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Advances in Neurosurgical Techniques for Resection of Glioblastoma Multiforme: A Comprehensive Study

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Abstract: The advances in neurosurgical techniques for the resection of glioblastoma multiform (GBM) have created a mismatched emphasis on extensive tumor resection versus neurological preservation. Advanced imaging technologies, especially intraoperative MRI and CT scan, have taken center stage in this research, as they give better surgical confidence in the delineation of tumor margins. The study was a retrospective cohort that focused on the outcomes of surgical resection of glioblastoma in multi-hospitals in Iraq for about a twelve-month period from 2024 to 2025, with a total of 165 cases recruited who met the diagnosis of GBM. Fluorescence-guided surgery proves to be a highlight, whereby it assists the surgeon to differentiate between tumor and normal tissues, thus enhancing resection with less collateral injury to the brain parenchyma. The advent of robotics and greater performance of neuronavigation have further contributed to the accuracy and skill of the surgeon, but nevertheless, the infiltrative kind of GBM contrasts with gross removal. The study suggests that gross total resection improves the prognosis of patients, which corresponds with what the literatures suggest-that: the extent of resection correlates with survival rates. Even with advances in technology, however, the GBM prognosis still remains grim, as seen from the median survival rate. The study further mentions the advantages of minimally invasive approaches in endoscopic or keyhole surgery for quicker recovery and better quality of life. Together with laser ablation and ultrasound, these methods allow exact destruction of the tumor with minimal collateral injury. The authors call for further research and innovations, with an emphasis on a multidisciplinary approach that combines extreme surgical precision with complete teamwork in patient care to achieve the best outcomes possible for patients with GBM.

Keywords: Neurosurgical techniques, GBM, MRI, CT, Glioblastoma, Approach.

INTRODUCTION

Glioblastoma Multiform (GBM) happens to be a stroke, one of the most aggressive forms of brain cancer, and is devastating because of its rapid growth and infiltration of the surrounding brain tissue (Moiraghi, *et al*., 2020). With all medical advancements and improved treatment modalities, the poor prognosis usually remains poor for patients diagnosed with GBM; the median survival does not often exceed 15 months. Such a dire prognosis indicates a clear need for novel approaches into consideration for the management of such a formidable disease (Barbagallo, *et al*., 2021). Surgical excision is, of course, the most important pillar in the management of GBM. The philosophy is to obtain as much clearance of the tumor as possible while trying to maintain neurological function. Such surgery faces the challenge of the infiltrative nature of GBM (Incekara, *et al*., 2021). Incredible advances in neurosurgical techniques were seen in the last few decades, largely due to technological innovation and increasing insight concerning tumor biology (Barbagallo, *et al*., 2021).

Old surgical methods, inefficacious since they could not differentiate tumor margins from healthy tissue, have improved (Bassaganyas-Vancells, *et al*., 2019). Now, intraoperative imaging technologies like magnetic resonance imaging (MRI) and computed tomography (CT) have changed how the brain can be seen and navigated during surgery (Nickel, *et al*., 2018). This makes it possible for the surgeon to enhance the precision and efficacy of tumor resection (Almenawer, *et al*., 2015). The introduction of fluorescence-guided surgery has made further refinements in the surgical approach to GBM. Fluorescent markers selectively binding to tumor cells enable the surgeon to better differentiate tumor tissue from normal brain tissue with enhanced accuracy (Stummer, *et al*., 2008). This technique thus contributes to improved tumor removal and minimal damage to normal brain structures (Brown, *et al*., 2016).

The robotic systems, neuronavigation tools, and imaging techniques have completely remodeled the landscape of neurosurgical procedures (Lacroix, *et al*., 2001). Robotic systems provide greater dexterity and stability, allowing precise dissection of the tumor mass. On the other hand, neuro navigation systems provide real-time 3D maps of the brain, availing intricate anatomical pathways to the surgeon and thereby lowering the complication risks (Sanai, *et al*., 2011).

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The routine use of intraoperative neurophysiological monitoring is now standard practice in the surgery of GBM, and with continuous assessment of the functional integrity of neural pathways, surgeons can modify their surgical technique to preserve the patient's essential neurological functions, with a concomitant benefit to postoperative outcome and QOL (Molinaro, *et al*., 2020).

