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*RESEARCH ARTICLE*

# PEDIATRIC BRAIN TUMORS: INSIGHTS FROM THE RADIOTHERAPY DEPARTMENT AT HASSAN II UNIVERSITY HOSPITAL, FES, MOROCCO

**Hassani Wissal, Kanounin Ouhaila, Khalif Samia, Soussy Kaoutar, Farhane Fatima Zahra, Alami Zenab and Bouha Fatouria**
Radiotherapy Department, Hassan II University Hospital, Fes, Morocco.

## *Manuscript Info*

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## *Abstract*

**Introduction:** Pediatric brain tumors are the second most common type of cancer in children, and despite improvements in diagnosis and treatment, they remain a leading cause of cancer-related mortality. This study aims to describe the clinical, epidemiological, and therapeutic characteristics of children treated for brain tumors at Hassan II University Hospital, Fes.

**Methods:** A retrospective study of 38 children under 15 years old diagnosed with primary brain tumors between January 2013 and December 2022. Data on clinical presentation, tumor type, treatment, and outcomes were analyzed using descriptive statistics. Results: The mean age at diagnosis was 7.37 years, with a male predominance (58%). Most patients presented with intracranial hypertension (78%) and neurological deficits (44%). Medulloblastoma (42.1%) was the most common tumor type. Surgical intervention was performed in all cases, with 55.26% achieving complete resection. Radiotherapy was used in 86%, and chemotherapy in 44.7%. Acute toxicities included nausea and hematological complications, while late effects included cognitive delays and sensory impairments. Remission was achieved in 89.47% of patients within three months, with a 39.47% mortality rate.

**Conclusion:** While treatment for pediatric brain tumors has improved, the risk of recurrence and long-term complications remains a significant challenge. Early diagnosis and tailored treatment protocols are crucial for improving survival and quality of life in these patients.



## Introduction:-

Childhood cancers are rare, accounting for around 1% of all cancers.[1] Among these, central nervous system tumors tumors are the second most common type of tumor in children, accounting for nearly 20% of cases, following leukemias. Despite their frequency, brain tumors remain the leading cause of cancer-related mortality in this population.[2]Pediatric brain tumors are highly diverse in terms of pathology, treatment options, and prognosis. They can manifest through a variety of symptoms, including headaches, nausea, vomiting, visual disturbances, apathy, and loss of coordination or balance. Despite advances in medical imaging, which facilitate rapid diagnosis, detailed topographical description of lesions, and comprehensive and precise staging, histopathological diagnosis combined with molecular biology data remains essential.[3] This approach is not only crucial for confirming the diagnosis with certainty but also for evaluating prognosis and guiding therapeutic management.

**Corresponding Author:- Hassani Wissal**
Address:- Radiotherapy Department, Hassan II University Hospital, Fes, Morocco.

The management of pediatric brain tumors must be multidisciplinary, involving the coordinated efforts of neurosurgery, neuroradiology, pediatric oncology, neuro-oncology, and radiotherapy teams. The goals of treatment are twofold: improving survival outcomes and minimizing the risk of long-term sequelae, particularly neurocognitive and endocrine complications associated with irradiation of the developing nervous system in children.Over the past two decades, the prognosis for pediatric brain tumors has significantly improved, with notable increases in long-term survival rates. However, morbidity, particularly due to neurological sequelae from various therapies, remains a significant challenge for clinicians.[4], [5].

Data on pediatric brain tumors in Moroccan children are scarce. In this context, our study aims to describe and analyze the epidemiological, clinical, paraclinical, therapeutic, and prognostic profiles of children treated for brain tumors at the Radiotherapy Department of Hassan II University Hospital in Fes.

## Patients and Methods:-

### Data

This study was conducted at the Radiotherapy Department of Hassan II University Hospital in Fez. Patient identification was carried out through the department's hospitalization register. Data were collected from electronic records maintained by the hospital, individual patient paper files, and TPS software treatment records. For data entry and analysis, Microsoft Excel (version 2016) and R statistical software were utilized. To systematically capture epidemiological, clinical, histological, therapeutic, and prognostic data, we developed a comprehensive exploitation form based on bibliographic research. The variables included patient history, demographic information, diagnostic parameters, stage, therapeutic protocols, and treatment outcomes. To ensure comprehensive data collection aligned with our study objectives, we developed an evaluation sheet.

### Patient Selection:

This is a single-center study involving patients managed for brain at the Radiotherapy Department of Hassan II University Hospital in Fes over a 10-year period, from January 2013 to December 2022. Inclusion criteria for the study include patients with a primary brain tumor, under the age of 15. Exclusion criteria include patients over the age of 15, those with brain metastases, and patients with incomplete medical records.we defined the age threshold for our cases as 15 years. This age limit is commonly used in epidemiological studies and aligns with the practices of our hospital and administrative structure.

### Statistical Analysis:

Descriptive statistics were utilized to summarize the baseline characteristics of the patients. Qualitative variables were represented as counts and percentages, while quantitative variables were presented as means with standard deviations (SD). Categorical data were reported using frequencies and percentages, whereas numerical data were summarized using medians with interquartile ranges or means with standard deviations, depending on the variable distribution.

