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Original article

A comparative Study Between Medulloblastoma and Cerebellar Astrocytoma in Children

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Abstract:

- ***Background*:** Medulloblastoma and cerebellar astrocytoma are common brain tumors in children, often associated with intracranial pressure and cerebellar dysfunction. Early diagnosis and complete surgical resection are crucial for improving patient outcomes. This study aimed to evaluate the clinical presentation, radiological features, surgical outcomes, and postoperative complications in children with these two tumors.
- ***Methods:*** A prospective study was conducted between 2000 and 2002 at the Surgical Specialties Hospital on 50 children with histopathologically confirmed medulloblastoma and cerebellar astrocytoma. The patients, aged 2 to 19 years, had a peak incidence between 5 and 10 years, with no significant gender differences. CT imaging assessed tumor location and characteristics. Surgical interventions included shunt operations for hydrocephalus and suboccipital craniectomy for tumor resection. Postoperative complications, such as pseudomeningocele and cerebellar mutism, were monitored.
- ***Result:*** Medulloblastomas showed a typical midline location with hyperdensity and homogeneous enhancement on CT. In cerebellar astrocytomas, 60% were midline and solid. Total tumor removal occurred in 46.7% of medulloblastomas and 50% of cerebellar astrocytomas. Incomplete removal was often due to brain stem involvement, particularly in medulloblastomas. Postoperative complications were more common in medulloblastoma patients, with a mortality rate of 6.7% for medulloblastomas and 10% for cerebellar astrocytomas.
- ***Conclusions:*** Early diagnosis and complete tumor removal with proper postoperative care are essential to reducing morbidity and mortality in children with these tumors.
- **Keywords:** Medulloblastoma, cerebellar astrocytoma, children

INTRODUCTION

Primary tumors of the central nervous system (CNS) account for 20% of childhood neoplasms and are the second most common type of cancer in children, following leukemia (1). The most frequent brain tumors in children are astrocytomas (35%) and medulloblastomas (20%) (2). The cerebellum is the most common site for CNS neoplasms in children, representing 58.9% of cases (1). Most posterior cranial fossa tumors in children are intra-axial, with medulloblastomas (40%) and astrocytomas (23%) being the most common types (3).

Medulloblastoma is a malignant embryonal tumor, primarily affecting children, and originates from undifferentiated neuroepithelial cells in the cerebellum. Its etiology remains unknown, but it typically occurs in the midline cerebellar region and is prone to invading the meninges and cerebrospinal fluid (CSF) spaces (4). Medulloblastomas can occur at any age, from neonates to the elderly, although they predominantly affect children. The incidence is highest in the first decade, with 70% of cases occurring in children under 8 years old (6). The peak incidence occurs between ages 3 and 8, with a well-established male predominance, ranging from 1.33:1 to 2:1 (4).

Cerebellar astrocytoma is a benign childhood tumor with excellent long-term survival rates when complete surgical resection is achievable (7). However, 4–10% of cerebellar astrocytomas are malignant, either as anaplastic variants or, more rarely, glioblastomas (8, 9). These tumors are most common in the middle to later part of the first decade of life, are rare in the first year of life, and uncommon in adults (5). They occur equally in males and females, with no significant racial predilection (6).

