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ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION

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DECLARATION

I solemnly declare that this declaration entitled **"ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION"** was prepared by me in the Institute of Neurology, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai- 3 from November 2011 to November 2013.

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CERTIFICATE

This is to certify that the dissertation entitled **"ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION"** is a bonafide work done by Dr.R.Nithyanand at Institute of Neurology in partial fulfillment of the University rules and regulations for award of M.Ch. Neurosurgery under my guidance and supervision during the academic year 2014.

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CONTENTS

INTRODUCTION

Brain tumors are the most common neoplasms in children. They represent second most common pediatric malignancy overall, following leukemia. After 1 year of age, most of the pediatric brain tumors occur in in the posterior fossa. They include medulloblastomas, juvenile pilocytic astrocytomas, ependymomas, haemangioblastomas, germ cell tumors of pineal gland and brain stem gliomas. Children with posterior fossa brain tumors usually present with symptoms of increased intracranial pressure, gait disturbances, and/or cranial nerve deficits. The symptoms and signs depend upon the size, type and location of the tumor.

Computed tomography (CT) and magnetic resonance imaging (MRI) are critical in the work-up and follow-up of these patients. Treatment options depend upon the patient's age and the disease extent. Surgical resection with radiation and/or chemotherapy is the usual treatment option. These tumors frequently metastasize through cerebrospinal fluid (CSF) and produce "drop metastasis" along craniospinal axis. Hence it is necessary to irradiate the entire craniospinal axis if it is present. In addition, posterior fossa has to be treated with booster dose radiotherapy.

Medulloblastoma is a malignant tumor which occurs most frequently in children but may also affect adults. It is the second most common pediatric brain tumor overall, following astrocytoma. But it is the most common posterior fossa tumor in the pediatric population which contributes up to 40% of cases. Children with medulloblastomas often present clinically with rapid onset of symptoms over the course of weeks or a few months. This is due to the rapid growth and malignant features of the neoplasm. The most common symptoms include headache, nausea and vomiting due to fourth ventricular obstruction and the resulting hydrocephalus. Truncal ataxia and papilledema are common clinical signs. Tumor cell seeding of the cerebral spinal fluid (CSF) is seen in nearly one third of the cases. MRI brain with gadolinium contrast is the investigation of choice. Screening of entire neural axis is included in the imaging study. The primary treatment of medulloblastoma is surgical excision of tumor which should be followed by adjuvant therapy. The adjuvant therapy depends on the child's age, extent of resection and presence/absence of CSF dissemination of tumor cells.

Juvenile pilocytic astrocytomas are low grade neoplasms belonging to WHO grade I. They are the most common subtype of pediatric gliomas and contribute

85% of all cerebellar astrocytomas. They represent approximately one-third of posterior fossa tumors in children, second in incidence only to medulloblastoma. Patients with cerebellar pilocytic astrocytoma typically present with a gradual onset of symptoms due to its slow growth. They involve midline vermis or cerebellar hemisphere laterally. They are usually well-circumscribed and have a large cystic component with a mural nodule. Surgical resection of cerebellar astrocytomas is the primary modality of treatment. Surgery is curative if resected completely. Repeat surgical excision is the treatment for recurrences or regrowth after subtotal resection. Radiation and/or chemotherapy are reserved for rare instances which are not amenable to surgical resection.

Ependymomas arise from ependymal cells which line the ventricles. They also arise from spinal cord from the ependymal lining of central canal. Supratentorial (lateral ventricle) and spinal ependymoma are common in adults. Infratentorial ependymomas are more common in children where they arise from ependymal cells of floor of the IV ventricle. Ependymomas rank three among the posterior fossa tumors in pediatrics after medulloblastoma and cerebellar pilocytic astrocytoma. They occur along the floor (more common) or roof of the fourth ventricle. Ependymomas of IV ventricle are usually WHO grade II. CSF dissemination is seen in approximately 12% of cases. Children with ependymoma

present with features of increased intracranial pressure (ICP) due to fourth ventricular obstruction and hydrocephalus. They are usually mixed intense lesion on imaging with propensity for calcification and cystic degeneration. Complete surgical excision is the treatment of choice but it is difficulty because of its adherence to adjacent vital structures. Adjuvant therapy is based on age of the child and presence of CSF dissemination.

Brainstem gliomas are fourth in incidence in terms of pediatric posterior fossa tumors representing approximately 15% of total. Diffuse intrinsic pontine glioma (DIPG) is the most common and most aggressive type of brainstem glioma. Histologically fibrillary astrocytomas (WHO grade II) are common but they can progress to anaplastic or even glioblastoma multiforme. Children with brainstem gliomas have rapid onset of cranial nerve deficits, long tract signs and ataxia. Due to its location, surgery is not the primary treatment. Surgery is reserved for focal, exophytic lesion with cystic component. Radiotherapy and chemotherapy are the mainstays of the treatment of brain stem gliomas.

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AIM OF THE STUDY

1. To study the distribution of various types of posterior fossa tumors in children of age group 6 months to 12 years during my study period.
2. To study the frequency of symptoms of posterior fossa tumors in children.
3. To study the various imaging features of posterior fossa tumors seen in children.
4. To analyze the need of preoperative shunting in patients with obstructive hydrocephalus.
5. To study the prognosis of different types of tumors after definitive surgical treatment.

This is a descriptive study on the incidence, symptoms and signs, imaging features, treatment and prognosis of posterior fossa tumors in pediatric population. This work has been compared with related works available in the literature. The period of this study is from November 2011 to November 2013.

REVIEW OF LITERATURE

There are many studies conducted by pioneering authors on the posterior fossa children in pediatric population. Various papers have been published at various points of time across the world, most of these from premier institutes in neurosciences.

HISTORY

Development of posterior fossa surgery was one of the hallmarks of Harvey Cushing contribution to pediatric branch of neurosurgery[1]. During the pre-Cushing era, posterior fossa lesions were considered inoperable and bony decompression alone was done without attempting tumor removal. The evolution of Cushing's surgical expertise from subtotal excision to total excision of vascular fourth ventricular tumors reflects the importance of fine neurosurgical techniques. This was proven by dramatic decrease in his operative mortality rate. In 1931, Cushing published the first series of posterior fossa astrocytoma in pediatric population which is one of the most important contributions to pediatric neurosurgery. It appeared in *Surgery, Gynecology and Obstetrics* in 1931. This was entitled "Experiences with cerebellar astrocytomas: a critical review of 76 cases. In another

study, Cushing treated 109 boys and 64 girls who were less than 18 years of age with posterior fossa tumors. The most common presenting symptoms included unsteadiness, progressive visual loss, projectile vomiting, headache, double vision, motor deficits and sensory deficits and opisthotonic convulsions ("cerebellar fits"). His examination findings included fundus examination, visual acuity and field, tenderness in suboccipital region, hypotonia and "crack pot resonance of the skull."

DEMOGRAPHY

Naseem Ahmed et al[2] from Karachi reviewed 81 cases in his study of which 58 were male and 23 were female (ratio 2.5:1). He divided the patients into 3 groups according to age (0 - 4, 5 - 9, 10 -14 years) mean age being 8.8 years The maximum number of cases (43 cases - 33 males and 10 females) were observed in the age group 5 - 9 years. 25 cases (17 males and 8 females) were present in the age group 10 - 14 years. The least number of cases (13 cases - 8 males and 5 females) were present in the age group 0 - 4 years. The pathology of various tumors he found in his study population included astrocytoma (28 cases, 34.6%), medulloblastoma (40 cases, 49.4%), ependymoma (8 cases, 10%) and others (5 cases, 6.2%). The study reflects a developing country scenario, with a strong male predisposition and a late presentation with a peak in the 5 - 9 year age group.

Tai-Tong Wong, M.D et al[3] of Taiwan conducted a trial of single institutional series of 986 pediatric patients with primary brain tumors from 1975 to 2004. Of these patients, they were able to identify the histological diagnosis in 886 patients. Of these 886 patients, the most common tumors encountered by him were astrocytoma (31.1%), germ cell tumor (14.0%), medulloblastoma (13.3%), craniopharyngioma (8.3%), and ependymal tumor (5.8%). In addition to 91 cases of pineal tumors, there were 575 supratentorial tumors and 405 infratentorial tumors. 6 patients had both supra- and infratentorial tumors. The mean age was 7.8 years. Except for the age group between 2 and 8 years, males were predominantly affected in all other age groups. In the posterior fossa, most tumors were mainly medulloblastomas, astrocytomas, brain stem gliomas, ependymoma and atypical rhabdoid tumors. In cerebellar vermis, 65.3% tumors were medulloblastomas. In cerebellar hemisphere, 63.5% were astrocytomas. Among 120 patients of primary brain stem tumors, only 46 (38.3%) had been operated and the histology was known. The predominant histologic diagnosis was astrocytomas.

PRESENTATION

Anthony. J. Raimondi et al[4] studied the incidence, symptoms and hydrocephalus management associated with posterior fossa tumors. In his study, 156 children with posterior fossa tumors and 21 children with pineal tumors were

analyzed. Of 117 children with cerebellar fourth ventricle tumor, 110 (94.01%) had obstructive hydrocephalus, whereas 11 (32.35%) of 34 patients with brain-stem tumors had hydrocephalus and all children 21 (100%) with pineal tumors presented with obstructive hydrocephalus. The symptoms and signs of these patients were grouped into hydrocephalic (headache, vomiting, lethargy, increased head circumference, papilledema, 6th nerve palsy) and non-hydrocephalic (unsteadiness, head tilt, weakness, seizures, cerebellar signs, lower CN palsy). Of the total 143 (91.67% of total) patients with hydrocephalus, shunt was inserted before craniotomy in 123 children before tumor removal. Upward herniation and CSF seeding of peritoneum through the shunt tube are contraindications to shunt insertion before craniotomy.

Leland Albright et al[5] reviewed 86 patients with posterior fossa tumors with secondary hydrocephalus. In this study 47 children had not been treated with any CSF diversion procedures like external ventricular drainage (EVD) or ventriculoperitoneal (VP) shunt. 27 patients were treated with VP shunt. 12 patients were treated with EVD during posterior fossa surgery. Patients treated with VP shunt before tumor surgery had favorable outcome compared to non-shunted patients. The peri-operative mortality was also less in the former (3.7 %) group compared to latter (12.8 %). Complication of placement of a shunt before

posterior fossa surgery included problems related to shunt placement like shunt infection, dysfunction, etc and the chance of seeding of peritoneum with tumor cells.

TIME OF RADIOLOGICAL DIAGNOSIS

Lutz Dörner et al[6] analyzed 50 children with posterior fossa tumors retrospectively. He analyzed the time interval between the onset of first symptom and radiological diagnosis. The mean age at time of diagnosis was 98 months. Clinical symptoms of the patients in this series included headache, nausea, vomiting, decreased level of consciousness, unsteadiness or cranial nerve deficit. The mean time interval from the onset of first symptom to radiological diagnosis was 142 days. The mean time interval for Grade I and II tumors (n=19) was 238 days. The mean time interval for Grade III and IV (n=31) was 117 days. Inspite of the fact that posterior fossa tumors are among the most significant solid tumors in childhood age, they are sometimes misdiagnosed for more common differential diagnoses. Patients in this study have been misdiagnosed and treatment was given for gastroenteritis (n=9), appendicitis (n=1), behavioral problems (n=4), cervical spine pathologies (n=9) and different ophthalmologic diagnosis (n=5). The symptoms of obstructive hydrocephalus led to early the diagnosis.

Roger J. Packer, MD[7] et al studied the distribution and characteristics of various pediatric brain tumors. Infratentorial tumors may present with focal neurologic deficits, but they frequently present to the clinical attention because of obstruction of cerebrospinal fluid with associated hydrocephalus. The classical triad associated with increased intracranial pressure of morning headaches, nausea, and vomiting, may occur, but nonspecific headaches are more frequent. In infants, cerebrospinal fluid obstruction with ballooning of the third ventricle and the resultant tectal compression causes paresis of up gaze "the sun set sign". Because of the speed and availability of CT, it is often the first imaging technique for children with posterior fossa tumor symptoms. CT will detect 95% or more of brain tumors. Because of the superior spatial resolution of MRI, it is essential in the diagnosis of brain tumors. In attempts to avoid postoperative artifacts, an MRI of the entire neurospinal axis often is undertaken before surgery in patients who have presumed malignant tumors.

NEURORADIOLOGICAL ASSESSMENT

Jeffrey E. Arle, M.D[8] et al obtained radiological data obtained via MRI in 33 children with posterior fossa tumor. Eleven imaging characteristics were noted for each patient. These included:

1. Midline or hemispheric location
2. Proton density
3. Tumor intensity on T2 weighted image (hypo, iso or hyperintense)
4. Cystic
5. Solid
6. Contrast enhancement
7. Edema
8. Flow void
9. Hemorrhage within the tumor
10. Focal versus diffuse involvement
11. Obstructive hydrocephalus

The medulloblastomas and ependymomas were the most confusing tumors whereas astrocytomas had a 100 % of positive predictive value. Ependymomas had the lowest positive predictive value (0.57). When using three spectroscopy ratios, almost 60% of the cases could be predicted. Addition of patient age, sex and size of the tumor to the spectroscopy data could achieve almost as much predictive

value of 87.8%. This study provides the value of an accurate preoperative histological diagnosis in pediatric posterior fossa tumors. A preoperative neuroimaging data with good diagnostic accuracy can replace the intraoperative frozen section biopsy in guiding surgery. Another advantage of knowing the histological type of tumor from diagnostic studies is that pre-operative adjuvant chemotherapy can be considered based on the imaging diagnosis. Furthermore, time-consuming spinal staging MR studies in search of drop metastases may be avoided for patients with typical cerebellar astrocytomas and they may be selectively obtained for ependymoma and medulloblastoma preoperatively when the tests are most accurate.

PILOCYTIC ASTROCYTOMA

Pilocytic astrocytoma accounts for 6% of all brain tumors in humans but in children these tumors constitute approximately 15%. The properties of these tumors were location within the cerebellum, commonly cystic, presentation at younger age group and most importantly these tumors have a very good prognosis. These cystic lesions of the cerebellum were previously referred to as "gliomatous cysts". In 1932, Bergstrand found that many of the tumor cells were uni- or bipolar spongioblasts. These were reminiscent of cells found during the late embryonal development. Hence the term "gliocytoma embryonale" was proposed by him for

these tumors. Bucy and Gustafson were not favouring this theory and stated that the cerebellar astrocytoma is a neoplastic entity. In addition they found typical hyaline bodies in these lesions and named these bodies as “Rosenthal fibers”. In 1977 Russell and Rubinstein introduced the term "juvenile pilocytic astrocytoma”. The name "pilocytic astrocytoma" was given to these tumors by the WHO classification system of CNS tumors. Mostly the cerebellar pilocytic astrocytomas occur in the age group 5 - 10 years, with equal predilection among males and females[9]. Presenting symptoms and signs can be grouped into: symptoms caused by increased intracranial pressure and symptoms due to local brain dysfunction at the site of the tumor (cerebellar and brain stem features). In infants the increased head size may be the first symptom. The raised intracranial pressure may cause widening of sutures with a bulging fontanelle. The child will become irritable, lethargic and decreased cry and activities at later period if not treated. Most commonly they are located in the cerebellar vermis, extending asymmetrically to one or both cerebellar hemispheres. Sometimes they are confined to one cerebellar hemisphere. Mostly these tumors consist of a single large cyst with a mural tumor nodule.

