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Original Research Paper

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ASTROCYTOMA OF THE POSTERIOR FOSSA IN CHILDREN – PEROPERATIVE SURGICAL COMPLICATIONS

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Introduction

Definition:

Peroperative surgical complications mean all complications that occur intraoperatively and postoperatively which result from anesthesia technique, patient position, surgical technique and postoperative care (1).

Epidemiology:

In pediatric population, an incidence of primary tumor of central nervous system (CNS) form 20% of neoplasia seen in children and about 31 of 100000 children at risk. They are the second commonest type of cancer seen in children after leukemia (2, 3).

Brain tumors are of most devasting form of human illness especially when occurring in post. fossa and involving the brain stem (3).

It has traditionally been thought that the most pediatric brain tumors are infratentorial. The commonest site of CNS neoplasia in children was the cerebellum (4).

Majority of post. cranial fossa tumors in children were intra-axial tumors. The commonest type was medulloblastoma followed by astrocytoma.

Some authors reported that the peroperative surgical complications encountered in surgery done upon such types of tumors in post. fossa can be categorized into two main categories; intraoperative and postoperative (1).

- **Surgical consideration:**

The operative approach to the Fourth ventricle (4th vent.) may require splitting the vermis, removing a tonsil, resecting part of one cerebellar hemisphere, opening the inferior medullary vellum, separating a tumor from the floor and roof of the 4th vent., dissecting in region of cerebellar peduncles and deep cerebellar nuclei and retracting or removing the flocculus. The tonsil can be elevated from medulla to open the cerebellomedullary fissure and expose the ventricle (vent.) and lateral (lat.) recess. In exposing this area care is necessary to avoid damaging the posterior inferior cerebellar artery (PICA) which may be tethered by their branches to the tonsils and walls of cerebellomedullary fissure (4, 5).

Pathology:

One of the commonest types of post fossa tumors in pediatric age group is Cerebellar Astrocytom (4, 6).

Cerebellar Astrocytoma:

- Constitutes 10-20% of childhood brain tumors.
- Cystic cerebellar astrocytoma represents about 33% of all post. fossa tumors in childhood.
- They occur equally frequently in male and females.
- Peak incidence is (5-10) years old.
- 75-85% of these tumors are located in cerebellum are juvenile pilocystic Astrocytoma.
- Midline tumors are predominantly solid and lateral predominantly cystic.

Clinical features:

The signs & symptoms are the result of two mechanisms, cerebellar dysfunction & obstructive hydrocephalus. The indolent growth pattern of these tumors allows for gradual ventriculomegaly, which is usually very well compensated for by the patients, nonetheless, headache is the most common symptom to be found initially (82%). Associated with this are nausea & vomiting (81%), visual impairment (21%), altered mentation (8%), hemiparesis (5%) seizure (2%) & speech impairment (2%) (6, 8).

Papillodema was present in 83% of the children with cerebellar astrocytoma & was most common in the older children with closed sutures. Abducens palsy was observed in 15% of children & was the second most common cranial nerve involvement was seen in only a few of the children (4).

Signs of cerebellar dysfunction constitute the second most common finding and are dependent on the tumor location. Truncal ataxia, which often result in gait disturbances, is quite typical of midline (vermain) lesions, whereas unsteadiness & incoordination of the upper & lower extremities are usually due to tumors location of the midline & ipsilateral to the clinical signs (6).

Nystagmus is far less common than ataxia & tends to be a late sign (4).

Neuro-imaging studies:

Skull Roentgenograms:

Plain skull X-ray usually reveals changes consistent with long-standing raised I.C.P., including thinning & asymmetrical bulging of the occipital squama , chronic splitting of the cranial sutures in patients under age of 15 years, and, if the sutures are closed , demineralization or erosion of the sella turcica (4).

CT scan:

Solid tumors are of low attenuation on unenhancing C.T, with varied degrees of enhancement after contrast infusion (4).

The density of tumor was of value to distinguish medulloblastoma from astrocytoma. Cerebellar astrocytoma had an obvious tendency to develop cystic changes, especially the configuration of 'cyst with mural nodule' and a non enhancing cyst wall (9).

C.T shows that pilocystic cerebellar astrocytoma was vermian in 63.6% compared to hemispheric (36.4%). It was cystic in 51%, calcification found in 15%, necrosis in 4% and perifocal edema in 2%. No enhancement seen in 6% (10).

MRI

MRI should be the examination of choice, if the patient's clinical status does not prevent its use. C.T should be used only in emergency cases (acute intracranial hypertension) to identify hydrocephalus and intratumoral hemorrhage. C.T allowed the correct diagnosis to be made in 48%, with questionable finding in 40% and misdiagnosis to be made in 12% of patients. MRI allowed correct diagnosis to be made in 83% with questionable finding in 17% and no misdiagnosis of patients (11).

In Cerebellar astrocytoma the MRI characteristics vary with the gross morphology and histology of these lesions. The cystic components may image as equivalent to CSF on all pulse sequences or, less frequently, may be isointense on T1 and T2 images, because of the presence of proteinacious. The mural nodule or solid component of the tumor is commonly isointense on T1 W. images and isointense to hyperintense on T2 W. images. Enhancement with gadolinium on MRI parallels that observed with iodinated contrast material on C.T. (12).

