



Original Article

Diagnostic Profile of Central Nervous System Tumours: Histopathological Insights from A Tertiary Care Hospital

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ABSTRACT

Background: Central nervous system (CNS) tumours are a heterogeneous group of neoplasms with variable clinical behaviour, prognosis, and treatment responses. Despite advances in radiological techniques, histopathology remains the gold standard for diagnosis and classification, particularly in resource-limited settings.

Aim & Objectives: To study the histopathological spectrum of CNS tumours and correlate findings with clinical and radiological data.

Methods: A cross-sectional study was conducted over 18 months at a Tertiary Care Hospital, involving 88 surgically resected CNS tumours. Specimens were processed using standard histopathological techniques and classified per WHO CNS Tumour Classification, 5th Edition (2021). Clinical and radiological data were analysed for correlation.

Results: Patients ranged from 2 to 76 years, with a male-to-female ratio of 1.2:1. The most affected age group was 41–50 years. Neuroepithelial tumours (51.1%) were most common, followed by meningothelial tumours (33%). Astrocytomas were the predominant subtype. WHO Grade I tumours were most frequent. Histopathological and radiological correlation was observed in 88.6% of cases.

Conclusion: Histopathological examination, integrated with clinical and radiological findings, is essential for accurate CNS tumour diagnosis and grading. It remains the cornerstone of diagnosis in settings with limited access to molecular testing.

Keywords: CNS tumours, Histopathology, WHO 2021 Classification, Astrocytoma, Meningioma.

INTRODUCTION

The first documented case of a fungal tumour involving the dura mater was reported by Louis in 1774. Since then, space-occupying lesions in the cerebral cavity have become well understood⁽¹⁾. Historically, CNS tumours were considered rare in India, but advancements in diagnostic technologies have revealed that their prevalence is comparable to global rates⁽²⁾.

CNS tumours are a diverse group of neoplasms, both benign and malignant, originating from various neural cell types such as glial cells, neurons, or meningeal cells. These tumours exhibit significant variation in clinical and histological features. According to the International Agency for Research on Cancer (IARC), the incidence of CNS tumours is 9.9 per 100,000 in developing countries and 6.3 per 100,000 in developed nations⁽³⁾. In India, CNS tumours account for 1.9% of all cancers, with 60–80% being primary and 20–40% metastatic^(4,5).

Tumour location significantly impacts prognosis. In children, ~70% of CNS tumours occur in the posterior fossa, whereas in adults, most are found in the cerebral hemispheres⁽⁶⁾. A bimodal age distribution is observed, peaking in childhood and between 45–70 years⁽⁷⁾. In India, incidence rates are 1.5/100,000/year in males and 0.7/100,000/year in females⁽⁸⁾.

Risk factors include genetic mutations and prior ionizing radiation exposure (e.g., X-rays, CT scans), though these account for <10% of cases. Recently, IARC classified low-frequency electromagnetic radiation from mobile phones as a possible carcinogen, linked to gliomas, meningiomas, and acoustic neuromas⁽⁹⁾.

Tumours of the central nervous system are histologically typed by WHO as tumours of neuroepithelial tissue, meninges, embryonal tumours, tumours of sellar region, haematolymphoid tumours, germ cell tumours and metastatic tumours. Accurate histological identification, including use of histochemical stains and immunohistochemistry, is critical for diagnosis, grading, and prognosis⁽¹⁰⁾.

Although molecular diagnostics offer enhanced prognostic capabilities, their cost and limited availability make histopathology the primary diagnostic tool in many developing regions⁽¹¹⁾.

A comprehensive evaluation—incorporating clinical, radiological, histological, and immunohistochemical findings—is essential. Even benign tumours may be life-threatening due to their location, mass effect, and potential for malignant transformation, underscoring the importance of early and accurate diagnosis^(12,13).

AIM:

To study histopathological findings in patients with central nervous system tumours at a tertiary care hospital.

OBJECTIVES:

1. To determine distribution of cases depending in age and gender of patient.
2. To identify different histologic types of central nervous system tumours.
3. To determine clinical and radiological correlation of central nervous system tumours with histopathological spectrum.

MATERIALS & METHODS:

Study Design: Cross Sectional Study.

Study Setting: Study was carried out at Pathology department of Dr. Panjabrao Alias Bhausaheb Deshmukh Memorial Medical College, Amravati.

Study Population: All the patients diagnosed with CNS tumours.

Sample Size: All the patients at our tertiary care hospital meeting inclusion criteria coming in study duration were included in the sample. The sample size calculated was 88.

Sampling Technique: Convenience sampling method.

Study Duration: 18 Months.

Data Collection Procedure:- The study was conducted in the Department of Pathology at Dr. Panjabrao Alias Bhausaheb Deshmukh Memorial Medical College, Amravati, following approval from the Institutional Ethics Committee. Operated specimens of central nervous system (CNS) tumours were received from the Department of Neurosurgery. For each case, accompanying clinical details, operative findings, and radiological reports were obtained to support histopathological evaluation. The CNS tumour specimens were fixed in 10% formalin, and gross morphological features were recorded.

All specimens were processed using standard paraffin embedding techniques. Sections were stained with Haematoxylin and Eosin (H&E) for histopathological examination. The tumours were classified and graded based on the World Health Organization (WHO) Classification of CNS Tumours, 5th Edition (2021), considering features such as increased cellularity, nuclear atypia, mitotic activity, microvascular proliferation, and necrosis.

Inclusion Criteria:- Tissues from patients of all age groups diagnosed with central nervous system neoplasms, who underwent surgical intervention followed by histopathological analysis, were included in this study.

Exclusion Criteria:- 1. Non-neoplastic lesions 2. Inadequate biopsy, 3. Inflammatory lesions.

RESULTS

During the study period, a total of 88 cases of central nervous system tumours were received in the department of Pathology for histopathological examination at Dr. Panjabrao Alias Bhausaheb Deshmukh Memorial Medical College, Amravati.