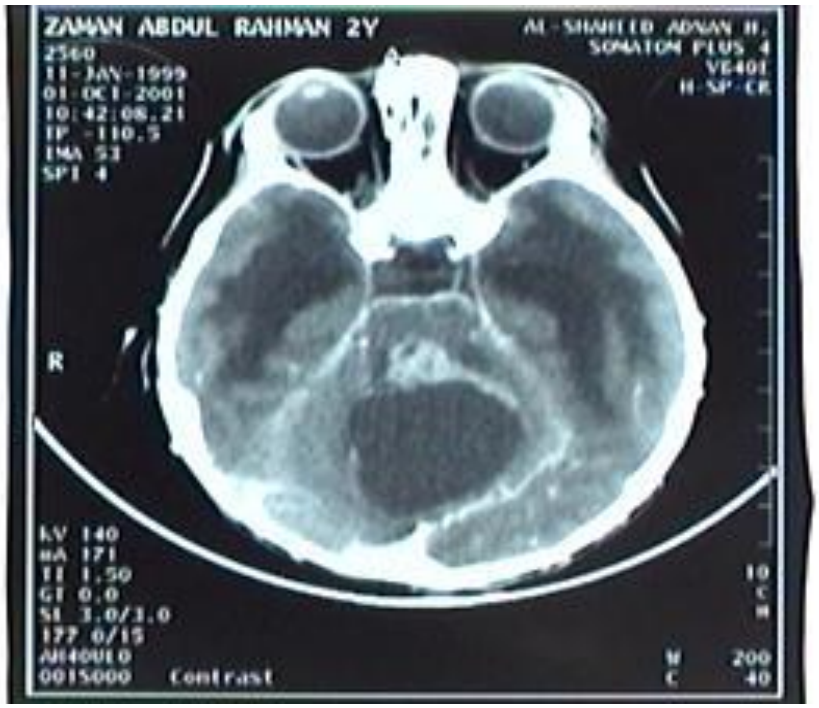

Figure 1. Cerebellar astrocytoma. CT scan of a 2 years old child shows cystic lesion with mural nodule enhancement.

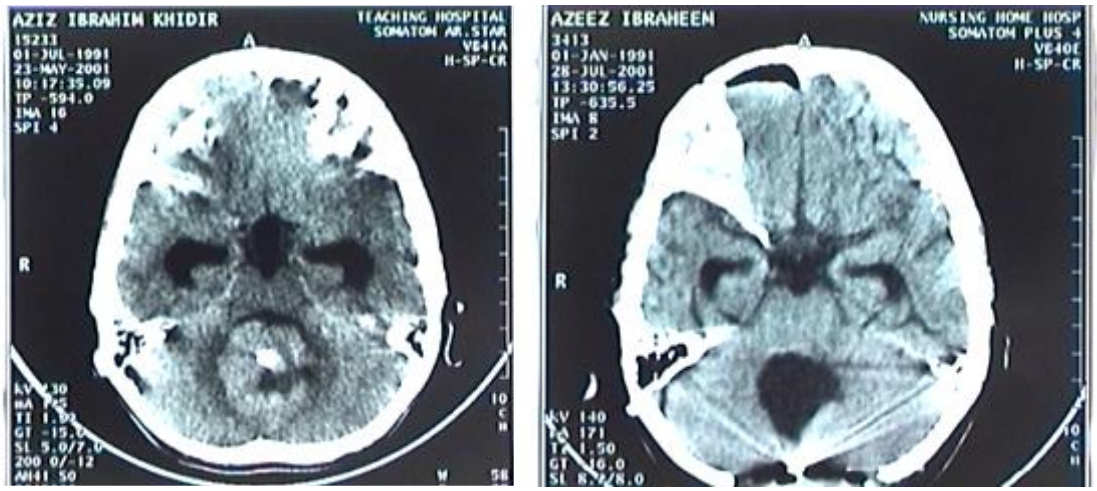

Figure 2. Medullablastoma in an 10 years old child. A: preoperative CT scan shows midline isodense lesion with small hyperdense area (calcification). B :postoperative CT scan of the same patient confirm the total removal of the tumor.

PATIENT and METHOD

This prospective study was conducted on 50 patients admitted to the neurosurgical department of the Surgical Specialties Hospital in 2000 and 2001, all diagnosed with histopathologically confirmed medulloblastoma or cerebellar astrocytoma. The patients were aged 2 to 19 years, from different geographical regions across Iraq.

CT scans were performed for all patients, serving as the primary imaging tool for diagnosing posterior fossa tumors in children. To address the associated hydrocephalus, patients were divided into five groups for treatment: elective shunt (I), emergency shunt (II), direct attack with safety burr-hole (III), direct attack with external drain (IV), and direct attack only (V).

During surgery, various tumor characteristics such as type, texture, color, demarcation, vascularity, and extension were documented. The extent of tumor resection, as estimated by the surgeon, was classified as partial, subtotal, or total. Brain stem injury was identified by the occurrence of bradycardia and/or arrhythmia during surgery, while air embolism was detected through resistant hypotension, as Doppler ultrasonography was unavailable.

Operative specimens were examined in the histopathology lab at the Surgical Specialties Hospital, and the results were documented based on the histopathologist's report.

Patient outcomes were assessed after six months of follow-up for 33 patients (excluding those lost to follow-up or deceased). Outcomes were categorized as good, fair, or poor. A good outcome was defined as patients being free of major neurological deficits and able to return to their previous activity levels. A fair outcome included patients living independently but unable to resume full activity due to new or persistent neurological deficits. Poor outcomes were characterized by dependence and major neurological deficits.