Peroperative management:

Corticosteroid therapy with dexamethasone or an equivalent has provided beneficial in preparing children with post. fossa tumor for surgery, in performing the actual resection, and in managing the condition postoperatively. The recommended dose is 1 mg/kg once daily for a period of 2-3 days before surgical intervention.

Controversy still exists regarding the initial management of patient with post. fossa tumors. Previously, elective V.P shunting had been carried in most patients with obstructive hydrocephalus prior to definitive tumor surgery, which was typically deferred for 7 to 10 days until the child's papillodema and other symptoms and signs had resolved (4).

Insertion of precraniectomy shunt improved the clinical features of raised ICP. It is also provided a lax brain during definitive surgery and a smooth postoperative course (13, 14).

Shunt related complications consisting of block and/or infection were observed in 32.8% of patients (13).

The principle disadvantage lies in the fact that only 22% of children with cerebellar astrocytoma will require a permanent shunt postoperatively (13, 15, 16).

It is possible that the failure of hydrocephalus to respond to the removal of the tumor in these patients correlate with disease severity, i.e. extensive tumor are most likely to benefit from preoperative CSF diversion (17).

Therefore, the policy to manage these patients now is by using preoperative external ventricular drainage (EVD) in attempt to avoid preresection shunt (4).

Seizures are uninfrequent problem in treating either the post. fossa tumors or their associated hydrocephalus and prophylactic anticonvulsants are not recommended.

Antibiotic are not needed but intraoperative antibiotics effectively decrease the risk of postoperative infection (5).

Surgical treatment:

Anesthesia:

Anesthesia usually induced with thiopental and maintained with a mixture of intravenous fentanyl plus nitrous oxide or with an inhalation agent such as isoflurane. The chest should be auscultated after the head is in its final position; the neck is commonly flexed in either the prone or sitting position and the endotracheal tube may advance into the right main stem bronchus after the neck is flexed. A precordial Doppler monitor is often applied to detect air embolism, which caused a characteristic washing-machine sound. If air is detected the operative field can be flooded with saline and the venous pressure can be increased, either by lowering the head of the operative table or by jugular venous compression. A brain stem evoked potential can be used to detect and evaluate the brain stem responses intraoperatively, if any changes were detected, brain stem manipulation must be avoided (5).

1.8.2Operative positions:

The patient position selected for approaching post. fossa tumors depends largely on the prior experience of the neurosurgeon. Each position affords certain advantages and carries certain risks (4).

1. Sitting position:

This position is used for removal of midline and paramidline post. fossa tumors. Its advantages include direct orientation of the patient / tumor position allows draining of blood and CSF from surgical site by gravity and probably offers better access to the superior vermis. Its disadvantages include the risk of air embolism and the fatigue of the surgeon's elevated arms. The actual risk of air embolism can be reduced by intraoperative fluid expansion and the use of positive air way pressure. Patients should have a right arterial central venous catheter placed preoperatively and should be monitored by Doppler ultrasonography and end-expiratory Co_2 in order to detect and treat any air embolism that occurs.

In the sitting position, decompression of the ventricles also allows substantial quantities of air to pass into the subdural and subarachnoid spaces during surgery, so these patients are much sicker in the immediate postoperative period.

2. Prone (angulated concorde) position:

The prone position reduces the risk of air embolism but subject the facial structures to increased pressure and potential damage. There is less risk of tearing bridging veins between cerebellum and tentorium than in sitting position. The patient's orientation is direct and the surgeon can stand comfortably.

Intraoperative complications, as well as postoperative complications were more frequent in the prone position & stay hospital stay was longer compared to sitting position in children (18).

For the prone position, patients are supported on chest rolls that abdominal viscera. Head support varies with the age of the patient: less than 10-20 months, the skull is usually too soft to permit reliable pin fixation & therefore supported in the foam – padded pediatric horseshoe head holder; pediatric pins are used 1-2 years old; and adult pins are used therefore. The head is fixed in the three-pins (Mayfield) head holder & angulated about 30 ^{0}, a distance of one to two fingers breaths must be left between the chin & the chest (4, 5).

3. Lateral decubitus (park bench) position :

The lateral decubitius position used for tumors in the lateral cerebellar hemisphere with a roll under the axilla & the head fixed in the Mayfield head holder. It offers the advantages of good access to the airway & little possibility of air embolism. However, the weight of the cerebellar hemisphere on the superior side makes retraction of the hemisphere & exposure of large cystic tumors a significant problem (**4**,**5**).

Skin incision:

To approach midline & paramidline tumors, a midline incision is made from the external occipital protuberance to the midcervical level. For lateral hemispheric tumors, a vertical incision is made between the midline, centered over the maximal volume of the tumor (4,5).

Operative Procedure:

The incision is carried deeply throughout the relatively avascular ligamentum nuchae to reach the periosteum. The periosteum deep to the cervical musculature is stripped away to occipital bone from mastoid to mastoid (4).

An osteoblastic craniotomy is preferable to craniectomy for posterior fossa exploration. The former provides more anatomical closure of the wound & creates less dead space in the suboccipital region. Because children have less bulk in the suboccipital musculature, craniectomy can result in postoperative pseudomeningocele (6, 19).

