

Original Research Article

An analysis of factors determining the requirement of ventriculoperitoneal shunt surgery in the children suffering from posterior fossa tumour: a single centre retrospective review

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ABSTRACT

Background: Hydrocephalus is a relatively common occurrence in a children suffering from the posterior fossa tumour (PFTm). However, there is a divided opinion regarding the ventriculoperitoneal shunt (VPS) surgery before the posterior fossa tumour resection in a child. For the better clinical outcome, we should be able to predict which patient will require VPS following the resection of PFTm. Purpose of our retrospective analysis is to analyse various factors that predicts the necessity of VPS following PFTm resection.

Methods: A consecutive series of twenty-six patients who underwent PFTm resection without undergoing VPS preoperatively are analysed in our series.

Results: In our series, we found that the younger age at presentation, incomplete tumour resection, longer period of artificial ventilatory support, insertion of external ventricular drain (EVD) and its duration during the postoperative period correlate the necessity of VPS following PFTm resection. However, the severity of hydrocephalus prior to tumor surgery, tumour size, anatomical location of the tumour, tumour dissemination, use of Dural grafts during closure and histopathological type do not predict the requirement of the VPS following PFTm.

Conclusions: Patients who are younger at diagnosis should be treated with utmost importance. Gross total resection should be the goal. Factors which predict the likelihood of the EVD which parallels the likelihood of postresection hydrocephalus must be prevented for the better clinical outcome.

Keywords: External ventricular drain, Hydrocephalus, Posterior fossa tumour, Ventriculoperitoneal shunt

INTRODUCTION

Due to the anatomic relationships of the posterior fossa tumours to the cerebrospinal fluid (CSF) drainage pathways, hydrocephalus is common, occurring in 71-90% of children with posterior fossa tumors.¹ In contrast to adults, the majority of central nervous system tumours of childhood are located infratentorially.² The proximity to the fourth ventricle, and therefore, the cerebrospinal fluid (CSF) pathways, predisposes children with posterior fossa tumours to the development of obstructive

hydrocephalus.^{3,4} Medulloblastoma usually arise in the cerebellar vermis, at the apex of the roof of the 4th ventricle (fastigium in the region of the posterior medullary velum), which predisposes to the early obstructive hydrocephalus.⁵ Hydrocephalus after tumor resection occur in 10-36% of cases, with a worldwide average of 30%.⁶⁻⁸ The optimal management of hydrocephalus in a child with a posterior fossa tumor is a topic of debate.⁹ Various treatments have been reported including multiple ventricular taps, insertion of external ventricular drains, internal CSF shunts for initial therapy of hydrocephalus. it has also been reported that

precraniotomy CSF shunting with a waiting period of one or two weeks between the insertion of the shunt and the removal of the posterior fossa tumour (PFTm) results in a better operative field and a lower level of morbidity and mortality.^{10,11}

Purported benefits of permanent pre-resection CSF diverting surgery, such as ventriculoperitoneal shunt (VPS) other than the reduced incidence of postresection hydrocephalus, include the following. Being able to delay resection surgery, thus avoiding resection under emergent conditions or allowing for pre-resection adjuvant therapy in certain circumstances; reducing the likelihood of needing external CSF diversion, which may carry risk of infection; and potentially reducing risk of post-resection CSF leak or pseudomeningocele.^{6,12}

It has been established that after PFTm resection in majority of the patients of paediatric age group, resolution of the hydrocephalus occurs. Moreover, before undergoing tumour resection, if VPS is done, many a complication can occur. Shunt malfunction, infection, seeding of tumour cells through the shunt tube, upward transtentorial herniation, intratumoural haemorrhage, subdural hygroma, subdural haemorrhage are known complications. Purported disadvantages of VPS includes performance of a procedure that may not be clinically indicated following the resection of the tumour, risk of exposing the patients to the unnecessary surgery; and inability to externally drain the spillage of blood products after the resection.

Moreover, the patients, who underwent VPS before the tumour resection, may become shunt dependent or may have a permanently inserted shunt tube in-situ, when the diversion of the CSF into the abdominal cavity is not required. Hence, to treat the hydrocephalus in a child with PFTm, an alternative, yet effective and safe method of treatment is to identify the patients' group that will require shunting ultimately either before or after the tumour resection surgery.

