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Combined Endoscopic Third Ventriculostomy and Choroid Plexus Cauterization as Primary Treatment of Hydrocephalus for Infants in Egypt

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Abstract

Background: Children depending on shunt in developing countries is a very serious problem. The usage endoscopic third ventriculostomy (ETV) with bilateral choroid plexus cauterization (BCPC) had shown promising resultsin hydrocephalus treatment than ETV alone in infants below 2 years of age.

Aim of Study: A retrospective study to evaluate the success of ETV-CPC as primary management of hydrocephalus in infants in Egypt.

Patients and Method: Twenty three consecutive infants with hydrocephalus requiring treatment for hydrocephalus with ETV-BCPC. Patient data was collected retrospectively. Our results were assessed using life table analysis.

Results: Twenty three patients had a completed ETV-BCPC with mean follow-up 13.4 months. The ETV-BCPC procedure was successful in 13 patients (56.5%) from 1st operation, two cases operated within six months reopen stoma (8.7%) and eight cases (34.8%) fail procedure end by shunt.

The operative mortality rate was 0%, and there were two cases infections, two cases control convulsions and one case CSF leak end by shunt.

Conclusions: Combined ETV/BCPC was better in treating hydrocephalus in infancy avoiding shunt dependence in the majority.

Key Words: *Third ventriculostomy – Choroid plexus Cauterization – Hydrocephalus.*

Introduction

HYDROCEPHALIC patients are not easy to management in Egypt, due to socioeconomic difficulties patients and his families suffer to get proper care. Treating hydrocephalus in Egypt with Ventriculo - Peritonial shunt (VPS) is the most common used. The risk of infection and obstruction in shunt dependent patient, make it a dangerous operation on the long run in comparison with developed countries. These concerning light on prospective study, with 43.6% incidence of shunt failure (which included an 8.1% infection rate) during the first 2 years of placement **[1]**. So, avoidance ofshunt dependence in our country isour target.

Failure of endoscopic third ventriculostomy (ETV) in infants with communicating hydrocephalus and non-communicating hydrocephalus, due to decrease in cerebrospinal fluid (CSF) absorption. It was important to addition of choroid plexus cauterization (CPC) to the ETV at the time of the ETV, to simultaneously decrease CSF production, which may improve the outcome.

Causes of hydrocephalus in infancy are: (1) Anatomic etiology like Aqueduct Stenosis (AS) and posterior fossa lesions that prevent CSF flow in basal cistern. (2) Non anatomic etiology or communicating hydrocephalus likecongenital idiopathic hydrocephalus (CIH), post infection hydrocephalus (PIH) and post myelomeningocele (MM).

Abbreviations:

AS = Aqueductal stenosis.
ETVSS = ETV success score.
CPC = Choroid plexus cauterization.
MMC = Myelomeningocele.
ETV = Endoscopic third ventriculostomy.
VPS = Ventriculoperitoneal shunt.
LT = Lamina terminalis.
CIH = Congenital idiopathic hydrocephalus.
PIH = Post infection hydrocephalus.
HCP = Hydrocephalus.
HC = Head circumference.
cms = Centimeters.

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Pathophysiology of communicating hydrocephalus:

There are different types of communicating hydrocephalus in infancy including:

1- Hydrocephalus after subarachnoid hemorrhage or meningitis leading to dysfunctional subarachnoid space.

2- Congenital idiopathic hydrocephalus [3].

The etiology of communicating hydrocephalus is controversyin deferentliteratures. Demonstration of pathophysiology can be discussed under four headings.

1- Loss of balance between production and absorption of CSF caused by obstruction or dysfunction at the level of the arachnoid granulations [2,4].

2- Reduce capillary absorption of CSF has been suggested the etiology of communicating hydrocephalus since Walter Dandy [2,5].

3- Elevation dural venous sinus pressure due to venous outflow obstruction or elevated arterial inflow ("hyperemic hydrocephalus") developed increased collateral venous outflow has been enrolled as the primary cause of CIH [3,6].

4- Increased CSF pulsatility had been experimentally discussed as a cause of progressive ventriculomegaly in communicating hydrocephalus, by usinga hydrodynamic model to increased intraventricular CSF pulsatility [7,8].