### Ethical Considerations:

As this study was a retrospective, observational, non-interventional analysis, obtaining written consent was not required. The study was conducted with strict adherence to principles of patient anonymity. Ethical approval for the research was granted by the ethical committee of CHU Hassan II in Fes.

## Results:-

38 patients were included over a 10-year period, from January 2013 to December 2022.

### General characteristics:

The age at diagnosis for our patients ranged from 2 to 15 years, with a mean age of 7.37 years. The most common age group was 5-9 years. Of the 38 patients, 58% were boys (n = 22) and 42% were girls (n = 16), resulting in a male-to-female ratio of 1.37. The patient delay, defined as the interval between the onset of symptoms and the initial medical consultation, ranged from 1 to 9 months, with an average of 3.5 months. Most patients (53%) sought consultation within 3 months of symptom onset, while 47% experienced a delay of more than 3 months.

**Clinical and paraclinical patterns:**

Intracranial hypertension was the most frequent presenting symptom, seen in 78% of patients, followed by neurological deficits in 44%, and cerebellar syndrome in 15 children. (Figure 1)

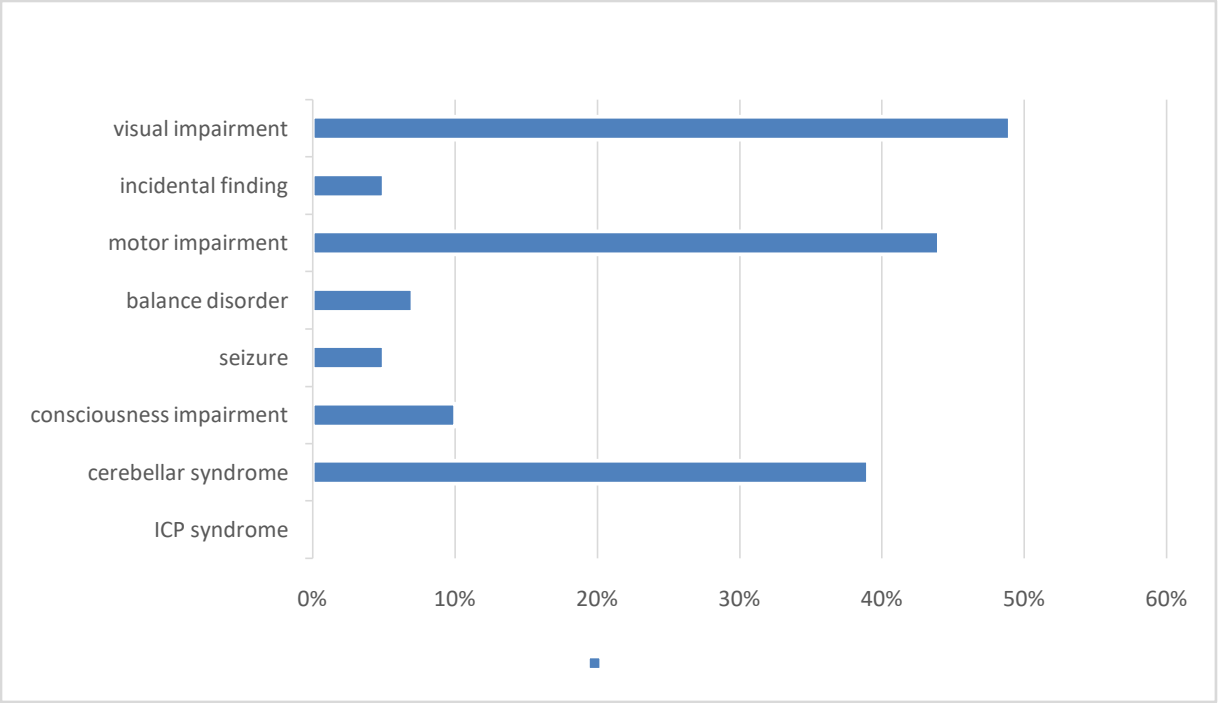


**Figure 1:-** Clinical presentation.

All patients underwent imaging, with MRI performed in 73% and CT in 89%. MRI is preferred for evaluating pediatric brain tumors (Figure 2), but CT remains more accessible. (Figure 3) Imaging showed that 66% of tumors were located in the sub-tentorial region, while 34% were over-tentorial. Among over-tentorial tumors, 54.54% involved medial structures, with the sellar and para-sellar regions affected in 66% of these cases, and the pineal region in 34%. Tumors in the cerebral hemispheres comprised 45.45%, with 40% affecting the lateral ventricles and 60% affecting the lobes. In the sub-tentorial region, tumors primarily affected the vermis (40%), followed by the brainstem (24%), the fourth ventricle (20%), and the cerebellar hemispheres (16%).Spinal MRI was not routinely indicated for all brain tumors; it was only performed in cases of medulloblastoma, where it was found to be normal in all instances.

