A Comparative Study of Posterior Fossa Tumor Approach in Pediatric Patients; Craniotomy Vs. Craniectomy

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ABSTRACT:

BACKGROUND:

The posterior fossa is the biggest and the deepest intracranial fossa, containing the most complicated intracranial organs. Posterior fossa tumor access used to involve bone removal permanently, the first craniotomy was done in 1974 using burr holes to access CPA tumors.

OBJECTIVE:

To evaluate the postoperative complications of posterior fossa tumor surgery operated by craniotomy versus craniectomy in pediatric patients.

PATIENTS AND METHODS:

A prospective single-center study of 35 pediatric patients with posterior fossa tumors operated in the neurosurgical center in Martyr Ghazi Al-Hariri Hospital from Oct. 2017 to Oct. 2018. Patients were categorized into two groups using craniotomy or craniectomy for tumor access; these patients were followed postoperatively for 3 months and any signs or symptoms of complications were recorded (CSF leak, Pseudomeningocoele, wound dehiscence and infection).

RESULTS:

Thirty-five patients were studied, craniotomy was done for 15 patients, and craniectomy for 20 patients. The patients' age averaged 2-16 years with a mean age of 7 years. The study included 17 male and 18 female patients with a male: female ratio of 1:1.058.

CONCLUSION:

Craniotomy resulted in less postoperative complications like Pseudomeningocoele, CSF leak, wound infection and dehiscence as well as less hospital stay than craniectomy.

KEYWORDS: posterior, fossa, craniotomy, craniectomy

INTRODUCTION:

Historical Perspective

Posterior fossa tumor access used to involve bone removal permanently, in 1974, the first craniotomy was done to approach CPA tumors by Yasargil and Fox. In 1993, Ogilvy and Ojeman adopted a midline suboccipital craniotomy with hand-held instrumentations, and in 1999, Kurpad and Cohen fashioned a midline sub occipital craniotomy flab in children with high-speed instruments[1].

Anatomy

The skull base interior is separated into three cranial fossae, the Anterior, Middle and Posterior cranial fossae[2].

The posterior cranial fossa is the biggest and the deepest intracranial fossa, and contains the most complicated intracranial organs[3].

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The posterior cranial fossa is described by the "rule of three" where the brainstem describes three parts (midbrain, pons, and medulla) and the cerebellum describes three outer surfaces (petrosal, tentorial, and suboccipital), three cerebellar peduncles (superior, middle, and inferior), three fissures (cerebellomesencephalic, cerebellopontine, and cerebellomedullary), three major arteries (superior cerebellar artery, anterior inferior cerebellar artery, and posterior inferior cerebellar artery), and three major venous draining collections (petrosal, galenic, and tentorial)[4].

The posterior fossa stretches from the tentorial incisura to the foramen magnum, where it communicates with the supratentorial compartment and the spinal canal respectively. It is bounded by the occipital, temporal, parietal, and sphenoid bones[5].

Within the posterior cranial fossa, the scarcity of area and the instant transmission of pressure straight to the brain stem implies that a small mass effect can be precipitously lethal. obstruction of CSF flow through the aqueduct can result in acute hydrocephalus and possible tonsillar herniation[6].

Etiology

There are no specific causes for posterior fossa tumors. Yet, genetic factors, such as malfunction of various tumor suppressor genes (*p53* gene) and activation of several oncogenes, may aid in their progression. Environmental factors like irradiation and toxins may also be a factor[7].

Clinical Presentation:

The presentation is determined by location in the posterior fossa and tumor aggressiveness. The more aggressive the tumor, the shorter the interval from the onset of symptoms to diagnosis. The most common sign of a posterior fossa tumor is hydrocephalus, while symptoms are correlated with intracranial hypertension and involve headache, macrocephaly (in small children), nausea, vomiting, diplopia, and failure to thrive[8].

Incidence and Pathology

CNS tumors comprise approximately 20% of all tumors in children aged below 15 years[9]. They are the second most common solid tumor form of pediatric tumors, behind the only Leukemia[10]. The incidence of pediatric brain tumors is about 3.3 per 100,000 in developed countries[11]. 54% to 70% of pediatric brain tumors are infratentorial and occur in the Posterior Fossa[12].

