Case Report

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Extra-axial cerebellopontine angle nodular medulloblastoma mimicking meningioma: a case report with literature review

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Introduction: Medulloblastoma, a highly malignant embryonal tumor predominantly found in the pediatric population, typically arises within the cerebellum. This case report holds particular importance due to the rarity of medulloblastoma within the cerebellopontine angle (CPA). The distinct anatomical challenge posed by the CPA complex neurovascular structures, along with the absence of pathognomonic clinical or radiographic features, highlights the unique diagnostic and management challenge of this case.

Case presentation: A 5-year-old boy presented with mild, progressively worsening headaches on CT/MRI imaging, which revealed a solid mass in the left CPA. Radiologically, the lesion closely resembled a CPA meningioma. The patient underwent a left retrosigmoid suboccipital craniectomy, utilizing a modified park bench position and careful burrhole creation. Intraoperatively, the tumor exhibited well-defined margins, firm adherence to cranial nerves, and complex tissue characteristics. Postoperatively, histopathological analysis identified nodular medulloblastoma, WHO grade IV, with immunohistochemical markers confirming its subtype.

Discussion: This case highlights the critical role of surgical intervention in addressing rare tumors, emphasizing the need for multidisciplinary collaboration in both diagnosis and management to achieve a favorable outcome. Uncommon tumor locations, such as the CPA, require tailored approaches, and the utilization of advanced diagnostic techniques, including immunohistochemistry, aids in accurate subtype classification.

Conclusion: This case highlights the critical role of surgical intervention in addressing rare tumors, emphasizing the need for multidisciplinary collaboration in both diagnosis and management to achieve a favorable outcome.

Keywords: cerebellopontine angle, extra-axial medulloblastoma, medulloblastoma, pediatric tumor

Introduction

Medulloblastoma is a highly malignant embryonal tumor that predominantly affects the pediatric population[1]. It arises from neuroepithelial cells in the cerebellum, often presenting as an infratentorial mass[2]. Medulloblastomas are conventionally associated with the cerebellum, particularly the vermis, and grow into the fourth ventricle[3]. Some medulloblastomas are located in the cerebellar hemispheres, especially in adults, and rarely in the Cerebellopontine angle (CPA).

The CPA is a narrow anatomical space situated at the junction of the cerebellum, pons, and medulla oblongata[4]. The CPA, housing vital cranial nerves including the facial nerve (VII), the vestibulocochlear nerve (VIII), and the lower cranial nerves (IX–XI), plays a pivotal role in various sensory and motor functions[5]. Within the CPA, medulloblastomas represent a rarity, characterized by the absence of pathognomonic clinical or

HIGHLIGHTS

- This case featured an exceptionally rare occurrence of medulloblastoma located in the cerebellopontine angle (CPA), a distinct and challenging anatomical site.
- Radiologically, the tumor closely mimicked a cerebellopontine angle meningioma, underscoring the diagnostic complexities associated with tumors in atypical locations.
- Surgical intervention required a left retrosigmoid suboccipital craniectomy and careful burrhole creation, emphasizing the intricacies of addressing tumors near vital neurovascular structures.
- Histopathological analysis, supported by immunohistochemistry, revealed the tumor as a nodular medulloblastoma, WHO grade IV, highlighting the role of advanced diagnostic techniques in tumor subtype classification.
- The successful outcome of this case underscores the importance of multidisciplinary collaboration in both diagnosis and management, especially when dealing with rare and challenging tumor presentations.

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radiographic features that definitively differentiate them from other tumors in the same location[6].

We present a case of CPA medulloblastoma in a 5-year-old male child adhering Surgical CAse REport (SCARE) 2020 Guidelines[7]. The distinct anatomical location of the tumor in the CPA presents unique challenges in diagnosis, management, and treatment strategies.

