmurget M	Science	518
6	Lessons from brain mapping in surgery for low-grade glioma: insights into associations between tumour and brain plasticity	Duffau H	Lancet Neurology	510
7	Contribution of intraoperative electrical stimulations in surgery of low grade gliomas: A comparative study between two series without (1985-96) and with (1996-2003) functional mapping in the same institution	Duffau H	Journal of Neurology, Neurosurgery and Psychiatry	487
8	Intraoperative mapping of the subcortical language pathways using direct stimulations. an anatomo-functional study	Duffau H	Brain	474
9	Usefulness of intraoperative electrical subcortical mapping during surgery for low-grade gliomas located within eloquent brain regions: functional results in a consecutive series of 103 patients	Duffau H	Journal of Neurosurgery	450
10	Emerging insights into the molecular and cellular basis of glioblastoma	Dunn G	Genes and Development	433
11	Intraoperative subcortical stimulation mapping of language pathways in a consecutive series of 115 patients with Grade II glioma in the left dominant hemisphere	Duffau H	Journal of Neurosurgery	425
12	Survival in glioblastoma: a review on the impact of treatment modalities	Delgado-López PD	Clinical and Translational Oncology	417
13	Cortical localization of temporal lobe language sites in patients with gliomas	Haglund MM	Neurosurgery	405
14	Beyond the arcuate fasciculus: consensus and controversy in the connectional anatomy of language	Dick AS	Brain	342
15	Does the left inferior longitudinal fasciculus play a role in language? A brain stimulation study	Mandonnet E	Brain	336

Top 100 Most Cited Articles on Awake Glioma Surgery *(continued)*

Rank	Title	First Author	Journal	Citations
16	Awake craniotomy with brain mapping as the routine surgical approach to treating patients with supratentorial intraaxial tumors: a prospective trial of 200 cases	Taylor MD	Journal of Neurosurgery	328
17	Propofol: an update of its use in anaesthesia and conscious sedation	Bryson HM	Drugs	327
18	Intraoperative subcortical stimulation mapping for hemispherical perirolandic gliomas located within or adjacent to the descending motor pathways: evaluation of morbidity and assessment of functional outcome in 294 patients	Keles GE	Journal of Neurosurgery	319
19	Dexmedetomidine: a review of clinical applications	Carollo DS	Current Opinion in Anaesthesiology	311
20	Awake surgery for WHO grade II gliomas within "noneloquent" areas in the left dominant hemisphere: toward a "supratotal" resection - Clinical article	Yordanova YN	Journal of Neurosurgery	299
21	Maximizing safe resection of low- and high-grade glioma	Hervey-Jumper SL	Journal of Neuro-Oncology	294
22	Patterns of care for adults with newly diagnosed malignant glioma	Chang SM	JAMA	292
23	Improved survival time trends for glioblastoma using the SEER 17 population-based registries	Koshy M	Journal of Neuro-Oncology	288
24	Awake craniotomy to maximize glioma resection: methods and technical nuances over a 27-year period	Hervey-Jumper SL	Journal of Neurosurgery	284
24	Stimulation mapping of white matter tracts to study brain functional connectivity	Duffau H	Nature Reviews Neurology	284
25	Functional recovery after surgical resection of low grade gliomas in eloquent brain: hypothesis of brain compensation	Duffau H	Journal of Neurology Neurosurgery and Psychiatry	281
26	Intraoperative electrical stimulation in awake craniotomy: methodological aspects of current practice	Szelényi A	Neurosurgical Focus	268
27	Functional cortex and subcortical white matter located within gliomas	Skirboll SS	Neurosurgery	267
28	Dexmedetomidine: an updated review	Gerlach AT	Annals of Pharmacotherapy	264
29	A re-examination of neural basis of language processing: Proposal of a dynamic hodotopical model from data provided by brain stimulation mapping during picture naming	Duffau H	Brain and Language	262
30	The anatomo-functional connectivity of language revisited. New insights provided by electrostimulation and tractography	Duffau H	Neuropsychologia	257
31	Dexmedetomidine: applications in pediatric critical care and pediatric anesthesiology	Tobias JD	Pediatric Critical Care Medicine	255
32	Perioperative complications and neurological outcomes of first and second craniotomies among patients enrolled in the Glioma Outcome Project	Chang SM	Journal of Neurosurgery	249
33	A comparison of language mapping by preoperative navigated transcranial magnetic stimulation and direct cortical stimulation during awake surgery	Picht T	Neurosurgery	240
33	Current trends in the surgical management and treatment of adult glioblastoma	Young RM	Annals of Translational Medicine	240
34	The huge plastic potential of adult brain and the role of connectomics: new insights provided by serial mappings in glioma surgery	Duffau H	Cortex	233
35	Dexmedetomidine	Coursin DB	Current Opinion in Critical Care	232
36	Dexmedetomidine: current role in anesthesia and intensive care; [Dexmedetomidina: Papel Atual em Anestesia e Cuidados Intensivos]	Afonso J	Revista Brasileira de Anestesiologia	231
37	Update on bispectral index monitoring	Johansen JW	Best Practice and Research: Clinical Anaesthesiology	227
38	Functional mapping-guided resection of low-grade gliomas in eloquent areas of the brain: improvement of long-term survival - Clinical article	Chang EF	Journal of Neurosurgery	226
38	New concepts in the management of diffuse low-grade glioma: proposal of a multistage and individualized therapeutic approach	Duffau H	Neuro-Oncology	226