Patients and Methods

This retrospective study was carried on 23 successive patients who sought medical advice from 2018 to 2020 in Sporting Students' Hospital in Alexandria. Cases clinically and operative data was collected retrospectively, including standardized operative data such as the intraventricular anatomy, aqueduct, and cisterns. Patients underwent MRI or CT brain, and head circumference was measured preoperatively.

Postoperative date, complications, clinical examination had been recorded.

Inclusion criteria involved children less than two yearsago at time of intervention who have hydrocephalus due to idiopathic, post infection and post closure myelomeningocele underwent a completed ETV with CPC.

Exclusion criteria included the following: Dandy Walker variant; tumor, schizencephaly, hydranencephaly obstructed foramen of Monro.

Operative technique used in this study GAAB and LOTTA rigid endoscopic systems where used (Karl Storz, GmbH, Tutlingen, Germany).

Method of endoscopic third ventriculostomy:

After general anesthesia, the patients were kept in supine position. A curved skin incision U shape was made in the right lateral corner of the anterior fontanel keeping the center of skin flap at midpupillary line. The dura wasopened sharply with No.15 blade. We used a brain cannula to make an initial track through the brain cortex, and followed by the trocar of a 14 Fr introducer sheath; CSF come out of the sheath as we remove the trocar, so we safely apply the endoscope into the sheath and lock it. Now we should be in the frontalhorn of the right lateral ventricle then into the third ventricle. After inspecting the anatomy of the 3rd ventricular floor, the site for the ETV was identified.

The basilar apex was not visible through the thick floor of 3rd ventricle, but its pulsation was visible. At pre mammillary recess site of stoma done by grasping forceps and widening of stoma by ballooning of Fogarty catheter No. 4. Avoiding use of electrocautery in piercing the membrane to prevent basilar artery injury. Then, the catheter now can be passed completely into the prepontine cistern where the basilar artery and the cranial nerves were inspected. Liliequist membrane and adhesion were released, if presented.

If the pre pontine space is wide we inspect any obstruction bythe scope itself. Then, we observe the flow of CSF across the Liliequist membrane fenestration and the ETV ostium and endoscope withdrawn back slowly with inspection of any source of bleeding need to be controled.

Some variations such asthickened floor of third ventricle, aqueductal stenosis, interthalamic adhesion and absent septum pellucidum, must be detected in the MRI preoperatively.

Choroid plexus cauterization procedure:

After ETV we cauterized the CP beginning at the right foramen of Monroby monopolar, and move backward to the glomus choroideum in the atrium. If the ventricle are wide and the temporal part of the CP is accessible, we cauterize it. Otherwise, we stop cauterization at the maximum point we can reach posteriorly. To avoid any hazardous maneuver could injure the brain tissue.

To access the contralateral ventricle,we did a septostomy, just superior to the posterior margin of the foramen of Monro in avascular area. It's cauterized in a ring shape, both leaves of the septum. The septostomy opening was widened by gentle traction to its margins and the endoscope was being in the left lateral ventricle where the CP is viewed. On the left side, we cauterize only the CP from the left foramen of Monro to the mobile glomus choroideum in the atrium.

Ringer lactate solution was used as continuous irrigation during the surgery. Before withdrawal of the endoscope, we inspected the stoma of ETV, and the endoscope was withdrawn slowly through the brain tissue and cauterize any minor bleeder. The galea and skin were closed in layers tightly.

Results

Twenty three infants operated in sporting student hospital in Alexandria between 2018-2020 (Table 1).

Ages ranged from 2-15 months (mean 8.65 months). 12 infants are males and 11 infants are females. 19 patients were younger than 12 months and just four were above 12 months at the time of surgery.

According to cause of hydrocephalus 12 infants HCP due to CIH (52.2%), 6 infants were due to PIH (26.1%), and five were due to post MM closure (21.7%) (Fig. 1).

As regard procedure 19 cases with ETV and CPC 82.6%. Three cases with ETV, CPC and LT Fenestration 13%. One case needed LT Fenestration, CPC 4.3% because anomalies in floor of 3rd ventricle.

The patients were followed-up from 6-18 months with a mean 13.4 months. The Follow-up was difficult due to the in cooperation of the relatives.