In the present study, the patients' age ranged from 02 to 76 years with a mean age of 45.26 years. The most common age group was 41-50 years (33%) followed by 51-60 years (19.3%).

Table no 1: Distribution of Cases Depending on Age Groups:

Age Groups	Frequency	Percentage
0-10 Years	05	5.7%
11-20 Years	05	5.7%
21-30 Years	06	6.8%
31-40 Years	12	13.6%
41-50 Years	29	33.0%

Age Groups	Frequency	Percentage
51-60 Years	17	19.3%
61-70 Years	10	11.4%
>70 Years	04	4.5%
Total	88	100%

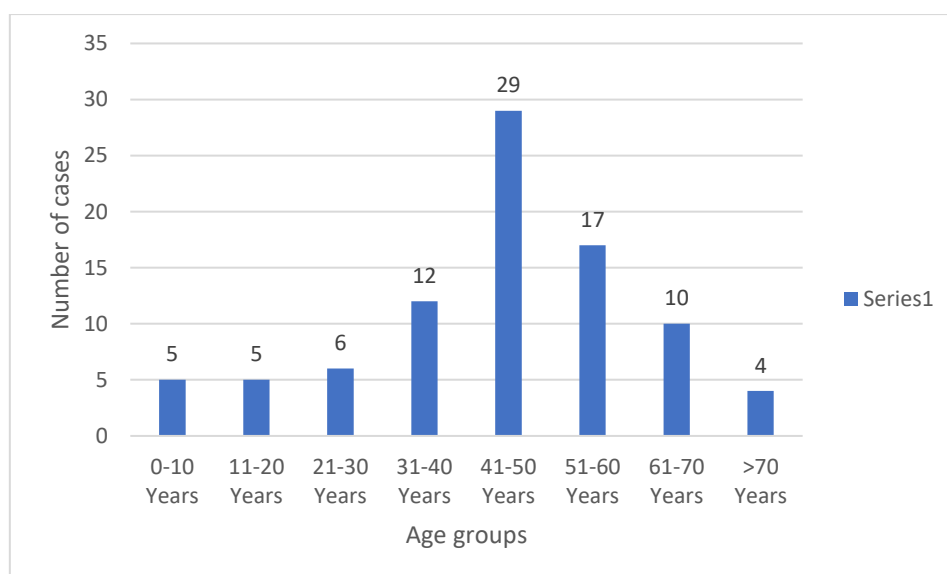


Chart no. 1: Distribution of Cases Depending on Age Groups:

Distribution of cases depending on Gender:

Out of total 88 patients, 48 (54.5%) patients were males and 40 (45.5%) patients were females with M:F ratio of 1.2:1.

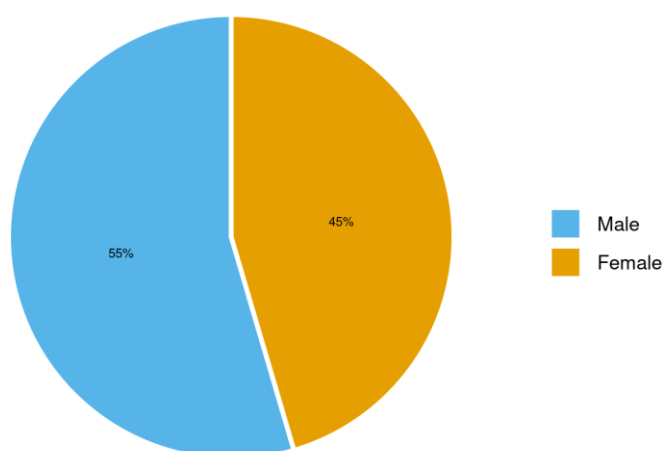


Chart no.2: Distribution of cases depending on Gender:

Table no.2: Distribution of cases depending on Clinical Features:

Clinical Features	Yes	No
Headache	47 (53.4%)	41 (46.6%)
Seizures	29 (33.0%)	59 (67.0%)
Motor weakness	28 (31.8%)	60 (68.2%)
Sensory Disturbances	16 (18.2%)	72 (81.8%)
Backache	16 (18.2%)	72 (81.8%)
Vomiting	12 (13.6%)	76 (86.4%)
Giddiness	6 (6.8%)	82 (93.2%)

Headache was the most common symptom seen in 53.4% of total patients followed by seizures seen in 33% of total patients.

Table no.3: Distribution of cases depending on Site of Tumour:

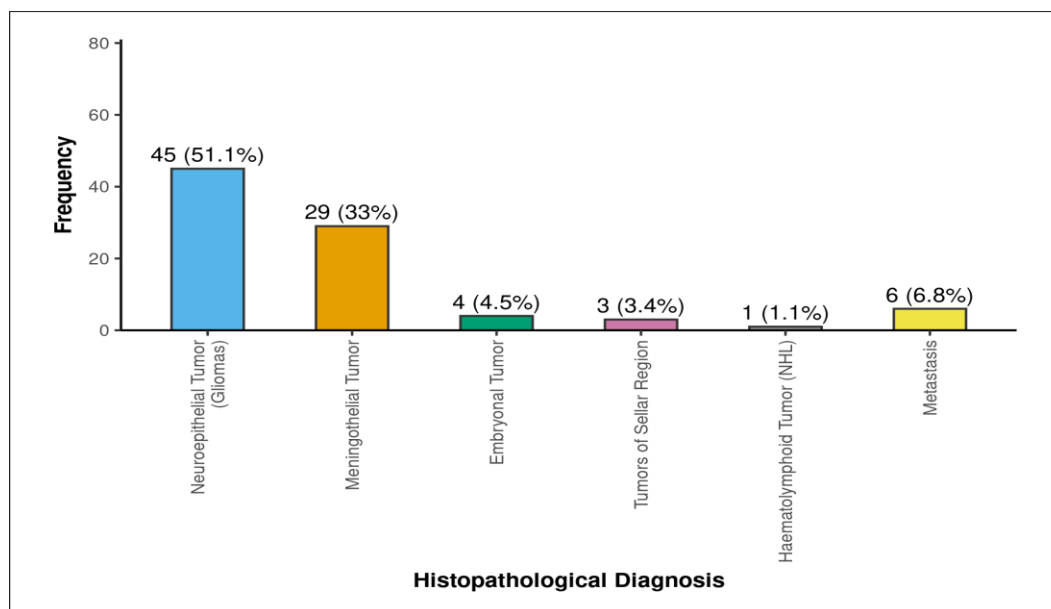
LOCATION OF TUMOUR	No.	Percentage
Supratentorial		
Cerebral	58	65.91%
Frontal	26	29.55%
Parietal	05	5.68%
Temporal	04	4.55%
Occipital	01	1.14%
Multilobe	22	25%
Ventricular	02	2.27%
Sellar and Suprasellar	03	3.41%
Thalamus	01	1.14%
Infratentorial		
Cerebellum	05	5.68%
Spinal	19	21.59%

