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Histomorphological Appraisal of Central Nervous System Tumors: Retrospective Study In Tertiary Care Center

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ABSTRACT

Introduction: Brain is a complex organ controlling various important processes that regulate the body, serves as centre of nervous system in vertebrates. Pathology in any part of the brain, compromises its function. This leads to high mortality in the patients with brain diseases. Central nervous system (CNS) tumors consist of brain tumors along with tumors of the spinal cord. They form about 2% of all the malignancies in humans. Tumors (benign or malignant) are the unwanted growth of cells, which impact brain function if they grow large enough to compress surrounding tissue. We aim to study the spectrum of histopathological findings of different types of CNS tumors and classify them according to the 2021 WHO classification. Here we present a series of 72 cases.

Material and Methods: Retrospective observational histopathological study of CNS tumors was carried out in the Pathology Department of tertiary care center for duration of two years. 72 cases were studied. Various benign and neoplastic conditions were analysed with reference to age, gender, clinical findings, gross and histopathology. Hematoxylin and eosin-stained and paraffin-embedded tissue were also received for microscopy. Tumors diagnosed were classified according to 2021 WHO classification for CNS tumors.

Result: Based on histopathological findings, we have diagnosed 72 cases of CNS tumors and classified them. Majority were Meningioma 28 cases (38.89%) followed by Astrocytoma 19 cases (26.39%). Affects wide range of age group, youngest being 2 years to eldest being 79 years, with mean age group of 41-50 years in our study. Males (51.39%) are affected more compared to females (48.61%).

Conclusion: The study provides a picture of CNS tumors, demographic incidence and resenting features. Histopathology plays an important role in the diagnosis of tumor types. Early detection, Proper diagnosis and appropriate treatment are essential for better outcomes and for increasing longevity of the patients.

Keywords: CNS tumors, Histopathology, Meningioma, Schwannoma, Astrocytoma.

INTRODUCTION

The gross and microscopic anatomy of the human central nervous system (CNS) is dauntingly complex and characterised by extraordinary variation in regional architecture[1]. CNS is affected by a variety of conditions including inflammatory conditions, infections, malignancies and metastasis. The CNS tumors are diverse group of neoplasms and most dreaded form of cancers having high morbidity and mortality[2]. These tumors represent a diverse group of neoplasms with significant variability in histopathology, clinical behaviour and prognosis. Majority of the CNS tumors are primary tumors and about one-fourth to half being metastatic with annual incidence of 10 to 17 per 100,000 individuals for intracranial tumors and 1 to 2 per 100,000 individuals for intraspinal tumors[3]. CNS tumors show a bimodal age distribution with a peak in childhood and another in elderly between the age group of 45-70 years[4].

First case of CNS tumor was reported by Louis in 1774, fungal tumor of the dura mater[5]. CNS tumors are rare, being second most common type of malignancy in children after leukemia being most common malignancy[6]. Globally, these tumors constitute approximately 3.5% of all new diagnosed cancer cases[7] while in India, incidence is 2.3%[8]. To assess

the prognosis, molecular diagnostics play an important role; however these tests are expensive and not easily available in developing countries[9]. During the past two decades, there has been evolution in investigation techniques in India, which has significantly increased the incidence of brain tumors like anywhere else in the world[5].

Conventionally, based on the cell of origin or the site of origin, brain tumors are classified as neuroepithelial origin tumors comprising of astrocytic tumors, oligodendroglial tumors, oligoastrocytic tumors, ependymal, choroid plexus tumors, neuronal and mixed neuronal-glial tumors, pineal tumors; tumors of cranial nerves; tumors of meninges; lymphomas and hematopoietic neoplasms; germ-cell tumors; tumors of sellar region and metastases[10].

Histomorphological evaluation remains the gold standard for diagnosis, guiding therapeutic strategies and prognostic assessments. Epidemiological studies highlight geographical and institutional variations in tumor prevalence, influenced by genetic, environmental, and diagnostic practices. Despite advancements in imaging and molecular diagnostics, histopathological analysis retains irreplaceable value in subclassifying tumors and identifying rare entities. This study aims to delineate the spectrum of CNS tumors diagnosed at a tertiary care center, emphasizing their relative frequencies and clinicopathological correlations. By contextualizing these findings with global data, this work seeks to enhance regional understanding and inform resource allocation for diagnosis and management.

