RE-OPERATIVE CSF DIVERSION VERSUS DIRECT SURGICAL ATTACK IN POSTERIOR FOSSA TUMOURS WITH SECONDARY HYDROCEPHALUS

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ABSTRACT:

Background: *Posterior fossa tumors could usually be complicated by secondary hydrocephalus due to obstruction or compression of the 4th ventricle.*

Aim of the work: *To analyze the efficacy of preoperative CSF diversion versus direct tumour attack in long-term management of hydrocephalus.*

Patients and Methods: *A retrospective study carried out on 30 patients presenting with posterior fossa tumors and secondary obstructive hydrocephalus managed at Ain Shams University Hospitals.*

Results: *About one third of posterior fossa tumour patients become shunt dependent, surgical excision alone could be life threatening. Midline posterior fossa tumors were associated with a higher incidence of shunt dependance compared with those that only affected the cerebellar hemispheres or the CPA.*

Conclusion: *Less than one-third of patients with posterior fossa tumours require a CSF diversion during the course of their illness, the fact that refutes the role of prophylactic shunting or ETV. However, higher post-operative morbidity and mortality in cases with direct tumour attack raises the protective role of preoperative CSF diversion especially in midline posterior fossa tumours.*

Recommendations: *Finally, previous results may need to be strengthened in the future study of more cases.*

Key words: *CSF diversion, secondary hydrocephalus, posterior fossa tumors*

INTRODUCTION:

Being in close proximity to the fourth ventricle, posterior fossa tumors predisposes patients to develop secondary obstructive hydrocephalus (HCP) due to direct invasion or compression of the CSF pathway[(1)]. In pediatric population, Over 80% of cases with posterior fossa tumours present with hydrocephalus, and about 30% still have hydrocephalus postoperatively, which could be related to scarring at the aqueduct or 4th ventricular foramina or distortion of the 4th ventricle [(2)]. Therefore, about one third of patients with posterior fossa tumors will require a mandatory management of hydrocephalus by CSF diversion at some time during the course of their illness[(1)].

The perioperative management of this associated obstructive hydro-cephalus remains controversial. Some authors proposed a preoperative ventriculo-peritoneal shunting as most advantageous for the subsequent surgical resection of the tumor, advocated by decreases in post tumor resection morbidity and mortality of the in shunted cases[2]. However, CSF shunting could predispose to a number of complications: shunt malfunction or obstruction, Shunt and CSF infection, upward vermian herniation, tumor hemorrhage and various abdominal complications [2].

Some authors have preferred the use of preoperative external ventricular drainage (EVD) devices to control symptomatic hydrocephalus, thus avoiding the need of permanent shunts and their associated complications. They noted that this approach allows about two thirds of patients remain shunt free after tumor resection [3].

Recently, endoscopic third ventriculus-tomy (ETV) is introduced as an optional initial surgical management of secondary obstructive hydrocephalus [4]. Even though it does not prevent the development of post-operative hydrocephalus in all cases, ETV does protect against acute post-operative hydrocephalus due to cerebellar swelling [5].

AIM OF THE WORK:

The aim of this study is to analyze the role of pre-operative CSF diversion versus direct tumour resection in long term management of obstructive hydrocephalus secondary to posterior fossa tumours. This study therefore compares outcome in relation to different treatment modalities for the hydrocephalus namely:

- Pre-Operative V-P shunting
- Pre-Operative Endoscopic 3rd ventrculostomy (ETV)
- Direct surgical resection (Direct Attack) with or without External ventricular drain (EVD)

PATIENTS AND METHODS

Type of study: Retrospective study

Sample size: 30 cases presented with obstructive hydrocephalus secondary to posterior fossa tumours treated at Ain Shams University Hospitals. Data were collected retrospectively and include:

1) **Pre intervention assessment**:

- ✓ **Personal data:**
- ○ Age
- ○ Gender
- ✓ **Clinical history data**
- ○ Symptoms of increased intra-cranial tension:
- ▪ Headache
- ▪ Nausea/Vomiting
- ▪ Blurring of vision
- ▪ Squint
- ○ Symptoms related posterior fossa lesions:
- ▪ Cerebellar symptoms
- ▪ Brain Stem manifestations due to compression/Invasion
- ▪ Cranial Nerves deficits
- ✓ **Clinical examination data:**

Throughout neurological examination we stressed on:

- ○ Manifestation of increase ICP
- ✓ Papilledema
- ✓ 6th nerve palsy

Manifestation of lesion in posterior fossa

- ✓ Cerebellar Signs
- ✓ Brain Stem signs due to compression/Invasion
- ✓ Cranial Nerves deficits
- ○ Clinical evidence of metastasis whether supratentorial or spinal
- ✓ **Radiological assessment data**
- ○ **CT brain**
- ✓ **Assessment of supra-tentorial tri-ventricular hydrocephalus**
- ○ Degree of Hydrocephalic changes (Evan's ratio):

According to Evans ratio: By dividing the maximal width of the frontal horns of lateral ventricles by the largest transverse diameter of the skull's internal table, we produced a standardized ratio [(3)]:

- Mild: 0.27-0.34
- Moderate: 0.35-0.40
- Severe: > 0.4
- Size of temporal ventricle horn (normally <3mm)
- Third ventriclular balooning
- Trans-ependymal permeation

✓ **Assessment of the fourth ventricle:**

- Degree of obstruction (Partial/Complete)
- Invaded or compressed

✓ **Assessment of tumour**

- Site (midline/cerebellar/CPA)
- Type (Solid and/or cystic)
- **MRI brain with contrast**
- Site (midline/cerebellar/CPA)
- Size and Mass Effect
- Type (Solid and/or cystic) and consistency
- Peri-lesional edema

2) **Method of CSF diversion**

- Ventriclo-peritoneal Shunting (V-P shunt)
  - Type of shunt
- Endoscopic Third Ventriculostomy (ETV)
  - Type of scope
- Direct tumor excision with or without EVD
  - Approach

(Choice of surgical decision and procedure were according to the preference and experience of the surgeon)

In each method

- duration till tumor resection

3) **Assessment after CSF diversion**: (Till tumor resection)

- Assessment of symptoms and signs of increased intra-cranial pressure
- Assessment of degree of hydrocephalic changes on CT brain
- Assessment of complications
- Hydrocephalus (failed CSF Diversion)
  - Timing
  - Cause
  - Method of management
- Infection
  - Diagnosis (clinically, CSF analysis)
  - Management
- Upward herniation
  - management

4) **Assessment after Tumour resection**:

a. Tumor assessment

i) Site (midline 4th ventricular or vermian, lateral cerebellar,brain stem, cerebello-pontine angle)
ii) Size
iii) Type (solid, cystic)
iv) Pathology
v) Residual

b. complication assessment

- Hydrocephalus
  1. Timing
  2. Cause
  3. Method of management
- Infection

Diagnosis (clinically, CSF analysis), Management

- Pseudomeningiocoele
- CSF leak
- Subdural collection

5) **Follow up assessment:**

- Duration of follow up
- Method of follow up
  1. Clinically
  2. Radiologically

RESULTS:

Analysis of demographic data of patients

a. Sex:

Table (1): Distribution of the studied cases as regard sex

Sex		
	N	%
M	13	43
F	17	57
Total	30	100

b. Age:

The age ranged from 2.5-70 years with mean of 34.583 ±19.431 years (mean±standard deviation). Mean age of males was 33.1 years and for females was 38.6.

Table (2): Age Distribution among Males and Females;

Age				
Range		Mean	±	SD
2.5 -	70	34.583	±	19.431

Table (3): Age groups of the studied patients:

Age (years)	Number of patients	Proportion (%)
<10	5	16.67
10-40	11	36.67
>40	14	46.67

Analysis of clinical presentation of patients

- 24 patients (80%): Increased ICP (headache, nausea/vomiting, blurring of vision)
- 18 patients (60%): Cerebellar manifestation (mainly ataxia)
- 16 patients (53.33%): Focal neurological deficits (facial palsy, hearing loss, bulbar etc.).

Table (4): Clinical presentations:

	Increase ICP	**Cerebellar manifestation**	**Cranial nerve deficit**
Nm of patients	**24**	**18**	**16**
%	**80**	**60**	**53.33**

Analysis of radiological presentation of patients

- ***Hydrocephalus:***

According to Evan's ratio:

- 11 patients (36.67%): Mild hydrocephalic changes (0.29-0.34)
- 12 patients (40%): Moderate hydrocephalic changes (0.35-0.4)
- 7 patients (23.3%): Severe hydrocephalic changes (>0.4)

Evan's ratio ranged: 0.31-0.49 with a mean of 0.38 ±0.055.