AIM OF THE STUDY:

To evaluate the postoperative complications of posterior fossa tumor surgery operated by craniotomy versus craniectomy in pediatric patients.

PATIENTS AND METHODS:

This is a prospective single-center study of 35 pediatric patients with posterior fossa tumors operated in the neurosurgical center in Martyr Ghazi Al-Hariri Hospital from Oct. 2017 to Oct. 2018.

Patients were categorized into two major groups (according to surgeon preference) using either craniotomy or craniectomy techniques for tumor access, and these patients were followed postoperatively for 6 months and any signs or symptoms of complications were recorded (CSF leak, Pseudomeningocoele, wound dehiscence and infection).

Of these 35 patients, 15 patients (42.9%) underwent craniotomy and 20 patients (57.1%) underwent craniectomy. The age range of the patients averaged 2-16 years with a mean age of 7 years. The study included 17 male patients (48.6%) and 18 female patients (51.4%) with a male: female ratio of 1:1.058. As detailed in table 1.

Table 1: Demographic details in 35 children with posterior fossa tumors

Demographic Data	Total	Craniotomy	Craniectomy
Number of patients (%)	35	15 (42.9%)	20 (57.1%)
Sitting position (%)	23 (65.7%)	11 (73.3%)	12 (60%)
Prone position (%)	12 (34.3%)	4 (26.7%)	8 (40%)
Age range (years)	2-16	3-12	2-16
Mean age (years)	7	7.2	6.8
Gender (M/F ratio)	1:1.058	1:0.875	1:1.22

All patients were presented as a case of acute hydrocephalus complicating the tumor, a VP shunt was done for them prior to evaluation and enrollment in the study, during follow-up, neuroimaging studies (Brain MRI with Contrast) were obtained and eligible patients were scheduled for definitive tumor surgery.

Inclusion Criteria

1. Pediatric patients (16 years or younger) as regarded in this study with a posterior fossa tumor accessible by a midline sub-occipital approach.
2. First time surgery.
3. Patients willing to participate in this study freely.

Exclusion criteria

1. Patients older than 16 years old.
2. Patients with tumor recurrence (i.e., previous scar).
3. Patients with limited follow-up to our time.
4. Patients with posterior fossa tumors not operated on with a midline sub-occipital approach

Surgical procedure

Craniotomy was carried out using a high-speed drill preceded by two burr-holes placed laterally just inferior to the transverse sinus. At the end of the operation, the bone flap was replaced and secured. Posterior fossa craniectomy was accomplished by placing one or two burr holes laterally between the superior and inferior nuchal lines on either side with a perforator followed by a dilator; the remaining bone was removed with rongeurs. For all craniotomy and craniectomy cases, the dura mater was closed with 3-0 prolene, the cervical muscles and fascia were closed in layers using absorbable sutures, followed by skin closure and dressing.

Patients were followed during their admission, and during their subsequent visits, for six months. Signs and symptoms of possible postoperative complications were followed up carefully and recorded if any.

Histologically speaking, the tumors were Medulloblastomas 16 (45.7%), Pilocytic Astrocytomas 10 (28.6%), Ependymomas 6 (17.1%), Brainstem Gliomas 2 (5.7%), and Epidermoid Cyst 1 (2.8%). Table 2 describes the histological types of tumors in both groups.

Table 2: Tumor types in children with posterior fossa tumors

Tumor Type	Total	Craniotomy	Craniectomy
Medulloblastoma	16 (45.7%)	6 (40%)	10 (50%)
Pilocytic Astrocytoma	10 (28.6%)	5 (33.3%)	5 (25%)
Ependymoma	6 (17.1%)	3 (20%)	3 (15%)
Brainstem Glioma	2 (5.7%)	1 (6.7%)	1 (5%)
Epidermoid cyst	1 (2.8%)	0 (0%)	1 (5%)

Regarding the intraoperative details in those patients, an additional C1 laminectomy was done in 12 patients (34.3%), macroscopic clearance was achieved in 23 patients (65.7%), complete dural closure was achieved in all 35 patients (100%), Duraplasty materials were required in 22 patients (62.9%), wound drains were not required in any group. As shown in table 3.