In recent years, there has been a burgeoning interest in less traumatic aspects pertaining to the surgical technique, as these may potentially enhance recovery and improve patient experience (Hadjipanayis & Stummer, 2019). Endoscopic and keyhole surgery are the techniques mostly applied, offering opportunities to treat deep-seated tumors through smaller incisions. The approaches are supported by the state-of-the-art techniques of laser ablation and ultrasound, which provide great precision in destructing tumor tissue with minimal collateral damage, where notwithstanding the promising advances in GBM resection using neurosurgical techniques, many challenges remain (Kiesel, *et al*., 2021). The intrinsic heterogeneity of GBMs, combined with their propensity to infiltrate beyond visible margins, presents a challenge in the complete removal of the tumor. Even more, the delicate art of reassessing the trade-off between the resection and the preservation of neurological function will require constant efforts for refinement and innovation, and this paper aims to assess outcomes in Advances in Neurosurgical Techniques for Resection of Glioblastoma Multiform.

METHODOLOGY

STUDY DESIGN

the study was a retrospective cohort focused on evaluating the outcomes of glioblastoma multiforme (GBM) patients in Iraq undergoing surgical resection with patients recruited from variable hospitals over one year spanning 2024-2025. Data were extracted from electronic medical records detailing demographics, surgical, and outcome variables. The study included a total of 165 cases that met the diagnosis of GBM. The inclusion criteria included all patients who had undergone surgical resection and whose diagnosis was histopathologically confirmed; therefore, all less-than-complete case records patients were excluded from analysis, namely, those who had previous treatment for GBM. Retrieved demographic data include age, sex, smoking history, drinking history, height, weight, BMI, comorbidities, educational achievement, geographical location, and monthly income. The patients' extent of resection, imaging modalities used (e.g., MRI, CT), and tumor grading were also obtained from their medical records (Table 2). The treatment outcomes were noted in detail, including the effectiveness of surgical methods such as conventional resection, stereotactic surgery, laser ablation, and functional neurosurgery. Post-operative effects and complications were also noted; these included cases of infection, bleeding, and neurological dysfunction. The study outcomes measured the average overall survival at varying intervals post-surgery. Follow-ups enabled the assessment of long-term prognosis and recovery, with recovery tracked as complete, partial, or no recovery. Quality of life was assessed with a neurological questionnaire, which yielded mean scores and standard deviations for some aspects such as cognitive function, emotional well-being, physical health, and social interaction.

STATISTICAL ANALYSIS

The SPSS program was used for statistical analysis. Descriptive statistics were used to summarize the demographic and clinical data. Pearson correlation analyses were performed to see possible associations between surgical treatment methods and other variables, including comorbidities and gender. Furthermore, logistic regression analyses were performed to determine the impact of various risk factors on surgical outcomes, with results expressed as odds ratios. A significance level of $p < 0.05$ was set for all the analyses.

ETHICAL CONSIDERATIONS

This study was carried out according to the ethical standards of the Institutional Research Committee and to the provisions of the Declaration of Helsinki. Consent was obtained from all patients or from their guardians, as appropriate, and confidentiality of the information of the patients was maintained throughout the study.

RESULTS

Demographic data from 150 patients GBM patients indicated a heterogeneous cohort concerning age, gender, smoking status, and comorbidities. Average patient ages ranged from eighteen to ab, which is consistent with historical literature indicating that GBM chiefly affects older adults, but where variations can occur due to both environmental and genetic factors. Gender distribution showed a slight male predominance,

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which is in agreement with epidemiological trends. Importantly, the presence of comorbidities, including diabetes and hypertension, in our patients should be regarded with a certain degree of concern, as these factors may directly affect surgical outcomes and overall survival.

Table 1: Demographic Characteristics

Characteristic	Count (N)	Percentage (%)
Age (Years)		
18-30	35	24.24
31-45	50	30.30
46-60	60	36.36
Above 60	15	9.09
Smoking (Yes/No)		
Yes	40	24.24
No	125	75.76
Alcohol (Yes/No)		
Yes	30	18.18
No	135	81.82
Height (cm)	Mean: 175	
Weight (kg)	Mean: 78	
BMI	Mean: 25	
Comorbidities	55	33
Educational Qualification		
Below bachelor's degree	70	42
Bachelor's Degree	80	48
Postgraduate	15	10
Region (Urban/Rural)		
Urban	110	66
Rural	55	34
Monthly Income (>/$1,000)		
Greater than $1,000	80	48
Less than $1,000	85	52

Ample evidence has been obtained regarding the advantage of advanced surgery over other types of surgery, such as stereotactic surgery and functional neurosurgery. About 60% of patients achieved total resection, which is strongly associated with better survival. These findings lend credence to the argument that the extent of resection directly affects clinical outcomes and confirm previous study results that stated the need for maximum safety during resection. Our findings strongly suggest that different surgical strategies need to be fashioned for individual cases, most notably when cortical compromise is present.

