

Intracranial complications of ventriculo-peritoneal shunt: computed tomography evaluation

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ABSTRACT

Objective: To analyze the intracranial complications following ventriculo-peritoneal (V-P) shunt among patients in our locality.

Design: Prospective study utilizing CT scan.

Participants: 140 hydrocephalus patients with V-P shunt.

Setting: Computed tomography (CT) scanner Unit at Ibn Sina Teaching Hospital over a period between January 2001 and September 2003 in Mosul City .

Main results: One hundred forty hydrocephalus patients with V-P shunt covering all age groups were analyzed, 93 cases (66.4%) were males and 47 cases (33.6%) were females. 37 cases (26.4%) showed impaired or malfunctioning shunt due to obstructive causes, 26 cases (18.6%) were suffering from inter ventricular collection/cyst. 20 cases (14.3%) were suffering from chronic subdural heamatomas.

Conclusions: Inter ventricular collection/cyst ,and subdural heamatomas were found as frequent complications among our patients. This may be related to unavailability of programmable valves during embargo or their poor quality, together with lack of proper antibiotics and also break down of the CT scanner which led to delay in the diagnosis and follow up in the shunted patients.

Key words: CT scan, post VP shunt complications.

الخلاصة

الهدف: إجراء دراسة وصفية للتعقيدات التي تحدث في الدماغ بعد إجراء عملية (بزل الدماغ).
التصميم: تمت الدراسة في مستشفى ابن سينا التعليمي من عام 2001-2003 لتقييم أنواع التعقيدات التي تحدث في الدماغ ونسبة حصولها.

المشاركون: مائة وأربعون حالة تعاني من موهة الدماغ أجريت لها عمليات (بزل الدماغ) وتم فحصهم بالمفراخ الحلزوني في أوقات متفاوتة بعد العملية وبعد حدوث التعقيدات.

الطريقة: كافة المرضى تم فحصهم بجهاز المفراخ الحلزوني ذو الأبعاد الثلاث نوع سيمنس (+4).
النتائج: ثلاثة وتسعون حالة (66.4%) من الذكور و47 حالة (33.6%) من الإناث حدث فشل في كفاءة البزل في 37 حالة (26.4%) بسبب الانسدادات وفي 26 حالة (18.6%) بسبب تكون كيس من سائل الدماغ بين البطينين الجانبيين وفي 20 حالة (14.3%) تكون نزف دماغي تحت ألام الجافية .

الاستنتاج: تكون كيس من سائل الدماغ بين البطينين وحدث نزف تحت ألام الجافية ظهرتا في الدراسة بشكل ملفت للنظر بالمقارنة مع باقي الدراسات. بالإضافة إلى باقي التعقيدات وذلك بسبب استخدام أجهزة البزل غير المناسبة والتي كانت من نوعيات غير جيدة للحالة أثناء الحصار في تلك الفترة وكذلك بسبب شحة الأدوية المضادة لالتهابات وعطل الجهاز بين فترة وأخرى مما أضر التشخيص والمتابعة.

المفتاح: المفراخ، الدماغ، تعقيدات بزل الدماغ.

The most common surgery for the treatment of hydrocephalus is the insertion of a shunt device that diverts cerebrospinal fluid (CSF) from brain

ventricles to the abdominal cavity where it is safely absorbed into the blood through a V-P Shunt inserted in the infants, children, and adults. The procedure is

essentially the same regardless of the size of the patient (1). V-P shunt systems are not perfect devices. Following ventricular shunting, a wide variety of complications can occur, these complications can be categorized into three groups:

1-Mechanical obstructive failure due to improper function of shunt device.

2-Wound complications and infection related to implanted foreign material.

3- Complications occurring after shunting as a functional failure resulting from an inadequate flow rate of shunt; also breaking or dislocation of the shunt and overdrainage of (CSF) can be associated with post shunt surgery⁽²⁻⁴⁾. Shunt malfunction is fairly common with a reported one year failure rate of (30%-40%). Higher rates of failure have been described in younger patients with most significant risk occurring in patients younger than 6 months of age at the time of implantation. The causes of shunt malfunction include obstruction, infection and overdrainage. (5,6)

The most serious complication that can occur is a subdural haematoma because most shunts drain C.S.F. from the center of the brain ventricles and may cause the surface of the brain to pull away from the skull, thus stretching and tearing blood vessels on the surface of the brain⁽²⁾. Negative intracranial pressure creates a pressure gradient across the subarachnoid and subdural spaces, which results in opening of the subdural space causing subdural collection or effusion, which is not uncommon (2.6%). It occurs as delayed complication when there is shunt overdrainage^(7,9,10).

