Original Article

Histological Spectrum of Central Nervous System Lesions at a Tertiary Care Center in India

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Abstract

Background: Central nervous system (CNS) lesions show considerable geographic and racial variations with respect to the incidence and their pattern of distribution. The histological spectrum of CNS lesions is broad and it varies among extremes of age groups. The study is aimed to determine the diversity of CNS lesions as well as to highlight the incidence and the histological spectrum of CNS lesions in a tertiary health center in India. **Materials and Methods:** A total of 238 CNS lesions were retrospectively analyzed in the Department of Pathology from October 2014 to November 2017. The specimens were processed by routine histotechniques, and immunohistochemistry (IHC) was performed whenever required. The diagnosis was confirmed by applying the existing World Health Organization classification. **Results:** Two hundred and thirty-eight cases of CNS lesions were analyzed, of which 33 (13.86%) cases were nonneoplastic, with the majority being cystic lesions 12 (36.36%). The neoplastic lesions comprised 205 (86.13%) cases, which included 200 (97.56%) primary and 5 (2.43%) metastatic lesions. Among the primary lesions, gliomas 57 (27.80%) were the most common followed by meningiomas 43 (20.97%) and schwannomas 37 (18.04%). **Conclusion:** The present study highlights the histological diversity of CNS lesions in both adult and pediatric age groups. Although with the advent of modern imaging techniques, a provisional diagnosis could be given to these diseases, histological examination with further utilization of IHC remains the gold standard in diagnosis and grading of all CNS lesions. This has further helped in management as well as the prognosis of these diseases.

Keywords: *Central nervous system, gliomas, immunohistochemistry*

Introduction

"Intra-cranial space-occupying lesion" (ICSOL) is defined as any mass lesion in the cranial cavity with varied etiology such as infectious, neoplastic, inflammatory, or any vascular malformation.[1] The SOLs of the central nervous system (CNS) can have a serious clinical course even when they are inflammatory lesions or benign neoplasms. Their potentially life-threatening behavior results from their emergence in a confined space as well as their proximity to vital structures. Therefore, it is of great importance to establish an accurate diagnosis for timely neurosurgical intervention.[2] The tumors of the CNS account to be <2% of all malignancies. In India, they constitute about 1.9% of all tumors.[3] The pathologist plays a great role in differentiating between neoplastic and nonneoplastic mimickers since a varied number of nonneoplastic conditions can mimic brain tumors, both clinically and radiologically.

Multiple risk factors, including genetic mutations (Li–Fraumeni syndrome) and ionizing radiation, contribute to the pathogenesis of brain tumors, but the exact etiological agent and risk factors are still not clear.[2] Tumors of the CNS are histologically typed by the World Health Organization (WHO) as tumors of neuroepithelial tissue, peripheral nerves, meninges, mesenchymal nonmeningothelial tumors, lymphomas, germ cell tumors, and metastatic tumors.[4] The exact histopathological diagnosis of CNS tumors using techniques like the application of histochemical stain and immunohistochemistry (IHC) has played a major role in differential diagnosis and improving diagnostic accuracy, which is essential to predict the grading and prognosis.[3]

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The histological spectrum of CNS lesions is broad and it varies among extremes of age groups. In developing countries like India, due to the privation of complete registration of newly diagnosed cases with local cancer registries, the precise tumor burden of such diseases goes unnoticed and underestimated. Thus, hospital-based prevalence databases are imperative for estimating the disease load.[4] The purpose of this study is to determine the diversity of CNS lesions as well as to highlight the incidence and the histological spectrum of CNS lesions in a tertiary care hospital in India.

Materials and Methods

This retrospective study was conducted in a tertiary care hospital in India for 3 years from October 2014 to November 2017 on neurosurgical biopsies. The cases were diagnosed and characterized, where necessary using IHC and categorized according to the WHO 2016 classification. The inclusion criteria were cases of CNS tumors of all age groups. The tumors of the peripheral nervous system were excluded. With these criteria, a total of 238 cases of CNS lesions were studied, and their histological typing and grading were done.

Results

In a total of 238 cases of ICSOL, 205 cases (86.13%) were neoplastic and 33 cases (13.86%) were nonneoplastic. The mean age was 36 (range: 23 days to 80 years) years. The peak incidence was seen in 31–40 years, which accounted for 52 (21.84%) cases. Males represented 121 (50.84%) of the study population, whereas 117 (49.15%) were female, with male-to-female ratio of (1.03:1) [Figure 1]. There were only 48 (23.41%) cases of pediatric brain tumors (age <18 years) in our study.