Case presentation

A 5-year-old boy presented with a gradual onset of mild headaches that worsened progressively over the past one and a half months, accompanied by vomiting episodes and a 20-day period of drowsiness. The headaches were localized to the posterior cranial region and intensified during early mornings. The vomiting was recurrent, nonbilious, and notably increased in frequency during the early hours. The patient did not exhibit fever, loss of consciousness, abnormal motor patterns, facial asymmetry, hearing impairment, speech difficulties, dysphagia, neck rigidity, or limb weakness. Despite the drowsy state persisting for 20 days, the child's overall health was robust, with no significant underlying chronic illnesses. Family and psychosocial histories were unremarkable, and the patient achieved normal birth and developmental milestones.

On examination, the patient's vital signs revealed a respiratory rate of 34 breaths per minute, a pulse rate of 140 beats per minute, and a blood pressure of 100/60 mmHg. Oxygen saturation in room air was 100%. Neurological examination indicated intact higher mental functions without signs of meningeal irritation. There were no observable upper eyelid drooping or facial deviation. Cranial nerve assessment revealed no abnormalities, and both superficial and deep reflexes were normal. Additionally, there were no abnormal cerebellar signs or sensory deficits noted.

The patient underwent CT/MRI imaging. The imaging revealed a solid mass located in the left CPA, which demonstrated a homogeneously hyperintense T2 signal (Fig. 1), isointensity in FLAIR, hyperintensity in DWI, and hypointensity on ADC mapping. Similarly, the sagittal section showing a space occupying lesion abutting the cerebellum (Fig. 2). Approximately 44×39 mm ill-defined isodense lesion in left CPA was seen in CECT (Fig. 3). Furthermore, the mass exhibited intense, homogenous enhancement on contrast images. Radiologically, this presentation bore resemblance to a CPA meningioma located in the right CPA.

The patient underwent a left retrosigmoid suboccipital craniectomy and tumor excision procedure, ensuring safety by creating a burrhole at Frasier's point. The surgical approach involved adopting a modified park bench position with appropriate padding, performed under endotracheal general anesthesia. A curved retroauricular incision in the S-shaped pattern, positioned 3 cm behind the ear and extending 2 cm above the pinna to the mastoid process, was executed. Intraoperatively, the tumor exhibited a fleshy, whitish-reddish appearance with relatively well-defined margins. The tumor was encapsulated with neovascularization, extending from the tentorium superiorly and abutting the superior petrosal sinus and the trigeminal and CN 7–8 complex laterally, reaching down to the lower CN (Fig. 4).

Utilizing a medtronic electric drill, multiple burrholes were carefully created. The surgical team achieved an extensive craniectomy by integrating these burrholes, revealing the transverse sinus superiorly, the sigmoid sinus laterally, the posterior rim of the foramen of magnum, and the near midline region. The dura was meticulously incised, enabling medial retraction of the left cerebellar hemisphere through aspiration of cerebrospinal fluid from the cisterna magna. Macroscopically, the tumor exhibited a fleshy, whitish-reddish appearance with relatively well-defined margins. The tumor was encapsulated with neovascularization, extending from the tentorium superiorly and abutting the superior petrosal sinus and the trigeminal and CN 7–8 complex laterally, reaching down to the lower CN.

The tumor exhibited numerous necrotic areas, accompanied by a presence of several thrombosed microvessels. Notably, the tumor tissue displayed firm adherence to the seventh-eighth cranial nerve complex laterally. However, the demarcation of a clear brain-tumor interface was challenging, as the normal medial cerebellar peduncle was not distinctly delineated from the tumor tissue in the medial aspect.

The histopathological analysis revealed the presence of round to oval cells, forming nodules of varying sizes enveloped by a fibrous tissue rim. These cellular nodules exhibited tumor cells characterized by limited cytoplasm, large monomorphous round to oval nuclei with granular chromatin, and inconspicuous nucleoli. Additionally, regions of necrosis, apoptosis, and a limited number of mitotic events were observed. Notably, certain areas displayed fibrotic tissue intertwined with infiltrating tumor cells. The findings were consistent with a diagnosis of nodular medulloblastoma, categorized as WHO grade IV (Fig. 5). On immunohistochemistry (IHC), the cells are positive for synaptophysin, NeuN, GAB1 (few cells), and YAP1. P53 is weak positive in few cells (wild type). The cells are immunonegative for CK, GFAP, Melan-A, and BCOR. IN1 is retained in tumor cells. Ki-67 is 60%. Findings are consistent with desmoplastic/nodular medulloblastoma, Sonic Hedgehog (SHH) activated, P53 wild type.

