Scientific Research Publishing

Open Journal of Modern Neurosurgery, 2026, 16(1), 1-7
https://www.scirp.org/journal/ojmn
ISSN Online: 2163-0585
ISSN Print: 2163-0569

# Surgical Outcomes of Glioblastoma in a Low-Resource Environment

**Djiby Jean Marcel Okamon[1*], Soress Dongo[2], Wilfred Meuga[1], Louis Derou[2], Landry Drogba[1], Dominique N'Dri[1]**

[1]Department of Neurosurgery, Yopougon Teaching Hospital, University Félix Houphouet Boigny, Abidjan, Ivory Coast
[2]Department of Neurosurgery, Bouaké Teaching Hospital, University Alassane Ouattara, Bouaké, Ivory Coast
Email: *marcelokamon@gmail.com

**How to cite this paper:** Okamon, D.J.M., Dongo, S., Meuga, W., Derou, L., Drogba, L. and N'Dri, D. (2026) Surgical Outcomes of Glioblastoma in a Low-Resource Environment. *Open Journal of Modern Neurosurgery*, **16**, 1-7.
https://doi.org/10.4236/ojmn.2026.161001

**Received:** October 7, 2025
**Accepted:** November 23, 2025
**Published:** November 26, 2025



## Abstract

**Background:** Glioblastoma (GBM) is the most common and most aggressive primary brain tumor in adults, with a poor prognosis despite multimodal therapy. Prognosis is influenced by several clinical, radiological, and molecular factors, but data from Africa remain scarce. This study aimed to analyze survival outcomes and prognostic factors in patients undergoing surgical treatment for GBM in a low-resource setting. **Methods:** We conducted a retrospective single-center study of 31 patients treated for glioblastoma from January 2020 to December 2024. Overall survival was estimated with the Kaplan-Meier method, and prognostic factors were assessed using Cox regression. Statistical analyses were performed with SPSS v22, with significance set at $p \leq 0.05$. **Results:** The mean age was 53 years (range, 35 - 76), with a male-to-female ratio of 2.1. Intracranial hypertension (100%), motor deficit (65%), and seizures (38%) were the main presenting symptoms. Resection was total in 45%, subtotal in 32%, and partial in 16%; 7% of patients underwent biopsy only. The Stupp protocol was initiated in 26 patients (84%), of whom 6 did not complete treatment. Median overall survival was 9.86 months. Median survival was 13 months for patients with Karnofsky Performance Status (KPS) > 70% and 8 months for those with KPS ≤ 70%. Patients < 60 years survived longer than older patients, although the difference was not significant ($p = 0.578$). Survival did not differ by sex ($p = 0.829$), extent of resection ($p = 0.575$), or time to surgery ($p = 0.575$). Median survival was 20 months with a complete Stupp protocol versus 7 months with incomplete treatment. In multivariate Cox regression, none of the studied variables significantly influenced overall survival. **Conclusion:** In this series, completion of the Stupp protocol was the main factor associated with prolonged survival. Larger prospective studies with molecular profiling are needed to refine prognostic assessment and improve therapeutic strategies.

**Keywords**

Glioblastoma, Prognostic Factors, Survival Analysis, Surgical Resection, Low-Resource Setting

## 1. Introduction

Glioblastoma (GBM) is the most frequent and most aggressive form of primary brain tumor in adults [1] [2]. Its epidemiology varies across regions of the world, with a higher incidence among Caucasians [3]. Despite significant advances in neuro-oncology, GBM continues to carry a dismal prognosis [2] [4]. The current standard of care is based on maximal safe surgical resection followed by concomitant radiotherapy and temozolomide chemotherapy, with adjuvant temozolomide cycles thereafter [5]-[8].

Several prognostic factors have been identified in GBM, including age, neurological and cognitive status, tumor location, extent of resection, access to adjuvant therapies, and O6-Methylguanine-DNA Methyltransferase (MGMT) promoter methylation status [9]-[11]. Reported mean survival varies from 12 to 24 months depending on the combination of these factors [12] [13].

Few studies from Africa have analyzed the outcomes of patients operated on for GBM [14] [15]. In our country, no prior study has specifically assessed postoperative survival following glioblastoma surgery. Given the aggressiveness of GBM and the limited resources available, postoperative outcome remains a major concern for patients and their families. The objective of this study was therefore to analyze the variables influencing survival in patients who underwent surgical treatment for glioblastoma in a low-resource environment.

