Assessing the Effect of Ventriculo-peritoneal Shunt Treatment for Congenital Hydrocephalus

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ABSTRACT

Context: Congenital hydrocephalus is one of the common neurological problems in infants, characterized by excessive accumulation of cerebrospinal fluid (CSF) in the central nervous system. Numerous babies delivered every day with this anomaly all over the world most of them in the developing countries. There are several forms of treatment; the commonest one is ventriculo-peritoneal shunt that transfers the CSF to the peritoneal cavity. It is associated with relatively low morbidity and mortality rates. Aim: This study aimed to evaluate the ventriculo-peritoneal shunt therapy outcomes for congenital hydrocephalus and find its complications.

Patients and methods: In this research, an observational case series study design had been adopted in Ibn-Sina teaching hospital applied on a convenient sample of 52 infants of both sexes with congenital hydrocephalus over a period of three years. Ethical consents were obtained from their parents. Then, clinical evaluation was done through head circumference and fontanel examinations followed by CT-scan and ultrasonic testing to confirm the diagnosis. All patients were subjected to the ventriculo-peritoneal shunt (VP) surgery with full coverage of appropriate antibiotics, and then they were followed for 6 months to assess the effectiveness of VP shunt in the treatment of hydrocephalus and to identify any complication associated with this surgery.

Results: Most cases (79%) were below 3 months of age and 55.5% of them were males. Only 13.5% of cases developed complications including upper and lower shunt obstruction, shunt infection (28.6% for each), and skin laceration in 14.2% of those 13.5% complicated cases. Most of these complications happened to infants older than 3 months of age.

Conclusion and recommendation: The study concluded that Ventriculo-peritoneal shunt was associated with low complication rate especially among young infants. Thus, it is recommended to adopt this procedure for the treatment of infantile hydrocephalus particularly among infants below 3 months of age.

Key words: Congenital, Hydrocephalus, Ventriculo-peritoneal, Shunt.

تقييم فعالية التحويلة البطينية-الصفاقية لعلاج الاستسقاء الدماغي الخلقي

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الخلاصة

المقدمة: يعتبر الاستسقاء الدماغي واحدا من التشوهات الخلقية العصبية الشائعة لدى الاطفال والتي تتمثل بتجمع غير طبيعي للسائل السحائي الدماغي في الجهاز العصبي المركزي. هنالك العديد من الاطفال في جميع دول العالم يولدون بهذا التشوه الخلقي

يوميا وخاصة في بلدان العالم الثالث, وتعتبرعملية التحويلة البطينية-الصفاقية واحدة من اكثر طرق العلاج شيوعا وتتميز بنسب مشاكل و وفاة منخفضة نوعا ما. الهدف: تحديد مدى فاعلية التداخل الجراحي في علاج الاستسقاء الدماغي باستخدام التحويلة البطينية-الصفاقية ومعرفة ماهية المشاكل المتعلقة بها.

المرضى وطريقة العمل: في هذا البحث تم استخدام دراسة سلسلة الحالات والتي من خلالها تم جمع 52 حالة مرضية من الاطفال الرضع و من كلا الجنسين المراجعين لمستشفى ابن سينا التعليمي وفي فترة امتدت لثلاث سنوات تم خلالها فحص الاطفال المصابين سريريا عن طريق قياس محيط الرأس وفحص اليافوخ, ومن ثم اجريت فحوصات المفراس والسونار التي اكدت التشخيص السريري. تم اخضاع جميع المرضى لعملية التحويلة البطينية-الصفاقية بعد أخذ الموافقات اللازمة من أهالي المرضى, واتبعت العملية باستخدام المضادات الحيوية المناسبة, وبعد ذلك تم تتبع المرضى لمدة ستة اشهر من اجل الكشف المبكر عن مضاعفات العملية الذكورة.