Discussion

Medulloblastoma, the most prevalent malignant tumor within the central nervous system located in the posterior fossa of children, accounting for ~20% of all pediatric brain tumors. It exhibits an annual incidence of ~0.5–0.8 cases per 100 000 among individuals under the age of 19. In terms of age distribution, there are two prominent peaks of incidence, occurring between the ages of 3 to 4 years and 8 to 9 years. Notably, males are disproportionately affected, with a male-to-female ratio of around 2:1[8]. Adult cases are infrequent, constituting less than 1% of all brain tumors[9,10] , and medulloblastoma's occurrence is rare beyond the fifth decade.

The origin of medulloblastomas within the CPA remains uncertain. In the context of CPA medulloblastoma's origin, two plausible theories exist. The first theory proposes that CPA medulloblastomas may stem from remnants of the external granular layer of the cerebellar flocculus. The cerebellar flocculus, a small lobe in the cerebellum, contains developmental layers that contribute to its growth during the embryonic and early postnatal stages. Remnants of undifferentiated or immature cells within this external granular layer could potentially undergo abnormal proliferation or aberrant differentiation, leading to the formation of tumors within the CPA. This theory is supported by the histopathological similarities observed between medulloblastomas

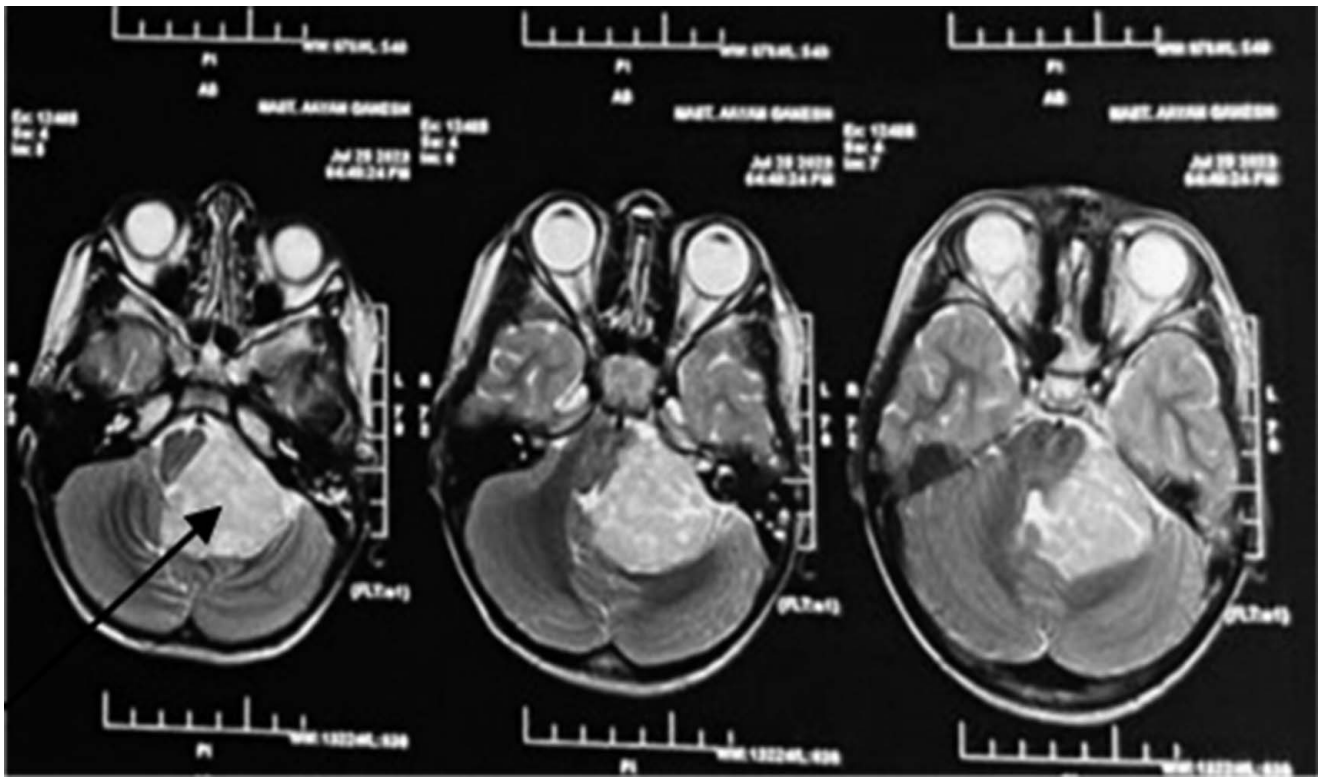

Figure 1. Hyperintense extra-axial space-occupying lesion (SOL) measuring around 43 × 39 mm in the left cerebellopontine angle region in T2 weighted MRI.

arising within the CPA and those found in the posterior fossa. Evidence from molecular and genetic studies has also revealed shared markers and mutations between these tumors, indicating a common cellular origin[11].

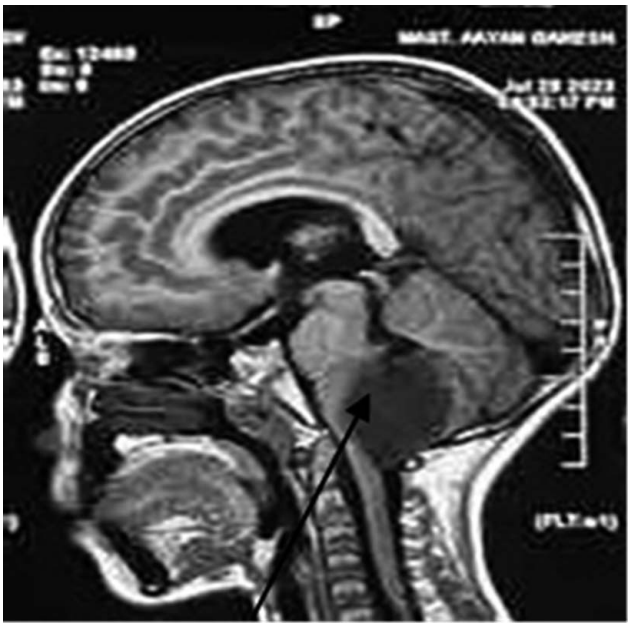

