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Pediatric cerebellar mutism syndrome after posterior fossa tumor surgery: a single-center experience

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Abstract

Purpose

The study aims to characterize pediatric cerebellar mutism syndrome (CMS) following posterior fossa tumor surgery, with particular attention to its incidence, clinical course, associated factors, and management.

Methods

We retrospectively reviewed children aged 3–17 years who underwent posterior fossa tumor resection at a single pediatric neurosurgical center between 2015 and 2025. CMS ascertainment was restricted to postoperative complete mutism. Demographic, clinical, tumor-related, and operative characteristics were compared between children with and without CMS, and management of affected patients was reviewed.

Results

Among 150 patients, 10 developed CMS (6.7%). Median onset was 1 day after surgery, and median duration of mutism was 41 days. All children with CMS had fourth ventricular tumor involvement. Medulloblastoma (60.0% vs 23.6%; p = 0.020) and urgent surgery (90.0% vs 56.4%; p = 0.047) were more frequent among affected children. The telovelar route was the standard approach to fourth ventricular tumors at our institution (90.9%). Among patients with fourth ventricular tumors treated via the telovelar or transvermian route, CMS occurred in 15.0% and 16.7%, respectively (p = 1.000). Extent of resection did not differ significantly (p = 0.543). Seven children with CMS received pharmacological treatment, most commonly sertraline or benzodiazepines.

Conclusions

In our institutional experience, CMS occurred in 6.7% of patients and was observed exclusively in children with fourth ventricular involvement. Medulloblastoma and urgent surgery were more frequent among affected patients, although independent effects could not be established. Treatment was individualized, precluding conclusions regarding efficacy.

Introduction

Posterior fossa tumors represent up to 60% of all primary central nervous system tumors in children, with a higher prevalence in the pediatric population than in adults [1]. Within this age group, the most common histopathological entities include pilocytic astrocytoma, embryonal tumors (predominantly medulloblastoma, with atypical teratoid/rhabdoid tumor occurring less frequently), and ependymoma [2-4]. Among these, medulloblastoma is particularly relevant due to its common location in the cerebellar

vermis and the fourth ventricle roof [5]. Tumors involving the fourth ventricle can be approached through either the transvermian or telovelar corridor, with each providing a different surgical exposure of the ventricular floor, lateral recesses, and foramina of Luschka [6, 7]. Although the transvermian approach has traditionally been considered more invasive to the cerebellar parenchyma, recent evidence has not consistently demonstrated differences in postoperative neurological outcomes between the techniques [8].

Although gross-total resection (GTR) is often regarded as a measure of surgical success, the primary goal is to maintain a delicate balance between maximizing oncological benefit and minimizing the risk of motor, language, cognitive, and affective deficits [9]. This is particularly relevant in the context of cerebellar mutism syndrome (CMS), which remains a well-recognized post-operative complication following posterior fossa tumor resection, presenting with speech impairment ranging from complete mutism to reduced speech, along with emotional and behavioral lability, cerebellar dysfunction, dysphagia, and other motor signs [8, 10]. These manifestations usually improve spontaneously over a period of weeks to months, although many children continue to experience persistent neurological deficits, most commonly ataxic dysarthria [11, 12].

No consensus exists on perioperative management of CMS, while evidence supporting pharmacological treatment remains limited to small retrospective cohorts or case studies involving heterogeneous agents, often derived from studies lacking control groups [13].Similarly, no standardized rehabilitation protocol has been established, and its strategies may vary according to the individual therapist's experience and the specific patient's clinical needs [14]. Considering the multidimensional nature of CMS, affecting speech and communication, cognition and behavior, and motor function, the management requires an interdisciplinary approach involving specialists from different fields [15]. Therefore, the present study describes our institutional experience with CMS following posterior fossa tumor surgery in children, focusing on its incidence, associated clinical and operative characteristics, and management.

Material and Methods

Study design

A retrospective single-center cohort study was conducted among pediatric patients who underwent surgical treatment for posterior fossa tumors between 2015 and 2025 at the Department of Pediatric Neurosurgery, Medical University of Silesia in Katowice.