MATERIALS AND METHODS

Our present study is retrospective observational analysis of CNS tumors data involving the patients' clinicopathological details, histopathological slides and blocks. 72 cases were studied over a period two years from January 2023 to December 2024, in the Department of Pathology, Government Medical College, Jalgaon, Maharashtra.

Inclusion Criteria: Patients of all ages with histopathologically confirmed primary or metastatic CNS tumors.

Exclusion Criteria: Non-neoplastic lesions, insufficient biopsy material, and tumors originating outside the CNS.

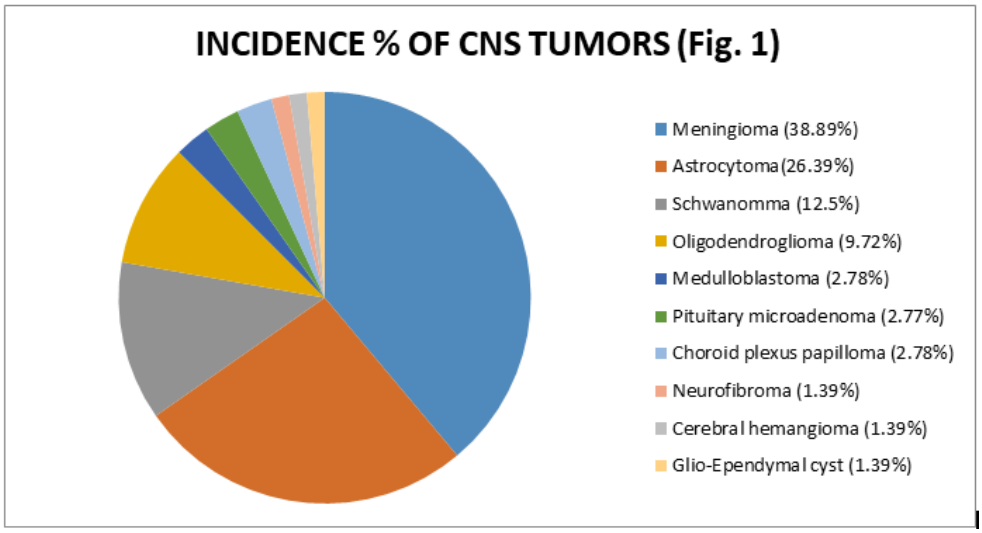
Data Collection: Archived histopathology reports were reviewed, and tumors were classified according to the 2021 WHO Classification of CNS Tumors. Demographic and clinical data were extracted from electronic records.

Statistical Analysis: Descriptive statistics were used to calculate frequencies and percentages. Data were analyzed using SPSS v26.

RESULTS AND DISCUSSION

According to the data we collected, common symptoms among these patients were headache, seizures, visual disturbances, vomiting, gait disturbances and behavioural problems.

Meningiomas and astrocytomas collectively constituted 65.28% of cases, reflecting their predominance. Rare entities such as glioependymal cysts and cerebral hemangiomas accounted for <2% each. Our findings align with global trends where meningiomas and astrocytomas dominate CNS tumor profiles. The 38.89% prevalence of meningiomas correlates with studies from North America and Europe but exceeds rates reported in some Asian cohorts, possibly due to demographic factors or referral bias in a tertiary centre. The high frequency of astrocytomas (26.39%), particularly glioblastomas (subgroup not specified here), underscores the aggressive nature of glial tumors and their diagnostic urgency. Schwannomas (12.5%) and oligodendrogliomas (9.72%) were consistent with global averages, though oligodendrogliomas may be underrepresented due to diagnostic challenges in identifying 1p/19q co-deletion without molecular testing. Notably, medulloblastomas (2.78%) were less frequent compared to pediatric-focused studies, reflecting our centre's adult-skewed population. Rare tumors, including choroid plexus papillomas and glioependymal cysts, highlight the importance of histopathological expertise in distinguishing mimics (e.g., ependymal cysts vs. neoplastic lesions). The low incidence of neurofibromas (1.39%) contrasts with neurofibromatosis-associated cohorts, suggesting under-referral of genetic syndrome patients.

