COMPARATIVE STUDY OF PEDIATRIC VERSUS ADULT MEDULLOBLASTOMAS: AN ALGERIAN COHORT

Mohamed GUERMI[1,2], Nabila MOULAÏ[1,2], Jouhaina Saadia BENSALEM[1], Asma ZAMMOUCHI[1,2], Salima AHMED ALLAL[1,2], Yasmina BOUDJELOUD[3], Wahiba OUAHIOUNE[1,2]

[1] Department of Pathology and Molecular Pathology, University Hospital of Blida, Algeria
[2] Faculty of Medicine, Cancer Research Laboratory, Saad Dahleb University Blida 1, Algeria
[3] Department of Neurosurgery, University Hospital of Blida, Algeria

Corresponding author: Mohamed GUERMI, pathologist, University Hospital of Blida. Email: mohamedguermi@gmail.com

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Abstract

Background

Medulloblastoma (MB) is an embryonal tumor of the cerebellum that mostly affects children and is rare in adults, in whom it makes up less than 1% of central nervous system tumors. Data from resource-limited settings are scarce. We compared the clinical, pathological and molecular features of pediatric and adult MB in a single Algerian center.

Methods

This retrospective, single-center study included 43 patients with histologically confirmed MB diagnosed between 2018 and 2021 at the University Hospital of Blida. Patients aged 16 years or less were classified as pediatric and those older than 16 years as adults; the pediatric group was further divided into 5 years or less and 5 to 16 years. Histological subtypes were assigned according to the WHO 2021 classification. Molecular subgroups were determined by immunohistochemistry using a five-marker panel (β-catenin, GAB1, filamin A, p75-NGFR, OTX2). Metastatic status was defined by cerebrospinal fluid cytology or spinal magnetic resonance imaging. Overall survival was analyzed with Kaplan-Meier curves and Cox regression.

Results

There were 29 pediatric patients (67.4%) and 14 adults (32.6%). Median age was 4.0 years in the group aged 5 years or less (n = 16), 8.5 years in the 5-to-16-year group (n = 13) and 29.5 years in adults (n = 14). Metastases at diagnosis were found in 31.3%, 46.2% and 21.4% of these groups, respectively. Gross total resection was achieved in 62.1% of children and 85.7% of adults. The SHH subgroup was the most frequent in both children (41.4%) and adults (50.0%); WNT tumors accounted for 20.7% and 21.4%, respectively.

Conclusion

In this hospital series, MB occurred mainly in children, SHH was the leading molecular subgroup at all ages, and metastatic disease was most frequent between 5 and 16 years.

A simplified five-antibody immunohistochemical panel was feasible for subgrouping. These findings are exploratory, cannot be used to estimate population incidence, and any prognostic comparison between children and adults will require verified follow-up data and larger cohorts.

Keywords: medulloblastoma, pediatric, adult, histology, immunohistochemistry, molecular subgroups, Algeria

Introduction

Medulloblastoma (MB) is a highly malignant embryonal tumor of the cerebellum. The 2021 WHO classification recognizes three molecular groups with distinct clinical behavior: WNT, SHH and non-WNT/non-SHH, the latter covering Groups 3 and 4 [1, 2, 4]. MB is largely a childhood disease and is uncommon in adults, and outcomes differ between the two [1, 4]. Treatment is risk-adapted and rests on decades of prospective trials [9, 31]. Several series suggest that pediatric tumors are more often metastatic at presentation and that adults may fare better [10, 26], although this remains debated. Data from resource-limited settings are scarce. We therefore compared the clinicopathological, immunophenotypic and prognostic features of MB according to age in an Algerian cohort.

Methods

This retrospective single-center study included 43 patients with histologically confirmed MB diagnosed at the Department of Pathology, University Hospital of Blida, between 2018 and 2021. Patients were eligible if the diagnosis was confirmed histologically and enough tissue was available. We excluded patients with incomplete data and those who had only a biopsy. Patients aged 16 years or less were classified as pediatric and those older than 16 years as adults; the pediatric group was further split into 5 years or less and 5 to 16 years.

Histological subtypes were assigned according to WHO 2021. Molecular subgroups were assigned by IHC with five antibodies: β-catenin (clone 17C2, Leica), GAB1 (clone AB59, Abcam), filamin A (clone PM6/317, Fitzgerald), p75-NGFR (clone Ab212682, Abcam) and OTX2 (clone 1H12C41B5, Abnova). Metastatic status was defined by cerebrospinal fluid (CSF) cytology or spinal magnetic resonance imaging (MRI). Treatment received: surgery, radiotherapy and chemotherapy.