The traditional method of occipital bone removal is by a craniectomy from the foramen magnum upward until the inferior margin of the transverse sinus is seen.

A C1 laminectomy does not have to be performed in the majority of these operations, but may be needed if the cerebellar tonsils have herniated to the C1/C2 interspace. If the dura is tense, the external ventricular drain (EVD) should be opened & CSF drained until the dura is slack before it is opened.

To approach midline & paramidline tumors, the dura is opened in a Y-shaped manner. Dural take up sutures are inserted & the dural leaves are retracted back over cottoniod strips. The arachnoid over the cisterna magna is opened. Cottoniod patties are inserted at the foramen magnum to lessen caudal migration of blood during the operation (5).

Benign cerebellar astrocytomas of children are potentially surgically curable lesions (20). Comprehensive review of the literature has shown that the treatment of choice for cerebellar astrocytoma has primarily been gross- total resection of the mass (21). Complete surgical excision was possible in 88.7% of patients (7).

The demarcation between tumor & brain is usually quite distinct, even in tumors that do not exhibit pseudoencapsulation . The major portion of astocytoma, therefore, may usually be removed easily by microdissection, suction, and bipolar cautery. Small residual portion of the tumor is difficult areas may be removed with the CO_2 laser. In patients with cystic astrocytomas, extirpation of the mural nodule may be sufficient to affect cure. However, it is preferable to remove the cyst wall as well, especially if the wall is thick or enhances on MRI. In other patients, especially those with solid tumors, growth of the tumor through the cerebellar peduncle into the brain stem may make complete resection impossible , despite the surgeon's desire for complete removal , these lesions should not be followed into the brain stem , lest violation of the floor of the fourth ventricle cause additional neurological deficit. Every effort should be made to avoid inflicting cranial nerve palsies & incapacitating ataxia on these children (4).

Closure techniques:

The dura mater should be closed tightly to prevent the formation of a postoperative pseudomeningocele. Often, intraoperative shrinkage of dura requires use of dural substitute or pericranial graft to achieve the dural closure (4).

Anatomical closure of the dura , cranium , & suboccipital muscle layers prevents postoperative leak of the CSF , pseudomeningocele , & chemical meningitis (6).

Postoperative management:

It is essential to obtain immediate postoperative CT scans, before the intravenous infusion of a contrast agent, to check the extent of tumor resection & also to look for the presence of hematoma. This C.T. study is obtained urgently if the patient has any impairment of consciousness in the immediate postoperative period (4).

It has been shown that postoperative CT scan or MRI images are more reliable than the surgeon's estimate of the degree of tumor resection at the time of surgery. C.T. scan confirmed the surgeon's judgment of the extent of tumor removal in 79% of cases. It is not possible, therefore, to make an accurate determination regarding a postresection prognosis based on the degree of suspected tumor resection without the availability of appropriate radiographic images (21, 22).

Peroperative surgical complications:

Intraoperative complications:

1. Air embolism:

Non cardiogenic pulmonary oedema is seen after large air embolus occurring during neurosurgery.

The air space disease was self limited expected for pulmonary edema caused by a single large intravenous air embolus. This syndrome has been described as relatively acute pulmonary microvascular permeability or rupture of capillary integrity occurring within several hours of air embolus. This phenomenon caused by either large bolus of intravenous air or by prolonged low level introduction of air into the venous system during post. fossa surgery (1, 6, 23).

Avoidance:

- Copious irrigation
- Bone wax to bone edges.

Treatment:

- Immediate head down.
- Jugular venous compression.
- Oxygen.
- Bone wax.

2. Hemodynamic instability:

This occurred due to either previous patient's cardiac problem or by manipulation of brain stem where the tumor had extended. It shows itself by any type of intraoperative arrhythmia like ectopic, sudden bradycardia (1, 6, 23).

Avoidance:

- Protection of floor of Fourth ventricle.
- Refrain from removal of brain stem component.

Treatment:

1. Immediate cessation of brain stem manipulation.
2. Appropriate cardiac medication.

3. Skull perforation with fracture:

This occurs during skull stabilization by pins and usually occurs in young children where the skull vault still thin (1, 23).

Avoidance:

- Careful application.
- No pins if the patient is younger than 2 years and a half.

Treatment:

Surgical management for fracture.

5. Massive swelling and cerebellar herniation:

This occurs due to massive cerebellar oedema and acute cerebellar herniation will result (1, 5, 6, 23).

Avoidance:

- Liberal use of manitol.
- Opening of cisterna magna.
- Wide dural opening.
- Ventriculostomy based upon preoperative imaging.

Treatment:

- Ventriculostomy.
- Hyperventilation.
- Head up.
- Additional manitol.
- Expedient tumor resection.

6. Subdural hematoma:

It occurs due to:

1. Unsecured hemostasis of cortical vasculature.
2. Coagulopathy.

3. Severe increase of venous pressure (1, 5, 6, 23).

7. Extradural hematoma:

It is the least type of hematoma occurd in post. fossa surgery (1, 5, 23).

1. Unsecured hemostasis of extradural vessels.
2. Continuous bone oozing which was not stopped.

Avoidance:

- Preoperative evaluation of coagulation parameters.
- Meticulous hemostasis.
- Avoidance of hypertension or sever increase in venous pressure.

