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Complications And Influence of Surgical Approaches of Fourth Ventricle Tumors in Children

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Abstract: Background: Tumors of the fourth ventricle in children pose a particular surgical challenge due to the proximity of eloquent neural parenchyma in the region. The two most common surgical routes to the fourth ventricle are the transvermian and telovelar approaches.

Objectives: The goal of this study was to characterize the complications and morbidity related to the surgical management of pediatric fourth ventricle tumors

Methods: this retrospective study includes 50 patients with 4th ventricle tumors from three centers (Dr.Saad Alwatry hospital, neurosurgical teaching hospital and Ghazi Al-Hriri hospital) in period from oct.2021 to oct.2022 . Preoperative imaging and clinical notes were reviewed to extract data on presenting symptoms, surgical techniques, and postoperative complications.

Results: Across the whole series, the transvermian approach was more frequent than the telovelar approach (60% vs 40%). The most common postoperative deficit was cerebellar mutism syndrome (CMS12%), followed by new weakness (10%), cranial neuropathy (8%), and new gait abnormality/ataxia (6%). There was no significant difference in the rate of CMS between telovelar or transvermian approaches (p = 0.722).

Conclusions: Surgical management of pediatric fourth ventricle tumors continue to evolve. CMS is enduringly the major postoperative complication in this patient Population..

Keywords: 4th ventricle tumor, transvermian, telovelar and cerebellars mutism syndrome.

1. Introduction

Medulloblastoma is one of the most common malignancies in children. It usually starts in the 4th ventricle region of the brain [(1)]. However, it is a high-grade tumor that can use the fluid circulating in the nervous system to spread throughout the brain and spine [(2)]. Telovelar and transvermian approaches are two of the most common approaches for resection of the fourth ventricle tumors [(3)]. There is controversy regarding the rates of postoperative complications attributed to each of these approaches [(4)]. Transvermian the oldest and most widely used surgical approach to the fourth ventricle consists of splitting the inferior vermis on the suboccipital surface [(5)]. The extent of the incision through the inferior vermis has been poorly described [(6).] The incision extends a variable distance through the uvula, pyramid, tuber, and folium of the vermis, depending on the location and size of the pathological area [(7)]. Most authors advocate limiting the vermian incision to the smallest possible length necessary to gain access to avoid complications associated with splitting the vermis [(8).] The vermian incision exposed the

underlying nodule, which was necessarily incised along with the tela choroidea and inferior medullary velum to gain access to the fourth ventricle [9]. Retraction of the two halves of the lower vermis provided approximately 1 to 2 cm of working space between the two edges of the inferior vermis [10]. Surgical resection of fourth ventricle tumors in children, primarily approached via transvermian or telovelar routes, carries risks such as cerebellar mutism syndrome (CMS), occurring in approximately 28.7% of cases [11] [12]. Other potential complications include new-onset weakness (24.0%), cranial neuropathies (18.0%), and gait abnormalities or ataxia (12.6%) [13].While the telovelar approach has gained favor due to its cerebellum-sparing nature, studies indicate that the choice between transvermian and telovelar approaches does not significantly impact the incidence of postoperative complications, suggesting that surgical strategy should be tailored to individual tumor characteristics [14] [15].

2. Method

A longitudinal (prospective and retrospective) study performed in 3 center (Dr Saad Alwatry Hospital, neurosurgical teaching hospital and Ghazi Al- Hariri Hospital) to compare the early surgical related complications between transvermian and telovelar approaches of fourth ventricle in children between oct.2021 and oct. 2022 of 50 cases. 15 cases of telovelar approach taken from Dr. Saad Alwatry hospital and 5 cases from neurosurgical teaching hospital while 20 cases of transvermian approach taken from neurosurgical hospital and 10 cases from Ghazi Al- Hariri Hospital. Preoperative imaging of these patients was reviewed to screen for true fourth ventricle tumors. This included tumors in the fourth ventricle with extensions into the vermis or medial cerebellar hemispheres, cerebellopontine angle (CPA) via foramina of Luschka, and exophytic midbrain or medullary tumors.