- ***Posterior fossa tumors:***

Site (localization):

A. Midline tumors: Including 4th ventricular, vermian and brainstem tumors (7 patients) (23.33%)

B. Lateral tumors: Involving the cerebellar hemispheres (8 patients). (26.67%)

C. CPA tumors: Tumors located within the cerebello-pontine angle (13 patients) (43.33%).

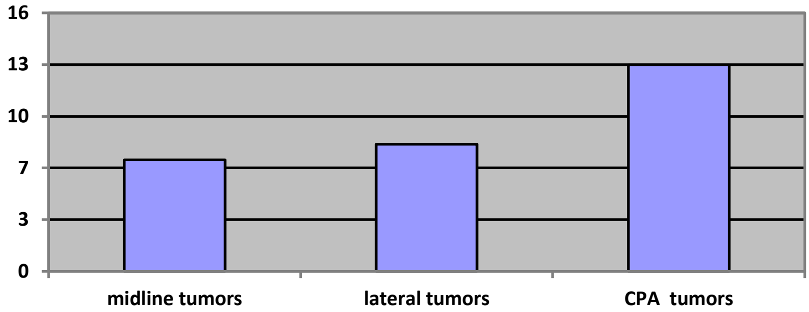

Diagram (1): Localization of the tumors

Table (5): List of cases and their Management

Pathology	Number of patients	Pre-Op CSF diversion	Degree of tumor resection
CPA Schwannoma	**6 (20%)**		
	2	VP shunt	1 case: Gross total resection 1 case: subtotal resection (75%)
	1	ETV	Subtotal resection (75%)
	1	EVD	Gross total resection
	2	none	Subtotal resection (70%) and (85%)
Medulloblastoma	**6 (20%)**		
	1	VP shunt	Subtotal resection (85%)
	3	EVD	2 Gross total resection 1 subtotal resection (75%)
	2	none	subtotal resection (80%) and (60%)
Metastatic Lesion	**5 (16.7%)**		
	3	VP Shunt	Gross total resection
	1	ETV	Gross total resection
	1	None	Gross total resection
Pilocytic Astrocytoma	**4 (13.3%)**		
	2	VP Shunt	Gross total resection
	2	None	Gross total resection
Ependymoma	**3 (10%)**	ETV	1 case: gross total resection 2 case: subtotal resection (75%) and (85%)
Hemangioblastoma	**2 (6.7%)**		
	1	ETV	Gross total resection
	1	None	Gross total resection
CPA Meningioma	**2 (6.7%)**	VP shunt	Gross total resection
CPA Epidermoid	**1 (3.3%)**	VP shunt	Subtotal resection (70%)
CPA Dermoid	**1 (3.3%)**	VP shunt	Subtotal resection (80%)
Total	**30 (100%)**		

Methods of intervention:

We included 30 patients in our study who presented with obstructive hydrocephalus secondary to posterior fossa tumours, they were managed as follows:

1) Ventriculo-peritoneal shunting:

- ✓ 12 patients (40%) were treated with VP shunts before tumor resection.
- ✓ All were treated by medtronic medium pressure shunt.

2) Endoscopic 3rd ventriculostomy:

- ✓ 6 patients (20%) were treated with ETV before tumor resection.
- ✓ All cases were operated using the conventional rigid endoscope.

3) Direct tumor surgical attack:

a. With EVD

✓ 4 patients (13.3%) were managed by EVD before proceeding with the tumor attack

b. Without EVD

✓ 8 patients (26.67%) were proceeded for direct tumor attck without any CSF diversion procedure.

Table (6): Methods of CSF diversion in study cases:

V-P shunt (12 pts.)	Endoscopic 3rd ventriculostomy (6 pts.)	Direct tumor surgery with EVD (4pts.)	Direct tumor surgery without EVD (8 pts.)
40%	20%	13.3%	26.67%

Clinical outcome in different management modalities:

Ventriculo-peritoneal shunting (12 patients)

✓ **One mortality** case (8.3%) due postoperative CSF infection.

✓ Improvement regarding symptoms of increased ICP occurred in mean time of 1.8 days.

Endoscopic 3rd ventriculostomy (6 patients)

✓ **One mortality** case (16.7%), died from hypoxic arrest due to aspiration

✓ Improvement regarding increased intra-cranial pressure manifestations occurred in a mean period of 3.7 days

Direct tumor surgery with EVD (4 patients)

✓ **2 mortality cases (50**%) died from post-operative CNS infection.

✓ Improvement regarding increase ICP manifestations occurred in mean period 2 days.