Top 100 Most Cited Articles on Awake Glioma Surgery *(continued)*

Rank	Title	First Author	Journal	Citations
39	Dexmedetomidine: review, update, and future considerations of paediatric perioperative and periprocedural applications and limitations	Mahmoud M	British Journal of Anaesthesia	225
40	Functional MR activation correlated with intraoperative cortical mapping	Yetkin FZ	American Journal of Neuroradiology	221
41	Presurgical functional MR imaging of language and motor functions: validation with intraoperative electrocortical mapping	Bizzi A	Radiology	220
42	What is the role of the uncinate fasciculus? Surgical removal and proper name retrieval	Papagno C	Brain	218
43	Intraoperative subcortical language tract mapping guides surgical removal of gliomas involving speech areas	Bello L	Neurosurgery	209
44	Dexmedetomidine in children: current knowledge and future applications	Mason KP	Anesthesia and Analgesia	206
44	Seizures in low-grade gliomas: natural history, pathogenesis, and outcome after treatments	Rudà R	Neuro-Oncology	206
45	New concepts in surgery of WHO grade II gliomas: functional brain mapping, connectionism and plasticity - a review	Duffau H	Journal of Neuro-Oncology	205
46	Mapping neuroplastic potential in brain-damaged patients	Herbet G	Brain	202
47	Awake craniotomy for brain tumors near eloquent cortex: Correlation of intraoperative cortical mapping with neurological outcomes in 309 consecutive patients	Kim SS	Neurosurgery	199
48	Awake mapping optimizes the extent of resection for low-grade gliomas in eloquent areas	De Benedictis A	Neurosurgery	198
49	Intra-operative direct electrical stimulations of the central nervous system: the Salpetriere experience with 60 patients	Duffau H	Acta Neurochirurgica	197
49	Surgical oncology for gliomas: the state of the art	Sanai N	Nature Reviews Clinical Oncology	197
50	Prospective study of awake craniotomy used routinely and nonselectively for supratentorial tumors	Serletis D	Journal of Neurosurgery	192
51	The impact of surgery in molecularly defined low-grade glioma: an integrated clinical, radiological, and molecular analysis	Wijnenga MMJ	Neuro-Oncology	191
52	Advances in brain tumor surgery for glioblastoma in adults	Lara-Velazquez M	Brain Sciences	188
53	Dexmedetomidine for neurological surgery	Bekker A	Neurosurgery	186
54	The left inferior fronto-occipital fasciculus subserves language semantics: a multilevel lesion study	Almairac F	Brain Structure and Function	185
54	Role of fronto-striatal tract and frontal aslant tract in movement and speech: an axonal mapping study	Kinoshita M	Brain Structure and Function	185
55	Anaesthesia for awake craniotomy - Evolution of a technique that facilitates awake neurological testing	Sarang A	British Journal of Anaesthesia	180
56	Surgery of low-grade gliomas: towards a 'functional neurooncolngy'	Duffau H	Current Opinion in Oncology	179
57	Awake craniotomy vs surgery under general anesthesia for resection of supratentorial lesions	Sacko O	Neurosurgery	176
58	Long-term outcomes after supratotal resection of diffuse low-grade gliomas: a consecutive series with 11-year follow-up	Duffau H	Acta Neurochirurgica	174
59	Analysis of naming errors during cortical stimulation mapping: implications for models of language representation	Corina DP	Brain and Language	172
60	Mapping the connectivity underlying multimodal (verbal and non-verbal) semantic processing: a brain electrostimulation study	Moritz-Gasser S	Neuropsychologia	170
61	Clinical practice guidelines for the management of adult diffuse gliomas	Jiang T	Cancer Letters	168
62	Assessment of verbal working memory before and after surgery for low-grade glioma	Teixidor P	Journal of Neuro-Oncology	167
63	Dexmedetomidine in anaesthesia	Paris A	Current Opinion in Anaesthesiology	164