18 cases passed without complications (78.2%). Two cases post operation with controlled convulsions (8.6%). Two cases suffered from infections (8.6%) and one case with CSF leak from wound (4.3%), and this patient needed VPS application.

13 cases improve with the first operation and did not need any further interventions (56.5%) (Figs. 3,4). While, two cases need revision surgery to reopen the closed stoma of the third ventricle floor within 6 months of first operation (8.7%). While, unfortunately eight patients ended by VPS (34.8%) (Fig. 2).

The head circumference (HC) was measured pre and post-operative. It ranged pre operatively between 44.5-50 centimeters (cms) with mean 48.28±1.5 cms. While post-operative, the mean was 47.59±1.3 cms (Table 2). The value of t is -3.467181. The value of *p* is 0.001095. The result is statistically significant ($p \leq 0.05$).

Two cases have been illustrated bleow showing the results of CBC+ETV Figs. (3,4).

Table (1): Demographic demonstration of all the patients in our study.

Case	Age	Sex	Etiology	Anomalies	Procedure	Complications	Post op
1	7	M	CIH	NA	ETV + BCPC	NO	Relive vent. Megaly & sign
2	4	F	PIH	SSP	ETV + BCPC	IHC	VPS
3	11	M	PIH	TTV + SSP	ETV + BCPC + LT F	BLEEDING	Relive vent. Megaly & sign
4	12	F	CIH	SSP	ETV + BCPC	NO	Relive vent. Megaly & sign
5	6	M	PMM	Scar CP	ETV + BCPC	NO	VPS
6	15	M	PMM	CM	ETV + BCPC	No	Relive vent. Megaly & sign
7	8	M	CIH	SSP	ETV + BCPC	convulsion	VPS
8	5	F	CIH	SSP	ETV + BCPC	NO	Reop the stoma
9	7	M	PIH	TTV	ETV + BCPC + LT F	IHC	VPS
10	9	M	CIH	NA	ETV + BCPC	NO	Relive vent. Megaly & sign
11	15	F	CIH	NA	ETV + BCPC	NO	Relive vent. Megaly & sign
12	9	F	PIH	Scar CP	ETV + BCPC	NO	Reopen the stoma
13	5	M	PMM	CM	ETV + BCPC	CSF leak	VPS
14	14	F	PIH	TTV	ETV + BCPC + LT F	NO	Relive vent. Megaly & sign
15	11	F	CIH	NA	ETV + BCPC	NO	Relive vent. Megaly & sign
16	8	M	CIH	SSP	ETV + BCPC	Infection	VPS
17	9	F	CIH	NA	ETV + BCPC	NO	Relive vent. Megaly & sign
18	12	F	PMM	NA	ETV + BCPC	NO	Relive vent. Megaly & sign
19	10	M	CIH	SSP	ETV + BCPC	NO	Relive vent. Megaly & sign
20	11	M	PIH	TTV + MB Distortion	ETV + BCPC + LT F	NO	Relive vent. Megaly & sign
21	3	M	CIH	NA	ETV + BCPC	Fever, convulsion	VPS
22	2	F	CIH	NA	ETV + BCPC	NO	VPS
23	6	F	PMM	CM	ETV + BCPC	NO	Relive vent. Megaly & sign

Table (2): Clinical assessment, by measuring and comparing the head circumference pre and post-operative. And assessing the difference in fontanel laxity.

Case	HC Pre	HC Post	Fontanel
1	48	46.5	Lax
2	46	46.5	Tens
3	50	48.5	Lax
4	49	48	Lax
5	49	49	Tens
6	50	48	Lax
7	49	49	Tens
8	46	45	Lax
9	48	48.5	Tens
10	48.5	47.5	Lax
11	50	48.5	Lax
12	48	47	Lax
13	49	49	Tens
14	50	48.5	Lax
15	48.5	47	Lax
16	49	50	Tens
17	48	47	Lax
18	48.5	47.5	Lax
19	49	47.5	Lax
20	50	48.5	Lax
21	46	47	Tens
22	44.5	45.5	Tens
23	46.5	45	Lax
Mean	48.28261	47.58696	
SD	1.528711	1.311247	

