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Original Research Article

Histomorphological Spectrum of Intracranial Space Occupying Lesions: Experience at a Tertiary Care Centre

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Abstract:

Background: Intracranial space occupying lesions (ICSOLs) comprise a diverse group of neoplastic and non-neoplastic conditions affecting the central nervous system. Histopathological examination remains the gold standard for definitive diagnosis and classification of these lesions.

Aim: To study the histomorphological spectrum, demographic characteristics, and anatomical distribution of intracranial space-occupying lesions at a tertiary care centre and to establish an accurate pretherapeutic diagnosis for guiding optimal therapeutic management and achieving better clinical outcomes.

Materials and Methods: This retrospective observational study was conducted in the Department of Pathology, All India Institute of Medical Sciences, over a period of 3 years from January 2022 to December 2024. A total of 320 intracranial biopsy and resection specimen were analyzed. Histopathological evaluation was performed using hematoxylin and eosin staining. Lesions were classified on the basis of histomorphological features and graded according to WHO grading criteria wherever applicable. Statistical analysis was performed using SPSS version 26.0.

Results: Out of 320 cases, 274 (85.6%) were neoplastic and 46 (14.4%) were non-neoplastic lesions. The highest incidence was observed in the 41–60 years age group (38.1%). Male predominance was noted with a male-to-female ratio of 1.3:1. Gliomas were the most common neoplastic lesions (41.2%), followed by meningiomas (24.5%). Glioblastoma was the predominant glioma subtype. Supratentorial lesions accounted for 68.4% of cases. Statistical analysis showed a significant association between age group and lesion category ($p<0.001$).

Conclusion: Gliomas remain the most common intracranial tumors encountered in tertiary care practice. Histopathological evaluation continues to play a pivotal role in accurate diagnosis, grading, and management of intracranial lesions.

Keywords: Intracranial space occupying lesion; Histomorphology; Glioma; Meningioma; CNS tumors.

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Introduction

Intracranial space occupying lesions (ICSOLs) represent a heterogeneous group of lesions that include neoplastic, inflammatory, infectious, congenital, vascular, and parasitic conditions affecting the cranial cavity. These lesions are associated with significant morbidity and mortality due to compression of adjacent neural structures and raised intracranial pressure. Accurate diagnosis is therefore essential for effective management and prognostication.[1]

Central nervous system tumors account for approximately 2% of all malignancies worldwide but contribute disproportionately to cancer-related mortality because of their critical anatomical location.[2] The incidence of intracranial lesions has increased over recent decades owing to advances in neuroimaging techniques and improved accessibility to healthcare facilities.[3]

Radiological modalities such as computed tomography and magnetic resonance imaging provide valuable information regarding localization

and radiological characterization of lesions; however, histopathological examination remains the gold standard for definitive diagnosis.[4] Histomorphological assessment not only establishes tumor type but also determines tumor grade, biological behavior, and therapeutic planning.[5]

The World Health Organization (WHO) classification of central nervous system tumors has evolved considerably over the years. The latest 2021 WHO classification integrates molecular alterations with histopathological features to improve diagnostic precision and prognostic stratification.[6]

Gliomas constitute the most common primary intracranial tumors in adults, whereas embryonal tumors and pilocytic astrocytomas are more frequent in pediatric populations.[7] Meningiomas are another major category of intracranial tumors and demonstrate a higher prevalence among females.[8]

The distribution of intracranial lesions varies according to geographic location, referral pattern, environmental exposure, and institutional practices.[9] Therefore, regional studies are important to understand the epidemiological and histomorphological spectrum of these lesions.

The present study was undertaken to analyze the histomorphological spectrum of intracranial space occupying lesions at a tertiary care centre with emphasis on demographic distribution, anatomical location, and histopathological diagnosis.

Materials and Methods

Study Design: Retrospective observational study.

Study Location: Department of Pathology, All India Institute of Medical Sciences.

Study Duration: January 2022 to December 2024.

Sample Size: 320 cases.