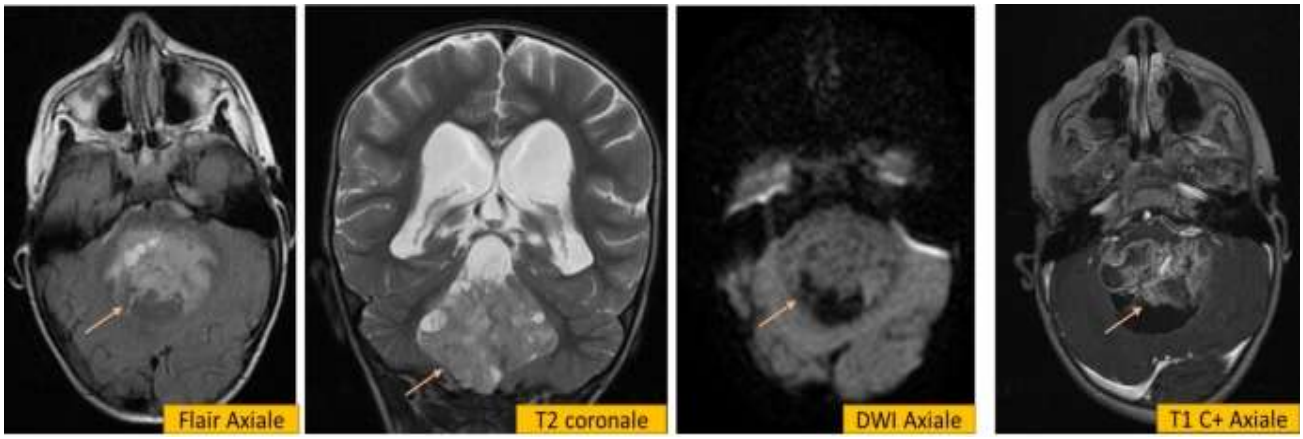


Figure 2:a)MRI of the brain suggesting an ependymoma. The image shows an intraventricular lesion affecting the floor of the fourth ventricle, solid-cystic in nature, with a solid portion exhibiting heterogeneous FLAIR hyperintensity, non-restrictive on diffusion, and showing intense and heterogeneous enhancement after contrast administration. Radiology Department,Hassan II University Hospital, Fes.

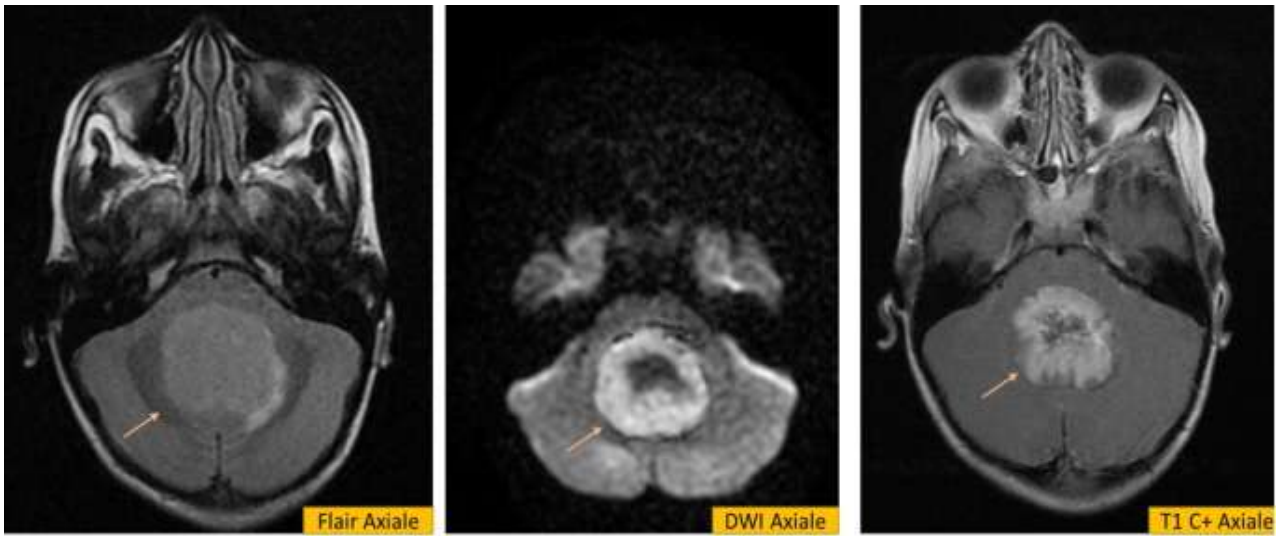


**Figure 2:-** b)Brain MRI from one of our patients: the imaging reveals a midline mass in the posterior fossa with heterogeneous intermediate FLAIR signal, containing areas of central necrosis. The lesion is diffusion-restricted and shows heterogeneous enhancement after contrast administration, suggesting a medulloblastoma.