Direct tumor surgery without EVD (8 patients)

✓ **2 mortality** cases (25%) died from postoperative hydrocephalus

✓ **One mortalitiy case (12.5%) died from posterior fossa hematoma post operative to tumor debulking**

Table (7): Patients mortality and causes:

	V-P shunt (12 pts)	Endoscopic 3rd ventriculostomy (6 patients)	Direct tumor surgery + EVD (4 patients)	Direct tumor excision (8 patients)	All cases (30 patients)
Hydrocephalus	0	0	0	2 (25%)	2(6.7%)
Infection	1 (8.3%)	0	2 (50%)	0	3(10%)
Others • Hypoxic arrest • Posterior fossa hematoma	0 0	1 (16.67%) 0	0 0	1 (12.5%)	2(6.7%)
All mortality	1 (8.3%)	1 (16.67%)	2 (50%)	3 (37.5%)	7 (23.3%)

Radiological evaluation:

☒ **Ventriculo-peritoneal shunting**

✓ Evan's ratio (Pre-operative): ranging from (0.32-0.49) with a mean of 0.377 ±0.053 (mean ± standard deviation).

- ✓ Evan's ratio (Post-operative): <0.26 in all cases, and all had no hydrocephalic changes (100%)
- ✓ Highly significant decrease in post-operative Evan’s ratio if compared to pre-operative values**. *(P=<0.001).***

Table (8): analysis of the pre-and post-operative Evans ratio for the cases that underwent VP shunt

VP shunt				
EVANS Pre	Range	0.32	-	0.49
	Mean ± SD	0.377	±	0.053
EVANS Post	Range	0.25	-	0.32
	Mean ± SD	0.278	±	0.021
Differences	Mean ± SD	0.098	±	0.046
Paired Test	P-value	<0.001		

Endoscopic Third Ventriculostomy (ETV):

- ✓ Evan's ratio (Pre-operative): ranging from (0.29-0.4) with a mean of 0.343±0.037 **(**mean ± standard deviation).
- ✓ Evan's ratio (Postoperative): ranged from (0.28-0.31) with a mean of 0.292 ±0.013 **(**mean ± standard deviation).
- ✓ Significant decrease in post-operative Evan’s ratio if compared to pre-operative values ***(P=0.005).***

Table (9): Analysis of the pre- and post-operative Evan’s ratio cases that underwent ETV

		T-Test		
		ETV		
EVANS Pre	Range	0.29	-	0.4
	Mean ±SD	0.343	±	0.037
EVANS Post	Range	0.28	-	0.31
	Mean ±SD	0.292	±	0.013
Differences	Mean ±SD	0.052	±	0.026
Paired Test	P-value	0.005		

Direct surgical attack with pre-operative External Ventricular Drainage:

- ✓ Evan's ratio (Pre-operative): ranging from (0.32-0.35) with a mean of 0.333 ±0.015 (mean ± standard deviation).
- ✓ Evan's ratio (Post-operative): ranging from (0.25-0.3) with a mean of 0.275 ± 0.024 (mean ±s tandard deviation).
- ✓ Significant decrease in post-operative Evan’s ratio if compared to pre-operative values ***(P=0.040).***

Direct tumor surgery without EVD:

- ✓ Preoperative Evan's ratio: ranging from (0.31-0.46) with mean 0.393 ±0.068 (mean ±standard deviation).
- ✓ Postoperative Evan's ratio: ranging from (0.27-0.33) with mean 0.303 ± 0.018 (mean ± standard deviation).
- ✓ Significant decrease in post-operative Evan’s ratio if compared to pre-operative values ***(P=0.007).***

Table (10): Analysis of the pre- and post-operative Evan's ratio cases that underwent direct surgical attack

		T-test		
		Direct tumor attack WITHOUT EVD		
EVANS Pre	Range	0.31	-	0.46
	Mean ±SD	0.393	±	0.068
EVANS Post	Range	0.27	-	0.33
	Mean ±SD	0.303	±	0.018
Differences	Mean ±SD	0.090	±	0.067
Paired Test	P-value	0.007*		

Table (11): Evaluation according to Evan's ratio of different modalities of management:

	VP shunting	Endoscopic 3rd ventriculostomy	Direct tumor resection with EVD	Direct tumor resection without EVD
Preop ➢ Range ➢ mean ±SD	 0.32-0.49 0.377 ±0.053	 0.29-0.4 0.343 ±0.037	 0.32-0.35 0.333±0.015	 0.31-0.46 0.393 ±0.068
Postop ➢ Range ➢ mean ±SD	 0.25-0.32 0.278±0.021	 0.28-0.31 0.292 ±0.013	 0.25-0.3 0.275±0.024	 0.27-0.33 0.303 ±0.018
P value	<0.001	0.005	0.04	0.007
significance	HS	S	S	S

*HS: highly significant, S: significant

This table shows a highly significant correlation between V-P shunt before tumor excision compared to other three methods.