During clinical examination, the majority of the patients presented with headache (61.34%) followed by visual deterioration, fever, epilepsy, vomiting, papilledema, altered sensorium, and loss of consciousness [Figure 2]. The frontal lobe was the most common site (21.00%) involved in most intracranial lesions. Some of the tumors involved >1 lobe of the brain. Other site-specific features such as scalp swelling and protrusion of meninges were seen in 16 cases.

Out of 205 (86.13%) neoplastic lesions encountered, 200 (97.56%) cases were primary and 5 (2.43%) were metastatic lesions. Among the primary tumors, gliomas (27.80%) constituted the largest category, followed by meningeal tumors (20.97%) and tumors of cranial and paraspinal nerves (18.04%) [Table 1].

Among the glial tumors, glioblastoma NOS grade IV was the most common histological subtype, with 27 (47.36%) cases. The youngest age of presentation of glioblastoma NOS was 21 years with a mean age at diagnosis being 42.38 years. Male-to-female ratio was 1:1.6. Other gliomas encountered in the present study were diffuse astrocytoma NOS-7 cases, pilocytic astrocytoma-5 cases, anaplastic astrocytoma NOS-4 cases, subependymal giant cell astrocytoma-1 case, gliosarcoma-1 case, pleomorphic xanthoastrocytoma-1 case, oligodendroglioma NOS-5 cases, anaplastic oligodendroglioma NOS-3 cases, oligoastocytoma-1 case, and anaplastic oligoastrocytoma-2 case.

The second predominant histological diagnosis was meningioma seen in 43 patients. The mean age of presentation was 44 years. Females outnumbered males in sex distribution with a ratio of 1:1.6. Meningothelial meningioma (WHO Grade I) was the most common histological subtype (53.48%) followed by transitional meningioma (WHO Grade I) 20.9%. Tumors of the cranial and paraspinal nerves constitute the third common histological pattern, all of which were Schwannomas. The mean age of diagnosis was 43.04 years with a male-to-female ratio of 1.4:1. Most of the tumors were located at the cerebellopontine angle.

According to the WHO grading, out of 57 gliomas, the majority were Grade IV tumors constituting