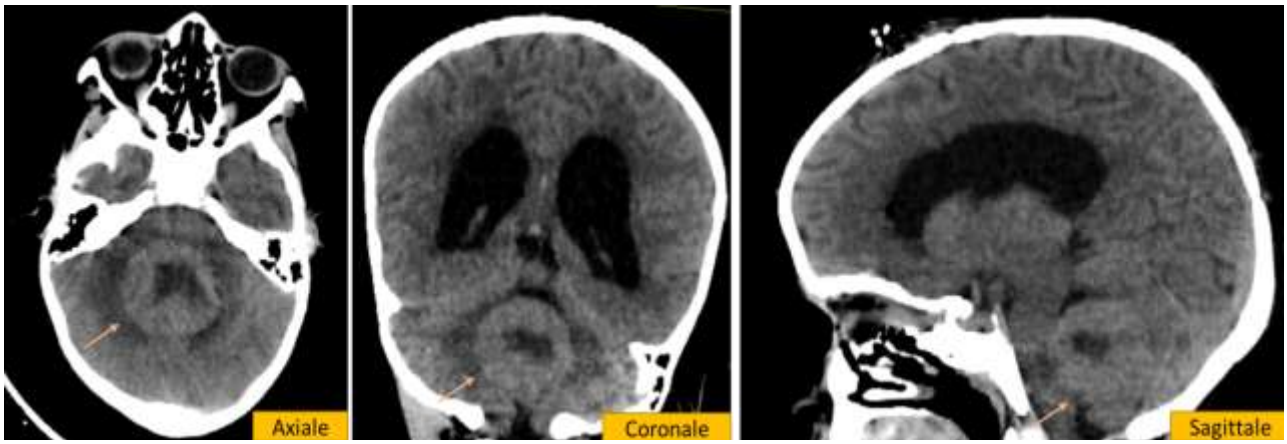


**Figure 3:-** Brain CT scan of one of our patients reveals a posterior fossa lesion centered on the cerebellar vermis. The lesion appears spontaneously hyperdense and contains a hypodense area with liquid density at its core, surrounded by a hypodense zone of perilesional edema, most likely indicating a medulloblastoma.

The WHO anatomical classification for central nervous system tumors, updated in 2021, should be used for tumor categorization. In our series, medulloblastoma was the most common, comprising 42.10% of cases, followed by ependymoma at 26.31%. (Figure 4)

Therapeutical management:

Management of brain tumors requires a multidisciplinary approach within an appropriate clinical setting. In our series, 23 patients (60.52%) received corticosteroids, while 8 patients (21%) were treated with anticoagulants. Hydrocephalus was managed with either ventriculoperitoneal (VP) or ventriculocysternostomy (VCS) shunts; 22 patients (57.89%) underwent ventricular shunting either prior to or concurrently with tumor resection surgery. All patients in our study underwent surgical intervention, with 21 patients (55.26%) having complete resections, 13 patients (34.21%) undergoing partial resections, and 4 patients (10.52%) receiving only biopsies. Cerebrospinal fluid (CSF) studies were performed in 4 patients (10.52%) to evaluate tumor cell presence and assess medulloblastoma extension.