النتائج: لقد كانت غالبية اعمار الاطفال المشاركين في الدراسة (79%) دون الثلاثة اشهر, و اكثر من نصفهم (55.5%) ذكورا, اما عن نسبة المضاعفات التابعة للعملية فقد بلغت 13.5% وشملت الانسداد العلوي والسفلي والالتهاب المصاحب للتحويلة وبنسب 28.6% لكل منهم, بالاضافة الى تمزق الجلد في 14.2% من هذه المشاكل. ان معظم هذه الحالات حدثت لاطفال تجاوزت اعمارهم الثلاثة اشهر.

الاستنتاج والتوصيات: استنتجت الدراسة الحالية أن هذه العملية ذات نسبة منخفضة من المضاعفات مما يجعلها العملية الانسب لعلاج الاستسقاء الدماغي وخاصة للاطفال دون سن الثلاثة اشهر. ويوصى باستخدام هذه العملية في علاج الاستسقاء الدماغي لدى الاطفال.

الكلمات المفتاحية: الاستسقاء, الدماغي, التحويلة, البطينية, الصفاقية.

INTRODUCTION

Hydrocephalus is one of the common neurosurgical problems in infancy characterized by abnormal widening of one or more of cerebral ventricles. It can be defined as "a disturbance either in cerebrospinal fluid (CSF) formation, flow, or absorption, leading to an increase in the volume occupied by this fluid in the central nervous system" [1]. There are two main types of hydrocephalus, congenital which occurs in utero either due to developmental abnormalities, exposure to infections, trauma, or teratogenic agent, and acquired type that develops either at birth or thereafter due to infections as meningitis, trauma, bleeding, or tumours [2,3].

Although hydrocephalus is a common CNS problem, its global burden is still lacking. After systematic reviews of several studies during 2018, authors found that congenital hydrocephalus was highest in Africa and Latin America and lowest in the United States/Canada (145, 316, and 68 per 100,000 births respectively) [4]. According to Oliveras et al. [5] an estimated 200,000 new-borns are affected annually by the disease in South, East, and Central Africa, and only 10% of them are subjected to surgical treatment by ventriculo-peritoneal (VP) shunt which in turn associated with high complication and death rates. A clear estimate of hydrocephalus frequency in Iraq is absolutely deficient. However, the incidence of various forms of congenital anomalies including hydrocephalus had been increased especially in Basra and Fallujah since the American war on Iraq in 2003 [6].

Hydrocephalus, if untreated, can result in several complications among them are delayed milestones, learning difficulties, blindness, and even death [7]. Surgical treatment with VP shunt makes a path for the accumulated CSF to the peritoneal cavity and thus reduces intracranial pressure [8]. However, despite the fact that VP shunts can lead to a dramatic improvement in patient survival and neurological function, they may lead to several complications in up to 40% of cases such as infections, shunt malfunction, shunt extrusion, and breakage [9], in addition, while VP shunt reduces the ventricular volume, occipito-frontal circumference (OFC) may decrease or remain plateau [10,11].

Thus, it is important to shade the light on this problem in our community and explore the complications of its surgical treatment.

Aim

To evaluate VP shunt surgery outcomes for treating congenital hydrocephalus in Ibn-Sina General Teaching Hospital and evaluate its complications.

Patients and Methods

In this research, a case series study design was applied on a convenient sample of congenital hydrocephalus cases including both sexes who were collected from Ibn-Sina General Teaching Hospital in Mosul City over a period of three years (from June 2017 to June 2019). A total of 52 hydrocephalus cases were gathered, all of them under the age of one year and ethical consents were obtained from their parents to include the infants in this research.

A preliminary diagnosis was applied on all patients to confirm the disease involving both clinical examinations (of fontanels, OFC measurements, and sun setting eyes checking) and radiological assessment by using CT-scan and ultrasound. Progressive increase in OFC and fontanels measurements were observed among all patients pre-operatively that confirmed the diagnosis and all patients had OFC measures above 2 standard deviations (SD) that made them candidate for surgical intervention.