Treatment:

- Evacuation of symptomatic hematoma.
- Correction of coagulopathy.

Postoperative complications:

1. Cranial nerve deficits and long tract signs (hemiparesis):

Such as abducens and facial weakness, internuclear ophthalmoplagai, horizontal gaze palsy and vocal cord palsy are related to the manipulation of the floor of Fourth ventricle (1, 5, 6, 22).

Avoidance:

1. Avoidance of tumor in brain stem.
2. Avoidance of any manipulation of the floor of Fourth ventricle.
3. Delicate manipulation of cranial nerves.

Treatment:

1. Prolonged intubation and trachestomy, gastrostomy if necessary.
2. Eye patch and oculoplastics consultation for prolonged diplopia.
3. Symptomatic treatment for dry eye after Fourth nerve, possible tarsorraphy.

3. Cerebellar dysfunction:

The most common complication is increased cerebellar ataxia and nystagmus, although it is transient and often rapidly resolves over several weeks. The risk of post operative cerebellar deficit depends on the tumor location and on the trauma of its removal and ranges from 15-18% (1, 5, 6).

Avoidance:

1. Delicate manipulation of cerebellar peduncle.
2. Avoidance of trauma to cerebellar peduncle during tumor removal.

Treatment:

Corticosteroids are usually given in high doses for 2-3 days post operatively and then tapered over 4-7 days.

4. CSF leak or pseudomeningocele:

These complications are usually due to inadequate drainage of CSF and are better prevented than treated (1, 5, 6, 22).

Avoidance:

1. Ventriculostomy intraoperatively.
2. Lapras catheter if significant tumor.
3. Watertight dural closure with graft if necessary.
4. Tight closure of fascial layers.

Treatment:

1. Lumbar-subarachnoid drain if no hydrocephalus.
2. V.P shunt if hydrocephalus.
3. Reoperation and closure of dura using fibrin glue.
4. Head at least 30° post operatively.

5. Tension pneumocephalus:

This is a serious post operative complication, results from little irrigation of tumor side by fluid during surgery and entrance of air intracranially. It occurs mostly in sitting position (1, 4, 6).

Avoidance:

Prone position associated with little percentage of this complication.

Treatment:

Burr hole and aspiration.

6. Infections:

A. Meningitis-like syndrome

The condition manifests with headache, photophobia and fever with neck stiffness. The clinical evidences are consistent with the diagnosis of bacterial meningitis. Laboratory evaluation of CSF obtained via lumbar puncture is also consistent with bacterial meningitis but if all cultures are negative, this post resection syndrome usually resolves over a few days and probably represents chemical meningitis secondary to intraoperative bleeding and residual surgical debris. This complication is rare if appropriate hemostasis achieved, subarachnoid and ventricular spaces are sealed off during the tumor resection and watertight dural closure is performed. A low dose steroid may be helpful (5,6).

B. Wound infection

The risk of post operative wound infection is approximately 1.5 to 2.5% in spite of intraoperative antibiotic. The likelihood of staphylococcal infection of the external ventricular drain is 5-10%. CSF sample should be cultured daily from extra ventricular drain. The infection may be decreased by daily instillation of vancomycin 10-20 mg into the external ventricular drain catheter (5).

7. Seizure:

The incidence of seizure in patient who underwent post. fossa operation via a suboccipital craniectomy was 5-9% within 2 weeks post operatively. The incidence was high in patient with astrocytoma. The sitting position associated with venous air embolism and or pneumocephalus was related to the occurance of post operative seizure. Intraoperative significant venous air embolism occurred in 33% of patients and post operative C.T revealed pneumocephalus in 67%.

A higher percentage was found in patients with preoperative V.P shunt or intraoperative ventriculostomy (6.5%) than in those without (5.1%) (1, 24).

Prophylactic anticonvulsants are not necessary since such seizure readily controlled and since not child's condition has deteriorated because of such seizures (1, 4).

8. Dural sinus infection and thrombosis:

It is a rare and potentially serious condition and associated with intracranial surgery. Venous hypertension is a result of venous outflow obstruction. Adverse effects of increased intracranial pressure (ICP) include headache, visual obscuration and blindness. Transverse and sigmoid sinuses occlusions are usually asymptomatic particularly when affected sinus is non dominant and when collateral circulation is rich (1, 4, 6).

Prognosis and outcome:

The favorable prognosis for children with cerebellar astrocytoma is well established. Many of these tumors are amenable to total excision and the recurrence rates following excision are low. Even children whose tumors are subtotally excised may often exhibit long survival periods despite no additional therapy (8).

One-year survival for patient with cerebellar astrocytoma was 97% and five-year survival was 89% (16).

The main factor of negative prognostic value of cerebellar astrocytoma was the presence of brain stem involvement

(transitional form). In cystic tumors the surgical excision of the cyst wall did not offer significant advantage on survival. (25).

Mortality:
Total surgical mortality of children treated for cerebellar astrocytoma was 4.2% (7, 26).

1.13 Recurrence:
In cerebellar astrocytoma tumor recurrence rate after surgical removal of the lesion was 9.5% and incomplete tumor excision with respect to an increased risk of recurrence (7).