Table 3: Intraoperative details in children with posterior fossa tumors

Intra-operative data	Total	Craniotomy	Craniectomy
Additional C1 laminectomy	12 (34.3%)	5 (33.3%)	7 (20%)
Macroscopic clearance	23 (65.7%)	10 (66.7%)	13 (65%)
Dural closure (complete)	35 (100%)	15 (100%)	20(100%)
Duraplasty materials	22 (62.9%)	9 (60%)	13 (65%)
Cervical fascia	15 (68.2%)	6 (66.7%)	9 (69.2%)
Pericranium	7 (31.8%)	3 (33.3%)	4 (30.8%)
Wound drains	0 (0%)	0 (0%)	0 (0%)

Ethical Issues

Verbal consent was obtained from the families of the patients regarding participation in this study after explaining the study benefits to them.

Statistical analysis

Statistical analysis was performed with a chi-square test using Microsoft Excel 2016; p-value ≤0.05 was considered significant.

RESULTS:

In this prospective study, we recruited 35 pediatric patients with posterior fossa tumors operated using a midline sub-occipital approach from the period of Oct. 2017 to Oct. 2018.

The length of hospital stay for the patients in this study ranged from 5-60 days with a mean of 16.3 days. There was a significant statistical difference between the two groups in terms of mean hospital stay.

Regarding postoperative complications noted in the patients in the study, CSF leak was observed in 5 patients (14.3%), Pseudomeningocoele in 6 patients (17.1%), wound infection in 3 patients (8.6%), and wound dehiscence in 1 patient (2.9%).

There was a significant statistical difference between these groups regarding CSF leak and Pseudomeningocoele, where 4 patients (20%) in the craniectomy group developed CSF leak compared to only 1 patient (6.7%) in the craniotomy group, while Pseudomeningocoele occurred in 5 patients (25%) of the craniectomy group compared to 1 patient (6.7%) in the craniotomy group, as demonstrated in table 4 below.

Table 4: Postoperative complications associated with the procedure

Complication	Total	Craniotomy	Craniectomy
Pseudomeningocoele*	6 (17.1%)	1 (6.7%)	5 (25%)
CSF leak*	5 (14.3%)	1 (6.7%)	4 (20%)
Wound infection	3 (8.6%)	1 (6.7%)	2 (10%)
Wound dehiscence	1 (2.9%)	0 (0%)	1 (5%)
Length of hospital stay (days)	5 – 60	5 – 45	5 – 60
Mean hospital stay (days)*	16.3	14	18

* P-value for this group was statistically significant

A significant statistical difference was noted between the craniotomy and the craniectomy groups with regard to the need for shunt revision and wound re-closure as a treatment for post-operative complications.

Table 5 summarizes the details of treatment given with regard to both groups that were effective in treating complications.

Table 5: Summary of treatment options effective in treating complications

Treatment	Total	Craniotomy	Craniectomy
Conservative measures	2 (5.7%)	1 (6.7%)	1 (5%)
Wound re-closure*	6 (17.1%)	1 (6.7%)	5 (25%)
Shunt Revision*	5 (14.3%)	1 (6.7%)	4 (20%)
Pressure bandage	0 (0%)	0 (0%)	0 (0%)
Aspiration	2 (5.7%)	0 (0%)	2 (10%)

* P-value for this group was statistically significant

DISCUSSIONS:

Midline suboccipital craniotomy is safe and well suited in children. It grants access to virtually any lesion in the posterior fossa, maintains normal anatomic planes, offers protection to the posterior fossa and relative freedom from immediate and long-term complications[13].

Our study showed that craniectomy resulted in a higher incidence of CSF leak, pseudomeningocoele formation, wound re-closures, and so longer hospitalization. In turn, CSF leakage resulted in more wound infections and prolonged hospital stay. Those findings were consistent with those of K.K. Gnanalingham et al[14] and the study by F.G. Legnani et al[15].