RESULTS

Out of the 50 patients in this study, 30 (60%) had medulloblastoma and 20 (40%) had cerebellar astrocytoma. The ages of the patients ranged from 2 to 19 years, with the peak incidence for both medulloblastoma and cerebellar astrocytoma occurring between 5 and 10 years. Medulloblastoma was equally distributed between male and female patients, while cerebellar astrocytoma showed a slight female predominance (male-to-female ratio 1:1.2).

Common symptoms observed in both medulloblastoma and cerebellar astrocytoma patients included headache, vomiting, and unsteadiness of gait. The most frequent signs were papilledema, ataxia, and nystagmus.

CT Scan Findings:

- Medulloblastoma: 28 (93.3%) were vermian, and 2 (6.7%) were hemispheric.
- Cerebellar Astrocytoma: 12 (60%) were vermian, and 8 (40%) were hemispheric.
- Medulloblastoma: 25 (83.3%) were solid, 4 (13.4%) were mixed, and 1 (3.3%) was cystic.
- Cerebellar Astrocytoma: 8 (40%) were solid, 7 (35%) were cystic, and 5 (25%) were mixed.
- Calcification was found in 7 (23.3%) medulloblastomas and 1 (5%) cerebellar astrocytoma (Figure 3).

Surgical Procedures:

Shunt operations were performed before tumor resection in 28 (93.3%) medulloblastoma patients and 15 (75%) cerebellar astrocytoma patients (Table 1). Intraoperative findings revealed:

- Tumor texture was soft in 24 (80%) medulloblastoma patients and 16 (80%) cerebellar astrocytoma patients.
- Tumor color was purple red in 20 (66.7%) medulloblastoma patients, while it was white in 13 (65%) cerebellar astrocytoma patients. Cystic tumors exhibited golden yellow fluid.
- Medulloblastomas were well-demarcated in 19 (63.3%) cases, while cerebellar astrocytoma were ill-demarcated in 12 (60%) cases.
- Vascularity was higher in medulloblastomas compared to cerebellar astrocytomas.
- Intraventricular extension was observed in 26 (86.7%) medulloblastomas, compared to 9 (45%) cerebellar astrocytomas.
- Brain stem violation occurred in 15 (50%) medulloblastoma patients and 7 (35%) cerebellar astrocytoma patients.

Table 1. Modes of CSF diversion.

CSF diversion procedures		**Medulloblastoma**	**Astrocytoma**
Shunt	Elective	25 (83.3 %)	15 (75 %)
	Emergency	3 (10 %)	----
Non-Shunt	Attack + safety burrhole	2 (6.7 %)	1 (5 %)
	Attack + external drain	----	3 (15 %)
	Attack only	----	1 (5 %)

Tumor Removal and Postoperative Outcomes:

- Total tumor removal was achieved in 14 (46.7%) medulloblastomas and 10 (50%) cerebellar astrocytomas (Figure 3).
- Postoperative complications, as shown in Table 2, were more frequent in medulloblastoma patients. Mortality was documented in 2 (6.7%) medulloblastoma patients and 2 (10%) cerebellar astrocytoma patients.

