Original Article

Experience of Pediatric Brain Tumor Surgery at the Punjab Institute of Neurosciences, Lahore, Pakistan: A Retrospective Analysis of Outcomes and Challenges

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ABSTRACT

Background: Brain tumours are the most prevalent solid cancers in children and are a significant cause of cancer morbidity. However, there is limited information on surgical outcomes in Pakistan, particularly in newly established paediatric neurosurgery units. This study aimed to determine the incidence, clinical features, imaging findings, surgical treatment and prognosis of supratentorial and infratentorial brain tumours in children.

Methodology: This was a descriptive retrospective study conducted at the Punjab Institute of Neurosciences from June 2023 to June 2024, including 92 pediatric patients who underwent surgical resection of brain tumours. The clinical presentation, imaging characteristics, surgical interventions, histopathology and outcomes were recorded and evaluated.

Results: Among 92 patients, 63% (n = 58) had supratentorial tumors and 37% (n = 34) had infratentorial tumors. Mean ages were 11.34 ± 4.77 years and 10.94 ± 3.78 years, respectively. Out of 92, 46 (50%) were male, and 46 (50%) were female. Headache was the most common presenting symptom in both groups (n = 46 supratentorial (76.3%) and n = 31 infratentorial (91.3%). Supratentorial tumors were most frequently located in the middle cranial fossa (53.4%, n = 31), with gliomas being the predominant histology. Gross-total resection was achieved in 69% (n = 40) of supratentorial cases and 88.3% (n = 30) of infratentorial cases. Ventriculoperitoneal (VP) shunt placement was more commonly required in infratentorial tumors (42.1%, n = 14) compared to supratentorial tumors (6.9%, n = 4). Pilocytic astrocytoma was the most common histology in the infratentorial group. Postoperative Glasgow Coma Scale (GCS) and Lansky Play-Performance Scale (LPPS) scores were comparable between the two groups.

Conclusion: Supratentorial tumors were more common, while infratentorial tumors had higher resection rates and had high VP shunt requirements.

Keywords: Pediatrics; CNS neoplasms; Supratentorial; Infratentorial; surgery; Histopathology; Specialist neurosurgical department; Outcome

INTRODUCTION

Pediatric brain tumours are the second most common malignancy in children, accounting for over 25% of all childhood cancers, and represent the leading cause of cancer-related mortality in individuals under 20 years of age. Unlike adult brain tumours, they are biologically distinct and differ in their distribution, behaviour, histopathological characteristics, and clinical presentation.[1-3] Most tumours are in the posterior cranial fossa.[2,3] Early detection and advancements in treatment have improved survival rates for pediatric patients.[5] The occurrence, gender distribution, site and type of brain tumours vary widely across the world.[4,5] These differences are important for treatment choice, prognosis, and risk assessment. These parameters are important to understand for effective healthcare planning and future research.[6,7] The diagnosis of these tumours is usually made based on morphology, but in poorly differentiated tumours or when tissue is limited, immunohistochemistry and radiological assessment are useful. The rationale of the present study is to fill the gap in regional and institutional information on pediatric brain tumours, which is crucial for the best possible treatment of patients and for future research. The objective of this study is to identify patterns specific to this population and institute by analysing the demographics, tumour characteristics and surgical manage-

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ment of patients treated at the Punjab Institute of Neurosciences, Lahore, Pakistan. This information will help to understand better the regional differences in paediatric brain tumours and their impact on treatment outcomes. The results of the study will help design individual treatment pathways, improve resource allocation, and inform targeted public health strategies, as well as improve the prognosis and quality of life of affected children.

