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Research Article

Histopathological Spectrum of Central Nervous System Tumours in a Tertiary Care Centre: A Five-Year Study

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Abstract: ***Introduction:*** Central nervous system (CNS) tumours constitute a heterogeneous group of neoplasms with diverse histopathological features, biological behaviour, and clinical outcomes. Accurate histopathological classification remains essential for diagnosis, prognostication, and therapeutic decision-making.**Aim**:To study the histopathological spectrum of CNS tumours, determine their prevalence, and evaluate clinicopathological correlations in a tertiary care centre.**Materials and Methods:**This retrospective and prospective observational study was conducted in the Department of Pathology in collaboration with the Department of Neurosurgery, King George's Medical University, Lucknow. A total of 587 histologically confirmed CNS tumours diagnosed between May 2017 and May 2021 were included. Tissue specimens were processed using standard histopathological techniques and classified according to the revised World Health Organization (WHO) classification of CNS tumours. Demographic, clinical, anatomical, and pathological data were analysed using SPSS version 15.0.**Results:**A total of 587 CNS tumours were evaluated. The mean age of patients was 33.0±18.0 years, with the highest frequency observed in the 21–40-year age group. Males constituted 54.51% of cases. Headache was the most common presenting symptom (83.4%), followed by nausea and vomiting (39.52%). The posterior fossa was the most frequently involved site (25.56%). Astrocytic tumours represented the largest histological category (42.9%), with glioblastoma multiforme being the most common individual tumour subtype (18.56%). According to WHO grading, Grade I tumours were most common (47.87%), followed by Grade IV tumours (29.47%).**Conclusion:**Astrocytic tumours constituted the predominant category of CNS neoplasms in the present study. Glioblastoma multiforme was the most frequent individual tumour subtype, while WHO Grade I tumours were the most common overall. Histopathological evaluation remains the cornerstone for accurate diagnosis and classification of CNS tumours.

Keywords: Central nervous system tumours; Histopathology; Glioblastoma multiforme; Astrocytic tumours; WHO grading

INTRODUCTION

Central nervous system (CNS) tumours comprise a heterogeneous group of neoplasms arising from the brain, spinal cord, meninges, cranial nerves, and associated structures. Although they constitute less than 2% of all malignancies, they are associated with considerable morbidity and mortality because of their critical anatomical location and potential to cause irreversible neurological deficits [1,2]. CNS tumours encompass a wide spectrum of lesions ranging from benign slow-growing neoplasms to highly aggressive malignant tumours.

Globally, the incidence of CNS tumours has shown a gradual increase over recent decades, largely attributable to improvements in neuroimaging techniques, increased life expectancy, and enhanced cancer registration systems [3,4]. Population-based registries have reported marked geographical variation in incidence and tumour distribution, reflecting differences in environmental exposures, genetic factors, healthcare accessibility, and diagnostic capabilities [5,6]. In India, CNS tumours continue to represent a significant healthcare burden, with increasing numbers being reported from tertiary referral centres [7,8].

The clinical manifestations of CNS tumours are highly variable and depend on tumour location, size, growth rate, and associated mass effect. Headache, seizures, nausea, vomiting, visual disturbances, focal neurological deficits, and gait abnormalities are among the most frequently encountered presenting symptoms [9,10]. Owing to the nonspecific nature of these manifestations,

diagnosis often requires integration of clinical, radiological, and pathological findings.

Histopathological examination remains the cornerstone for definitive diagnosis and classification of CNS tumours. The World Health Organization (WHO) classification system provides a standardized framework for categorizing tumours based on histological and molecular characteristics and facilitates prognostic stratification and therapeutic planning [11,12]. Recent revisions of the WHO classification have further refined tumour categorization by incorporating molecular markers into routine diagnostic practice [12].

Astrocytic tumours, meningiomas, schwannomas, metastatic lesions, embryonal tumours, and ependymal tumours constitute the major categories of CNS neoplasms encountered in routine practice [13,14]. Several studies from India and other countries have demonstrated considerable variation in tumour prevalence, age distribution, gender predilection, anatomical location, and histological subtype patterns [15–20]. Such differences highlight the importance of institution-specific epidemiological studies for understanding regional disease characteristics.

The present study was undertaken to evaluate the histopathological spectrum of CNS tumours diagnosed over a five-year period at a tertiary care referral centre. The study aimed to analyse demographic characteristics, clinical presentation, tumour location, histopathological patterns, and WHO grading profiles, thereby contributing to the existing epidemiological data on CNS tumours in the Indian population.

MATERIALS AND METHODS

Study Design and Setting

A retrospective and prospective observational study was conducted in the Department of Pathology in collaboration with the Department of Neurosurgery, King George's Medical University, Lucknow. The study included histopathologically diagnosed CNS tumour specimens received from the Department of Neurosurgery.