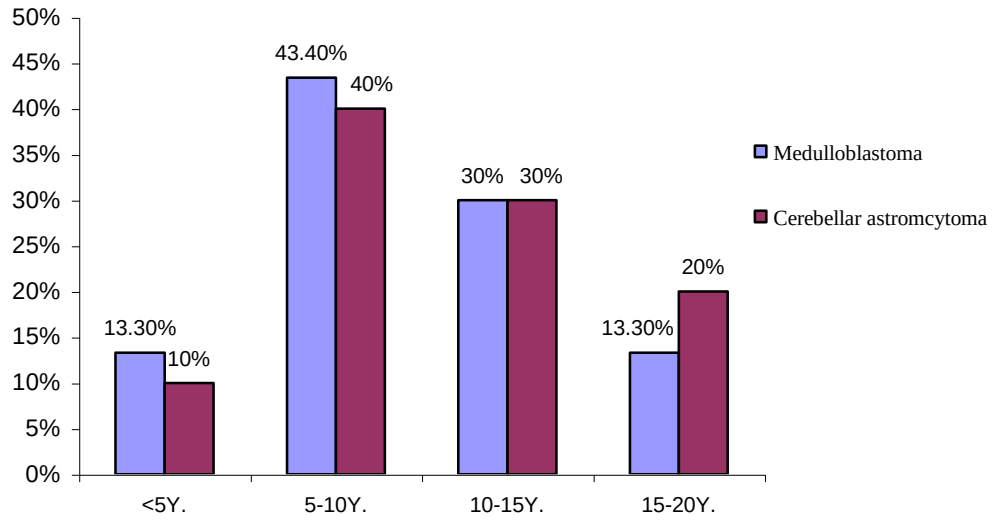

Figure 3. Age distribution

Table 2. Incidence of complications.

Complications		Medulloblastoma	Astrocytoma
Preoperative	Bradycardia	5 (16.7%)	2 (10%)
	Arrhythmia	1 (3.3%)	2 (10%)
Postoperative	↟ Cerebellar dysfunction	6 (20%)	7 (35%)
	Pseudomeningocele	3 (10%)	----
	Cerebellar mustim	4 (13.3%)	----
	Meningitis	2 (6.7%)	----
	Absence gag reflex	2 (6.7%)	2 (10%)
	Hemiparesis	3 (10%)	1 (5%)
	Cranial nerve palsy	1 (3.3%)	----
	CSF Leak	1 (3.3%)	----
	Seizure	1 (3.3%)	----
	Local skin infection	1 (3.3%)	----

Histopathological Findings:

- 27 (90%) of medulloblastomas were classical, and 3 (10%) were dysmoblastic.
- 11 (55%) cerebellar astrocytomas were pilocytic, and 9 (45%) were fibrillary (Figure 4).

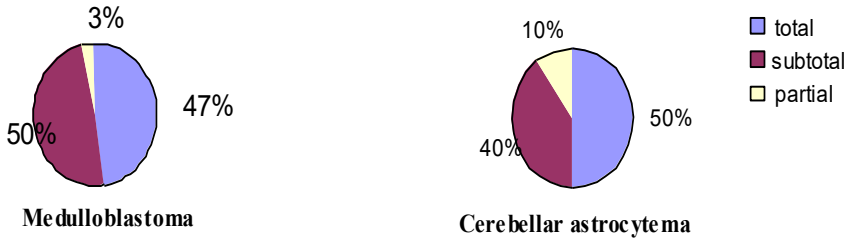

Figure 4. Extent of tumour removal.

Patient Outcomes:

- Medulloblastoma: 12 (63.2%) had a good outcome, 5 (26.3%) had a fair outcome, and 2 (10.5%) had a poor outcome.
- Cerebellar Astrocytoma: 10 (71.4%) had a good outcome, 3 (21.4%) had a fair outcome, and 1 (7.2%) had a poor outcome (Figure 5).

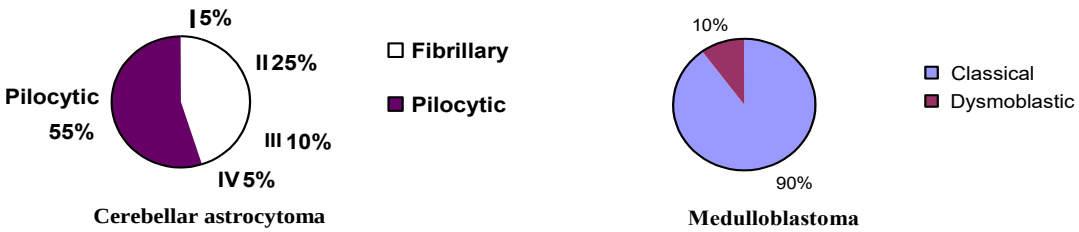

Figure 5. Histopathological classification.

DISCUSSION

Medulloblastoma and cerebellar astrocytoma are the most common posterior fossa tumors in children. As confirmed in the literature, both tumors show a peak incidence between 5 and 10 years of age (5, 4). In this study, medulloblastoma was equally distributed between male and female patients, while cerebellar astrocytoma showed a slight female predominance. This finding is inconsistent with the literature, where Farewell et al. (10) demonstrated male predominance in medulloblastoma, and Wilkins & Rengechary (6) reported an equal sex distribution in cerebellar astrocytomas. This discrepancy may be attributed to the relatively small sample size in our study.