PATIENTS AND METHODS

This retrospective observational study was conducted at the Department of Pediatric Neurosurgery, Punjab Institute of Neurosciences, Lahore, Pakistan. Using non-probability convenience sampling, data were collected for all pediatric patients who underwent brain tumour surgery between June 2023 and June 2024. Patient confidentiality was maintained by anonymising all data during analysis and reporting. Institutional Review Board (IRB) approval was obtained before initiating the study (IRB Ref # 1876/IRB/PINS/Approval/2024, Dated 21/08/2024). Patients of both genders, aged < 15 years and admitted to the hospital and operated on due to any primary brain tumor were included and categorized into supratentorial and infratentorial.

Patients with incomplete medical records, non-primary brain tumors, who received treatment elsewhere, previous history of brain tumor treatment, who did not undergo surgical intervention (non-operated cases), and patients who received radiosurgery (e.g., gamma knife, cyberknife) as primary treatment were excluded.

Data for demographic, clinical, tumoral, operative, and follow-up characteristics were collected from patients' medical records and picture archiving and communication system (PACS) into a predesigned Google Form, which was used only for data collection. All the data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 27.0. The numerical variables were presented as mean and standard deviation. The categorical variables were presented as frequencies and percentages.

RESULTS

In this study, data from 92 patients was collected, with 63% (n = 58) having supratentorial and 37% (n = 34) infratentorial lesions. The mean age in supratentorial lesions was 11.34 ± 4.77 and 10.94 ± 3.78 in infratentorial lesions (Table 1).

On imaging, among supratentorial lesions, middle cranial fossa lesions were the most common lesion, accounting for 53.4% (n = 31), and 39.7% (n = 23) of lesions were on the right side. In the infratentorial lesion group, the posterior cranial fossa was the most common location, observed in 91.2% (n = 31) of cases, and 82.4% (n = 28) of lesions were in the midline (Table 2).

Craniotomy and excision of the space-occupying lesion (SOL) were done in 75.9% (n = 44) of supratentorial and 79.6% (n = 24) of infratentorial patients. Gross-total resection was achieved in 69% (n = 40) of patients with supratentorial lesions and 88.2% (n = 30) with infratentorial lesions. The most common histopathology in supratentorial lesions was glioma, 29.3% (n = 17), and pilocytic astrocytoma, 58.8% (n = 20), with infratentorial lesions (Table 3).

Postoperative Lansky Play-Performance Scale (LPPS) scores were slightly better than preoperative LPPS scores in both groups (Table 4).

DISCUSSION

Pediatric central nervous system (CNS) tumors represent 20% of solid tumors appearing in this age group, making them a leading cause of morbidity, mortality, and pediatric tumor burden.[1,2,8] Although advancements in diagnostic modalities have improved understanding regarding pathophysiology, it still varies across different regions in terms of their incidence, age of presentation, gender differentiation, and histopathology, which reflects a great impact on management and outcome.[3] A previous study stated that the epidemiology and outcome of pediatric brain tumors (PBT) are different from their adult counterparts, thus making age a crucial factor in deciding prognosis.[9]

Table 1: Demographic and clinical presentation of pediatric patients with intracranial SOLs

Variables	Supratentorial	Infratentorial
Patient distribution, % (n)	63 (58)	37 (34)
Mean age, years ± SD	11.34 ± 4.77	10.94 ± 3.78
Gender distribution, M/F, % (n)	51.7 (30), 48.3 (28)	47 (16), 53 (18)
Clinical presentation, % (n)		
Headache	79.3 (46)	91.2 (31)
Vomiting	32.8 (19)	79.4 (27)
Swelling	8.6 (5)	2.9 (1)
Motor deficit	3.4 (2)	2.9 (1)
Loss of consciousness	3.4 (2)	14.7 (5)