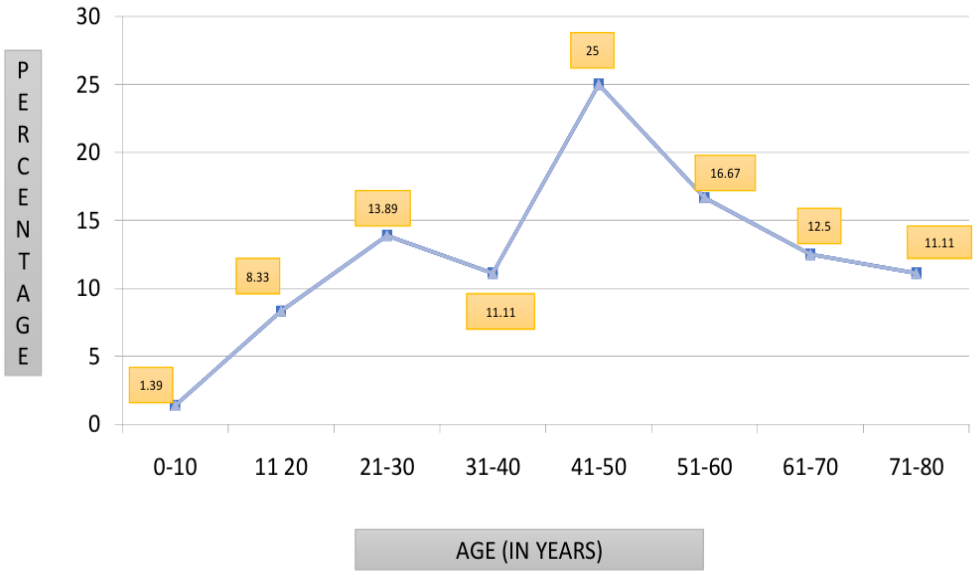


The findings are similarly found in studies by Surawaicz et al[12], Lee et al [13] and Ghanghoria et al[14].

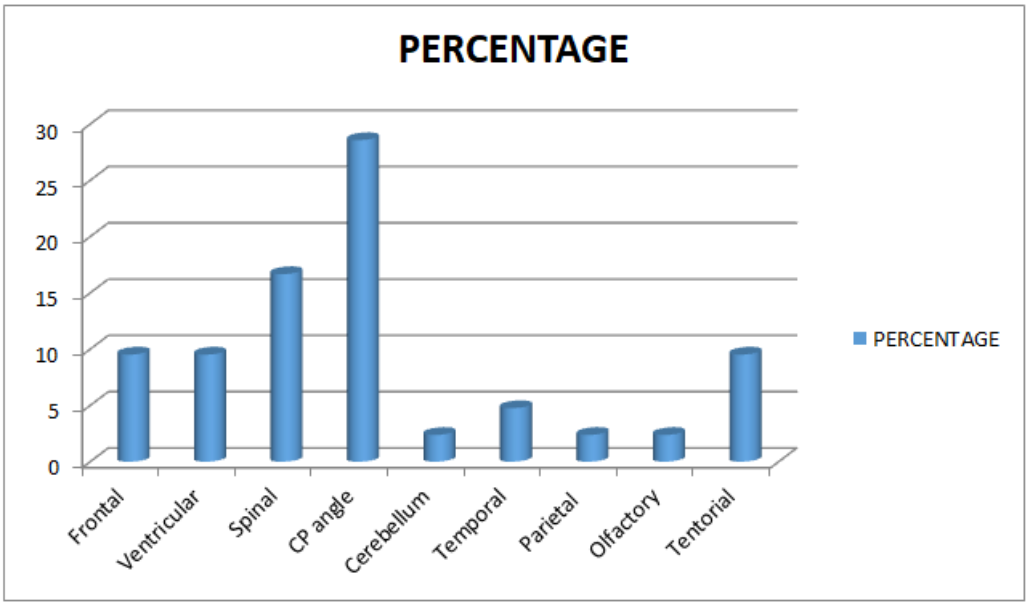
AGE (IN YEARS)	FEMALES	MALES	TOTAL
0-11	1	0	1
11-20	2	4	6
21-30	7	3	10
31-40	5	3	8
41-50	11	7	18
51-60	4	8	12
61-70	3	6	9
71-80	2	6	8
TOTAL	35	37	72

AGE AND GENDER DISTRIBUTION OF CNS TUMOR CASES (Fig. 2)

Slight male predominance was found in our study 37 cases (51.39%) while females constituted 35 cases (48.61%) which is similar to Lee et al [13].