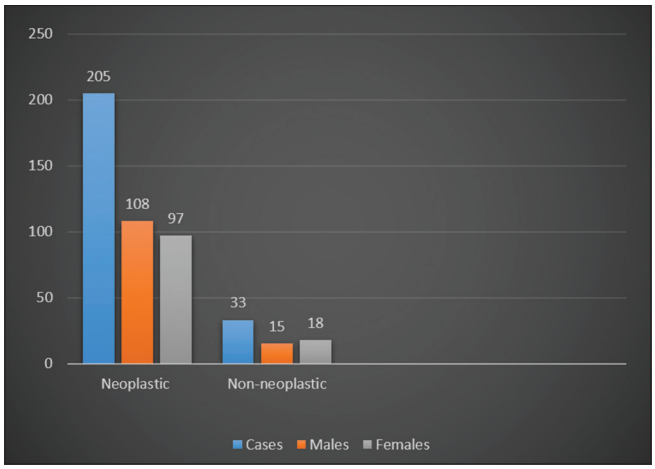

Figure 1: Gender distribution of intra-cranial space-occupying lesion

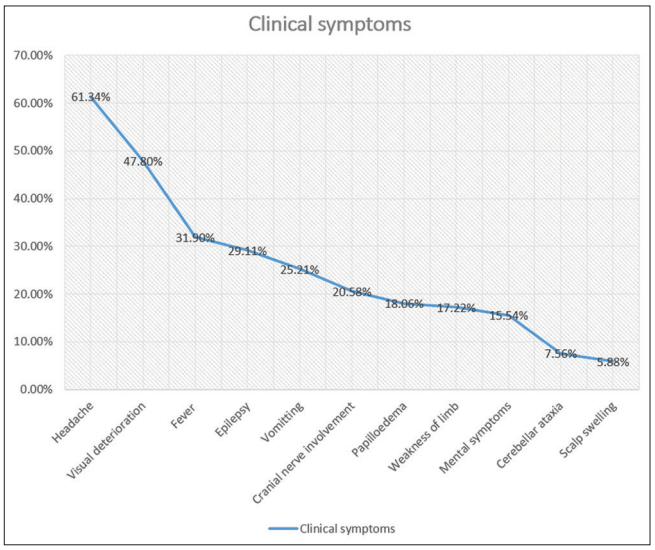

Figure 2: Clinical presentations of intra-cranial space-occupying lesion

Table 1: Age and sex distribution of neoplastic intracranial tumors

Categories of neoplastic tumors	Number of cases	Male	Female	Mean age of diagnosis (years)	Percentage
Astrocytic tumors	57	32	25	25.6	27.80
Ependymal tumors	12	7	5	16.6	5.85
Astroblastoma	1	1	0	38	0.48
Choroid plexus tumors	5	2	3	5.6	2.43
Neuronal and mixed neuronal-glial tumors (central neurocytoma)	2	0	2	29	0.97
Embryonal tumors	11	7	4	11	5.36
Tumors of cranial and paraspinal nerves (schwannomas)	37	22	15	43	18.04
Meningiomas	43	16	27	44	20.97
Mesenchymal tumors	9	6	3	25.2	4.39
Lymphomas	4	3	1	54	1.95
Germ cell tumors (Germinoma)	2	2	0	13	0.97
Tumors of sellar region (craniopharyngioma)	17	7	10	20.5	8.29
Metastatic tumors	5	3	2	59.5	2.43
Total	205	108	97		100

28 cases (49.12%) followed by 14 cases of Grade II tumors accounting for 24.56% [Table 2]. Among tumor of the meninges, Grade I meningiomas were predominant followed by Grade II [Table 3].

On IHC, all the 57 cases of gliomas were positive for GFAP, including a single case of gliosarcoma, that showed positivity for Vimentin in the mesenchymal component with a strong Ki-67 proliferation index of >20% [Figure 3]. Among the 9 cases of mesenchymal tumors, 4 cases of hemangioblastoma were diagnosed and confirmed with CD 34 antigen highlighting the vascular component [Figure 4]. Two cases of germinoma were detected with IHC showing positive reaction for CD 117 and PLAP [Figure 5]. An interesting case of Lymphoma was initially diagnosed as the poorly differentiated tumor, and the patient was started on steroids. Figure 6 shows the image finding of the tumor pre- and post-steroid therapy. On IHC, the tumor showed positivity for CD 45 and CD 20, while CD 3 was positive in the reactive T-cells. CD 7 positivity in a case of metastatic adenocarcinoma, documented that the primary was from the gastrointestinal tract [Figure 7]. Another eye-catching case was a case of low-grade chondrosarcoma of the left petrous apex, which was initially given as myxoid schwannoma with cystic degeneration on squash smears. The final diagnosis of low-grade chondrosarcoma was made on histology based on morphology and IHC that showed positive reaction for S-100 and Vimentin and were negative for Pan-CK and EMA [Figure 8]. Some of the histopathological patterns of CNS tumors encountered in the present study are shown in Figure 9.

Among the 33 nonneoplastic intracranial lesions, cystic lesions (36.36%) including dermoid cyst, arachnoid cyst, ependymal cyst, and hydatid cyst form the majority of the CNS nonneoplastic lesions followed by meningocele/meningomyelocele (30.30%). The highest number of nonneoplastic lesions was encountered in the third decade, with a female predominance [Table 4].

Table 2: WHO grade of gliomas

Gliomas	WHO grade	Number of cases	Total (%)
Pilocytic astrocytoma	I	5	6 (10.52)
SEGA	I	1	
Diffuse astrocytoma NOS	II	7	14 (24.56)
Oligodendroglioma NOS	II	5	
Oligoastrocytoma	II	1	
Pleomorphic xanthoastrocytoma	II	1	
Anaplastic astrocytoma NOS	III	4	9 (15.78)
Anaplastic oligodendroglioma NOS	III	3	
Anaplastic oligoastrocytoma	III	2	
Glioblastoma NOS	IV	27	28 (49.12)
Gliosarcoma	IV	1	
Subtotal		57	100

SEGA: Subependymal giant cell astrocytoma, NOS: Not-otherwise-specified

Table 3. WHO grade of meningiomas

Meningiomas	WHO grade	Number of cases	Total (%)
Meningothelial meningioma	I	23	35 (81.39)
Transitional meningioma	I	9	
Psammomatous meningioma	I	1	
Angiomatous meningioma	I	2	
Atypical meningioma	II	5	7 (16.27)
Clear-cell meningioma	II	2	
Anaplastic meningioma	III	1	1 (2.32)
Total		43	100

Discussion

A retrospective epidemiological review of CNS neoplasms is of great importance for future research because it can demonstrate the changes in the spectrum of CNS lesions of a population, unveil the possible associated risk factors as well as indicating the potential therapy methods of various neoplastic and nonneoplastic lesions.

