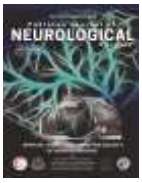

PAKISTAN JOURNAL OF NEUROLOGICAL SURGERY QUARTERLY – OFFICIAL JOURNAL OF PAKISTAN SOCIETY OF NEUROSURGEONS

Original Article

The Association of Brain Tumor and Hydrocephalus in the Patients Managed with Craniotomy and Ventriculoperitoneal Shunt

Abdul Samad Panezai[1], Aurangzeb Kalhoro[2], Lal Rehman[2], Sher Hassan[2], Farrukh Javeed[1]

[1]Sandeman Provincial Hospital, Quetta, Pakistan

[2] Department of Neurosurgery, Jinnah Postgraduate Medical Centre (JPMC), Karachi

ABSTRACT

Objective: A prospective descriptive study was aimed to evaluate frequency of hydrocephalus in preoperative brain tumor to determine the need of permanent ventriculoperitoneal shunt (VP) shunt.

Material and Methods: We operated 156 cases of brain tumor concomitant with hydrocephalus (pre-operative and post-surgery development). The tumor character, type & volume of tumor, histopathology and location of tumor were documented and therefore, the need of postoperative radiotherapy and chemotherapy were recorded on a structured proforma. We divided hydrocephalus into pre and post-operative in this study.

Results: 41.6% were adults and 58.33% were pediatric patients, who had hydrocephalus due to brain tumor. Supratentorial tumor location was found in 41% patients and Infratentorial was found in 59% patients. The patients who had preoperative hydrocephalus were 21.7% among adults, and 35.25% in pediatric patients. The most common type of brain tumor with hydrocephalus in 15.3% adults was Cerebellopontine (CP) Angle Tumor. Most common type of brain tumor with hydrocephalus in 15.3% pediatric patients was Medulloblastoma. We administered Mannitol in 42.9% patients, while corticosteroid was received by all patients. The VP shunt was done in most of the patients (87%). Majority of the patients (86.5%) were found with a Karnofsky score of > 70.

Conclusion: The common brain tumor associated with hydrocephalus in children were Craniopharyngioma and in CP angle tumor in adults. 2.6% cases required the VP shunt dependency. Considering the cause of hydrocephalus in brain tumors, perioperative decision-making plays a pivotal role in the management of tumor-associated hydrocephalus.

Keywords: Craniotomy, ventriculoperitoneal shunt, brain tumor, hydrocephalus.

Abbreviations: ETV: External Third Ventriculostomy. EVD: External Ventricular Drain. CPA: Cerebellopontine Angle.

Corresponding Author: Aurangzeb Kalhoro
Department of Neurosurgery, Sohail University, Karachi
Email: draurangzebkalhoro@gmail.com

Date of Submission: 28-12-2020
Date of Revision: 20-01-2021
Date of Online Publishing: 31-03-2021
Date of Print: 31-03-2021

DOI: 10.36552/pjns.v25i1.402

INTRODUCTION

Brain tumors are the pathological condition that causes the neurological deficit to cause a low stream and quality of life. A brain tumor is usually treated with craniotomy and the resection of tumor.[1] However, craniotomies present risk factors such as hematoma, post-surgery infection, associated neurological deficit, and infraction. They can also lead to the altered dynamic of cerebrospinal fluid leading to hydrocephalus.[2] A hydrocephalus results from the overproduction, obstruction to the flow or decreased absorption of cerebrospinal fluid (CSF), which results in the dilatation of the ventricles of the brain[3]. If they are not treated accordingly, they may lead to adverse outcomes in the adults and children.[4] Some tumors tend to develop hydrocephalus depending on the location, tumor histopathology, and therefore, this condition may lead to permanent hydrocephalus.[5] There are many factors, which may indicate the permanent CSF–Diversion after intracranial tumor surgery as a risk factor for the surgical approach. These factors are compression on parenchymal structure, tumor histology, young age and infections.[6]

The damage to the brain structure following the intracranial brain surgery or the changes in the dynamics of the flow of cerebrospinal fluid may lead to a set new hydrocephalus or its persistence may follow.[7,8] Consequences and complications related to Ventriculoperitoneal Shunt (VP) are presented and discussed commonly in literature and have been a subject of extensive research.[9,10,11] but there a little is found on patients with VP shunt having hydrocephalus as a postcranial surgery itself. The Ventriculoperitoneal shunt complication is very well known and discussed at different platforms, some of them include shunt infection, shunt blockage, gastrointestinal and urological issues.[12] The current study was based on our experience, which included a data collection from the patients who had craniotomies for intracranial brain tumors associated with hydrocephalus preoperatively or postoperatively operated at our institute, although it is difficult to predict shunt dependency among the patient.