Patient Selection

The study included pediatric patients (≥3 and <18 years at the time of surgery) who underwent resection of posterior fossa tumors between 2015 and 2025. All patients were qualified for neurosurgical intervention based on radiological and clinical criteria. Patients younger than 3 years and those with insufficient data were excluded.

Data extraction

Medical records, imaging findings, operative reports, and histopathological findings were retrospectively reviewed. Collected data included demographic characteristics, presenting symptoms, preoperative neurological status, tumor location, and details of surgical procedures. The postoperative course was reviewed for the occurrence of CMS, postoperative clinical status, complications, and length of hospital stay (LOS). Functional status was assessed using the modified Rankin Scale (mRS). For the purposes of this retrospective study, CMS ascertainment was restricted to postoperative complete mutism; children with reduced but preserved speech were not classified as CMS cases. The extent of resection was assessed on postoperative magnetic resonance imaging (MRI) performed within 48 hours after surgery or, in exceptional cases, within 72 hours.

Statistical analysis

Continuous data were reported as medians with interquartile ranges (IQRs), while categorical data were presented as absolute numbers (n) with percentages. Continuous and ordinal variables were compared between patients with and without CMS using the Mann-Whitney U test. Binary categorical variables were analyzed using Fisher's exact test, and categorical variables with more than two levels were analyzed using the Fisher–Freeman–Halton exact test. Medulloblastoma was additionally analyzed as a binary histopathological category. Because CMS occurred exclusively in patients with fourth ventricular involvement, exploratory analyses of histopathology and surgical approach were also performed within this subgroup. In the presence of complete separation, Firth-penalized logistic regression was used to estimate odds ratios (ORs) with 95% confidence intervals (CIs). Given the limited number of CMS cases, no multivariable analysis was performed. A two-sided p-value < 0.05 was considered statistically significant. Statistical analysis was performed with Jamovi software (version 2.7, The Jamovi Project, Sydney, Australia) [16].

Results

Study cohort

A total of 150 pediatric patients (56 female, 94 male) who underwent surgical treatment for posterior fossa tumors were included in the analysis. The median age at admission was 8.13 years [5.62–12.2; range 3.0–17.7 years].

The median mRS score at admission was 1 (IQR 1–2). The most common neurological abnormalities included balance disturbances (n = 49; 32.7%), limb ataxia (n = 46; 30.7%), gait disturbances (n = 33; 22.0%), and speech disturbances (n = 16; 10.7%). At presentation, ventricular system enlargement was noted in 52.7% of patients (n = 79). History of hydrocephalus treatment prior to tumor surgery was present in 10 patients (6.7%). Cohort characteristics and clinical presentation at admission are summarized in Table 1.

Table 1
Baseline characteristics of 150 patients.

Feature		**No. of patients (%)**
Patient characteristics		150 (100.0)
Female		56 (37.3)
Male		94 (62.7)
Age at admission in years, median [IQR]		8.13 [5.62–12.2]
Clinical presentation at admission		**No. of patients (%)**
Speech disturbance, n (%)		16 (10.7)
Balance disturbance, n (%)		49 (32.7)
Gait disturbance, n (%)		33 (22.0)
Limb ataxia, n (%)		46 (30.7)
Truncal ataxia, n (%)		6 (4.0)
mRS at admission, median [IQR]		1 [1–2]
Hydrocephalus		**No. of patients (%)**
Ventricular system enlargement		79 (52.7)
Previous hydrocephalus treatment	None	140 (93.3)
	CSF shunt	2 (1.3)
	EVD	8 (5.3)

Abbreviations: CMS, cerebellar mutism syndrome; IQR, interquartile range; mRS, modified Rankin Scale; CSF, cerebrospinal fluid; EVD, external ventricular drain.

Tumor characteristics and surgical treatment

The most common tumor locations were the fourth ventricle (n = 66; 44.0%), cerebellar hemisphere (n = 50; 33.3%), cerebellar vermis (n = 36; 24.0%), and brainstem (n = 25; 16.7%). Tumors were also found in the cerebellar peduncle in 8 patients (5.3%) and in the cerebellopontine angle in 6 patients (4.0%), while multifocal tumors were identified in 6 patients (4.0%). Tumor locations were not mutually exclusive, as individual lesions could involve more than one anatomical compartment.

