Frequency of CSF Leak after Craniotomy for Paediatric Brain Tumors

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ABSTRACT

The management of brain tumors of the pediatric brain tumors may involve surgical option like craniotomy. This procedure can lead to the complications like cerebrospinal fluid (CSF) leakage which is difficult to manage. This study was an audit of craniotomy among pediatric brain tumor patients.

Objective: *To determine the frequency of CSF leak after craniotomy for paediatric brain tumor.*

Study Design: *Descriptive case series.*

Setting: *Department of Neurosurgery, Nishtar Hospital, Multan.*

Duration: *03 year 01/06/2010 to 30/06/2013.*

Methods: *This study included 208 patients with pediatric brain tumors. All the patients had craniotomy done through supratentorial or infratentorial approach. The patients were followed up for occurrence of CSF leakage upto two weeks. Data was collected in a specially designed performa.*

Results: *The mean age of the patients was 10.36 ± 4.97 years (range 6 months – 18 years). There were 44 (21.2%) female and 164 (79.8%) patients were male. Craniotomies through supratentorial and infratentorial approach were done in 176 (84.6%) and 32 (15.4%) patients, respectively. CSF leakage was observed among 28 (13.5%) patient.*

Conclusions: *The CSF leakage rates after craniotomy in pediatric population having brain tumors are high. However, this rate is high among patients who undergo through infratentorial techniques as compared to supratentorial technique.*

Key Words: *Cerebrospinal fluid; leakage; brain tumors; craniotomy.*

Abbreviations: *CSF = Cerebrospinal fluid. CNS = Central nervous system.*

INTRODUCTION

The brain tumor is one of the most complex and deadly diseases known to human beings. According to the Central Brain Tumor Registry of The United States, over 612,000 people are living with primary brain and central nervous system (CNS) tumor being diagnosed. It was estimated that 64,530 new patients would be diagnosed with primary non-malignant and malignant brain tumor in the US.[1]

Brain tumors are the most common solid tumors occurring in childhood. The incidence of all primary brain and central system tumors in childhood (age, 0 – 19) is 4.71 per 100 000 person per years.[2] Childhood neoplasms are the second most common cause of death after trauma, the commonest cause beyond the neonatal age group.[3]

Childhood brain tumors differ from those arising in adulthood in their relative incidences, histological features, sites of origin, and responsiveness to therapy. Most childhood brain tumors are primary central nervous system lesions occurring in 2.5 to 4 per 100,000 children at risk per year. Tumors of the nervous system are now the most common form of childhood malignancy and the leading cause of cancer-related morbidity and mortality. The reported incidence of primary central nervous system tumors in children has increased by 35% over the past 2 decades, and this apparent increase has raised serious concern that environmental exposures are causative.[4]

Intracranial childhood tumors affect 33 per 100,000 children annually[5] and comprise about 20 – 23% of all pediatric cancers.[6] Approximately 1100 new cases are diagnosed in the United States each year. A 20 year survey of pediatric CNS tumors in patients below 20 years of age revealed an incidence of 31.0 and 25.9 per million in boys and girls respectively.[7]

The cornerstone of pediatric brain tumor treatment is surgery. Craniotomy with maximal surgical excision of a brain tumor provides the best treatment for prolonging survival and improving neurological status of patients with brain tumors. The primary goal of craniotomy in the case of malignant brain tumors is diagnosis, reduction of mass effect, and theoretically improved response to adjuvant therapy.[8]

Craniotomies are not, however, without inherent risks. Deaths, postoperative hematomas, and infections, including meningitis, bone flap infections, subdural empyemas, and cerebral abscesses, are all important complications of surgery, but they occur so infrequently that most studies are too small to give meaningful rates on their own.[9]

Incidence of CSF leakage after craniotomy for paediatric brain tumours ranges from 2.0 to 10.3%.[10]

The normal blood brain barrier typically consists of the arachnoid membrane, the dura mater and skull; and also includes the skin and the mucosa membranes of the air sinuses.[11] However, trauma or other conditions may cause a defect of this barrier creating thus an opening between the intracranial space and the pneumatized space of the skull base, which is by definition a CSF fistula. In three areas, these two compartments are narrowly separated so that the brain is more exposed to the external environment or to iatrogenic damage during surgical procedures: these are the labyrinth within the temporal bone, the orbit and even more so, the olfactory region.[12]