Supratentorial tumours were more than infratentorial tumours. CNS tumours in this study were most frequently found in the cerebrum comprising of 58 cases (65.91%) out of which 26 (29.55%) of them were located in frontal lobe and 22 (25%) had multilobe involvement.

Table no. 4: Distribution of the cases depending on 'Histopathological Diagnosis':

Histopathological Diagnosis	Frequency	Percentage
Neuroepithelial Tumours (Gliomas and Ependymal Tumours)	45	51.1%
Meningothelial Tumours	29	33.0%
Embryonal Tumours	04	4.5%
Tumours of Sellar Region	03	3.4%
Hematolymphoid Tumour (NHL)	01	1.1%
Metastasis	06	6.8%
Total	88	

Amongst the primary tumours, the tumours of neuroepithelial origin (51.1%) were the most common followed by meningothelial tumours (33%) and embryonal tumours (4.5%).

**Chart no.3: Distribution of the cases depending on 'Histopathological Diagnosis':**

Distribution of neuroepithelial tumours:

Out of 45 neuroepithelial tumours, astrocytomas (32 cases, 71.11%) were the most common tumours followed by Ependymal tumours (8 cases, 17.78%). Astrocytic tumours included pilocytic astrocytomas (2 cases), astrocytomas grades 2,3,4 tumours (18 cases) and glioblastoma multiforme (12 cases).

Table no. 5: Distribution of meningothelial tumours:

Histopathological type of Meningioma	No. of Cases	Percentage
Transitional	17	58.62%
Fibrous	07	24.14%
Psammomatous	04	13.79%
Meningothelial	01	3.45%
Total	29	100%

Among meningothelial tumours, transitional meningiomas (58.62%) were most common followed by fibrous meningiomas (24.14%).

Table no. 6: Distribution of CNS tumours depending on WHO grading:

WHO grade	Number of cases	Percentage
I	31	39.7%
II	21	26.9%
III	07	9%
IV	19	24.4%
Total	78	

According to WHO 2021 classification, 78 primary tumours were graded. Most of the tumours belonged to grade 1 (39.7%) followed by grade 2 (26.9%) and grade 4 (24.4%).

Table no. 7: Distribution of histological types of CNS tumours depending on age groups:

HISTOLOGICAL TYPE	AGE GROUPS							TOTAL
	0-10 YEARS	11-20 YEARS	21-30 YEARS	31-40 YEARS	41-50 YEARS	51-60 YEARS	>60 YEARS	
Pilocytic Astrocytoma	01	01	-	-	-	-	-	02
Astrocytoma (Grade 2,3,4)	01	02	01	06	11	06	03	30
Oligodendroglioma	-	-	02	01	01	01	-	05
Ependymal tumours	01	-	02	01	03	01	-	08
Meningioma	-	-	01	03	13	07	06	29
Medulloblastoma	02	02	-	-	-	-	-	04
Pituitary Macroadenoma	-	-	-	-	-	01	02	03
NHL	-	-	-	-	-	-	01	01
Metastasis	-	-	-	01	01	01	03	06
TOTAL	05	05	06	12	29	17	14	88

Astrocytoma and meningioma were seen mostly in 41-50 years age group whereas medulloblastoma was seen in children below 20 years. Metastatic tumours were seen mainly above 60 years of age group.

To test correlation between distribution of CNS tumours and age, chi square and p value were calculated. *p value* was 0.001 which is less than 0.05. This indicates that there is significant difference observed in the distribution of CNS tumours according to age.

Table no 8: Distribution of histological types of CNS tumours depending on Gender:

HISTOLOGICAL TYPE	MALE	FEMALE	TOTAL
Neuroepithelial tumours	28 (31.8%)	17 (19.3%)	45 (51.14%)
Pilocytic Astrocytoma	01	01	02 (4.4%)
Astrocytoma Grade 2,3,4	23	07	30 (66.7%)
Oligodendroglioma	01	04	05 (11.1%)
Ependymal tumours	03	05	08 (17.8%)
Meningothelial tumours	13 (14.8%)	16 (18.2%)	29 (32.95%)
Embryonal tumours	02 (2.3%)	02 (2.3%)	04 (4.55%)
Tumours of Sellar region	02 (2.3%)	01 (1.1%)	03 (3.41%)
Haematolymphoid tumours(NHL)	-	01 (1.1%)	01 (1.14%)

Metastatic tumours	03 (3.4%)	03 (3.4%)	06 (6.81%)
TOTAL	48 (54.5%)	40 (45.5%)	88 (100%)

Neuroepithelial tumours were commonly seen in males (31.8%) whereas meningiomas were common in females (18.2%). Among the neuroepithelial tumours, astrocytomas were most commonly found in males.