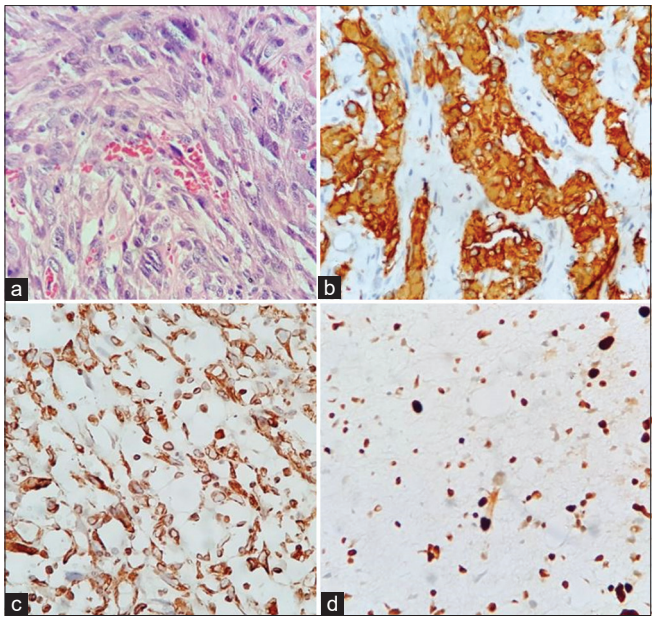

Figure 3: Gliosarcoma (a) H and E section showing spindled shape tumor cells with a high mitotic count. (b) GFAP positive in the astrocytic tumor cells (IHC). (c) Vimentin positivity in mesenchymal component (IHC). (d) Ki-67 proliferation index >20% (IHC) (×40)

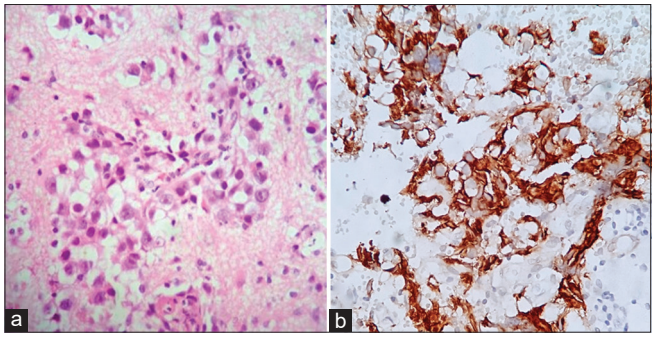

Figure 5: Germinoma (a) H and E section showing large tumor cells with clear cytoplasm and large round nucleus. (b) CD 117 positive in the tumor cells (IHC) (×40)

The present study shows that the 238 cases of CNS lesions share several features common with other published series [Table 5].

In the current study comprising 238 CNS lesions, there were 205 (86.13%) neoplastic and 33 (13.86%) nonneoplastic lesions. Other studies in India conducted by Bajaj *et al*., Bhardwaj *et al*., and Nibhoria *et al*. showed 93.86% versus 6.14%, 92.85% versus 7.14% and 89% versus 11% distribution of lesions of neoplastic versus nonneoplastic pathology, respectively.[4,8,9]

The age range of brain lesion starts from the 1st year of life to 70 years. In studies conducted by Ahsan *et al*., in 2015, Butt *et al*., in 2005 and Ghanghoria *et al*., in 2014 showed an age range of 1–85 years, 1–69 years, and 2–80 years, respectively.[7,10,11] The male-to-female ratio is 1.03:1. A study conducted by Butt *et al*. and Ghanghoria *et al*. showed a ratio of 1.7:1 and 1:0.86, respectively.[10,11]

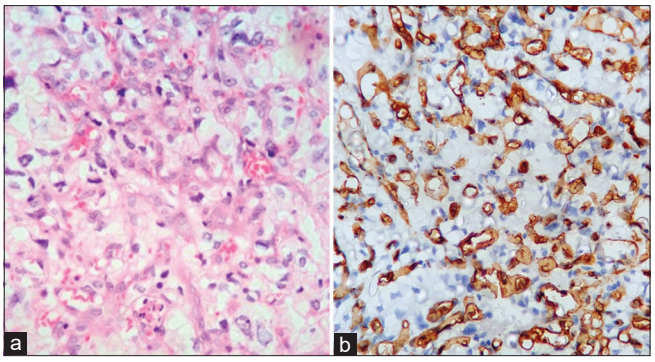

Figure 4: Hemangioblastoma (a) H and E section showing proliferation of variable-sized capillaries along with large neoplastic cells containing pink to clear cytoplasm. (b) CD 34 positive in the endothelial cells of thin-walled blood vessels (IHC) (×40)