The aim of the study was to identify the association of shunt-dependency with pre and post intracranial surgery. Brain tumors are associate with the hydrocephalus that mostly occurred due to the obstruction of the ventricle by tumor, and the removal of tumor is expected to associate with the correction of hydrocephalus, but this is not as simple, as many others factors are involved and that causes the permanent need of VP shunt in brain tumors and development of hydrocephalus after craniotomy. Considering this fact, we need more research on brain tumor and hydrocephalus, in order to manage the earliest placement of VP shunt, which will improve quality of life and prevent further brain damage. This study can be consulted as a criterion for subsequent studies.

MATERIAL AND METHODS

Study Design & Study Settings

This was a prospective descriptive study conducted at Jinnah postgraduate medical centre, Karachi, Sindh from 24th June, 2014 to 30th September, 2020. The study was conducted after ethical approval from the hospital and informed consents were taken from all the patients. Patients who fulfilled the inclusion criteria were included in this study.

Inclusion Criteria

The patients with brain tumor having hydrocephalus preoperative, or who developed hydrocephalus postoperatively within three months of brain tumor surgery were included.

Exclusion Criteria

Those patients were excluded who had VP shunt

previously due to some other reason, history of operation of brain tumor or history of trauma.

Data Collection

Sample size of 156 patients was calculated with the proportion of 8.7% on 95% CI. All the patients who were operated for brain tumor who had hydrocephalus pre- or post-operatively and kept on a follow-up for 3 months and those who developed hydrocephalus post-surgery and who had hydrocephalus at presentation were included in this study. Age from 1 to 60 years was included. Patient demographic age, gender was recorded.

For the confirmation of hydrocephalus neuroimaging CT scan, the MRI brain was used and Evan's ratio was calculated. The tumor character, type & volume of tumor, histopathology and location of tumor were documented and therefore, the need of a postoperative radiotherapy and chemotherapy were recorded on a structured proforma. Frequencies and mean values were calculated through SPSS (v 24).

RESULTS

Background & Clinical Information

During the study, we operated 156 cases of brain tumor concomitant with hydrocephalus including cases of pre-operative and post-surgery development of hydrocephalus. 65 (41.6%) were adults and 91 (58.33%) were pediatric patients, who had hydrocephalus due to brain tumor. Males were 90 (57.6%) and females were 66 (42.3%). The mean age for adults was 34.2 ± 8 years and 8.1 ± 4 years for a pediatric patients. Around 8% patients reported hypertension and 11.5% found with diabetes. Supratentorial tumor location was found in 41% patients and Infratentorial was found in 59% patients (**Table 1)**.

We divided hydrocephalus into pre and post-operative in this study. The patients who had preoperative hydrocephalus were 34 (21.7%) among adults, and 55 (35.25%) in pediatric patients. The post-operative development of hydrocephalus was in 28 (17.9%) adults and 41 (26.28%) pediatric patients.

Table 1: Clinical parameters.

Characteristics	N = 156	Percentage
Age		
Pediatric (16 years)	91	58.33%
Adult (>16 years)	65	41.66%
Gender		
Male	90	57.69%
Female	66	42.3%
Comorbidity		
Hypertension	12	7.68%
Diabetes	18	11.5%
Tumor Location		
Supratentorial	64	41%
Infratentorial	92	58.97%
Duration of Symptoms		
< 3 Months or During tumor surgery	87	55.76%
> 3 Months	69	44.2%

Tumor Distribution

Most common types of brain tumor with hydrocephalus in 24 (15.3%) adults was Cerebellopontine (CP) Angle Tumor (Figure 1) and low-grade Glioma in 15 (9.6%). Whereas, the most common types of brain tumor with hydrocephalus in 24 (15.3%) pediatric patients were Medulloblastoma and Ependymoma in 17 (11%). The relevant etiologyisrepresented in **Table 2**.