Distribution of histological types of CNS tumours depending on Site of tumour:

Neuroepithelial tumours were most commonly encountered in cerebrum consisting of 33 cases out of which 14 of them were located in frontal lobe followed by multiple lobe involvement (12 cases).

2nd most common meningotheial tumours also were most frequently found in cerebrum consisting of 20 cases out of which 10 cases were located in frontal lobe followed by multiple lobe involvement (7 cases).

Table no. 9 : Correlation of histopathological diagnosis of CNS tumours with Radiological Diagnosis:

CNS TUMOURS	Number	Correlated with Radiology	Did not correlate with Radiology	Overall correlation percentage
Neuroepithelial tumours	45	38	07	84.4%
Meningothelial tumours	29	28	01	96.6%
Embryonal tumours	04	03	01	75%
Tumours of sellar region (Pituitary adenoma)	03	03	00	100%
Haematolymphoid tumours (NHL)	01	01	00	100%
Metastasis	06	05	01	83.3%
Total	88	78	10	88.6%

Tumours of sellar region (Pituitary adenoma) and Haematolymphoid tumours (NHL) showed 100% correlation between histopathology and radiology, while, neuroepithelial tumours, meningotheial tumours, embryonal tumours and metastatic tumours showed 84.4%, 96.6%, 75% and 83.3% correlation between histopathology and radiology respectively.

To test the association between radiological and histopathological diagnosis, *p value* was calculated which came out to be 0.8684. The test statistics χ^2 equals 1.8585, which is in the 95% region of acceptance. The observed effect size phi is small, 0.15. This indicates that there is no significant difference observed in histopathological and radiological diagnosis of CNS tumours which signifies that diagnosis of CNS tumours identified by histopathological and radiological evaluation is same.

IMAGES:

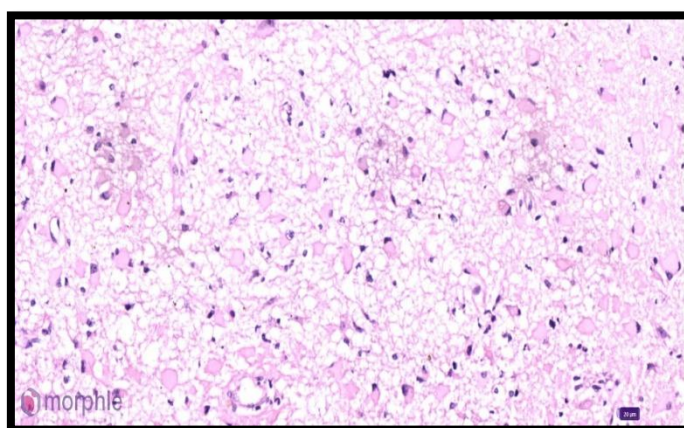


Figure no. 1: Astrocytoma with Gemistocytic change showing dense eosinophilic cytoplasm and eccentrically displaced nucleus.

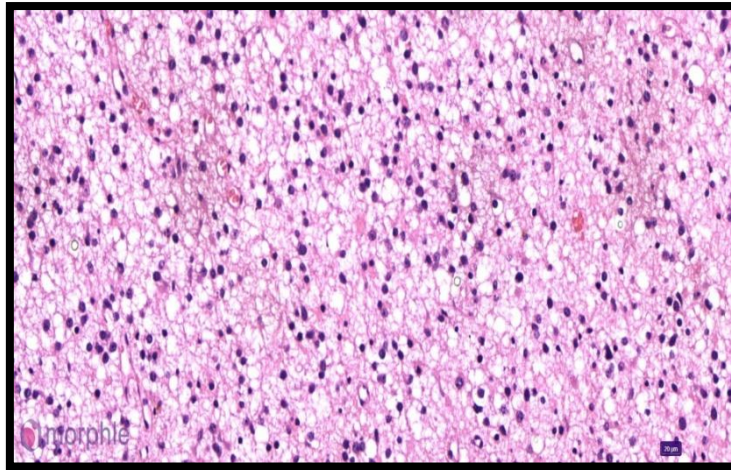


Figure no.2: Astrocytoma grade 2 showing diffusely infiltrating tumour cells with round to oval astrocytic nuclei and fibrillar glial processes.

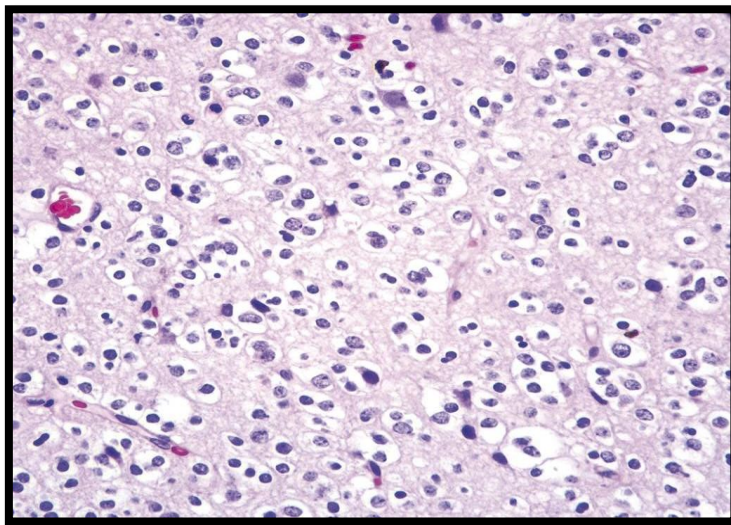


Figure no. 3: Oligodendroglioma showing chicken wire like blood vessels and fried egg appearance.