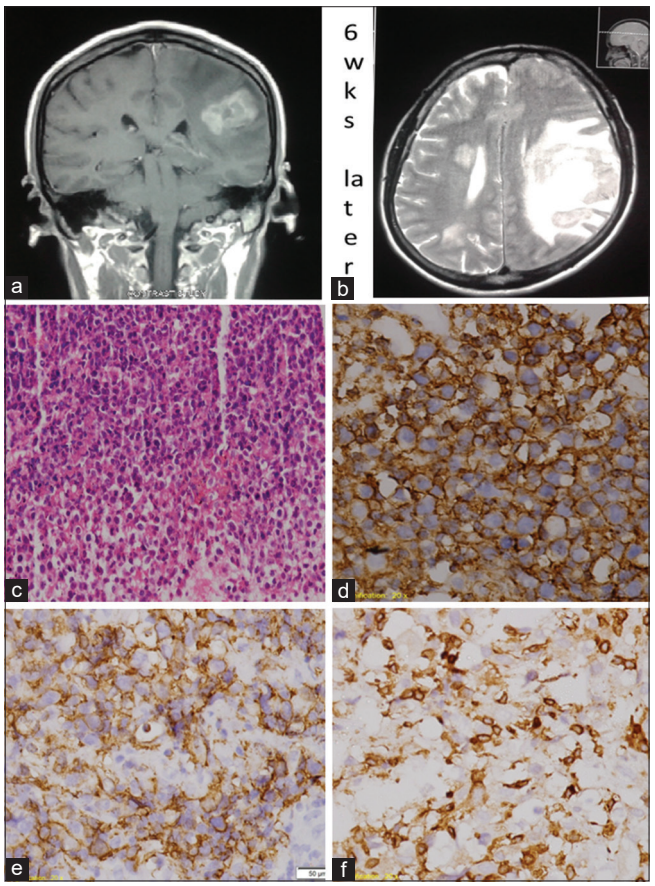

Figure 6: Lymphoma (a and b) magnetic resonance imaging findings pre- and post- steroids. (c) H and E section showing atypical cells mostly in sheets (×20) (d-f) IHC showing CD45+, CD20+ and CD3, respectively (×40)

Despite some differences in ratios, all these studies show a higher affliction of the male gender, which is similar to our study.

Most of the cases in our study presented with multiple symptoms. Headache was the most common presenting symptom in this series, which is supported by the findings of all other studies.[12,13] More than half of the patients suffered from visual deterioration. This can be explained by the late presentation of the patients to the physician. The

common presence of fever can be explained by the fact that gliomas and abscesses constitute a significant proportion of SOLs in this study and could be responsible for the fever.[14] The frontal lobe was the commonest site (21.00%) of the involvement of CNS lesions. This trend was comparable to that reported by Pidakala *et al*., and Jalali and Datta.[15,16]

The tumors have been categorized according to the 2016 WHO classification. In the present study, glial tumors (27.80%) were the most frequent type of intracranial tumors among all the primary CNS tumors, which was in agreement with all other observations.[4,17]

With regard to the age distribution of glial tumors, the mean age of patients with astrocytic tumors was 25.60 years. These findings were comparable to those of Butt *et al*., and Anadure *et al*., who also reported that the majority of the astrocytic tumors were found in the younger age group.[1,10] Glioblastoma NOS forms the largest subtype of astrocytic tumors (57.7%) with a mean age at diagnosis being 42.38 years. This is similar to the study conducted in Pakistan by Ahsan *et al*., but in contrast to international literature, where the mean age at diagnosis is 64 years.[7,18]

In the present study, according to the WHO grading, out of 57 glial tumors, the majority were Grade IV tumors constituting of 28 cases (49.12%), followed by 14 cases

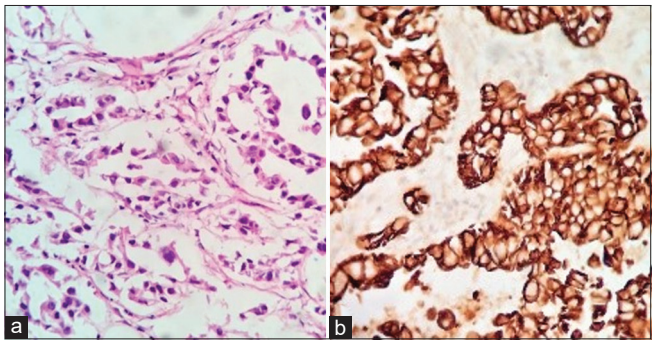

Figure 7: Metastatic adenocarcinoma (a) H and E section showing tumor cells arranged in glandular pattern (×20) (b) CD 7 positive in the tumor cells (IHC) (×40)