Histologically they have a biphasic pattern. These tumors show loose areas of microcysts and stellate or protoplasmic-type astrocytes with more compact areas

containing the typical elongated piloid astrocytes with cytoplasmatic fibrillation [10]. In the more compact areas, Rosenthal fibers are almost always present. Mitoses and necrosis are rare presenting in less than 20%. The treatment of first choice is surgical resection and the aim of surgery should be total resection. If the cyst wall shows contrast-enhancement on CT or MRI, it is very likely to contain tumor cells and should be resected[11]. In tumors showing cyst which is not enhanced, only the resection of the mural nodule alone will be sufficient. Intraoperatively when the inside of the cyst is smooth, the presence of tumor cells in the cyst wall is very unlikely. Conversely, when the cyst-wall is thick and shows a gelatinous appearance, it indicates the infiltration of cyst wall with tumor cells and those cyst walls should be resected. Survival after complete total tumor removal is excellent. The role of radiation therapy is very limited in the treatment of cerebellar pilocytic astrocytomas except when there is a recurring tumor at an inoperable site.

MEDULLOBLASTOMA

Medulloblastoma once thought to be a fatal tumor may be apparently cured by complete surgical resection as far as possible with adequate irradiation of the posterior fossa and entire craniospinal axis. Dattatraya Muzumdar and Enrique CG Ventureyra[12] reviewed many articles published of posterior fossa tumors about posterior fossa tumor. In his review article it is stated that medulloblastoma occurs

predominantly in males (ratio 1.4:1) and more commonly in the age group 5 to 7 years. It occurs in association with Gorlin's syndrome and Turcot's syndrome. Seeding of tumor cells in the craniospinal axis is found in 11 – 43% of patients and is one of the most important predictors of outcome. The WHO classification of medulloblastoma is based on light microscopy and immunohistochemical findings. It comprises classical medulloblastoma, the large cell anaplastic variant, desmoplastic variant, medullomyoblastoma variant and melanotic variant[13]. The nodular type has a better prognosis when compared with classical medulloblastoma. The most malignant variant is the large cell anaplastic medulloblastoma which accounts for 4% of cases. Drop metastases through CSF occur in up to 40% of patients. These drop metastases are more commonly seen in lumbosacral and thoracic levels. They are best seen on post-contrast T1-weighted images in which they appear as "icing sugar appearance". Hence it is necessary to have MRI of the spine before treatment for staging the disease. The extraneural metastasis of medulloblastoma occurs in bone and bone marrow.

The aim of the surgery should be aimed at total removal of the tumor without endangering life or causing significant morbidity. The current standard adjuvant treatment for average risk medulloblastoma includes postoperative craniospinal irradiation with 23.4 Gy and posterior fossa booster with 54 Gy

followed by 12 months of chemotherapy. Irradiation in young children causes severe neurological morbidity and cognitive impairment. Hence irradiation is contraindicated in children younger than the age of 3 years. Chemotherapy includes cisplatin, vincristine, lomustine, cyclophosphamide and oral etoposide which are used alone or in combination.

Treatment regimen of medulloblastoma according to risk stratification

Stratification	Treatment	Outcome
Average-risk (residual tumor ≤1.5 cm², M0 disease), age ≥3 years	Safe maximal resection, spinal MRI and lumbar cerebrospinal fluid study 2 weeks following surgery. Craniospinal irradiation 23.4 Gy with posterior fossa boost 54 Gy followed by chemotherapy for 12 months	80% event-free survival
High-risk (residual tumor >1.5 cm², stage M1–4), age >3 years	Safe maximal resection, craniospinal irradiation 30 Gy with posterior fossa boost 54 Gy; chemotherapy prior, during and/or after radiation therapy	50–60% event-free survival
Medulloblastoma in infants & children <3 years		
No disseminated disease	Postirradiation chemotherapy or focal irradiation	Less than 20% event-free survival
Disseminated disease	Chemotherapy with or without methotrexate; radiation therapy (local or craniospinal) after chemotherapy	20–40% event-free survival; desmoplastic variant: 60% event-free survival
Disease relapse	MRI of the brain and spine including lumbar cerebrospinal fluid cytology analysis; bone scan and bone marrow exam if extraneural metastases; surgical resection, irradiation, myeloablative chemotherapy with autologous stem cell rescue	24 ± 10%, overall event-free survival

EPENDYMOMA

Fulya Yaman Agaoglu, MD[14] et al studied demographic data and treatment results of 40 patients below 16 years of age with ependymoma. There were 22 males and 18 females aged from 3 months to 15 years old, with a median age of 5.5 years. These tumors represent for 5–10% of all brain tumors in the pediatric age group ranking third in the frequency following astrocytoma and medulloblastoma. The origin is from ependymal cells from the floor of fourth ventricle. The risk of meningeal dissemination in ependymomas is about 2–30%[23]. CT and MRI with gadolinium are the main modality of investigating ependymoma. MRI should include entire craniospinal screening to detect "drop metastasis" preoperatively. Post treatment MRI should be taken 6 weeks following surgery to eliminate post-operative artifacts.

Fourth ventricular ependymomas can be preoperatively classified as lateral type or mid floor type tumors. This correlates well with extent of resection. Lateral-type tumors have significantly increased risk of residual tumor compared to mid floor type tumors[15]. Treatment should be aimed at complete tumor resection without compromising neurological function. Total tumor resection was performed in 20 patients (50%), subtotal in 18 patients (45%) and biopsy only in 2 patients (5%). Histologic diagnosis was 18 Grade I ependymomas (Grade 1- 45%) and 22

anaplastic ependymomas (Grade 3 - 55%). Postoperative treatment consisted of regional radiotherapy alone in patients with ependymoma without CSF seeding of tumor cells (n=8). Regional and craniospinal irradiation (n=9) in patients were given for patients with CSF seeding. Regional and craniospinal irradiation with chemotherapy in patients with anaplastic ependymoma (n=14). Chemotherapy alone was given in one patient (less than 3 years of age). The standard technique for posterior fossa irradiation was followed in this study which is craniospinal irradiation of 36 Gy (range 30 – 40 Gy) and booster to the primary site of 54 Gy (range 46 - 60 Gy). These patients received adjuvant therapy of radiotherapy (boost and craniospinal irradiation) and concomitant infusion of cisplatin (as radiosensitizer) followed by ‘‘VCPCU’’ (vincristine, cyclophosphamide, procarbazine, lomustine) administered every 4 weeks for eight course. The majority of complete responders were patients who had total tumor removal. The completeness of the surgical resection is the most significant factor that has the greatest impact on the outcome of children with ependymoma.

BRAIN STEM GLIOMA

Albright et al[16] published a manuscript that changed the course for the treatment of children with diffuse intrinsic pontine gliomas (DIPGs). The point of the paper was that if a child presented with a short clinical history, had cranial

nerve findings and long-tract signs and had the typical MR imaging appearance of a diffuse pontine glioma, there was no difference in treatment or outcome in that patient population based on biopsy findings. Children with brain stem gliomas have poor prognosis. Mostly they die within 2 years of diagnosis. Intrinsic brain stem tumors have traditionally been treated with non-operative measures like irradiation and adjuvant chemotherapy. Despite this dismal prognosis, that there may be at least a few cases of brain stem gliomas that were both surgically resectable and low-grade.

Fred Epstein, M.D et al[17] analyzed surgical indication in 34 children with brain stem gliomas. Three tumor subgroups had been described in his study: Focal, Diffuse and Cervicomedullary based on MRI findings. A focal tumor is a circumscribed mass less than 2 cm in diameter without edema. A diffuse tumor has a large hypodense component with or without a "focal" component. Cervicomedullary neoplasms involve the lower two-thirds of the medulla and the rostral segments of the spinal cord. In his series (n=34), 22 were diffuse, 4 focal, and 8 cervicomedullary types. All patients (22) with diffuse neoplasms had rapidly progressive signs and symptoms typical of a brain-stem glioma like multiple cranial nerve dysfunction associated with spasticity in the lower extremities. All of these patients were severely disabled at the time of surgery. 3 of 4 patients with a

focal tumor had an atypical clinical presentation with insidious onset of one cranial nerve palsy. They had remission lasting from 12 to 24 months but significant neurological deterioration gradually evolved after 2 years and 2 patients were severely disabled at the time of surgery. 8 patients with cervicomedullary tumors had lower cranial nerve dysfunction associated with symptoms mimicking upper cervical cord lesion like hemiparesis, quadriparesis and spasticity. The clinical course was consistently protracted and significant disability did not occur until 1 to 3 years follow up after radiotherapy. With brain stem evoked potential monitoring these tumors were approached through floor of fourth ventricle or retromastoid approach. The dissection was limited within the tumor only aiming at radical tumor excision without neurological deterioration. All diffuse type tumors (22) had malignant grade (Grade 3 or 4) and they respond poorly for any form of treatment. 3 out of 4 focal tumors had benign histology (Grade 1 or 2). All cervicomedullary tumors (8) were benign astrocytomas (Grade 1 or 2). Both focal and cervicomedullary type tumor responded well to the surgery and they had excellent neurological recovery.

In 1980, Hoffman et al[18] reported that children with exophytic brainstem gliomas survived substantially longer than children with the usual intrinsic brain stem tumors. A. Leland Albright, M.D[16] et al published a series of 84 children with

brainstem gliomas and found that the prognosis of children with brain-stem gliomas is significantly worse in children whose first symptoms include one or more cranial nerve palsy. Poor prognosis was also seen in patients whose CT scans show a hypodense or diffuse tumor and in those whose tumor biopsy material contains mitoses or features of high grade tumor. Conversely, the prognosis is much better for patients in whom the above features are absent, particularly if the biopsy specimen contains calcification or Rosenthal fibers.

COMPLICATIONS

Jay Riva Cambrin. M.D. M.Sc. et al[19] studied the frequency of post resection hydrocephalus in children with posterior fossa tumors. Approximately 30% of pediatric patients with posterior fossa tumors exhibit hydrocephalus after tumor resection. Recently many literatures suggested that prophylactic ETV diminishes the risk of postoperative hydrocephalus. However treating all children with posterior fossa tumors this way potentially exposes approximately 70% of patients to an unnecessary procedure that can have significant risks[20]. In this study individual variables like age, degree of hydrocephalus and intracerebral metastases in combination with novel predictors such as papilledema and preoperative estimations of specific tumor pathological findings were validated.

Canadian preoperative prediction rule for Hydrocephalus(CPPRH)[19]

Predictor	Score
Age < 2 year	3
Presence of papilledema	1
Moderate/ severe hydrocephalus	2
Cerebral metastasis	3
Pre op provisional diagnosis	
Medulloblastoma	1
Ependymoma	1
Dorsally exophytic brain stem glioma	1
Total	10

The CPPRH's predicted probabilities of Post-resection Hydrocephalus at 6 months[19]

CPPRH SCORE	PROBABILITY
0	0.071
1	0.118
2	0.191
3	0.293
4	0.422
5	0.562
6	0.693
7	0.799
8	0.875
9	0.925
10	0.956

Steinbok et al[21] retrospectively analyzed children with posterior fossa tumors treated surgically who had CSF leak and pseudomeningocele formation. Craniotomy has proved to have some protective effect compared to craniectomy. The replaced bone flap limit the stretching of the sutured dural membrane in case of postoperative swelling of the cerebellum or/and fluid accumulation within the posterior cranial fossa.

Luigi Ferrante, M.D et al[22] reported three cases of mutism after posterior fossa surgery. Generally speech disturbances occur frequently after surgical removal of posterior cranial fossa tumors especially when the surgery involves a resection of a cerebellar lobe (particularly the left) and part of the vermis. These are generally termed as “dysarthria”. An unusual finding after posterior fossa surgery is mutism (complete absence of speech in a conscious patient). In this study, mutism arose 18 to 72 hours after the operation (mean - 41.5). Extensive destruction of the median and paramedian cerebellar substance involving the deep nuclei (dentate nuclei) is probably the most important anatomical substrate of mutism.

MATERIALS AND METHODS

STUDY PATTERN

This study was conducted at Institute of Neurology, Madras Medical College & Rajiv Gandhi Govt. General Hospital from November 2011 to November 2013 after obtaining proper clearance from ethical committee. The study included 52 patients of age more than 6 months and less than 12 years with posterior fossa tumors.

INCLUSION CRITERIA

All patients admitted in pediatric neurosurgical ward with age more than 6 months and less than 12 years having posterior fossa tumors were included in this study.

EXCLUSION CRITERIA

The following patients were excluded from the study,

1. Children less than 6 month of age
2. Children with posterior fossa mass but the imaging features and/or histological features suggestive of inflammatory pathology
3. Children with posterior fossa cystic mass but the imaging and/or histological features suggestive of arachnoid cyst
4. Children who underwent any form of surgical intervention at some other institutions
5. Children with lesions in both supra and infratentorial compartments
6. Children who died before commencing any form of intervention
7. Children who died before MRI was taken
8. Children for whom their parents not willing for any form of intervention
9. Patients who were discharged from the hospital against medical advice

On admission, patient's clinical profile such as age, sex, presenting symptoms and signs were recorded. All children with features of increased ICP

and/or decreased alertness were subjected to urgent CT brain to rule out obstructive hydrocephalus.

Patients having obstructive hydrocephalus and features of raised ICP and/or decreased alertness were treated with emergency VP shunt. If the children with hydrocephalus did not have features of raised ICP or decreased alertness were observed cautiously. This subgroup of children was subjected to urgent MRI study with craniospinal screening with a neurosurgical resident accompanying the child during study. They were posted in next elective theatre list if possible.

If the admission CT scan show mild obstructive hydrocephalus and children were relatively well preserved, they are subjected to elective MRI study. They were treated with elective posterior fossa tumor surgery without prior shunting.

The intraoperative EVD or VP shunt during posterior fossa surgery was determined by alertness of the child on the day of elective surgery and intra operative factors (possibility of post-operative intraventricular (IVH) , tumor not completely resected, tense posterior fossa).

Almost all children (except few intrinsic brain stem lesions) were treated surgically. Almost all of the surgically treated patients were positioned prone (except tumor epicenter in CP angle) on pediatric horse-shoe frame, their head plastered to the frame. Pediatric May field pin fixator was not used for fear of skull

fracture and extra-axial hematomas. Midline suboccipital craniectomy (craniotomy was not done) was done for all midline vermian tumors and midline dorsally exophytic brain stem tumors. If major proportion of the tumor was present laterally over cerebellar hemisphere or cerebellopontine angle, either paramedian suboccipital craniectomy or retromastoid suboccipital craniectomy was done respectively. If retromastoid suboccipital craniectomy was the approach, then the child was positioned lateral with mastoid at the highest point. Most of the midline vermian and lateral hemispheric tumors (> 50%) were resected radically (either near total or total excision). Brain stem lesions were treated either with biopsy alone or partial excision.

Postoperative EVD or shunting was based on patient's condition during the postoperative period. The first follow up CT brain was taken on the first postoperative day. If CT scan showed fresh IVH and/or hydrocephalus (moderate to severe) with residual tumor they were subjected to CSF diversion procedure irrespective of clinical condition. If the children had CSF leak from the wound and/or bulging pseudomeningocele in the presence of hydrocephalus, they are also subjected to shunting after the failure of conservative measures.

Almost all the patients with posterior fossa tumors (except pilocytic astrocytoma) were subjected to adjuvant therapy. Children less than 3 years of age were treated with chemotherapy till they reached 3 years of age. After 3 years of

age, they were subjected to radiotherapy which included 54 Gy given in fractionated doses to posterior fossa along with 23.4 Gy to entire craniospinal axis in fractionation.