## 2. Methods

### 2.1. Study Design and Setting

This was a single-center, retrospective, descriptive, and analytical study conducted over a four-year period, from January 1, 2020, to December 31, 2024.

### 2.2. Study Population and Inclusion Criteria

The cohort included 31 patients identified through operative theater registries and clinical records. All patients with a diagnosis of glioblastoma suspected on neuroimaging and confirmed by histology and/or immunohistochemistry were eligible. The histological diagnosis of glioblastoma was mandatory for all patients.

### 2.3. Data Collection

Epidemiological, clinical, diagnostic, therapeutic, and outcome variables were collected from medical records and operative reports. Additional information was obtained during follow-up consultations. Data entry and organization were per-

formed using Microsoft Excel®.

### 2.4. Statistical Analysis

Overall survival was estimated using the Kaplan-Meier method. Prognostic factors influencing survival were assessed using Cox proportional hazards regression. The Wilcoxon test was applied to compare patient outcomes. Statistical analyses were performed with SPSS version 22. Statistical significance was set at $p \leq 0.05$.

## 3. Results

The mean age was 53.3 years (range, 35 - 76). The male-to-female ratio was 2.1. The average time to surgery was 3 months (range, 2 weeks - 4 months). Presenting symptoms included intracranial hypertension (100%), motor deficit (65%), and seizures (38%). Sixty-five percent of patients had a KPS greater than 70%, and 35% had a KPS below 70%.

Tumors were most frequently frontal (42%), followed by temporal (30%) and parietal (25%) (**Figure 1**). Multifocal lesions occurred in 3% of cases. Resection was total in 45%, subtotal in 32%, and partial in 16%; 7% of patients had biopsy only.

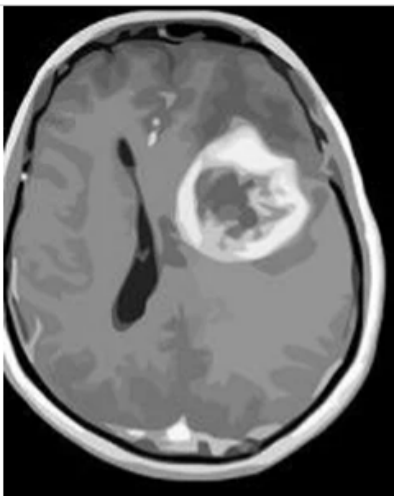

**Figure 1.** Axial T1-weighted MRI with gadolinium enhancement showing a left frontal glioblastoma.

The Stupp protocol was administered in 26 patients (84%), with 6 incomplete courses. Five patients were lost to follow-up. Median overall survival was 9.86 months (**Figure 2(A)**). No significant survival difference was observed between sexes ($p = 0.829$), although cumulative survival was higher in females. Median survival was 13 months for patients with KPS > 70% and 8 months for those with KPS ≤ 70% (**Figure 2(B)**). Patients < 60 years had longer survival than those ≥60, but the difference was not significant ($p = 0.578$, Cox regression).

Survival did not differ by time to surgery ($p = 0.575$) or extent of resection ($p = 0.575$). Median survival was 20 months for patients completing the full Stupp pro-

tocol versus 7 months for incomplete treatment. On multivariate Cox regression, sex, age, preoperative KPS, Stupp protocol, extent of resection, and time to surgery showed no significant association with overall survival (p = 0.351, 0.669, 0.19, 0.83, 0.844, and 0.821, respectively).