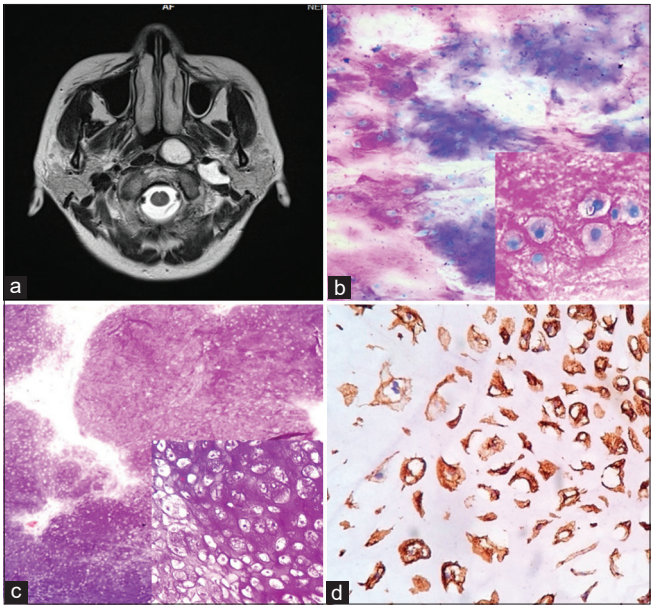

Figure 8: Low-grade chondrosarcoma (a) magnetic resonance imaging brain shows a multilobulated cystic lesion. (b) H and E crush smears showing sheets of tumor cells in a myxoid background (×10) (inset): Round cells with eccentric nucleus and abundant cytoplasm (×40) (c) H and E section showing lobules of cartilage (×10) (inset): Tumor cells present within a lacunae (×40) (d) S-100 positive in the tumor cells (IHC) (×40)

Table 4: Age and sex distribution of nonneoplastic intracranial lesions

Nonneoplastic lesion	Number of cases	Male	Female	Mean age of diagnosis (years)	Percentage
Cysts (dermoid, hydatid, ependymal, arachnoid)	12	8	4	35.5	36.36
Meningocoele/meningomyelocoele/meningoencephalocoele	10	1	9	2.5	30.30
Inflammatory lesions/abscess	5	3	2	-	15.15
AV malformation	2	2	0	34.5	6.06
Tuberculosis	1	0	1	37	3.03
Pituitary apoplexy	1	0	1	19	3.03
Rosai-dorfman disease	1	0	1	18	3.03
False aneurysm	1	1	0	59	3.03
Total	33	15	18		100

AV: Arteriovenous

Table 5: Different types of central nervous system tumors and their prevalence in different studies

Country	Author	Diffuse astrocytic and oligodendroglial tumors (%)	Meningiomas (%)	Tumors of cranial and paraspinal nerves (%)	Tumors of sellar region (%)	Lymphoma and hematopo ietic neoplasms (%)	Metastatic tumors (%)
China	Chen *et al*.[5]	38.0	36.5	13.3	4.1	1.7	5.1
Korea	Lee *et al*.[6]	19.4	31.2	1.8	15.8	1.8	No data
Pakistan	Ahsan *et al*.[7]	56.0	28.3	5.4	2.6	2.4	4.9
India	Presentstudy	27.80	20.97	18.04	4.8	1.95	2.43