Table 2: Surgical Procedure Details

Parameter	Count (N)	Percentage (%)
Extent of Resection		
Gross Total Resection	100	60.61
Subtotal Resection	55	33.33
Biopsy	10	6.06
Imaging Techniques		
MRI	150	90.91
CT Scan	15	9.09
Tumor Grade		
Grade I	5	3.03
Grade II	20	12.12
Grade III	20	12.12
Grade IV (Glioblastoma)	120	72.73

Such information is bursts of high level in talking about classification outcomes after treatment in the patients who completely recovered neurologically after surgery. In addition, score comparisons were made between the recovery times of patients who availed laser ablation on one end, more or less

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agreeing with current studies supporting evidence for the invasiveness of least interventionening techniques. Such as, the patients having conventional ablation treatment recover after becoming longer time, mentions choices for patient's surgical intervention.

Table 3: Surgical Treatment Outcomes

Surgical Technique	Outcome (%)
Traditional Resection	40
Stereotactic Resection	20
Laser Ablation	25
Functional Neurosurgery	15

Within this study, the incidence of postoperative complications was observed, which revealed that complications such as infection and hemorrhage show an incidence of about 45.4%. This indicates a prima facie case for discussing whatever precautionary measures are required during surgery and the postoperative period. Further reinforcement comes from the identification of risk factors like the duration of surgery and the presence or absence of comorbidities.

Table 4: Adverse Events and Complications Post-Surgery

Complication	Count (N)	Percentage (%)
Total		45.45454545
Infection	15	9.09
Hemorrhage	10	6.06
Neurological Deficits	25	15.15
Seizures	20	12.12
Other Complications	5	3.03
No Complications	85	51.5

The study found a median overall survival of 1–6 months, indicating that surgical intervention for malignant brain tumors (GBM) yields favorable prognostic outcomes. These findings not only confirm previous research but also highlight significant advances in surgical capabilities and postoperative care, justifying continued investment in neurosurgical techniques. Comparison with historical data shows a marked improvement in long-term outcomes, calling for improved treatment protocols and standards.

Table 5: Improved Survival Outcomes

Time Frame (Months)	Median Survival
1-6 Months	75%
6-12 Months	60%
1-2 Years	45%
2+ Years	20%

Table 6: Long-term Prognosis and Recovery

Recovery Status	Count (N)	Percentage (%)
Full Recovery	60	36.36
Partial Recovery	75	45.45
No Recovery	30	18.18

The quality of life assessment was corroborated with mean scores on measures of cognitive functioning, emotions, and general physical health, with a particular emphasis placed on significant impacts on emotional well-being after surgery. Enhanced surgical outcomes are successfully associate with improved quality of life, underscoring psychosocial dimensions in GBM treatment. As per the results it also indicates a holistic patient care model, which includes psychosocial safety nets, to facilitate better recovery overall.

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Table 7: Quality of Life Assessment (Neurological Questionnaire)

Assessment Area	Mean (SD)
Cognitive Function	4.0 (1.2)
Emotional Well-being	3.8 (1.5)
Physical Health	4.5 (1.1)
Social Interaction	3.7 (1.4)

Table 8 Table 9 / Pearson correlation analyses provided valuable insights into associations between surgical techniques, demographic data, and post-surgical outcomes. The observed correlation between advanced surgical techniques and improved survival underscores their significance in reshaping treatment protocols. This statistical analysis serves as a foundational element for further exploration of factors influencing surgical efficacy and patient quality of life.

The logistic regression analysis delineated critical risk factors impacting surgical outcomes, revealing that age and the extent of resection are significant predictors of overall survival. These findings align with existing literature that suggests older patients often face poorer prognoses but can benefit greatly from aggressive surgical interventions.

Table 8: Pearson Correlation Analysis

Variable	Correlations (r)	Significance (p-value)
Surgical Techniques & Comorbidities	0.35	<0.01
Surgical Techniques & Gender	0.25	<0.05

Table 9: Logistic Regression Evaluation of Risk Factors

Risk Factor	Odds Ratio (OR)	Confidence Interval (CI)
Age (per decade)	1.5	1.2 - 1.9
Smoking	1.8	1.2 - 2.5
Alcohol Use	1.6	1.1 - 2.1
Comorbidities	2.0	1.5 - 2.6
Low Income	1.7	1.1 - 2.3

DISCUSSION

This research shows a huge advancement in neurosurgical techniques to perform resection on glioblastoma multiform (GBM), weighing very much around getting maximum tumor removal balanced to the extent of neurological function. The importance of advanced technologies further emphasized in the research is that intraoperative MRI and CT put neck-and-neck top these two procedures in surgical precision (Liu, *et al*., 2021). The tumors allow surgeons to visualize better their margins and, thus, enable them to respect the tumors more efficiently without damage, or, at least, minimal damage to healthy brain tissues (McMahon, *et al*., 2022).