Urgent surgery was necessary in 58.7% of cases (n = 88). Gross total resection was achieved in 80 patients (53.3%). The choice of surgical approach varied according to tumor location. Of the 66 tumors involving the fourth ventricle, 60 (90.9%) were approached via the telovelar route and 6 (9.1%) via the transvermian route. The most common histopathological diagnosis was pilocytic astrocytoma (n = 89;

59.3%), followed by medulloblastoma (n = 39; 26.0%) and ependymoma (n = 14; 9.3%). Tumor characteristics and details of the index tumor resections are presented in Table 2.

Table 2. Tumor characteristics and details of the index surgery.

Feature		**Overall (n= 150)**
Tumor location*		**No. of patients (%)**
Fourth ventricle		66 (44.0)
Cerebellar hemisphere		50 (33.3)
Vermis		36 (24.0)
Brainstem		25 (16.7)
Cerebellar peduncle		8 (5.3)
Cerebellopontine angle		6 (4.0)
Multifocal tumor		6 (4.0)
Histopathology		**No. of patients (%)**
Medulloblastoma		39 (26.0)
Ependymoma		14 (9.3)
Pilocytic astrocytoma		89 (59.3)
Other		8 (5.3)
Operative characteristics		**No. of patients (%)**
Urgent surgery		88 (58.7)
Elective surgery		62 (41.3)
Extent of resection	Partial	13 (8.7)
	Subtotal	52 (34.7)
	Gross-total	80 (53.3)
	Biopsy	5 (3.3)
Surgical approach for fourth ventricular tumors, n (%)		**No. of patients (%)**
Telovelar		60 (90.9)
Transvermian		6 (9.1)

Legend:

* Tumor-location categories were not mutually exclusive; percentages do not sum to 100%.

Postoperative course and cerebellar mutism syndrome

The median length of hospitalization was 12 days (IQR 9-14; range 6-51 days). After index tumor resection, postoperative complications were identified in 71 patients (47.3%), and 9 patients (6.0%) required postoperative intensive care. Neurological deficits predominated, most commonly cranial nerve or oculomotor dysfunction in 40 patients (26.7%) and cerebellar deficits, including ataxia, incoordination, and dysmetria, in 35 patients (23.3%). Speech deficits occurred in 15 patients (10.0%), motor deficits in 9 (6.0%), seizures or altered consciousness in 5 (3.3%), and sensory deficits in 3 (2.0%). CSF-related complications occurred in 6 patients (4.0%), and postoperative infections in 3 (2.0%). Surgical wound revision was required in one patient (0.7%). Compared with their preoperative status, 100 patients (66.7%) showed clinical improvement at discharge, 18 (12.0%) remained unchanged, and 32 (21.3%) experienced clinical deterioration. The median mRS score at discharge was 1 (IQR 0-2; range 0–5).

Postoperative CMS occurred in 10 of 150 patients (6.7%). All affected children exhibited linguistic and motor manifestations, and 9 (90.0%) also developed neurobehavioral symptoms. The median time from surgery to symptom onset was 1 day (IQR 1–2; range 0–7 days), and the median duration of mutism was 41 days (IQR 16.5-62.3; range 5-87 days). Seven children (70.0%) received pharmacological treatment during the course of CMS. Sertraline was administered to 4 children (40.0%), benzodiazepines to 3 (30.0%; midazolam in 2 and diazepam in 1), and piracetam to 1 (10.0%); 1 child received both sertraline and midazolam. The remaining 3 children received no pharmacological treatment. Five children (50.0%) received speech-language rehabilitation. Representative preoperative, early postoperative, and 2-month follow-up MRI findings in a patient who developed CMS are presented in Fig. 1.