As extensively documented, headache was the most common symptom, occurring in 90% of medulloblastoma patients and 95% of cerebellar astrocytoma patients. Vomiting, a common symptom explained by increased intracranial pressure or direct pressure on the medullary emetic center, was also frequently observed. Papilledema was the most significant sign, found in 86.7% of medulloblastoma patients and 80% of cerebellar astrocytoma patients, corroborating findings by Delia et al. (11).

CT scanning, due to its availability and ease of application in children, was the primary diagnostic tool in this study. It confirmed the well-established midline location of medulloblastomas in 93.3% of cases. Cerebellar astrocytomas, while also predominantly midline (60%), showed a significant incidence of hemispheric location (40%). Medulloblastomas were generally solid, while cerebellar astrocytomas were often cystic, particularly in hemispheric tumors (6, 12, 13). In this study, CT scans showed a higher incidence of cystic tumors in cerebellar astrocytomas, particularly in hemispheric lesions.

The incidence of calcification on CT scans was 23.3% for medulloblastomas, significantly higher than the 5% for cerebellar astrocytomas, aligning with the study by Colosime et al. (14), although they reported a higher incidence of calcifications in astrocytomas (17%).

Regarding hydrocephalus management, most neurosurgeons advocate for shunt operations in patients with midline solid tumors, like medulloblastoma. This approach is believed to alleviate intracranial pressure, improve tumor resection, and smooth the postoperative course, as supported by Griwan et al. (15) and Goel (16). Lee et al. (17) further concluded that pre-craniotomy shunting benefits patients with extensive tumors, especially in late-stage presentations, as commonly seen in developing countries.

Tumor removal was achieved in 50% of cerebellar astrocytoma patients and 46.7% of medulloblastoma patients. The primary factor affecting the extent of tumor resection was brain stem violation, observed in 20% of the cases, indicated by peroperative development of bradycardia or arrhythmia. Furthermore, the high vascularity of medulloblastomas and the poorly defined margins of cerebellar astrocytomas hindered complete resection. Gross total removal of medulloblastomas significantly improves prognosis (18), while even subtotal resection in cerebellar astrocytomas often leads to long-term survival (11, 19).

The mortality rate was 6.7% for medulloblastomas and 10% for cerebellar astrocytomas. This is in line with the findings of Helseth et al. (20), who reported a higher mortality rate for medulloblastoma (13%), and Pancalete et al. (7), who found a lower mortality rate for cerebellar astrocytomas (4.2%). In our study, meningitis was the leading cause of death in medulloblastoma patients due to the lack of antibiotics and inadequate management of external drains. Brain stem injury was the cause of death in cerebellar astrocytoma patients. This complication can be mitigated with advanced neurosurgical technologies such as CUSA, lasers, and improved illumination.

Although the follow-up period in this study was short (6 months), cerebellar astrocytoma patients showed better outcomes compared to medulloblastoma patients. However, to confirm the long-term survival advantages of cerebellar astrocytoma, further studies with extended follow-up are necessary.

CONCLUSION

The peak incidence of both medulloblastoma and cerebellar astrocytoma occurs between 5 and 10 years of age, with no significant gender difference. Most patients presented with headache and vomiting due to raised intracranial pressure, often misdiagnosed as gastrointestinal disorders. CT scans revealed that medulloblastomas were typically midline, solid, and hyperdense, while cerebellar astrocytomas were mostly solid, isodense, and partially enhanced, with cystic lesions in hemispheric tumors. Calcification was more common in medulloblastomas.

Shunt operations were performed for midline solid tumors, while alternative CSF diversion procedures were used for cystic tumors. Gross total tumor removal should be the goal, with a focus on avoiding brain stem injury. Advanced neurosurgical techniques reduced postoperative morbidity and mortality, which were higher in medulloblastoma patients compared to those with cerebellar astrocytoma. Brain stem violation was the primary factor adversely affecting outcomes and reflected the delayed presentation of many cases.

Ethical Clearance:

In accordance with the 2013 WMA Helsinki Declaration, all ethical aspects of this study were approved. Before enrolling the participants, an informed oral consent was obtained from their families as an ethical agreement. Additionally, approval from the hospital administrator was obtained.

Financial support and sponsorship:

Nil.

Conflicts of interest:

There are no conflicts of interest.

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