All recurrence reported after removal of cerebellar astrocytoma was in patients with subtotal resection (20).

Aims of the study:
1. To clarify and detect the main peroperative surgical complications in posterior fossa astrocytoma in children.
2. To know the factors that lead to these surgical complications.
3. To determine the methods that can minimize the complications as much as possible.
4. To find the best and rapid way to manage and to treat these complications.

Patients and methods
This is a prospective study conducted at the Neurosurgical Hospital in Baghdad and Surgical Specialties Hospital, between July 2004 to November 2011. It was conducted on 35 patients with histopathologically proven to have astrocytoma.

The patients had different ages, ranging from 3-16 years of both sexes and different geographical regions of Iraq.

Clinical data were collected; chief complaint and its duration, other symptoms were found including headache, nausea, vomiting, unsteadiness of gait, visual impairment, double vision, squint, gaze abnormality, difficulty in swallowing, disturbed consciousness, and lethargy. The signs were found including papillodema, nystagmus, visual acuity, cranial nerves palsy or paresis, cerebellar signs including ataxia, dysmetria, and signs of meningial irritation.

Signs and symptoms were analyzed before shunt operation and after it and after the tumor resection.

All patients were admitted and investigated, skull X-Ray done for about 75% of patients looking for signs of increase ICP and thinning of the occipital bone. C.T scan was done for all patients with and without contrast and it was the main imaging study used for diagnosis of post. fossa tumor depending on reports of neuroradialogist.

Regarding the location of tumor; midline, midline/cerebellar hemisphere or cerebellar hemisphere. Density of tumor either isodense or hyperdense or mixed densities. Cystic changes or necrosis, calcification, presence of ventriculomegaly either mild dilatation, moderate or markedly dilated ventricle and the degree of enhancement on contrast C.T scan either homogeneously enhanced tumor, irregularly enhanced, or faint enhancement. The size of tumor was estimated from C.T scans with contrast.

The same items mentioned before were reported for MRI which was done for only 8 patients and MRA was done for 4 of them to differentiate cystic lesion from vascular lesion and to clarify the vasularity of the tumor.

Preparation for surgery including blood investigation include complete blood picture (Hb, WBC, ESR), blood group and Rh compatibility, prothrombin time (PT) and partial thromboplastin time (PTT), renal function tests and chest X-Ray films. Blood prepared as one unit for shunt surgery and 2-4 units for tumor resection.

All patients received dexamethason in a dose of 4-8 mg three to four times daily, which was tapered postoperatively. Antibiotic therapy was started with induction of anesthesia third generation cephalosporin, ampiclox and gentamycin according to availability of the item. Anticonvulsant used only for few patients having convulsion presentation.

The initial surgery was V.P shunt or direct post. fossa craniectomy with external drainage or just burr hole ventricular tap. Post. fossa surgery was done under general anesthesia in all patients, usually in sitting position (29 patients, 83%) and in prone position (6 patients, 17%) with Mayfield or Sugita head holder. Skin incision was always midline. The incision was hockey stick incision with suboccipital craniectomy in all patients usually with removal of post. part of foramen magnum. Dura opened either U-shaped or Y-shaped to less extent, bleeding from occipital sinus was almost always controlled by silver or titanium clips. The tumors were approached either by vermian incision with diathermy and suction in case of midline or midlinehemispheric lesions or cerebellar cortical incision in hemispheric tumors. Tumor resection was usually done by suction and cautary or to less extent by biopsy forceps (piecemeal).

The extent of tumor resection was always based on the surgeon estimate as total resection (grossly) was achieved in 19 patients (54.2%) or subtotal resection in 13 patients (37.1%) and partial resection in 3 patients (8.6%).

Brain stem violation was indicated by bradycardia encountered during the operation and air embolism was detected by resistant hypotension, precordial Doppler was used. Dura mater usually closed in watertight fasion with or without pericranial graft, synthetic dura was used in three patients, fascia was closed without visible defect in 7 patients. All patients admitted to intensive care unit after operation for variable periods.

Postoperative C.T scan was done for 22 patients for follow up purposes and because of deterioration in the level of consciousness or persistent CSF leak. Patients followed up for variable periods till they were discharged, died or returned back because of late deterioration and some of them followed for 6 months.

The most common intraoperative surgical complications encountered were the hemodynamic instability and intraoperative hemorrhage in form of subdural hematoma. The most common postoperative surgical complications were cerebellar dysfunction, cerebellar mutism, hematoma, pseudomeningocele, cranial nerves palsies VII and VI and CSF leak.

Surgical mortality was defined as death within the postoperative period (one month) including the period while the patient was in the hospital. Follow up of survival was difficult after they were discharged from the hospitals, although some patients came back due to deterioration or symptoms of recurrence.

Results
Age and gender:
In this study it was found that the age of the patients ranged from 3-16 years. The peak incidence of the tumor was between 5 - 10 years of age. Regarding the gender, there were 17 female and 18 males among the total number.