Preoperative demographic and clinical characteristics, including age, sex, neurological status at admission, and preoperative mRS score, did not differ significantly between the groups. Preoperative speech disturbance was present in 1 of 10 children with CMS (10.0%) and 15 of 140 children without CMS (10.7%; $p = 1.000$). All 10 patients with CMS had tumors involving the fourth ventricle. Among the 66 children with fourth ventricular involvement, 10 (15.2%) developed CMS, whereas no cases occurred among the 84 children without fourth ventricular involvement ($p < 0.001$). Because of complete separation, the magnitude of this association was estimated using Firth-penalized logistic regression (OR 31.4, 95% CI 3.91-4068.86; $p < 0.001$). Although the overall distribution of histopathological diagnoses did not differ significantly between the groups ($p = 0.083$), medulloblastoma was more frequent among patients with CMS than among those without CMS (60.0% vs. 23.6%; $p = 0.020$). Given that all CMS cases occurred in patients with fourth ventricular involvement, an additional exploratory analysis restricted to fourth ventricular tumors was performed to examine the association with histopathology. Within this subgroup, the overall distribution of histopathological diagnoses did not differ significantly between patients with and without CMS ($p = 0.861$). Medulloblastoma was present in 6 of 10 patients with CMS (60.0%) and 29 of 56 patients without CMS (51.8%; $p = 0.739$). Urgent surgery was also more frequent among patients with CMS (90.0% vs. 56.4%; $p = 0.047$). Within the subgroup of

patients with fourth ventricular tumors, CMS occurred in 9 of 60 children (15.0%) treated through the telovelar approach and in 1 of 6 (16.7%) treated through the transvermian approach (Fisher's exact test, p = 1.000). No significant difference was found in the extent of resection (p = 0.543). A detailed comparison of patients who developed CMS and those who did not is presented in Table 3.

Table 3. Comparison of preoperative, tumor-related, and operative characteristics of patients with and without CMS.

Feature		No CMS (n=140)	CMS (n=10)	p-value
Patient characteristics				
Age at admission in years, median [IQR]		8.33 [5.81–12.3]	7.04 [4.13–8.33]	0.156
Female sex, n (%)		50 (35.7)	6 (60.0)	0.176
Clinical presentation at admission				
mRS at admission, median [IQR]		1 [1–2]	1.5 [1–2]	0.123
Speech disturbance, n (%)		15 (10.7)	1 (10.0)	1.000
Balance disturbance, n (%)		43 (30.7)	6 (60.0)	0.080
Gait disturbance, n (%)		29 (20.7)	4 (40.0)	0.228
Limb ataxia, n (%)		42 (30.0)	4 (40.0)	0.496
Truncal ataxia, n (%)		6 (4.3)	0 (0.0)	1.000
Hydrocephalus, n (%)				
Ventricular system enlargement		71 (50.7)	8 (80.0)	0.103
Previous hydrocephalus treatment	None	132 (94.3)	8 (80.0)	0.064
	CSF shunt	1 (0.7)	1 (10.0)	
	EVD	7 (5.0)	1 (10.0)	
Tumor location*, n (%)				
Fourth ventricle		56 (40.0)	10 (100.0)	< 0.001
Vermis		35 (25.0)	1 (10.0)	0.452
Cerebellar hemisphere		50 (35.7)	0 (0.0)	0.031
Brainstem		25 (17.9)	0 (0.0)	0.215
Cerebellar peduncle		8 (5.7)	0 (0.0)	1.000
Cerebellopontine angle		6 (4.3)	0 (0.0)	1.000
Multifocal tumor		5 (3.6)	1 (10.0)	0.344
Histopathology, n (%)				
Medulloblastoma**		33 (23.6)	6 (60.0)	0.083
Ependymoma		13 (9.3)	1 (10.0)	

Pilocytic astrocytoma		86 (61.4)	3 (30.0)	
Other		8 (5.7)	0 (0.0)	
Operative characteristics, n (%)				
Urgent surgery		79 (56.4)	9 (90.0)	0.047
Extent of resection	Partial	13 (9.3)	0 (0.0)	0.543
	Subtotal	50 (35.7)	2 (20.0)	
	Gross-total	72 (51.4)	8 (80.0)	
	Biopsy	5 (3.6)	0 (0.0)	
Surgical approach for fourth ventricular tumors, n (%)				
Telovelar		51 (91.1)	9 (90.0)	1.000
Transvermian		5 (8.9)	1 (10.0)	

Abbreviations: CMS, cerebellar mutism syndrome; IQR, interquartile range; mRS, modified Rankin Scale; CSF, cerebrospinal fluid; EVD, external ventricular drain.

Footnotes:

* Tumor-location categories were not mutually exclusive, as individual tumors could involve more than one anatomical compartment; therefore, percentages do not sum to 100%.