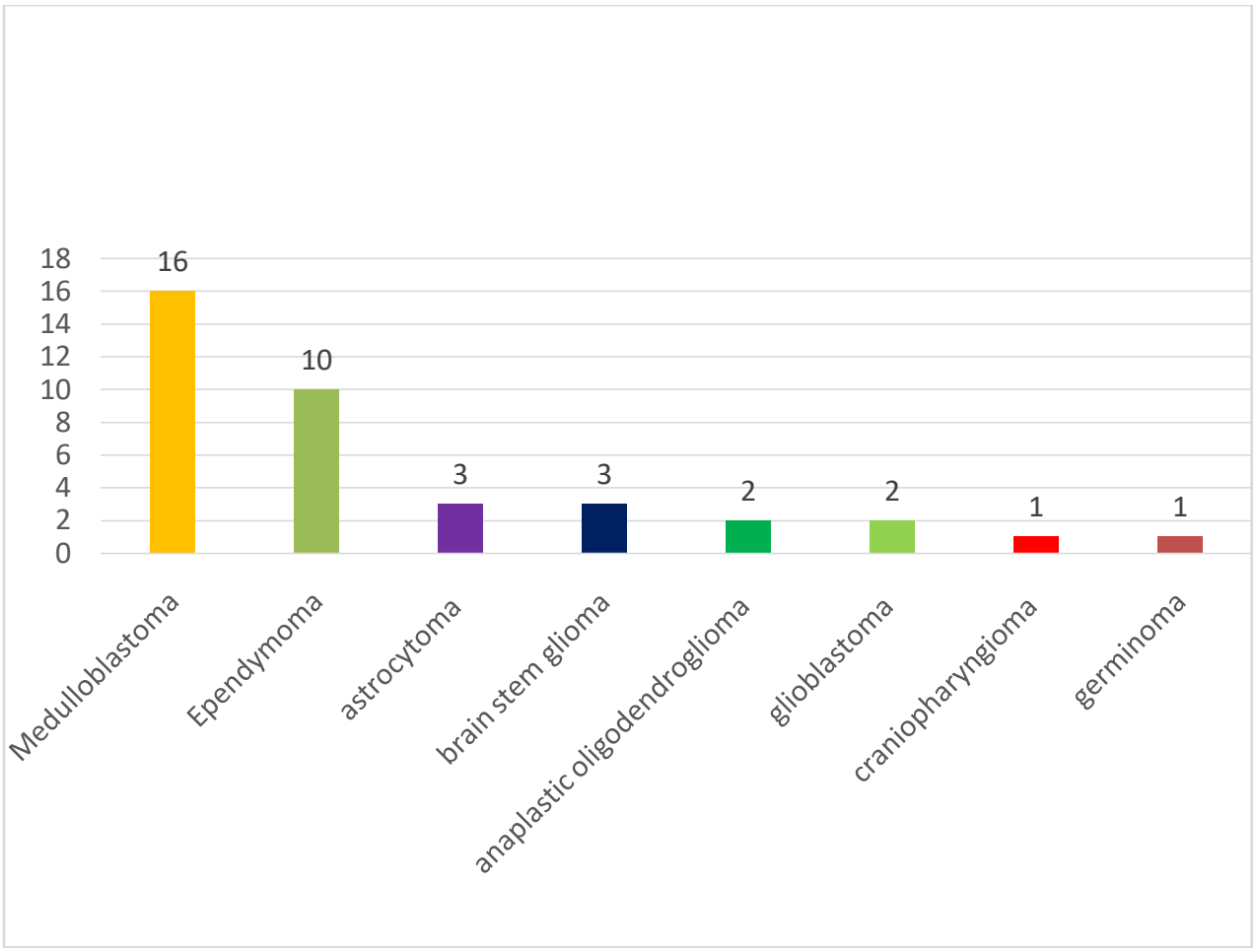


**Figure 4:-** Histological types in our series.

Radiotherapy is a critical component of treatment for childhood brain tumors, often initiating or complementing chemotherapy. The interval between surgery and the commencement of radiotherapy ranged from 1 to 9 months, with a median of 2.5 months. Radiotherapy was primarily administered using 3D conformal techniques in 86% of cases and intensity-modulated radiotherapy (IMRT) in 14% of cases. The average duration of radiotherapy was 45.53 days, ranging from 36 to 56 days. Interruptions occurred with an average of 2.6 days per patient, mainly due to myelotoxicity, which caused 45% of these interruptions. Two patients developed thrombocytopenia during the course of radiotherapy. (Figure 5)

Acute complications, defined as those arising during or within three months post-radiotherapy, included grade 1–2 nausea and/or vomiting in 3 patients and thrombocytopenia in 2 patients. Late complications, occurring more than three months after treatment, included cognitive delays in 1 patient, growth retardation in 2 patients, hearing loss in 3 patients, visual impairment in 7 patients, balance disturbances in 2 patients, and chronic headaches in 1 patient.

In comparison, chemotherapy was administered to 17 patients (44.73%), with treatment protocols tailored to specific tumor types. For medulloblastoma, 12 patients were treated with the SM HOP MEDULLO 2012 protocol, involving 3 cycles of Cisplatin/Etoposide followed by 3 cycles of Cyclophosphamide/Vincristine. Additionally, 3 ependymoma cases were managed with the VP16-CDDP protocol, 1 glioblastoma case with Temozolomide over 6 months, and 1 germinoma case with the SIOP CNS GCT96 protocol. Acute toxicities from chemotherapy included grade I nausea and vomiting in all children, and hematological toxicities in 5 patients.

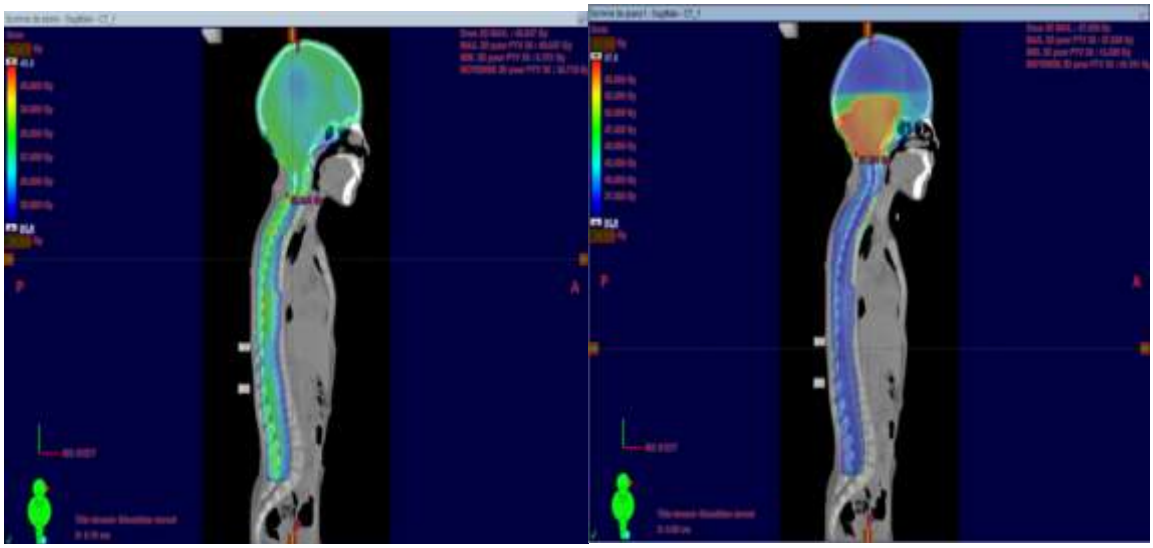

**Figure 5:-** Pediatric medulloblastoma treated with 3D conformal radiotherapy (RC3D): craniospinal irradiation with a mobile junction.

