SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Saha *et al*., 2025
doi: 10.21276/SSR-IIJLS.2025.11.2.34

Original Article

open access

Outcome and Survival Following Surgical Resection of Low-Grade Glioma: A Clinical Study

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Received: 19 Dec 2024/ Revised: 27 Jan 2025/ Accepted: 27 Feb 2025

ABSTRACT

Background: Low-grade gliomas (LGGs) are slow-growing brain tumors with the potential for malignant transformation. Surgical resection remains the primary treatment approach, with the extent of resection serving as a critical prognostic factor.

Methods: This prospective study analyzed 40 patients with histologically confirmed LGG who underwent surgical resection between October 2024 and December 2024 at Agartala Government Medical College and GB Pant Hospital. Demographic data, the extent of resection, postoperative Karnofsky Performance Status (KPS), tumor progression, and malignant transformation were recorded. Patients were followed up for up to 3 months postoperatively.

Results: Of the 40 patients, 25 underwent gross total resection (GTR) and 15 had subtotal resection (STR). At the 3-month follow-up, 90% of GTR patients showed improved KPS compared to 53% in the STR group. Tumor progression was observed in 16% of GTR cases and 47% of STR cases. The malignant transformation occurred in 8% of GTR and 33% of STR patients. The 3-month survival rate was significantly higher in the GTR group (92%) compared to the STR group (67%).

Conclusion: The extent of resection plays a significant role in influencing survival and progression outcomes in LGG. Gross total resection is associated with better postoperative recovery, reduced recurrence, and prolonged survival. Maximal safe resection should be prioritized, and supported by advanced neurosurgical tools.

Key-words: Glioma, Malignant transformation, Neurosurgery, Outcome, Resection, Survival, Tumor progression

INTRODUCTION

Diffuse infiltrative low-grade gliomas (LGGs) of the cerebral hemispheres represent approximately 20–30% of gliomas in adults [1]. These tumors, classified as grade I and II by the World Health Organization (WHO), present with a variety of histologic and molecular features and are typically slow-growing [2].

How to cite this article
Saha D, Nath AL, Trivedi AS. Outcome and Survival Following Surgical Resection of Low-Grade Glioma: A Clinical Study. SSR Inst Int J Life Sci., 2025; 11(2): 7223-7228.

Access this article online
https://iijls.com/

Despite their indolent nature, LGGs pose a substantial concern in neuro-oncology due to the risk of malignant transformation, particularly in WHO grade II tumors [3]. LGGs include entities such as pilocytic astrocytoma, subependymal giant cell astrocytoma, fibrillary astrocytomas, oligodendrogliomas, ependymomas, pleomorphic xanthoastrocytomas, and others [4].

The epidemiological and biological characteristics of LGGs differ significantly from high-grade gliomas in terms of proliferation rates, mitotic activity, angiogenesis, and genetic mutations [5]. While LGGs have better median survival (5–10 years), they tend to progress over time, with most patients eventually succumbing to the disease [6,7]. Prognostic factors influencing survival include

doi: 10.21276/SSR-IIJLS.2025.11.2.34

patient age, Karnofsky Performance Score (KPS), histological type, and IDH mutation status [8]. However, the role of extent of resection (EOR) in influencing survival and recurrence is still being systematically studied [9].

The surgical management of LGGs has evolved significantly. Initially, a conservative "wait-and-watch" approach was adopted due to slow tumor growth and minimal initial symptoms, mainly seizures [10]. However, increasing evidence suggests that early maximal resection delays malignant progression, improves seizure control, and enhances overall survival [11–13]. The primary obstacle in achieving GTR lies in the tumors' proximity to eloquent cortical areas and subcortical functional pathways [1,12]. With the integration of neuronavigation and intraoperative imaging, including MR and cortical mapping, safer resection in eloquent areas has become feasible [14].

Although no randomized controlled trials have definitively proven the survival benefit of GTR in LGGs, volumetric studies have shown that patients achieving GTR have significantly better long-term outcomes. A 10-year survival rate of nearly 100% has been reported in cases with complete resection, while survival declines with lesser EOR [15]. These results, although not supported by Class I evidence, have led many neurosurgeons to advocate for maximal safe resection at the time of initial diagnosis [16–18].

The present study explores outcomes and survival following surgical resection of LGGs, emphasizing the role of GTR in improving prognosis while maintaining neurological function. This analysis supports the growing body of evidence suggesting that surgical strategy should prioritize radical yet safe tumor removal to optimize both survival and quality of life (QoL).