The clinical course of patients included in the study was assessed over the first 30 postoperative days. Postoperative pediatric CMS was defined as present or absent based on the description of mutism by medical notes by the attending neurosurgeon or multidisciplinary staff, who covered pediatric neurology and physiotherapy. Postoperative weakness was defined as new postoperative focal motor weakness or long tract signs such as hypotonia or hyperreflexia. thirty of 50 patients (60%) were placed in the sitting position; 20/50(40%) were positioned prone. The posterior fossa was exposed via a suboccipital craniotomy and craniectomy was undertaken. The surgical approach to the fourth ventricle was Transvermian in 30 (60%) and Telovelar in 20 (40%) patients. Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used, and the significance of differences in qualitative data was tested using Pearson's Chi-square test, Yate's correction, or Fisher's exact test where applicable, with a significance threshold of $P \leq 0.05$. Ethical considerations included obtaining approval from the ethical committee of the Scientific Council for Neurosugery and the Ministry of Health, maintaining participant confidentiality, and securing verbally informed consent from participants or their relatives after explaining the study's objectives.

3. Results

Table (1) presenting symptoms and signs

Presenting Symptoms & Signs	No.	%
Headache	15	30%
Vomiting	24	48%
Ataxia	4	8%
visual disturbance	7	14%
Hydrocephalus	32	64%

Table (1) show the mean age at presentation was 5.98 years (SD 4.12 years); 28 patients were male (56%). Hydrocephalus was seen in 32 patients (64%) at the presentation. The most common presenting symptom was vomiting (24/50, 48%), followed by headache (15/50,30%), Visual change (7/50, 14%), ataxia (4/50, 8%).

Table (1) Tumor histology

Characteristic Histology	No.	%
medulloblastoma	27	54%
ependymoma	12	24%
pilocytic astrocytoma	11	22%

Table 2 the most common histology type was medulloblastoma (27/50,54%) then ependymoma (12/50,24%) and astrocytoma (11/50,22%).

Table (3) post operative morbidity in 50 patients with 4th vent. Tumor

Post-Op. Morbitiy	No.	%
CMS	6	12%
Weakness	5	10%
cranial neuropathy	4	8%
Gait disturbance	3	6%
Infection	3	6%
CSF leak	2	4%
sensory deficit	1	2%
ICH	1	2%
30-day death rate	1	2%

14 patients (28%) had no postoperative complications documented. The remainder had at least one postoperative complication documented (Table 3).

Table (4) demonstrates the association of surgical approach and postoperative neurological morbidity.

Characteristic	Telovelar	Transvermian	P-Value
CMS	2/20 (10%)	4/30 (13%)	0.722
Weakness	3/20 (15%)	2/30 (6%)	0.335
Cranial Neuropathy	2/20(10%)	2/30(6%)	0.915
Gait Disturbance	1/20(5%)	2/30(3%)	0.133
Infection	2/20(10%)	1/30(3%)	0.33
CSF Leak	1/20(5%)	1/30(3%)	0.195

The most common was CMS (12%), more associated with transvermian approach although statistically there is no association between surgical approach and CMS ($p = 0.722$). 5/50 patients (10%) had new or worsened weakness postoperatively. As the second most encountered neurological sequela of fourth ventricle tumor surgery, this appeared to be more frequent following telovelar surgery than transvermian surgery, although this result seems to be not statistically significant ($p = 0.335$). There were 1 death (2%) within 30 days of operation operated by transvermian approach after staying in RCU 7 days and cause of the death was cerebellar ischemia.