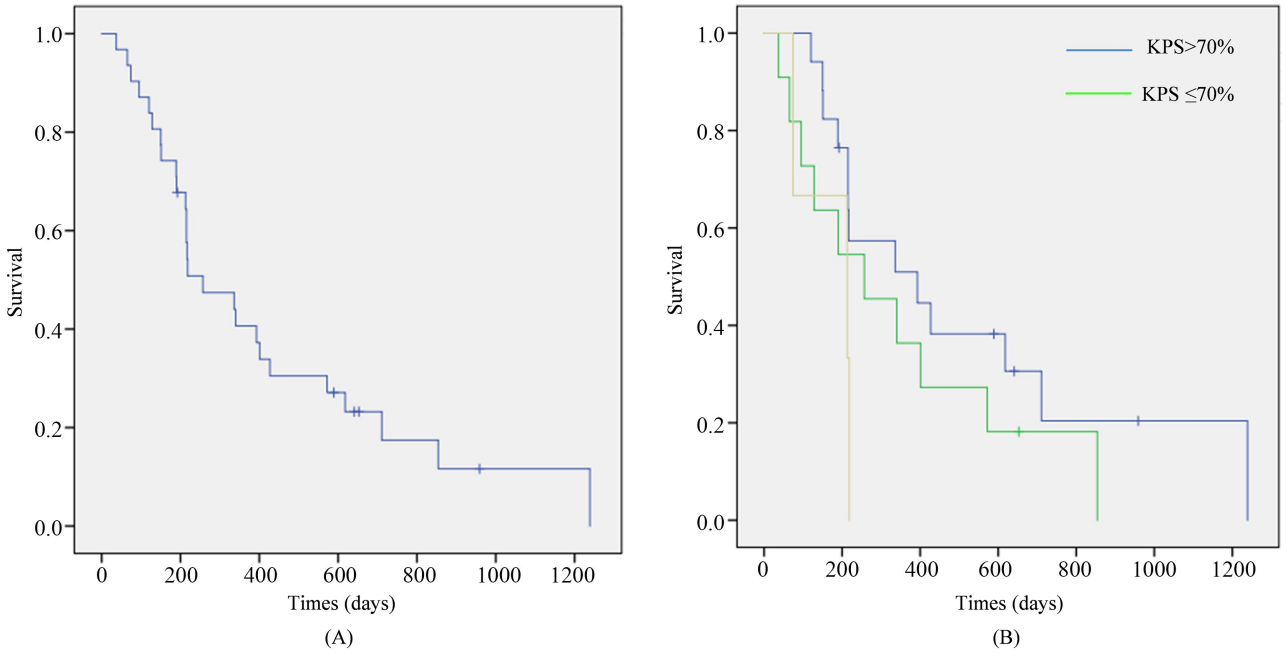


**Figure 2.** Kaplan-Meier survival curve showing overall survival (A) and survival stratified by KPS (B).

## 4. Discussion

In our series, the mean patient age was 53 years, a relatively young age that has also been reported by other authors [15] [16]. The male predominance (sex ratio, 2.1) is consistent with previous epidemiological reports [17] [18]. Intracranial hypertension, motor deficit, and seizures were the most frequent presenting symptoms, reflecting the tumor locations predominantly in the frontal and temporal lobes.

The extent of resection remains a key prognostic factor in glioblastoma management. Larger studies have consistently demonstrated improved survival with maximal safe resection [19]-[23]. In our cohort, total resection was achieved in 45% of patients; however, survival did not significantly differ according to the extent of resection. Indeed, the availability of neuroimaging modalities, neuronavigation systems, and intraoperative adjuncts (such as fluorescence-guided surgery or intraoperative monitoring) is limited, making gross total resection more difficult to achieve. The inability to consistently achieve maximal safe resection may partly explain these results [24].

The Stupp protocol was administered in the majority of patients (84%), but only 65% completed the full course. Median survival was 20 months in patients with a complete protocol compared with 7 months in incomplete cases. This survival ad-

vantage underscores the central role of combined radiotherapy and temozolomide in glioblastoma treatment, as established by Stupp *et al*. [7].

Age and KPS are well-recognized prognostic factors [11] [25]-[27]. In our series, patients younger than 60 years and those with KPS > 70% had longer survival, although the differences did not reach statistical significance. Again, this may be explained by sample size limitations and loss to follow-up.

Interestingly, survival was not influenced by the time to surgery. This suggests that, within the observed delay (2 weeks to 4 months), other factors such as tumor biology and treatment compliance may play a greater role in prognosis.

Overall, our findings confirm the importance of multimodal treatment in glioblastoma and highlight the prognostic value of functional status and completion of the Stupp protocol. The absence of statistically significant associations in multivariate analysis likely reflects the small cohort size and retrospective design, both of which limit the generalizability of our conclusions.

### Limitations

The limited number of patients likely reduced the statistical power of our analyses, particularly the multivariate model. As a result, some associations that showed strong trends in univariate analysis—most notably the beneficial effect of completing the Stupp protocol on overall survival—did not reach statistical significance after adjustment for other variables. This suggests that the study was likely underpowered to detect independent predictors of survival.