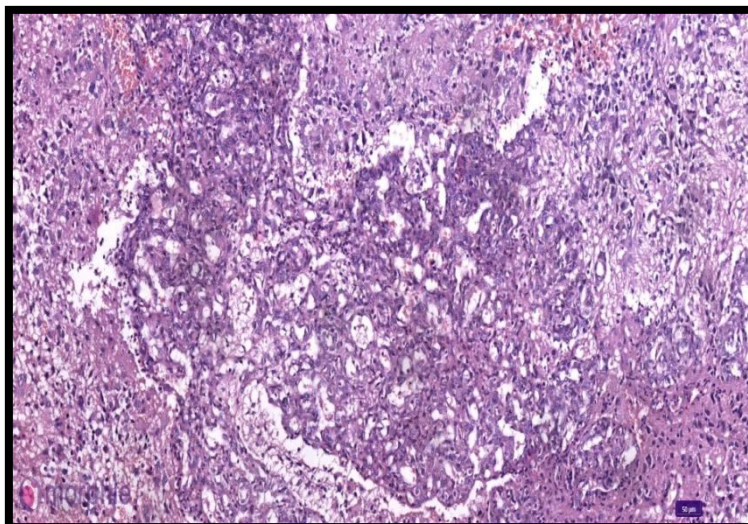


Figure no. 4: Glioblastoma multiforme showing microvascular proliferation and glomeruloid bodies.

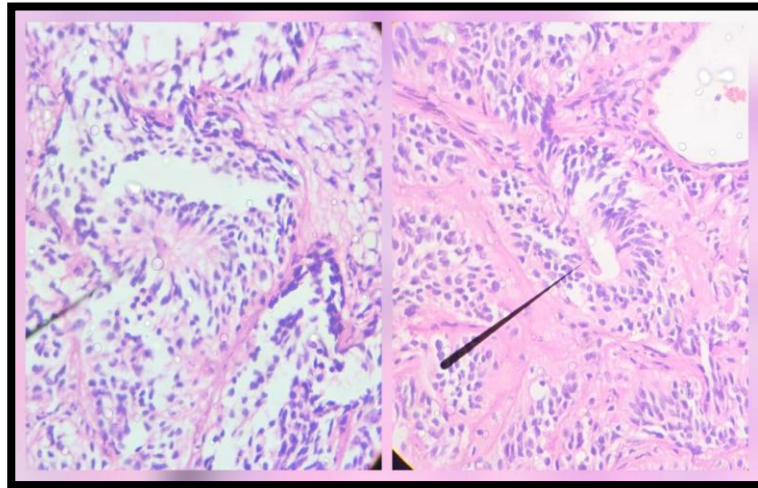


Figure no.5: Ependymoma showing pseudorosettes and true ependymal rosettes.

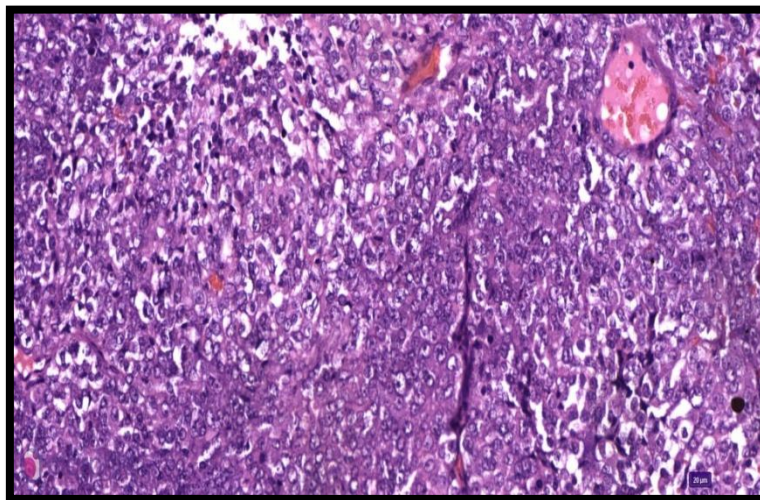


Figure no.6: Medulloblastoma showing syncytial arrangement of densely packed undifferentiated cells.

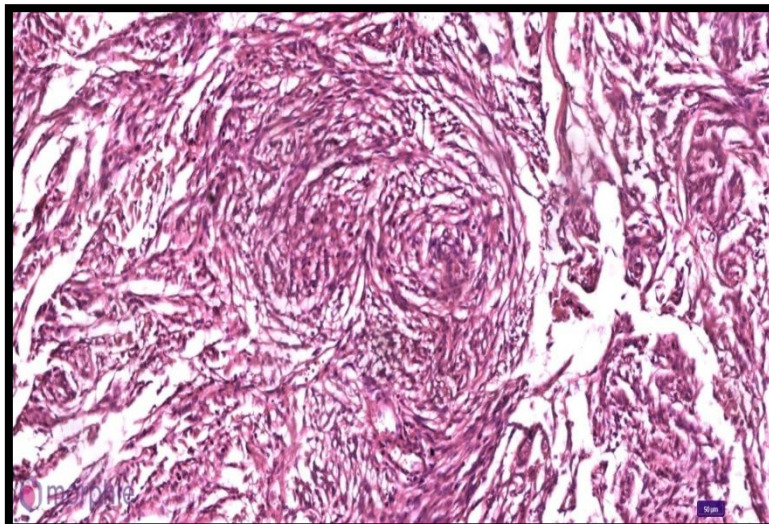


Figure no. 7: Meningothelial meningioma showing meningothelial whorls.