MATERIALS AND METHODS

Research design- This prospective observational study was conducted in the Department of Neurosurgery, Agartala Government Medical College and GB Pant Hospital from October 2024 to December 2024. A total of 40 patients diagnosed with LGG and treated surgically were included. Data were extracted from patient medical records and operative notes. Follow-up assessments were performed postoperatively at 1 month and then at 3 months.

The extent of resection was categorized as:

- Gross Total Resection (GTR): No residual tumor on postoperative imaging.
- Subtotal Resection (STR): Presence of residual tumor on postoperative imaging.

Neurological status was assessed using the Karnofsky Performance Status (KPS) scale. Tumor progression was defined based on radiological evidence of increased tumor size or new symptoms. Malignant transformation was diagnosed by imaging (contrast enhancement) and/or histopathological confirmation.

Inclusion Criteria

- Patients aged 18 years and above.
- Histopathologically confirmed cases of WHO grade I or II gliomas.
- Patients who underwent surgical resection (GTR or STR).
- Available follow-up data for at least 3 months.

Exclusion Criteria

- Patients with recurrent glioma or prior surgery for glioma.
- High-grade gliomas (WHO grade III and IV).
- Patients with incomplete records or lost to follow-up.
- Patients, who only underwent biopsy without resection.

Statistical Analysis- All data were tabulated using Microsoft Excel and analyzed using SPSS software (version 25.0). Descriptive statistics were calculated for demographic and clinical variables. Comparative analyses between the GTR and STR groups were done using the Chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Ethical Approval- The study was approved by the Institute ethics committee of Agartala Government Medical College and GB Pant Hospital. Informed consent was obtained from all participants before inclusion in the study.

RESULTS

A total of 40 patients with histologically confirmed LGG were included in this study, of which 25 patients (62.5%) underwent GTR and 15 (37.5%) underwent subtotal resection (STR). The average age at diagnosis was 37.2

doi: 10.21276/SSR-IIJLS.2025.11.2.34

years (range: 20–55 years), and the male-to-female ratio was approximately 1.5:1. Seizure was the most common presenting symptom, reported in 72.5% of cases, followed by headache and focal neurological deficits (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of Patients

Parameter	Value
Number of patients	40
Mean age (years)	37.2
Male: Female ratio	1.5:1
Common presenting symptom	Seizure (72.5%)

Postoperative outcomes were evaluated using KPS. At the 3-month follow-up, a notable improvement in KPS was observed in 90% of patients who underwent GTR, compared to only 53% in the STR group. No postoperative mortality was reported in either group. Temporary neurological deficits were noted in seven patients (three from GTR and four from STR), all of whom recovered over time. One patient in the STR group developed a permanent neurological deficit.

Tumor progression was seen in 4 out of 25 (16%) GTR patients and in 7 out of 15 (47%) STR patients. Additionally, malignant transformation occurred in 8% of GTR cases and 33% of STR cases. These comparative outcomes are detailed in Table 2.

Table 2: Comparative Outcomes Between GTR and STR groups

Group	Improved KPS (%)	Tumor Progression (%)	Malignant Transformation (%)	3-months Survival (%)
GTR (n=25)	90	16	8	92
STR (n=15)	53	47	33	67

GTR- Gross total resection; STR- Subtotal resection

Kaplan-Meier survival analysis was performed to assess overall survival. The survival curve indicates a higher survival probability in patients who underwent gross total resection. By the end of the 3-month follow-up period, survival in the GTR group remained above 90%, while it declined more steeply in the STR group, dropping to 67%. Fig. 1 below demonstrates the survival trends over the 3-month follow-up period.

These findings clearly emphasize the prognostic significance of the extent of resection. Patients undergoing GTR not only demonstrated superior functional recovery but also had reduced rates of tumor progression and malignant transformation, ultimately leading to prolonged survival. Thus, maximal safe resection plays a vital role in improving outcomes in patients with low-grade glioma.