AGE-WISE DISTRIBUTION OF CNS TUMOR CASES (Fig.3)



SITE-WISE DISTRIBUTION OF CNS TUMOR CASES (Fig. 4)

HISTOPATHOLOGY	CBTRUS Data[15]	TMH Data[16]	NIMHANS[17]	OUR STUDY
Meningioma	65	46.5	45	54
Glioblastoma	64	50	50	48
Diffuse astrocytoma	48	NA	37	36
Anaplastic astrocytoma	53	36	36	28
Oligodendroglioma	43	37	40	47
Mixed glioma	42	NA	36	47
Ependymal tumor	19	18.5	18	16
Peripheral nerve sheath tumor	55	NA	40	51
Pituitary adenoma	51	39	42	38

HISTOPATHOLOGY AND MEDIAN AGE (IN YEARS) (Fig. 5)

MENINGIOMA

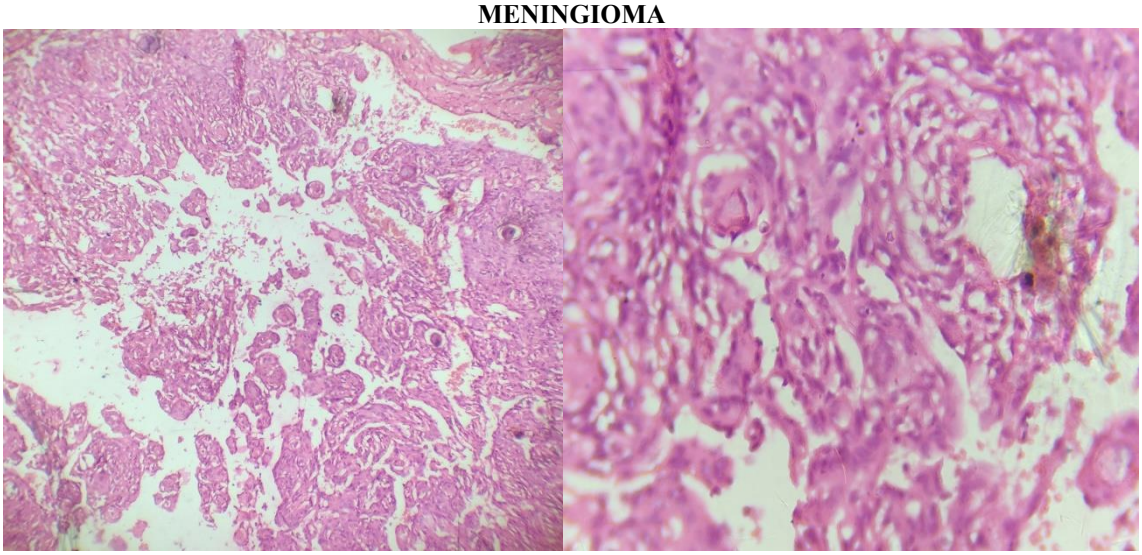


IMAGE 1: Meningioma

Meningioma is the most common CNS tumor. We found oval to spindle cells forming whirling pattern and classic psammoma bodies in psammomatous variant.