Figure 2. Saggital section showing space occupying lesion abutting cerebellum.

The second theory postulates that CPA medulloblastomas might originate from germinal residues present in the lateral medullary velum, which extends into the CPA. The lateral medullary velum consists of specialized structures and cell populations involved in the formation and differentiation of neural elements during development. It is proposed that these residual cells or germinal residues could undergo uncontrolled proliferation, possibly triggered by genetic or environmental factors, leading to the development of tumors within the CPA. When considering medulloblastomas located in different regions, those arising in the fourth ventricle are believed to extend laterally into the CPA through the Foramen of Luschka or it may exhibit direct exophytic growth from the surfaces of the cerebellum or pons[12,13].

The clinical presentation of medulloblastomas is multifaceted, often reflecting the effects of an expanding mass within the posterior fossa. Nausea, vomiting, and headaches are commonly observed symptoms, attributed to the increased intracranial pressure exerted by the growing tumor. These manifestations arise due to the tumor's impact on the cerebrospinal fluid dynamics and the resultant elevated intracranial pressure[14]. Additionally, ataxia, a lack of muscle co-ordination, may develop due to the tumor's influence on cerebellar function. The progression of medulloblastoma can lead to hydrocephalus, a condition characterized by the accumulation of cerebrospinal fluid within the brain's ventricles. This can result in papilledema, optic disc swelling, due to increased intracranial pressure affecting the optic nerve. Cerebellar tonsillar herniation, wherein the cerebellar tonsils descend through the foramen magnum, may also occur, accompanied by neck pain[15].