Top 100 Most Cited Articles on Awake Glioma Surgery *(continued)*

Rank	Title	First Author	Journal	Citations
64	Intraoperative stimulation techniques for functional pathway preservation and glioma resection	Sanai N	Neurosurgical Focus	163
65	Awake craniotomy for aggressive resection of primary gliomas located in eloquent brain	Meyer FB	Mayo Clinic Proceedings	162
65	Long term reshaping of language, sensory, and motor maps after glioma resection: a new parameter to integrate in the surgical strategy	Duffau H	Journal of Neurology Neurosurgery and Psychiatry	162
65	Language mapping with navigated repetitive TMS: proof of technique and validation	Tarapore PE	NeuroImage	162
66	Direct electrical stimulation as an input gate into brain functional networks: principles, advantages and limitations	Mandonnet E	Acta Neurochirurgica	160
67	Five-aminolevulinic acid for fluorescence-guided resection of recurrent malignant gliomas: a phase II study	Nabavi A	Neurosurgery	158
67	Neuronavigation in the surgical management of brain tumors: current and future trends	Orringer DA	Expert Review of Medical Devices	158
68	Selection of intraoperative tasks for awake mapping based on relationships between tumor location and functional networks: a review	Coello AF	Journal of Neurosurgery	156
69	Image guided surgery for the resection of brain tumours	Barone DG	Cochrane Database of Systematic Reviews	155
70	Patient tolerance of craniotomy performed with the patient under local anesthesia and monitored conscious sedation	Danks RA	Neurosurgery	154
71	Day case and short stay surgery: 2		Anaesthesia	153
72	Contribution of cortical and subcortical electrostimulation in brain glioma surgery: methodological and functional considerations	Duffau H	Neurophysiologie Clinique	151
73	The "onco-functional balance" in surgery for diffuse low-grade glioma: integrating the extent of resection with quality of life	Duffau H	Acta Neurochirurgica	150
74	Brain hodotopy: from esoteric concept to practical surgical applications	De Benedictis A	Neurosurgery	149
75	The use of dexmedetomidine infusion for awake craniotomy	Bekker AY	Anesthesia and Analgesia	147
76	Non-rigid alignment of pre-operative MRI, fMRI, and DT-MRI with intra-operative MRI for enhanced visualization and navigation in image-guided neurosurgery	Archip N	NeuroImage	146
77	Awake craniotomy with dexmedetomidine in pediatric patients	Ard J	Journal of Neurosurgical Anesthesiology	143
78	Dexmedetomidine as an anaesthetic adjuvant in patients undergoing intracranial tumour surgery: a double-blind, randomized and placebo-controlled study	Tanskanen PE	British Journal of Anaesthesia	140
78	Failed awake craniotomy: A retrospective analysis in 424 patients undergoing craniotomy for brain tumor; Clinical article	Nossek E	Journal of Neurosurgery	140
79	Awake craniotomy for removal of intracranial tumor: considerations for early discharge	Blanshard HJ	Anesthesia and Analgesia	139
79	Operative techniques for gliomas and the value of extent of resection	Sanai N	Neurotherapeutics	139
80	Mutant IDH1 and seizures in patients with glioma	Chen H	Neurology	138
81	Current and future trends on diagnosis and prognosis of glioblastoma: from molecular biology to proteomics	Silantyev AS	Cells	137
82	Towards a functional atlas of human white matter	Sarubbo S	Human Brain Mapping	136
82	Intraoperative mapping during repeat awake craniotomy reveals the functional plasticity of adult cortex	Southwell DG	Journal of Neurosurgery	136
82	The frontal aslant tract (FAT) and its role in speech, language and executive function	Dick AS	Cortex	136
83	Protocol for motor and language mapping by navigated TMS in patients and healthy volunteers; workshop report	Krieg SM; Lioumis P	Acta Neurochirurgica	134
84	5-ALA in the management of malignant glioma	Stepp H	Lasers in Surgery and Medicine	133
85	Dexmedetomidine and neurocognitive testing in awake craniotomy	Mack PF	Journal of Neurosurgical Anesthesiology	130