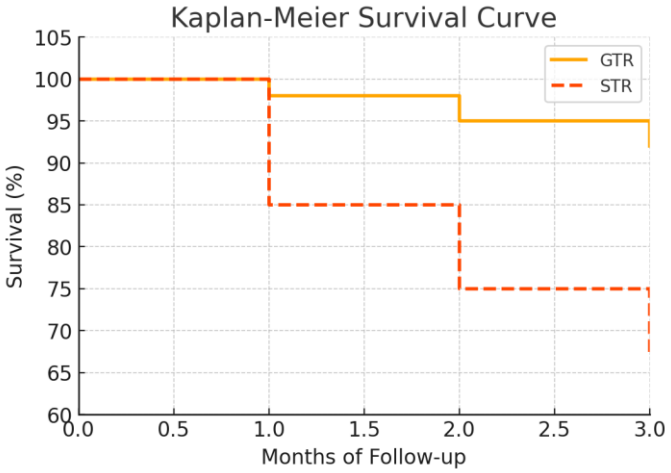

Fig. 1: Kaplan-Meier Survival Curve

Fig. 2 visually highlights the significant differences in functional recovery and tumor behavior between the two surgical groups. GTR resulted in a much higher rate of improvement in KPS and substantially lower rates of tumor progression and malignant transformation compared to STR.

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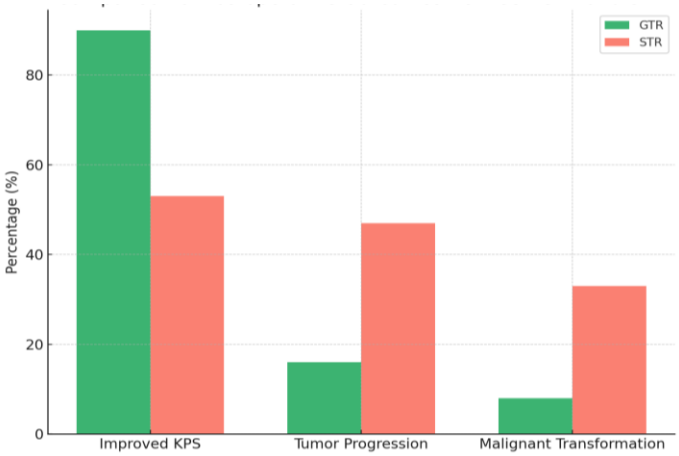

Fig. 2: Comparison of Postoperative Outcomes Between GTR and STR

DISCUSSION

The present study reaffirms the critical role of surgical resection in determining outcomes for patients with LGGs. The observed higher rates of functional improvement reduced tumor progression, and superior survival outcomes in the GTR group underscore the importance of maximal safe resection. These findings are consistent with numerous prior studies that support aggressive surgical strategies in LGG management [19,20].

Extent of resection (EOR) has long been associated with progression-free survival (PFS) and overall survival (OS) in LGGs. Smith et al. and Ius et al. demonstrated that patients undergoing GTR had significantly better long-term survival than those undergoing STR or biopsy [21,22]. The reduced incidence of malignant transformation in GTR patients, as seen in our study, is also echoed in the literature suggesting that aggressive early intervention may suppress oncogenic molecular evolution [23].

Preservation of neurological function remains a challenge, especially in lesions involving the eloquent cortex. However, in this study, temporary neurological deficits occurred in only a small number of patients and all resolved during follow-up except in one case. The advent of intraoperative mapping and neuro-navigation has enhanced the safety of resections even in functionally sensitive areas [24,25]. This aligns with current surgical principles emphasizing functional preservation alongside oncological benefit [26].

Another notable finding is the difference in KPS postoperatively. Patients in the GTR group showed significantly better improvement, indicating that early and complete removal of tumor not only extends life but also improves quality of life, consistent with results from previous perspective trials [27].

Survival outcomes in this study were encouraging, particularly in the GTR group with 92% 3-month survival. This supports evidence from multicenter studies indicating GTR as a key factor in extending survival, even more so when combined with favorable molecular profiles such as IDH mutation and 1p/19q codeletion [28]. Though molecular profiling was not a part of this retrospective dataset, future integration of these markers can help refine risk stratification.

Our findings justify a surgical-first approach to managing LGGs and emphasize the integration of imaging, functional monitoring, and individualized planning. While randomized control trials are limited in this area due to ethical constraints, large prospective registries and meta-analyses continue to support these trends [29].

CONCLUSIONS

Gross total resection significantly improves survival, reduces recurrence, and minimizes malignant transformation in low-grade glioma patients. The integration of advanced neurosurgical techniques has enabled safer resections, even in eloquent brain regions. Our study supports the need for early surgical intervention and emphasizes a multidisciplinary approach to optimizing outcomes. Continued follow-up and integration of molecular data will further improve prognostication and personalized treatment strategies.

CONTRIBUTION OF AUTHORS

Research concept- Debadatta Saha
Research design- Debadatta Saha
Supervision- Debadatta Saha
Materials- Debadatta Saha
Data collection- Debadatta Saha
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