5. Discussion

This study demonstrates that resection of fourth ventricle tumors in children carries a high risk of neurological morbidity in the early postoperative period. Fifty patients were included in this analysis. Surgical approach evolved significantly over the course of the series, with more emphasis on sitting positioning and the transvermian approach. Only 14/50 had no documented complications. Presenting symptoms in this series were most found to be vomiting and headache, younger patients were more likely to present with ataxia which is plausible because older children have better developed cerebellar motor function. Older patients were more likely to describe visual changes and headaches on presentation, owing to greater language capacity. The

analysis revealed that children tended to present with either “global” neurological deficits (such as hydro-cephalus or symptoms thereof) or more focal ones (such as cranial neuropathy). In the 32 patients (64%) who presented with hydrocephalus, 24 underwent VPS, and 8 underwent ETV. The most common complication of fourth ventricle tumor surgery remains CMS; its incidence has remained relatively constant throughout the series (12% overall), and we found no evidence that this is influenced by favoring a transvemian over a telovelar intradural approach.in compare to our study ,a study done by Sebastian M. Toescu et al, at 2021 167 fourth ventricle tumors with full data sets were included in his analysis. One hundred patients were male (mean age ± SD, 5.98 ± 4.12 years). The most common presenting symptom was vomiting (63.5%). The most common tumor types, in order, were medulloblastoma (94 cases) > pilocytic astrocytoma (30 cases) > ependymoma (30 cases) > choroid plexus neoplasms (5 cases) > atypical teratoid/rhabdoid tumor (4 cases), with 4 miscellaneous lesions. Of the 67.1% of patients who presented with hydrocephalus and they found thatThe most common postoperative deficit was cerebellar mutism syndrome (CMS)(28.7%), followed by new weakness (24.0%), cranial neuropathy (18.0%), and new gait abnormality/ataxia (12.6%). Use of intraoperative ultrasonography significantly reduced the incidence of CMS ($p = 0.0365$). There was no significant difference in the rate of CMS between telovelar or transvermian approaches ($p = 0.745$) [(16)]. in a study done at 2004 by Necmettin Tanriover M.D. et al. concluded that The transvermian approach provides slightly better visualization of the medial part of the superior half of the roof of the fourth ventricle. The telovelar approach, which lacks incision of any part of the cerebellum, provides an additional exposure to the lateral recesses and the forum of Luschka [(17)].

A study done in 2019 by Kelsey Cobourn et al. found that Seven of 65 patients (10.8%) developed CMS postoperatively. Factors found to be significantly associated with a higher risk of CMS were the degree of retraction utilized during the procedure ($p = 0.0000$) and incision of the vermis ($p = 0.0294$). Although they did not reach the threshold of statistical significance, tumor vascularity ($p = 0.19$), adoption of a transvermian approach ($p = 0.19$), and lack of intraoperative imaging ($p = 0.17$) exhibited strongly suggestive trends towards a correlation with CMS [(18)].

A study at Ain Shams University Hospital and Nasser Institute in which 40 patients included done by Khaled et al.in 2019 found that 6 patients underwent telovelar approach,1 case of superficial infection, 3 cases of bulbar palsy (15% of patients operated via telovelar approach), and 3 cases of cerebellar mutism (15% of patients operated via transvermian approach and 7.5% of all patients) [(19)].

A single-institution cohort of 92 consecutive pediatric patients harboring tumors involving the fourth ventricle, surgically treated via the telovelar or transvermian approach, was retrospectively reviewed to analyze the impact of surgical route on surgery-related outcomes done by Nicola Onorini in 2021concluded that Cerebellar mutism was observed in 10 cases (11%). No significant difference in the onset of cerebellar mutism was detected between telovelar and transvermian approach. The choice of surgical approach did not significantly modify any other postoperative outcome. [(20)]

6. Conclusion

The choice of the surgical approach (telovelar vs. transvermian) to fourth ventricular tumors in children did not significantly modify any considered postoperative outcome, including the incidence of postoperative CM. Our findings offer significant data to reconsider the real impact of the choice of surgical route to the fourth ventricle on the incidence of CM and surgery-related morbidity. Surgical approach to the fourth ventricle, like all surgical approaches, should be individualized according to the location of the tumor, degree of vermian infiltration, and lateral and upward extension. Surgeons should fully master both approaches and choose the one that they consider the best for the patient according to preoperative imaging evaluation.

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