**Outcome:**

Among our 38 patients, 34 (89.47%) achieved remission within three months. At the six-month follow-up, 29 patients were seen, with 20 children (52.63%) showing complete remission.We documented 9 cases of tumor recurrence, representing 23.68% of the cohort. Medulloblastoma was the most common histological type among recurrences, occurring in 5 cases (55.55% of recurrences). The interval to recurrence ranged from 11 to 57 months. No cases of metastatic dissemination were observed. The mortality rate was 39.47%, with 15 deaths reported; notably, two children died before starting radiotherapy.Overall survival, calculated using Kaplan-Meier months.

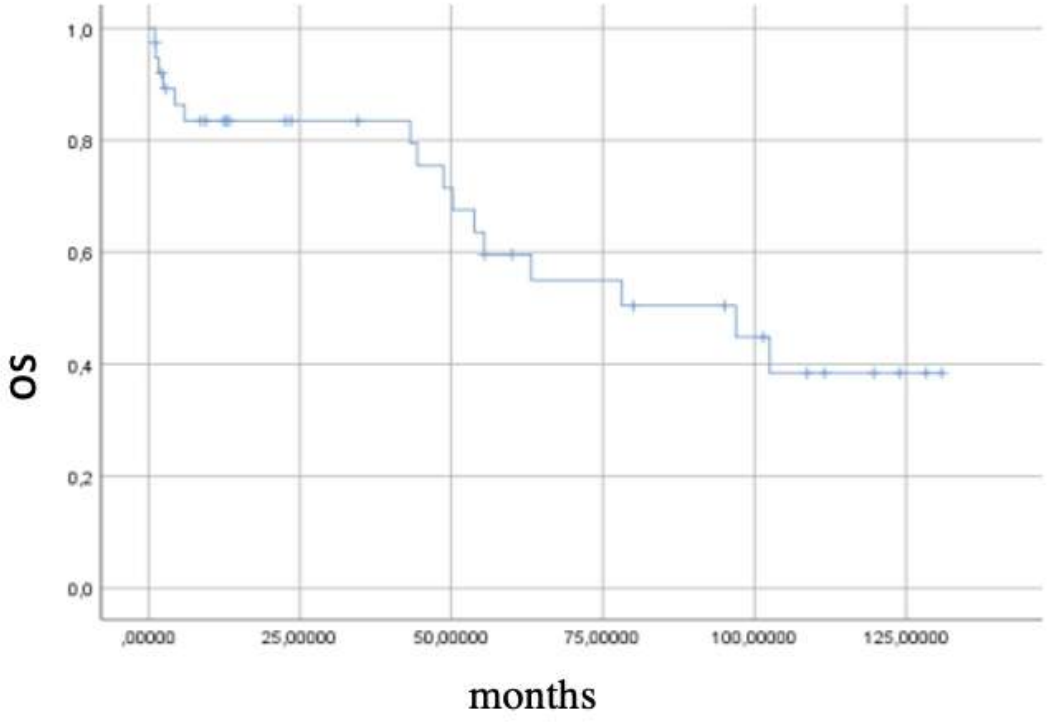


**Figure 6:-** Kaplan–Meier estimates of overall survival.

## Discussion:-

Estimating the incidence of pediatric CNS tumors is challenging due to significant variability in data sources, including records from general and specialized hospitals, neurosurgical and neuropathological series, autopsy findings, surgical specimens, and geographic differences. Nonetheless, studies consistently identify primary brain tumors as the most common solid tumors diagnosed in children under 15 years of age, both in developed and developing countries [6], [7], [8]The incidence of pediatric brain tumors in Moroccan children appears to be nearly identical to that reported in other African countries, reflecting comparable epidemiological patterns across the region.[9]. The peak incidence is typically reported between 4 and 8 years, while tumors in infants represent only 10% of all malignant cases.[10]

Sex distribution is generally balanced.[11] However, similar to some studies reporting a male predominance, our study also found a male predominance, with a sex ratio of 1.37.Pediatric brain tumor risk factors include tumor histology, location, age, sex, race, and ethnicity. Confirmed risks are limited to ionizing radiation and rare genetic syndromes. Reported associations include birth defects, fetal growth markers, advanced parental age, maternal dietary NOCs, and pesticide exposure.[8]

Clinical manifestations of brain tumors in children are variable and depend on factors such as age, tumor location, and neurofibromatosis status. Symptoms related to raised intracranial pressure are present in less than 50% of children with intracranial tumors.Increased intracranial pressure (ICP) syndrome arises from an increase in cranial content, such as tumor growth, peritumoral edema, or intratumoral hemorrhage. The syndrome can be partial or complete, presenting with morning or late-night headaches, which are aggravated by coughing. Vomiting, which may initially relieve headaches, is also common. In older children, the clinical picture can include abdominal pain, particularly with posterior fossa tumors, or otalgia. Motor abnormalities, especially gait and coordination issues, are common across all tumor types, as are eye signs. Macrocephaly is frequent in children under 4, and weight loss, growth failure, and precocious puberty are associated with specific tumor types or conditions like neurofibromatosis. Visual impairment is often seen in patients with sellar tumors, while nausea, vomiting, and headaches are more common in cerebellar and fourth ventricle tumors.[12], [13]Our findings align with the literature, as raised intracranial pressure syndrome was the most common presentation in our study, consistent with previous reports.