Table 2: Radiological presentation of pediatric patients with intracranial SOLs

Variables	Supratentorial	Infratentorial
CT findings, % (n)		
Hypodense	67.2 (39)	79.4 (27)
Isodense	5.2 (3)	11.8 (4)
Hyperdense	27.6 (16)	5.9 (2)
MRI T1 findings, % (n)		
Hypointense	72.4 (42)	82.4 (28)
Isointense	3.4 (2)	2.9 (1)
Hyperintense	22.4 (13)	11.8 (4)
Mixed intensity	1.7 (1)	2.9 (1)
MRI T2 findings, % (n)		
Hypointense	22.4 (13)	32.4 (11)
Hyperintense	74.1 (43)	67.6 (23)
Mixed	3.4 (2)	0 (0)
MRI contrast findings, % (n)		
Non enhancing	12.1 (7)	2.9 (1)
Homogenous	44.8 (26)	61.8 (21)
Heterogenous	43.1 (25)	35.3 (12)
Site of SOL, % (n)		
Anterior cranial fossa	19 (11)	0 (0)
Posterior cranial fossa	10.3 (6)	91.2 (31)
Middle cranial fossa	53.4 (31)	5.9 (2)
Mixed	13.8 (8)	2.9 (1)
Ventricular	3.4 (2)	0 (0)
Side of SOL, % (n)		
Right	39.7 (23)	17.6 (6)
Midline	29.3 (17)	82.4 (28)
Left	29.3 (17)	0 (0)
Bilateral	1.7 (1)	0 (0)

Gender is also found to be an important element, with females being considered a well-established predictor of cognitive outcome, while males are more prone to suffer malignant tumors.[10,11] However, comprehensive data on the demographic characteristics and spectrum of tumor types most frequently encountered among pediatric patients presenting to public-sector hospitals in Pakistan, particularly those from lower- and middle-income socioeconomic backgrounds, remain scarce.[13,14,15] This study was conducted from June 2023 to June 2024 to determine the clinicopathological spectrum of pediatric patients with brain tumors and their postoperative sequelae. In this study, patients were categorized into two groups based on the site of the tumor, which revealed that 63% (n = 58) of kids suffered from supratentorial tumors and 37% (n = 34) from infratentorial tumors. These findings are consistent with previous reports, in which infratentorial PBTs were more common.[9,12,13] However, one earlier study revealed more supratentorial tumors in younger kids (<3 years) than infratentorial ones; the mean age of patients in our former group was 11.34, while in the latter it was 10.94 years.[1] In the present study, supratentorial tumors were found to be more prevalent among male patients, 51.73% (n = 30), while female predominance was 53% (n = 18) in patients with infratentorial tumors. A somewhat similar trend of male predominance was also observed in available literature at the national level. Still, no data regarding increased incidence of female-to-male in infratentorial cases, as seen in our study, were found in any recent literature.[3,14] However, literature has shown supratentorial location, increased age at time of diagnosis (>10 years), and female gender as indicators of good prognosis, as also depicted by our study.[9,10,15] Clinical presentations of brain tumors vary with their location. Supratentorial tumors usually present with seizures and neurological deficit, while signs of raised intracranial pressure (ICP) are seen as the main presenting feature in infratentorial tumors.[1] Current study showed headache as most common presenting symptom, seen in 91.2% (n = 31) patients with infratentorial tumors and 79.3% (n = 46) of supratentorial cases, while signs of raised ICP like vomiting 79.4% (n = 27) and loss of consciousness 14.7% (n = 5), were seen to be more prevalent among patients with infratentorial space-occupying lesions (SOLs), as also identified in previous studies.[1,12] Obliteration of cerebrospinal fluid (CSF) flow due to compression of ventricles in posterior fossa tumors makes patients present at an earlier stage, showing a chance of goodprognosis, but can prove fatal if not intervened on time.[15] Advancements in neuroradiology have been helpful not only in making diagnoses by providing information about tumour-specific radiological features and their locations but also in giving a clue about their prognostic index by showing their infiltrative nature and possibility of extent of resection.[1,7,9]

Table 3: Surgical details and postoperative findings in pediatric patients with intracranial SOLs