Study Duration

The study was conducted over a five-year period from May 2017 to May 2021. Cases from the initial period were analysed retrospectively, while subsequent cases were evaluated prospectively.

Study Population

A total of 587 cases of CNS tumours were included in the study. All cases underwent histopathological examination and classification according to the revised WHO classification of CNS tumours.

Inclusion Criteria

- Patients of all age groups.
- Cases with clinicoradiological findings suggestive of CNS tumours.
- Histopathologically confirmed CNS neoplasms.

Exclusion Criteria

- Autolysed or poorly preserved biopsy specimens.
- Inadequate tissue samples.
- Non-consenting patients.

Methodology

Clinical and demographic details were collected using a structured data collection format. Surgical specimens were fixed in formalin and processed according to standard histopathological protocols. Tissue sections measuring approximately 3–5 μm were prepared from paraffin-embedded blocks and stained using haematoxylin and eosin.

Histopathological evaluation was performed using light microscopy. Whenever necessary, immunohistochemistry was utilized to establish the final diagnosis. Tumours were classified and graded according to WHO recommendations.

Outcome Measures

The primary outcome was the histopathological spectrum of CNS tumours. Secondary outcomes included demographic distribution, clinical presentation, tumour location, histological subtype distribution, and WHO grading patterns.

Statistical Analysis

Data were analysed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Statistical significance was considered at a p-value <0.05.

RESULTS

A total of 587 histopathologically confirmed CNS tumours were included in the study. The mean age of the patients was 33.0±18.0 years. The majority of patients belonged to the 21–40-year age group (33.22%), followed closely by the 41–60-year age group (31.35%). Pediatric patients (<20 years) accounted for approximately 31% of the study population, indicating a substantial burden of CNS neoplasms in younger age groups.

Table 1. Age-wise distribution of patients

Age Group (Years)	Number	Percentage
0–10	88	14.99%
11–20	94	16.01%

21–40	195	33.22%
41–60	184	31.35%
>60	105	17.89%
Total	587	100.00%

The study demonstrated a predominance of CNS tumours among young and middle-aged adults. Nearly two-thirds of cases occurred between 21 and 60 years of age, suggesting that CNS tumours contribute significantly to disease burden during the most productive years of life. The relatively high proportion of paediatric cases further highlights the broad age distribution of these neoplasms.

Male patients constituted 54.51% of the study population, while females accounted for 45.49%, resulting in a male-to-female ratio of approximately 1.2:1.

Table 2. Gender distribution of patients

Gender	Number	Percentage
Male	320	54.51%
Female	267	45.49%
Total	587	100.00%

A slight male predominance was observed in the present study. This pattern has been consistently reported in epidemiological studies of CNS tumours and may reflect biological, hormonal, environmental, or genetic influences affecting tumour development.

Clinical presentation varied considerably among patients. Headache was the most frequent presenting complaint, followed by nausea/vomiting and gait abnormalities or weakness.

Table 3. Clinical features of patients

Clinical Feature	Number	Percentage
Headache	490	83.40%
Vomiting/Nausea	232	39.52%
Weakness/Ataxia/Gait abnormality	106	18.05%
Blurring/Diminution of vision	81	13.71%
Seizures/Epilepsy/GTCS	80	13.62%
Loss of consciousness	75	12.78%

Headache was the predominant symptom and was reported by more than four-fifths of patients. Symptoms related to raised intracranial pressure, including nausea and vomiting, were also common. Neurological deficits such as gait abnormalities, weakness, and seizures reflected tumour-related involvement of functional brain regions.

The anatomical distribution of tumours revealed substantial variation according to intracranial location. The posterior fossa was the most commonly affected region.

Table 4. Anatomical distribution of CNS tumours

Site	Number	Percentage
Posterior fossa SOL	150	25.56%
Frontal SOL	87	14.82%
CP angle SOL	69	11.75%
Sellar/Suprasellar SOL	47	8.00%
Parietal lobe	42	7.15%
Frontoparietal SOL	30	5.11%
Parietotemporal region	30	5.11%
Parieto-occipital region	26	4.42%
Ventricular SOL	26	4.42%
Frontotemporal region	23	3.91%
Temporal region	22	3.74%
Thalamic SOL	19	3.23%
Spinal/Vertebral region	16	2.72%
Total	587	100.00%

The posterior fossa represented the most common anatomical site, accounting for approximately one-quarter of all lesions. Frontal lobe tumours constituted the second most common group. This distribution reflects the diverse origin of CNS neoplasms and the inclusion of both paediatric and adult tumour populations.