The 2021 fifth edition of the WHO Classification of CNS Tumors introduced updated tumor nomenclature and grading systems, highlighting the importance of integrated diagnoses and detailed reports. This edition placed greater emphasis on molecular diagnostics in tumor classification, while still incorporating traditional methods like histology and immunohistochemistry. Additionally, it recognized new tumor types and subtypes, enabled by advanced diagnostic technologies such as DNA methylome profiling.[13], [14], [15]Generally, four histological types dominate pediatric brain tumors: astrocytomas, oligodendrogliomas, medulloblastomas, and ependymomas. In our series, medulloblastomas were the most frequent histological type, a finding consistent with a more comprehensive Moroccan epidemiological study on pediatric brain tumors.[7], [13]

Pediatric brain tumors are predominantly located in specific brain regions, with the posterior fossa—encompassing the cerebellum and brainstem—being the most common site. Approximately 60% arise in this region, with medulloblastomas as the most frequently diagnosed tumors, followed by juvenile pilocytic astrocytomas and ependymomas. In contrast, supratentorial tumors, representing around 40% of cases, are more common in adolescents and include astrocytomas, craniopharyngiomas, and other primitive neuroectodermal tumors (PNETs). This distribution aligns with our findings. [16], [17]

Therapeutic management of pediatric brain tumors depends on the histological nature, tumor location, and the child's age. It involves the three main treatment modalities: surgery, radiotherapy, and chemotherapy.

Surgery is typically the first-line treatment for accessible tumors. The goal is to provide tissue diagnosis,remove as much of the tumor as possible while preserving surrounding healthy brain tissue, alleviate mass effect, and restore CSF-flow abnormalities. Standard craniotomies, such as pterional and suboccipital approaches, remain fundamental in neurosurgery, supplemented by advanced techniques aimed at improving outcomes and reducing complications. Stereotactic methods have simplified minimally invasive biopsies for subcortical lesions, while transcranial magnetic stimulation paired with functional MRI allows for preoperative mapping of critical motor and language areas in pediatric patients unable to undergo awake procedures. Endoscopic techniques, both rigid and flexible, are effective for accessing ventricular, pineal, and skull-base tumors, including craniopharyngiomas, and offer superior

visualization compared to traditional microscopic methods. Additionally, ultrasonic aspirators enhance tumor debulking, particularly for firm masses, ensuring safer and more comprehensive resections.[5], [18]

Radiotherapy, historically the primary therapeutic modality, is now frequently integrated with surgery and chemotherapy. It remains a cornerstone in the management of brain tumors, ensuring effective tumor control. The adoption of modern radiotherapy techniques has significantly enhanced outcomes, particularly in preserving higher cognitive functions and improving patients' quality of life.RT has demonstrated its efficacy in improving medium-term survival rates, whether employed as a monotherapy, as an adjunct to surgical resection, or in combination with chemotherapy, while reducing the risk of debilitating neurocognitive sequelae through precision-based approaches.[19], [20]

Despite its limitations, including cellular resistance mechanisms to cytotoxic agents and the challenges of delivering these agents across the blood-brain barrier, chemotherapy plays an increasingly crucial role in the management of brain tumors. Numerous chemotherapy protocols, often in combination with surgery and radiotherapy, have been established or are under investigation.Its main advantage lies in reducing the need for radiotherapy, as well as minimizing the volume and dose of radiation delivered, thereby improving survival quality and cure rates. Chemotherapy can be administered preoperatively, during, or post-radiotherapy.

Survival outcomes in patients with brain tumors are influenced by factors such as tumor histology, the age at diagnosis, and the tumor's location.Outcomes are influenced by the extent of surgical resection, with 10-year progression-free survival (PFS) rates exceeding 85% following complete resection but falling below 50% in cases of radiologically detectable residual tumor.[13], [21]

## Conclusion:-

Pediatric brain tumors are the most common solid tumors in children. The diagnosis of intracranial tumors primarily relies on imaging (MRI), along with histological and molecular biological criteria. Management of children with brain tumors requires a multidisciplinary approach, involving neurosurgery, pediatric oncology, radiotherapy, and rehabilitation. Radiotherapy remains a key therapeutic modality in the treatment of these tumors. Continued efforts should be directed towards further improving and refining therapeutic strategies to enhance the quality of care and outcomes for children with brain tumors.