** Although the overall distribution of histopathological diagnoses did not differ significantly between the groups (p = 0.083), medulloblastoma was more frequent among patients with CMS than among those without CMS (60.0% vs. 23.6%; p = 0.020).

Note: Continuous and ordinal variables were compared using the Mann–Whitney U test. Binary categorical variables were compared using Fisher's exact test, whereas categorical variables with more than two levels were compared using the Fisher–Freeman–Halton exact test. All tests were two-sided.

Follow-up and oncological treatment

Median follow-up was 3.2 years (IQR 1.0-5.3; range 0-11.1 years). Following surgery, radiotherapy was administered to 47 patients (31.3%), while 59 patients (39.3%) received chemotherapy. At discharge, patients who developed cerebellar mutism syndrome had higher mRS scores than those who did not (median 3 vs. 1; Mann–Whitney U = 191, $p < 0.001$), and this difference remained significant at last follow-up (median 2 vs. 1; Mann–Whitney U = 402, $p < 0.017$). Twelve patients (8.0%) died during follow-up, all after documented progression of the underlying malignancy. Moreover, 40 patients (26.7%) underwent at least one subsequent neurosurgical procedure, including 26 patients (17.3%) who required

repeat tumor resection. Overall, 56 subsequent surgical procedures were performed, including 36 repeat tumor resections. Only one patient who developed CMS following the index surgery subsequently underwent repeat tumor resection. Particularly, the patient underwent 4 additional tumor resections, none of which was followed by recurrent CMS.

Discussion

In this retrospective series, CMS occurred in 10 of 150 children (6.7%), and every affected child had a tumor involving the fourth ventricle. This incidence should be interpreted in light of our case definition. Given the retrospective design and the absence of routine standardized speech-language assessment, milder postoperative speech disturbances could not be classified reliably from the available clinical documentation. We therefore restricted case ascertainment to unequivocal episodes of postoperative complete mutism, thereby minimizing the risk of misclassification bias. Children with reduced but preserved speech were therefore not classified as CMS cases. The consensus definition of postoperative pediatric CMS proposed by the Iceland Delphi Group is broader, encompassing reduced speech and mutism, as well as emotional lability, following cerebellar or fourth ventricle tumor surgery [10]. Accordingly, the incidence reported in our cohort reflects a severe CMS phenotype characterized by complete mutism and does not capture the full clinical spectrum recognized by the consensus definition.

This distinction may largely account for the lower incidence in our cohort compared with many published series [17-19]. In an international multicenter retrospective study that distinguished cerebellar mutism as a postoperative speech symptom from CMS as a full clinical syndrome, cerebellar mutism occurred in 23.5% of children, whereas CMS occurred in 6.5% (range 0-10.3%) [20]. The 6.7% incidence observed in our cohort falls within this range. Moreover, differences in cohort composition must also be considered. Pilocytic astrocytoma accounted for 59.3% of our patients and medulloblastoma for 26%. Within the medulloblastoma subgroup, CMS occurred in 6 of 39 children (15.4%), compared with 24% reported by Robertson et al. in a prospective study of 450 children with medulloblastoma [5]. The retrospective design may also have contributed to underestimation of CMS incidence, as milder postoperative speech disturbances are more likely to go unrecognized in clinical records [21]. Thus, our estimate reflects the incidence of severe CMS phenotype in a pilocytic astrocytoma-predominant cohort. It should not be interpreted as a measure of the overall burden of postoperative speech impairment after posterior fossa surgery.

Patients younger than 3 years were excluded from the study. In preverbal children, the diagnosis of CMS cannot rely on loss of speech and must instead be inferred from an abrupt and marked loss of previously acquired vocalizations accompanied by pronounced emotional lability [17]. Such assessment is necessarily more subjective and potentially less reproducible than diagnosis based on the loss of established speech. We therefore selected 3 years as a pragmatic lower age threshold, reasoning that, before this age, speech may not yet be sufficiently established to provide a stable preoperative verbal baseline against which delayed postoperative loss can be assessed. We acknowledge that this cutoff

was a study-specific methodological decision rather than one based on published criteria, and that large prospective cohorts in this field have included children of all ages [22]. Evidence regarding the effect of age is inconsistent across published series, with some reporting greater susceptibility to postoperative speech impairment (POSI) in younger children [22] and others identifying children between 8 and 16 years as being at highest risk of CMS [23]. Our findings therefore cannot be generalized to children younger than 3 years. Whether excluding this age group increased or decreased the observed incidence cannot be determined, as the available evidence points in both directions.