Evaluation of complications:

During a period ranged from 3-18 months, with average 7.8 months of followup:

Failure:

- 3 patients managed with pre-operative VP shunting showed malfunctioning (failure), 2 of them were underwent shunt revision and one of them was treated by shunt removal and ETV
- 2 patients had a failed 3rd ventriculostomy, one was treated by V-P shunting, and the other case was managed by reopening of the ventriculostomy.
- 1 patients of tumor resection treated patient with no EVD died from intracerebellar hematoma.
- 2 patients who were treated pre-operatively with EVD, died from CNS infection.

Infection :

No cases of infection were reported in Endoscopic 3rd ventriculostomy and direct tumor surgery without EVD, while in V-P shunted cases and in cases of EVD placement we reported 3 cases (6.67% patients).

2 mortality cases were reported due to severe ventriculitis (organisms E coli and klebsiella).

Ethical committee:

The ethics committee at the faculty of medicine, Ain shams university has reviewed the study protocol from the ethical point of view and approves it. The approval is valid for one year till 23/10/2023.

DISCUSSION:

The association of secondary hydrocephalus with posterior fossa tumors, each a potentially lethal condition, necessitates urgent surgical treatment [5].

30 cases presented with obstructive hydrocephalus secondary to posterior fossa tumors were retrospectively studied in our work.

We excluded cases of posterior fossa tumors who did not develop hydrocephalus as well as cases with acute deterioration in level of consciousness on presentation were not included in our study.

28 patients (93.3%) presented with symptoms and sings of increased ICP (headache, nausea/vomiting, and diplopia) which correlates with clinical findings reported by Pamir et al.**(6)**

Papilledema was evident in all of our patients (100%). Sutton & Schut **(7)** reported presence of papilledema secondary to increased ICP in almost all cases with posterior fossa tumors at the time of diagnosis, however, and according to Chazal **(8),** we cannot rule out the diagnosis of early intracranial hypertension with the absence of papilledema.

In our study, hydrocephalus was managed as follows: 12 patients were managed with pre-operative V-P shunting before tumor resection, 6 patients underwent pre-operative endoscopic 3rd ventriculus-tomy, 4 patients were managed with external ventricular drain, and in 8 patients direct tumor attack was the mean to re-open the CSF circulation.

In our study, all procedures (V-P shunt, ETV, EVD and direct surgical excision) were successful in managing hydrocephalus clinically and radiologically. Improvement of symptoms of increased ICP was in 100% of VP Shunt, ETV and EVD while only 80% of cases who underwent direct tumor surgery case with no CSF diversion showed improvement (with 2 mortality cases: 1 patients deteriorating rapidly postoperative from acute hydrocephalus and the other from intracerbellar hematoma inside the tumor bed). Our results are comparable to El-Ghandour **(9)** who reported improvement of intracranial hypertension symptoms in 100% of the V-P shunted patients and in 96.9% of ETV patients.

The mean period for clinical improve-ment of symptoms oh increased ICP ranged from 1.8 days with VP Shunting to (3.7 days) in ETV.

Our results detected high statistically significant decrease in the post-operative Evan's Ratio in relation to the pre-operative value in cases that underwent VP Shunting, while significant decrease was detected in cases managed by other modalities.

El-Ghandour(9) reported post-operative radiological improvement of hydrocephalus (decrease in ventricular size) in 100% of VP shunted patients and in 87.5% of ETV patients.

Cases managed with Ventriculo-peritoneal shunting:

All cases showed clinical improvement after a mean period of 1.8 days.

3 patients (25%) of V-P shunt treated patients showed shunt infection, one of these patients was treated by shunt extraction and follow up of hydrocephalic changes while on antibiotic followed by another shunt session insertion, another was treated conser-vatively, and the third one underwent shunt extraction and ETV procedure. Our incidence is higher than the rated recorded by Rustamzadeh and Lam**(10)** (5-10%).

Staph. epidermidis was the causative organism in 2 of our 3 cases which correlates with Greenberg **(11)** who reported that 60-75% of the organisms in shunt infection were staph. Epidermidis, the source is probably the patient's contaminated skin.

Our high incidence of infection with commensal staph. epidermidis should direct our attention to re-standardize our personal hygiene, wound sterilization and to shorten the length of the procedure.

Among 12 patients managed with VP shunting, we encountered 2 mortalities: one case developed shunt infection and subsequent ventriculitis (8.3%) and the other one suffered intracerebellar hematoma inside the tumor bed (8.3%).