In this series, various factors have been analysed that predicts the necessity of VPS surgery.

METHODS

This is a retrospective type of study conducted during the time period between November 2017 to August, 2019, in the department of Neurosurgery, Gauhati Medical College and hospital, Assam, after taking the clearance from the ethical committee. We specifically analysed the various factors which predicts the VPS surgery following the PFTm resection. 26 patients with PFTm were analysed.

Inclusion criteria

Inclusion criteria were age <14 years, patient diagnosed to have posterior fossa tumour and patient who underwent resection of PFTm.

Exclusion criteria

Age more than 14 years, patients with known coagulopathy and patients with severe systemic disorder were excluded.

Study group classification. They were assessed in two groups. The patients that required VPS surgery following the tumour resection and the patients that did not require VPS surgery following the tumour resection.

The following parameters have been analysed, Age at diagnosis, gender, presence and duration of raised intracranial pressure symptoms pre-operatively, maximum diameter of the tumour, cerebellum and tumour size ratio, size of the temporal horn (TH), presence or absence of the periventricular lucency on computerized tomography (CT) of brain, Evan's ratio (ER) i.e. FH (frontal horn) : maximum BPD (biparietal diameter) in the same CT slice, FH (frontal horn) : ID (internal diameter) ratio (where FH is the largest width of the frontal horn and ID is the internal diameter from inner table to the inner table at the same level), presence of tumour dissemination (craniospinal or extraneural), tumour location, extent of tumour resection (complete, subtotal, partial, or biopsy sample), requirement of dural graft during dural closure (autologous/artificial), application and duration (days) of external ventricular drain (EVD), duration of artificial ventilatory support post-operatively, histopathological diagnosis and post-operative complications (e.g. CSF leak, pseudomeningocele formation, meningitis).

Neuroimaging studies

Following characteristic features of tumours were noted on CT/MR imaging- location, size, and presence of the spinal metastasis. Relevant investigations were analysed to determine the absence or presence of the extra-neural metastasis. Computerized tomography scanning, which was performed within 24 hours of tumour removal in all patients to grade the extent of tumour resection (in cases of complete and subtotal resection, no areas of contrast enhancement were evidenced), were also analysed retrospectively.

During the postoperative period, VPS surgery were done whenever patient develops EVD dependence, hydrocephalus, pseudomeningocele.

Statistical analysis

Data received were plotted into excel sheet on MS Office Excel 2007. Unpaired t-test was used to detect the difference between the intervention arms. The categorical data were analysed by Fisher's exact test. The p value <0.05 was considered significant.

RESULTS

Age of the patients were 8.58±4.62 years. In this series, 17 patients (65.38%) were male and 9 patients (34.62%)

were female. Male and female ratio was 1.89:1. Maximum diameter of the tumours (in cm) were 3.74±2.18. The ratio between the size of cerebellum and the tumour being 2.86±0.32. Diagnosis of hydrocephalus were made on the following criteria such as size of the TH (mm), Evan's ratio, FH: IPD ratio and presence or absence of the periventricular lucency.

Table 1: Characteristics of total 26 patients suffering from the posterior fossa tumours.

Characteristics	Values
Age (years)	8.58±4.62
Male:female	1.89:1
Tumour size (maximum diameter in cm)	3.74±2.18
Cerebellum: tumour size ratio	2.86±0.32
Size of the TH (mm)	4.12±0.99
Evan's ratio	0.45±0.09
FH:IPD ratio	0.59±0.07
Number of patients having periventricular lucency (%)	26 (100)
Number of patients having tumour dissemination (%)	6 (19.23)
Number of patients having tumour at midline (%)	21 (80.77)
Nos. of cases required dural graft for dural closure (%)	3 (11.54)
Nos. of patients required perioperative EVD (%)	9 (34.62)
Duration of EVD (days)	3.55±0.97
Duration of artificial ventilatory support post-operatively (hours)	16.90±25.78
Nos. (%) of postoperative complications	9 (34.62)

*Data given as mean±SD unless otherwise indicated, *IPD= internal parietal diameter.