Infection is a relatively frequent complication of shunt placement, with most authorities reporting 5 % and 15 % of shunts to be expected to become infected over the life of the shunt. It can present with signs of meningitis, ventriculitis, brain abscess and subdural empyema^(2,10).

Collapsed wall of the ventricles (slit-like ventricles) occurring secondary to the over drainage puts the ependymal surface of the ventricle in contact with the holes of the ventricular catheter. Slit like ventricles may occur as frequently as 40% in pediatric series⁽¹¹⁾. Siphon central device or flow regulated valves may alleviate this complication⁽¹²⁾. Intraventricular haemorrhage with post haemorrhagic hydrocephalus can occur in 11 %, also

intracerebral and extracerebral haemorrhage can result as shunt complications^(10,16). Other rare complications like multiple epidural haematoma, collection cyst, (accumulation of CSF in the space between the corpus callosum and lower surface of hemispheres)⁽²²⁾, neoplastic metastasis and pneumocephalus were also encountered^(9,11,13-15).

Patients and methods

The study presents a series of 140 patients of shunted hydrocephalus at all age groups. They were studied in the department of radiology at Ibin Sena Teaching Hospital in Mosul, over a period between January 2001 and September 2003.

Of all patients undergoing ventriculo-peritoneal shunts, most cases were operated upon at the neuro-surgical department in Ibin Sena Teaching Hospital; the classic technique of shunt insertion was used. All actual shunt infection preventing measures were undertaken. The shunt devices used were Medtronic P.S Medical Pudenz system.

Contrast enhancement of iodine type was obtained with:

1-OMNIPAQUE (iohexol).

2-IOPAMARIO (iopamidol).

Both used in a concentration of (300-370 mg iodine/ml) in a recommended dose 0.5-2 (ml/kg).

Sedation was used for children under 6 years of age:

1. Diazepam I.V dose 0.2-0.3 mg/kg or per rectal dose 5 mg or I.M.

2. Chloral Hydrate in a dose 5 mg/kg I.V.

3. General anesthesia.

The established patients follow -up protocol was supposed to attend a periodic clinic and imaging cerebral CT examinations.

The spiral CT scanner used was (Siemens Somatom plus 4). The availability of spiral CT scanner has revolutionized the diagnostic approach to patients suspected to be harboring V-P shunt complications. Multi slice helical CT x-ray the body from many angles producing 3 dimensional images. The procedure takes minutes, so rapid scanning minimizes the risk of movement artifact, gives a markedly improved spatial resolution and the contrast media were used with greater precision.

Table (1) A: Showing age distribution for infants.

Age in months	Number of patients	%
0-2	2	11
3-4	4	22
5-6	5	27
7-8	3	16.67
9-10	1	5.56
11-12	3	16.67

Table (1) B: Showing age distribution in years in patients covering all ages.

Age in years	Number of the cases	%
0-5	59	42.15
6-10	23	16.43
11-15	18	12.85
16-20	11	7.85
21-25	13	9.30
26-30	3	2.14
31-35	3	2.14
36-40	3	2.14
41-45	2	1.43
46-50	2	1.43
51-55	0	0
56-60	3	2.14
Total	140	100%

Results

Computed tomography scan of the brain was performed on 140 patients of post shunted hydrocephalus covering all age groups.

Table 1:(A) shows age distribution of 18 patients (13%) in their first year of age, the maximum incidence was of 5-6 months. **Table 1: (B)** the maximum incidence of 59 patients (42%) was between 1-5 years of age, also showing decreased incidence as the age increased, most of the complicated cases were seen below 5 years of age.

Table: 2 shows gender distribution, 93 patients (66.4 %) were males and 47 patients (33,6%) were females, (male : female ratio is 2:1)

Unilateral shunt was done to 62 patients (44.3 %) and bilateral shunt to 78 patients (55.7%).