The following factors were studied and analyzed descriptively and statistically, whether they could prove as positive predictive factors

1. **Demographic data**

   Age

   Sex

2. **Presentation**

   ICP features (headache, vomiting)

   Cranial nerve deficit

   Others (torticollis, recurrent lower respiratory tract infection (LRI), failure to thrive, weakness, unsteadiness)

3. **Imaging characteristics**

   Solid

   Cystic

   Mixed

   Midline

   Midline with lateral extension

   Presence of hydrocephalus

4. **Intervention**

    Preoperative shunting

    Intra operative shunting/ EVD

    Post-operative shunting/ EVD

5. **Extent of tumor resection**

    Partial excision

    Subtotal excision

    Near total excision

    Total excision

6. **Complications of treatment**

    CSF leak

    Pseudomeningocele

    Lower cranial nerve palsy

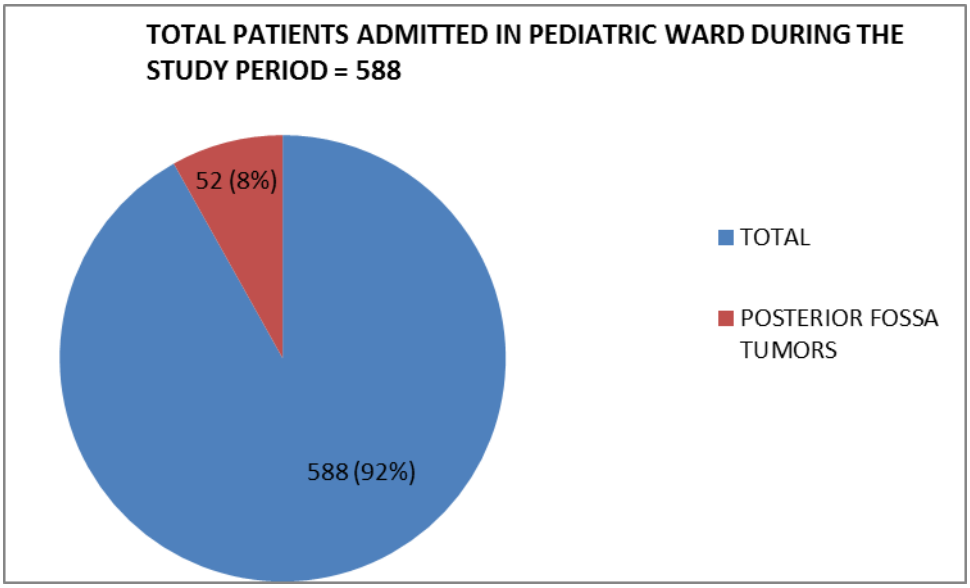
    Aspiration pneumonitis

    Death

RESULTS

Total number of patients (age less than 12) admitted in the pediatric ward in the study period was 588. Of which 52 (8%) patients had posterior fossa tumors. The rest of the patients (92%) had other diagnosis like congenital or infective hydrocephalus, trauma, other tumors and CV junction anomaly).

CHART – 1

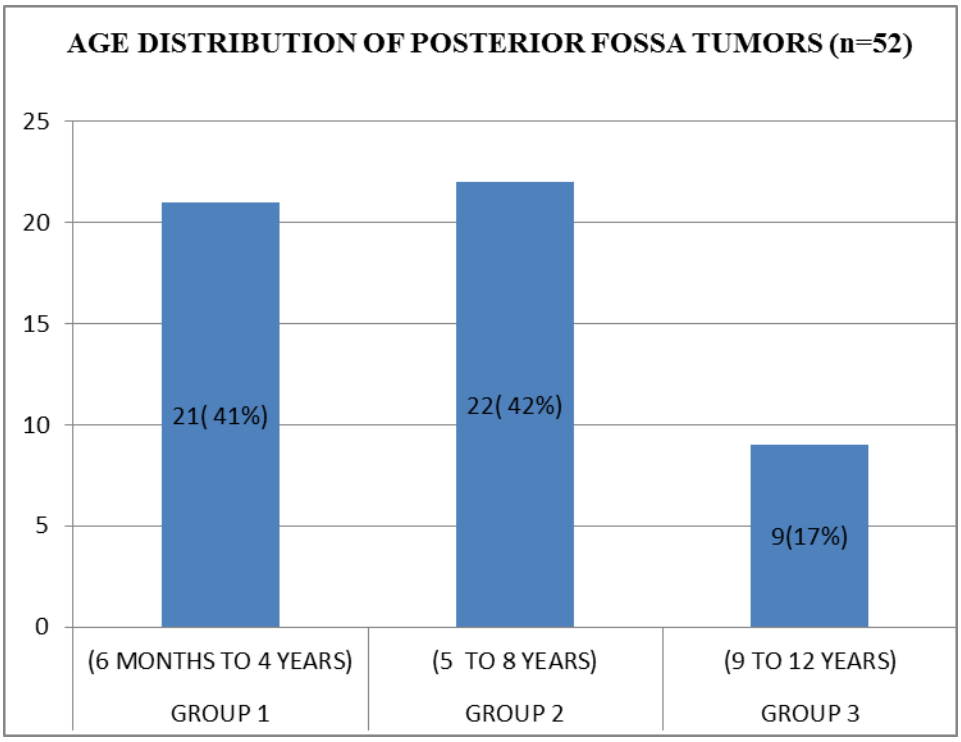


All the patients with posterior fossa tumors were grouped into three groups based on age

1. Group 1 – 6 months to 4 years
2. Group 2 – 5 years to 8 years
3. Group 3 – 9 years to 12 years.

The incidence of posterior fossa tumors in each group is noted and plotted in the graph as follows:

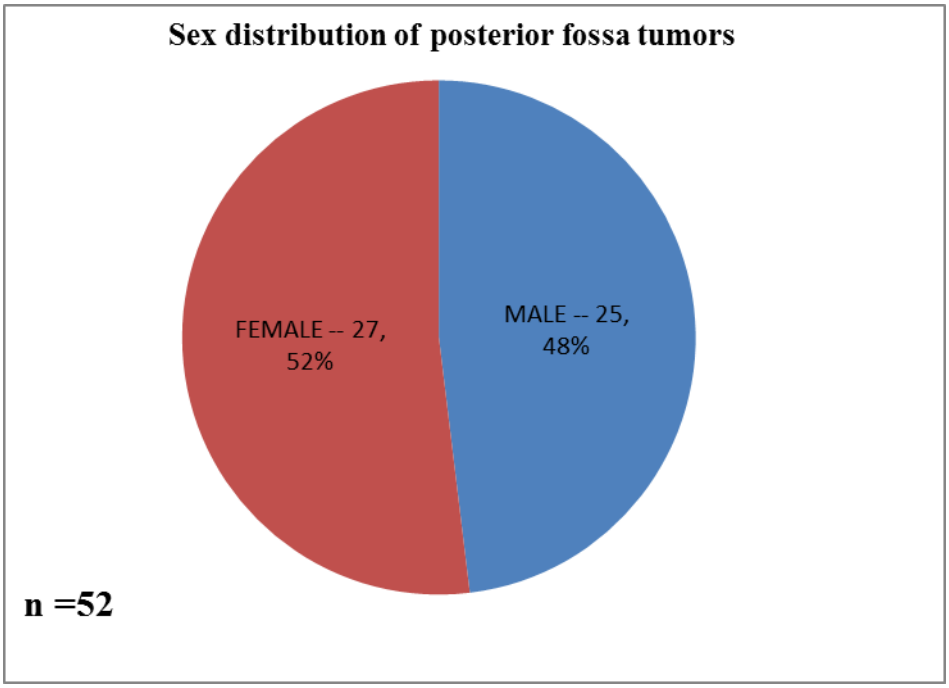
CHART - 2



In this study, posterior fossa tumors are more common in group 1 and group 2. This implies that these tumors are more common below 9 years of age.

Similarly the sex distribution of posterior fossa tumors in the study population was noted. The distribution is almost equal among both sexes (male – 25, female – 27). However the distribution of different types of posterior fossa tumors was not equal among both the sexes which are described subsequently.

CHART – 3


Sex distribution of posterior fossa tumors
FEMALE -- 27, 52%
MALE -- 25, 48%
n =52

a) Distribution of different types of posterior fossa tumors among different age groups and sex in the study population

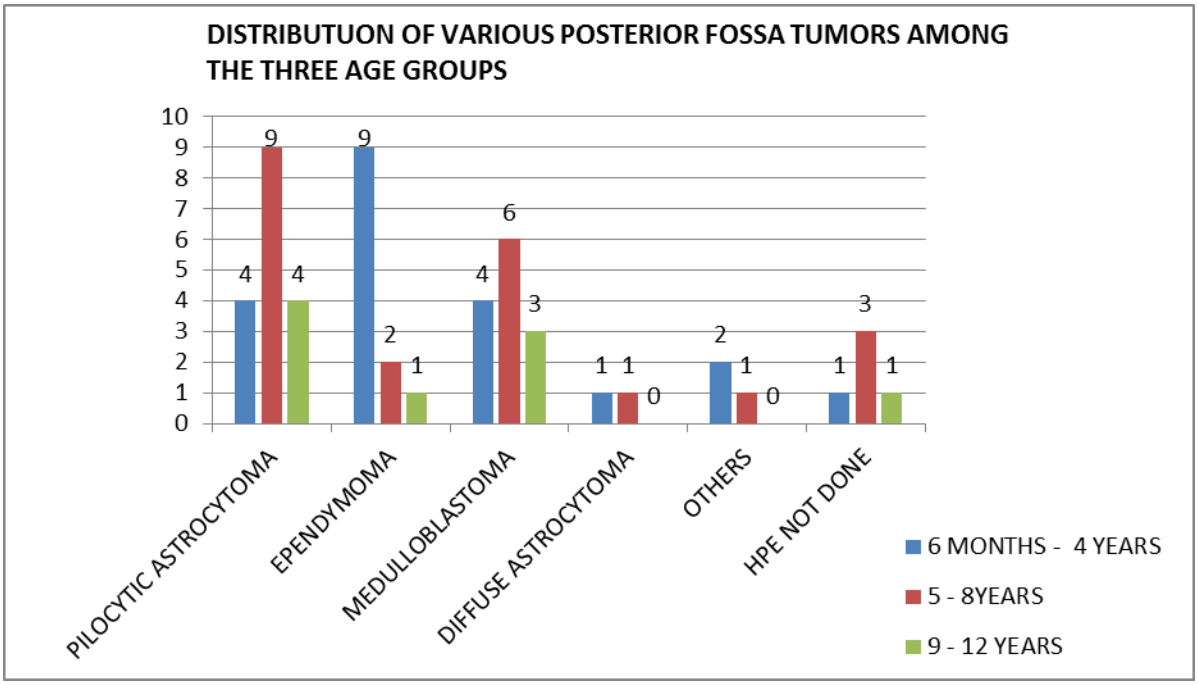
The distribution of various types of posterior fossa tumors among various age groups in the study population was analyzed.

TABLE - 1

		HISTOLOGY						
		PILOCYTIC ASTROCYTOMA	EPENDYMOMA	MEDULLOB LASTOMA	DIFFUSE ASTROCYTOMA	OTHERS	HPE NOT DONE	TOTAL
AGE	6 MONTHS - 4 YEARS	4	9	4	1	2	1	21
	5 - 8YEARS	9	2	6	1	1	3	22
	9 - 12 YEARS	4	1	3	0	0	1	9
	Total	17	12	13	2	3	5	52

OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

CHART – 4



OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

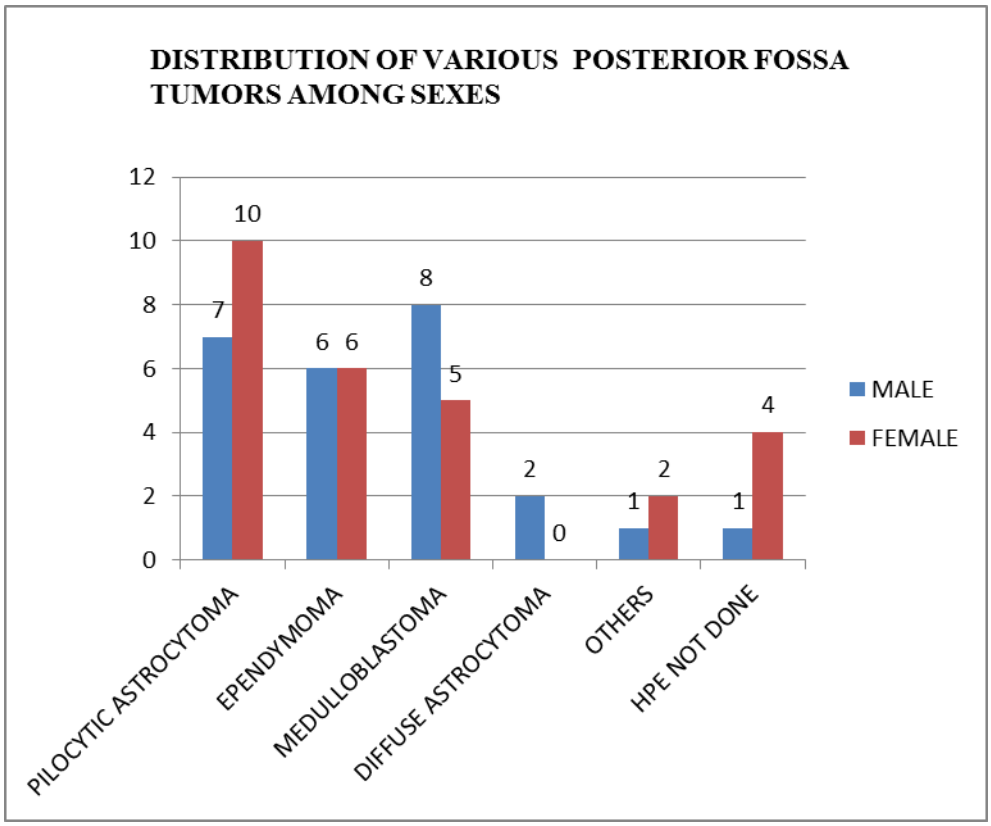
From the above chart - 4 and table - 1, it is clear that pilocytic astrocytoma and medulloblastoma were common in the age group 5 to 8 years compared to other groups. And ependymoma is common in the age group 6 months to 4 years.

TABLE - 2

	HISTOLOGY						
	PILOCYTIC ASTROCYTOMA	EPENDYMOMA	MEDULLOBLASTOMA	DIFFUSE ASTROCYTOMA	OTHERS	HPE NOT DONE	TOTAL
MALE	7	6	8	2	1	1	25
FEMALE	10	6	5	0	2	4	27
TOTAL	17	12	13	2	3	5	52

OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors.

CHART – 5



OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

From the above chart - 5 and table - 2, ependymomas were equally distributed among males and females, medulloblastomas were more common in males (Male to Female Ratio is 1.6: 1) and pilocytic astrocytoma is more common in females (Female to Male Ratio is 1.4: 1).

b) Distribution of various clinical presentations of posterior fossa tumors in the study population.

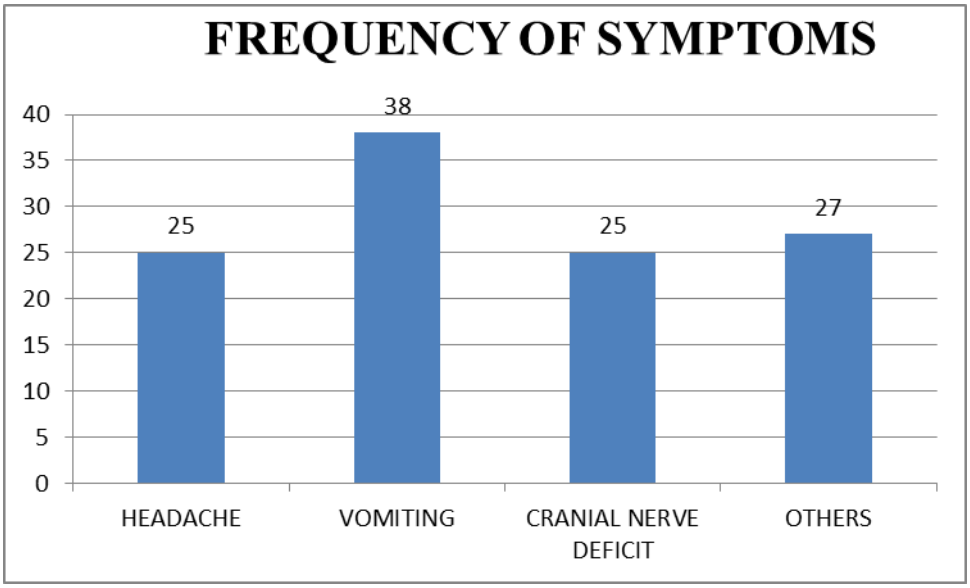
The presenting symptoms of posterior fossa tumors in the study population were analyzed.