Inspite 75% of our patients showed clinical and radiological improvement with pre-operative V-P shunting without morbidity or mortality, the relatively high percentage of serious morbidity (infection) and mortality (25%), should direct our attention to rely on alternative more safe and less risky procedures when managing hydrocephalus secondary to posterior fossa tumors.

Cases managed with Endoscopic 3rd ventriculostomy:

In our study, clinical improvement was evident in all of our patients managed with endoscopic 3rdventriculostomy (100%) after a mean duration of 3.7 days. Our results are comparable to what is mentioned in literature: In his series of 67 cases, Sainte-Rose *et al.* [5] mentioned that 98.5% of his cases showed immediate clinical resolution of hydrocephaus, concluding that: “ETV had a curative effect”, also from 32 cases reported by ***El***-Ghandour [9], improvement of ICP symptoms was evident in 96.9% of ETV group.

In contradiction to this, Hopf et al. [12] have reported that successful management of hydrocephalus was evident in only 76% of his 17 patients with posterior fossa tumors in whom ETV was the procedure of CSF diversion, Bhatia et al.[13] reported a success rate of 87.1% and Ruggiero et al.[4] reported 80% successful ETVs in his 20 patient series.

With a P Value of 0.005, a statistically significant decrease in the post-operative Evan's Ratio in relation to pre-operative values.

However, despite the significant post-operative decrease in Evan's Ratio and the evident clinical improvement in all patients, about 50% of them still manifested hydrocephalic changes radiographically. Our results are correlating to what was reported by Kombogiorgas et al.[15] **,** Buxton et al.[14], and El-Ghandour[9] who concluded that clinical outcome is the most important guide to success or failure of the ETV procedure and not the size of the ventricular system.

3 of our ETV managed cases (37.5%) showed total resolution of hydrocephalus, with no recurrence after excision of the posterior fossa tumour during the period of follow-up. While 5 cases (62.5%) had a failed procedure as they presented within 6 weeks with recurrence of hydrocephalus, and they were all proceeded to V-P shunting. Hellwig et al.[16] and Feng et al. [17] reported 75% failure rate in ETVs within 6 months post-operative. However, variable rates of ETV failures for obstructive hydrocephalus is mentioned in literature ranging from 8% to 69% [18].

Takehira et al. [19] attributed high failure rates to the small size of the ventriculo-stoma, non-fenstered Liliequist’s membrane, or from hematomas and infections that could increase the CSF concentration of protein and fibrinogen, reduce the rate of CSF reabsorption, and lead to glial scarring of the fenestrated floor.

In contradiction to this, and despite acknowledging it as an “un-necessari” procedure, Ruggiero et al.[4] reported successful long term control of hydrocephalus in (80%) of his patients, and Sainte Rose et al. [5] reported 94% success rate.

In our study, we encountered 1 mortality case (12.5%) due to direct hypothalamic injury leading to post-operative malignant hypernatremia, no mortality cases were reported by Sainte Rose et al.[5], Bhatia et al.[13] and El-Ghandour et al. in their seres. Our results should encourage us to raise our efforts for further training in ETV practice and precise identification of the point of ventriclostoma in the floor of 3rd ventricle.

Despite, single mortality there were no cases of hydrocephalus related death in this study. If we compare these results with patients with hydrocephalus who underwent direct tumor surgery**,** we will find that ETV acts as a buffer against sudden increase in ICP after tumor resection.

Ruggiero et al.**[(4)]** and Sainte Rose et al.**[(5)]** concluded that ETV had a prophylactic role by preventing the development of acute hydrocephalus after tumor resection due to cerebellar swelling; pre-operative hydro-dynamic normalization of CSF seems to lower the risk of post-operative permanent impairment of CSF circulation.

In patients treated with ETV; total excision of the tumor was performed in 7 cases (87.5%) while 1 patient (12.5%) had subtotal excision due to surgical inaccessibility, this patient had recurrence of hydrocephalus after posterior fossa surgery.

In our series we had 3 complicated cases (37.5%): one case (12.5%) had malignant intractable hypernatremia and died, one case (12.5%) had subdural collection and the third one (12.5%) had CSF leak from wound.

Among a series of 67 patients**[(5)]**, only one patient developed “brain herniation”, but after immediate tumour removal he made a complete recovery. Complications included: Wound CSF leak (3%), pseudo-meningocele (2%), sub-dural collection (2%), and epidural hematoma (1%). Another study including 37 patients **[(13)]**, two cases (5.4%) had CSF infection and meningitis (both treated with antibiotics), and bleeding was encountered in one case (2.7%). Our much fewer number of cases could explain our higher complication rates.