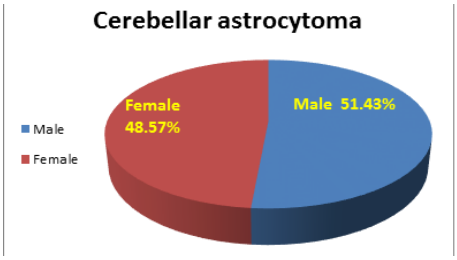

Figure (3.1): Gender distribution

Frequency of symptoms for astrocytoma:

Table (3.1): Frequency of symptoms for astrocytoma of the patients enrolled in the study

Symptoms	Number of patients
Headache	32 (91.4%)
Nausea and vomiting	31 (88.6%)
Unsteadiness of gait	21 (60%)
Visual impairment	16 (45.7%)
Double vision	11 (31.4%)
Squint and gaze abnormality	6 (17.1%)
Disturbed consciousness	3 (8.6%)
Swallowing difficulties	3 (8.6%)
Hemiparesis	1 (2.8%)
Fits	1 (2.8%)
Neck pain and stiffness	3 (8.6%)

Frequency of signs for astrocytoma:

Table (3.2): Frequency of signs for astrocytoma of the patients enrolled in the study:

Signs	Number of patients
Papillodema	26 (74.3%)
Ataxia	24 (64.6%)
Nystagmus	20 (57.1%)
Incoordination	12 (34.3%)
Dysmetria	8 (22.9%)
Impaired gag reflex	5 (14.3%)
Cranial nerves palsy (VI, VII, IX, X)	15 (42.9%)
Low GCS	5 (14.2%)
Dysartheria	3 (8.6%)
Tremor	2 (8.6%)

CSF diversion procedure:

Shunt operation was conducted before tumor resection in twenty six patients.

Table (3.3): CSF diversion procedure

CSF diversion procedure		Patients
Shunt	Elective	26
	Emergency	-
Non shunt	Attack + safety burr hole	3
	Attack + external drain	4
	Attack only	2

CSF pressure as judged by surgeon during ventricular taping was high in 20 patients.

Site of shunt application, CSF pressure and complications:

All patients showed improvement in their clinical condition following shunt operation.

Malfunction of shunt was reported in 4 patients. Shunt infection was also reported in 2 patients. All of the 4 patients who developed malfunction were treated successfully by shunt revision.

The 2 patients who developed shunt infection treated by shunt removal.

In this study non shunt CSF diversion procedures were done for 9 patients only.

External drain at time of tumor resection was performed for 4 patients and left for few days postoperatively. Safety burr hol and ventricular decompression also performed for 3 patients at time of tumor resection.

Two patients underwent direct attack of tumor without CSF diversion procedure.

Table (3.4): Site of shunt application, CSF pressure and complications

Shunt		No. of patients
Site	Post parietal	16
	Frontal	12
CSF pressure	Severe	20
	Moderate	6
	Mild	2
Complications	Malfunction	4
	Infection	2

Tumor resection and tumor features during post. fossa exploration:

The texture of the tumor was soft in 30 patients (85.7%). The color of fluid in all cystic tumors was golden yellow. The majority of tumors in astrocytoma were ill demarcated. Intraventricular extension was reported in 16 patients (45.7%). Brain stem was violated in 12 patients (34.2%).

Table (3.5): Extents of tumor removal done for the patients enrolled in the study:

Tumor removal	Number of patients (%)
Total	19 (54.2%)
Subtotal	13 (37.1%)
Partial	3 (8.6%)

Peroperative surgical complications:

1. Intraoperative complications:
   In this study, the most common intraoperative complication was hemodynamic instability (3 patients (8.6%)) in form of bradycardia and arrhythmia.
   The second most common intraoperative complication was hemorrhage in form of subdural hematoma in 1 patients (2.8%).
2. Postoperative complications:
   In the present study, the most common postoperative complication was cerebellar dysfunction in 7 patients (20%) in form of ataxia and nystagmus.

Table (3.6): Intraoperative surgical complications seen in patients enrolled in the study:

Intraoperative complications	Patients Number (%)
Hemodynamic instability (bradycardia, arrhythmia)	2 (5.7%)
Subdural hematoma (SDH)	1 (2.8%)

Table (3.7): Postoperative surgical complications seen in patients enrolled in the study:

Postoperative complications		Patients Number (%)
Cerebellar dysfunction		7 (20%)
Cranial nerves deficit		1 (2.8%)
Long tract signs (hemiparesis)		2 (5.7%)
CSF leak		1 (2.8 %)
Pseudomeningocele		2 (5.7%)
Infection	Wound infection	1 (2.8 %)
Meningitis		1 (2.8 %)

Table (3.8): Postoperative surgical complications according to time of occurrences:

Immediate (< 6 hr)	Early (< 72 hr)	Late (> 72 hr)
None	Cerebellar dysfunction CSF leak Cranial nerves deficit Pseudomeningocele Long tract signs (hemiparesis)	Wound infection Meningitis Seizure

Surgical complications related to age and gender:

Table (3.9): Distribution of Intraoperative surgical complications according to age and gender of patients enrolled in the study:

Intraoperative complications	Patients Number (%)	Age (years)	Gender
Hemodynamic instability (bradycardia, arrhythmia)	2 (5.7%)	4 and 7	1 Male 1 Female
Subdural hematoma (SDH)	1 (2.8%)	8	Male

Table (3.10): Distribution of Postoperative surgical complications according to age and gender of patients enrolled in the study:

Postoperative complications		Patients Number (%)	Age (years)	Gender
Cerebellar dysfunction		7 (20%)	5-15	4 Males 3 Females
Cranial nerves deficit		2 (5.7%)	8 and 11	1 Male 1 Female
Long tract signs (hemiparesis)		2 (5.7%)	10 and 14	1 Male 1 Female
CSF leak		1 (2.8 %)	4	1 Male
Pseudomeningocele		2 (5.7%)	4 and 6	1 Male 1 Female
Infection	Wound infection	1 (2.8 %)	7	1 Male
Meningitis		1 (2.8 %)	5	1 Female

Surgical complications related to tumor site

Table (3.11): Distribution of Intraoperative surgical complications according to tumor site:

Intraoperative complications	Patients Number (%)	Tumor site	
		Midline	Hemispheric
Hemodynamic instability (bradycardia, arrhythmia)	2 (5.7%)	1	1
Subdural hematoma (SDH)	1 (2.8%)	-	1

Table (3.12): Distribution of postoperative surgical complications according to tumor site:

Postoperative complications	Patients Number (%)	Tumor site	
		Midline	Hemispheric
Cerebellar dysfunction	7(20%)	3	4
Cranial nerves deficit	1 (2.8%)	-	1
Long tract signs (hemiparesis)	2 (5.7%)	1	1
CSF leak	1 (2.8%)	1	-
Pseudomeningocele	2 (5.7%)	1	1
Tension pneumocephalus	1 (1.4%)	1	
Infection Wound infection	1 (2.8%)	1	-
Meningitis	1 (2.8%)	-	1

Table (3.13): Intraoperative surgical complications according to patients' position and extent of tumor removal:

		Position		Extent of tumor removal		
Intraoperative complications	Patients Number (%)	Sitting	Prone	Total	Subtotal	Partial
Hemodynamic instability (bradycardia, arrhythmia)	2 (5.7%)	1	1	1	1	
Subdural hematoma (SDH)	1 (2.8%)		1		1	

Table (3.14): Postoperative surgical complications according to patients' position and extent of tumor removal

		Position		Extent of tumor removal		
Postoperative complications	Patients Number (%)	Sitting	Prone	Total	Sub Total	Partial
Cerebellar dysfunction	7 (20%)	4	3	2	4	1
Cranial nerves deficit	1 (2.8%)	1			1	
Long tract signs (hemiparesis)	2 (5.7%)	1	1		1	1
CSF leak	1 (2.8 %)	1		1		
Pseudomeningocele	2 (5.7%)	1	1	1	1	
Infection Wound infection	1(2.8%)		1	1		
Meningitis	1(2.8%)	1		1	0	

3 Other findings:

- The patients who were complicated with cerebellar dysfunction (7 patients) in form of ataxia and nystagmus (5patients), and ataxia only (2 patients). All were recovered after 2 weeks-one month.
- Pseudomeningocele was developed in 2 patients, one of them had only safety burr hole without shunt. The other patient had poorly functioning shunt treated conservatively and disappeared spontaneously.
- The patient with CSF leak was treated conservatively. The CSF leak was stopped, but unfortunately he developed meningitis.
- Patient with cranial nerve deficit hadVII cranial nerve deficit and has recovered after 2 weeks.

Table (3.15): Finding of patients with infection

Number of patient	Type of infection	C / S*	Management	Result
1	Meningitis preceded by CSF leak	Staph.	1. External drain 2. Antibiotics(3rd generation Cephalosporin (3 g/d I.V) + Ampiclox (2 g/d I.V) + Metronidazole (2 g/d I.V))	Improved
1	Wound infection	Staph.	1. 3rd generation Cephalosporin (3 g/d I.V) + Ampiclox (2 g/d I.V) 2. Abscess drainage 3. Wound dressing	Improved

* Culture and sensitivity done for CSF sample.

Discussion

Cerebellar astrocytoma represents one type of the main bulk of post. fossa tumor in children. As agreed in the literature, both medulloblastoma and astrocytoma exhibited a peak of incidence between 5-10 years (6, 27).

As strongly agreed in the literature (Julian (6) & Delia et al (8), headache was the commonest symptom. It was reported in 95% of patients with cerebellar astrocytoma. The second prevalent symptom was vomiting, explained by increased intracranial pressure (ICP) or direct pressure on medullary emetic center or both. Symptoms resulting from tumor compression and/or invasion of neural structures, as unsteadiness of gait and acute symptoms of raised ICP, as visual impairment were reported. These symptoms are more prevalent than reported in the literature indicating the delayed presentation of our children to neurosurgeon.

Signs of cerebellar dysfunction are considered as the second common finding. Cranial nerve dysfunction (especially VII nerve palsy) was detected and was higher than reported in the literature. Again, delayed diagnosis of the disease explained this.

Because of its availability and easier application in children, C.T scan was the main diagnostic tool used in this study. Astrocytoma has high tendency of midline location (60%) but with significant incidence of hemispheric location (40%).

It was evident radiologically that cerebellar astrocytoma was cystic in majority of hemispheric lesion, and could be either cystic or solid

in vermian lesion (4, 8, 28).