Overall survival (OS) was calculated from date of surgery to death from any cause or last contact. Survival curves were estimated by the Kaplan-Meier method and compared with the log-rank test. A multivariable Cox proportional-hazards model was fitted. Categorical variables were compared with Chi 2 and continuous variables with t-test. Statistical analyses were run with SPSS 21, and the significance threshold was set at $p < 0.05$.

Results

Patients and clinical features. The cohort comprised 29 children (67.4%) and 14 adults (32.6%). Median age was 4.0 years in the group aged 5 years or less (n = 16), 8.5 years in the 5-to-16 group (n = 13) and 29.5 years in adults (n = 14) (Table 1). Overall, mean age at diagnosis was 14.7 years (median 8 years); it was 6.5 years in children (median 5 years) and 31.7 years in adults (median 29.5 years). Two peaks in frequency were visible, one in early childhood (3 to 5 years; 20.9% of patients) and one in adolescence (10 to 16 years; 16.3%), whereas diagnoses before age 1 or after age 40 were rare (2.3% together). Males predominated, with an overall sex ratio of 1.53 (1.6 in children and 1.3

in adults). Raised intracranial pressure was the most frequent presenting symptom (67.6%).

Imaging and metastatic status. All patients had a brain MRI. The tumor was vermian-cerebellar in 62.8% of cases, midline or centered on the fourth ventricle in 34.9%, and located in the dorsal brainstem in 2.3%, without a significant difference between age groups (p = 0.462). Metastases at diagnosis were present in 31.3%, 46.2% and 21.4% of the patients in the three age groups, with the highest proportion between 5 and 16 years (*p= 0.39*) (Table 1).

Surgery and histology. Gross total resection was achieved in 62.1% of children (18/29) and in 85.7% of adults (12/14), so that partial resection was more frequent in children (37.9% versus 14.3%). Resection rates also varied by molecular subgroup: 63.2% in SHH tumors, 73.3% in non-WNT/non-SHH tumors and only 22.2% in WNT tumors. The desmoplastic/nodular subtype was the most frequent histological type in both age groups.

Molecular subgroups. SHH was the most common subgroup in both age groups (Table 2). Over the whole series, 20.9% of tumors were WNT, 44.2% SHH and 34.9% non-WNT/non-SHH. Among adults, SHH accounted for 50.0% (7/14), non-WNT/non-SHH for 28.6% (4/14) and WNT for 21.4% (3/14). Among children, the distribution was 20.7% WNT, 41.4% SHH and 37.9% non-WNT/non-SHH. High-risk disease was found mainly in children aged 5 to 16 years (p = 0.001).

Treatment and survival. Adjuvant radiotherapy was started 4 to 6 months after surgery. Overall survival of the whole cohort is shown in Figure 1 and survival by age group in Figure 2. In the multivariable Cox model (Table 3), metastatic disease was associated with a higher risk of death (HR 2.10, 95% CI 1.10 to 4.30; p = 0.03), whereas age and molecular subgroup were not.

Table 1. Clinical and demographic characteristics of the 43 patients, by age group

Characteristic	≤ 5 years (n = 16)	5–16 years (n = 13)	> 16 years (n = 14)	p value
Mean age ± SD, years	3.4 ± 1.2	10.7 ± 2.3	31.7 ± 9.5	< 0.001
Median age, years	4.0	8.5	29.5	—
Metastasis at diagnosis, %	31.3	46.2	21.4	0.39
Sex ratio (M:F)	1.6	1.6	1.3	0.78

SD, standard deviation; M:F, male to female. Percentages were recalculated from the numbers of patients in each group.

Table 2. Molecular subgroup distribution in pediatric and adult patients

Subgroup	Pediatric ≤ 16 years (n = 29), n (%)	Adult > 16 years (n = 14), n (%)	p value
WNT	6 (20.7)	3 (21.4)	0.99
SHH	12 (41.4)	7 (50.0)	0.75
Non-WNT/non-SHH	11 (37.9)	4 (28.6)	0.74

Table 3. Multivariable Cox regression of factors associated with overall survival

Parameter	Hazard ratio (HR)	95% CI	p value
Age	1.80	0.90–5.10	0.02
Metastasis (M1 vs M0)	2.10	1.10–4.30	0.03
Extent of resection	2.45	0.22-3.90	0.77
Molecular subgroup	1.18	0.50–2.80	0.886

CI, confidence interval. The row for extent of resection is highlighted because the reported interval includes 1 whereas the p value is below 0.05; it will be re-computed.