ASTROCYTOMA

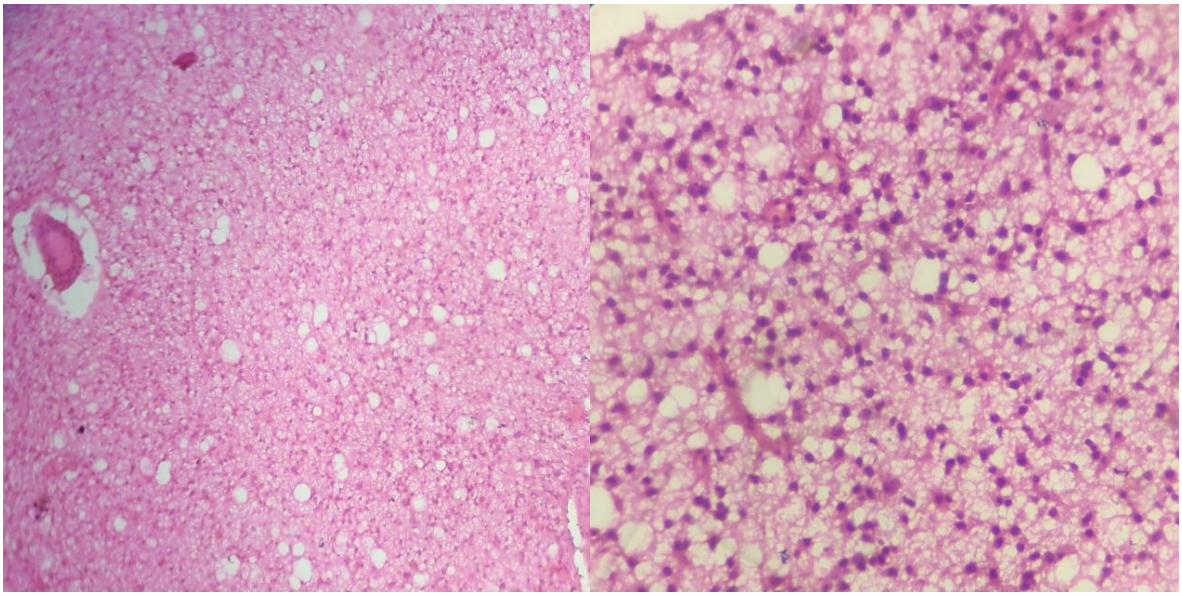


IMAGE 2: Astrocytoma

Pleomorphic cells show high mitoses. Pleomorphic nuclei has giant forms and multinucleated giant cells. Interlacing bundles of pleomorphic astrocytes show perivascular growth. Focal areas of pallisading necrosis.

OLIGODENDROGLIOMA

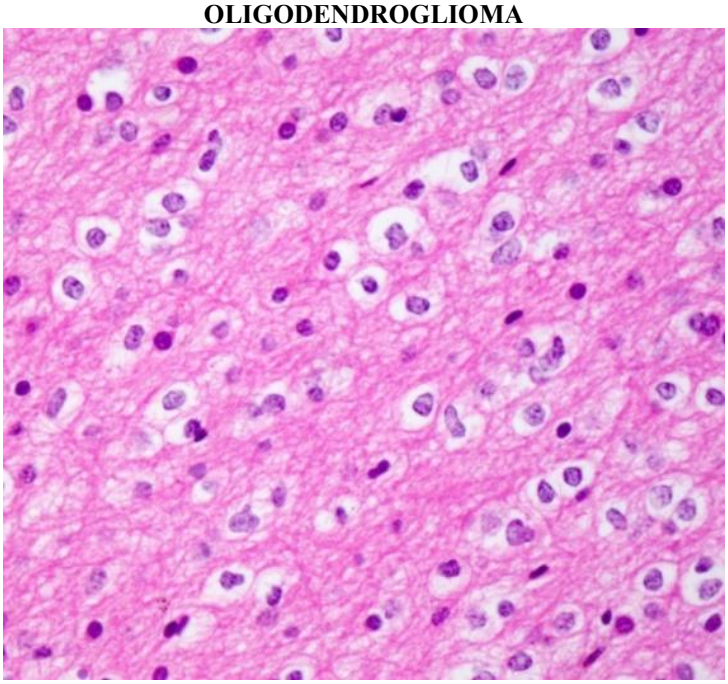


IMAGE 3: Oligodendroglioma

Diffusely infiltrating tumor with moderate cellularity. Cells are typically monomorphic with round nuclei, nuclear atypia, salt-n-pepper chromatin pattern, inconspicuous nucleoli and cytoplasm with fried-egg appearance. Chicken-wire pattern of vascular proliferation and hemorrhage. Blood vessels are dilated and congested.