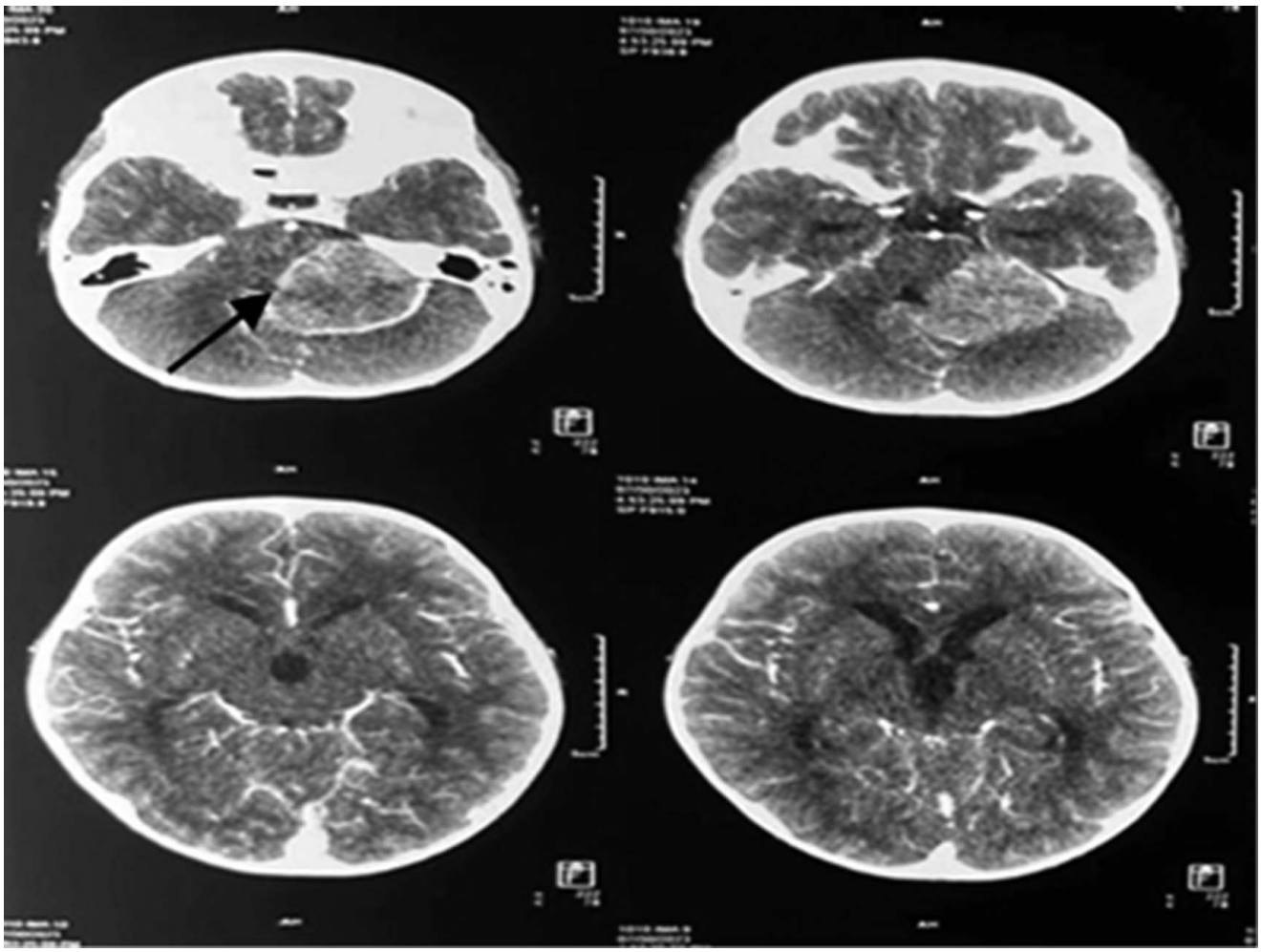

Figure 3. Approx 44 × 39mm ill defined isodense lesion in left cerebellopontine angle.

