# Risk factors for Ventriculoperitoneal shunting in children with posterior fossa tumor

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## ABSTRACT

**Objectives:** To investigate the Predictors of the need of post-operative VP- shunting, in pediatric patients who underwent primary surgical resection for posterior fossa tumors, without pre-operative VP-shunt, were investigated.

**Methods:** All the 52 pediatric patients who presented to King Hussein Cancer Center in the last 12 years with a diagnosis of posterior fossa tumor, and who did not have a VP shunt inserted prior to undergoing their primary surgical resection in our institution, were included in the study. Patients were divided retrospectively into those who ended up with VP-shunt insertion and those who did not need a VP-shunt insertion, and then factors such as age, sex, duration of pre-operative symptoms, size of primary tumor, presence of preoperative spinal metastasis, extent of surgical resection, post-operative ICP readings, presence of post-operative spinal metastasis and the development postoperative infection and leak were investigated and compared between the two groups.

**Results:** 24 patients needed a VP- shunt to be inserted in the post-operative period. The extent of tumor excision and age below 3 years were the only significant predictors of post-operative need for VP-shunt insertion among the factors that were included in this study.

**Conclusion:** age of the patient less than 3 years was a significant factor in the need for shunt placement.The average age of the patients who needed a VP- shunt in our set of patients is 6.2 years compared to 7.3 years in patients who did not need a VP- shunt, The extent of tumor excision was also important factor in predicting the need for post-operative shunt insertion. Other factors were not significant in this study even infection which increases the basal adhesion.

**Key words:** External ventricular drain, Hydrocephalus, Posterior Fossa Tumor, Ventricular peritoneal Shunt.

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## Introduction

Central nervous system tumors are the most common solid tumors in children, and the majority of these tumors are infratentorial in comparison to adults. Obstructive hydrocephalus is a well-known complication of posterior fossa tumors due to their proximity to CSF pathways, and many children with posterior fossa tumor present with sign and symptoms of increase intracranial pressure .[2,4,6,10] That is why many patients with posterior fossa tumors require some form of CSF diversion at some point in their illness. The use of different forms of CSF diversion prior to the definitive tumor resection has been advocated by some surgeons claiming that this would decrease the morbidity and mortality of the operative resection of the tumor .[2,6,9] However, pre-operative shunting has been shown to result in making patients end up with a permanent shunt or becoming shunt dependent, and increasing their risk for the development of all the well-known complication of permanent CSF shunting .[8,11,14]

Since hydrocephalus resolves in many pediatric patients after the resection of their posterior fossa tumor, while others will require permanent CSF shunting, looking for peri-operative factors that would predict the future need for permanent CSF shunting is very important to avoid the insertion of an unnecessary VP-shunt .[1,3,5,9]

The approach that we advocate at King Hussein Cancer Center is to use pre-operative steroids to control the symptoms of increase intracranial pressure, the optional use of external ventricular drains intra-

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operatively, for five days post operation and the close follow up of the clinical and radiological status of children post-operatively to assess the need for permanent VP-shunting . [1,5,9]

## Methods

In the period between January 2004 till December 2015, all pediatric patients (< 18 years old) who underwent their primary surgical resection at KHCC were included in the study. Patients who had prior CSF diversion procedures for symptoms of increase intracranial pressure were excluded. The total number of patients fulfilling the inclusion criteria was 52. Patients were divided into 2 groups: those who did not need a post- operative VP- shunt insertion and those who ended up with a VP-shunt for this group using Fisher exact test to calculate statistical significance and p values. Factors that were compared between the 2 groups include : age at diagnosis, sex, duration of pre-operative symptoms, maximum dimension and location (midline vs hemispheric) of primary tumor on pre-operative MRI, presence of preoperative spinal metastasis according to the pre-operative MRI, extent of surgical resection according to the intra-operative findings and the post-operative MRI done within 3 days of the operation, maximum post-operative ICP reading for those who had an EVD inserted at the time of surgery, histopathology of tumor, presence of post-operative spinal metastasis on a follow up MRI done within 1 months of the operation and the development postoperative infection and leak.

All patients had head CT scan followed by MRI of the brain and spine at the time of admission. Establishment of the diagnosis of posterior fossa tumor, the size of the tumor in terms of the maximum dimension, the location of tumors in terms of midline or hemispheric location, and the presence of pre-operative spinal metastasis were determined according to the official reports of these imaging modalities. All patients were started on dexamethasone at the time of presentation, and the timing of surgery and the need for an intra-operative EVD was planned according to the urgency of the clinical and radiological status of the patient. Operative records were reviewed to document the use of an EVD and the extent of tumor resection. EVD was inserted in 34 patients using a right occipital burr hole. Microscope and ultrasonic aspirator were used in most patients in an attempt to achieve gross total excision, which was defined as the intra-operative absence of gross residual tumor and the absence of residual tumor in the post-operative MRI done within 3 days of the operation. The dura was closed in a watertight fashion or using a dural graft in 42 patients, and was left open or loosely closed in the rest of patients.