Mutism developed at a median of 1 day after surgery, consistent with the characteristic delayed onset of CMS [10, 24]. Its median duration was 41 days, comparable to the 45-day median reported by Yang et al. [25]. Among the 66 children with tumors involving the fourth ventricle, 10 (15.2%) developed CMS and 56 (84.8%) did not. In contrast, no cases of CMS occurred among the 84 children without fourth ventricular involvement (Fisher's exact test, $p < 0.001$). This finding is consistent with a systematic review of 28 studies comprising 2,276 patients, in which involvement of the fourth ventricle, superior cerebellar peduncle, and brainstem was associated with CMS [24]. The association with fourth ventricular involvement is also anatomically plausible, given the proximity of these tumors to cerebellar outflow structures implicated in the pathophysiology of CMS, particularly the superior cerebellar peduncles and dentato-rubro-thalamo-cortical pathways [26, 27].

Medulloblastoma was more frequent among children with CMS than among those without it (60.0% vs. 23.6%; $p = 0.020$), consistent with the association between medulloblastoma and CMS reported in pooled analyses [24]. However, all CMS cases occurred in patients with fourth ventricular involvement. In an additional exploratory analysis restricted to this subgroup, neither the overall distribution of histopathological diagnoses nor the frequency of medulloblastoma differed significantly between children with and without CMS. Given the small number of CMS cases, these findings do not permit conclusions regarding an independent association between tumor histology and CMS.

Because CMS occurred exclusively in patients with tumors involving the fourth ventricle, the analysis of surgical approach was restricted to this subgroup. The transvermian route was also used for tumors involving the cerebellar vermis, where it represented an approach to the tumor itself rather than a corridor to the fourth ventricle. Within the fourth ventricular subgroup, CMS occurrence did not differ significantly between the telovelar and transvermian approaches ($p = 1.000$). However, 60 patients underwent a telovelar approach, and only 6 underwent a transvermian approach. This marked imbalance and the small number of CMS cases preclude a reliable comparison of CMS risk between the two approaches; the nonsignificant result should not be taken as evidence of equivalent risk**.** Grønbæk et al. similarly found no difference in POSI risk between the transvermian and telovelar approaches in a prospective multicenter study of 426 children and no evidence to favor either route [22].

Urgent surgery was performed in 90.0% of children with CMS and 56.4% of those without it ($p = 0.047$). Given the limited number of CMS cases, this association should be interpreted cautiously. In our practice, the indication for urgent surgery was generally related to hydrocephalus or substantial mass

effect from a large posterior fossa tumor. Thus, the observed association with CMS may reflect the severity of the clinical and anatomical presentation rather than an effect of surgical urgency itself. Preoperative ventricular enlargement was also more common among children with CMS (8/10, 80.0%) than among those without it (71/140, 50.7%), but the difference was not statistically significant (Fisher's exact test, p = 0.103). Xu et al., however, found preoperative hydrocephalus to be significantly associated with CMS in a larger series of 292 children [23]. Taken together, these observations raise the possibility that hydrocephalus and posterior fossa mass effect may contribute to the association observed with urgent surgery, although their independent effects could not be assessed in our cohort.

The extent of resection did not differ between children with and without CMS (p = 0.543). Renne et al. likewise reported in the multicenter analysis that none of the operative variables examined, including complete or near-total resection, treatment of hydrocephalus before tumor resection, prone positioning, ultrasonic aspirator use, external ventricular drainage, and the telovelar approach, was associated with CMS [20]. However, a recent systematic review identified gross-total resection as a potential intraoperative risk factor for CMS [28].

In our cohort, no cases of CMS were observed following repeat tumor resection. Twenty-six children (17.3%) underwent at least one subsequent resection. Only one had developed CMS after the primary operation; this child subsequently underwent four additional resections without recurrent CMS. This observation is consistent with reports suggesting that POSI may occur less frequently after repeat than after primary posterior fossa surgery [29]. Although consistent with previous reports, the limited number of patients undergoing repeat tumor resection in our cohort limits the conclusions that can be drawn regarding CMS risk after reoperation.