Subsequently, they were subjected to surgical treatment by VP shunt using Codman medium-low VP shunt pressure (70mmHg) and covered with parenteral antibiotics for 24 hours post-operatively, then continued with oral ones for 5 days. Follow up of all cases continued for more than 6 months post-operatively to ensure their progression. Most patients had reduced or stationary values of OFC in relation to their age with normalization of fontanels and improvement in their neurological and general health. On the other hand, few patients failed to show any advance but instead their OFC continued to rise above 2 SD which means that the shunt was complicated and failed, mainly due to infections and mechanical obstruction.

All these data were tabulated and analysed by using various rates and proportions that were constructed depending on Excel system of Microsoft Office version 2010. Z-test of one proportion was used to identify any significant differences within the study sample. A p-value of 0.05 was considered the level of significance in this research.

RESULTS

This study was conducted to confirm the effect of VP-shunt therapy for treating infantile hydrocephalus. A total number of 52 patients with congenital hydrocephalus due to aqueduct stenosis was collected, all of them were less than one year of age. The majority of those patients (79%) were younger than 3 months and the remaining patients were distributed variably among other age groups. More than half of patients (55.5%) were males with male to female ratio equal to 1.2:1, as seen in table (1).

Table (1): Age and sex distribution of infants with congenital hydrocephalus

Age and sex characteristics	Number (n=52)	%
Age (months)		
0-3	41	79
3-6	2	4
6-9	6	11.5
9-12	3	5.5
Sex		
Male	29	55.5
Female	23	44.5
Male: Female ratio	1.2 : 1	

Table (2) demonstrates the most important examination results before and after the operation. It is found that all patients had progressive increase in OFC scale above the normal centile values. At the time of operation, the OFC was between 2 and 3 SD in 67% of the patients, and above 3 SD in the remaining 33% with significant difference (p=0.013). All infants had abnormally bulging fontanels and possess spinal neural tube defect. One month post-operatively, the OFC measures became normal in 9.6% of patients with highly significant differences from those with abnormal OFC (p=0.000). Whereas the fontanels return to their normal appearance among all infants shortly post operatively.

Table (2): Examination results of infants with hydrocephalus pre-operatively and post-operatively

Examination data	Number (n=52)	%	P-value*
Pre-operatively			
OFC measurement:			
2-3 SD	35	67	0.013
≥3 SD	17	33	
2. Fontanel examination:			
Normal	-	-	
Bulging and widening	52	100	
3. Associated congenital anomalies:			
Neural tube defect	52	100	
Post-operatively (1month)			
1. OFC measurement:			
Normal	5	9.6	0.000
Abnormal	47	90.4	
2. Fontanel examination:			
Normal	52	100	
Abnormal	-	-	

*Z-test of one proportion

Table (3) exhibits the most important complications associated with VP shunt. Among all the 52 patients, only 7 developed complications throughout the 6 months post-operative follow up period with a rate of 13.5%. Of these 13.5%, upper end obstruction, lower end obstruction, and shunt infection had occurred in equal percentages of 28.6% for each, and only one patient (14.2%) had skin laceration post-operatively. Most complications happened to infants older than 3 months (71.4%) and more than half of them (57.2%) were males.

Table (3): Complications of VP shunt treatment and characteristics of the affected infants

Cases with complications	Number (n=7)	%
VP shunt complications		
Upper end obstruction	2	28.6
Lower end obstruction	2	28.6
Shunt infection	2	28.6
Skin laceration	1	14.3
Age (months)		
0-3	2	28.6
3-6	1	14.3
6-9	3	42.8
9-12	1	14.3
Sex		
Male	4	57.2
Female	3	42.8

DISCUSSION

Congenital anomalies are one of the leading causes of infant mortality in Nineveh governorate for many years [12]. There is an obvious increase in the frequency of congenital anomalies in Iraq since 2003; among them is hydrocephalus [6]. Globally, more than three quarters of hydrocephalus cases (77%) are infants [13] with annual incidence of 400 000 cases among the new-borns, and developing countries have the greatest share with more than 20 folds higher rates compared with the developed ones [4].