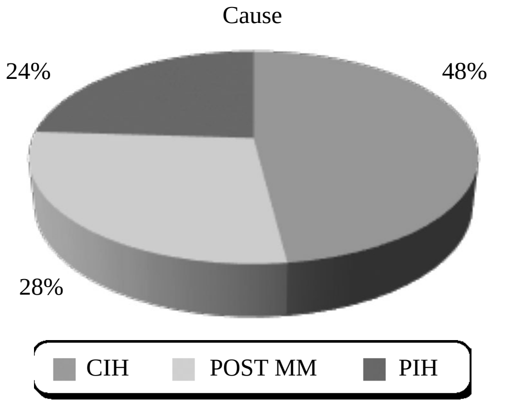


Fig. (1): Pei chart Distribution of different etiologies.

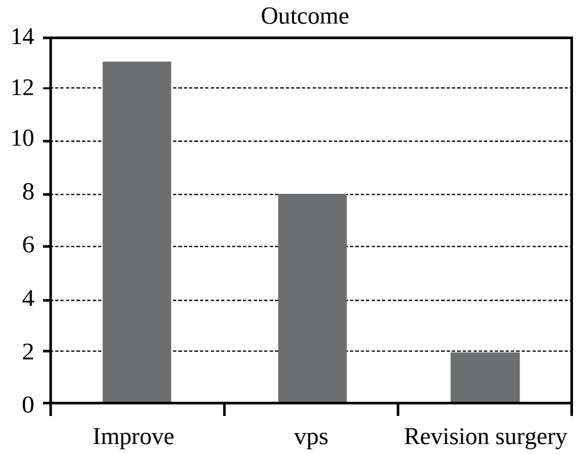
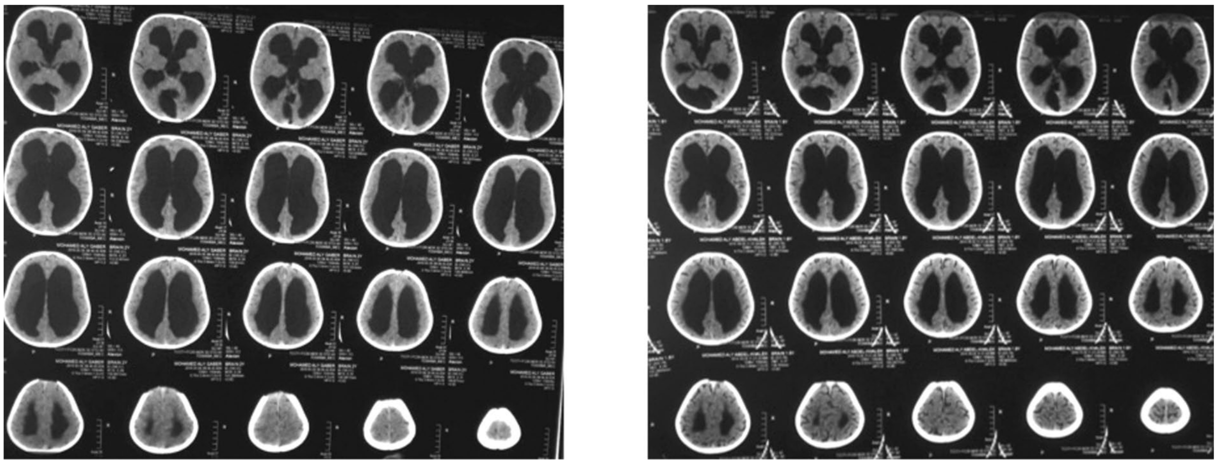


Fig. (2): Chart showing the surgical outcome.



(A) (B)

Fig. (3): Male case 15 months age. Head circumference 50 cms (N: 47-49 cms) Manifested with increase intracranial pressure due to PMM. Operated by ETV and bilateral CPC. Five months after surgery and no complication recorded. (A): Pre-operative, (B): Five months post-operative.