Histopathological examination demonstrated considerable heterogeneity. Astrocytic tumours were the largest histological category, followed by tumours of meninges and tumours of cranial/paraspinal nerves.

Table 5. Major histopathological categories of CNS tumours

Histopathological Category	Number	Percentage
Astrocytic tumours	252	42.90%
Tumours of meninges	86	14.31%
Tumours of cranial and paraspinal nerves	78	13.29%
Tumours of sellar region	50	8.52%
Embryonal tumours	38	5.96%
Ependymal tumours	22	3.92%
Oligodendroglial tumours	20	3.24%
Metastatic tumours	15	2.56%
Mesenchymal non-meningothelial tumours	13	2.21%
Choroid plexus tumours	4	0.68%
Lymphomas	3	0.51%
Vascular tumours	3	0.51%
Neuronal tumours	2	0.34%
Germ cell tumours	1	0.17%
Total	587	100.00%

Astrocytic tumours constituted nearly half of all CNS neoplasms diagnosed in the study. Glioblastoma multiforme was the most common individual tumour subtype (n=109, 18.56%), followed by meningiomas (n=86, 14.31%) and schwannomas (n=74, 11.93%). These findings highlight the predominance of glial neoplasms in the institutional case spectrum.

WHO grading revealed a predominance of low-grade tumours, although a substantial proportion of cases belonged to Grade IV lesions.

Table 6. WHO grading distribution of CNS tumours

WHO Grade	Number	Percentage
Grade I	281	47.87%
Grade II	96	16.35%
Grade III	37	6.30%
Grade IV	173	29.47%
Total	587	100.00%

Grade I tumours were the most common category, representing nearly half of all diagnosed lesions. Grade IV tumours constituted almost one-third of cases, indicating a considerable burden of aggressive malignant CNS neoplasms. This dual predominance of Grade I and Grade IV lesions reflects the coexistence of both benign and highly malignant tumour entities within the CNS.

Additional Findings

Among astrocytic tumours (n=252), Grade IV lesions were the most common subtype, accounting for 42.02% of cases, followed by Grade I tumours (29.76%), Grade II tumours (21.85%), and Grade III tumours (10.50%). Glioblastoma multiforme represented the dominant astrocytic neoplasm and the single most common CNS tumour identified in the study population.

DISCUSSION

The present study evaluated 587 histopathologically confirmed CNS tumours diagnosed over a five-year period at a tertiary care referral centre. The findings provide valuable insight into the demographic characteristics, clinical presentation, anatomical distribution, histological spectrum, and grading profile of CNS tumours in the study population.

The mean age of patients in the present study was 33.0±18.0 years, with the highest proportion of cases occurring in the 21–40-year age group, followed by the 41–60-year age group. These findings are comparable to those reported by Chen et al., who observed the highest incidence of CNS tumours between 30 and 60 years of age, particularly among adults [21]. Similarly, Thambi et al. demonstrated a predominance of tumours among middle-aged individuals in a large South Indian series [22]. Ghanghoria et al. also reported maximum tumour occurrence in the third and fourth decades of life [23]. The predominance of tumours in economically productive age groups underscores the significant social and healthcare burden associated with CNS neoplasms.

A slight male predominance was observed in the present study, with males accounting for 54.51% of cases. Similar observations have been reported by Joshi et al., who documented male predominance among patients with CNS lesions [24]. Mondal et al. found that 56.15% of patients were male, while Chen et al. also reported higher tumour incidence among males, particularly for neuroepithelial neoplasms [21,25]. The male predominance observed across studies may be related to hormonal influences, occupational exposures, genetic susceptibility, or differences in healthcare-seeking behaviour.

Regarding symptomatology, headache was the most common presenting complaint, occurring in 83.4% of patients, followed by nausea/vomiting and gait abnormalities. These findings are consistent with the observations of Mondal et al., who identified headache as the most frequent symptom in patients with brain tumours [25]. Gerald Leu and colleagues similarly reported headache and seizures as common presenting manifestations of intracranial neoplasms. The predominance of headache may be attributed to raised intracranial pressure, tumour-associated cerebral oedema, and mass effect on adjacent structures. Recognition of these symptoms remains important for early diagnosis and timely intervention.

Analysis of tumour location revealed that the posterior fossa was the most frequently involved site, accounting for 25.56% of cases, followed by the frontal region and cerebellopontine angle. Similar findings were reported by Raaschou-Nielsen et al., who documented a predominance of posterior fossa lesions, particularly among paediatric patients [26]. However, several Indian studies have reported frontal lobe predominance. Thambi et al. observed the frontal lobe as the most common site, followed by parietal and temporal regions [22]. Vimal and colleagues also documented frontal lobe predominance in their series [27]. These differences may reflect variation in age distribution, referral patterns, and tumour subtype composition across institutions.

