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HISTOPATHOLOGICAL SPECTRUM AND ANATOMICAL DISTRIBUTION OF CENTRAL NERVOUS SYSTEM TUMOURS AT A TERTIARY CARE CENTRE IN CENTRAL INDIA: AN OBSERVATIONAL STUDY

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ABSTRACT **Background:** Central nervous system (CNS) tumours show demographic and anatomical variation, while histopathology remains central to classification where molecular testing is limited. Objective: To characterize the histopathological spectrum and anatomical distribution of CNS tumours diagnosed at a tertiary care centre in Central India. **Methods:** This hospital-based observational study combined retrospective and prospective components. All eligible CNS tumour biopsies available during the study period were reviewed. Demographic and anatomical data were obtained from clinical, imaging and operative records, and specimens were assessed histologically using the 2021 World Health Organization framework. Diagnosis was compared across anatomical compartments using the Fisher-Freeman-Halton exact test. **Results:** Fifty-four tumours were analysed. The mean age was 45.41 ± 16.99 years, and 34 (63.0%) patients were female. Brain tumours accounted for 42 (77.8%) cases and spinal tumours for 12 (22.2%); 51 (94.4%) were primary. Meningioma was most frequent [19 (35.2%)], followed by diffuse astrocytoma, not otherwise specified [11 (20.4%)], and schwannoma [9 (16.7%)]. Among 48 gradeable tumours, 31 (64.6%) were World Health Organization grade 1. Diagnosis was strongly associated with anatomical compartment ($p<0.001$): meningiomas predominated in the extra-axial brain compartment, all diffuse astrocytomas were intra-axial, and most schwannomas were spinal extramedullary. **Conclusion:** CNS tumours in this biopsy series were predominantly primary and brain-based, with meningioma, diffuse astrocytoma and schwannoma comprising the principal diagnoses. Their distinct compartmental distribution supports the diagnostic value of interpreting anatomical location together with histomorphology.

KEYWORDS : Central nervous system tumours; histopathology; meningioma; astrocytoma; schwannoma; anatomical compartment

INTRODUCTION

Central nervous system (CNS) tumours are a heterogeneous group of neoplasms involving the brain, meninges, spinal cord and associated nerves. Their classification has moved beyond morphology alone: the fifth edition of the World Health Organization (WHO) classification incorporates molecular alterations into the definition of several entities, particularly diffuse gliomas [1,2]. Histomorphology nevertheless remains the starting point for diagnosis and is especially important where molecular testing is not routinely available.

The age, sex, histological type and anatomical distribution of CNS tumours vary between series. Population registries describe broad epidemiological patterns, whereas hospital-based pathology studies document the case mix encountered in diagnostic practice [3-6]. Such institutional data are useful for service planning and comparison between centres, provided that specimen proportions are not interpreted as population incidence.

The present study was undertaken to characterize the histopathological spectrum of CNS tumours in patients treated at a tertiary care centre in Central India, describe their age and sex distribution, compare primary with secondary tumours, and examine the relationship between histological diagnosis and anatomical compartment.

MATERIALS AND METHODS

This hospital-based observational study, with two-year retrospective and one-year prospective components, was conducted in the Department of Pathology, R.D. Gardi Medical College, Ujjain, Madhya Pradesh. All eligible CNS tumour specimens available during the study period were included; 54 cases formed the analytical cohort.

Neurosurgical biopsy specimens submitted with a provisional diagnosis of a primary or secondary, benign or malignant CNS tumour were eligible. These included meningeal lesions and specimens from the spinal cord, vertebral bodies and spinal nerves. Non-neoplastic and inflammatory lesions of the CNS and spinal column were excluded. Age, sex, imaging findings, anatomical site and perioperative details were recorded in a pretested proforma from clinical records and the hospital and laboratory information systems.

For retrospective cases, archived paraffin blocks and slides were retrieved and reassessed by the investigator and a histopathologist. Prospectively received tissue was fixed in 10% formalin, processed routinely, embedded in paraffin and stained with haematoxylin and eosin. Periodic acid-Schiff and reticulin stains, and other ancillary tests, were used when indicated and feasible. Diagnoses and grades were assigned within the 2021 WHO classification framework. Molecular characterization required for an integrated diagnosis was unavailable for adult diffuse gliomas; these were therefore reported as diffuse astrocytoma, not otherwise specified (NOS). Recorded variables included primary or secondary status, histological diagnosis, grade, and brain or spinal anatomical compartment.

Data were coded in Microsoft Excel and analysed using statistical software. Age was summarized as mean ± standard deviation, median with interquartile range, and range; categorical variables were reported as number (percentage). The association between histological diagnosis and anatomical compartment was examined using the Fisher-Freeman-Halton exact test because of sparse cell counts. A p value <0.050 was considered statistically significant. All p values were reported to three decimal places, with values below 0.001 shown as $p<0.001$.