In present series, 4 cases (15.38%) were having neural metastasis and 2 cases (3.85%) were having extraneural metastasis. Gross total resection was done in 17 (65.38%) patients, subtotal resection was done in 7 (26.92%) patients, partial resection was done in 1 (3.85%) patient and biopsy sample was taken in 1 (3.85%) patient. Out of 26 patients, only 3 (11.54%) patients needed dural graft during the Dural closure. Total 9 (34.62%) patients needed post-operative EVD. Duration of keeping the EVD (in days) was 3.55±0.97, in the post-operative period. During the post-operative period, the duration of keeping the artificial ventilatory support (in hours) was 16.90±25.78.

Postoperative complications were seen like wound dehiscence (CSF leak), surgical wound site infection, psedumeningocele, cerebellar mutism and death.

On histopathological analysis, medulloblastoma was found in 17 (65.38%) patients, ependymoma in 6

(23.08%) patients, and astrocytoma in 3 (11.54%) patients.

Table 2: Relative frequency of surgical resection procedures.

Extent of resection	Frequency (%)
Gross total	17 (65.38)
Subtotal	7 (26.92)
Partial	1 (3.85)
Biopsy only	1 (3.85)

Table 3: Histopathological subtypes of the posterior fossa tumour.

Histopathological subtypes	Frequency (%)
Medulloblastoma	17 (65.38)
Ependymoma	6 (23.08)
Astrocytoma	3 (11.54)

Table 4: Different parameters in the comparison of patients with and without post-operative VPS.

Parameters	Shunted	Non-shunted	P value
Age (years)	5.31±2.67	10.77±3.56	0.001
Tumour size	4.13±2.36	3.03±0.51	0.060
Size of the TH (mm)	4.31±1.34	4.00±0.89	0.499
Evan's ratio	0.51±0.13	0.43±0.08	0.069
FH:IPD ratio	0.65±0.05	0.56±0.13	0.090
Duration of the EVD (days)	5.88±0.91	2.23±1.02	<0.0001
Duration of support of ventilation (hrs)	30.56±25.99	09.67±21.49	0.048

*VPS= Ventriculo-Peritoneal Shunt.

Out of the 26 patients, seven (26.92%) cases were shunted postoperatively. Young age at diagnosis was found to be a significant predictor for postoperative shunting (p=0.001). Tumour size does not have any statistically significant relation with the post-operative requirement of the VPS (p=0.424) and so is the ratio between the size of the cerebellum and the tumour (p=0.600). Size of the temporal horn (p=0.499), Evan's ratio (p=0.069), FH: IPD ratio (p=0.900), presence or absence of the tumour dissemination (p=0.692), Tumour location whether midline or lateral (p=0.541) does not have any association with necessity of the post-operative VPS.

The patient group who had gross total resection is less likely to undergo the VPS in the post-operative period (p=0.019), however the requirement of the Dural graft during the Dural closure does not have any association

with VPS surgery after the resection of the tumour. Post-operatively the requirement of the EVD, duration of the EVD and the ventilatory support are associated with more likelihood of post-operative EVD ($p=0.001$, <0.0001 and 0.048 , respectively), unlike the post-operative complications ($p=0.599$).

However, the histo-pathological subtype does not predict the likelihood VPS post-operatively ($p=0.599$).

Table 5: Correlation between the tumour dissemination and requirement of VPS.

Presence of tumour dissemination	Shunted	Non-shunted	P value
Yes	2	4	0.692
No	5	15	

Table 6: Correlation between the tumour location and requirement of VPS.

Tumour location	Shunted	Non-shunted	P value
Midline	6	15	0.541
Lateral	1	4	

Table 7: Correlation between the type of tumour resection and requirement of VPS.

Gross total resection	Shunted	Non-shunted	P value
Yes	2	15	0.019
No	5	4	

Table 8: Correlation between the placement of artificial dural graft and requirement of VPS.

Artificial dural graft	Shunted	Non-shunted	P value
Yes	1	2	0.948
No	6	17	

Table 9: Correlation between the placement of EVD and requirement of VPS.