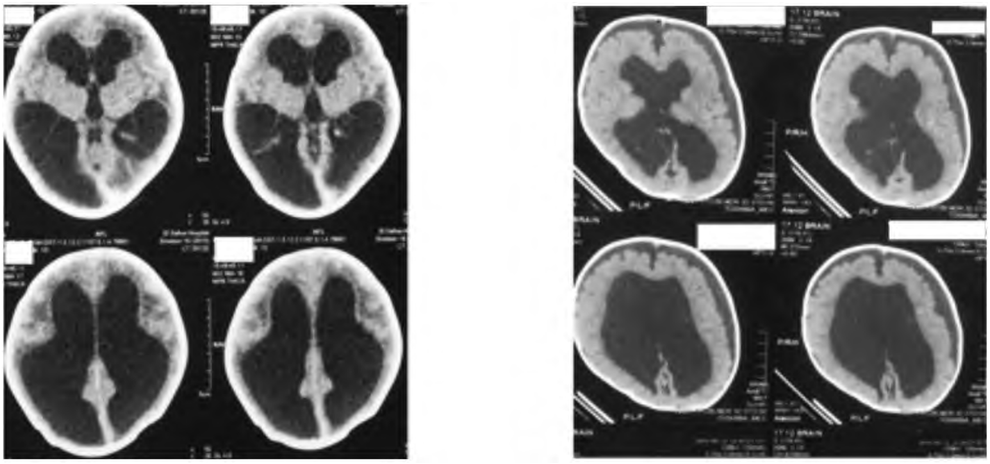


Fig. (4): Female case six months age. Head circumference 46cms (N: 40-44cms) Manifested with increase intracranial pressure after MMC Operated by ETV and bilateral CPC. Six months after surgery and no complication recorded. Left: Pre-operative, Right: 6 months post-operative.

Discussion

In this study we explain role of ETV/CPC as primary management of hydrocephalus in infancy. And evaluate the safety and efficacy of this procedure in sporting student hospital in Alexandria in comparison with others study and others procedure.

The effect of ETV with CPC may be in decrease pulsations force of intraventricular and CSF productions to decrease ventricular dilatation. The complication of ETV with CPC is less than that of ETV alone or CSF shunting. So CPC does not increase complications rate compared with ETV when performed alone in infants, where the rate of meningitis is 0%–12.0%, CSF leakage in 0%–8.5%, hemorrhage in 0%–4.3%, and hygroma in 0% 4.7% *[9]*.

In our series we have 8.6% infection which controlled, 4.3% CSF leak, no hematoma.

However, the mortality rate is 0% inour series and, we reported the Kulkarni et al. (8.3%), *[10]* in Uganda (1.0%) by Warf et al., *[11]*.

The success of ETV/CPC act by decrease CSF production and decrease CP pulsations. The success rate in Bankole et al., 68% in 2015 with range age 6-12 months. Stone and Warf (57%), in our series we have 56.5% success rate from 1st operation with 8.6% in 2nd operation with range age from 2-15 months follow-up.

The author found that ETV with CPC has less failure rate when it compared with ETV alone, in our series we have 56.5% success rate. Benjamin C. Warfin CURE hospital in Uganda, had better results of ETV–CPC (66%) in comparison with ETV alone (47%) incases below 1 year old. He also found that the combined technique ispreferred in cases with a myelomeningocele (76% compared with 35% success in ETV alone) *[12]*.

However ETVSS cannot expect the success rate of ETV with CPC, as it has been used with ETV cases alone *[10]*.

The success of this procedure depends on age, causes and anomalies.

For example, the mean ETVSS was 44, 8% and actual 56% in our series, However, a more recent North American study by Stone and Warf of 91 cases underwent ETV with CPC found that the success rate after six months was 59% which is more than that expected by the ETVSS (45%) *[13]*. Moreover, some studies have shown that just performing CPC without ETV was a successful treatment with good results (38%) in hydrocephalic infants *[14]*.

ETV/CPC more safe and physiological than VP shunt avoiding dependence and shunt complications. Benjamin C. Warf et al., *[11]* reviewed VPS complications. He found that infection was about (9.7%), tube migration or valve disconnection (6.3%), wound complication (5.7%), valve dysfunction (3.4%), ventricular end obstruction (2.8%), and peritoneal tube obstruction (1.1%). On the other hand, there is no high morbidity with ETV failure; this procedure doesn't raise the risk of infection if VPS is needed in the futur.