Symptomatology

The common presentation of the patients was headache (80%), followed by nausea or vomiting (65%), seizures (35%), limb weakness (28%), gait disturbances (27%) and altered state of consciousness (10%). The average duration of stay in the hospital was 16 ± 3 days. Ceftriaxone and gentamicin were administered as antibiotics.

We also administered Mannitol in 67 (42.9%) patients, while corticosteroid was received by all patients and anti-convulsing drug was used in 90 (57.69%) patients. A right-sided shunt was inserted in 121 (77.56%) patients and the left side shunt in 35 (22.4%).

Table 2: Subdivision into tumor types.

BRAIN TUMOR	N	Percentage
Pediatric Patients		
Craniopharyngioma	25	16%
Medulloblastoma	24	15.38%
Ependymoma	17	10.89%
Choroid Plexus Tumor	5	3.2%
Astrocytoma	14	8.9%
Brain Stem Tumor	6	3.8%
Adults Patients		
CP Angle	24	15.38%
Meningioma	10	6.4%
Glioblastoma	10	6.4%
Hemangioblastoma	5	3.2%
Metastasis	4	2.56%
Low-Grade Glioma	15	9.61%
Pituitary Tumor	7	4.48%

Pre- and Post-operative Shunt Requirements

In the current study, in 81 (51.9%) patients, the ventriculoperitoneal shunt (VP) was done as apre-requirement of the tumor removal or in the same settings, while in 75 (48%) patients the shunt was done as a post removal of tumor. Among 6026 cases of brain surgeries in our centre, 2.6% required a VP shunt dependency.

Complications and Radiotherapy

Table 3 shows the information on complications and need of radiotherapy in the patients. Around 34% patients the radiotherapy treatment. The VP shunt was done in most of the patients (87%), especially right-sided (77%). Majority of the patients (86.5%) were found with a Karnofsky score of greater than 70.

Table 3: Complications and Radiotherapy.

Parameter	N	Percentage
Radiotherapy		
Yes	38	24.38%
Shunt		
Blockade	16	10.2%
Infection	9	5.76%
Shunt Type		
VP Shunt	136	87.17%
VA Shunt	20	12.83%
Right Side VP Shunt	120	77.0%
Left Side VP Shunt	36	23%
Karnofsky Score		
< 70	21	13.4%
>70	135	86.5%

Figure 1: MRI brain showing that cerebellopontine (CP) angletumor having a solid portion developing mild to moderate hydrocephalus.

DISCUSSION

The ventriculoperitoneal shunt (VP) is a popular treatment option for the hydrocephalus that covers multiple etiological factors in the pediatric and adult populations. The other known method is endoscopic third ventriculostomy, while it has

its boundaries and limitations. The current study focused on a patient who developed hydrocephalus due to intracranial brain tumor, considering supra and infratentorial tumors.In our study, the antibiotics (ceftriaxone and gentamicin) were given for 5 days post counted from the day of operation. We did a cerebrospinal fluid analysis report before passing the shunt, while studies have shown that the prophylactic use of antibiotics had some promising results.[13] Whereas, some other studies with long term use of antibiotics have shown a resistance, which serves as a reason for pro infection and no promising results were observed due to the prolonged use of antibiotics that can affect the natural inflammatoryprocess, which can result as the formation of conglomerate micro-abscesses.[14,15]

In our study, the corticosteroid was used in the perioperative treatment of all patients, as all of them had a brain tumor edema and had positive effects of steroids. Such positive effects are already proven in brain tumor with steroids tapered-off in 3 weeks duration, while one of the study, reported that steroids can worsen the status of the patient having ventriculoperitoneal shunt.[16] Moreover, in another study, as per complications related to shunt entry, it was reported that complications included the development of subdural hematoma, subdural hygroma, sub-glial collection, intraventricular hemorrhage, urinary tract infection and wound infection,[17] as compared to our study, in which the blockage was seen 16 (10.2%) patients, while the infection was seen in 9 (5.76%) patients. We did not observe any intracranial bleed, subdural hygroma or urinary issues in our patients.