TABLE - 3

SYMPTOMS	FREQUENCY (n= 52)	PERCENTAGE
HEADACHE	25	48.1
VOMITING	38	73.1
CRANIAL NERVE DEFICIT	25	48.1
OTHERS	27	51.9

OTHERS – Torticollis, failure to thrive, obtundation, recurrent respiratory tract infection, unsteadiness and weakness

CHART – 6



OTHERS – Torticollis, failure to thrive, obtundation, recurrent respiratory tract infection, weakness, unsteadiness

Most of the posterior fossa tumors among the study population presented with symptoms of increased intracranial tension secondary to obstructive hydrocephalus. The second most common symptom include cranial nerve palsies including third, fourth, sixth, seventh and lower cranial nerve palsies.

c) Distribution of various imaging features among the histology of posterior fossa tumors in the study population.

The various MR imaging characteristics of the posterior fossa tumors were studied. They were grouped into:

1. Tumor characteristic
    a) Cystic
    b) Solid
    c) mixed

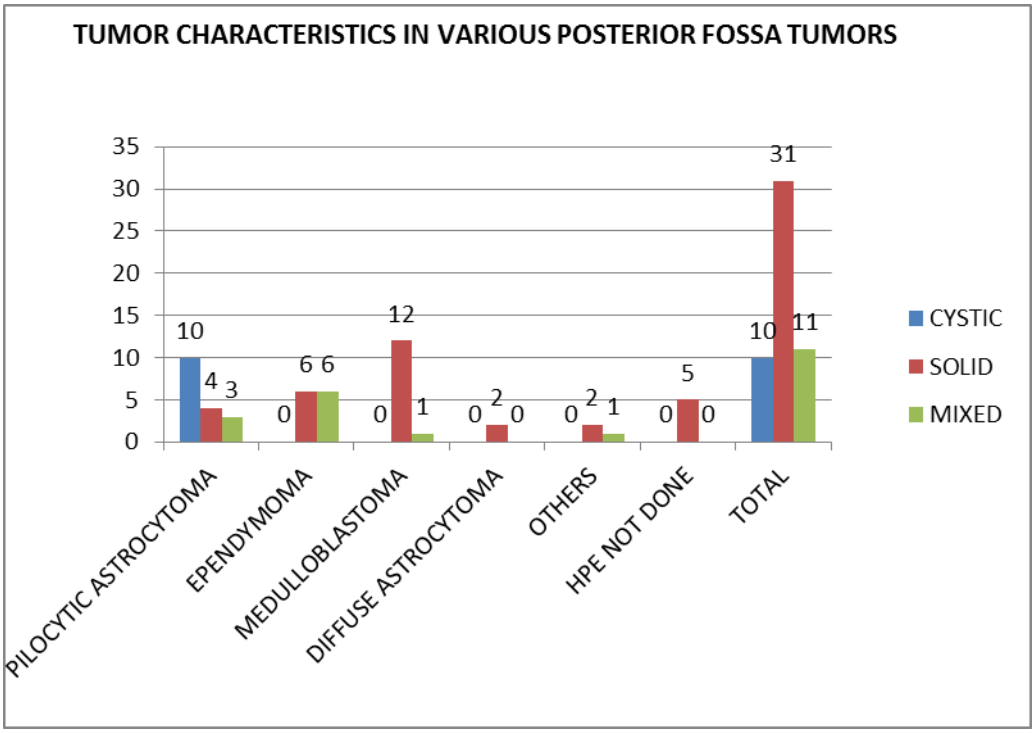
2. Tumor location
    a) Midline
    b) Midline with lateral extension

TABLE – 4

	HISTOLOGY						
	PILOCYTIC ASTROCYTOMA	EPENDYMOMA	MEDULLOBLASTOMA	DIFFUSE ASTROCYTOMA	OTHERS	HPE NOT DONE	TOTAL
CYSTIC	10	0	0	0	0	0	10
SOLID	4	6	12	2	2	5	31
MIXED	3	6	1	0	1	0	11
TOTAL	17	12	13	2	3	5	52

OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

CHART - 7



OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

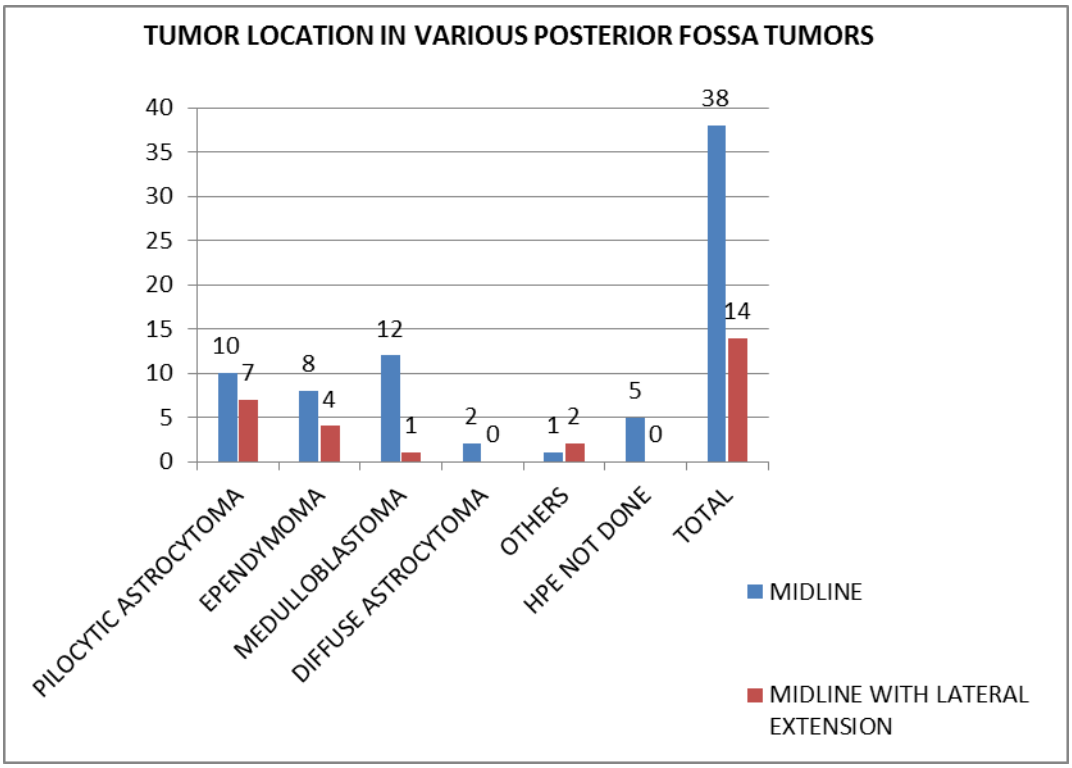
From the above table - 4 and chart - 7, it is clear that pilocytic astrocytoma more commonly appears as cystic mass in the MRI where as medulloblastoma and intrinsic brain stem tumors almost always present as solid lesions. Ependymoma present as solid as well as mixed lesions in equal proportions.

TABLE - 5

	HISTOLOGY						
	PILOCYTIC ASTROCYTOMA	EPENDYMOMA	MEDULLOBLASTOMA	DIFFUSE ASTROCYTOMA	OTHERS	HPE NOT DONE	TOTAL
MIDLINE	10	8	12	2	1	5	38
MIDLINE WITH LATERAL EXTENSION	7	4	1	0	2	0	14
TOTAL	17	12	13	2	3	5	52

OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

CHART - 8



OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

From the above table - 5 and chart - 8, more than 60 % of posterior fossa tumors occur in the midline without any lateral extension. Of all posterior fossa tumors, medulloblastoma and intrinsic brain stem tumors almost exclusively occur in the midline. Though pilocytic astrocytoma and ependymoma more commonly occur in the midline, they have higher probability of lateral cerebellar hemispheric extension than other posterior fossa tumors.

d) Distribution of obstructive hydrocephalus in the study population

CHART- 9

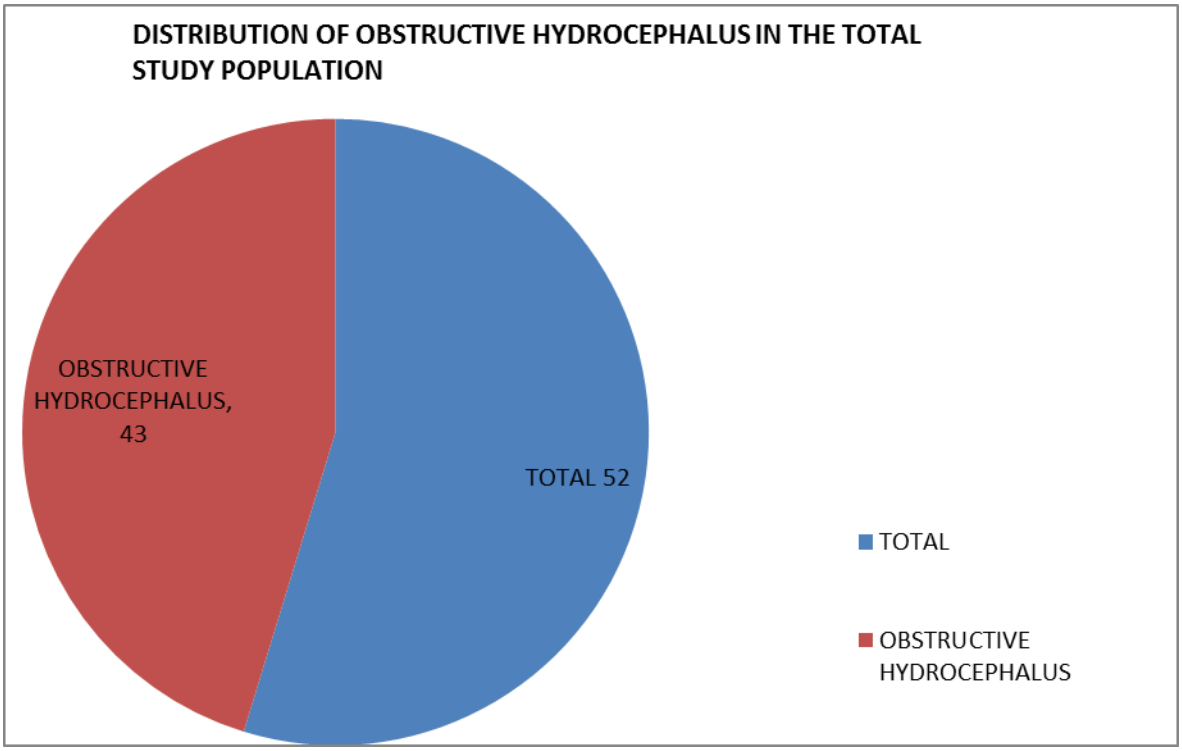
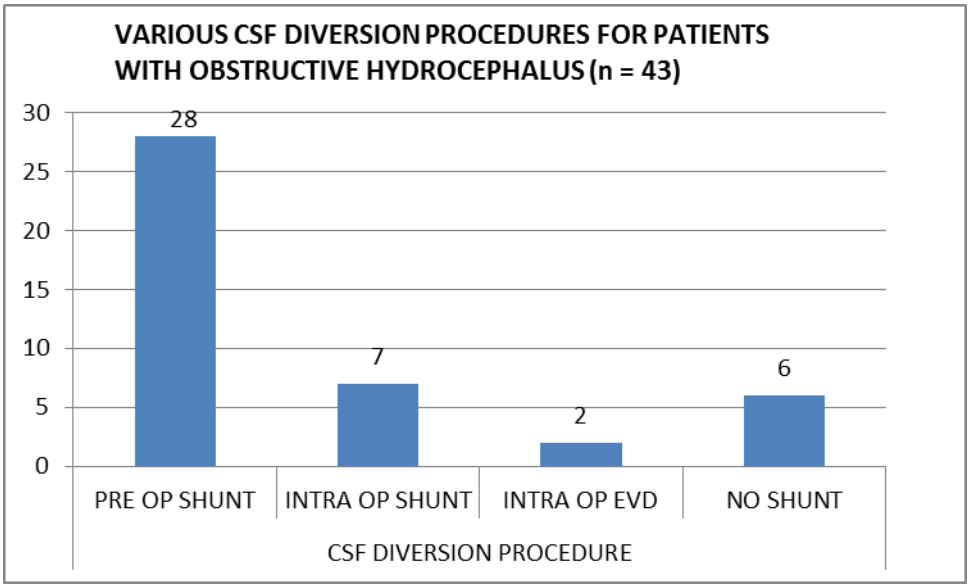


CHART – 10



From the above charts - 9 and 10, it is clear that among the total 52 patients, 43 (82.7%) had obstructive hydrocephalus. Among those 43 patients, 28 had pre-operative shunting and 7 had intra-operative shunt and 2 patients had intra-operative EVD. 6 patients with obstructive hydrocephalus were not treated with any form of pre-operative or intra-operative CSF diversion procedure.

e) The possibility of extent of tumor resection among the histology of posterior fossa tumors in the study population.

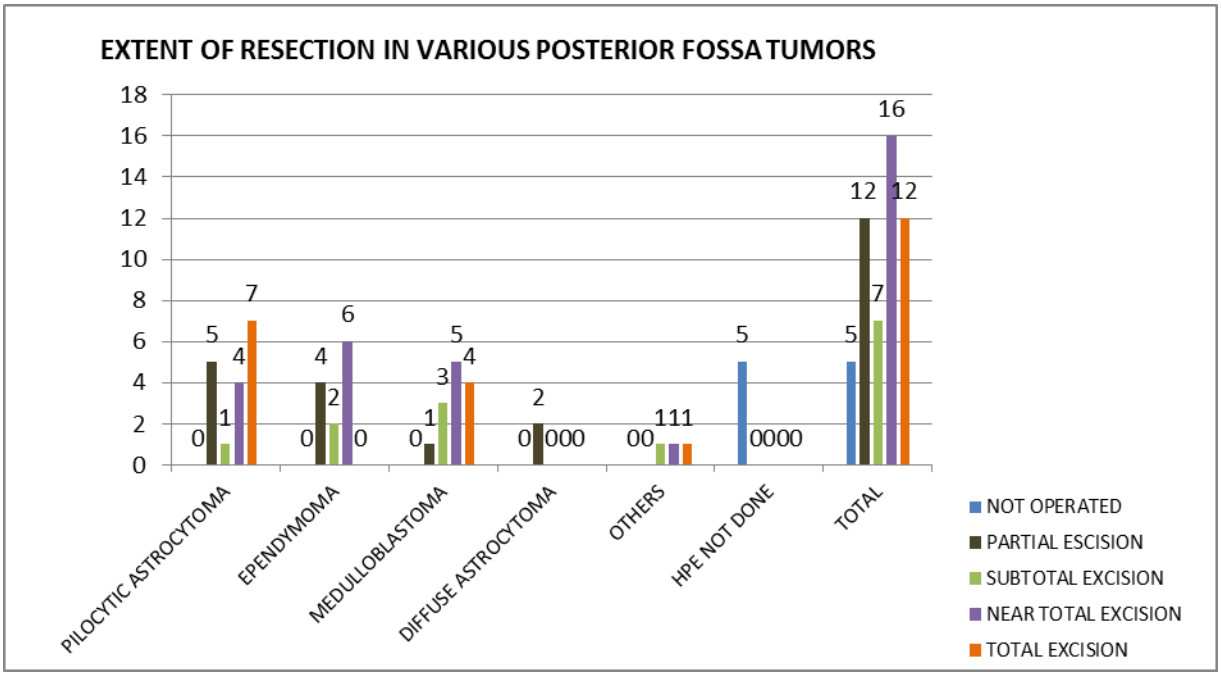
Except children with diffuse intrinsic brain stem lesions (5 out of 52), all the other children in the study group were subjected to surgical resection. The extent of resection varied among the different types of tumors due to several pre-operative and intra-operative factors like pre-operative general condition of the children, intra-operative torrential bleeding, intra-operative bradycardia, presence or absence of tumor-brain tissue plane and tumor adherence to brain stem, cranial nerves and important vessels.