Management of CMS in our cohort was heterogeneous. Seven of the 10 affected children received pharmacological treatment, most commonly sertraline or benzodiazepines, while 3 received no pharmacological therapy. Given the small number of patients and non-standardized treatment selection, the contribution of individual pharmacological interventions to recovery cannot be determined from our data. In a previous case report from our institution, we described rapid but transient improvement in speech following intravenous midazolam, with symptoms recurring within approximately two hours, whereas subsequent oral midazolam did not produce a comparable clinical response [30]. The isolated observation, however, cannot establish treatment efficacy. The evidence base for pharmacological treatment of CMS remains limited, as a systematic review identified only 11 reports comprising 13 treated patients, while an earlier literature review similarly found the available evidence to consist predominantly of case reports and small case series [13]. Additionally, more recent comparative data have not demonstrated a clear overall benefit of SSRI treatment, although earlier initiation of fluoxetine was associated with shorter CMS duration [23]. In the absence of an established pharmacological therapy, multidisciplinary rehabilitation addressing speech and language, swallowing, motor, and neurobehavioral impairments remains a key component of CMS management, although evidence-based standards for rehabilitation have yet to be established [14, 15].

Limitations

This study has several limitations related to its retrospective, single-center design and the limited number of CMS cases. With only 10 affected children, statistical power was limited, and independent risk factors could not be assessed reliably. Children with reduced but preserved speech were not counted as cases; therefore, the incidence we report is likely an underestimate. The age threshold of 3 years was chosen based on speech development milestones, as no established cutoff exists for CMS diagnosis. Speech was not assessed with a standardized instrument at fixed intervals, so the recorded duration of mutism has limited precision. Finally, management was not standardized throughout the study period, precluding an assessment of the effects of individual treatments on recovery.

Conclusions

In this single-center series, CMS occurred in 6.7% of children following posterior fossa tumor surgery. All children who developed CMS had fourth ventricular tumor involvement. Medulloblastoma and urgent surgery were more frequent among children with CMS, but the small number of CMS cases and the interrelationships among tumor location, histology, and clinical presentation precluded assessment of their independent effects. Management was heterogeneous, and the available data did not support recommendation of any specific treatment strategy. Prospective multicenter studies using uniform diagnostic criteria and standardized longitudinal assessment are needed to clarify risk factors, recovery patterns, and the role of targeted treatment in CMS.

Declarations

Acknowledgments

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Conflict of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethics approval

The study was approved by the Bioethics Committee of the Medical University of Silesia in Katowice (Resolution No. BNW/NWN/0052/KB1/74/1/24).

Consent for publication

Not applicable.

Availability of data and material

Datasets analyzed during the current study preparation are available from the corresponding author upon reasonable request.

Authors' contributions

Conceptualization: KS, NW, NK, RS; Methodology: NW, NK, RS; Validation: RS; Formal analysis: KS, NW, NK, RS; Investigation: KS, NW, NK, RS; Data Curation: NW; Visualization: NW, RS; Writing - Original Draft: KS, NW, NK, RS; Writing - Review & Editing: NW, MM, RS; Supervision: MM, RS.

All authors have approved the final version of the manuscript.