The study of Warf in sub-Saharan Africa (developing counties with limited economic facilities) highly supports adding CPC to ETV, as itsresults was nearly two times better than that of ETV alone, especially in patients with MMC, AS; and three time better in cases of post infectious or communicating hydrocephalus *[11]*.

Conclusions:

ETV with CPC showed much better than ETV alone in management of hydrocephalus in infancy, and obviates any shunts complications.

Declarations:

• *Ethics approval:*

The protocol was accepted and approved by "THE ETHICS COMMITTEE, FACULTY OF MEDICINE, ALEXANDRIA UNIVERSITY" on 15/11/2018, with a serial number 0304157.

IRB NO: 00007555-FWA NO: 00018699

http://www.hhs.gov/ohrp/assurances/index.html

• *Consent to participate:*

All participants' parents provided informed written consent to participate in the study.

• *Consent for publication:*

A consent to publish were obtained from the parents of the children.

• *Availability of data and material:*

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

• *Competing interests:*

"The authors declare that they have no competing interests".

• *Funding:*

The authors declare that they have no external funding.

• *Authors' contributions:*

Samer Samy is the main surgeon who did the surgeries and cooperated in writing the manuscript. Ahmed Elzebak assisted in surgeries, collected the data and was a major contributor in writing the manuscript. All authors read and approved the final manuscript".

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عملية استبضاع البطين الثالث بالمنظار مع كى الضفيرة المشيمية كعلاج أساسى لمرض استسقاء الرأس عند الأطفال فى مصر

الخلفيــة: يعتبـر اعتمـاد الأطفـال علـى جهـاز تحويـل مسـار السـائل النخاعـى فـى البلـدان الناميـة مشـكلة خطيـرة للغايـة. وقـد أظهـر اسـتخدام بضـع البطـين الثالث بالمنظارمـع كـى الضفيرتـين المشـيميتين الثنائـى نتائـج واعـدة فـى عـلاج استسـقاء الـرأس مقارنـةً باسـتخدام بضـع البطـين الثالـث بالمنظـار وحـده فـى الرضـع دون سـن السـنتين.

هــدف الدراســة: دراسـة اسـتعادية لتقييـم نجـاح بضـع البطـين الثالـث بالمنظـار مـع كـى الضفيرتـين المشـيميتين كعـلاج أولـى لاستسـقاء الـرأس لـدى الرضـع فـى مصـر.

الطريقــة: تمـت دراسـة ٢٣ رضيعًـا يعانـون مـن استسـقاء الـرأس وتلقـوا علاجًـا باسـتخدام بضـع البطـين الثالـث بالمنظـار مـع كـى الضفيرتـين المشـيميتين. تم جمـع بيانـات المرضـى بشـكل اسـتعادى، وتم تقييـم النتائـج باسـتخدام تحليـل جـداول الحيـاة.

النتائـج: أكمـل ٢٣ مريضًـا عمليـة بضـع البطـين الثالـث بالمنظـار مـع كـى الضفيرتـين المشـيميتين بمتوسـط متابعـة ١٣,٤ شـهرًا. كانـت العمليـة ناجحـة فـى ١٣ مريضًـا (٥٦,٥٪) مـن العمليـة الأولـى، بينمـا تم إعـادة فتـح الفتحـة فـى حالتـين (٨,٧٪) خـلال سـتة أشـهر، وفشـلت العمليـة فـى ٨ حـالات (٣٤,٨٪) وانتهـت بوضـع تحويلـة.

كان معـدل الوفيـات الجراحيـة ٠٪، وتم تسـجيل حالتـين مـن العـدوى، وحالتـين مـن النوبـات التشـنجية، وحالـة واحـدة مـن تسـرب السـائل النخاعـى انتهـت بوضـع تحويلـة.

الاسـتنتاجات: كان الجمـع بـين بضـع البطـين الثالـث بالمنظـار وكَـيِّ الضفيرتـين المشـيميتين أفضـل فـى عـلاج استسـقاء الـرأس لـدى الرضـع، ممـا أدى إلـى تجنب الاعتمـاد علـى جهـاز تحويـل مسـار السـائل النخاعـى فـى الغالبيـة العظمـى مـن الحـالات.