Inclusion Criteria

- All intracranial biopsy and resection specimens received during the study period.
- Both neoplastic and non-neoplastic lesions.
- Adequately preserved specimens with complete histopathological, clinical and radiological details.

Exclusion Criteria

- Inadequate or autolyzed specimens.
- Recurrent lesions without primary histopathological diagnosis.
- Cases with incomplete records.

Histopathological Examination: Specimens were fixed in 10% neutral buffered formalin and routinely processed. Paraffin embedded sections were stained with hematoxylin and eosin.

Histopathological examination was performed on formalin-fixed paraffin-embedded tissue sections stained with hematoxylin and eosin. Tumors were classified and graded based on histomorphological features. Immunohistochemistry and molecular studies were not routinely available and were therefore not included in the diagnostic workup.

Gliomas were graded according to WHO grading criteria based on histomorphological features including cellularity, nuclear atypia, mitotic activity, microvascular proliferation, and necrosis observed on hematoxylin and eosin-stained sections.

Statistical Analysis: Data were analyzed using SPSS version 26.0. Categorical variables were expressed as percentages and frequencies. Chi-square test was applied to determine statistical significance. A p-value <0.05 was considered statistically significant.

Ethical Clearance: The study was approved by the Institutional Ethics Committee of AIIMS, India. Patient confidentiality was strictly maintained throughout the study. Owing to the retrospective nature of the study, informed consent was waived by the ethics committee.

Results

A total of 320 intracranial space occupying lesions (ICSOLs) were studied during the period from January 2022 to December 2024. The lesions included both neoplastic and non-neoplastic entities diagnosed on histopathological examination.

The age of the patients ranged from 2 to 81 years with a mean age of 43.7 ± 16.2 years. The highest number of cases was observed in the 41–60 years age group accounting for 122 cases (38.1%), followed by the 21–40 years age group with 102 cases (31.9%). Pediatric age group (0–20 years) constituted 11.9% of cases. The age-wise distribution of cases is summarized in Table 1.

Table 1: Age-wise Distribution of Intracranial Space Occupying Lesions (n=320)

Age Group (Years)	Number of Cases	Percentage (%)
0–20	38	11.9
21–40	102	31.9
41–60	122	38.1
>60	58	18.1
Total	320	100

Male predominance was observed in the present study. Out of 320 patients, 181 (56.6%) were males and 139 (43.4%) were females with a male-to-female ratio of 1.3:1, as shown in Table 2.

Table 2: Gender Distribution of Cases

Gender	Number of Cases	Percentage (%)
Male	181	56.6
Female	139	43.4
Total	320	100

Clinical Presentation: The clinical manifestations varied according to the location and nature of the lesion. Headache was the most common presenting symptom, observed in 228 patients (71.3%), followed by vomiting in 176 patients (55.0%) and seizures in 132 patients (41.3%). Focal neurological deficits were present in 98 patients (30.6%), while altered sensorium was noted in 74 patients (23.1%). Visual disturbances and gait abnormalities were observed in 52 (16.3%) and 38 (11.9%) patients respectively. Fever was present in 26 patients (8.1%), predominantly among patients with infective lesions. The frequency distribution of presenting symptoms is shown in Table 3.

Table 3: Frequency Distribution of Presenting Symptoms among Patients with ICSOLs (n = 320)

Presenting Symptom	Number of Cases (n)	Percentage (%)
Headache	228	71.3
Vomiting	176	55.0
Seizures	132	41.3
Focal neurological deficit	98	30.6
Altered sensorium	74	23.1
Visual disturbances	52	16.3
Gait disturbances	38	11.9
Cranial nerve deficits	34	10.6
Fever	26	8.1
Others	18	5.6

Among the total cases studied, neoplastic lesions constituted the majority with 274 cases (85.6%), whereas non-neoplastic lesions accounted for 46 cases (14.4%). The distribution of lesions is shown in Table 4 and Figure 1.