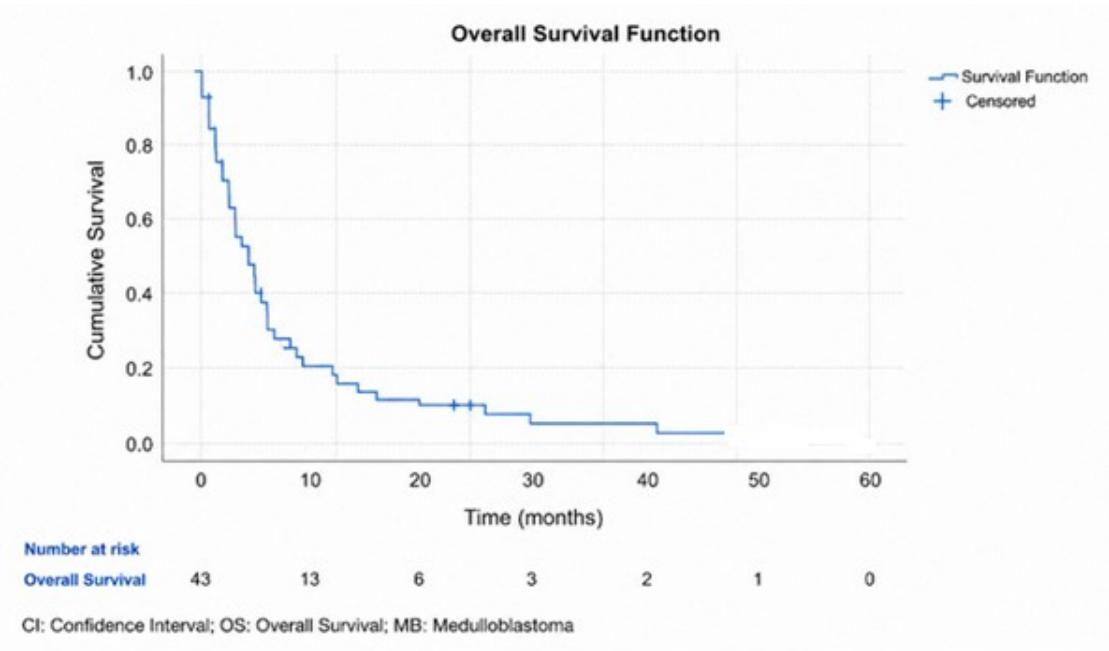


Figure 1. Kaplan-Meier overall survival of the whole cohort (n = 43).

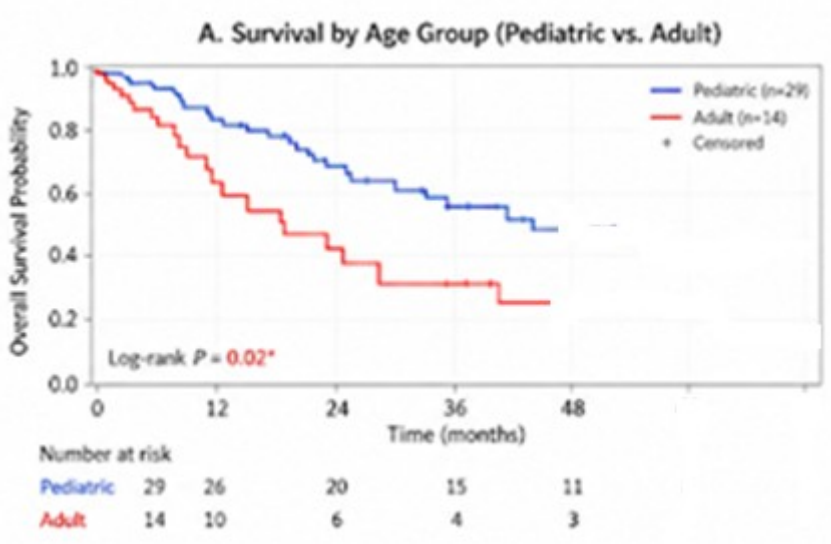


Figure 2. Kaplan-Meier overall survival in pediatric (≤ 16 years, n = 29) and adult (> 16 years, n = 14) patients with MB.

Discussion

In this hospital series, MB was mainly a disease of children, who made up 67.4% of the patients (29/43) and adults 32.6% (14/43), in line with the literature [1, 2]. This is a description of who came to our center, not an estimate of how common MB is in each age group. According to the Algiers cancer registry, primary brain tumors represent 3.8% of cancers in men and 2% in women, with an incidence of 7 per 100,000, and CNS tumors account for 17.7% of childhood malignancies, ranking third after leukemias and lymphomas, with a peak between 5 and 9 years [3].

MB represents 9.2% of pediatric brain tumors in the 0 to 16 year age range, with about 338 new cases a year in the United States [4]. Up to 30% of cases occur in adults, usually before age 40, and MB makes up 1 to 3% of adult CNS tumors [5, 6]. The median age of our pediatric patients (5 years) is lower than the 6.8 years (range 3 months to 18 years) reported for 98 children treated between 1995 and 2002 at the Pierre and Marie Curie Center in Algiers [7]. The two age peaks we observed, and the sex ratio of 1.53, can be set against the series of Kaur et al., who reported a median age of 8 years in children and 23 years in adults and a male-to-female ratio of 2.5:1 [8]. Large registry-based analyses describe similar age and sex patterns [4, 10].