TABLE - 6

	HISTOLOGY						
	PILOCYTIC ASTROCYTOMA	EPENDYMOMA	MEDULLOBLASTOMA	DIFFUSE ASTROCYTOMA	OTHERS	HPE NOT DONE	TOTAL
NOT OPERATED	0	0	0	0	0	5	5
PARTIAL EXCISION	5	4	1	2	0	0	12
SUBTOTAL EXCISION	1	2	3	0	1	0	7
NEARTOTAL EXCISION	4	6	5	0	1	0	16
TOTAL EXCISION	7	0	4	0	1	0	12
TOTAL PATIENTS	17	12	13	2	3	5	52

OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

CHART - 11



OTHERS – Haemangioblastoma, germinoma, chloroma
HPE NOT DONE – Histology was not done because these tumors are intrinsic brain stem tumors

From the above table 6 and chart 11, the maximum extent of tumor resection was done for 28 patients (16 – near total; 12 –total excision). The intrinsic brain stem lesions with diffuse involvement of brain stem were not operated. The maximal extent of resection was done for medulloblastoma and pilocytic astrocytoma. When less than 50% of tumor removal was done, it was considered as biopsy or partial excision. When most of the tumor capsule was left unremoved, it was considered as subtotal excision. When the tumor capsule attached to the vital structures like brain stem and cranial nerves alone was left untouched and remaining tumor capsule excised, it was considered as near total excision. When

the tumor was excised along with its capsule completely, it was considered as total excision.

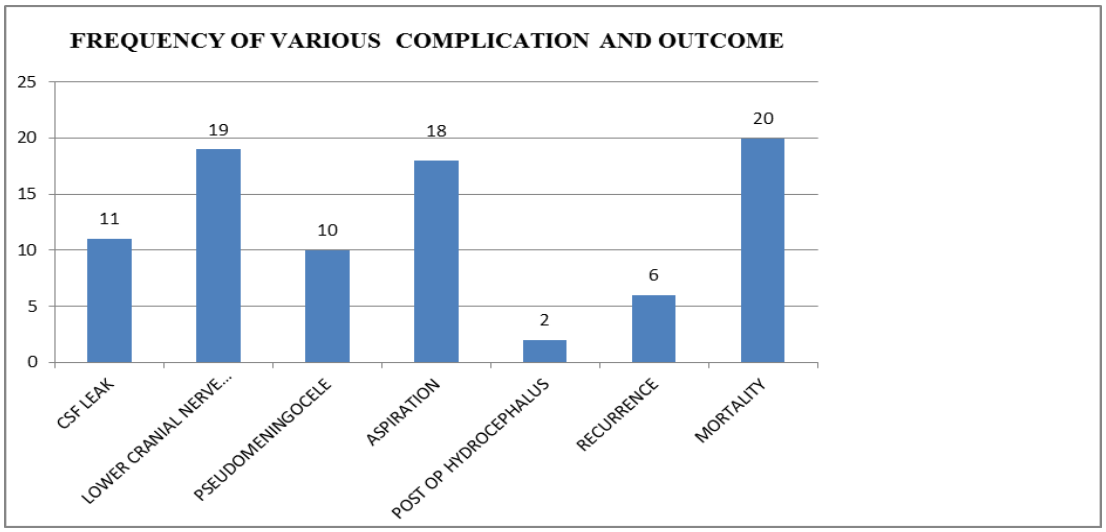
f) Frequency of various outcome among the study population

The outcome of the study population (including operated as well as non-operated cases) was analyzed.

TABLE- 7

	TOTAL (n = 52)	
	FREQUENCY	PERCENTAGE
CSF LEAK	11	21.20%
LOWER CRANIAL NERVE PALSY	19	36.50%
PSEUDOMENINGOCELE	10	19.20%
ASPIRATION	18	34.60%
POST OPERATIVE HYDROCEPHALUS	2	3.84%
RECURRENCE	6	11.50%
MORTALITY	20	38.50%

CHART- 12



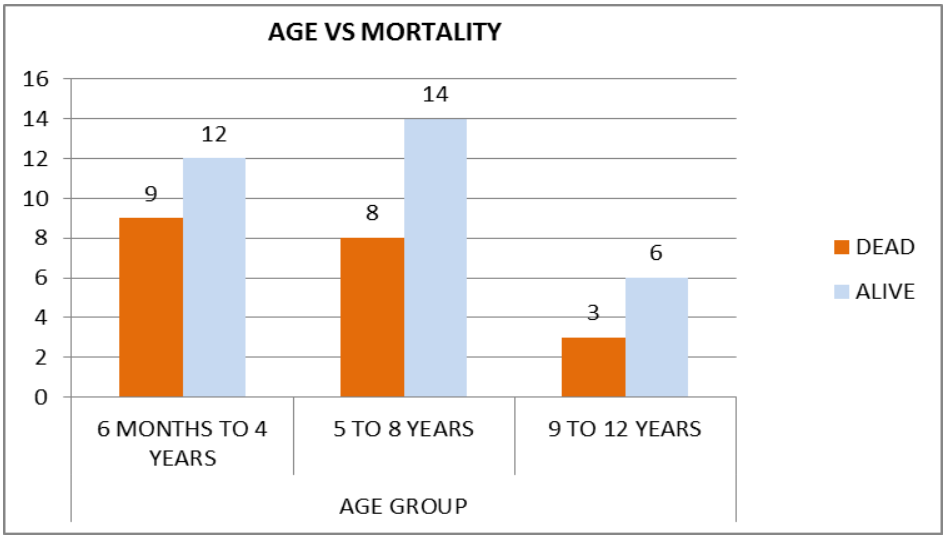
From the above table - 7 and chart - 12, mortality is the most common outcome followed by aspiration pneumonitis and lower cranial nerve palsy. Being the most common outcome in this study, mortality is analyzed in more detail using statistical data and chi- square tests.

I. Analyzing the age of presentation as a predictive factor in predicting the outcome

TABLE- 8

		DEATH			P VALUE
		PRESENT	ABSENT	TOTAL	
AGE GROUP	6 MONTHS TO 4 YEARS	9	12	21	0.855
	5 TO 8 YEARS	8	14	22	
	9 TO 12 YEARS	3	6	9	
	Total	20	32	52	

CHART- 13



When the age of presentation among different subgroups of age were analyzed as a predictor of outcome using chi square test, it was found to be statistically not significant (p = 0.855).

II. Analyzing the presence of increase ICP features (headache and vomiting) as a predictive factor in predicting the outcome

TABLE- 9

		DEATH			P VALUE
		PRESENT	ABSENT	TOTAL	
HEADACHE	PRESENT	6	19	25	0.39
	ABSENT	14	13	27	
	TOTAL	20	32	52	

CHART- 14

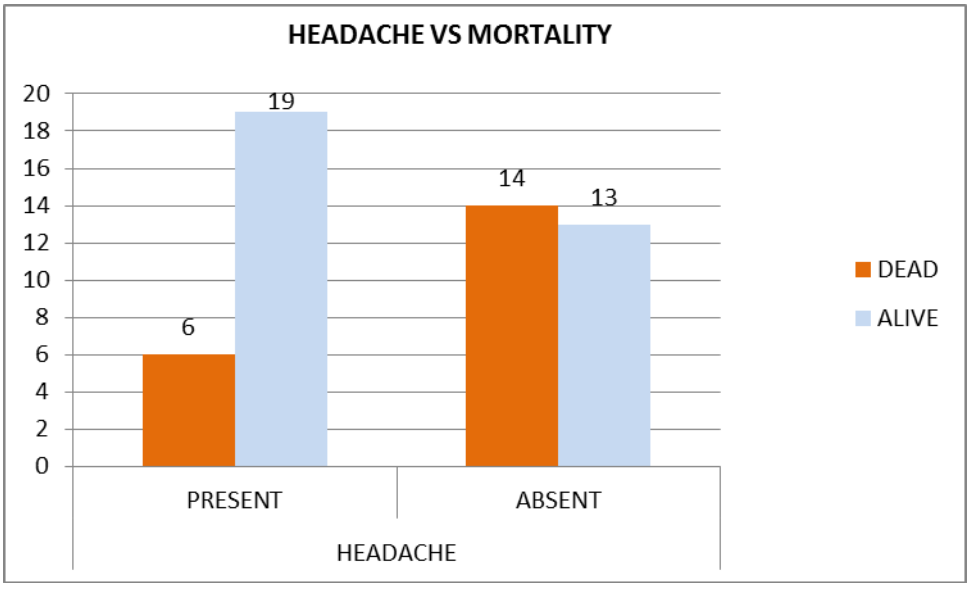
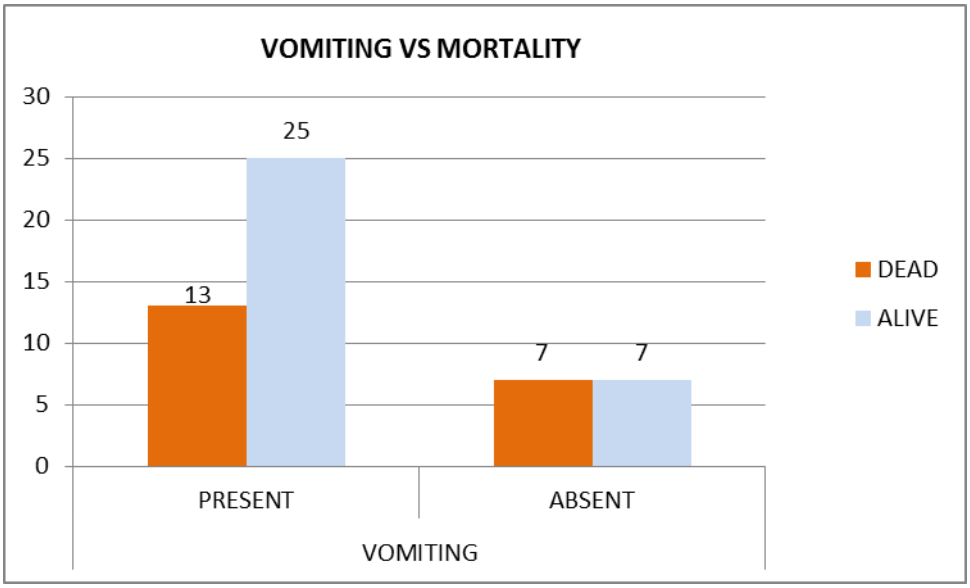


TABLE- 10

		DEATH			P VALUE
		PRESENT	ABSENT	TOTAL	
VOMITING	PRESENT	13	25	38	0.299
	ABSENT	7	7	14	
	TOTAL	20	32	52	

CHART - 15



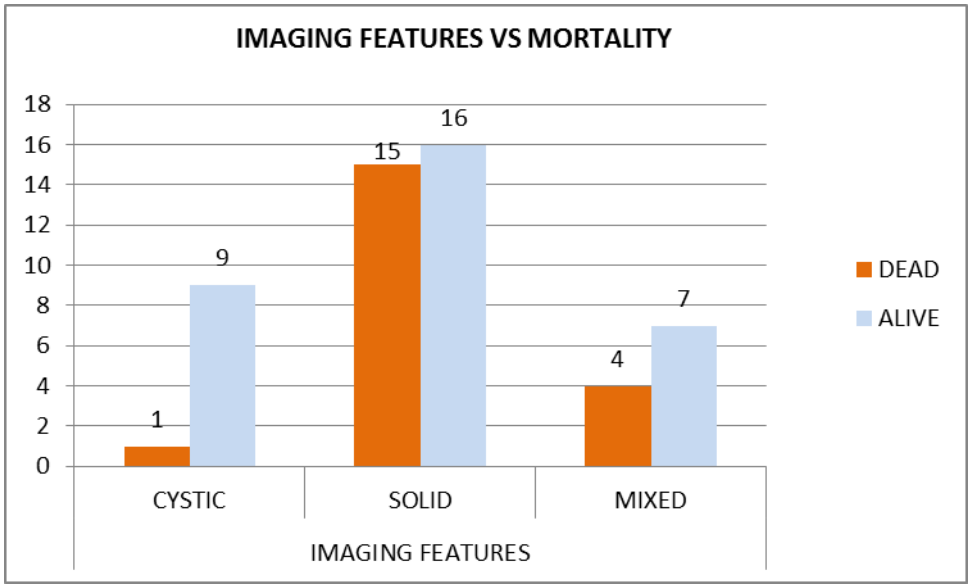
When the presence of increased ICP features (headache and vomiting) was analyzed as a predictor of outcome using chi square test, it was found to be statistically not significant (Headache p value = 0.39; Vomiting p value = 0.29). When the presence of increased ICP features secondary to obstructive hydrocephalus was detected pre-operatively, emergency CSF diversion procedures were done. This may be the reason why the presence of increased ICP features was not correlating significantly with post-operative mortality.

III. Analyzing tumor characteristic (cystic or solid or mixed) as a predictive factor in predicting the outcome

TABLE- 11

		DEATH			P VALUE
		PRESENT	ABSENT	TOTAL	
IMAGING FEATURES	CYSTIC	1	9	10	0.094
	SOLID	15	16	31	
	MIXED	4	7	11	
	TOTAL	20	32	52	

CHART-16



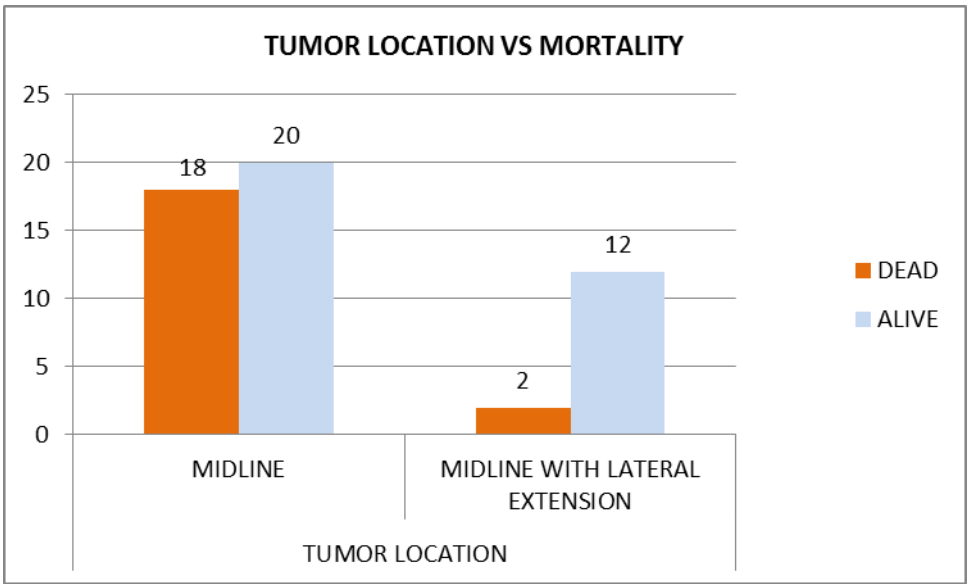
When different imaging characteristics of tumor were analyzed as a predictor of outcome using chi square test, it was found to be statistically not significant (p= 0.094).