## 5. Conclusion

Glioblastoma in our series predominantly affected middle-aged men and commonly presented with intracranial hypertension, motor deficits, and seizures. Completion of the Stupp protocol was the main factor independently associated with improved survival. Although age and functional status showed strong trends toward significance in univariate analysis, these associations were not confirmed in the multivariate model, likely reflecting limited statistical power. Larger, prospective studies incorporating molecular biomarkers are needed to refine prognostic assessment and guide management strategies in our setting.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

## References

[1] Rončević, A., Koruga, N., Soldo Koruga, A. and Rončević, R. (2025) Artificial Intelligence in Glioblastoma—Transforming Diagnosis and Treatment. *Chinese Neurosurgical Journal*, **11**, Article No. 10. https://doi.org/10.1186/s41016-025-00399-2

[2] Tan, A.C., Ashley, D.M., López, G.Y., Malinzak, M., Friedman, H.S. and Khasraw, M. (2020) Management of Glioblastoma: State of the Art and Future Directions. *CA*: *A Cancer Journal for Clinicians*, **70**, 299-312. https://doi.org/10.3322/caac.21613

[3] Urbańska, K., Sokołowska, J., Szmidt, M. and Sysa, P. (2014) Review Glioblastoma Multiforme—An Overview. *Współczesna Onkologia*, **5**, 307-312. https://doi.org/10.5114/wo.2014.40559

[4] Ghosh, M., Shubham, S., Mandal, K., Trivedi, V., Chauhan, R. and Naseera, S. (2017) Survival and Prognostic Factors for Glioblastoma Multiforme: Retrospective Single-Institutional Study. *Indian Journal of Cancer*, **54**, 362-367. https://doi.org/10.4103/ijc.ijc_157_17

[5] Ma, R., Taphoorn, M.J.B. and Plaha, P. (2021) Advances in the Management of Glioblastoma. *Journal of Neurology, Neurosurgery & Psychiatry*, **92**, 1103-1111. https://doi.org/10.1136/jnnp-2020-325334

[6] Clarke, J., Butowski, N. and Chang, S. (2010) Recent Advances in Therapy for Glioblastoma. *Archives of Neurology*, **67**, 279-283. https://doi.org/10.1001/archneurol.2010.5

[7] Stupp, R., Mason, W.P., van den Bent, M.J., Weller, M., Fisher, B., Taphoorn, M.J.B., *et al.* (2005) Radiotherapy Plus Concomitant and Adjuvant Temozolomide for Glioblastoma. *New England Journal of Medicine*, **352**, 987-996. https://doi.org/10.1056/nejmoa043330

[8] Wang, Y. and Feng, Y. (2020) The Efficacy and Safety of Radiotherapy with Adjuvant Temozolomide for Glioblastoma: A Meta-Analysis of Randomized Controlled Studies. *Clinical Neurology and Neurosurgery*, **196**, Article 105890. https://doi.org/10.1016/j.clineuro.2020.105890

[9] Brandes, A.A., Tosoni, A., Franceschi, E., Reni, M., Gatta, G. and Vecht, C. (2008) Glioblastoma in Adults. *Critical Reviews in Oncology/Hematology*, **67**, 139-152. https://doi.org/10.1016/j.critrevonc.2008.02.005

[10] Chaichana, K.L., Chaichana, K.K., Olivi, A., Weingart, J.D., Bennett, R., Brem, H., *et al.* (2011) Surgical Outcomes for Older Patients with Glioblastoma Multiforme: Preoperative Factors Associated with Decreased Survival. *Journal of Neurosurgery*, **114**, 587-594. https://doi.org/10.3171/2010.8.jns1081

[11] Helseth, R., Helseth, E., Johannesen, T.B., Langberg, C.W., Lote, K., Rønning, P., *et al.* (2010) Overall Survival, Prognostic Factors, and Repeated Surgery in a Consecutive Series of 516 Patients with Glioblastoma Multiforme. *Acta Neurologica Scandinavica*, **122**, 159-167. https://doi.org/10.1111/j.1600-0404.2010.01350.x

[12] Luo, C., Song, K., Wu, S., Hameed, N.U.F., Kudulaiti, N., Xu, H., *et al.* (2021) The Prognosis of Glioblastoma: A Large, Multifactorial Study. *British Journal of Neurosurgery*, **35**, 555-561. https://doi.org/10.1080/02688697.2021.1907306

[13] Ladomersky, E., Scholtens, D.M., Kocherginsky, M., Hibler, E.A., Bartom, E.T., Otto-Meyer, S., *et al.* (2019) The Coincidence between Increasing Age, Immunosuppression, and the Incidence of Patients with Glioblastoma. *Frontiers in Pharmacology*, **10**, Article 200. https://doi.org/10.3389/fphar.2019.00200