Ethical clearance was obtained from the Institutional Ethics Committee of R.D. Gardi Medical College, Ujjain (No.PG/PATHOLOGY/80/2024). Written informed consent was obtained for the prospective component before inclusion.

RESULTS

A total of 54 central nervous system tumour cases were analysed. The mean age was 45.41 ± 16.99 years, the median age was 50 years (IQR 37.50-55.50), and the age range was 1-78 years. Cases aged >25-50 years were most frequent [27 (50.0%)], followed by those aged >50 years [19 (35.2%)]; the 1 day-14 years and >14-25 years groups each included 4 (7.4%) cases (Figure 1). Females accounted for 34 (63.0%) cases and males for 20 (37.0%) cases.

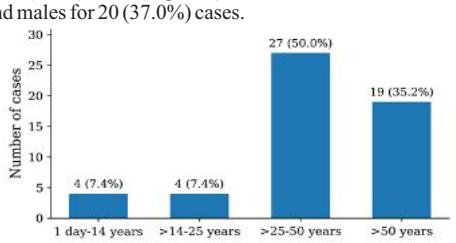

Figure 1. Age-group distribution of the study cases (N=54).

Of the 54 tumours, 51 (94.4%) were primary and 3 (5.6%) were secondary. Meningioma was the most frequent diagnosis [19 (35.2%)], followed by diffuse astrocytoma, NOS [11 (20.4%)], schwannoma [9 (16.7%)] and pilocytic astrocytoma [4 (7.4%)]. Pituitary adenoma and metastatic adenocarcinoma occurred in 3 (5.6%) cases each; five other entities occurred once each (1.9%) (Table 1). Among the 48 gradeable tumours, CNS WHO grade 1 predominated [31 (64.6%)], followed by grade 2 [8 (16.7%)], grade 4 [5 (10.4%)] and grade 3 [4 (8.3%)].

Table 1. Histopathological spectrum of central nervous system tumours (N=54)

Tumour origin	Histological diagnosis	n (%)
Primary	Meningioma	19 (35.2)
	Diffuse astrocytoma, NOS (CNS WHO grades 2-4)	11 (20.4)
	Schwannoma	9 (16.7)
	Pilocytic astrocytoma	4 (7.4)
	Pituitary adenoma	3 (5.6)
	Embryonal tumour with multilayered rosettes (ETMR)	1 (1.9)
	Adamantinomatous craniopharyngioma	1 (1.9)
	Haemangioblastoma	1 (1.9)
	Solitary fibrous tumour (SFT)	1 (1.9)
	Neurofibroma	1 (1.9)
Secondary	Metastatic adenocarcinoma	3 (5.6)
Total	**54 (100.0)**	

Data are presented as number (percentage); percentages use N=54 as the denominator. NOS, not otherwise specified; SFT, solitary fibrous tumour; ETMR, embryonal tumour with multilayered rosettes. Adult-type diffuse gliomas were reported as diffuse astrocytoma, NOS (CNS WHO grades 2-4), because immunohistochemical and molecular subtyping was unavailable.

Brain tumours accounted for 42 (77.8%) cases and spinal cord tumours for 12 (22.2%). The anatomical compartments comprised 25 (46.3%) extra-axial, 17 (31.5%) intra-axial, 10 (18.5%) extramedullary and 2 (3.7%) intramedullary tumours. Histological diagnosis differed significantly across these compartments ($p<0.001$). Meningioma comprised 18 (72.0%) extra-axial tumours; diffuse astrocytoma, NOS and pilocytic astrocytoma comprised 11 (64.7%) and 4 (23.5%) intra-axial tumours, respectively; and schwannoma comprised 7 (70.0%) extramedullary tumours. Both intramedullary tumours were metastatic adenocarcinomas (Table 2).

Table 2. Histological diagnosis by anatomical compartment (N=54)

Histological diagnosis	Extra-axial (n=25)	Intra-axial (n=17)	Extra-medullary (n=10)	Intra-medullary (n=2)	p value
Meningioma	18 (72.0)	0 (0.0)	1 (10.0)	0 (0.0)	<0.001
Diffuse astrocytoma, NOS (CNS WHO grades 2-4)	0 (0.0)	11 (64.7)	0 (0.0)	0 (0.0)	
Schwannoma	2 (8.0)	0 (0.0)	7 (70.0)	0 (0.0)	
Pilocytic astrocytoma	0 (0.0)	4 (23.5)	0 (0.0)	0 (0.0)	
Pituitary adenoma	3 (12.0)	0 (0.0)	0 (0.0)	0 (0.0)	
ETMR	1 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Adamantinomatous craniopharyngioma	1 (4.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Haemangioblastoma	0 (0.0)	1 (5.9)	0 (0.0)	0 (0.0)	
SFT	0 (0.0)	0 (0.0)	1 (10.0)	0 (0.0)	
Neurofibroma	0 (0.0)	0 (0.0)	1 (10.0)	0 (0.0)	
Metastatic adenocarcinoma	0 (0.0)	1 (5.9)	0 (0.0)	2 (100.0)	

Data are presented as number (column percentage). The p value represents the overall association between histological diagnosis and anatomical compartment and was calculated using the Fisher-Freeman-Halton exact test. p values were rounded to three decimal places; values below 0.001 are shown as <0.001. NOS, not otherwise specified; SFT, solitary fibrous tumour; ETMR, embryonal tumour with multilayered rosettes.