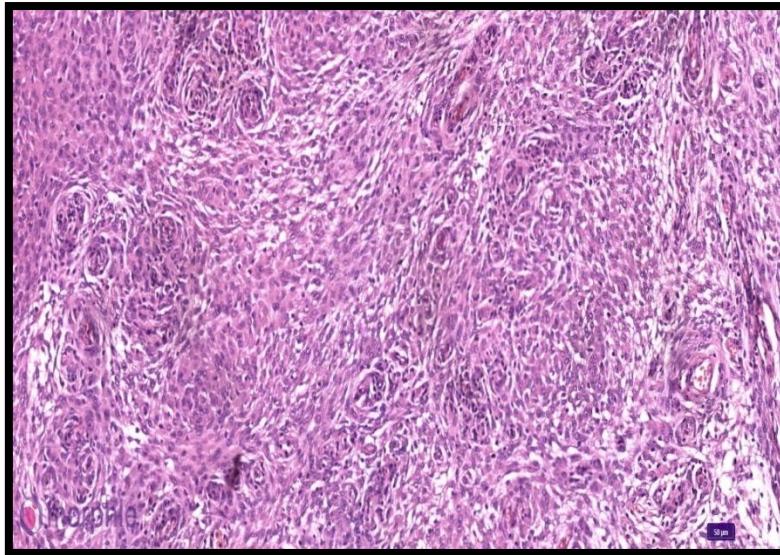


Figure no. 8: Transitional meningioma showing mixed meningotheelial and fibroblastic features.

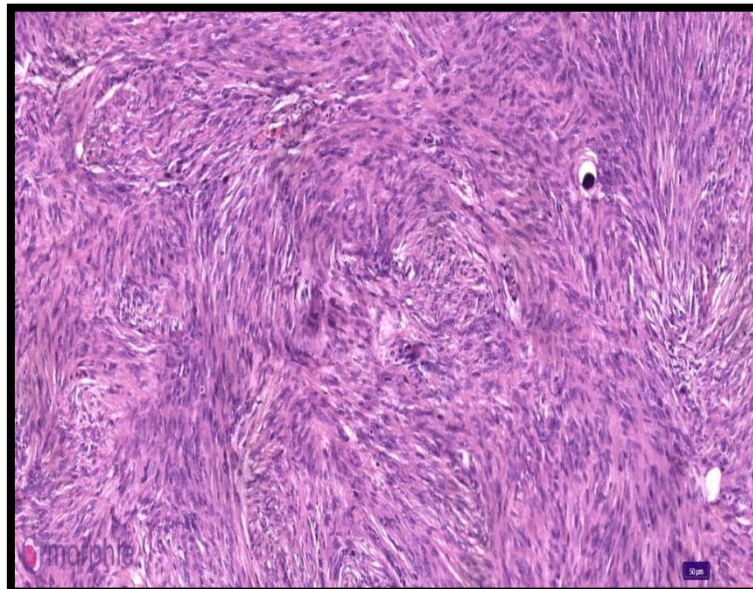


Figure no. 9: Fibrous meningioma showing monomorphic elongated cells and spindly nuclei

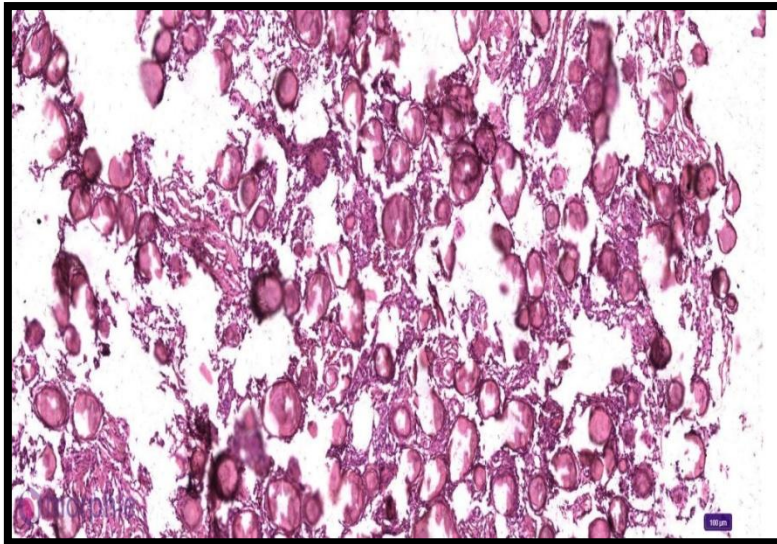


Figure no. 10: Psammomatous meningioma showing numerous psammoma bodies.

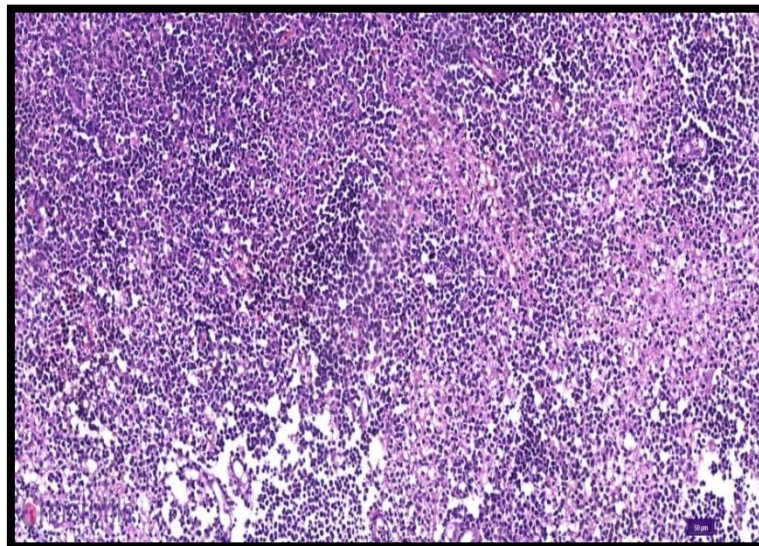


Figure no. 11: Non-Hodgkin's lymphoma showing diffuse sheets of medium sized atypical large lymphoid cells.