In one of the studies, 21 out of the 39 patients a persistent postoperative hydrocephalus ventriculoperitoneal shunt was performed,[18] whereas, at our institute, the patients who had preoperative hydrocephalus was in 34 (21.7%) adults and 55 (35.25%) in pediatric, and the post-operative development of hydrocephalus was in 28 (17.9%) in adults and in 41 (26.28%) pediatric patients. A post-radiation may have played the part to cause edema, depends on the location. A study reported that the histology of tumor did not show a high risk of the ventriculoperitoneal shunt or its dependency exception was Craniopharyngioma- the tumor which had an increase postoperative risk of a shunt.[19] Also, a larger study has shown that the volume of the tumor was not marked related to the shunt dependency, especially in the series of posterior fossa tumors,[20] similarly, in our study, we had 25 (16.0%) Craniopharyngioma patients among them 12 (48%) patients were those who had cystic as well as a solid component of tumor and all of them were treated with the ventriculoperitoneal shunt with tumor with posterior fossa having size > 3.5cm inclined towards the requirement of ventriculoperitoneal shunt.

Similarly, Roth et al.[21] showed that, 16 out of 530 patients (3%) had ventriculoperitoneal shunt placement from within ten months postoperatively, which helped the improvement of the cognitive function in eleven patients. In our study, we received 13% patients with a Karnofsky score of < 70, and 86.5% patients with a Karnofsky score of > 70. The patients who had < 70 Karnofsky scores, were observed with an improved cognitive function post-cranial surgery and ventriculoperitoneal shunt.Another study reported that tumor with the highest risk for de novo postoperative VP shunt-dependency was found in Craniopharyngioma (6.5%) as well as in the choroid plexus tumors (12.5%), as they had significant extension into ventricular compartments, and risk of postoperative hydrocephalus was more increased in craniotomies having a ventricular entry for the tumor resection.[22] Similarly, in our study, the choroid plexus tumor, Craniopharyngioma and pituitary tumor having ventricular part were more favoredin having a ventriculoperitoneal shunt.

CONCLUSION AND RECOMMENDATIONS

The common brain tumor associated with hydrocephalus in children was Craniopharyngioma and in CP angle tumor in adults. Among 6026 cases of brain surgeries, a 2.6% required the VP shunt dependency. Considering the common cause of hydrocephalus in brain tumors, perioperative decision-making plays a pivotal role in the management of tumor-associated hydrocephalus. Although, we had a large number of patients fora VP shunt operated for hydrocephalus related to a brain tumor, but still there is a need of a larger study. This study can highlight the survival problems of shunt due to brain tumor, which may helpful in the future for a larger number of the patients or for a combined multiple center studies and experiences.

LIMITATIONS

The surgery was performed by four different surgeons, the hydrocephalus due to the brain tumor was based on observation of an MRI brain and CT scans. The study did not include patients whose hydrocephalus was improved post-surgically.

REFERENCES

1. Keles GE, Chang EF, Lamborn KR, Tihan T, Chang CJ, Chang SM, Berger MS. Volumetric extent of resection and residual contrast enhancement on initial surgery as predictors of outcome in adult patients with hemispheric anaplastic astrocytoma. Journal of Neurosurgery, 2006; 105 (1): 34-40.
2. Malm J, Kristensen B, Stegmayr B, Fagerlund M, Koskinen LO. Three-year survival and functional outcome of patients with idiopathic adult hydrocephalus syndrome. Neurology, 2000; 55 (4): 576-8.
3. Rekate HL. The definition and classification of hydrocephalus: a personal recommendation to stimulate debate. Cerebrospinal fluid research, 2008; 5 (1): 1-7.
4. Lassen B, Helseth E, Egge A, Due-Tønnessen BJ, Rønning P, Meling TR. Surgical mortality and selected complications in 273 consecutive craniotomies for intracranial tumors in pediatric patients. Neurosurgery, 2012; 70 (4): 936-43.
5. Castro BA, Imber BS, Chen R, McDermott MW, Aghi MK. Ventriculoperitoneal shunting for glioblastoma: risk factors, indications, and efficacy. Neurosurgery, 2017; 80 (3): 421-30.
6. Riva-Cambrin J, Detsky AS, Lamberti-Pasculli M, Sargent MA, Armstrong D, Moineddin R, Cochrane DD, Drake JM. Predicting postresection hydrocephalus in pediatric patients with posterior fossa tumors. Journal of Neurosurgery: Pediatrics, 2009; 3 (5): 378-85.
7. Margules A, Jallo J. Complications of decompressive craniectomy. JHN Journal, 2010; 5 (1): 4.
8. Stiver SI. Complications of decompressive craniectomy for traumatic brain injury. Neurosurgical focus, 2009; 26 (6): E7.
9. Ghritlaharey RK, Budhwani KS, Shrivastava DK, Srivastava J. Ventriculoperitoneal shunt complications needing shunt revision in children: A review of 5 years of experience with 48 revisions. African Journal of Paediatric Surgery, 2012; 9 (1).
10. Wu Y, Green NL, Wrensch MR, Zhao S, Gupta N. Ventriculoperitoneal shunt complications in California: 1990 to 2000. Neurosurgery, 2007; 61 (3): 557-63.
11. Goldschmidt E, Hem S, Ajler P, Ielpi M, Loresi M, Giunta D, Carrizo A, Yampolsky C, Argibay P: A new model for dura mater healing: Human dural fibroblast culture. Neurol Res. 2013; 35: 300-307,
12. Paff M, Alexandru-Abrams D, Muhonen M, Loudon W. Ventriculoperitoneal shunt complications: A review. Interdisciplinary Neurosurgery, 2018; 13: 66-70.
13. Fan-Havard P, Nahata MC. Treatment and prevention of infections of cerebrospinal fluid shunts. Clinical Pharmacy, 1987; 6 (11): 866.
14. Enger P, Svendsen F, Wester K. CSF shunt infections in children: experiences from a population-based study. Actaneurochirurgica. 2003; 145 (4): 243-8.