MEDULLOBLASTOMA

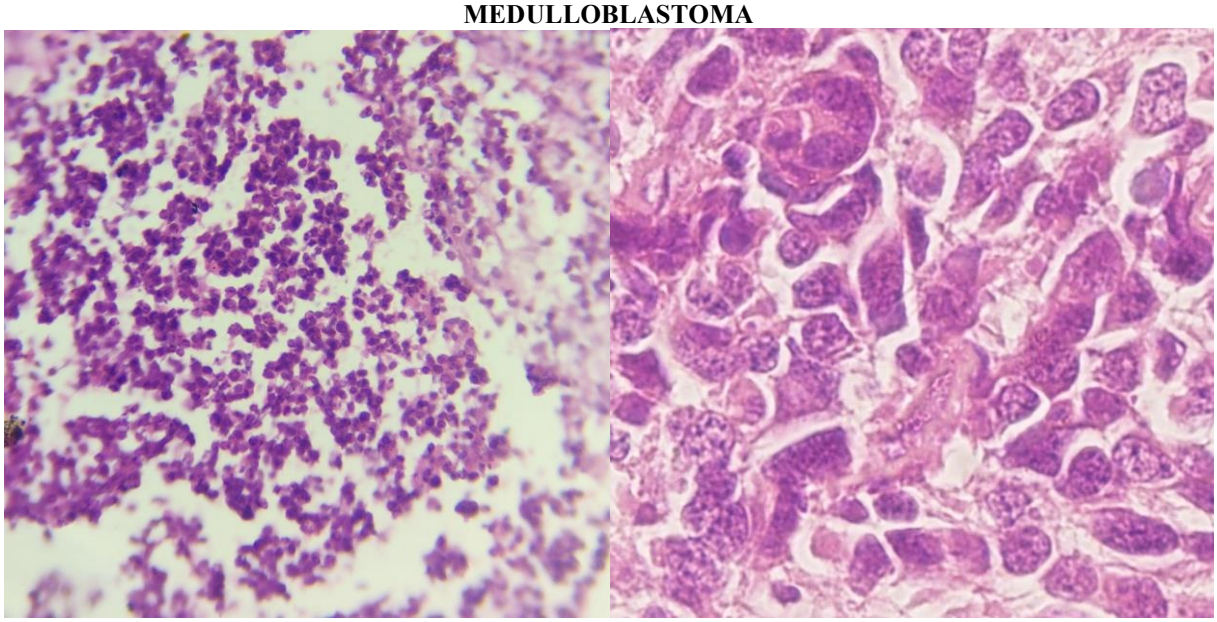


IMAGE 4: Medulloblastoma

Undifferentiated tumor cells in honeycomb pattern. Increased cellularity, pleomorphism and atypia. Homer-Wright rossettes.