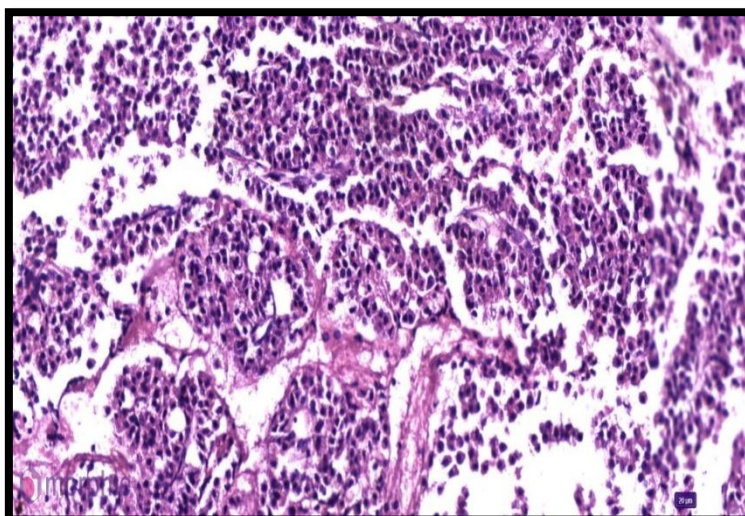


Figure no. 12: Pituitary adenoma showing monomorphic round to polygonal cells arranged in sheets, nests separated by delicate fibrovascular stroma with nuclei showing finely stippled chromatin.

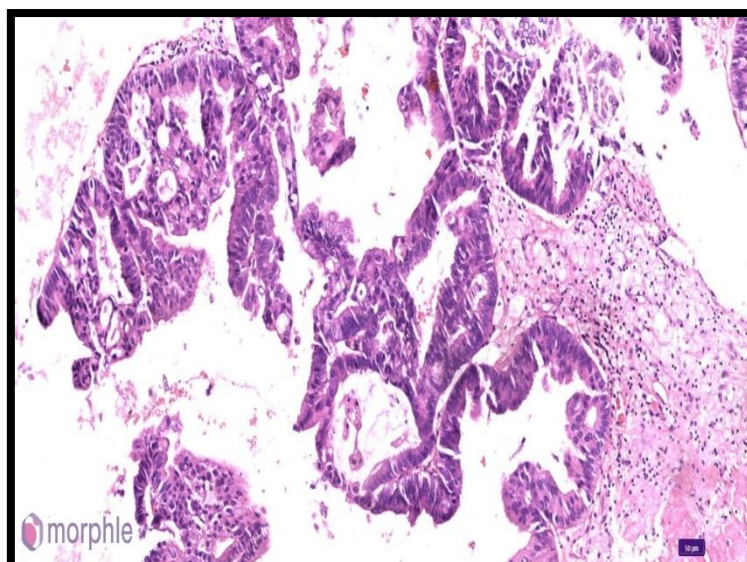


Figure no. 13: Metastatic adenocarcinoma showing brain parenchyma infiltrated by malignant epithelial cells arranged in glands with pleomorphic hyperchromatic nuclei, moderate cytoplasm and prominent nucleoli.

DISCUSSION

The present study was conducted in the Department of Pathology at a tertiary care hospital and included 88 cases of central nervous system (CNS) tumours submitted for histopathological examination. The cases were analyzed with respect to age, gender, tumour location, clinical presentation, radiological findings, and histopathological diagnosis.

In the present study, the highest incidence of CNS tumors was observed in the 41–50 years age group (33%), followed by the 51–60 years age group (19.3%). Similar findings were reported by Pidakala et al⁽¹⁴⁾, who observed the highest frequency of cases in the 41–50 years age group (26.08%), and Kanthikar et al⁽¹⁵⁾, who reported 36.8% of cases in the same age group. In contrast, Hamdani et al⁽¹⁶⁾ reported the highest incidence among patients aged 51–60 years.

A male predominance was noted in the present study, which is consistent with the findings of Sen et al⁽¹⁷⁾ (59.5%), Mondal et al⁽¹⁸⁾ (56.2%), and Nibhoria et al⁽¹⁹⁾ (55%). However, Kanthikar et al⁽¹⁵⁾ reported a female predominance, accounting for 52.64% of cases.

Headache was the most common presenting symptom, observed in 47 cases (53.4%), followed by seizures in 29 cases (33%). Similar observations were made by Kadaru et al⁽²⁰⁾, who reported headache (39 Cases, 44.8%) and seizures (19 Cases, 21.8%) as the most common symptoms. Mondal et al⁽¹⁸⁾ also identified headache (63 Cases, 48.46%) and seizures (48 Cases, 36.92%) as the predominant clinical manifestations. Likewise, Shashidhar et al⁽²¹⁾ reported headache (42%) and difficulty in movement (31%) as the most frequent symptoms, whereas Vodithala et al⁽²²⁾ observed headache (65%) and vomiting (22.5%) as the leading clinical presentations.

In our study, frontal lobe (29.55%) involvement was the most frequent which presented the similar behaviour in the studies conducted by Thamby et al⁽⁸⁾ and Sen et al⁽¹⁷⁾ in which the frontal lobe was most frequently involved. In the study done by Kadaru et al⁽²⁰⁾, most of the CNS tumours were located in the frontal lobe (39.08%) followed by multilobe (27.13%) involvement which is in agreement with the present study.

Table no. 10: Distribution of histologic types of CNS tumours in other studies:

Histological type	Present study	Gunge et al ⁽¹⁰⁾	Muddha et al ⁽²³⁾	Mondal et al ⁽¹⁸⁾	Shashidhar et al ⁽²¹⁾	Kanthikar et al ⁽¹⁵⁾
Neuroepithelial tumours (Gliomas and Ependymal)	51.1% (45 cases)	57% (20 cases)	54.6% (36 cases)	70.76% (92 Cases)	41% (41 Cases)	42% (13 cases)
Meningothelial tumours	33% (29 cases)	20% (7 cases)	34.9% (23 cases)	15.3% (20 Cases)	18% (18 Cases)	48.4% (15 cases)
Embryonal tumours (Medulloblastoma)	4.5% (4 cases)	8.6% (3 cases)	4.5% (3 cases)	-	-	-

Tumours of sellar region (Pituitary adenoma)	3.4% (3 cases)	2.9% (1 case)	3% (2 cases)	3.83% (5 Cases)	6% (6 Cases)	3.2% (1 case)
Haematolymphoid tumours (NHL)	1.1% (1 case)	2.9% (1 case)	-	0.76% (1 Case)	4% (4 Cases)	-
Metastatic tumours	6.8% (6 cases)	5.7% (2 cases)	-	1.53% (2 Cases)	6% (6 Cases)	6.5% (2 cases)

Out of total 88 cases of CNS tumours, 82 (93.2%) cases were primary CNS tumours and 06 (6.8%) cases were metastatic. Similar results were seen in the study conducted by Gunge et al⁽¹⁰⁾ in which primary CNS tumour cases were 36 (94.7%) and 02 cases (5.3%) were metastatic.