Leakage of cerebrospinal fluid (CSF) is an important risk factor for developing postoperative meningitis and wound infection and prolonged hospital stay.[13] Previously suboccipital **craniectomies** were the preferred approach to posterior fossa tumors, but it has been shown that **craniotomies are associated with a lower rate of CSF leaks.**[14]

CSF leaks and pseudomeningoceles are usually treated according to following scale: compression bandages, direct aspiration of subcutaneous CSF collection, secondary skin sutures, multiple lumbar punctures, lumbar drainage, operative closure of fistula, and permanent CSF diversion.[15]

Patients younger than 3 years had a significantly higher incidence of CSF leaks than the older patients. Interestingly, girls had a significantly lower risk of postoperative CSF leakage undergoing an infratentorial craniotomy and having an untreated preoperative hydrocephalus were very strong risk factors for postoperative CSF leaks.[15]

Controlling intracranial pressure is the single most important factor in preventing CSF leakage.

Than et al,[16] showed that the use of polyethylene glycol hydrogel dural sealant (DuraSeal) could reduce incisional CSF leak postoperatively.

Lassen et al,[17] have shown that postoperative CSF leak was 7.3% in 273 craniotomies after infratentorial surgery, 12.7% had a CSF leak, whereas the corresponding rate was 5.2% after supratentorial surgery. The leak resolved after treatment with only compression bandages in 2 cases, aspiration of pseudomeningocele in 1 case, secondary skin sutures in 3 cases, multiple lumbar punctures in 4 cases, with lumbar drainage in 3 cases, permanent shunts in 6 cases, and endoscopic fenestration in 1 case.

Drake et al,[18] found that the CSF leak were 12.9% after craniotomy in their pediatric unit.

So far limited data regarding the incidence of CSF leakage after craniotomy for paediatric brain tumour is available both locally and internationally. The current study has provided accurate data about operative risk to give to patients and their guardian; this study will be further helpful in prevention treatment and management protocol.

OBJECTIVES

The objective of this study was:

To determine the frequency of CSF leak after craniotomy for paediatric brain tumor. CSF leakage was taken as percutaneous leaks through the operative wound and leakage of CSF fluid along external drainage lines. A craniotomy was a surgical operation in which a bone flap was temporarily moved from the skull to access the brain supra / infratentorially.

MATERIAL AND METHODS

The study design was Descriptive Case Series. The study was done at the Department of Neurosurgery, Nishtar Hospital, Nishter Medical College, Multan. 208 patients were included in the study. The duration of study was three year from 01-06-2010 to 30-06-2013.

Inclusion Criteria

The sampling technique was Non-Probability, Purposive Sampling. Patients of age 06 month to 18 year undergoing craniotomy for intracranial tumor were included in study.

Exclusion Criteria

Patients undergoing stereotactic biopsy and with intrinsic brainstem tumors were excluded.

Two hundred and eight patients presenting in the department of neurosurgery outdoor, fulfilling the inclusion criteria were selected. An informed consent was obtained from patients after explaining the procedure to them. The study was conducted after permission from the ethical committee of the hospital. Patients were prepared for general anesthesia and craniotomy and removal of tumour was done by same consultant surgeon. Drain was placed under the skin flap. Patient were observed for CSF leakage through the operative wound and / drains in ward upto 2 weeks after the surgery.

Data Analysis

Data was entered in the proforma attached. All the data was entered and analyzed using computer program SPSS – 15. Frequencies were calculated for gender, post-operative CSF leakage and stratification was undertaken on gender, surgical approach and age and post stratification Chi-Square test was applied, $P < 0.05$ was taken as significant. Mean and standard deviation was presented for age.

RESULTS

The total number of patients included in the study were 208 (including both males and females).

Distribution of Patients by Age

The mean age of the patients in the study was 10.36 ± 4.97 years (age range 6 months – 18 years). There were 54 (26%) patients of age range of 6 months to 6 years, 72 (34.6%) patients of age range of 7 – 12 years and 82 (39.4%) patients of age range of 12 – 18 years. (Table 1).