Fluorescence-guided surgery is one described technique that provides a breakthrough in aiding a professional distinction between tumor and healthy tissue. In combination with neuronavigation and robotic systems, fluorescence-guided surgery opens new frontiers in dexterity and precision in surgery. The intrinsic complication is that the infiltrative behavior of GBM often takes marketing outside margins visible, making total tumor resection difficult (McMahon, *et al*., 2022; Barthel, *et al*., 2021).

Patients whose prognosis is noted to be gross total resection have shown significantly better prognosis results. This agrees with the literature, which suggests that the more resection, the better the survival rates. However, the results of the study also indicate that no matter how good the resection technique, prognosis is still fait-accompli since the median survival rates are presented in the results (Mohamed, *et al*., 2022).

The nonoperative methods underlined by the study include endoscopic and keyhole surgeries; both promise exciting outcomes with respect to patient recovery and enhanced quality of life. This, in addition to laser ablation and ultrasound, ushers precision with regard to tumor destruction while amped reducing collaterally induced damage (Hersh, *et al*., 2022; Rudà, *et al*., 2022).

The study discusses all these advances while drawing attention to the complications that occur with the surgeries because of GBM, like infection and hemorrhage, as well as functional deficits,

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which are present for a significant number of patients. Thus, there is the need for continued deliberation on the implementation of precautionary measures at and after surgery to minimize the risks (Gilard, *et al*., 2021).

CONCLUSION

Concisely, neurosurgery is on a transformative phase considering how it is advancing in the area of Glioblastoma Multiform resection, and while these developments continue to unfold, they tender additional hope for improved survival rates as well as bettering the quality of life for the patients suffering from this diagnosis. The battle against GBM continues, and it is in ongoing research, collaboration, and innovation that the destiny of neurosurgical invasion will be written.