However, and as mentioned by **El** Ghandour**[(9)]**, ETV has a low incidence of complications, being simple and minimally invasive procedure of relief of ICP with a relatively low-risk.

Cases managed with direct tumour surgical attack:

In our study 8 patients were managed by direct tumor surgeical attack, 6 patients (75%) clinically and radiologicaly improved, while 1 patient (12.5%) deteriorated due to development of posterior fossa hematoma after surgery.

5 of our patients (83.3%) showed recurrence of hydrocephalus within 2 weeks and proceeded to V-P shunting. This correlates Santos et al.**[(20)]** who concluded that with (66%) of patients did not require a CSF diversion and most of the shunts (55%) were placed within 30 days after the original surgery

However failure incidence had been reported to be low by others: Fritsch et al. **[(22)]** (27%), Sainte-Rose et al.**[(5)]** (20%) and Abou Madawi**[(22)]** (16.4%).

From data mentioned above, according to literature and to our results, we can conclude that excision of posterior fossa tumors without pre-operative management of secondary obstructive hydrocephalus might risk lives of a considerable percentage of patients. Berger et al.**[(23)]** reported that despite about two thirds of patients treated by direct surgery were cured, but the morbidity and mortality rates for the remaining patients deserves to attract our attention to the lethal complications of untreated hydrocephalus.

In comparison, cases who were treated preoperatively with external ventricular drain, the drain was removed gradually over the course of 10 days, with serial CT scans done to evaluate the ventricular state. In 2 cases (50%), the drain was removed successfully with no need of any CSF diversion in regular follow up. One case (25%), started to develop CSF leak from the wound, despite the ventricular size did not change, and as a result the patient died from ventriculitis 2 months after the procedure. The other case died from DIC and chest infection.

Age/onset of symptoms:

Patient's age at time of tumor surgery was found to be non-significant predictor of postoperative CSF diversion, as also reported in several other series Dias Albright [24], Morelli et al.[25], Schmid et al.[3]. However, Bognar et al.[26], Due-Tonnessen and Helseth[27], Abou-Madawi[22], and Papo et al.[28] contradicted our results by reporting age as a significant predictor of post-operative CSF diversion.

No significant difference was detected in the duration of pre-operative symptoms between patients who needed post-operative shunting and those who did not.

Preoperative hydrocephalus/Evan's Ratio:

Despite all of our cases presented with hydrocephalus, pre-operative hydrocephalic changes (Evan's Ratio) was not a significant factor (P value= 0.93) for predicting the need for shunting, this was also reported in Bognar et al.[26], Abou-Madawi[22], and Santos et al.[20].

In contradiction to this, Kombogiorgas[15] and Morelli et al.[25] reported a statistically significant predictive value for the degree of preoperative hydrocephalus to have a for postoperative shunt requirement in cases with posterior fossa lesions. This could be explained that pathology of all cases was medulloblastoma and small number of patients which is accentuated by the variability in preoperative ventricular volume.

Tumor site:

Higher incidence of postoperative shunt dependence was asscociated with tumors involving midline cerebellar structures if compared with those that only affected the cerebellar hemispheres.

This difference was statistically significant with a P value= 0.04 which is consistent with what was mentioned by Abou-Madawi[22] and Papo et al.[28]. However, Bognar et al. [26], Dias and Albright [29], and Schmid et al. [3] found no difference in the post-operative shunt dependance based on tumor site.

Our explanation is that midline tumours directly invade and fill the 4th ventricle making subtotal tumour excision not satisfactory for restoring CSF circulation with subsequent shunt dependence, while lateral tumours especially CPA tumours exert only external compression on the 4th ventricle which could be re-opened with tumour debulking thus restoring CSF circulation.

Extent of resection:

Our study concluded that with a P value of 0.014, the extent of tumor resection is a significant predictor of the need for post-operative CSF diversion, which was also reported by Due-Tonnessen and Helseth[27]. Also, Dias and Albright[29], and Kumar et al.[30] who used postoperative CT or MR imaging to evaluate the extent of tumor resection noted a significant increase in postoperative shunt placement in patients with less than complete tumor resection.

However, Santos et al.[20], Bognar et al.[26] contradicted our results by denying the significance of the extent of tumour resection as a predictor for the need to post-operative CSF diversion. Stein et al. [31] explained this by chronic post-operative arachnoiditis that could lead to adhesions and thus higher rates of shunt dependance in cases of posterior fossa tumours.