DISCUSSION

This hospital-based series describes the histological and anatomical spectrum of 54 CNS tumours. Most patients were older than 25 years, women predominated, and nearly all lesions were primary. Meningioma was the leading diagnosis, followed by diffuse astrocytoma, NOS, and schwannoma. The most distinct analytical finding was the close association between histological diagnosis and anatomical compartment.

The mean age was 45.41 ± 16.99 years, and 85.2% of patients were older than 25 years. Thambi et al. reported that most brain tumours in their South Indian series occurred between 40 and 60 years, while Bhattacharya et al. found the sixth decade to be the most frequently affected [4,6]. The present age profile is therefore broadly comparable with other Indian surgical pathology series. The small number of paediatric cases, however, precludes a detailed assessment of childhood tumour patterns.

Women constituted 63.0% of the study population, corresponding to a male-to-female ratio of 0.59:1. Maurya et al. also reported a female excess, with a ratio of 0.7:1 [5]. The high proportion of meningiomas in the present material may have contributed to this distribution, since meningioma has a well-recognized female predominance [7]. Sex distributions nevertheless vary between hospital series because referral patterns and the relative frequencies of individual tumour types differ.

Primary tumours comprised 51 of 54 cases, whereas only three were metastatic adenocarcinomas. Maurya et al. similarly found that 98.26% of tumours were primary [5]. This proportion reflects neurosurgical biopsy and resection material received by the pathology department; it should not be taken as the relative occurrence of primary and metastatic CNS disease in the community. Meningioma was the most frequent diagnosis (35.2%), followed by diffuse astrocytoma, NOS (20.4%) and schwannoma (16.7%). Meningeal tumours were also the largest category in the series of Bhattacharya et al. [4], whereas Maurya et al. and Ahsan et al. reported neuroepithelial tumours as the leading group [5,8]. Differences in anatomical coverage, inclusion criteria and access to neurosurgical care probably account for part of this inter-centre variation.

Among the 48 gradeable tumours, CNS WHO grade 1 lesions predominated (64.6%); grades 2, 3 and 4 accounted for 16.7%, 8.3% and 10.4%, respectively. Naik et al. likewise found grade 1 to be the largest group, representing 54.8% of graded lesions [9]. In the present series, this pattern is consistent with the large contribution of meningioma and schwannoma. Prognostic conclusions cannot be drawn, because treatment response and survival were not evaluated.

Histological diagnosis was strongly associated with anatomical compartment ($p<0.001$). Eighteen of 19 meningiomas were extra-axial, all diffuse and pilocytic astrocytomas were intra-axial, and seven of nine schwannomas were spinal extramedullary. These distributions follow the tissue of origin of meningeal, glial and nerve-sheath tumours recognized in the WHO classification [1]. Anatomical location can therefore narrow the diagnostic differential, but final classification still requires histological evaluation and appropriate ancillary testing.

The 2021 WHO framework relies on integrated histological and molecular diagnosis for several glial neoplasms [1,2]. Testing for IDH alterations, 1p/19q codeletion and other defining abnormalities was not available in this study; diffuse astrocytic tumours were consequently reported with an NOS designation. This wording makes the diagnostic limitation explicit, but restricts molecular subclassification, prognostic stratification and direct comparison with fully integrated contemporary series.

LIMITATIONS

This was a single-centre study of 54 histologically confirmed neurosurgical specimens. Referral and surgical-selection bias are therefore likely, and the observed proportions should not be interpreted as population incidence. The retrospective component depended on the completeness of existing clinical and laboratory records, while sparse numbers limited subgroup precision. Most importantly, the absence of advanced immunohistochemical and molecular testing prevented fully integrated classification of diffuse gliomas under the 2021 WHO framework.

CONCLUSION

Meningioma, diffuse astrocytoma, NOS, and schwannoma formed the

principal histological spectrum in this series, with primary and grade 1 tumours predominating. The strong correspondence between histological type and anatomical compartment supports the combined interpretation of location and morphology. Wider access to molecular testing is required for complete contemporary classification of diffuse gliomas.

DECLARATIONS

- **Ethical approval:** Institutional Ethics Committee approval was obtai-ned before initiation of the study(No.PG/PATHOLOGY/80/2024).
- **Conflict of interest:** Nil.
- **Source of funding:** Nil.

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