Distribution of Patients by Sex

There were 44 (21.2%) female patients in the study, while 164 (79.8%) patients were male. The female to male ratio was 1:3.72 (Figure 1).

Table 1: *Distribution of patients by age (n = 208).*

Age	No. of Patients	Percentage
6 Months – 6 Years	54	26
7 Years – 12 Years	72	34.6
13 Years – 18 Years	82	39.4
Mean ± SD	10.36 ± 4.97	
Range	6 Months – 18 Years	

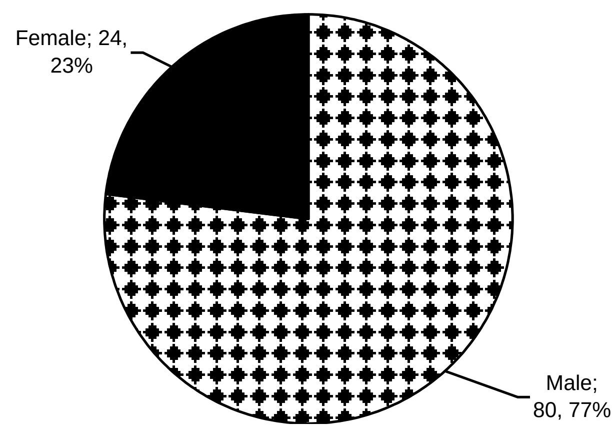

Fig. 1: Distribution of patients by sex (n = 208).

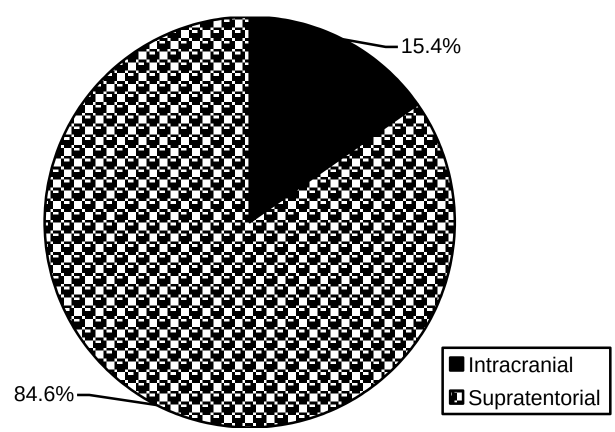

Fig. 2: Distribution of patients by surgical approach (n = 208).

Distribution of Patients by Surgical Approach

The patients were also distributed according to the surgical approach adopted. Supratentorial surgeries were done among 176 (84.6%) patients and infratentorial surgeries were done among 32 (15.4%) patients (Figure 2).

Distribution of Patients by CSF Leakage

CSF leakage was observed among 28 (13.5%) patient, while among 180(86.5%), no CSF leakage occurred. (Figure 3).

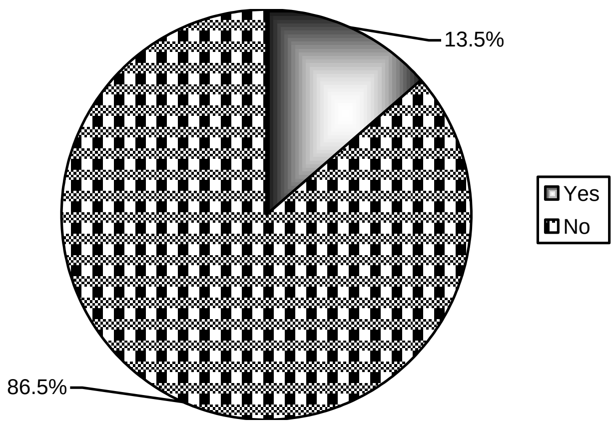

Fig. 3: Distribution of patients by CSF Leakage (n = 208).

Cross Tabulation of Patients by Surgical Approach with CSF Leakage

Of the 176 patients in whom supratentorial surgery was performed, CSF leakage was seen among 18 (11.3%) patients, while no leakage was observed in 158 (89.7%) patients.

