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Surgical Outcome of Metastatic Intracranial Brain Tumors in Different Location of Brain

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Abstract:

Background: *Metastatic intracranial brain tumors are among the most common types of brain tumors, often associated with poor prognosis and significant morbidity. The purpose of the study was to assess the surgical outcomes of metastatic intracranial brain tumors in different locations of the brain.*

Aim of the study: *The aim of the study was to evaluate the surgical outcomes of metastatic intracranial brain tumors in different locations of the brain.*

Methods: *This retrospective study was conducted in the Department of Neurosurgery at Shaheed Suhrawardy Medical College Hospital, Dhaka, from January 2021 to December 2023. It included 35 adult patients with metastatic intracranial brain tumors confirmed by imaging and histopathology, excluding those with primary brain tumors or severe systemic conditions. Data on medical histories, tumor locations, surgical outcomes, complications, and survival rates were collected and analyzed using SPSS version 22.0.*

Results: *The study involved 35 patients, with a mean age of 57.27 years and 60% male. The most common tumor location was the frontal lobe (42.9%). Complete resection was achieved in 74.3% of cases. Postoperative complications included infections (5.7%) and neurological deficits (14.3%). Survival rates were 80.0% at 12 months, dropping to 22.9% at 36 months. The cerebellum showed the highest neurological improvement (85.0%) and lowest complication rate (5.0%).*

Conclusion: *The study highlights that surgical outcomes for metastatic intracranial brain tumors vary significantly based on tumor location, with the cerebellum showing the best results.*

Key words: *Metastatic Brain Tumors, Surgical Outcomes, Intracranial Tumors, Brain Metastases, Tumor Location.*

1. INTRODUCTION

Brain tumors are a leading cause of morbidity and mortality worldwide, with metastatic intracranial tumors being among the most common types. Few clinical entities evoke more pessimism among physicians than the

discovery of a metastatic intracranial tumor, as it is often associated with a poor prognosis.[1] Metastatic brain tumors account for approximately 200,000 cases per year in the United States, making them the most common intracranial neoplasm in adults.[2,3] These tumors are often caused by the spread of cancer from primary sites such as the lung, breast, and melanoma, with lung cancer being the most frequent source.[4,5,6] The frequency of spontaneous intracerebral hemorrhage (ICH) in brain tumors ranges from 1.4% to 10%,[7,8,9] with highly vascularized tumors such as metastatic malignant melanoma showing a higher incidence of bleeding complications.

Metastatic brain tumors have a significant impact on survival, with approximately 40-50% of patients diagnosed with brain metastases dying within 3-27 months of diagnosis.[4,5] Prognosis varies based on factors such as the primary tumor type, with melanoma showing the highest frequency of brain metastasis at 40-60%.[10,11] The treatment and management of brain metastases have advanced over the past two decades, with surgical interventions, stereotactic radiosurgery (SRS), and whole-brain radiation therapy (WBRT) now being common options for local control.[12,13] However, the complexity of these treatment choices has increased as a result of improved survival rates, making the management of metastatic brain tumors a more challenging task for clinicians.

Surgical treatment plays a pivotal role in managing brain metastases (BM), offering significant benefits in improving both survival and quality of life. Currently, the surgical removal of BM is considered both feasible and safe, especially in cases of hemorrhagic metastases, where it provides immediate relief from neurologic deficits.[14] Surgery alleviates intracranial hypertension and enhances neurological function by removing the tumor mass, reducing surrounding edema, and resolving cerebrospinal fluid obstruction.[15] Despite advancements in systemic therapies that have extended the survival of cancer patients, surgery continues to be a cornerstone in the management of brain metastases, providing an essential approach for improving outcomes in carefully selected cases.[16]

However, challenges persist, particularly due to the variability of outcomes based on tumor location. Tumors situated in regions such as the frontal, parietal, temporal lobes, or the cerebellum may result in differing surgical outcomes, influenced by the functional significance of these areas and potential complications. Additionally, post-surgical management is often hindered by the absence of standardized protocols, with many studies excluding patients who have undergone neurosurgical tumor resection, leading to gaps in evidence-based guidelines. Overcoming these obstacles necessitates a multidisciplinary approach, involving neurosurgeons, medical oncologists, radiation oncologists, and other specialists, to develop individualized care plans that account for tumor location, patient comorbidities, and overall prognosis.[16] This collaborative strategy is critical to optimizing outcomes and advancing the management of brain metastases.

Despite advancements in the surgical management of brain metastases, significant knowledge gaps persist. Limited research has focused on the outcomes of surgery for hemorrhagic brain metastases or those originating from tumor types with a high predisposition for bleeding. Additionally, variability in surgical results based on tumor location, such as the frontal, parietal, temporal, or cerebellar regions, remains inadequately addressed. These gaps hinder the ability to develop standardized protocols and optimize patient outcomes. The purpose of the study was to assess the surgical outcomes of metastatic intracranial brain tumors in different locations of the brain.