## References:-

[1] R. R. G. Knops et al., « The volume effect in paediatric oncology: a systematic review », Ann. Oncol., vol. 24, no 7, p. 1749-1753, juill. 2013, doi: 10.1093/annonc/mds656.
[2] M. Koob et N. Girard, « Tumeurscérébrales :particularités chez l'enfant », J. Radiol. Diagn. Interv., vol. 95, no 10, p. 953-972, oct. 2014, doi: 10.1016/j.jradio.2014.05.011.
[3] E. M. Wells et R. J. Packer, « Pediatric brain tumors », Contin. Minneap. Minn, vol. 21, no 2 Neuro-oncology, p. 373-396, avr. 2015, doi: 10.1212/01.CON.0000464176.96311.d1.
[4] R. J. Packer, « Childhood Brain Tumors: Accomplishments and Ongoing Challenges », J. Child Neurol., vol. 23, no 10, p. 1122-1127, oct. 2008, doi: 10.1177/0883073808320758.
[5] I. F. Pollack, S. Agnihotri, et A. Broniscer, « Childhood brain tumors: current management, biological insights, and future directions », J. Neurosurg. Pediatr., vol. 23, no 3, p. 261-273, mars 2019, doi: 10.3171/2018.10.PEDS18377.
[6] M. Karkouriet al., « Epidemiologic profile of pediatric brain tumors in Morocco », Childs Nerv. Syst. ChNS Off. J. Int. Soc. Pediatr. Neurosurg., vol. 26, no 8, p. 1021-1027, août 2010, doi: 10.1007/s00381-010-1097-y.
[7] A. Amarti, S. Ottmani, M. Maher, Z. Bernoussi, A. Khamlichi, et A. Saidi, « Central nervous system tumors in Morocco. Retrospective analysis of 2374 cases », J. Neurosurg. Sci., vol. 45, no 3, p. 163-170, sept. 2001.
[8] A. F. M et S. Me, « Pediatric Brain Tumors: Descriptive Epidemiology, Risk Factors, and Future Directions », Cancer Epidemiol. Biomark. Prev. Publ. Am. Assoc. Cancer Res. Cosponsored Am. Soc. Prev. Oncol., vol. 30, no 5, mai 2021, doi: 10.1158/1055-9965.EPI-20-1443.
[9] A. Harmouch, M. Taleb, A. Lasseini, M. Maher, et S. Sefiani, « Epidemiology of pediatric primary tumors of the nervous system: A retrospective study of 633 cases from a single Moroccan institution », Neurochirurgie, vol. 58, no 1, p. 14-18, févr. 2012, doi: 10.1016/j.neuchi.2012.01.005.
[10] « Pediatric Primary Tumor | PEDIATRIC Data SEER*RSA ». Consulté le: 24 décembre 2024. [En ligne]. Disponible sur:

https://staging.seer.cancer.gov/pediatric/input/1.0/astrocytoma/ped_primary_tumor/?breadcrumbs=(~schema_list~),(~view_schema~,~astrocytoma~)
[11] F.-E. Hazmiri, F. Boukis, S. A. Benali, N. C. I. El Ganouni, et H. Rais, « Tumeurs cérébrales de l'enfant: à propos de 136 cas », Pan Afr. Med. J., vol. 30, 2018, doi: 10.11604/pamj.2018.30.291.13208.
[12] S. Wilne, J. Collier, C. Kennedy, K. Koller, R. Grundy, et D. Walker, « Presentation of childhood CNS tumours: a systematic review and meta-analysis », Lancet Oncol., vol. 8, no 8, p. 685-695, août 2007, doi: 10.1016/S1470-2045(07)70207-3.
[13] W. Yang et al., « Epidemiological characteristics, clinical presentations, and prognoses of pediatric brain tumors: Experiences of national center for children's health », Front. Oncol., vol. 13, janv. 2023, doi: 10.3389/fonc.2023.1067858.
[14] A. d'Amatiet al., « Pediatric CNS tumors and 2021 WHO classification: what do oncologists need from pathologists? », Front. Mol. Neurosci., vol. 17, mars 2024, doi: 10.3389/fnmol.2024.1268038.
[15] B. L. Cole, « Neuropathology of Pediatric Brain Tumors: A Concise Review », Neurosurgery, vol. 90, no 1, p. 7, janv. 2022, doi: 10.1093/neuros/nyab182.
[16] S. Subramanian et T. Ahmad, « Childhood Brain Tumors », in StatPearls, Treasure Island (FL): StatPearls Publishing, 2025. Consulté le: 8 janvier 2025. [En ligne]. Disponible sur: http://www.ncbi.nlm.nih.gov/books/NBK535415/
[17] H. C. Shah, B. P. Ubhale, et J. K. Shah, « Demographic and histopathologic profile of pediatric brain tumors: A hospital-based study », South Asian J. Cancer, vol. 4, no 3, p. 146, sept. 2015, doi: 10.4103/2278-330X.173165.
[18] E. S. Kulubya, M. J. Kercher, H. W. Phillips, R. Antony, et M. S. B. Edwards, « Advances in the Treatment of Pediatric Brain Tumors », Children, vol. 10, no 1, p. 62, déc. 2022, doi: 10.3390/children10010062.
[19] N. Major et al., « The Current State of Radiotherapy for Pediatric Brain Tumors: An Overview of Post-Radiotherapy Neurocognitive Decline and Outcomes », J. Pers. Med., vol. 12, no 7, p. 1050, juin 2022, doi: 10.3390/jpm12071050.
[20] N. J. DeNunzio et T. I. Yock, « Modern Radiotherapy for Pediatric Brain Tumors », Cancers, vol. 12, no 6, Art. no 6, juin 2020, doi: 10.3390/cancers12061533.
[21] J. H. Wisoffet al., « Primary neurosurgery for pediatric low-grade gliomas: a prospective multi-institutional study from the Children's Oncology Group », Neurosurgery, vol. 68, no 6, p. 1548-1554; discussion 1554-1555, juin 2011, doi: 10.1227/NEU.0b013e318214a66e.