IV. Analyzing tumor location (midline or midline with lateral extension) as a predictive factor in predicting the outcome

TABLE- 12

		DEATH		TOTAL	P VALUE
		PRESENT	ABSENT		
TUMOR LOCATION	MIDLINE	18	20	38	0.30
	MIDLINE WITH LATERAL EXTENSION	2	12	14	
TOTAL		20	32	32	

CHART- 17



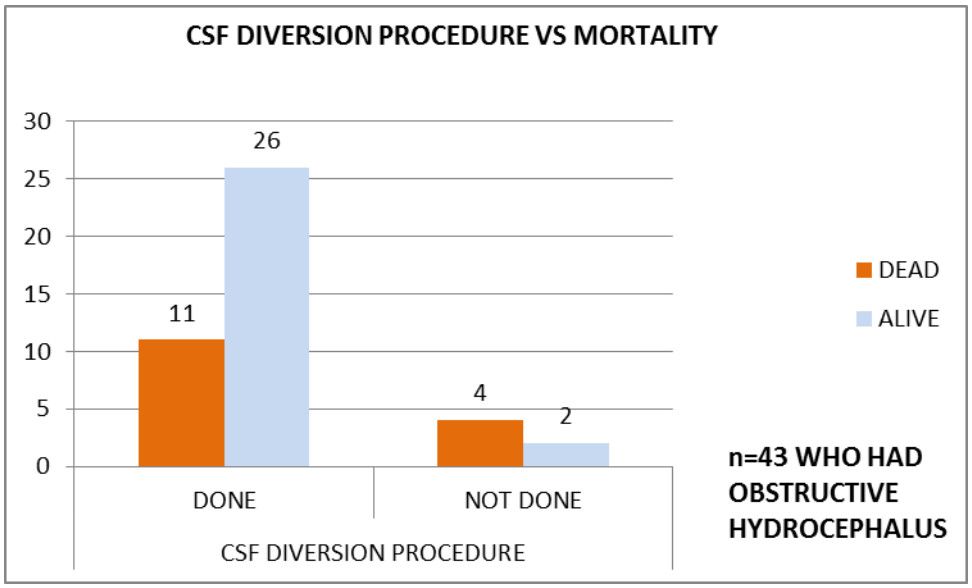
When the location of tumor was analyzed as predictor of outcome using chi square test, it was found to be statistically not significant (p=0.30).

V. Analyzing the CSF diversion procedure before posterior fossa surgery as a predictive factor in predicting the outcome

TABLE - 13

		DEATH		TOTAL	P VALUE
		PRESENT	ABSENT		
CSF DIVERSION PROCEDURE	DONE	11	26	37	0.078
	NOT DONE	4	2	6	
TOTAL		15	28	43	

CHART -18



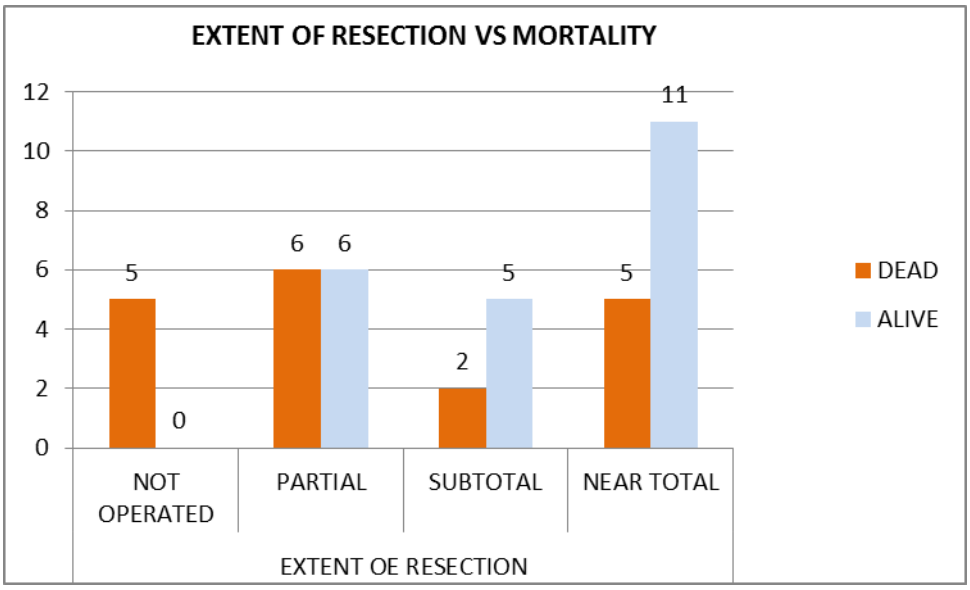
In the presence of obstructive hydrocephalus, pre-operative/ intra-operative CSF diversion procedure was analyzed as a predictor of outcome. It was found to be statistically just short of significant (p=0.078)

VI. Analyzing the extent of resection as a predictive factor in predicting the outcome

TABLE - 13

		DEATH			P VALUE
		PRESENT	ABSENT	TOTAL	
EXTENT OE RESECTION	NOT OPERATED	5	0	5	**0.020**
	PARTIAL	6	6	12	
	SUBTOTAL	2	5	7	
	NEAR TOTAL	5	11	16	
	TOTAL	2	10	12	
	TOTAL	20	32	52	

CHART -19



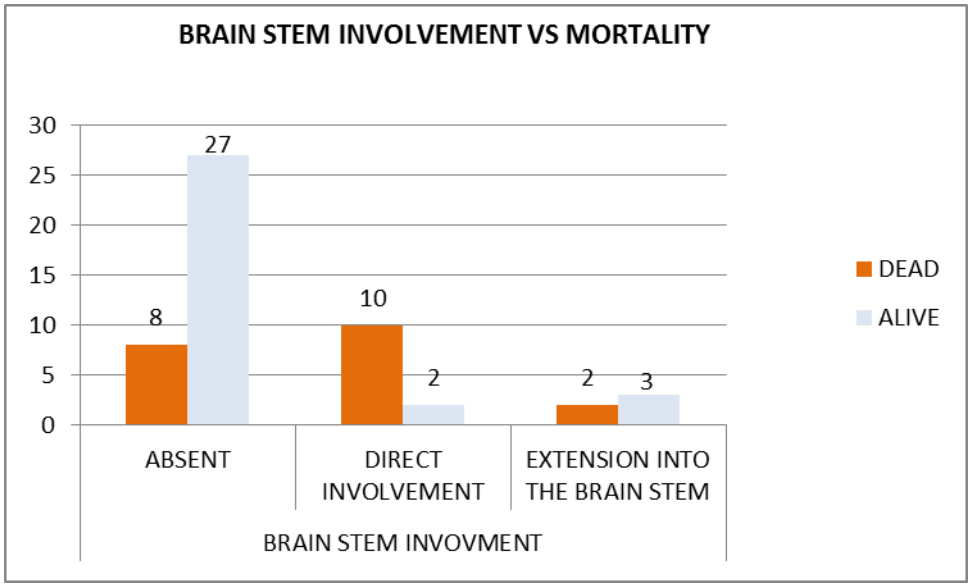
When the extent of tumor resection was analyzed as a predictor of outcome using chi square test, it was found to be statistically significant (p=0.020). When the extent of resection was maximal (total or near total excision), the frequency of mortality was low.

VII. Analyzing brain stem involvement (direct brain stem involvement or extension into the brain stem) as a predictive factor in predicting the outcome

TABLE- 14

		DEATH		TOTAL	P VALUE
		PRESENT	ABSENT		
BRAIN STEM INVOLVEMENT	ABSENT	8	27	35	**0.001**
	DIRECT INVOLVEMENT	10	2	12	
	EXTENSION INTO THE BRAIN STEM	2	3	5	
TOTAL		20	20	52	

CHART- 20



When the tumor involvement to the brain stem was analyzed as a predictor of outcome using chi square test, it was found to be statistically significant ($p=0.001$). When the tumor involves brain stem (either directly arising from the brain stem or brain stem invasion by the tumor which originated elsewhere in the posterior fossa, the probability of mortality is high.

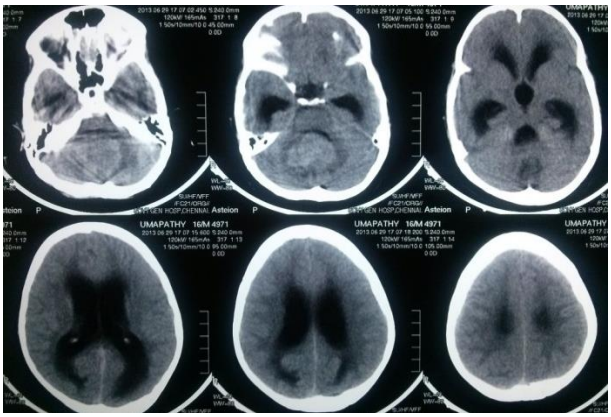


FIGURE – 1: CT BRAIN PLAIN SHOWING HYPERDENSE LESION IN THE MIDLINE COMPRESSING THE FOURTH VENTRICLE WITH OBSTRUCTIVE HYDROCEPHALUS

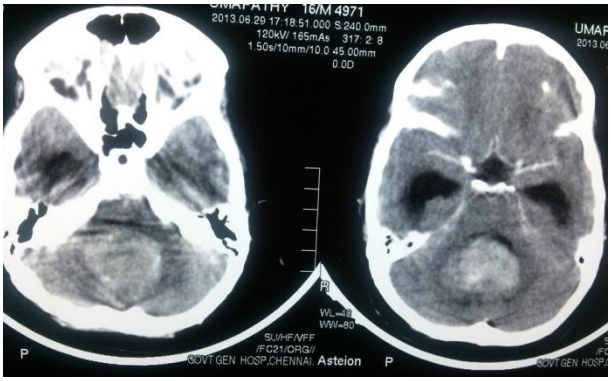


FIGURE – 2: CT BRAIN WITH CONTRAST OF THE SAME PATIENT SHOWING ENHANCEMENT OF THE LESION

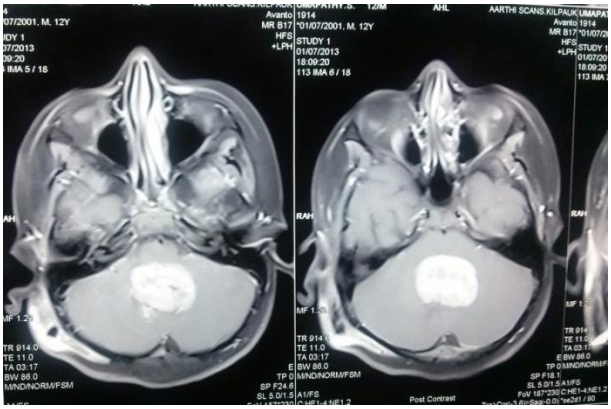


FIGURE – 3: MRI BRAIN OF THE SAME PATIENT SHOWING HOMOGENOUS ENHANCEMENT OF THE LESION

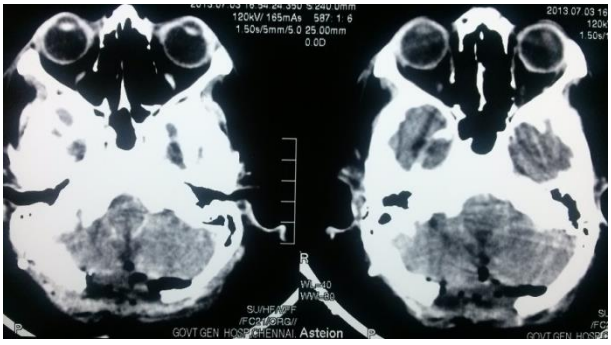


FIGURE – 4: POST-OPERATIVE CT SCAN OF THE SAME PATIENT SHOWING COMPLETE EXCISION OF THE LESION.

HISTLOGY WAS MEDULLOBLASTOMA

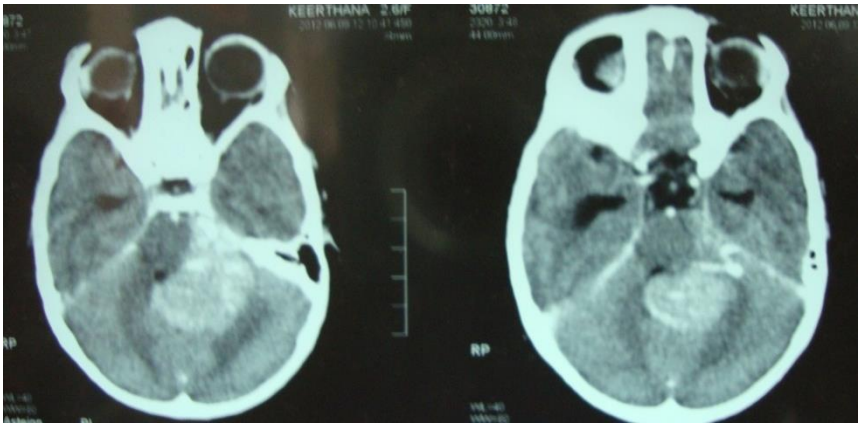


FIGURE – 5: CT BRAIN SHOWING ENHANCING LESION IN THE MIDLINE WITH EXTENSION INTO LEFT SIDE DISPLACING FOURTH VENTRICLE TO OPOSITE

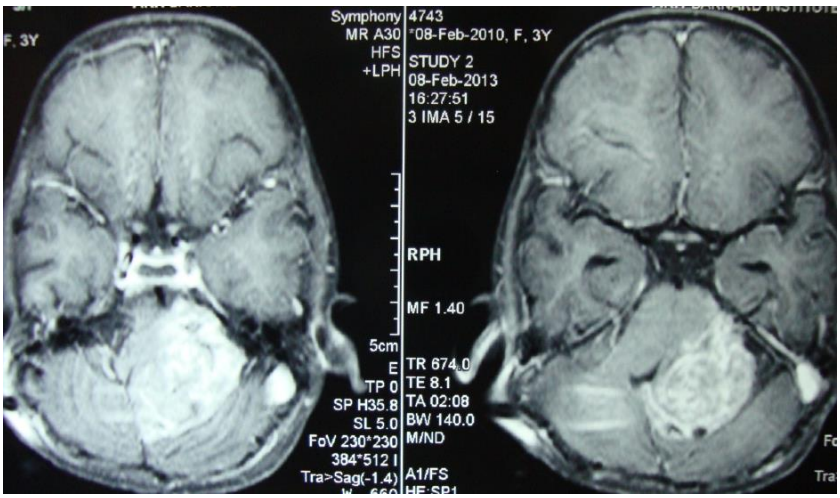


FIGURE – 5: MRI BRAIN OF THE SAME PATIENT SHOWING ENHANCING LESION IN THE MIDLINE WITH EXTENSION INTO LEFT SIDE DISPLACING FOURTH VENTRICLE TO OPPOSITE.

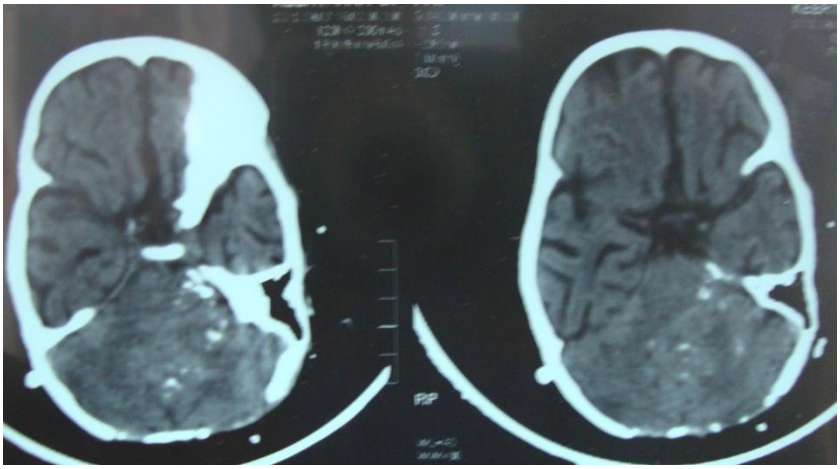


FIGURE – 6: POST OP CT SCAN OF THE SAME PATIENT AFTER PARTIAL EXCISION SHOWING RESIDUAL LESION.