Histologically, neuroepithelial tumours constituted the largest group, accounting for 51.1% of cases, followed by meningothelial tumours, which comprised 33% of cases. These findings are consistent with those reported by Gunge et al⁽¹⁰⁾, who found neuroepithelial tumours in 57% of cases and meningeal tumours in 20%. Similarly, Muddha et al⁽²³⁾ reported gliomas as the most common CNS tumours (54.6%), followed by meningiomas (34.9%). Comparable observations were made by Mondal et al⁽¹⁸⁾ and Shashidhar et al⁽²¹⁾. In contrast, Kanthikar et al⁽¹⁵⁾ reported meningothelial tumours as the most common category (48.4%), followed by neuroepithelial tumours (42%).

In the present study, out of 45 cases of neuroepithelial tumours, 32 cases (71.11%) were reported as astrocytomas. Among the astrocytic tumours, the most common type was glioblastoma multiforme constituting total 12 cases (37.5%). In the study conducted by Muddha et al⁽²³⁾, glioblastoma was the most common type among the gliomas accounting for 14 cases (38.9% of gliomas) which is in agreement with the present study data. Also, in the study conducted by Kinkhede et al⁽²⁴⁾, glioblastomas were the most common type in gliomas comprising 51 cases (41.1%).

In our study, the second most common CNS tumours were the meningothelial tumours constituting total 29 cases (32.95%) out of which 17 cases (58.62%) were diagnosed as transitional meningiomas, 7 cases (24.14%) as fibrous meningiomas, 4 cases (13.79%) as psammomatous meningiomas and 1 case (3.45%) as meningothelial meningioma. Similarly, in the study conducted by Poonia et al⁽²⁵⁾, transitional meningiomas were the most common type among other meningiomas constituting 10 cases (32.3%) followed by meningothelial and fibrous types. Also in the study done by Gadgil et al⁽²⁶⁾, transitional meningiomas were common followed by meningothelial (22.7%) and fibroblastic (22%) types. In contrast, the study conducted by Kadaru et al⁽²⁰⁾ showed meningothelial meningioma (51.61%) to be the commonest followed by fibrous meningioma (16.12%) among the meningothelial tumours.

According to WHO grading, Grade I tumours were the most common, accounting for 39.7% of cases, followed by Grade II tumours (26.9%). These findings are in accordance with the studies conducted by Amipara et al⁽²⁷⁾ (41.95%). and Kakshapati et al⁽²⁸⁾ (55%), both of whom reported Grade I tumours as the most prevalent category.

In our study, astrocytomas and meningiomas were commonly seen in the age group of 41-50 years. In Pidakala et al⁽¹⁴⁾ meningiomas and glioblastomas were mostly seen in 41-50 years age group whereas in Kanthikar et al⁽¹⁵⁾, astrocytomas and meningiomas were mostly seen in 41-50 years age group. Embryonal tumours (4.5%) were seen in children. Ramanavarapu et al⁽²⁹⁾ also found 4 cases (5.88%) of medulloblastomas in 2nd decades of age with minimum of 11 years old.

Neuroepithelial tumours were commonly seen in males in the present study. Amongst the neuroepithelial tumours, astrocytomas were commonly seen in males. Similarly, in the study conducted by Mehta et al⁽³⁰⁾, tumours of neuroepithelial origin were commonly seen in males. Ghanghoria S et al⁽³¹⁾ also found the incidence of astrocytomas more in males than in females. However, in meningiomas, females outnumbered the males in our study. A similar female preponderance was seen in meningiomas in the studies conducted by Mehta et al⁽³⁰⁾, Ghanghoria et al⁽³¹⁾ and Mohammad et al⁽³²⁾.

In the present study, Tumours of sellar region (Pituitary adenoma) and Haematolymphoid tumours (NHL) showed 100% correlation between histopathology and radiology, while, neuroepithelial tumours, meningothelial tumours, embryonal tumours and metastatic tumours showed 84.4%, 96.6%, 75% and 83.3% correlation between histopathology and radiology respectively. Thus, the histopathological diagnosis of CNS tumours correlates with the radiological diagnosis. Similarly, in the study done by Boni et al⁽³³⁾, tumours of sellar region and metastatic tumours showed 100% radiology correlation with histopathology while neuroepithelial tumours and Meningeal tumours showed 88.57%, 84.44% correlation.

Overall, the findings of the present study are comparable with those reported in the existing literature and highlight the importance of histopathological examination as the gold standard for definitive diagnosis of CNS tumours. Furthermore, the high degree of radiological-histopathological concordance underscores the value of neuroimaging in the diagnostic workup of these lesions.

CONCLUSION

Accurate diagnosis of CNS tumours is essential due to their varied behaviour, prognosis, and treatment options. While imaging has advanced, histopathology remains the gold standard, supported by clinical and radiological correlation.

The integration of histological, immunohistochemical, and molecular data ensures precise classification and guides effective management. Ongoing advancements in these fields continue to enhance prognostication and support personalized treatment, ultimately improving outcomes for CNS tumour patients.

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