Table 4: Distribution of Neoplastic and Non-Neoplastic Lesions

Lesion Category	Number of Cases	Percentage (%)
Neoplastic lesions	274	85.6
Non-neoplastic lesions	46	14.4
Total	320	100

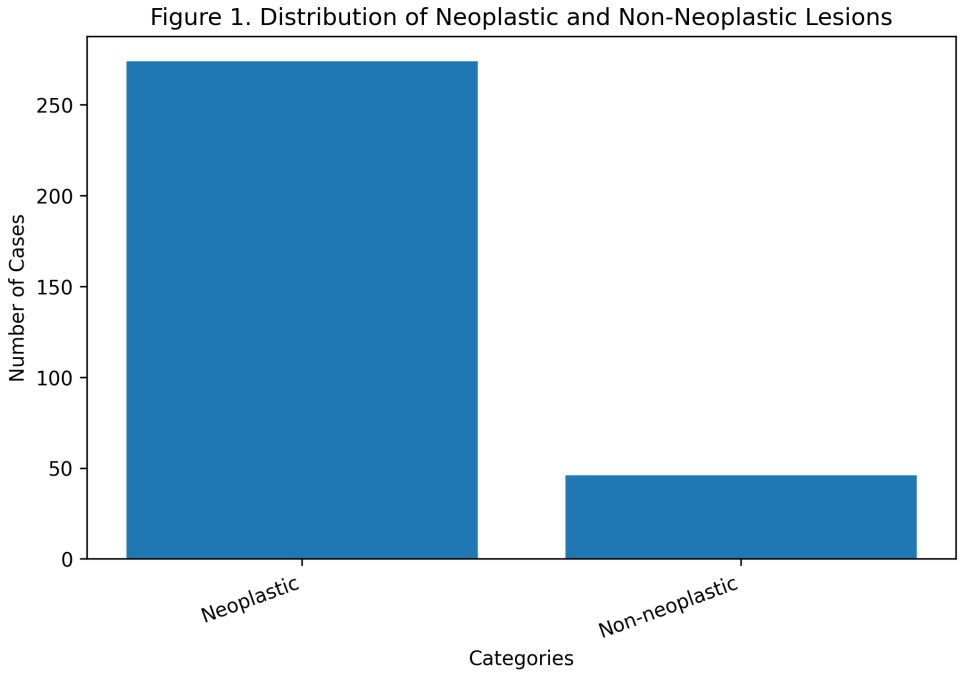

Figure 1: Distribution of Neoplastic and Non-Neoplastic Lesions

Histopathological analysis of neoplastic lesions revealed gliomas as the most common category comprising 113 cases (41.2%), followed by meningiomas with 67 cases (24.5%). Schwannomas constituted 8.0% of neoplastic lesions. Pituitary adenoma/PitNET accounted for 6.6% of cases, while metastatic tumors represented 5.8%. The detailed histopathological spectrum of neoplastic lesions is shown in Table 5 and Figure 2.

Table 5: Histopathological Spectrum of Neoplastic Lesions (n=274)

Histopathological Diagnosis	Number of Cases	Percentage (%)
Gliomas	113	41.2
Meningiomas	67	24.5
Schwannomas	22	8.0
Pituitary adenoma/PitNET	18	6.6
Metastatic tumors	16	5.8
Medulloblastoma	9	3.3
Craniopharyngioma	8	2.9
Ependymoma	6	2.2
Hemangioblastoma	5	1.8
CNS lymphoma	4	1.5
Germ cell tumors	3	1.1
Others	3	1.1
Total	274	100