HISTOLOGY WAS EPENDYMOMA

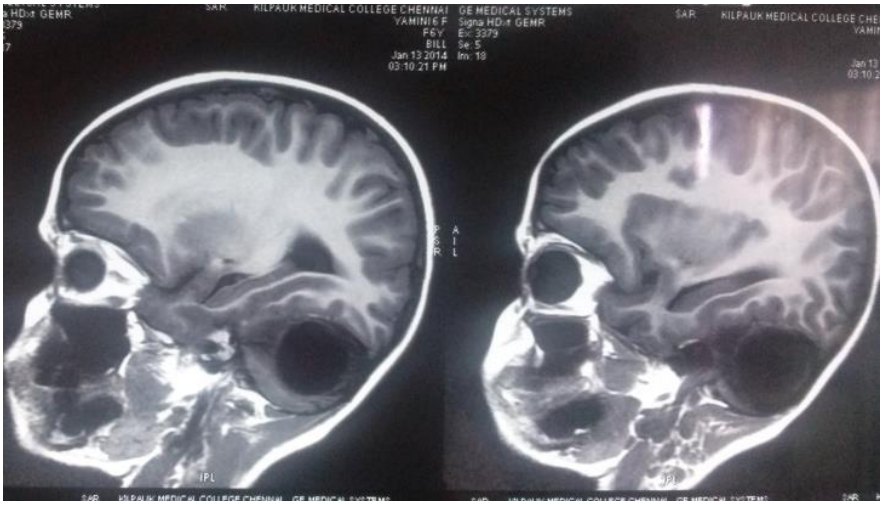


FIGURE – 7: T1 WEIGHTED MRI SHOWING CYSTIC LESION IN THE CEREBELLUM

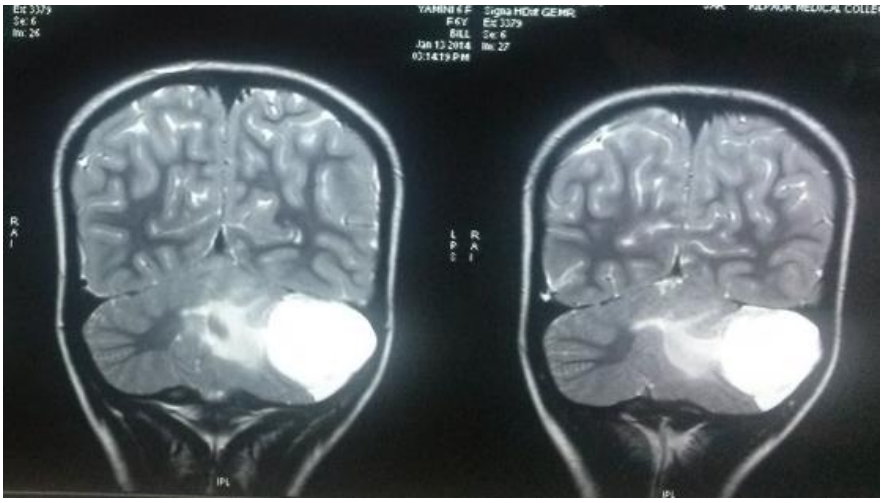


FIGURE – 8: T2 WEIGHTED MRI SHOWING CYSTIC LESION IN THE RIGHT CEREBELLUM

HISTOLOGY WAS PILOCYTIC ASTROCYTOMA

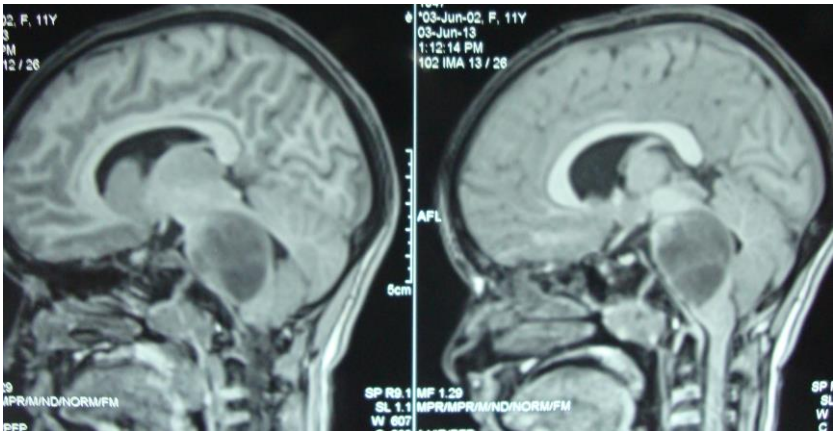


FIGURE – 9: MRI BRAIN SHOWING DIFFUSE INTRINSIC BRAIN STEM LESION WITH ENLARGEMENT OF THE BRAIN STEM.

DIRECT IRRADIATION WAS GIVEN.

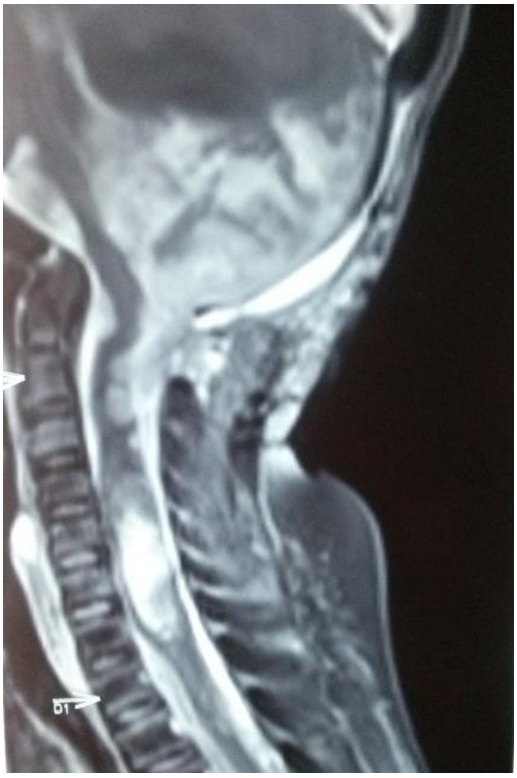


FIGURE – 10: SPINAL SCREENING MRI SHOWING DROP METASTASIS AT C5 – C7 REGION WITH POSTERIOR FOSSA LESION

HISTOLOGY WAS MEDULLOBLASTOMA

DISCUSSION

DEMOGRAPTHY

The study of Naseem Ahmed et al[2] who reviewed 81 cases of posterior fossa tumors at a tertiary center in Karachi was compared with our study. He studied the incidence of posterior fossa tumors among three age groups of children less than 14 years (0- 4 years, 5- 9 years, 10- 14 years). The maximum number of cases was observed in the second age group (5-9 years). The pediatric brain tumors in Karachi had a strong male predisposition (male- 58; female- 23) and a late presentation with a peak in the 5-9 year age group. Our study is comparable to this study. In our study also, the maximum number of cases (22 (42%) cases) was found in group 2 (5 to 8 years). This is followed by group 1 (6 months to 4 years) which had 21 (41%) cases. But in our study, there was slight female predisposition for posterior fossa tumors (female - 27 cases; male – 25 cases).

The study of Kayama T et al[9] in which piloytic astrocytoma commonly occurred in the age group 5 to 10 years with equal distribution among both sexes was compared with our study. In our study, pilocytic astrocytoma occurred commonly in the age group 5 to 8 years but these tumors were more common in the females (female to male ratio 1.4:1).

MEDULLOBLASTOMA

The review article published by Dattatraya Muzumdar and Enrique CG Ventureyra[12] which stated that medulloblastoma occurs predominantly in males (ratio 1.4:1) and at a median age of 5 to 7 years was compared with our study. In our study also, medulloblastoma is more common in the age group 5 to 9 years with male predisposition (male female ratio is 1.6:1).

EPENDYMOMA

On comparing the study of Fulya Yaman Agaoglu, MD[14] et al on ependymomas in which males (22) were more commonly affected than females (18) and the mean age was 5.5 year, our study showed ependymomas were more commonly seen below 4 years of age and these tumors were equally distributed among both sexes.

SYMPTOMS

The study done by Anthony. J. Raimondi et al[4] in which he studied the incidence, symptomatology and management of hydrocephalus associated with posterior fossa tumors in 156 children and with pineal tumors in 21 children was compared with our study. He classified the symptoms into two groups as hydrocephalic symptoms and non- hydrocephalic symptoms. Of total 177 patients, 143 patients had hydrocephalic symptoms. 123 children were subjected to CSF diversion procedure before tumor surgery. In our study also, the hydrocephalic

symptoms (60.6 %) were more common than the non-hydrocephalic symptoms (50%).

CSF DIVERSION PROCEDURES

The study done by Leland Albright et al[5] in which 86 patients with posterior fossa tumors with secondary hydrocephalus based on the treatment of obstructive hydrocephalus was compared with our study. In his study, 47 children had not been treated with any CSF diversion procedures. 27 patients were treated with VP shunt before tumor surgery and 12 patients were treated with EVD at the time of posterior fossa surgery. His conclusion was that the peri-operative mortality was less in the shunted group compared to non-shunted group was compared with our study. In our study, among the total 52 patients, 43 (82.7%) had obstructive hydrocephalus. Among those 43 patients, 28 had pre-operative shunting and 7 had intra-operative shunt and 2 patients had intra-operative EVD. 6 patients with obstructive hydrocephalus were not treated with any form of pre-operative or intra-operative CSF diversion procedure. Only 29.7% (11 cases out of 37) of the patients who were subjected to any form of CSF diversion procedures ultimately died after posterior fossa surgery. Around 66.7% (4 cases out of 6) of the patients who were not subjected to any CSF diversion procedure died after posterior fossa surgery. This implies that any CSF diversion procedure significantly reduces the peri-operative mortality.

IMAGING FEATURES

The study done by Jeffrey E. Arle, M.D[8] et al who obtained radiological data via MRI in 33 children with posterior fossa tumors was compared with our study. In his study, 11 imaging characteristics were noted for each patient and he correlated the imaging characteristics and the pathology of tumors. He was able to predict the tumor pathology in 87.8% of patients when other factors like age, sex and spectroscopy were added to the imaging characteristics. Based on his study, the imaging characteristics of posterior fossa tumors (solid/cystic/ mixed/ midline/ lateral extension) in our study were analyzed as a predictive factor of predicting post-operative mortality. But both the tumor appearance (solid / cystic /mixed) as well as tumor location on imaging was not correlating with mortality in our study population.

COMPLICATIONS

The study done by Jay Riva Cambrin. M.D. M.Sc. et al[19] who studied the frequency of post resection hydrocephalus in children with posterior fossa tumors was compared with our study. Approximately 30% of pediatric patients with posterior fossa tumors exhibit hydrocephalus after tumor resection. In our study, only 2 (3.8%) of the cases had post-operative hydrocephalus for whom there was no pre-operative hydrocephalus. Both the patients were subjected to VP shunt.

The retrospective analysis of Steinbok P et al[21] who analyzed children with posterior fossa tumors treated surgically who had CSF leak and pseudomeningocele was compared with our study. He concluded that craniectomy was protective in preventing pseudomeningocele and CSF leak. In our study, 10 patients (19.2%) had pseudomeningocele and 11 patients (21.2%) had CSF leak. This relatively high proportion of these complications was probably due to the fact that craniectomy was performed in our study population rather than craniotomy and replacing the bone flap.

On comparing Luigi Ferrante, M.D et al[22] who reported three cases of mutism after posterior fossa surgery, we had no patients with mutism postoperatively in our study.

PROGNOSTICATING FACTORS

Only few studies in the literature analyzed the predictors of outcome of posterior fossa tumors. Sarkar C et al[23] studied the new methods of risk stratifications among medulloblastoma. Previously a clinical risk-stratification system was widely used in medulloblastoma based on age, extent of resection and the Chang staging system. According to his study, the most accurate factor predicting the outcome till date has been obtained through microarray gene expression profiling. But in our study, micro array gene expression profiling was

not done. The most important factors predicting the outcome were brain stem involvement of the tumor (p=0.001) and extent of tumor resection (p=0.02).

The study done by Figarella-Branger D et al[24] who retrospectively assessed the prognostic factors in intracranial ependymomas in 37 children was compared with our study. He analyzed the prognostic relevance of patient age and sex, extent of tumor removal, location of the tumor (midline compared with lateral extension), tumor histological composition and adjuvant therapies in affecting the outcome of the patients. On univariate analysis of his study, total surgical resection and median infratentorial location were associated with a better outcome. Our study was comparable to this study because when the extent of resection was maximal (total or near total excision), the frequency of post-operative mortality was low. But the location of the tumor was not correlating with the better outcome in our study (p= 0.30).

CONCLUSION

1. The demographic data obtained in our study like frequency of posterior fossa tumors among different age group and their sex predilection was almost comparable to other studies with few exceptions.
2. The most common posterior fossa tumor in our study population was pilocytic astrocytoma (32.7%) followed by medulloblastoma (25%).
3. The most common symptom produced by the posterior fossa tumors in our study population were those due to increased intracranial pressure secondary to obstructive hydrocephalus.
4. Most of the posterior fossa tumors in our study population were solid tumors (59.6%) and present in the midline (73%).
5. CSF diversion procedures were done in most of the patients (86%) having obstructive hydrocephalus rather than subjecting to the posterior fossa surgery directly (14%).
6. Maximum extent of resection (67%) was more commonly done than partial excision/ biopsy (23%). Patients with diffuse intrinsic brain stem lesion (0.1%) were subjected to direct radiotherapy without surgery.
7. The most common outcome in our study was death.

8. The most important factors predicting the outcome of our study population were involvement of the brain stem by the tumor and the extent of resection.
9. The factors like age, imaging characteristic, location of the tumor within the cerebellum, pre-operative hydrocephalus, CSF diversion procedures were not significantly correlated with the outcome of the patients in our study population.

LIMITATIONS OF THE STUDY

1. Other imaging features like presence of T2 hypointensity, contrast enhancement, necrosis, calcification and distortion/displacement of the fourth ventricle were not taken for the analysis.
2. Intraoperative factors like uncontrollable bleeding, bradycardia and hypotension were not taken for the analysis.
3. The duration of the study period was only 2 years which was not significant for following up the patients.
4. Since it was decided to analyze the study with criteria like demographic data, symptoms, imaging features, CSF diversion procedures and extent of resection, it was decided to leave the details of adjuvant therapy (radiotherapy and chemotherapy).

INSTITUTE OF NEUROLOGY

MADRAS MEDICAL COLLEGE

RAJIV GANDHI GOVT GENERAL HOSPITAL, CHENNAI

PROFORMA

ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION

S.No:

NAME: AGE: SEX:

IP NO: MIN NO:

DATE OF ADMISSION: DATE OF DISCHARGE:

PRESENTING COMPLAINTS:

HEADACHE ☐ VOMITING ☐ VISUAL BLURRING ☐

REFUSAL OF FEEDS ☐ SWAYING ☐ OBTUNDATION ☐

FAILURE TO THRIVE ☐ ASPIRATION ☐

CT BRAIN:

SOLID ☐

CYSTIC ☐

MIXED ☐

MIDLINE ☐

MIDLINE WITH LATERAL EXTENSION ☐

OBSTRUCTIVE HYDROCEPHALUS ☐

MRI BRAIN

SOLID ☐

CYSTIC ☐

MIXED ☐

MIDLINE ☐

MIDLINE WITH LATERAL EXTENSION ☐

OBSTRUCTIVE HYDROCEPHALUS ☐

SURGERY

PRE OP VP SHUNT:

INTRA OP VP SHUNT/ EVD:

POST OP SHUNT/ EVD

EXTENT OF RESECTION: BIOPSY/PARTIAL

SUBTOTAL

NEAR TOTAL

TOTAL

HISTOLOGY:

MEDULLOBLASTOMA

EPENDYMOMA

PILOCYTIC ASTROCYTOMA

DIFFUSE ASTROCYTOMA

OTHERS

POST OP:

HYDROCEPHALUS/ IVH

MUTISM

MENINGITIS

PSEUDOMENINGOCELE

LOCAL WOUND INFECTION

LOWER CRANIAL NERVE PALSY

DEATH

INFORMATION SHEET

We are conducting **"ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION"**

Among patients attending Rajiv Gandhi Government General Hospital, Chennai and for that your specimen may be valuable to us.