Of the 32 patients in the study in whom infratentorial surgery was performed, CSF leakage occurred among 10 (31.3%) patients while no leakage occurred in 22 (68.7%) patients (Table 2).

Chi square test was applied to see if there is any significant difference between the two groups. P-value was 0.02 (i.e. < 0.05). So, it was found to be statistically significant.

Table 2: *Distribution of patients by site of leakage (n = 208)*

Site of Surgery	CSF Leakage	
	Yes No. (%)	**No No. (%)**
Supratentorial (n = 166)	158 (89.7)	18 (11.39)
Infratentorial (n = 32)	22 (68.7)	10 (31.3)
p-value*	0.035**	

* Chi-square test
**Significant

DISCUSSION

Cerebrospinal fluid leakage is a common problem among patients undergoing through cranial surgeries.[19,20] In this study, we studied 208 consecutive patients of pediatric age groups undergoing through craniotomies for brain tumors. The results of study showed a high frequency of CSF leakage i.e. 13.5%.

There are few studies in literature, which have analyzed the outcome of craniotomy in terms of CSF leakage in pediatric age groups in isolation. The results of these studies vary among different authors.[21,22]

The mean age of the patients in the study was 10.36 ± 4.97 years (age range 6 months – 18 years). The highest percentage of the patients was observed in age group 12 – 18 years i.e. 39.4%, followed by age group of 7 – 12 years i.e. 34.6% and then up to 6 years i.e. 26%. In a study by Ahmad N,[24] the mean age of the patients were 8.8 years. They included the patients of age up to 15 years. They divided the cases into 3 age groups each covering five years of life (0 – 4, 5 – 9, 10 – 14 years), with the greatest number in the second age group i.e. 5 – 9 years (i.e. 53.1%) followed by the third age group (30.6) and the 0 – 4 year age group (16.3%). Both of the studies showed that a higher frequency of patients was observed in age groups of more than 10 years. In another study by Lassen B, et al,[17] the mean age was 8.5 years (range, 0 – 18 years). The mean age of the patients in our study was a little higher than those previous one. This highlights the need for other studies to be conducted in different setups to determine the true mean age of the patients involved in the study.[23]

In our study, male patients dominated the female population. The female to male ratio was 1:3.72. Ahmed N, et al, also validated this observation. In their study, majority of the patients with brain tumors were male.[24]

Most of the craniotomies done were through supratentorial approach i.e. 84.6%. This observation is in concordance with observation of Lassen B, et al,[17] who also documented a higher rate of craniotomy through supratentorial approach. In their study, surgical approach was supratentorial in 71.1% and infratentorial in 28.9%. This is related to the increased incidence of supratentrorial tumors. However, study by Ahmed N, et al,[24] did not agree with our observation. In their study, they showed a lower frequency of supratentorial tumors i.e. 33.3% as compared to that of infratentorial tumors i.e. 66.7%.

The frequency of CSF leakage in our study was high i.e. 13.5% which is higher than observed by Lassen B, et al. i.e. 7.3%. Neervoort FW, et al,[25] in a study of 121 patients undergoing through surgeries for brain tumor, also documented a CSF leakage rate of 7.3%. Gnanalingham KK, et al,[13] also conducted a study in and determined that frequency of CSF leakage in their study who had craniotomy was 4%. They also compared this leakage rate with that of craniectomy. They observed a lower CSF leakage rate in craniotomy as compared to craniectomy (i.e. 4% versus 23%). They recommended craniotomy over craniectomy.

CSF leakage rate was more among patients with infratentrorial craniotomy as compared to those with supratentorial craniotomy i.e. (31.3% versus 11.3%). This reflects that there are higher chances of the CSF leakage among patients who undergo through infratentorial craniotomies.

This study had some limitations. This was a single center study with limited population size. This was not a blinded study.

CONCLUSION

1. The CSF leakage rates after craniotomy among patients with pediatric population with brain tumors are high.
2. However, this rate is high among patients who undergo through infratentorial techniques as compared to supratentorial technique.

This is recommended that the surgical techniques should be revised or some associated CSF drainage procedures can be considered to prevent this complication. Further prospective studies should be conducted in future in multiple centers to compare the CSF leakage rate with other procedure like craniectomies to compare the safety of this procedure.

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