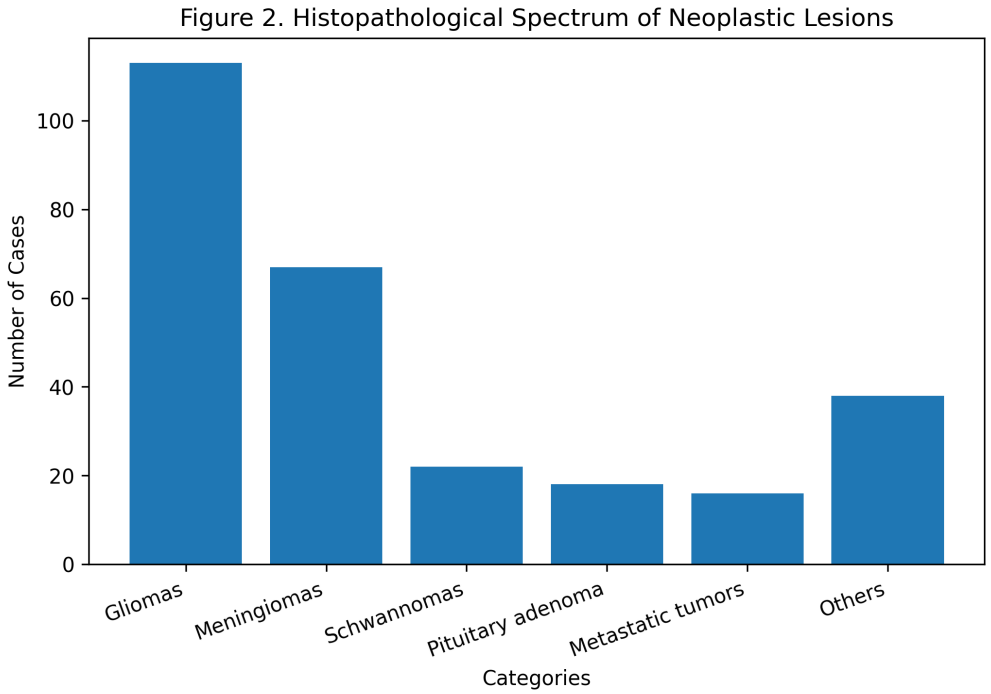

Figure 2: Histopathological Spectrum of Neoplastic Lesions

Detailed analysis of glial tumors demonstrated glioblastoma as the predominant subtype accounting for 46 cases (40.7%), followed by diffuse astrocytoma with 24 cases (21.2%). Anaplastic astrocytoma constituted 12.4% of cases. Oligodendroglioma and pilocytic astrocytoma represented 9.7% and 8.0% respectively. Other glial tumors accounted for 8.0% of cases. The distribution of diffuse and other glial tumors is summarized in Table 6 and Figure 3.

Table 6: Histomorphological Spectrum of Gliomas

Histomorphological Diagnosis	**Number of Cases**	**Percentage (%)**
Glioblastoma	46	40.7
Diffuse astrocytoma	24	21.2
Anaplastic astrocytoma	14	12.4
Oligodendroglioma	11	9.7
Pilocytic astrocytoma	9	8.0
Other glial tumors	9	8.0
Total	113	100