1.1. Objective

- The aim of the study was to evaluate the surgical outcomes of metastatic intracranial brain tumors in different locations of the brain.

2. Methodology and Materials

This retrospective study was conducted in the Department of Neurosurgery at Shaheed Suhrawardy Medical College Hospital, Dhaka, Bangladesh, from January 2021 to December 2023. A total of 35 patients diagnosed with metastatic intracranial brain tumors were enrolled in the study.

2.1. Inclusion Criteria

- Patients diagnosed with metastatic intracranial brain tumors confirmed by imaging (CT/MRI) and histopathological examination.

- Adults aged 18 years and older.
- Patients who provided written informed consent for participation in the study.

2.2. Exclusion Criteria

- Patients with primary brain tumors.
- Patients with severe systemic conditions contraindicating surgery.
- Pregnant or breastfeeding women.
- Patients with other significant neurological disorders that may confound the results.

Written informed consent was obtained from all participants to ensure confidentiality and voluntary participation. Upon enrollment, detailed medical histories were collected through structured interviews, and clinical examinations assessed the neurological status and severity of symptoms. Tumor locations were identified using imaging techniques (CT/MRI), and histopathological confirmation was performed post-surgery. Surgical interventions, including complete resection, partial resection, or biopsy, were carried out according to standard protocols based on tumor location and patient health status. Neurological outcomes were monitored postoperatively, focusing on improvement in neurological function and the occurrence of complications such as infection, seizures, and new neurological deficits. The follow-up period included assessments at 12, 24, and 36 months after surgery, evaluating survival rates and recurrence of tumors. Data were compiled and analyzed using SPSS version 22.0, employing descriptive statistics (frequencies, percentages) to summarize demographic characteristics, surgical outcomes, and postoperative complications. Survival rates were calculated for 12-month, 24-month, and 36-month intervals.

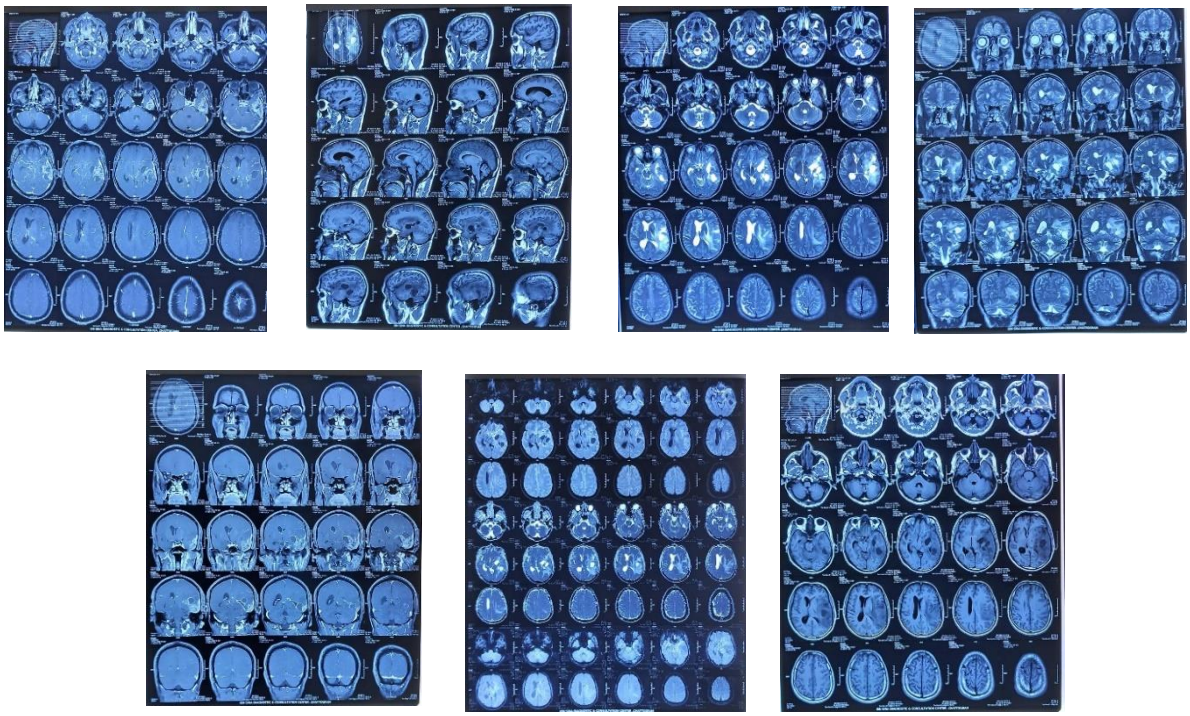

Figure 1. *MRI Image Showing Brain Metastasis.*

3. RESULTS

Table 1. *Demographic Characteristics of the Study Participants (n = 35)*

Variable		Frequency (n)	Percentage (%)
Age (In years)	≤ 45	7	20.0
	46–55	9	25.7
	56–65	10	28.6
	> 65	9	25.7
	Mean ±SD (years)	57.27±9.28	
Gender	Male	21	60.0