Top 100 Most Cited Articles on Awake Glioma Surgery *(continued)*

Rank	Title	First Author	Journal	Citations
86	The role of surgery in the management of patients with diffuse low grade glioma: a systematic review and evidence-based clinical practice guideline	Aghi MK	Journal of Neuro-Oncology	129
87	Functional brain mapping and its applications to neurosurgery	Tharin S	Neurosurgery	128
88	Intra-operative mapping of cortical areas involved in reading in mono- and bilingual patients	Roux F-E	Brain	127
88	Patient satisfaction with awake craniotomy for tumor surgery: A comparison of remifentanil and fentanyl in conjunction with propofol	Manninen PH	Anesthesia and Analgesia	127
88	Does the insula tell our brain that we are in pain?	Isnard J	Pain	127
89	Awake craniotomy versus surgery under general anesthesia for resection of intrinsic lesions of eloquent cortex-a prospective randomised study	Gupta DK	Clinical Neurology and Neurosurgery	126
89	The risk of getting worse: Surgically acquired deficits, perioperative complications, and functional outcomes after primary resection of glioblastoma	Gulati S	World Neurosurgery	126
90	Dexmedetomidine: present and future directions	Lee S	Korean Journal of Anesthesiology	125
91	The asleep-awake-asleep anesthetic technique for intraoperative language mapping	Huncke K	Neurosurgery	124
91	White matter tractography for neurosurgical planning: A topography-based review of the current state of the art	Essayed WI	NeuroImage: Clinical	124
92	Role of surgical resection in low- and high-grade gliomas	Hervey-Jumper SL	Current Treatment Options in Neurology	123
93	The challenge to remove diffuse low-grade gliomas while preserving brain functions	Duffau H	Acta Neurochirurgica	121
94	Does the left superior longitudinal fascicle subserve language semantics? A brain electrostimulation study	Maldonado IL	Brain Structure and Function	120
95	Extent of resection in glioma–a review of the cutting edge	D'Amico RS	World Neurosurgery	119
96	Glioma therapy in adults	Norden AD	Neurologist	118
97	Dexmedetomidine: sedation, analgesia and beyond	Chrysostomou C	Expert Opinion on Drug Metabolism and Toxicology	116
97	Surgical management of World Health Organization Grade II gliomas in eloquent areas: The necessity of preserving a margin around functional structures	Gil-Robles S	Neurosurgical Focus	116
97	A novel approach for documenting naming errors induced by navigated transcranial magnetic stimulation	Lioumis P	Journal of Neuroscience Methods	116
97	Cognition and resective surgery for diffuse infiltrative glioma: an overview	Klein M	Journal of Neuro-Oncology	116
98	Preoperative correlation of intraoperative cortical mapping with magnetic resonance imaging landmarks to predict localization of the Broca area	Quiñones-Hinojosa A	Journal of Neurosurgery	115
99	Language function and dysfunction among Chinese- and English-speaking polyglots: cortical stimulation, Wada testing, and clinical studies	Rapport RL	Brain and Language	114
99	Functional outcome after language mapping for insular World Health Organization grade II gliomas in the dominant hemisphere: experience with 24 patients	Duffau H	Neurosurgical Focus	114
99	Intraoperative subcortical electrical mapping of optic radiations in awake surgery for glioma involving visual pathways: clinical article	Gras-Combe G	Journal of Neurosurgery	114
99	Intraoperative seizures during awake craniotomy: Incidence and consequences: analysis of 477 patients	Nossek E	Neurosurgery	114
99	The effects of new or worsened postoperative neurological deficits on survival of patients with glioblastoma	Rahman M	Journal of Neurosurgery	114
100	Intraoperative mapping of the cortical areas involved in multiplication and subtraction: an electrostimulation study in a patient with a left parietal glioma	Duffau H	Journal of Neurology Neurosurgery and Psychiatry	113