Post-operatively, all patients were sent to the pediatric ICU and kept on dexamethasone, they were also started on prophylactic antibiotics, anti-epileptics were used in patients who were receiving them pre-operatively. ICU charts were reviewed to identify the maximum intraventricular pressure record in patients with an EVD. CT scans were done to all patients on day one postoperative, and MRI imaging was done to all patients within 3 days of the operation. Clinical and radiological evidence of persistent hydrocephalus, or EVD dependence defined as an increase in the IVP associated with clinical signs and symptoms of increased intracranial pressure in between intermittent drainage of the CSF were the indications for insertion of a VP- shunt, medium pressure VP shunt were used for the patient ended with increased intracranial pressure due to hydrocephalous regardless the external ventricular drain reading as routine procedure. The development of CSF leak as evident by the post-operative imaging and the development of CSF infection proved by positive CSF analysis and culture were also recorded.

The pathology reports of our laboratory at KHCC were used to identify the histopathological diagnosis of the tumor. MRIs done within 1 month of the operation were used to follow up the patients for the development of post-operative spinal metastasis.

## Results

The characteristics of the 52 patients who were included in our study are represented in Table I and II, 24 out of the 52 patients in our series needed a VP-shunt insertion during their follow up period while the remaining 26 did not need a VP- shunt insertion. The average age of the patients at time of diagnosis, the duration of symptoms before surgery, the size of the tumor in terms of the maximum diameter on a pre-op MRI and the post-operative maximum ICP readings were not significantly different between the patients who needed a VP- shunt and those who did not need a VP- shunt.

The factors that could be assessed per-operatively, namely; the gender of the patient, the location of the tumor and the presence of pre-operative spinal metastasis were not found to be significant predictors for the need of VP- shunting. Similarly, the tumor pathology and the use of an EVD are not significant predictors for the need of a VP- shunt. The significant predictors of the need of future VP- shunting in our study is the extent of tumor resection and patients age below 3 years. Patients who had a gross total excision of their tumor have significantly lower risk to need a VP- shunt insertion. The development of post-operative complications, namely; CSF leak and infection and the development of post-operative spinal

metastasis were not found to be significant predictors of the need of VP- shunting.

**Table I:** Variable risk factors regarding shunting and there P values.

| Variable (average) | Needed a shunt | Did not need a shunt | P value |
|---|---|---|---|
| **Age at diagnosis (yrs)** | 6.2 | 7.3 | 0.32 |
| **Duration of symptoms(wks)** | 4.3 | 4.6 | 0.77 |
| **Size of the tumor (cm)** | 4.85 | 4.81 | 0.69 |
| **Max. ICP reading (cm H2O)** | 26 | 25 | 0.97 |

**Table II:** P values for risk factors regarding shunting and there significant values.

| Characteristic | Value | Shunted (%) | P value |
|---|---|---|---|
| Gender: | | | |
| Male | 34 (65%) | 44 % | 0.686 |
| Female | 18 (35%) | 50% | |
| Age : | | | |
| <3 yrs | 10 (19%) | 80% | 0.031 |
| >3 yrs | 42 (81%) | 38% | |
| Tumor location: | | | |
| Midline | 42 (81%) | 45% | 0.786 |
| Hemispheric | 10 (19%) | 50% | |
| Presence of pre-operative spinal mets: | | | |
| Yes | 46 (88%) | 46% | 0.999 |
| No | 6 (12%) | 50% | |
| Tumor pathology | | | |
| Medulloblastoma | 34 (65%) | 41% | 0.579 |
| Astrocytoma | 12 (23%) | 58% | |
| Ependymoma | 6 (12%) | 50% | |
| Extent of resection | | | |
| Gross total | 27 (52%) | 30% | 0.013 |
| Subtotal | 25 (48%) | 64% | |
| Use of EVD | | | |
| Yes | 34 (65%) | 41% | 0.322 |
| No | 18 (35 %) | 55% | |
| Presence of post-operative spinal mets: | | | 0.272 |
| Yes | 9 (17%) | 67% | |
| No | 43 (83%) | 42% | |
| Presence of post-operative CSF infection: | | | 0.999 |
| Yes | 5 (10%) | 40% | |
| No | 47 (90%) | 47% | |
| Presence of post-operative CSF leak: | | | 0.493 |
| Yes | 2 (4%) | 0% | |
| No | 50 (96%) | 48% | |

## Discussion

Many researchers have studied the management of hydrocephalus complicating posterior fossa tumors in children, but there is still no consensus on the optimal management strategy. [17]

Age at diagnosis: The average age of the patients who needed a VP- shunt insertion in our set of patients was 6.2 years compared to 7.3 years in patients who did not need a VP- shunt, still, this difference was not found to be statistically significant. These results are comparable to what Dias and Albright [14], and Morelli et al [16] have reported in their studies. Nevertheless, these findings are in stark contrast to results documented by Papo *et al* [15], Deborah *et al* [11], Oliveira *et al* [13] and Bognar *et al* [18], who reported that younger patients have a significantly higher risk for a subsequent shunt insertion. They attributed their findings to the higher incidence of congenital tumors among younger patients with an associated alternation in the CSF flow dynamics. However, a statistical difference was found in the need of subsequent shunting when patients younger than 3 years were compared to those older than 3 years of age. This finding is consistent with the study performed by Deborah *et al* [11]) in which the most marked difference

was illustrated when patients were divided around the age of 3 years.