Obstructive hydrocephalus demonstrated in 95% of patient with crebellar astrocytoma which was significantly higher than Karoly et al (22) report which showed hydrocephalus in 80-90% of post. fossa tumors.

In MRI studies of cerebellar astrocytoma, as Larry et al (12) considered, cystic lesions showed the same intensity of CSF while solid lesions showed mixed intensity on both T1 and T2 W. image.

Still there is controversy about the management of hydrocephalus associated with post. fossa tumor in children. Precraniectomy shunt was performed in 74.2% of patients with cerebellar astrocytoma. Most of neurosurgeon indicated shunt operation for these patients with midline solid tumors claiming that it will improve the clinical features of raised ICP, provide lax brain during tumor resection and facilitate smooth postoperative course, as reported by Griwan et al (13) & Goel (14). Furthermore, Lee et al concluded that patient with extensive tumor that present in late stage of disease, especially in developing countries, are most likely to benefit from precraniotomy shunting (23).

CSF pressure as judged by surgeon, during taping of the ventricle, was high in majority of patients underwent shunt operation (57.1%) indicating the severity of hydrocephalus and late presentation of children.

The risk of upward transtentorial herniation and the potential dissemination of malignant tumor cells through the shunt, proved in the literature, were not reported in this study.

Malfunctions & infections were the main disadvantages reported in 11.4% & 5.7% of patients underwent shunt operations respectively. A different result was shown by Griwan et al (13) who observed shunt block & / or infection in 32.8% of patients.

All patients underwent suboccipital craniectomy attempting gross total removal of tumor were with minimal postoperative morbidity & mortality. As supported in the literature, most of lesions in cerebellar astrocytoma were soft, white in color & poorly demarcated.

The incidence intrarventricular extension was (45%). This can be logic for a tumor originated from the roof of fourth ventricle.

Total removal was achieved in 54.2% of patients & the most important parameter that affect the extent of tumor removal was brain stem violation, indicated by the peroperative development of bradycardia & / or arrhythmia during the surgeon's attempt to remove the tumor from the fourth ventricle floor. These peroperative warning signs occurred in 5.7% of cases. Furthermore, the poorly defined tumor margin in cerebellar astrocytoma was also adversely affecting the extent of tumor resection. It was strongly evident that even subtotal removal of tumor in cerebellar astrocytoma will exhibit long term survival of children (8).

Postoperative check CT scan was preformed for 22 patients, evaluating extent of tumor removal & searching for postoperative complications. Postoperative CT scan, as Morreal et al (21) concluded, was more reliable than surgeon's estimate of the extent of tumor removal during surgery. Among 9 patients presumed by surgeon to have total removal, only 1 patient showed residual tumor on postoperative check CT scan, & among 7 patients judged to be subtotally removed, surprising 1patients showed no residual tumor (small rim of tumor tissue could not be visible on CT scan). So generally, CT scan confirmed surgeon's estimation of tumor removal in more than 85% of cases. Karoly et al (22) reported 79% confirmation between surgeon's judgment of tumor removal & CT scan finding.

The commonest postoperative complication reported in this study, as wall as in the literature, was cerebellar dysfunction. Because of the higher percentage of lesion eccentricity recognized in cerebellar astrocytoma, patients with this tumor postoperatively showed higher incidence of cerebellar dysfunction (20%).

Pseudemeningocele was directly related to the presence of hydrocephalus postoperatively. It was developed in 5.7% of patients. These patients either not had shunt operation or had malfunctioning shunt.

Postoperative meningitis was developed in one patient (2.8%). It carried a variable prognosis.

Postoperatively, hemiparesis occurred in 5.7% of patients. Also these patients had brain stem invasion & they showed variable improvement after physiotherapy.

Mortality rate was undetected in this study, probably due to small study sample. Pancalete et al (7) showed mortality rate of (4.2%) in children with cerebellar astrocytoma. In cerebellar astrocytoma brain stem injury was considered to be the cause of death.

Follow up in this study showed that patients with cerebellar astrocytoma exhibited good outcome, but to confirm the higher rate of survivals reported in the literature for children having cerebellar astrocytoma, longer time of follow up is needed.

Conclusions:

1. Non shunt CSF diversion procedure could be an alternative in cystic tumors located away from the midline.
2. Gross total removal of tumor should be the goal standard of neurosurgeon but every effort should be given to avoid brain stem injury.
3. Age, anesthesia, technique, patient position during surgery, surgical technique and postoperative care are the main factors that determine the peroperative surgical complications.
4. The most common intraoperative surgical complications are hemodynamic instability and hemorrhage (SDH) and the most common postoperative complication is cerebellar dysfunction.
5. Brain stem violation was the main factor that affects the outcome.

Recommendations:

1. Gentle and delicate anesthesia technique during surgery is recommended, especially in low age group children.
2. Precraniectomy CSF shunting is still recommended for most of children.
3. We would like to suggest to do post. fossa craniotomy rather than craniectomy because it is associated with less peroperative complications.
4. Gross total removal of tumor should be the goal of neurosurgeon.
5. We recommend doing postoperative C.T scan with or without contrast for every patient underwent post. fossa surgery for removal of tumor to evaluate the extent of tumor removal, growing postoperative hematma.
6. We recommend using minimally invasive technique like radiosurgery to treat these tumors in the future.

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