Figure 3. Distribution of Glioma Subtypes

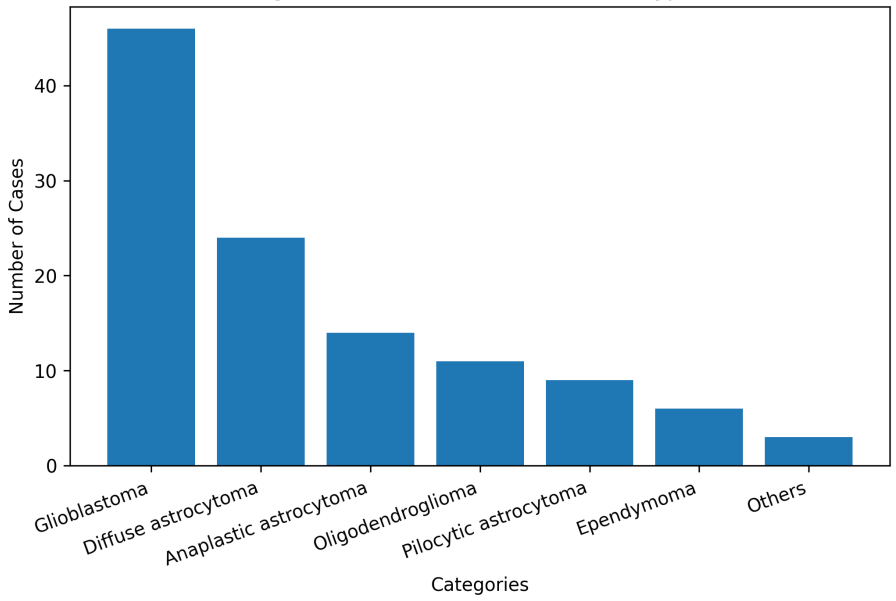

Figure 3: Distribution of Glioma Subtypes

Based on anatomical localization, supratentorial lesions predominated with 219 cases (68.4%), whereas infratentorial lesions accounted for 101 cases (31.6%). The anatomical distribution of lesions is shown in Table 7 and Figure 4.

Table 7: Anatomical Distribution of Lesions

Anatomical Location	Number of Cases	Percentage (%)
Supratentorial	219	68.4
Infratentorial	101	31.6
Total	320	100

Figure 4. Anatomical Distribution of Lesions

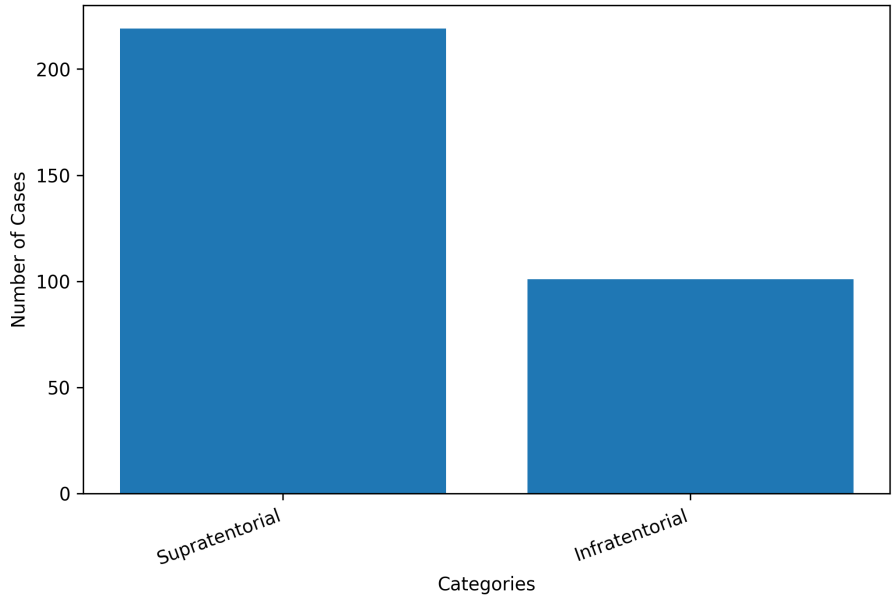

Figure 4: Anatomical Distribution of Lesions

Among the 46 non-neoplastic lesions, brain abscesses were the most common accounting for 14 cases (30.4%), followed by tuberculomas with 11 cases (23.9%). Epidermoid cysts constituted 15.2% of non-neoplastic lesions. The detailed spectrum of non-neoplastic lesions is shown in Table 8.

Table 8: Spectrum of Non-Neoplastic Lesions (n=46)

Lesion Type	Number of Cases	Percentage (%)
Brain abscess	14	30.4
Tuberculoma	11	23.9
Epidermoid cyst	7	15.2
Arachnoid cyst	5	10.9
Neurocysticercosis	4	8.7
Vascular malformations	3	6.5
Others	2	4.4
Total	46	100

Histopathological grading of gliomas revealed WHO Grade IV tumors as the most common category accounting for 46 cases (40.7%), followed by WHO Grade II tumors with 35 cases (31.0%). WHO Grade III tumors constituted 20.4% of cases. The grading pattern is summarized in Table 9.