Duration of symptoms: We did not find any statistically significant difference in the duration of symptoms among patients who needed a VP- shunt and those who did not need a VP- shunt. Similar findings have been reported by Dias *et al* [14] and Oliveira *et al* [13]. On the other hand, other investigators [12] have reported a longer duration of high ICP symptoms among patients who required a VP- shunt post-operatively. Size of tumor: According to our data, the size of the tumor was not significantly predictive for the future need of VP- shunting, and this is consistent with what has been reported in the literature.[13,19] Maximum ICP reading post-operatively: The average value of the maximum ICP reading for individual patients was not found to be significantly different between patients who needed a VP- shunt and those who did not need it. Five days external ventricular drain routinely used and 20 cm water is the upper normal level in this study for increased intracranial pressure due to hydrocephalous, While Kazen *et al* [12]reported that patients who had higher post-operative ICP readings had a higher rate of shunt insertion; the methods of recording the ICP pressures could vary according to different institutions. Gender: The gender of patients was not found to be significantly associated with the need of post-operative shunting and similar results have been reported by Kazan *et al*.[12] Tumor location: Tumor location was not predictive of the need for VP-shunt insertion in our study. Similar findings have been reported by some investigators.[14,18,19] On the other hand, other investigators[11,13,15] reported a higher risk for post-operative shunting in patients with tumors involving midline structures. This difference could be related to the different criteria used to assign tumors as midline tumors and the variable extent of such midline involvement. Presence of pre-operative spinal metastasis: Although it did not reach statistical significance, patients who had pre-operative spinal metastasis had a higher rate of post-operative shunting. Lee *et al* [20] and Riva- Cambrin *et al* [21] have reported a higher incidence of post-operative VP- shunting in patients with intracranial metastasis through CSF including leptomeningeal spread. Tumor pathology: According to our data, there was no statistically significant association between the histology of the tumor and the need for post-operative VP- shunting. While other reports in the literature reported a higher risk for post-operative VP- shunting in ependymomas [13,18,22] , Morelli *et al* [16] reported a higher rate of VP-shunting in medulloblastomas. At the same time, other investigators reported no difference in regards to the rates of post-operative VP- shunting among patients with different tumor histology's.[4,11,12] Other factors including the age of the patients and the location of the tumor should be taken into consideration when the tumor histology is being studied. Extent of tumor resection: We found that patients who underwent gross total excision of their tumor were less likely to need post-operative VP- shunting when compared to patients who had less than total excision. This association continued to show statistical significance even after logistic regression with the age groups. Similar results have been reported in the literature**.** [12,14,22] On the other hand, other reports [11,13,18] found no significant association between the completeness of surgical resection and the subsequent need for VP-shunting. There was one report [23] that showed an increased need for future VP- shunting in strocytoma patients who had gross total excision of their tumor.

Use of EVD: The use of an intra-operative EVD was not found to be significantly associated with the subsequent need for permanent VP- shunting in our cohort of patients, and this is consistent with some reports in the literature**.**[11,14,22] On the other hand, other reports [18] found that the use of EVD is associated with a higher risk of shunt insertion. At the same time, another report stated that the duration of EVD use rather than its' presence was associated with a higher rate of shunt insertion. [12]

Presence of post-operative spinal metastasis: We did not find any statistically significant difference between the need of post-operative shunting and the presence of post-operative spinal metastasis. We also did not find much literature addressing this issue. Post-operative complications (CSF infection and leak): The development of post-operative complications such as CSF infection and leak were not found to be predictive of the need for future shunting. Similar results were found in the literature [12,13,22]. Bognar et al[18] reported a higher incidence of CSF leak and meningitis in children younger than 3 years who needed a VP-shunt, they also reported that those differences were statistically insignificant. On the other hand, Culley *et al* [11]) reported a significantly higher rate of VP- shunt insertion in patients who developed CSF infections but not in those who had a CSF leak. It is difficult to draw any conclusions from that, due to the small number of patients with such complications. Three cases had complication of over drainage and were managed with a gusted magnetic controlled VP shunt. Also two cases managed for VP shunt obstruction by revision of ventricular end.

## Conclusion

Age of the patient less than 3 years was a significant factor in the need for shunt placement. The average age of the patients who needed a VP- shunt in our set of patients is 6.2 years compared to 7.3 years in patients who did not need a VP- shunt, The extent of

tumor excision was also important factor in predicting the need for post-operative shunt insertion. Other factors were not significant in this study even infection which increases the basal adhesion.

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