PITUITARY MICROADENOMA

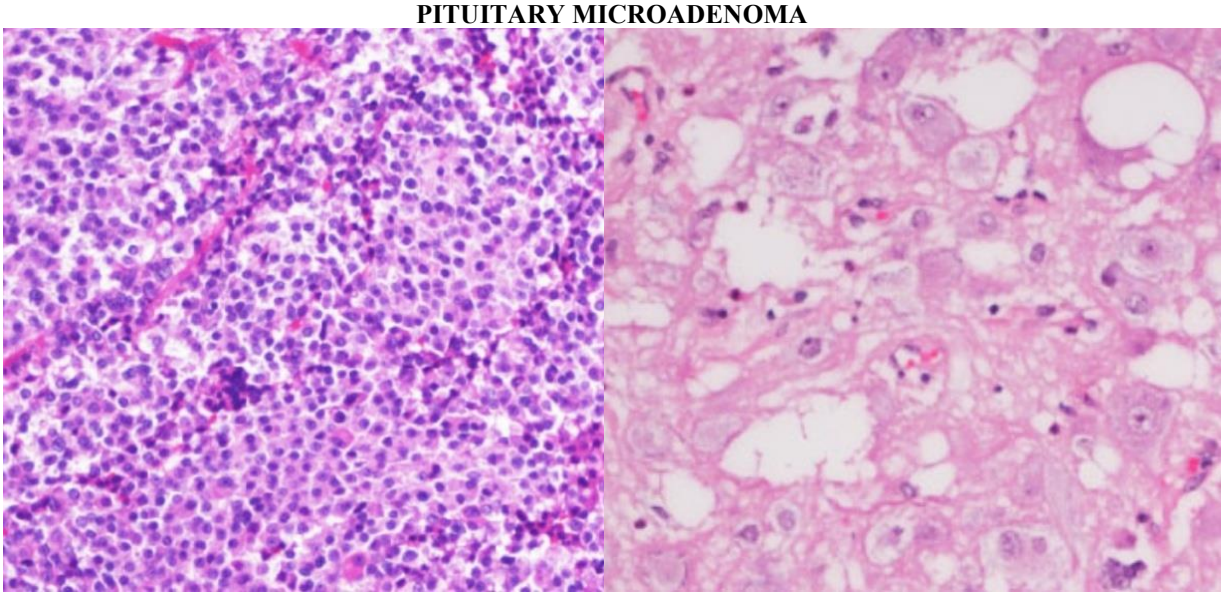


IMAGE 5: Pituitary microadenoma

Cells arranged in micro-acinar pattern, nests, cords. Cells have acidophilic cytoplasm. Nuclei have uniform morphology with stippled chromatin and inconspicuous nucleoli. Pseudorosette patterns.

CHOROID PLEXUS PAPILLOMA

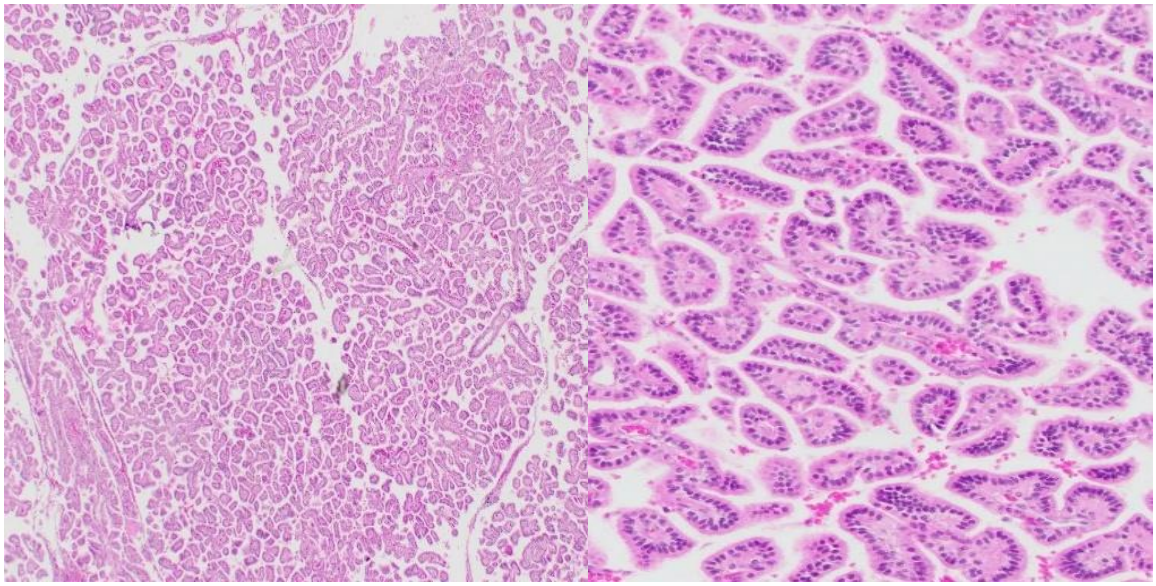


IMAGE 6: Choroid plexus papilloma

Papillary architecture, resemble normal choroid plexus. Mild nuclear polymorphism. Single layer of cuboidal to columnar monomorphic cells. Loss of cobblestone surface.