Among 140 patients, 115 complications (82.14%) developed post V-P shunt. Some of our patients harbored more than one complication, 49 shunted patients (35.%) were normal. Out of 37 patients (26.4%) having impaired shunt function due to obstructive causes, 6 (4.3%) were left sided and 8 (5.7%) were right sided, while 23 patients (16.4%) had bilateral shunts, Non-functioning shunt was seen in 44 patients (31.4%) of whom one case was left sided, 8 were right sided, and 35 patients (25%) were bilateral,(Table:3).

Table:(4) shows eleven patients (7.9%) with acute subdural haematoma, 7 patients were unilateral and 4 cases were bilateral. Eight patients (5.2%) were below 5 years, and 3 patients were above 5 years old. Twenty patients (14.3%) were suffering from chronic subdural haematoma (Fig.1A); 11 were unilateral and 9 were bilateral (7 on left side and 4 on right side). Four patients (2.9%) developed hygroma. Ten patients (7.14%) were suffering from overdrainage that led to slit like ventricle (Fig.1B).

Infection developed in 13 patients (9.3 %), 7 cases (5%) were brain abscess (Fig.1.E), 2 cases (1%) meningitis, 3 (2.14%) were ventriculitis (Fig.1-C), and one case (0.7%) was subdural empyema.

Inter ventricular collections/cyst, (Fig.1-D) were found in 26 patients (18.6%). Twenty one cases were below 5 years and 5 (3.6%) above 5 years.

Periventricular edema was observed in 9 patients(6.42%); intraventricular haemorrhage 6 patients (4.28%); all under 10 years of age, one patient (0.7%) due to injured choroid plexus haemorrhage, one patient with shunt metastasis, 2 cases(1.42)were malfunctioning due to shunt tip penetrating the wall of the ventricle with kinking. **Table: 4.**

Table (2): Gender distribution.

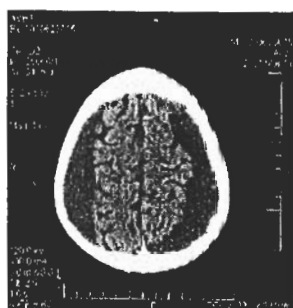
sex	No of cases	%
male	93	66.4
female	47	33.55
Total	140	100

Table (3): Incidence of types of shunt functioning according to the site of V-P shunt.

No. of cases	Functioning	Impaired function			Non Functioning			Over drainage	Total
	49 (34.98%)	37 (26.41%)			44 (31.41%)			10 (7.14%)	140 (100%)
		Left	Right	Both	Left	Right	Both		
		6	8	23	1	8	35		
		4.2%	5.7%	16.4%	0.71%	5.7%	4.9%		

Table (4): Showing types of post shunt complications.

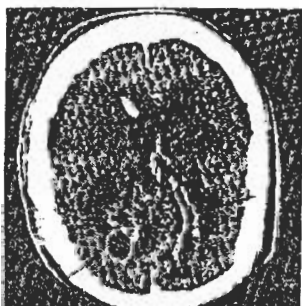
Type of complication	No. of Cases
1- Interventricular collection/cyst	26
2- Chronic subdural haematomas	20
3- Infection(ventriculitis, meningitis, abscess&subdural empyema)	13
4- Acute subdural haematomas	11
5- Slit like ventricles	10
6- Pneumocephalus(arocele ,gas bubbles)	9
7- Per ventricular oedema	9
8- Intraventricular hemorrhage	6
9- Chronic subdural hygromas	4
10- Acute epidural haematomas	3
11- Choroid plexus hemorrhage	1
12- Shunt metastasis	1
13- Shunt tip penetration with kinking	2
Total	115



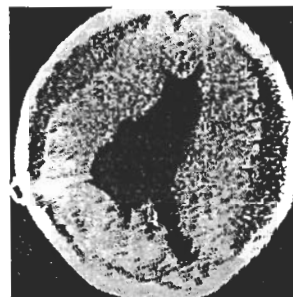
A : Chronic bilateral subdural heamatoama.