In our study we reported 3 complicated cases the direct tumour excision group: (wound CSF leak, pseudo-meningocele, and subdural collection), it is worth mentioning that all these complications developed in patients who showed recurrence of hydrocephalus, and all proceeded to V-P shunting. So direct tumor surgery without handling ICP had placed patients at risk of intracranial hypertension and its related complications, as reported by Ruggiero et al.[4] and Sainte-Rose et al.[5] that in adopting this expectant policy, those patients who ultimately require a shunt are placed at risk of intracranial hypertension, increased rate of CSF leak and pseudo-meningocele formation.

4 of our patients were treated with pre-operative EVD followed by direct tumor excision. All had clinical and radiological improvement post-operatively. Acting as a safely valve, the use of EVD for a few post-operative days guarded against the development of post-operative acute hydrocephalus with its subsequent morbidity and/or mortality. As well as helping in ICP monitoring to determine the possibility of persistence or resolution of hydrocephalus.

According to Bognar et al.[26], prolonged high daily CSF out-put and thus prolonged need for EVD with or without enlarged ventricles is a statistically significant factor for post-operative shunt dependence and the need to proceed to VP shunting.

We encountered no complications related to the EVD, this could be attributed to short duration of external drainage (maximum 3 days), healthy younger age of study population, as well as post-operative improvement in general clinical condition in all patients with continuous ICP control

As mentioned by Hoefnagel et al.[33], Camacho et al. [34], Hickman et al.[35] and Korinek et al. [36], factors increasing the risk of infection in EVD include: Most importantly the duration of external drainage, maintenance of a closed system, as well as patient's age and general condition, and the nursing environment in which the monitor is inserted.

Ruggiero et al.[4] reported that patients, placed at risk of suffering intracranial hypertension within the first month of surgery, have an increased rate of CSF leakage and pseudomeningocele formation, a prolonged hospitalization, and a high risk of pseudobulbar palsy.

Conclusion:

The fact that less than one-third of patients become shunt dependant after posterior fossa tumor resection refutes the role of prophylactic shunting or ETV. However, higher post-operative morbidity and mortality in cases with direct tumour attack raises the protective role of preoperative CSF diversion especially in midline posterior fossa tumours.

Incomplete gross total resection of the tumor usually does not result in treatment for hydrocephalus (Or recovery of hydrocephalus after surgery). Therefore, it is recommended to perform the surgery of the posterior fossa with the attempt to eradicate the tumor as full as possible in order to avoid shunt dependence. If total excision was not achieved, CSF diversion should be considered.

ETV for the treatment of hydrocephalus brain are considered low - risk and good results in many cases (after follow - up of at least six weeks after the

The external ventricular catheter could be helpful in managing preoperative hydrocephalus and in monitoring post-operative ICP to decide whether CSF circulated was restored or if the patient became shunt dependent. However, the risk of CSF infection remains an issue.

Finally, previous results may need to be strengthened in the future study of more cases.

Conflict of interest:

The authors declare that they have no conflict of interest.

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علاج الاستسقاء الثانوي للمخ سواء بتركيب صمام مسبق أو باستئصال مباشر لأورام بالحجرة الخلفية للمخ

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خلفية: أورام الحجرة الخلفية للمخ عادة ما تؤدي لحدوث استسقاء ثانوي بالمخ بسبب الضغط على البطين الرابع.

الهدف من العمل: دراسة و تحليل طرق علاج الاستسقاء الثانوي للمخ سواء بتركيب صمام مسبق أو باستئصال مباشر للورم بالحجرة الخلفية.

الطرق و الحالات: دراسة مرجعية على ٣٠ مريضا يعانون من أورام بالحجرة الخلفية للمخ و استسقاء ثانوي بالمخ تم علاجهم جميعا في مستشفيات جامعة عين شمس.

النتائج: حوالي ثلث حالات أورام الحجرة الخلفية للمخ سيحتاجون لتركيب صمام و هناك مخاطرة على حياتهم في حال استئصال الورم فقط دون علاج الاستسقاء. الأورام التي تحتل منطقة الوسط تحتاج للصمام أكثر من الاوام الجانبية او التي تخرج من الزاوية المخيخية الجسرية.

الاستنتاج: ثلث الحالات فقط هم من يحتاجون تركيب صمام بصفة دائمة وهو ما يعارض الاحتياج لعلاج مسبق للاستسقاء سواء بتركيب صمام او بالمنظار. ولكن العلاج المسبق للاستسقاء يحمي من المخاطر الناتجة عنه و التي قد تؤدي الى حدوث عجز مزمن او الوفاة خصوصا في حالات الأوام التي تحتل وسط الحجرة الخلفية.

التوصيات: نحتاج المزيد من الأبحاث المستقبلية لدعم النتائج الحالية.