Table 9: Distribution of Gliomas According to WHO Grade (n=113)

WHO Grade	Number of Cases	Percentage (%)
Grade I	9	8.0
Grade II	35	31.0
Grade III	23	20.4
Grade IV	46	40.7
Total	113	100

Statistical analysis demonstrated a significant association between age group and nature of lesion. Neoplastic lesions were predominantly observed in middle-aged and elderly patients, whereas non-neoplastic lesions were relatively more common in younger individuals. Chi-square analysis showed statistical significance with p-value <0.001, as shown in Table 10.

Table 10.:Association Between Age Group and Nature of Lesion

Age Group	Neoplastic	Non-neoplastic	Total
0–20	25	13	38
21–40	86	16	102
41–60	114	8	122
>60	49	9	58

Chi-square value = 18.62
Degrees of freedom = 3
p-value = 0.0003

The association between age group and lesion category was statistically significant.

Discussion

Intracranial space occupying lesions constitute a major diagnostic and therapeutic challenge because of their varied histogenesis and clinical manifestations.[10] Histopathological examination remains the definitive diagnostic modality despite advances in neuroimaging and molecular diagnostics.[11]

In the present study, neoplastic lesions accounted for 85.6% of cases, similar to observations made by Gupta et al. and Kumar et al., who reported predominance of neoplastic intracranial lesions in tertiary care centres. [12,13] The increased frequency of neoplastic lesions may be attributed to higher neurosurgical referrals and improved diagnostic facilities.

The peak incidence observed in the 41–60 years age group correlates with findings reported by Arora et al., who documented higher prevalence of CNS tumors in middle-aged adults.[14] Pediatric cases constituted a smaller proportion and predominantly included medulloblastomas and pilocytic astrocytomas.[15]

Male predominance noted in the present study is comparable with previous studies conducted by Sarkar and Sharma.[16] However, meningiomas demonstrated female predominance, likely related to hormonal receptor expression and endocrine influences.[17]

Gliomas represented the most common neoplastic lesions in this study. Similar findings have been reported in several epidemiological studies of CNS tumors.[18] Glioblastoma was the predominant glioma subtype, accounting for 40.7% of gliomas. Histologically, glioblastomas showed marked cellular pleomorphism, pseudopalisading necrosis,

endothelial proliferation, and increased mitotic activity.[19]

Meningiomas formed the second most common category of tumors in the present study. Most meningiomas belonged to WHO grade 1 category with meningothelial and transitional variants predominating.[20] These findings are consistent with previous neuropathological studies.[21]

Schwannomas constituted 8% of neoplastic lesions and were predominantly located in the cerebellopontine angle. Classical Antoni A and Antoni B areas with Verocay bodies were observed microscopically.[22]

Among non-neoplastic lesions, brain abscess and tuberculoma were the commonest lesions. Tuberculomas continue to represent an important intracranial lesion in developing countries and often mimic neoplasms radiologically.[23]

Supratentorial predominance observed in the present study is in agreement with previous literature on adult intracranial tumors.[24] Infratentorial lesions were more common among pediatric patients.

A limitation of the present study is the absence of immunohistochemical and molecular investigations. Therefore, classification of gliomas was based solely on histomorphological features, and integrated molecular diagnoses according to the WHO 2021 classification could not be assigned. Nevertheless, routine histopathological examination remains an essential tool for the diagnosis and grading of intracranial tumors, particularly in resource-limited settings.

The 2021 WHO classification has significantly improved diagnostic accuracy by integrating molecular alterations with histopathology.[25] However, histomorphological examination continues to remain the cornerstone for diagnosis, grading, and therapeutic planning.

Conclusion

Histopathological examination continues to play a pivotal role in the diagnosis and grading of intracranial space-occupying lesions and remains the foundation of routine neuropathological practice. Although morphological assessment provides valuable information regarding tumor classification and biological behavior, the incorporation of immunohistochemical and molecular techniques, whenever available, can further enhance diagnostic accuracy, prognostic stratification, and therapeutic decision-making.

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