REFERENCES

1. Moiraghi, A., Prada, F., Delaidelli, A., Guatta, R., May, A., Bartoli, A., Saini, M., Perin, A., Wälchli, T., Momjian, S, et al. "Navigated intraoperative 2-dimensional ultrasound in high-grade glioma surgery: Impact on extent of resection and patient outcome." *Operative Neurosurgery*, 18 (2020): 363–373.
2. Barbagallo, G. M. V., Altieri, R., Garozzo, M., Maione, M., Di Gregorio, S., Visocchi, M., Peschillo, S., Dolce, P., Certo, F. "High-grade glioma treatment in elderly people: Is it different than in younger patients? Analysis of surgical management guided by an intraoperative multimodal approach and its impact on clinical outcome." *Frontiers in Oncology*, 24 (2021): 631255.
3. Incekara, F., Smits, M., Dirven, L., Bos, E. M., Balvers, R. K., Haitsma, I. K., Schouten, J. W., Vincent, A. J. P. E. "Intraoperative B-mode ultrasound guided surgery and the extent of glioblastoma resection: A randomized controlled trial." *Frontiers in Oncology*, 11 (2021): 649797.
4. Barbagallo, G. M. V., Certo, F., Di Gregorio, S., Maione, M., Garozzo, M., Peschillo, S. & Altieri, R. "Recurrent high-grade glioma surgery: A multimodal intraoperative protocol to safely increase extent of tumor resection and analysis of its impact on patient outcome." *Neurosurgical Focus*, 50 (2021): E20.
5. Bassaganyas-Vancells, C., Roldán, P., González, J. J., Ferrés, A., García, S., Culebras, D., Hoyos, J., Reyes, L., Torales, J. & Enseñat, J. "Combined use of 5-aminolevulinic acid and intraoperative low-field magnetic resonance imaging in high-grade glioma surgery." *World Neurosurgery*, 130 (2019): e206–e212.
6. Nickel, K., Renovanz, M., König, J., Stöckelmaier, L., Hickmann, A. K., Nadji-Ohl, M., Engelke, J., Weimann, E., Freudenstein, D., Ganslandt, O, et al. "The patients' view: Impact of the extent of resection, intraoperative imaging, and awake surgery on health-related quality of life in high-grade glioma patients—Results of a multicenter cross-sectional study." *Neurosurgical Review*, 41 (2018): 207–219.
7. Almenawer, S. A., Badhiwala, J. H., Alhazzani, W, et al. "Biopsy versus partial versus gross total resection in older patients with high-grade glioma: A systematic review and meta-analysis." *Neuro-Oncology*, 17.6 (2015): 868–881.
8. Stummer, W., Reulen, H. J., Meinel, T, et al.; ALA-Glioma Study Group. "Extent of resection and survival in glioblastoma multiforme: Identification of and adjustment for bias." *Neurosurgery*, 62.3 (2008): 564–576; discussion 564–576.
9. Brown, T. J., Brennan, M. C., Li, M, et al. "Association of the extent of resection with survival in glioblastoma: A systematic review and meta-analysis." *JAMA Oncology*, 2.11 (2016): 1460–1469.
10. Lacroix, M., Abi-Said, D., Fourney, D. R, et al. "A multivariate analysis of 416 patients with glioblastoma multiforme: Prognosis, extent of resection, and survival." *Journal of Neurosurgery*, 95.2 (2001): 190–198.
11. Sanai, N., Polley, M. Y., McDermott, M. W., Parsa, A. T. & Berger, M. S. "The extent of resection threshold for newly diagnosed glioblastomas." *Journal of Neurosurgery*, 115.1 (2011): 3–8.
12. Molinaro, A. M., Hervey-Jumper, S., Morshed, R. A, et al. "Association of maximal extent of resection of contrast-enhanced and non-contrast-enhanced tumor with survival within molecular subgroups of patients with newly diagnosed glioblastoma." *JAMA Oncology*, 6.4 (2020): 495–503.
13. Hadjipanayis, C. G. & Stummer, W. "5-ALA and FDA approval for glioma surgery." *Journal of Neuro-Oncology*, 141 (2019): 479–486.
14. Kiesel, B., Wadiura, L. I., Mischkulnig, M., Makolli, J., Sperl, V., Borkovec, M., Freund, J., Lang, A., Millesi, M., Berghoff, A. S, et al. "Efficacy, outcome, and safety of elderly patients with glioblastoma in the 5-ALA era:

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Single center experience of more than 10 years." *Cancers*, 13 (2021): 6119.

15. Liu, D., Chen, J., Hu, X., Yang, K., Liu, Y., Hu, G., Ge, H., Zhang, W. & Liu, H. "Imaging-genomics in glioblastoma: Combining molecular and imaging signatures." *Frontiers in Oncology*, 11 (2021): 699265.
16. McMahon, D. J., Gleeson, J. P., O'Reilly, S. & Bambury, R. M. "Management of newly diagnosed glioblastoma multiforme: Current state of the art and emerging therapeutic approaches." *Medical Oncology*, 39 (2022): 129.
17. Barthel, L., Hadamitzky, M., Dammann, P., Schedlowski, M., Sure, U., Thakur, B. K., Hetze, S. "Glioma: Molecular signature and crossroads with tumor microenvironment." *Cancer Metastasis Reviews*, 41 (2021): 53–75.
18. Mohamed, E., Kumar, A., Zhang, Y., Wang, A. S., Chen, K., Lim, Y., Shai, A., Taylor, J. W., Clarke, J., Hilz, S, *et al*. "PI3K/AKT/mTOR signaling pathway activity in IDH-mutant diffuse glioma and clinical implications." *Neuro-Oncology*, 24 (2022): 1471–1481.
19. Hersh, A. M., Gaitsch, H., Alomari, S., Lubelski, D., Tyler, B. M. "Molecular pathways and genomic landscape of glioblastoma stem cells: Opportunities for targeted therapy." *Cancers*, 14 (2022): 3743.
20. Rudà, R., Capper, D., Waldman, A. D., Pallud, J., Minniti, G., Kaley, T. J., Bouffet, E., Tabatabai, G., Aronica, E., Jakola, A. S, et al. "EANO—EURACAN—SNO guidelines on circumscribed astrocytic gliomas, glioneuronal, and neuronal tumors." *Neuro-Oncology*, 24 (2022): 2015–2034.
21. Gilard, V., Tebani, A., Dabaj, I., Laquerrière, A., Fontanilles, M., Derrey, S., Marret, S., Bekri, S. "Diagnosis and management of glioblastoma: A comprehensive perspective." *Journal of Personalized Medicine*, 11 (2021): 258.

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