Reduced CSF leak post craniotomy may be due to in the fact that the bone flab offers firm support over the dural closure. In the postoperative period, CSF accumulation or increased posterior fossa pressure, e.g., when the patient coughs or strains cause the dura to project outward periodically. Following craniectomy, this dural bulging may tear out dural sutures, leading to multiple dural defects that may widen causing CSF leakage into the muscular and subcutaneous layers, resulting in pseudomeningocoele formation and CSF leak from the wound. In contrast, following craniotomy, this bulging dura will be pressed against the bone flab. This extra support may keep dural sutures from tearing out, reducing CSF leakage[14].

Both posterior fossae approaches strip off the muscle attachment at the periosteal level, resulting in a dead space deep in the muscular layer, where CSF may collect. This may serve as an adjunct for CSF leak and pseudomeningocoele formation in craniectomy patients. This potential space may be eliminated by replacing the bone flab and encouraging early reattachment of the muscles to the occipital bone flab[14].

In our study, 35 patients included, 15 patients (42.9%) underwent craniotomies, and 20 patients (57.1%) underwent craniectomies, this reflects a higher rate of using craniectomy. This was slightly different from the study by K.K. Gnanalingham et al[14] and the study by F.G. Legnani et al[15]. This difference was due to senior preferences in selecting the technique (i.e., the reluctance of most seniors to perform posterior fossa craniotomy).

Craniectomy is associated with higher mean hospital stay than craniotomy (14 days for craniotomy versus 18 days for craniectomy), this goes with the study by K.K. Gnanalingham et al[14] and the study by F.G. Legnani et al[15]. This reflects the more associated morbidities with craniectomy and the longer time needed for their management.

In our study, the most encountered complications were CSF leak and pseudomeningocoele formation , both were more frequently observed in the craniectomy group compared to the craniotomy group (20% for CSF leak and 25% for pseudomeningocoele in the craniectomy group versus 6.7% for each complication in the craniotomy group) and this goes with the study by K.K. Gnanalingham et al[14] and the study by F.G. Legnani et al[15]. The mechanisms of these complications were discussed above. This was statistically significant (p-value less than 0.05).

Other complications (i.e., wound infection and wound dehiscence) were more prevalent in the craniectomy group (10% for wound infection and 5% for wound dehiscence in the craniectomy group versus 6.7% for wound infection and 0% for wound dehiscence in the craniotomy group). This goes with the study by K.K. Gnanalingham et al[14] and the study by F.G. Legnani et al[15]. This might be due to higher dead space created after craniectomy and higher percentage of CSF leak. This was statistically not significant (p-value more than 0.05).

In managing postoperative complications, the most effective modalities of treatment were wound re-closure (25% for craniectomy versus 6.7% for craniotomy) and shunt revision (20% for craniectomy versus 6.7% for craniotomy); other modalities of treatment included aspiration of pseudomeningocoele (10% for craniectomy versus 0% for craniotomy), pressure bandage (0% for craniectomy versus 0% for craniotomy), and conservative measures (5% for craniectomy versus 6.7% for craniotomy).

This indicates that more treatment modalities are needed for craniectomy complication management and that it may utilize more aggressive treatment protocols that resulted in a prolonged hospital stay. This reflects the more destructive nature of craniectomy, and this goes with the study by K.K. Gnanalingham et al[14] and the study by F.G. Legnani et al[15]. This was statistically significant.

CONCLUSIONS:

1. Craniotomy and craniectomy are two commonly used techniques to access Posterior fossa tumors. Our study showed that craniotomy resulted in fewer postoperative complications, such as Pseudomeningocoele formation and CSF leak, which may be attributed to the surgical technique.
2. Craniotomy is associated with less hospitalization period than craniectomy.

RECOMMENDATIONS:

1. Encourage using craniotomy for pediatric patients with posterior fossa tumors, as it is more effective and associated with fewer postoperative complications.
2. Perform studies comparing both techniques for patients with tumor recurrence.

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