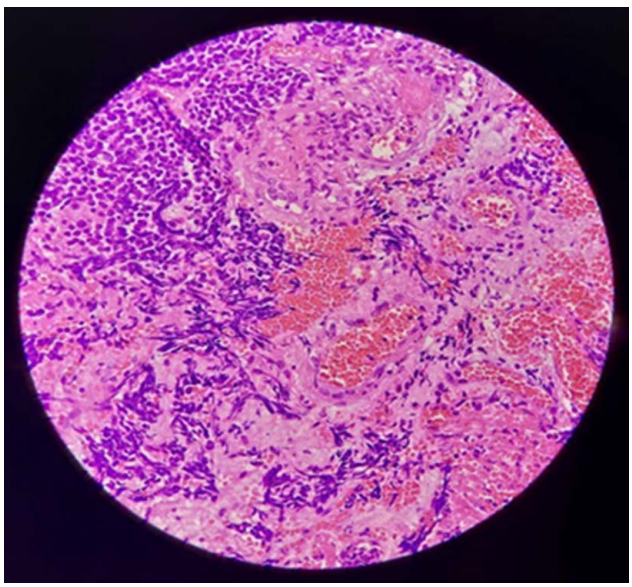

Figure 4. Hematoxylin and Eosin staining, showing pale nodules and densely packed, undifferentiated cells with hyperchromatic and pleomorphic nuclei.

Meningeal irritation arises from tumor spread in the subarachnoid space, causing neck stiffness and head tilt. These symptoms reflect the tumor's impact on the delicate meningeal structures. Furthermore, medulloblastoma can metastasize to the spinal cord, leading to localized findings at the spinal cord level or nerve root pain. In infants, a distinct clinical profile emerges, with

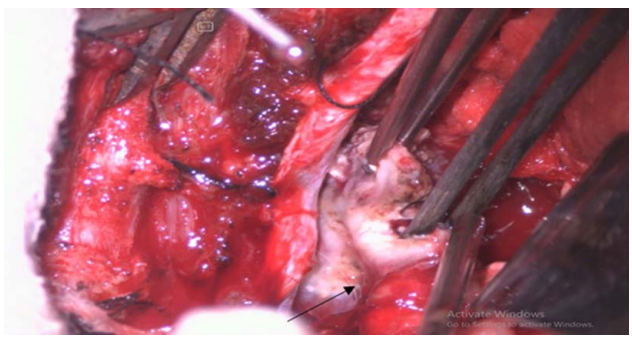

Figure 5. Tumor exhibited a fleshy, whitish-reddish appearance with relatively well-defined margins.

symptoms such as failure to thrive, vomiting, and irritability standing out as primary indicators.

The varied clinical manifestations of medulloblastomas underscore the intricate nature of these tumors and the diverse ways in which they impact the central nervous system. Awareness of these symptoms is crucial for early detection and effective management[16,17].

Medulloblastomas are categorized into distinct molecular subgroups, each marked by unique genetic characteristics and clinical implications for treatment approaches and prognosis[18].