Histopathological analysis demonstrated that astrocytic tumours constituted the largest tumour category, representing 42.9% of all CNS neoplasms. Similar findings have been consistently reported across the literature. Krishnatreya et al. identified astrocytic tumours as the predominant histological category in their study from northeastern India [16]. Khan et al., Ghanghoria et al., and Aryal et al. likewise reported astrocytic tumours as the most frequently encountered CNS neoplasms [18,23,29]. The predominance of astrocytic tumours reflects the biological susceptibility of glial cells to neoplastic transformation and mirrors global epidemiological trends.

Among individual tumour subtypes, glioblastoma multiforme (GBM) emerged as the most common lesion, accounting for 18.56% of all tumours and representing the largest subgroup of astrocytic neoplasms. This finding is consistent with reports by Jaiswal et al., who documented GBM as the most common astrocytic tumour subtype [28]. Similar observations were made by Thambi et al. and Shrestha et al., who identified GBM as the dominant high-grade astrocytic neoplasm [25,31]. The aggressive biological behaviour, infiltrative growth pattern, and poor prognosis associated with GBM make its predominance clinically significant and emphasize the need for early diagnosis and multidisciplinary management.

Meningiomas constituted the second most common tumour category in the present study. Comparable findings have been reported in several epidemiological investigations. Claus et al. described meningiomas as one of the most prevalent primary intracranial tumours worldwide [26]. However, certain institutional studies have demonstrated meningioma predominance over astrocytic tumours, reflecting regional variations in tumour distribution [33]. Such differences may arise from variations in referral patterns, population demographics, and diagnostic practices.

WHO grading analysis revealed that Grade I tumours were the most common lesions, accounting for 47.87% of cases, followed by Grade IV tumours (29.47%). Similar findings have been reported by Ghanghoria et al. and Neelkanthain et al., both of whom identified Grade I tumours as the predominant category [23,30]. Almutrafi et al. likewise observed a predominance of Grade I tumours, although Grade IV lesions constituted a substantial proportion of their series [27]. The coexistence of a large proportion of both Grade I and Grade IV tumours reflects the broad biological spectrum of CNS neoplasms encountered in tertiary care settings.

Within the astrocytic tumour subgroup, Grade IV lesions predominated, accounting for 42.02% of astrocytic tumours. This observation parallels findings reported by Jaiswal et al., Thambi et al., and Shrestha et al., all of whom documented Grade IV astrocytic tumours as the most common astrocytic neoplasm [28,30,31]. The predominance of high-grade astrocytic lesions emphasizes the aggressive nature of glial tumours and their substantial contribution to CNS tumour-related mortality.

The strengths of the present study include the large sample size, five-year duration, and histopathological confirmation of all diagnoses according to WHO criteria. The study provides comprehensive institutional data regarding CNS tumour epidemiology and contributes valuable information from northern India. However, certain limitations should be acknowledged. The study was conducted at a single tertiary referral centre and may not fully represent the community-based incidence of CNS tumours. In addition, molecular profiling was not available for all cases because the study period largely preceded the widespread implementation of integrated molecular diagnostics [32-36].

Overall, the present study confirms that astrocytic tumours remain the predominant category of CNS neoplasms, with glioblastoma multiforme representing the most common individual tumour subtype. The observed demographic and pathological patterns are broadly comparable with findings reported from other Indian and international centres, thereby supporting the reliability and generalizability of the results.

CONCLUSION

The present five-year study provides a comprehensive overview of the histopathological spectrum of central nervous system tumours encountered at a tertiary care referral centre. CNS tumours were observed predominantly in young and middle-aged adults, with a slight male predominance. Headache was the most common presenting symptom, while the posterior fossa constituted the most frequently affected anatomical location.

Astrocytic tumours emerged as the most common histopathological category, accounting for nearly half of all CNS neoplasms. Glioblastoma multiforme was the most frequent individual tumour subtype, highlighting the substantial burden of high-grade glial neoplasms. Meningiomas and schwannomas represented the next most common tumour groups. According to WHO grading, Grade I tumours were the predominant category overall, although a considerable proportion of patients presented with Grade IV lesions, reflecting the coexistence of both benign and highly aggressive neoplasms.

The findings of this study are largely consistent with previously published Indian and international data and reinforce the importance of histopathological examination in the accurate diagnosis, classification, and grading of CNS tumours. Continuous epidemiological surveillance, integration of advanced diagnostic techniques, and multidisciplinary management approaches are essential for improving patient outcomes. Larger multicentric studies incorporating molecular characterization are recommended to further enhance understanding of CNS tumour epidemiology and biological behaviour in the Indian population.

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