	Female	14	40.0

Table 1 presents the demographic profile of the study participants. The mean age of the participants was 57.27 ± 9.28 years. Among the 35 participants, 7 (20.0%) were aged ≤ 45 years, 9 (25.7%) were aged 46–55 years, 10 (28.6%) were aged 56–65 years, and 9 (25.7%) were aged > 65 years. Regarding gender distribution, 21 (60.0%) participants were male, while 14 (40.0%) were female.

Table 2. *Tumor Locations in the Study Participants (n = 35)*

Brain Location	Frequency (n)	Percentage (%)
Frontal Lobe	15	42.9
Parietal Lobe	4	11.4
Temporal Lobe	4	11.4
Occipital Lobe	3	8.6
Cerebellum	9	25.7

Table 2 shows the distribution of metastatic brain tumors across different brain locations. The most common site of metastasis was the frontal lobe, affecting 15 (42.9%) participants. Tumors in the cerebellum were observed in 9 (25.7%) patients, while the temporal and parietal lobes each had 4 (11.4%) affected participants. The occipital lobe was the least commonly involved, with 3 (8.6%) participants presenting with tumors in this location.

Table 3. *Surgical Outcomes of Metastatic Intracranial Brain Tumors (n = 35)*

Outcome	Frequency (n)	Percentage (%)
Complete Resection	26	74.3%
Partial Resection	6	17.1%
Biopsy Only	3	8.6%

Table 3 summarizes the surgical outcomes of metastatic intracranial brain tumors in the study participants. Complete resection was achieved in 26 patients (74.3%), representing the majority of cases. Partial resection was performed in 6 patients (17.1%), while biopsy alone was conducted in 3 patients (8.6%).

Table 4. *Postoperative Complications in the Study Participants (n = 35)*

Complication	Frequency (n)	Percentage (%)
Infection	2	5.7
Seizures	2	5.7
Neurological Deficits	5	14.3

Table 4 presents the postoperative complications observed in the study participants. Out of the 35 patients, 2 (5.7%) experienced infection, and 2 (5.7%) experienced seizures. Neurological deficits were the most common complication, affecting 5 (14.3%) patients.

Table 5. *Postoperative Survival Rates at Different Time Points (n = 35)*

Time Post-Surgery	Frequency (n)	Percentage (%)
12-month	28	80.0%
24-month	18	51.4%
36-month	8	22.9%

Table 5 outlines the postoperative survival rates of the study participants at different time intervals. At 12 months post-surgery, 28 patients (80.0%) were alive, which decreased to 18 patients (51.4%) at 24 months and further to 8 patients (22.9%) at 36 months.

Table 6. *Surgical Outcomes by Tumor Location in Metastatic Intracranial Brain Tumors*

Tumor Location	Neurological Improvement (%)	Complication Rate (%)
Frontal Lobe	80.0%	10.0%

Parietal Lobe	75.0%	15.0%
Temporal Lobe	70.0%	20.0%
Occipital Lobe	66.7%	33.3%
Cerebellum	85.0%	5.0%

Table 6 presents the surgical outcomes of metastatic intracranial brain tumors categorized by tumor location. It shows the percentage of neurological improvement and complication rates for each brain region. The cerebellum demonstrated the highest neurological improvement (85.0%) with the lowest complication rate (5.0%), indicating better surgical outcomes in this area. In contrast, the occipital lobe had the lowest neurological improvement (66.7%) and the highest complication rate (33.3%), highlighting the challenges of surgical intervention in this location.

4. Discussion

This study, conducted at the Department of Neurosurgery at Shaheed Suhrawardy Medical College Hospital in Dhaka, Bangladesh, assessed the surgical outcomes of metastatic intracranial brain tumors in various brain locations. Metastatic brain tumors remain a significant clinical challenge due to their aggressive nature and the complexity of their surgical management. The study's findings highlight the diverse outcomes based on tumor location, with variations in neurological improvement and complication rates observed across different brain regions. The data reveal the importance of tailored surgical approaches and the need for careful consideration of the tumor's location, vascularity, and patient-specific factors. These results underscore the ongoing challenges and opportunities for improving the surgical management of metastatic brain tumors.