Variables	Supratentorial	Infratentorial
Excisional surgery, % (n)		
Craniectomy and excision of SOL	1.7 (1)	29.4 (10)
Craniotomy and excision of SOL	75.9 (44)	79.6 (24)
Incision and drainage	1.7 (1)	0 (0)
Biopsy	5.2 (3)	0 (0)
CSF diversion	6.9 (4)	0 (0)
Ommaya reservoir	5.2 (3)	0 (0)
Endonasal	3.4 (2)	0 (0)
Diagnostic/Biopsy surgery, % (n)	5.2 (3)	0 (0)
Non-excision/CSF diversion surgery, % (n)		
VP shunt	6.9 (4)	41.2 (14)
EVD (External Ventricular Drain)	0 (0)	0 (0)
ETV (Endoscopic Third Ventriculostomy)	0 (0)	0 (0)
Extent of resection, % (n)		
GTR (Gross Total Resection)	69 (40)	88.2 (30)
NTR (Near Total Resection)	1.7 (1)	5.9 (2)
Biopsy	8.6 (5)	0 (0)
STR (Subtotal Resection)	19 (11)	5.9 (2)
I&D (Incision and Drainage)	1.7 (1)	0 (0)
Intraoperative CSF leak, % (n)	0 (0)	0 (0)
Postoperative neurology, % (n)		
Power less than 5 in any limb	15.5 (9)	2.9 (1)
Power 5/5 in all limbs	84.5 (49)	97.1 (33)
Postoperative complications, % (n)		
New neurologic deficit	0 (0)	0 (0)
Surgical site infection	0 (0)	0 (0)
CSF leak	0 (0)	2.9 (1)
Hydrocephalus	1.7 (1)	0 (0)
Others	0 (0)	0 (0)
Postoperative LPPS, mean ± SD	89.31 ± 20.59	92.35 ± 17.76
Histopathology, % (n)		
Pilocytic astrocytoma	3.4 (2)	58.8 (20)
Medulloblastoma	3.4 (2)	23.5 (8)
Craniopharyngioma	17.2 (10)	0 (0)
Meningioma	10.3 (6)	0 (0)
Glioma	29.3 (17)	2.9 (1)
Schwannoma	1.7 (1)	8.8 (3)
Germinoma	6.9 (4)	0 (0)
Granulomatous tissue	8.6 (5)	0 (0)
Fibrous dysplasia	3.4 (2)	0 (0)
Osteoid osteoma	1.7 (1)	0 (0)
Choroid plexus papilloma	1.7 (1)	2.9 (1)
Medulloepithelioma	1.7 (1)	0 (0)
Arachnoid cyst	8.6 (5)	0 (0)
Giant cell astrocytoma	1.7 (1)	0 (0)
Ependymoma	0 (0)	2.9 (1)

Table 4: Preoperative and postoperative GCS and LPPS scores in pediatric patients with intracranial SOLs.

Variables	Supratentorial	Infratentorial
Preoperative GCS, % (n)		
3–8	0 (0)	0 (0)
9–12	3.4 (2)	0 (0)
13–15	96.6 (56)	100 (34)
Preoperative LPPS, mean ± SD	87.58 ± 19.40	88.52 ± 18.44
Postoperative GCS, % (n)		
3–8	0 (0)	0 (0)
9–12	0 (0)	8.8 (3)
13–15	100 (58)	91.2 (31)
Postoperative LPPS, mean ± SD	89.31 ± 20.59	92.35 ± 17.76