The first subtype, WNT-activated medulloblastomas, arises from mutations in the WNT pathway genes, resulting in β-catenin pathway activation. Typically found in older children, these tumors exhibit a more favorable prognosis and often display histological features associated with differentiation[19]. On the other hand, SHH-activated medulloblastomas harbor alterations in the SHH pathway and encompass both pediatric and adult cases[18,19]. This subtype is further divided based on additional genetic alterations, such as TP53 mutations, and the tumor's location[20]. Group 3 medulloblastomas, characterized by high genomic instability, are often linked to MYC amplification. Predominantly affecting younger children, they present aggressive clinical behavior and an unfavorable prognosis[18]. Lastly, Group 4 medulloblastomas, the most common subtype, exhibit heterogeneity across age groups and clinical behaviors[18]. Group 4 medulloblastomas are the most common subtype and have variable outcomes. They are often seen in children of different age groups.

The medulloblastoma lesion exhibits distinct neuroimaging characteristics. On plain T1-weighted images, the lesion appears hypointense in comparison to the surrounding gray matter. Subsequent contrast-enhanced imaging reveals a uniform and intense enhancement pattern. Conversely, on T2-weighted images, the lesion presents as relatively hypointense. Furthermore, the lesion displays moderately restricted diffusion, indicating restricted movement of water molecules within the tissue.

In terms of advanced specialized MRI sequences, MR spectroscopy (MRS) analysis of medulloblastomas often showcases characteristic tumor spectra. These spectra frequently exhibit a significant elevation in choline (Cho) levels, alongside decreased levels of N-acetyl aspartate (NAA) and creatine (Cr). Additionally, susceptibility-weighted imaging (SWI) highlights noteworthy perfusion alterations in medulloblastoma. This is evident through increased perfusion parameters, such as relative cerebral blood volume (CBV) and relative cerebral blood flow (CBF). Importantly, these perfusion alterations can also be effectively demonstrated using the three-dimensional (3D) arterial spin labeling (ASL) technique, a newer MRI method that quantifies CBF without contrast agents[21–23].

The selection of specific markers in the IHC analysis played a pivotal role in explaining the characteristics and molecular profile of the desmoplastic/nodular medulloblastoma, contributing significantly to the final diagnosis. The markers chosen, including synaptophysin, NeuN, GAB1, YAP1, P53, CK, GFAP, Melan-A, BCOR, IN1, and Ki-67, were carefully selected for their specificity in identifying neuronal differentiation, signaling pathway activation, proliferation rates, and exclusion of differential diagnoses. Synaptophysin and NeuN, indicative of neuronal elements, supported the neural origin of the tumor. The presence of GAB1 and YAP1 hinted at potential dysregulated signaling pathways, potentially implicating aberrant cellular growth mechanisms. Moreover, the weakly positive P53 status, along with the absence of CK, GFAP, Melan-A, and BCOR, contributed to excluding alternative tumor origins. The retention of IN1 highlighted the involvement of the SHH pathway, consistent with SHH-activated medulloblastoma. The markedly elevated Ki-67 index indicated a high proliferation rate. These markers collectively corroborated the histopathological findings and molecular features, aiding in the definitive diagnosis of desmoplastic/nodular medulloblastoma with SHH activation, contributing to a comprehensive understanding of the tumor's molecular profile[24–26].

The differential diagnosis of an extra-axial CPA nodular lesion, particularly one resembling medulloblastoma, requires a comprehensive evaluation to differentiate it from various potential mimickers. CPA meningiomas, originating from the meninges, can share a similar location with medulloblastomas. However, they present distinct histological and genetic characteristics[24]. Schwannomas, arising from Schwann cells, also commonly occur in this region and exhibit radiological features such as the 'target sign'. IHC and histopathology differentiate them from medulloblastomas[27]. Hemangioblastomas, primarily intracranial tumors, can occasionally emerge in the cerebellopontine angle, possibly displaying radiological similarities to medulloblastomas. Histopathologically, hemangioblastomas are characterized by abundant capillaries and stromal cells. Epidermoid cysts, although rare in this location, can mimic medulloblastomas on imaging. However, their unique histological content of keratin and stratified squamous epithelium sets them apart. A typical teratoid/rhabdoid tumor (AT/RT), a highly malignant tumor occurring in young children, can also be considered in the differential diagnosis. Although primarily intracranial, it can manifest in the posterior fossa and cerebellopontine angle. Its aggressive behavior and distinct histology differentiate it from medulloblastomas. Ependymomas, typically intraventricular tumors, can also appear in the posterior fossa and cerebellopontine angle. Ependymal differentiation is a key histological feature that differentiates them from medulloblastomas[28].