In our study, the mean age of participants was 57.27 ± 9.28 years, similar to the findings of Rauschenbach et al.[17], who reported a mean age of 58 ± 12 years. The majority of our participants were aged 56–65 years (28.6%), reflecting a common trend in metastatic brain tumor cases, as older adults are more prone to develop these tumors. Regarding gender, 60.0% of participants were male, aligning with the results of Gupta et al.[18], who also observed a male predominance in metastatic brain tumor cases. This is likely due to the higher incidence of cancers such as lung and melanoma, which frequently metastasize to the brain. These demographic trends highlight the importance of considering age and gender when evaluating surgical outcomes and treatment strategies for metastatic intracranial brain tumors.

The distribution of metastatic intracranial brain tumors across different brain locations in our study revealed that the frontal lobe was the most commonly affected site, with 15 (42.9%) participants presenting with tumors in this region. This finding is consistent with the study by Rauschenbach et al.[17], who reported a similar predominance of metastases in the frontal lobe. The cerebellum was the second most frequent site, with 9 (25.7%) participants affected, highlighting its vulnerability to metastasis. Tumors in the temporal and parietal lobes were observed in 4 (11.4%) participants each, while the occipital lobe was the least affected, with only 3 (8.6%) participants presenting with tumors in this location. These results are consistent with previous research that underscores the frontal lobe's susceptibility to metastatic involvement. The distribution of metastases in our study aligns with established patterns of brain tumor metastasis, which is crucial for understanding the surgical outcomes and optimizing management strategies based on tumor location.

In our study, complete resection was achieved in 26 (74.3%) participants, partial resection in 6 (17.1%), and biopsy only in 3 (8.6%), reflecting the predominance of complete resections in managing metastatic brain tumors. This high-rate highlights advancements in surgical techniques and the emphasis on reducing tumor burden to improve neurological outcomes. Partial resection and biopsy were employed in cases with higher surgical risks, likely influenced by tumor location or systemic conditions, similar to findings reported by Yoo et al.[19] These outcomes underscore the need for individualized surgical strategies, where the extent of resection is tailored to optimize patient outcomes while considering tumor characteristics and comorbidities. Moreover, adjuvant therapies and systemic disease control remain critical in determining long-term

outcomes, emphasizing the importance of a multidisciplinary approach in managing metastatic intracranial brain tumors.

Neurological deficits were observed in 5 (14.3%) participants in our study, reflecting a notable postoperative complication. This aligns with the study by Lonjaret et al.[20], who reported that 8% of patients experienced new motor deficits. The comparable rates highlight the prevalence of neurological deficits as a significant concern following brain tumor surgery. While Lonjaret et al.[20] noted slightly higher rates, the findings underscore the inherent challenges and risks associated with such procedures. These results emphasize the critical need for individualized surgical planning, advanced intraoperative monitoring, and early postoperative interventions to minimize the risk of neurological complications and optimize patient recovery.

The survival rates in our study were 80.0%, 51.4%, and 22.9% at 12-, 24-, and 36-months post-surgery, respectively, mirroring the declining trend noted by Niedermeyer et al.[21] Both studies highlight the importance of individualized surgical and systemic management to optimize short- and long-term outcomes in metastatic intracranial brain tumors.

Finally, neurological improvement and complication rates in our study were significantly influenced by tumor location. The highest neurological improvement was observed in patients with tumors in the cerebellum (85.0%), followed by the frontal lobe (80.0%). These locations also exhibited relatively low complication rates, particularly the cerebellum, which had a complication rate of just 5.0%. In contrast, tumors located in the occipital lobe showed the lowest neurological improvement (66.7%) and the highest complication rate (33.3%). Tumors in the temporal and parietal lobes demonstrated moderate outcomes, with neurological improvement rates of 70.0% and 75.0%, respectively, and moderate complication rates. These findings suggest that the location of the tumor plays a significant role in both the success of surgery and the likelihood of postoperative complications, highlighting the need for tailored surgical approaches based on tumor positioning within the brain.

Limitations of the study

This study had some limitations:

- The study was conducted in a selected tertiary-level hospital.
- The sample was not randomly selected.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

5. Conclusion

The study evaluated the surgical outcomes of metastatic intracranial brain tumors in different brain locations. Participants had an average age of 57 years, with a majority being male. The frontal lobe was the most common site of metastasis. Most patients underwent complete resection, while a minority experienced postoperative complications, primarily neurological deficits. Survival rates declined significantly over three years post-surgery. The cerebellum showed the best surgical outcomes, with the highest neurological improvement and the lowest complication rate, highlighting the variability in surgical success based on tumor location.

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