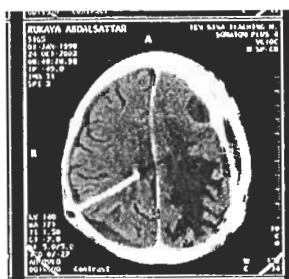
B: Slit ventricle, over drainage.



C: Ventriculitis



D: Interventricular collection / cyst with



E: Intracerebral abscess axial & coronal images.

**Figure (1): Showing different picture of V-P shunt complications.**

Discussion

In increasing hydrocephalus among shunted patients, the availability of C.T scanner has revolutionized the diagnostic approach to patients suspected to develop V-P shunt complications. (C.T) can be used to evaluate the ventricular size and to show the most definitive signs of malfunctions. A shunt series should also be done to look for continuity of the shunt and optimal placement of the shunt catheter, the presence of additional fluid collection, etc.; are all essential informations^(2,11).

Adolphsen⁽¹⁶⁾ stated that the peak age incidence of V-P shunt surgery complications was under 24 months at the time of insertion; mounting 61.85%, 22.4% of them were under 12 months^(14,16). In our work (13%) were below 12 months of age and (42%) were below 5 years of age. Tuli⁽¹⁷⁾ stated that it is no surprise that age is a risk factor for shunt failure .

In our series male to female ratio is 2:1 which is slightly higher than other work done by Zemak⁽¹⁸⁾, which was 1.3: 1. This reflects a likely better attention that male children are offered in our locality.

We had impaired function due to obstructive causes in 26.4% of cases which is similar to that of Tatarano et al (27.6%)⁽⁷⁾, while 31.4% had non-functioning shunts, which is higher than those reported by Roger and by Adolphsen^(12,16) of 25% and 21% respectively.

It is known that the dura mater in children and young adults is less adherent to the skull than in older patients, explaining why most cases of post ventriculostomy epidural haematomas occur in children and young adults. In this series (2.14%) developed epidural haematomas and that outcome is higher than that in the study done by other workers which was (0.7%)^(2,14,18).

Acute subdural haematomas have been ascribed to the abrupt detention of enlarged cerebral ventricles under tension and because of stretching and tearing of the bridging veins in the subdural space^(2,20). Carmel et al⁽¹⁹⁾, reported the incidence as (5.1%). In this series it is found (7.85 %) which is slightly higher.

Chronic subdural haematomas/hygroma are well known complications. In the study by Carmel, (6.10%) of patients were found to have chronic subdural haematoma or hygroma⁽¹⁹⁾, in this series (14 %) had chronic subdural haematoma and(3%) had pure hygromas. Tamburrini, et al stated the incidence of hygromas as (3.7%)⁽²⁾, our result is the same, but in chronic subdural haematoma the result is

higher because improper shunt devices were used during embargo period.

Chronic subdural hygromas are C.S.F. collections in the interface layers between the innermost layer of the dura mater and the outer most portion of the arachnoid, they are commonly found in long standing cases^(19,20).

Tataranu et al found the slit ventricles occurred in 3.94%⁽⁷⁾. While in our work this occurred in (7.14%) which is higher than others; this is because improper valves were used at the time of the embargo. The use of flow regulated valve can prevent this complication⁽⁹⁾.

Tamburrini⁽²⁾ reported 10-15% of post shunting craniostenosis. In our work the incidence was markedly lower (0.71%) because their neurosurgeons used Pudenz system with a burr hole design reservoir shunt devices (medium pressure) which reduced this complication by relief of intracranial hypertension^(2,9,21), which was not available in our country.

As for pneumocephalus the incidence in other works was 9.1%^(2,7,17,21), while in our series (6.42 %) were found to develop this complication .

Regarding infection, other workers found the incidence was(7.23%)⁽⁷⁾. That result is similar to ours which was(9.3%), in patients below 5 years of age.

Considering interventricular collection /cyst, the incidence in other work was (7.7%)⁽¹⁷⁾, while in our series this complication was(18.6 %). 21 patients were below 5 years of age, which is remarkably higher than other workers.

Regarding intra ventricular haemorrhage Zemack , showed the incidence of this complication as (4.95%) (18) , While in our work it was (4.3%).

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