[14] Dy, L.F., Ong, E.P., Espiritu, A.I., Spears, J. and Omar, A.T. (2022) Survival Times of Patients with Glioblastoma in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Neurosurgical Review*, **45**, 3393-3403. https://doi.org/10.1007/s10143-022-01844-x

[15] Baba, M.A., lmejjati, M. and Adali, N. (2022) Prognostic Factors for Survival of Patients with Glioblastoma in the Southern Region of Morocco. *Archives of Neuroscience*, **10**, e132014. https://doi.org/10.5812/ans-132014

[16] Faguer, R., Tanguy, J.Y., Rousseau, A., Clavreul, A. and Menei, P. (2014) Early Presentation of Primary Glioblastoma. *Neurochirurgie*, **60**, 188-193. https://doi.org/10.1016/j.neuchi.2014.02.008

[17] Dubrow, R. and Darefsky, A.S. (2011) Demographic Variation in Incidence of Adult Glioma by Subtype, United States, 1992-2007. *BMC Cancer*, **11**, Article No. 325. https://doi.org/10.1186/1471-2407-11-325

[18] Tavelin, B. and Malmström, A. (2022) Sex Differences in Glioblastoma—Findings from the Swedish National Quality Registry for Primary Brain Tumors between 1999-2018. *Journal of Clinical Medicine*, **11**, Article 486. https://doi.org/10.3390/jcm11030486

[19] Lacroix, M. and Toms, S.A. (2014) Maximum Safe Resection of Glioblastoma Multiforme. *Journal of Clinical Oncology*, **32**, 727-728. https://doi.org/10.1200/jco.2013.53.2788

[20] Marko, N.F., Weil, R.J., Schroeder, J.L., Lang, F.F., Suki, D. and Sawaya, R.E. (2014) Extent of Resection of Glioblastoma Revisited: Personalized Survival Modeling Facilitates More Accurate Survival Prediction and Supports a Maximum-Safe-Resection Approach to Surgery. *Journal of Clinical Oncology*, **32**, 774-782. https://doi.org/10.1200/jco.2013.51.8886

[21] Youngblood, M.W., Stupp, R. and Sonabend, A.M. (2021) Role of Resection in Glioblastoma Management. *Neurosurgery Clinics of North America*, **32**, 9-22. https://doi.org/10.1016/j.nec.2020.08.002

[22] Wolbers, J.G. (2014) Novel Strategies in Glioblastoma Surgery Aim at Safe, Supra-Maximum Resection in Conjunction with Local Therapies. *Chinese Journal of Cancer*, **33**, 8-15. https://doi.org/10.5732/cjc.013.10219

[23] Li, Y.M., Suki, D., Hess, K. and Sawaya, R. (2016) The Influence of Maximum Safe Resection of Glioblastoma on Survival in 1229 Patients: Can We Do Better than Gross-Total Resection? *Journal of Neurosurgery*, **124**, 977-988. https://doi.org/10.3171/2015.5.jns142087

[24] Almeida, J.P., Chaichana, K.L., Rincon-Torroella, J. and Quinones-Hinojosa, A. (2015) The Value of Extent of Resection of Glioblastomas: Clinical Evidence and Current Approach. *Current Neurology and Neuroscience Reports*, **15**, Article No. 517. https://doi.org/10.1007/s11910-014-0517-x

[25] Reihanian, Z., Abbaspour, E., Zaresharifi, N., Karimzadhagh, S., Mahmoudalinejad, M., Sourati, A., *et al*. (2024) Impact of Age and Gender on Survival of Glioblastoma Multiforme Patients: A Multicenter Retrospective Study. *Cancer Reports*, **7**, e70050. https://doi.org/10.1002/cnr2.70050

[26] Lamborn, K.R., Chang, S.M. and Prados, M.D. (2004) Prognostic Factors for Survival of Patients with Glioblastoma: Recursive Partitioning Analysis. *Neuro-Oncology*, **6**, 227-235. https://doi.org/10.1215/s1152851703000620

[27] Sasaki, S., Tsukamoto, S., Ishida, Y., Kobayashi, Y., Inagaki, Y., Mano, T., *et al*. (2024) The Karnofsky Performance Status at Discharge Is a Prognostic Indicator of Life Expectancy in Patients with Glioblastoma. *Cureus*, **16**, e66226. https://doi.org/10.7759/cureus.66226