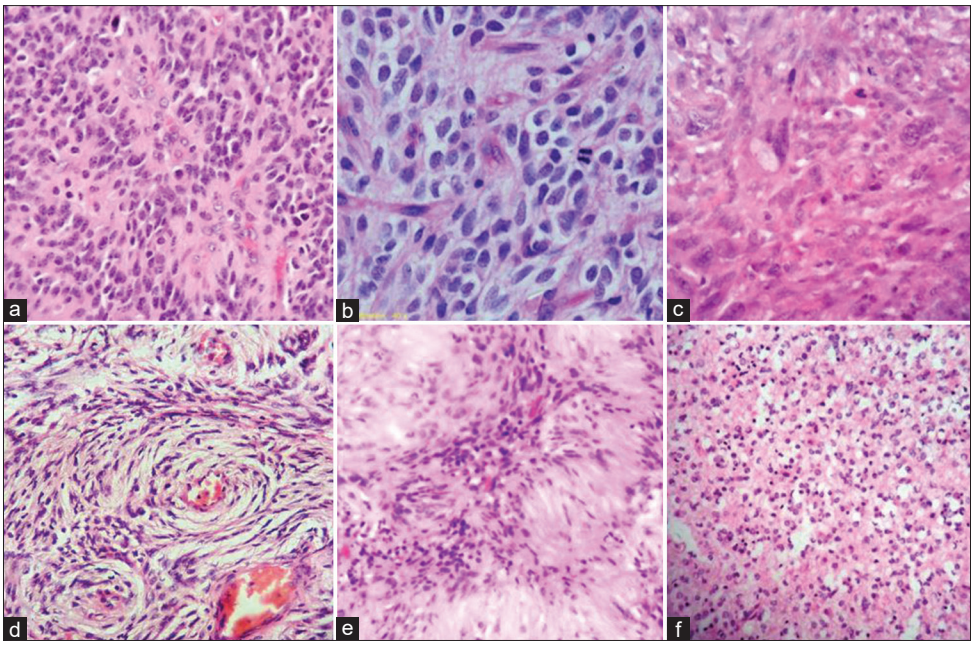

Figure 9: (a) Astroblastoma: Tumor cells with expanded processes in pseudo-rosettes. (b) Oligodendroglioma: Tumor cells with coarse nuclear chromatin and ill-defined cytoplasm. (c) PXA: Spindled-to-globoid-shaped cells with atypical nuclei. (d) Meningioma: Ovoid-shaped tumor cells forming whorls. (e) Schwannoma: Depicts a typical verocay body. (f) Neurocytoma displaying homogeneous cell population with round nuclei and dispersed chromatin (H and E, ×40)

of Grade II tumors accounting for 24.56%, which was in agreement with Kothari and Shah, where the majority were Grade IV with 11 cases (55%) out of 20 gliomas followed by Grade II with 7 cases (35%).[19] Hence, grading of glial tumors is important to predict their aggressiveness and prognosis to decide on the further treatment plan.

The mean age of patients diagnosed with meningiomas was 57.6 years (Europe), 59 years (United States), and 58.1 years (Asia).[19-21] The peak age group for this tumor type in the present series was considerably younger, at 44 years of age. This view is supported by other Indian studies who reported the average age of meningiomas to be 49.23 years (Jat *et al*.,) and 45.5 years (Nibhoria *et al*.,).[4,19] Meningiomas showed female preponderance similar to other studies indicating that the growth of meningiomas is subject to hormonal influence.[22] Grade I meningioma was the most common (81.39%) according to the WHO grade. This was in agreement with Kalyani *et al*., and Anadure *et al*., who also reported Grade I meningiomas as the majority with (75%) and (87.5%), respectively.[1,23]

The incidence of metastasis was (2.43%) in the present study, which was low as compared to other studies where the incidence was from 10% to 12%.[16,24] In comparison, Ahsan *et al*., Chen *et al*., and Nibhoria *et al*. also reported a low incidence of only 4.9%, 5.1%, and 5.6%, respectively, of CNS tumors with secondary deposits.[4,5,7] As expected, metastatic tumors occurred between 51 and 70 years, comparable to most studies in the literature.[4]

Cystic lesions (36.36%) were the most common nonneoplastic lesions encountered in the present series. This was similar to studies conducted by Rathod *et al*., and Butt *et al*., who also observed similar findings.[10,25]

Conclusion

The present study highlights the histological diversity in CNS lesions in both adults and the pediatric age groups. Although with the advent of modern imaging techniques, the provisional diagnosis could be given to these diseases, histological examination with further utilization of IHC remains the gold standard in diagnosis and grading of all CNS lesions. This has further helped in management as well as the prognosis of these diseases.