15. Korinek AM, Golmard JL, Elcheick A, Bismuth R, Van Effenterre R, Coriat P, Puybasset L. Risk factors for neurosurgical site infections after craniotomy: a critical reappraisal of antibiotic prophylaxis on 4578 patients. British Journal of Neurosurgery, 2005; 19 (2): 155-62.
16. Benzagmout M, Boujraf S, Góngora-Rivera F, Bresson D, Van-Effenterre R. Neurosarcoidosis which manifested as acute hydrocephalus: diagnosis and treatment. Internal Medicine, 2007; 46 (18): 1601-4.
17. Hosainey SA, Lassen B, Hald JK, Helseth E, Meling TR. Risk factors for new-onset shunt-dependency after craniotomies for intracranial tumors in adult patients. Neurosurgical Review, 2018; 41 (2): 465-72.
18. John JK, Robin AM, Pabaney AH, Rammo RA, Schultz LR, Sadry NS, Lee IY. Complications of ventricular entry during craniotomy for brain tumor resection. Journal of Neurosurgery, 2017; 127 (2): 426-32.
19. Hosainey SA, Lassen B, Hald JK, Helseth E, Meling TR. Risk factors for new-onset shunt-dependency after craniotomies for intracranial tumors in adult patients. Neurosurgical Review, 2018; 41 (2): 465-72.
20. Riva-Cambrin J, Detsky AS, Lamberti-Pasculli M, Sargent MA, Armstrong D, Moineddin R, Cochrane DD, Drake JM. Predicting postresection hydrocephalus in pediatric patients with posterior fossa tumors. Journal of Neurosurgery: Pediatrics, 2009; 3 (5): 378-85.
21. Roth J, Constantini S, Blumenthal DT, Ram Z. The value of ventriculo-peritoneal shunting in patients with glioblastoma multiforme and ventriculomegaly. Actaneurochirurgica. 2008; 150 (1): 41-7.
22. Hosainey SA, Lassen B, Hald JK, Helseth E, Meling TR. Risk factors for new-onset shunt-dependency after craniotomies for intracranial tumors in adult patients. Neurosurgical Review, 2018; 41 (2): 465-72.

Additional Information

Disclosures: Authors report no conflict of interest.
Ethical Review Board Approval: The study was conformed to the ethical review board requirements.
Human Subjects: Consent was obtained by all patients/participants in this study.
Conflicts of Interest:
In compliance with the ICMJE uniform disclosure form, all authors declare the following:
Financial Relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work.
Other Relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

AUTHORS CONTRIBUTIONS

Sr.#	Author's Full Name	Intellectual Contribution to Paper in Terms of:
1.	Abdul Samad Panezai	Analysis of data, study design and methodology.
2.	Aurangzeb Kalhoro	Proposed topics and basic Study design, manuscript writing & data collection.
3.	Sher Hassan	Statistical analysis and manuscript writing.
4.	Farrukh Javeed	Study design and data collection.
5.	Lal Rehman	Interpretation of results and final Literature review.