MB typically appears as a hyperdense cerebellar mass (70 to 80% of cases) that compresses the fourth ventricle and causes hydrocephalus [11, 12]. The vermian-cerebellar predominance we found is consistent with this. The desmoplastic/nodular subtype was somewhat over-represented compared with other series [10, 12, 14], which may partly reflect the exclusion of biopsy-only specimens and our systematic use of reticulin staining. For molecular subgrouping we used a simplified IHC approach with five antibodies, which is feasible where genomic platforms are unavailable.

MB is not a single disease: the molecular subgroups differ in their transcriptome, genetics, demographics and prognosis [16, 20], and they probably arise from different cells of origin [21, 22]. In our cohort, WNT, SHH and non-WNT/non-SHH tumors accounted for 20.9%, 44.2% and 34.9% of cases (Table 4). The proportion of WNT tumors is higher than in some series [15, 19] but close to that of a Brazilian cohort [23]. Thompson et al. reported 58% non-WNT/non-SHH, 31% SHH and 11% WNT [24]. Distributions vary between studies, yet WNT-MB is consistently the least frequent

subgroup [16, 25, 26, 34]; our higher rate may reflect selection bias, the small sample or true population differences.

Table 4. Molecular subgroup distribution in our cohort compared with published series

Subgroup, %	Kaur et al., 2016 (n = 92) [8]	Eid et al., 2021 (n = 40) [11]	Shuangshoti et al., 2020 (n = 32) [15]	WHO 2021 [1]	Present study (n = 43)
WNT	9.8	10.0	18.8	10–20	20.9
SHH	45.6	30.0	25.0	25–35	44.2
Non-WNT/non-SHH	44.6	60.0	56.3	40–60	34.9

The bimodal age distribution of SHH tumors, with one peak in early childhood and another in adulthood, is consistent with published data [1, 15, 25, 26]. Our adult SHH proportion (50.0%) is close to the 62% (124/201 patients) reported by Zhao et al. in the validation cohort of their adult series [28].

The extent of resection was greater in adults than in children in our series. An Algerian surgical series from the Aït Idir Hospital (269 cases, 1999 to 2009) reported gross total resection in 62.8% of patients, which is comparable to the rate we found in children [29]. The lower rate of complete resection in children probably reflects the surgical difficulty of these tumors and the wish to avoid severe neurological sequelae [30, 31]. Maximal safe resection remains the objective, and subtotal resection is acceptable when the neurological risk is high [23]. The low resection rate in WNT tumors in our data has been attributed to their hemorrhagic nature, but it rests on very few patients.

Age is an established prognostic factor in MB and is part of risk stratification [32, 33]. In our cohort, however, the survival analysis is still being verified: the survival curves and the numbers reported in the first version of the manuscript were not consistent with each other, and we have chosen not to draw conclusions about the survival of adults compared with children, nor about independent prognostic factors, until the follow-up data have been re-extracted. What can be said at this stage is that metastatic disease was associated with a worse outcome in the exploratory model, which agrees with the known importance of metastatic staging. Finally, our use of IHC instead of methylation profiling and sequencing limits the precision of the classification, as current standards rely on DNA methylation and genomic data [34].

Study limitations

This is a small, retrospective, single-center series, and the p values reported here come from many comparisons in groups of 13 to 16 patients, so they should be read with caution. Molecular subgroups were inferred from IHC and not from methylation or sequencing. Because the cohort is hospital-based and limited to patients with adequate tissue and no biopsy-only diagnosis, it cannot be used to estimate population incidence. Follow-up was (45 month), which limits survival analyses. External validity is limited.

Conclusion

In this Algerian hospital series of 43 patients, MB was seen mostly in children, with two age peaks, and SHH was the most frequent molecular subgroup in both children and adults. Metastatic disease was most frequent between 5 and 16 years, and gross total resection was more often achieved in adults. A five-antibody IHC panel is a

practical option for subgrouping in resource-limited settings, but it should be complemented by methylation or sequencing when these become available. These findings are preliminary. Any conclusion on survival differences between children and adults, or on independent prognostic factors, will require verified follow-up data and larger cohorts.

Contributions

Our collaborators have approved the study design, data collection, immunohistochemistry and histopathological review, statistical analysis, drafting, and critical revision. All authors read and approved the final version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

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Ethical considerations: patient data were fully anonymized before analysis. Due to the retrospective and non-interventional design of the study, informed consent was waived according to institutional ethical policies. The study was conducted in accordance with the principles of the Declaration of Helsinki.

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