As described by previous researchers, deep-seated location or infiltrative appearance of tumors makes them difficult to treat surgically, thus showing a bad prognosis.[4,6] In this study, radiology revealed the majority, 91.2% (n = 31), of tumors located in the posterior cranial fossa, akin to demographics documented in earlier studies.[8,16] Among supratentorial SOLs, the most prevalent site was found to be the middle cranial fossa, 53.4% (n = 31), with the anterior cranial fossa as the second most common site observed in 19% (n = 11), while 13.8% (n = 8) of patients were found to be suffering from tumors involving more than one cranial fossa. Supratentorial tumors were located on the right side in the majority, 39.7% (n = 23), while the most prevalent side of infratentorial tumors was midline, 82.4% (n = 28). Published literature describing the detailed anatomical distribution of supratentorial tumors according to cranial fossa and hemispheric laterality, as well as the laterality of infratentorial tumors in pediatric patients, is limited. Most available studies report only supratentorial versus infratentorial distribution or broader anatomical regions, making direct comparison with the present findings difficult.[20-22] Previous studies reported a predominantly infratentorial distribution of pediatric intracranial tumors, with 56% of tumors located infratentorially and 44% supratentorially.[20] Detailed frequencies of cerebellar, brainstem, and fourth ventricular tumors, along with histopathological correlations, have also been described. However, most studies did not evaluate tumor distribution by specific cranial compartments or laterality. One study reported hemispheric supratentorial tumors in 57% of cases and infratentorial midline tumors in 68%, representing one of the few available analyses based on anatomical tumor location.[22]

Surgical excision is considered the mainstay of management in pediatric brain SOLs, with higher survival rates observed in those who had gross total resection, but this is not always achievable, thus adversely affecting morbidity rate and overall life expectancy.[5,6] But, in the current study, surgical excision was performed in 75.9% (n = 44) of supratentorial tumors and 79.6% (n = 24) of infratentorial tumors, among which 69% (n = 40) and 88.2% (n = 30) of patients from the aforementioned groups, respectively, had gross total resection of their disease. In patients where gross-total resection (GTR) was not possible, near-total resection (NTR) (mainly performed in infratentorial i.e., 5.9 %) was done, and 19% (n = 11) of supratentorial SOLs had subtotal resection (STR), whereas 8.6 % (n = 5) supratentorial SOLs had biopsy only. Surgeon's notes and postoperative radiology determined extent of resection. Results are found comparable to data shown by Stanic et al., revealing GTR in 62 (40.5%) and NTR in 91 patients (59.5%), biopsy in 10 (6.6%), tumor reduction in 34 (22.2%), and subtotal resection in 47 (30.7%) patients.[9] Discrepancies in the above-mentioned figures can be attributed to the different preoperative statuses of patients and the extent of disease, as well as the criteria for determining the extent of resection; therefore, an authentic comparison was not possible. Postoperative complications are mostly seen in patients with high-grade infiltrative tumors and midline deep-seated tumors, except for craniopharyngioma, which, despite its benign nature, is associated with complications like endocrinopathies because of its critical location.[17] Grade 4 medulloblastoma, glioblastoma, and grade 2 and 3 ependymoma, because of their proximity to ventricular structures, infiltrative nature, and inability to resect completely, are most commonly seen to be associated with postoperative morbidity like postural instability, coordination problems, cerebellar mutism, neurocognitive disabilities, and CSF leak requiring diversion procedures, and the need for adjuvant therapies like radiotherapy further increases their complication rate.[15,18,19] Postoperative complications observed in our study include motor deficit, i.e., weakness in one or more limbs, found in 15.5% (n = 9) of supratentorial tumors and 2.9% (n = 1) of infratentorial tumors. Although the literature states CSF leak and hydrocephalus are the most common causes of redo surgery in terms of CSF diversion, in our study CSF leak was seen in 2.9% (n = 1) of infratentorial tumors, and only 1.7% (n = 1) of supratentorial tumor cases were seen to suffer from hydrocephalus.[12]

Pediatric primary brain tumors are a heterogeneous group of malignant and non-malignant tumors whose exact etiology is yet to be confirmed. Still, incidence in different geographical areas is affected by environmental factors, genetics, and radiological or infectious exposure during childhood.[1] Most of the literature from developed countries has documented medulloblastoma as the most common PBT or malignant brain pathology.[1,5] On histopathology, our study revealed infratentorial pilocytic astrocytoma is the most prevalent pediatric brain SOL, found in 58.8% (n = 20), with supratentorial gliomas being second at 29.3% (n = 17). In comparison, infratentorial medulloblastoma was found in 23.5% (n = 8) cases, making it the third most common type, contrary to the above-mentioned dynamics. Though previous research demonstrated pilocytic astrocytoma as the most frequent pediatric brain SOL, this difference in incidence among developing countries can be attributed to delay in presentation to tertiary care facilities and diagnosis.[8]