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Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Anadure HN, Ravindra RS, Karnappa AS. Morphological Patterns of Intracranial lesions in a tertiary care hospital in North Karnataka: A clinicopathological and Immunohistological Study. J Clin Diagn Res 2016;10:1-5.
2. Adnan HA, Kambhoh UA, Majeed S, Imran AA. Frequency of CNS lesion in a Tertiary Care Hospital – A 5-year study. Biomedica 2017;33:04-8.
3. Kanthikar SN, Nikumbh DB, Dravid NV. Histopathological overview of central nervous system tumours in North Maharashtra, India: A single centre study. Indian J Pathol Oncol.2017;4:80-4.
4. Nibhoria S, Tiwana KK, Phutela R, Bajaj A, Chhabra S,

Bansal S. Histopathological spectrum of central nervous system tumours: A single centre study of 100 cases. Int J Sci Study 2015;3:130-4.
5. Chen L, Zou X, Wang Y, Mao Y, Zhou L. Central nervous system tumours: A single centre pathology review of 34,140 cases over 60 years. BMC Clin Pathol 2013;13:14.
6. Lee CH, Jung KW, Yoo H, Park S, Lee SH. Epidemiology of primary brain and central nervous system tumors in Korea. J Korean Neurosurg Soc 2010;48:145-52.
7. Ahsan J, Hashmi SN, Muhammad I, Din HU, Butt AM, Nazir S, *et al*. Spectrum of central nervous system tumours A single center histopathological review of 761 cases over 5 years. J Ayub Med Coll Abbottabad 2015;27:81-4.
8. Bajaj NK, Somalwar. SB, Nagamuthu EA, Kotla SS. Study of intraoperative squash cytology of Intracranial and spinal cord lesions with histopathological and IHC study. J Evid Based Med Healthc 2016;3:2820-25.
9. Bhardwaj K, Kriplani D, Bhake A, Bhardwaj K. Study of intraoperative squash cytology of intracranial and spinal cord tumours. Int J Res Med Sci 2015;3:3101-8.
10. Butt ME, Khan SA, Chaudrh NA, Qureshi GR. Intracranial space-occupying lesions a morphological analysis. Biomedica 2005;21:31-5.
11. Ghanghoria S, Mehar R, Kulkarni C, Mittal M, Yadav A, Patidar H. Retrospective histological analysis of CNS tumours -A 5-year study. Int J Med Sci Public Health 2014;3:1205-7.
12. Benjarge PV, Kulkarni A. Clinical profile of intracranial space-occupying lesions of the brain. IMJ 2014;1:288-92.
13. Mahmoud MZ. Intra cranial space occupying lesions in Saudi patients using computed tomography. Asian J Med Radial Res 2013;1:25-8.
14. Mustafa, Mustafa Seidahmed. Clinical Pattern of Intracranial Space-Occupying Lesions in Adult Sudanese Patients. INIS Also Sudan Atomic Energy Commission, Khartoum (SD); 1999. Available from: http://inis.iaea.org/search/search.aspx?orig_q=RN:31058532. [Last accessed on 25 April 2020].
15. Pidakala P, Inuganti RV, Boregowda C, Mathi A, Lakhineni S. A five-year histopathological review of CNS tumours in a tertiary centre with emphasis on diagnostic aspects of uncommon tumours. J Evid Based Med Healthc 2016;3:2605-12.
16. Jalali R, Datta D. Prospective analysis of incidence of central nervous tumors presenting in a tertiary cancer hospital from India. J Neurooncol 2008;87:111-4.
17. Dogar T, Imran AA, Hasan M, Jaffar R, Bajwa R, Qureshi ID. Space occupying lesions of central nervous system: A radiological & histopathological correlation study. Biomedica 2015;31:15-20.
18. Schwartzbaum JA, Fisher JL, Aldape KD, Wrensch M. Epidemiology and molecular pathology of glioma. Nat Clin Pract Neurol 2006;2:494-503.
19. Kothari F, Shah A. Prospective study of intracranial tumour. SEAJCRR 2014;03:918-32.
20. Jat KC, Vyas SP, Bihari NA, Mehra K. Central nervous system tumours: A histopathological study. Int J Res Med Sci 2016;4:1539-45.
21. Provost D, Cantagrel A, Lebailly P, Jaffré A, Loyant V, Loiseau H, *et al*. Brain tumours and exposure to pesticides: A case-control study in southwestern France. Occup Environ Med 2007;64:509-14.
22. Flowers A. Brain tumors in the older person. Cancer Control 2000;7:523-38.
23. Kalyani D, Rajyalakshmi S, Kumar OS. Clinicopathological study of posterior fossa intracranial lesions. J Med Allied Sci 2014;4:62-8.
24. Madabhushi V, Venkata RI, Garikaparthi S, Kakarala SV, Duttaluru SS. Role of immunohistochemistry in diagnosis of brain tumours: A single institutional experience. J NTR Univ Health Sci 2015;4:103-11.
25. Rathod V, Bhole A, Chauhan M, Ramteke H, Wani B. Study of clinico-radiological and clinico-pathological correlation of intracranial space-occupying lesion at rural centre. Int J Neurosurg 2010;7:1-6.