In the present study, 52 cases of congenital hydrocephalus had been collected over a period of three years. Almost 8 for each 10 patients (79%) were below 3 months of age which may be attributed to the presence of NTD that should be treated surgically early in life. A little bit higher proportion of disease was demonstrated among males compared with females (55.5% vs. 44.5%) with male to female ratio of 1.2:1.

Similarly, Salvador et al. [14] found that 77% of cases in northern Mozambique were below 6 months of age with no sex preference, whereas an earlier study in Saudi Arabia, Murshid et al. [15] exhibited that 58% of patients were males. These variations depend on the sample size and study circumstances in each locality.

Measurements of head circumference are considered a good tool for the diagnosis and follow up of hydrocephalus patients. The specificity and sensitivity of OFC measurements are 97.1% and 72.1% respectively [16]. In the current study, all patients had increased OFC with one third (33%) of them had a circumference exceeding 3 SD during their preoperative diagnosis period and all patients (100%) had bulging fontanels and NTD at the time of initial diagnosis.

Correspondingly, Riva-Cambrin et al. [17] and Wright et al. [18] documented that bulging fontanels and increasing OFC are initial tools for the diagnosis of congenital hydrocephalus and the disease is highly associated with NTD especially myelomeningoceles.

One month post-operatively, the OFC remained abnormally high, but not increasing, in the vast majority of infants (90.4%) in the current study which is expected because their head size remains constant while the brain and body dimensions increasing until reaching the normal appearance,

then all parameters increase in the usual values with the growth of infants. Fontanels, on the other hand, returned to their normal sunken appearance as observed among the study sample during the 6 months follow up period. However, Nilsson et al. [19] showed that at the age of 2-3 years, shunt treated children will develop smaller head size if compared with healthy children. This can be documented in the current study if the follow up continued for longer period.

Shunt surgery is a common form for managing congenital hydrocephalus; however, it can be associated with several long-term complications like shunt malfunction, shunt infection, and shunt dependency [14]. In the current series the adoption of VP shunt operation for infantile hydrocephalus appeared to yield accepted outcome especially for infants below 3 months of age. Only 13.5% of all cases developed complications during the 6 months follow up period, these included upper end obstruction, lower end obstruction, and shunt infection in 28.6% for each, and only one patient (14.2%) developed skin laceration due to the advanced hydrocephalus with big craniometrical value at the time of intervention. Clinical examination by using OFC and fontanel size measurements were used among the four infants with shunt obstruction to diagnose shunt failure which was confirmed later on by CT scan.

Various complications' rates were registered in several studies depending on the availability of advanced health care system and the follow up period. In Sub-Saharan Africa, for instance, the complication rates fluctuated between 7%-69% during 2014 mostly resulted from obstructions and shunt infections [14], and in a most recent study in 2020, the complication rate reached 23.17% [5], whereas in North India, the rate was 32% during 2019 mostly included chamber migration and shunt obstruction [20]. In Pakistan, infection and failure rates of the shunt were 14% and 10% respectively [21], and in Egypt proximal blockage, distal blockage, and shunt infection formed 23.3%, 13.3%, and 20% from the total complications respectively [22]. The low incidence of infection rate in the present study may be related to smaller sample size or to the appropriate use of antibiotic regime during and after the surgery.

It is important to mention that, although the majority of patients in the current study (79%) were younger than 3 months, only 2 of them developed shunt complications, whereas three quarters (71.4%) of the post-operative problems occurred among infants older than 3 months of age and 57.2 % of them were males. No gender difference had been demonstrated by Shahi et al. [23] for the occurrence of VP shunt complications with mean age of 2.8±2.2 years for the victims; while Mwachaka et al. [24] found that around half of complicated cases (49.6%) were below 6 months of age, these differences are expected depending on the sample size and age distribution of the cases in each study.

Conclusion and Recommendation

Infantile hydrocephalus is one of the treatable congenital anomalies with relatively low complication rate especially if the intervention made early in infant's life. Treatment with VP shunt is relatively safe, easy to learn, and had low complications. Thus, it is recommended to adopt this method as a standard surgery for treating infantile hydrocephalus especially for infants below 3 months of age.

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