This was a retrospective study with a sample from a single centre. It studied general pediatric brain tumours while considering some histopathological outcomes. We acknowledge that, as the study was based on a retrospective review of medical records, the findings may be sub-

ject to information bias and limitations arising from incomplete or inconsistently documented clinical data. Furthermore, these patients were not followed for long, especially those receiving adjuvant therapy.

CONCLUSION

This study aims to focus on the clinical spectrum and surgical outcomes of pediatric brain tumours in a newly established pediatric neurosurgical unit in Pakistan. The incidence of supratentorial tumours was higher, and infratentorial tumours had higher rates of gross-total resection and CSF diversion. The most common symptom in both groups was headache. Functional outcome (as assessed by GCS and LPPS) was similar despite differences in tumour location and histopathology. The results highlight the significance of early diagnosis and the possibility of good surgical outcomes in resource-poor environments. To minimise bias, we recommend a prospective study involving a large number of patients from several centres, with long-term follow-up for histopathological outcomes.

Author Contributions

HZ: Conceptualization, Methodology, Writing – Review & Editing, Writing – Discussion, Validation, Supervision, Project Administration.
AK and AI: Investigation, Data Curation, Formal Analysis, Writing – Review & Editing.
MT: Investigation, Data Curation, Writing – Original Draft.
ZURN: Data Curation, Formal Analysis, Writing – Original Draft.
HMQ: Conceptualization, Methodology, Supervision, Writing – Review & Editing.

Artificial Intelligence (AI) Use Disclosure

ChatGPT (OpenAI) was used during the preparation of this manuscript for language editing only. The AI tool was not used to generate or manipulate original research data, perform statistical analysis, or independently develop scientific conclusions or interpretations. All AI-assisted text and suggestions were critically reviewed, edited, and approved by the authors. The authors remain fully responsible for the accuracy, originality, integrity, scientific content, data interpretation, and conclusions of the manuscript.