- The purpose of this study is to analyze the pediatric patients with posterior fossa tumors
- We are selecting certain cases and if your radiological image is found eligible, we may be using your specimen to perform extra tests and special studies which in any way do not affect your final report or management.
- The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.
- Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.
- The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of investigator

Signature of participant

Date:

Signature of Parent/Guardian

INFORMED CONSENT FORM

TITLE OF THE STUDY: ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION

Name of the Participant: Dr.Nithyanand.R

Name of the Principal (Co-Investigator): Prof.K.Maheshwar M.Ch.,

Name of the Institution: Institute of Neurology, Madras Medical College and Rajiv Gandhi Govt. General Hospital, Chennai

Name and address of the sponsor / agency(ies) (if any): None**.**

Documentation of the informed consent

I _____ have read the information in this form (or it has been read to me). I was free to ask any questions and they have been answered. I am over 18 years of age and, exercising my free power of choice, hereby give my consent to be included as a participant in **"ANALYTICAL STUDY OF POSTERIOR FOSSA TUMORS IN PEDIATRIC POPULATION"**

1. I have read and understood this consent form and the information provided to me.

2. I have had the consent document explained to me.

3. I have been explained about the nature of the study.

4. I have been explained about my rights and responsibilities by the investigator.

5. I have been informed the investigator of all the treatments I am taking or have taken in the past _____ months including any native (alternative) treatment.

6. I have been advised about the risks associated with my participation in this study.*****

7. I agree to cooperate with the investigator and I will inform him/her immediately if I suffer unusual symptoms. *****

8. I have not participated in any research study within the past _____month(s). *****

9. I have not donated blood within the past _____ months—Add if the study involves extensive blood sampling. *****

10. I am aware of the fact that I can opt out of the study at any time without having to give any reason and this will not affect my future treatment in this hospital. *

11. I am also aware that the investigator may terminate my participation in the study at any time, for any reason, without my consent. *

12. I hereby give permission to the investigators to release the information obtained from me as result of participation in this study to the sponsors, regulatory authorities, Govt. agencies, and IEC. I understand that they are publicly presented.*

13. I have understand that my identity will be kept confidential if my data are publicly presented*

14. I have had my questions answered to my satisfaction*.

15. I have decided to be in the research study*.

I am aware that if I have any question during this study, I should contact the investigator. By signing this consent form I attest that the information given in this document has been clearly explained to me and understood by me, I will be given a copy of this consent document.

*** For Children being enrolled in research:**

Whether child's assent was asked: Yes / No (Tick one)

[If the answer to be above question is yes, write the following phrase:

You agree with the manner in which assent was asked for from your child and given by your child. You agree to have your child take part in this study].

[If answer to be above question No, give reason (s)
:_____.

Although your child did not or could not give his or her assent, you agree to your child's participation in this study.

Name and Signature of / thumb impression of the participant's parent(s) (or legal representative)

Name _____ Signature_____
Date_____

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ABBREVIATIONS USED IN MASTER CHART

Y – YES

N – NO

P – PRESENT

A – ABSENT

P^1 – DIRECT BRAIN STEM INVOLVEMENT

NA – NOT APPLICABLE

Turnitin Originality Report

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S.N	NAME	AGE	SEX	COMPLAINTS					RADIOLOGY									MANAGEMENT												FOLLOW UP								
																SIZE			SHUNTING			SURGERY						RADIOTHERAPY				COMPLICATION						
				Headache	Vomiting	Refusal of feeds	Cranial nerve deficit	Others	Solid	Cystic	Mixed	MIDLINE	MIDLINE WITH LATERAL EXTENSION	BRAIN STEM	<3CM	>3CM	OBST HYDROCEPAHLUS	PRE OP	POST OP	INTRA OP	PARTIAL	SUBTOTAL	NEAR TOTAL	TOATAL	HISTOLOGY	PRE OP	ADJUVANT	CHEMOTHERAPY	CSF LEAK	LOWER CN PALSY	PSEUDOMENINGOCELE	RECURRENCE	LRI	DEATH			
1	JAISEEMAN	8	MALE	P	P	A	A	A	P	A	A	P	A	A	A	P	P	Y	N	N	N	Y	N	N	MEDULLOBLASTOMA	N	Y	Y	A	A	P	A	A	A			
2	VANITHA	11	FEMALE	A	P	P	P	A	A	A	P	P	A	A	A	P	P	N	N	Y	N	N	Y	N	CELLULAR EPENDYMOMA GR II	N	Y	N	A	P	A	A	P	A			
3	VIGNESH	4	MALE	P	A	P	A	A	A	P	A	A	P	A	A	P	P	Y	N	N	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
4	HARINI	6	FEMALE	P	A	A	A	P	P	A	A	P	A	A	A	P	P	N	N	Y	N	N	N	Y	MEDULLOBLASTOMA GR IV	N	Y	Y	A	A	A	P	A	P			
5	SARVESH	2	MALE	P	P	P	A	A	A	A	P	P	A	A	A	P	P	Y	N	N	N	N	Y	N	PNET	N	N	Y	A	A	A	A	A	A			
6	VEERANGALI	11 MON	FEMALE	A	P	P	A	P	A	A	P	P	A	P[1]	A	P	P	N	N	N	N	Y	N	N	EPENDYMOMA	N	N	Y	P	P	A	A	P	P			
7	LATHIKA	2	FEMALE	A	A	P	A	A	P	A	A	P	A	A	A	P	A	N	N	N	N	N	N	Y	MEDULLOBLASTOMA GR IV	N	N	Y	A	P	A	A	P	A			
8	PRIYADARSHINI	8	FEMALE	P	P	A	A	P	P	A	A	P	A	A	P	A	A	N	N	N	N	N	N	Y	MEDULLOBLASTOMA GR I	N	Y	Y	A	A	A	A	A	A			
9	GUNA	12	MALE	P	P	A	A	P	A	P	A	P	A	A	A	P	P	N	Y	N	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	P	A	P	A	A	A			
10	GOWTHAM	7	MALE	P	A	A	A	A	A	P	A	P	A	A	A	P	P	N	N	Y	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
11	KAMALI	3	FEMALE	A	P	P	P	A	P	A	A	A	P	A	A	P	P	N	N	Y	N	Y	N	N	PILOCYTIC ASTROCYTOMA	N	N	Y	A	P	A	P	A	A			
12	KEERTHANA	2	FEMALE	A	P	A	P	P	P	A	A	A	P	P[1]	A	P	P	N	N	Y	Y	N	N	N	EPENDYMOMA GR II	N	Y	Y	A	P	A	A	P	A			
13	SANJITH	2	MALE	P	P	P	P	A	A	A	P	P	A	A	A	P	P	Y	N	N	N	Y	N	N	EPENDYMOMA GR II	N	N	Y	A	A	A	P	P	P			
14	GAYATHRI	8	FEMALE	N	N	N	P	P	P	A	A	P	P	P	P	A	A	N	N	N	N	N	N	N	NA	D	N	N	A	A	A	A	A	P			
15	ANANTHAVALLI	10	FEMALE	P	P	N	N	P	A	P	A	A	P	A	A	P	P	Y	N	N	N	N	Y	N	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
16	VISWANATHAN	3	MALE	A	P	A	P	P	P	A	A	P	A	P	A	P	P	Y	N	N	Y	N	N	N	DIFFUSE ASTROCYTOMA	N	Y	Y	A	P	A	A	P	P			
17	FASIYA	6	FEMALE	P	P	A	P	P	A	A	P	P	A	P	A	P	P	Y	N	N	Y	N	N	N	PILOCYTIC ASTROCYTOMA	N	Y	Y	A	P	A	P	P	P			
18	DHARSHIYA	7 MONTH	FEMALE	A	P	P	P	P	P	A	A	A	P	P[1]	A	P	P	N	N	N	N	N	Y	N	MEDULLOBLASTOMA	N	N	Y	A	A	A	A	A	P			
19	ANUSHYA	3	FEMALE	A	A	P	P	P	P	A	A	P	A	P	P	A	A	N	N	N	N	N	N	N	NA	D	N	N	A	A	A	A	A	P			
20	ELAKKIYA	8	FEMALE	A	P	A	P	P	A	P	A	P	A	P	A	P	A	N	N	N	Y	N	N	N	PILOCYTIC ASTROCYTOMA	N	Y	Y	A	P	A	A	A	A			
21	SWEETY	5	FEMALE	A	A	A	P	P	P	A	A	P	A	P	P	A	A	N	N	N	N	N	N	N	NA	D	N	N	A	A	A	A	A	P			
22	MAGA	9	FEMALE	P	P	A	P	P	A	P	A	P	A	P	P	A	A	N	P	N	Y	N	N	N	PILOCYTIC ASTROCYTOMA	N	Y	Y	P	P	P	A	P	P			
23	NAVEEN	7	MALE	P	P	A	A	A	A	A	P	P	A	P[1]	A	P	P	Y	N	N	N	N	Y	N	EPENDYMOMA GR II	N	Y	Y	A	A	A	A	A	A			
24	LINGESWARAN	7	MALE	P	P	A	A	A	A	A	P	A	P	A	A	P	P	N	N	E	N	N	Y	N	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
25	SARATHY	8	MALE	P	P	A	A	A	A	A	P	P	A	A	A	P	P	Y	N	N	N	N	Y	N	EPENDYMOMA GR II	N	Y	Y	A	A	A	A	A	A			
26	SUKINRAJ	4	MALE	P	P	A	A	P	P	A	A	P	A	A	A	P	P	N	N	Y	Y	N	N	N	MEDULLOBLASTOMA	N	Y	Y	P	A	P	A	A	A			
27	DEEPALAKSHMI	8	FEMALE	P	P	P	P	A	P	A	A	P	A	A	A	P	P	N	N	E	N	N	Y	N	MEDULLOBLASTOMA	N	Y	Y	A	P	A	A	P	P			
28	AJAIKUMAR	12	MALE	P	A	A	A	A	A	A	P	P	A	A	A	P	P	Y	N	N	N	Y	N	N	MEDULLOBLASTOMA	N	Y	Y	A	P	A	A	P	A			
29	DILEEPAN	2	MALE	A	P	P	P	P	P	A	A	P	A	A	A	P	P	N	N	Y	N	N	Y	N	MEDULLOBLASTOMA	N	Y	Y	P	P	P	A	P	P			
30	HARISHKUMAR	6	MALE	P	A	A	P	P	P	A	A	P	A	P[1]	A	P	P	Y	N	N	N	Y	N	N	MEDULLOBLASTOMA	N	Y	Y	P	A	A	A	A	A			
31	JEYAPRAKASH	4	MALE	A	P	P	A	P	P	A	A	P	A	A	A	P	P	Y	N	N	Y	N	N	N	EPENDYMOMAM GR II	N	Y	Y	A	P	A	A	P	A			
32	KOKILA	12	FEMALE	P	P	A	A	A	A	P	A	A	P	A	A	P	P	Y	N	N	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
33	LOGESHWARAN	2	MALE	A	P	P	A	A	A	A	P	P	A	A	A	P	P	Y	N	N	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	P	A	P	A	A	A			
34	Md.SAMEEM	6MON	MALE	A	A	P	P	A	P	A	A	P	A	P	A	P	P	N	N	N	Y	N	N	N	PILOCYTIC ASTROCYTOMA	N	N	Y	A	A	P	A	A	P			
35	Md.AAROON	5	MALE	A	A	A	P	A	P	A	A	P	A	P	P	A	A	N	N	N	N	N	N	N	NA	D	N	Y	A	A	A	A	A	P			
36	MUNIAPPAN	7	MALE	A	A	A	A	P	P	A	A	P	A	P	P	A	A	N	N	N	N	N	N	N	PILOCYTIC ASTROCYTOMA	N	Y	Y	P	A	A	A	A	A			
37	SANJAY	5	MALE	A	A	A	P	P	P	A	A	P	A	P	A	P	P	N	N	N	Y	N	N	N	LOW GRADE ASTROCYTOMA	N	Y	Y	A	P	A	A	P	P			
38	UMAPATHY	12	MALE	A	P	A	P	A	P	A	A	P	A	A	A	P	P	Y	N	N	N	N	Y	N	MEDULLOBLASTOMA	N	Y	Y	A	P	A	A	P	P			
39	SANTHYA	6MON	FEMALE	A	P	P	P	P	A	A	P	P	A	A	A	P	P	Y	N	N	Y	N	N	N	anaplastic e pendymoma	N	Y	Y	P	P	P	P	P	P			
40	AYSHA PARVEEN	7	FEMALE	P	P	A	A	A	P	A	A	A	P	A	A	P	P	Y	N	N	N	N	Y	N	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
41	CHNADRU	10	MALE	P	P	A	A	P	P	A	A	P	A	A	A	P	P	Y	N	N	N	N	Y	N	MEDULLOBLASTOMA	N	Y	Y	P	A	A	A	A	A			
42	DEEPAN	2	MALE	A	P	A	A	A	P	A	A	P	A	A	A	P	P	Y	N	N	N	N	Y	N	EPENDYMOMA	N	N	Y	A	P	A	A	A	A			
43	JEEVITHA	3	FEMALE	A	P	P	P	A	P	A	A	A	P	A	A	P	P	Y	N	N	N	N	Y	N	EPENDYMOMA	N	N	Y	A	A	A	A	A	A			
44	JESSICA	5	FEMALE	P	P	A	A	A	A	P	A	P	A	A	A	P	P	Y	N	N	N	Y	N	N	PILOCYTIC ASTROCYTOMA	N	Y	N	A	A	A	P	A	A			
45	JANANI	5	FEMALE	A	P	A	A	P	P	A	A	A	P	A	A	P	P	N	N	N	N	N	N	Y	CHLOROMA	N	N	N	A	A	A	A	P	A			
46	KAVIARASU	1	MALE	A	P	P	A	P	P	A	A	A	P	A	A	P	P	Y	N	N	Y	N	N	N	EPENDYMOMA	N	N	Y	P	A	P	A	A	A			
47	PRASANNA	8	MALE	P	A	A	A	A	P	A	A	P	A	A	A	P	P	Y	N	N	N	N	N	Y	MEDULLOBLASTOMA	N	N	N	A	P	A	A	P	P			
48	PRIYADARSHINI	3	FEMALE	A	P	P	P	P	P	A	A	A	P	A	A	P	P	Y	N	N	N	N	Y	N	EPENDYMOMA	N	Y	Y	A	P	A	A	P	P			
49	SARANYA	7	FEMALE	P	A	A	A	N	P	A	A	A	P	A	A	P	P	Y	N	N	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
50	SRIHARINI	4	FEMALE	A	P	A	P	N	A	P	A	P	A	A	A	P	P	Y	N	N	N	N	N	Y	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	P	A	A	A			
51	YAMINI	6	FEMALE	P	P	P	N	N	A	P	A	A	P	A	A	P	P	Y	N	N	N	N	Y	N	PILOCYTIC ASTROCYTOMA	N	N	N	A	A	A	A	A	A			
52	SUPRIYA	11	FEMALE	A	P	P	P	P	P	A	A	P	A	P	A	P	P	Y	N	N	N	N	N	N	NA	D	N	Y	A	A	A	A	A	P			