The recommended treatment strategy for extra-axial CPA nodular medulloblastoma is similar to the approach used for other brain tumors, combining surgical resection, radiotherapy, and chemotherapy to optimize patient outcomes. Surgical intervention seeks to either achieve complete tumor removal [gross-total resection (GTR)] or safely remove as much as possible without compromising nearby neurovascular structures (maximal safe resection). Given the tumor's intricate location, attaining GTR can be challenging.

The subsequent steps in the treatment journey comprises radiation therapy and chemotherapy. Radiotherapy, delivered with precision, targets any remaining tumor cells following surgery. This is particularly vital in preventing tumor regrowth and minimizing the risk of recurrence. Concurrently, chemotherapy might be administered to further eliminate lingering tumor cells and enhance the overall effectiveness of the treatment approach[29]. The combination of these therapies is geared toward providing comprehensive coverage and minimizing the chances of tumor recurrence[30].

The prognosis of CPA medulloblastoma is influenced by multiple prognostic factors, each playing a crucial role in determining patient outcomes. Tumor-related factors, including histological subtype, molecular characteristics, and extent of resection, significantly impact the prognosis. Certain subtypes,

such as desmoplastic/nodular and SHH-activated medulloblastomas, have shown relatively favorable outcomes compared to other subtypes. The extent of surgical resection is a critical prognostic factor, where achieving GTR correlates with improved survival rates; however, the intricate location of CPA tumors often limits complete resection[25]. Additionally, molecular markers like MYC amplification, TP53 mutation, and certain chromosomal aberrations have been associated with poor prognosis in medulloblastoma cases. The molecular subtype of the tumor is significant. Certain molecular subgroups, such as the WNT-activated subtype, tend to have a more favorable prognosis compared to other subtypes[18]. Patient age also influences prognosis, with younger patients generally exhibiting better survival rates[31]. Furthermore, the presence of metastasis at diagnosis, particularly through cerebrospinal fluid dissemination, is a negative prognostic indicator. Other considerations, such as the response to adjuvant therapies like radiotherapy and chemotherapy, the molecular heterogeneity within medulloblastoma subtypes, and the emergence of treatment-resistant clones, also impact long-term outcomes. A comprehensive understanding and integration of these prognostic factors are crucial in tailoring treatment strategies and predicting outcomes for CPA medulloblastoma patients. Long-term follow-up is essential, as medulloblastomas have the potential for late recurrence. Regular monitoring for recurrence and any long-term effects of treatment is crucial to ensure the best possible outcome for the patient[32].

Conclusion

Generally, medulloblastoma, which is a highly aggressive brain tumor, is the most common malignant brain tumor occurring in the posterior fossa in children, accounting for ~20% of all pediatric brain tumors. However, extra-axial medulloblastoma located in the CPA, a distinct subtype, also called CPA medulloblastoma, is exceptionally rare and initial diagnosis and treatment can be challenging due to its rare occurrence, nonspecific clinical manifestations and critical location adjacent to sensitive neurovascular structures.

Ethical approval

Not Applicable. Our institution does not require ethical approval for reporting individual cases or case series.

Consent

Written informed consent was obtained from the patient's parents/legal guardian for publication and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contribution

M.Y., A.M., S.K.S., and S.B.: prepared the original manuscript; M.Y., A.M., D.Y., S.K.S., and S.B.: reviewed and edited the manuscript; S.K.S. and A.M.: reviewed the manuscript; M.Y., A.M., S.K.S., D.Y., and S.B.: were in charge of the case.

Conflicts of interest disclosure

The authors have no conflicts of interest to declare.

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Data availability statement

All the required information is within the manuscript itself.

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