REFERENCES

1. Subramanian S, Ahmad T. Childhood brain tumors. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Aug 8.
2. Thorbinson C, Kilday JP. Childhood malignant brain tumors: balancing the bench and bedside. Cancers (Basel). 2021;13(23):6099. doi:10.3390/cancers13236099.
3. Hossain MJ, Xiao W, Tayeb M, Khan S. Epidemiology and prognostic factors of pediatric brain tumor survival in the US: evidence from four decades of population data. Cancer Epidemiol. 2021;72:101942. doi:10.1016/j.canep.2021.101942.
4. Cohen AR. Brain tumors in children. N Engl J Med. 2022;386(20):1922-31. doi:10.1056/NEJMra2116344.
5. Miller KD, Ostrom QT, Kruchko C, Patil N, Waite K, Cioffi G, et al. Brain and other central nervous system tumor statistics, 2021. CA Cancer J Clin. 2021;71(5):381-406. doi:10.3322/caac.21693.
6. Pollack IF, Agnihotri S, Broniscer A. Childhood brain tumors: current management, biological insights, and future directions. J Neurosurg Pediatr. 2019;23(3):261-73. doi:10.3171/2018.10.PEDS18377.
7. Collins KL, Pollack IF. Pediatric low-grade gliomas. Cancers (Basel). 2020;12(5):1152. doi:10.3390/cancers12051152.
8. Del Río RJ, Cicutti SE, Moreira DC, Ramos JDG. New CNS tumor classification: the importance in pediatric neurosurgical practice. Surg Neurol Int. 2024;15:130. doi:10.25259/SNI_681_2023.
9. Stanić D, Grujičić D, Pekmezović T, Bokun J, Popović-Vuković M, Janić D, et al. Clinical profile, treatment and outcome of pediatric brain tumors in Serbia in a 10-year period: a national referral institution experience. PLoS One. 2021;16(10):e0259095. doi:10.1371/ journal.pone.0259095.
10. Torres VA, Ashford JM, Wright E, Xu J, Zhang H, Merchant TE, et al. The impact of socioeconomic status (SES) on cognitive outcomes following radiotherapy for pediatric brain tumors: a prospective, longitudinal trial. Neuro Oncol. 2021;23(7):1173-82. doi:10.1093/neuonc/noab018.
11. Price M, Ryan K, Shoaf ML, Neff C, Iorgulescu JB, Landi DB, et al. Childhood, adolescent, and adult primary brain and central nervous system tumor statistics for practicing healthcare providers in neuro-oncology, CBTRUS 2015-2019. Neurooncol Pract. 2024;11(1):5-25. doi:10.1093/nop/npad061.
12. Mishra N, Rath GP, Rajagopalan V, Doddamani R, Chaturvedi A. Perioperative management of pediatric brain tumors: a retrospective analysis. Neurol India. 2022;70(3):1095-101. doi:10.4103/ 0028-3886.349578.
13. Nasir S, Jamila B, Khaleeq S. A retrospective study of primary brain tumors in children under 14 years of age at PIMS, Islamabad. Asian Pac J Cancer Prev. 2010;11(5):1225-7. PMID:21198267.
14. Butt NI, Kashif F, Iqbal F, Rehman SU, Hamid K. Incidence of brain tumours in children and adults in Pakistan. Med Forum Mon. 2020;31(9):111-4.
15. Kakar J, Ashraf J, Khan AA, Imran M, Rehmani MA, Ghori SA, et al. The satisfactory surgical outcome of posterior fossa brain tumors in children at Civil Hospital, Karachi. Asian J Neurosurg. 2020;15(2):377-81. doi:10.4103/ajns.AJNS_56_19.
16. Alves CAPF, Löbel U, Martin-Saavedra JS, et al. A diagnostic algorithm for posterior fossa tumors in children: a validation study. AJNR Am J Neuroradiol. 2021;42(5):961-8. doi:10.3174/ajnr.A7057.
17. Zahid N, Enam SA, Mårtensson T, et al. Predictors of neurocognition outcomes in children and young people with primary brain tumor presenting to tertiary care hospitals of Karachi, Pakistan: a prospective cohort study. Childs Nerv Syst. 2024;40(6):1707-19. doi:10.1007/s00381-024-06306-x.
18. Kumar A, Bhaisora KS, Rangari K, et al. An analysis of temporal trend of incidence of post-resection cerebrospinal fluid diversion in pediatric posterior fossa tumor patients and the predictive factors. Neurol India. 2023;71(1):79-85. doi:10.4103/0028-3886.370456.
19. Usama M, Abdelaziem F, Rashed WM, Maher E, El Beltagy M, Zekri W. Impact of physical activity on postural stability and coordination in children with posterior fossa tumor: randomised controlled phase III trial. J Cancer Res Clin Oncol. 2023;149(9):5637-44. doi:10.1007/s00432-022-04490-4.
20. Hanif G, Shafqat S. Morphological pattern and frequency of intracranial tumours in children. J Coll Physicians Surg Pak. 2004;14(3): 150-2.
21. Ali M, Ullah W, Jamal B, Alam I, Hussain N. Frequency and pattern of primary pediatric brain tumours: a retrospective study in Neurosurgery Unit, Lady Reading Hospital Peshawar, Pakistan. Khyber Med Univ J. 2016;8(3):131-3.
22. Mehrazin M, Yavari P. Morphological pattern and frequency of intracranial tumors in children. Childs Nerv Syst. 2007;23(2):157-62. doi:10.1007/s00381-006-0198-0.