NEUROFIBROMA

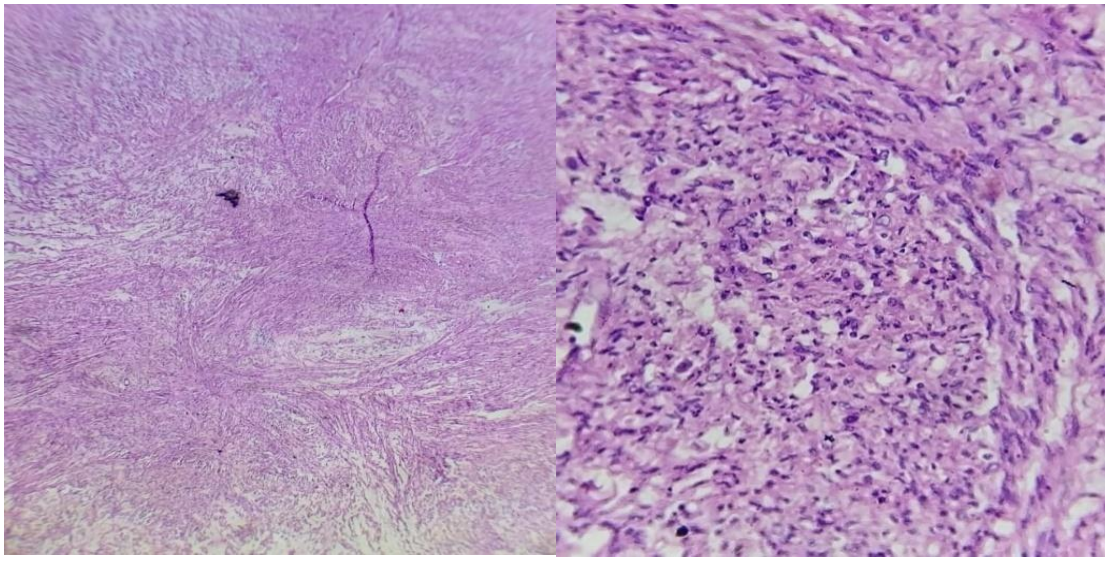


IMAGE 7: Neurofibroma

Spindle cell proliferation with waxy serpentine nuclei. Stromal mucosubstance shows neuro-fibrils and pacinian corpuscles. Perineural cells show compression with surrounding collagen showing calcification.

CEREBRAL HEMANGIOMA

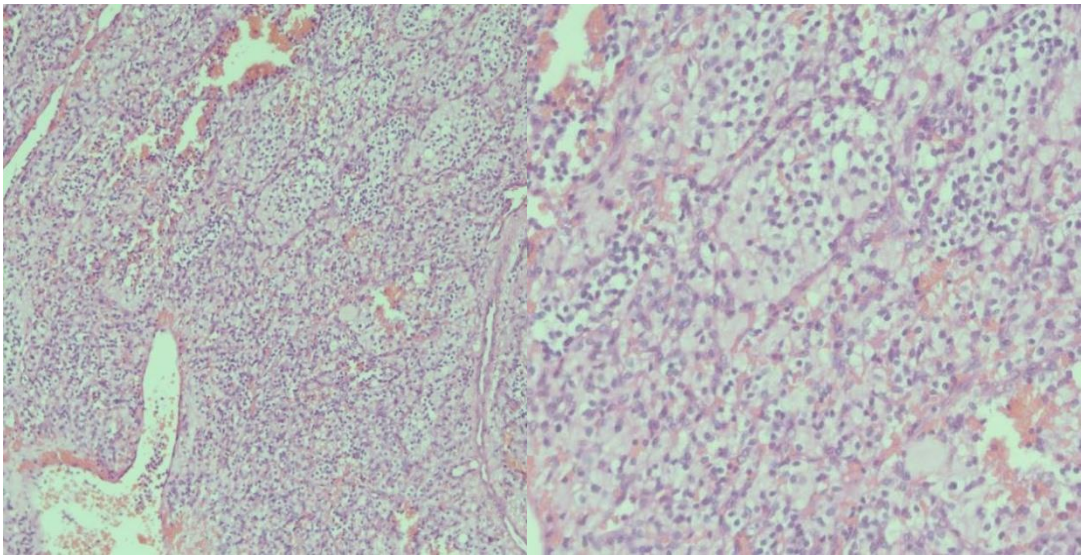


IMAGE 8: Cerebral hemangioma

Neoplastic stromal cells arranged between numerous small capillaries. Vascular part – thin walled vessels with congestion. Intra-tumor hemorrhage.

Limitations: Retrospective design, single-centre data, and potential selection bias toward surgically accessible tumors. Molecular subtyping was not routinely performed, which may affect classification accuracy.

CONCLUSION

Our study reaffirms meningiomas and astrocytomas as the most prevalent CNS tumors in our tertiary care setting, consistent with global patterns. The notable presence of rare entities underscores the need for specialized histopathological evaluation to guide management. These findings advocate for enhanced molecular diagnostics and regional cancer registries to refine epidemiological data. Future multi-centre studies integrating clinical, molecular, and demographic variables are warranted to address diagnostic disparities and optimize therapeutic outcomes.

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