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Figures

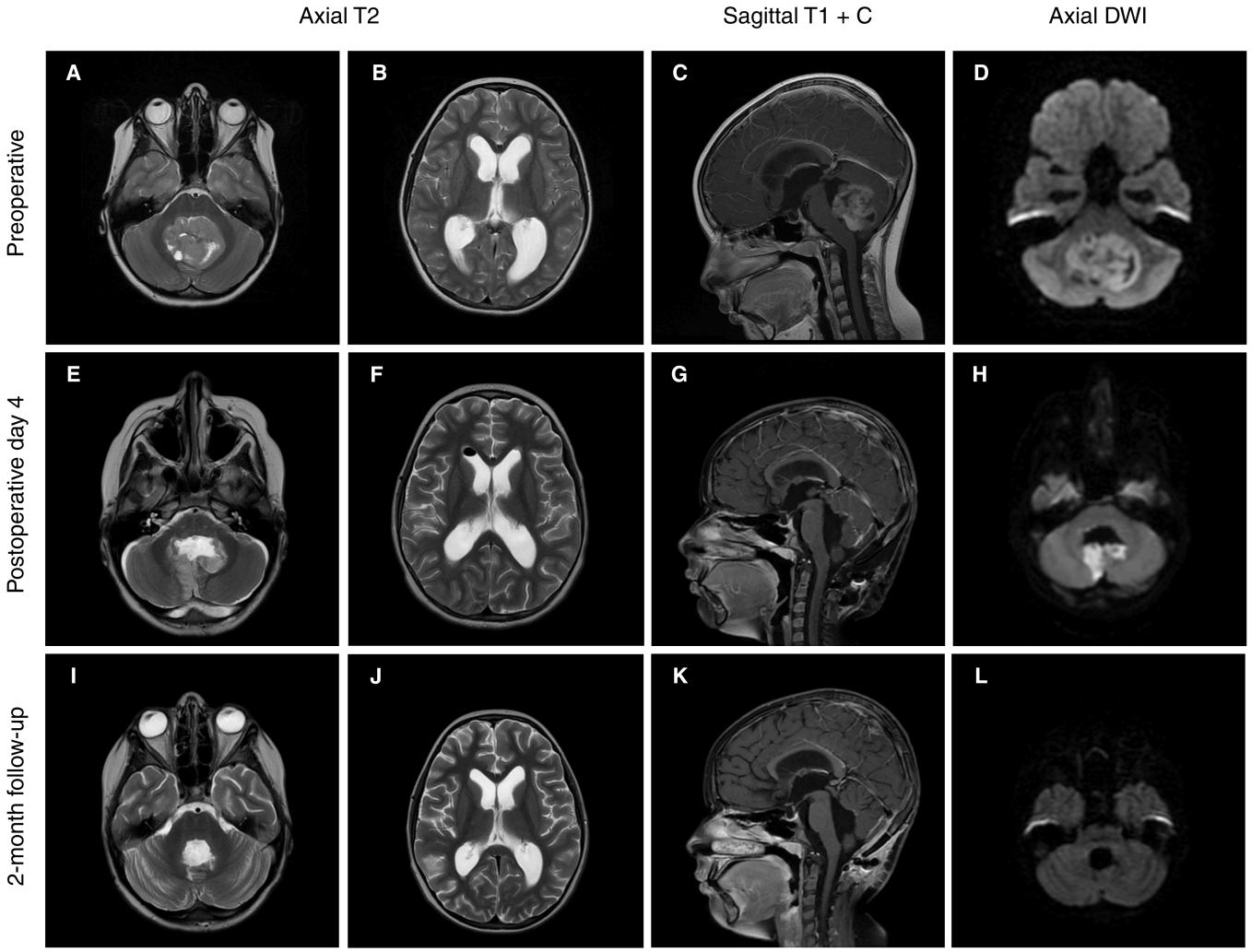


Figure 1

Preoperative and postoperative MRI findings in a patient who developed cerebellar mutism syndrome after resection of a fourth ventricular tumor.

Preoperative imaging (A-D) demonstrates a large fourth ventricular mass causing obstructive hydrocephalus (A, B), with heterogeneous contrast enhancement (C) and restricted diffusion (D). MRI obtained on postoperative day 4 (E-H) demonstrates the resection cavity with decreased ventricular dilatation and no residual enhancing tumor (E-G), together with a new area of diffusion restriction in the right cerebellar hemisphere, compatible with postoperative ischemic change (H). At 2-month follow-up (I-L), the postoperative diffusion abnormality had evolved into encephalomalacic change involving the medial cerebellar region, with associated supratentorial widening of cerebral sulci (I, J). No residual enhancing tumor or persistent diffusion restriction was identified (K, L). Panels A, E, and I are axial T2-weighted images through the posterior fossa; B, F, and J are axial T2-weighted images at the level of the lateral ventricles; C, G, and K are midline sagittal contrast-enhanced T1-weighted images; and D, H, and L are axial diffusion-weighted images through the posterior fossa.