EVD required	Shunted	Non-shunted	P value
Yes	6	3	0.001
No	1	16	

Table 10: Correlation between the peri-operative complications and requirement of VPS.

Peri-operative complications	Shunted	Non-shunted	P value
Yes	3	6	0.599
No	4	13	

Table 11: Correlation between the histo-pathological subtypes and requirement of VPS.

Histo-pathological subtypes	Shunted	Non-shunted	P value
Medulloblastoma	4	13	0.599
Other than medulloblastoma	3	6	

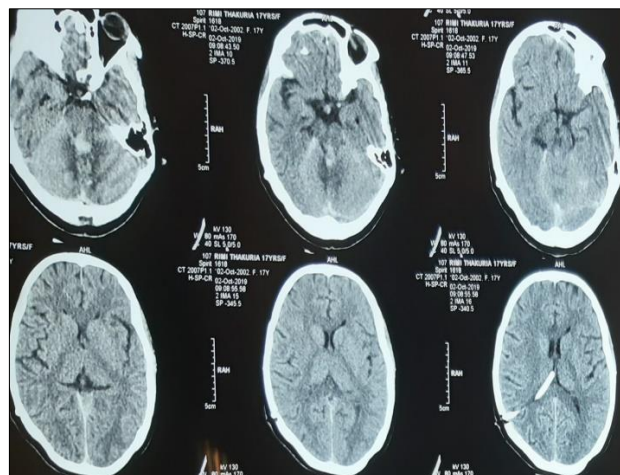


Figure 1: Plain CT image of brain showing the VPS in-situ following posterior fossa tumour resection to treat hydrocephalus.

DISCUSSION

The association of posterior fossa tumours with hydrocephalus is a potentially lethal condition.^{11,13} The optimal management of hydrocephalus in a child with posterior fossa tumour is a topic of debate.⁹ Ideally, we would be able to predict which patients will develop post-resection hydrocephalus.¹⁴

Younger age at diagnosis has been shown to be significantly associated with the post-resection hydrocephalus by most, but, not all authors.^{3,6,15-17} Similarly, it was found younger age correlates the requirement of post tumour resection VPS. The severity of hydrocephalus prior to posterior fossa tumor surgery seems to be a predictor that a shunt will be required in patients with medulloblastoma, but not in those with other histological tumor types.^{16,17} However, in our retrospective analysis no such association has been found. Midline location, incomplete tumor removal, the use of substitute dural grafts during closure, and higher Chang stages in patients with medulloblastoma are also considered by several authors to be significant risk factors for requirement of postoperative shunts.^{6,16} Out of all these factors, it was found that only incomplete tumour removal can predict the requirement of the post-operative VPS. Tumor size and the use of external ventricular drainage however, do not appear to have a direct prognostic effect.^{6,18} Both the use of EVD and its duration predicts the requirement of VPS, although

tumour size does not have any predictive value. Longer period of artificial ventilatory support correlates with the requirement of shunt placement surgery following the tumour resection surgery. Pseudomeningocele formation, and CSF infections were statistically significant factors associated with the need for postoperative shunt placement.⁶ However, authors did not found such kind of correlation in the study.

Due to the fact that the sample size in this series is not being too large, the actual result of series may not be the similar to the result when it is conducted in a much larger study population. Moreover, there are various unknown confounding factors that could not be assessed which may have an impact on the result of these analysis. In spite of these drawbacks and concerns, authors still believe that this review forms a basis for further evaluations on a much larger scale in order to confirm the retrospective analysis.

CONCLUSION

Patients who are younger at the time of presentation should be treated with utmost importance. Gross total resection should be the goal. Factors which predict the likelihood of the EVD, must be prevented. Duration of the ventilatory support also predicts shunt insertion. Dura should be tightly closed and complications of the surgery must be avoided for the better outcome.

Recommendations

In spite of these drawbacks and concerns, it was still believed that this review forms a basis for further research work and assessment on a much larger scale in an order to make a precise guideline for the surgical management of the hydrocephalus in a child suffering from the posterior fossa tumour.

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