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. 33 cases (26.4%) showed impaired of malfunctioning shunt due to obstructive causes, 26 cases (19.6%) were suffering from infective/intraventricular collectonyst, 20 cases (14.3%) were suffering from chronic subdural haematoma.

Conclusions: Inter ventricular collectionyst and subdural hematoma were found as frequent complications among out 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

المخاطر: إجراء دوارة وصفية للتعقيدات التي تحتفظ في الدماغ بعد إجراء عملية (مزق الدماغ) بدأ البحث في الدوارة في مستشفى أبي سفيان التعليمي في عام 2001-2005. لتقدير أثير المعقدات التي تحدث في الدماغ وتشمل الدكتورون، دماغ واستمرار في دراسة مع متعدد من المعقدات أخرى لعملية (مزق الدماغ) وتم فحصهم بالصور الفوتوغرافية في أتلافية نظيفة بالعملية وبدأت دراسة التساقطات على منتج مينيس (41).

النتائج: التقلد في مزق الدماغ في كفاءة في الحالة (66.6%) من الذكور (57) و 47 حالة (33.4%) من الإناث، حيث شمل ذلك في كافة الأعمار في جزء الدماغ (77 حالة (26.4%) بسب الإعدادات و26 حالة (16.6%) بسب تكون كيس من سائل الدماغ في باع ميلين (26.2%) وكانت نظرية الدماغ في الأماكن والحيوانات في قرابة (70%)(14%) (18%)

الانتقالات: تكون كيس من سائل الدماغ بابلطين وحدث من جديد. انظر في الدماغ بشكل مميزةに行く بالتحدي مع بسب الإعدادات، وذلك بسب استخدام أجهزة الزول في العمليات والمشكلة في الأجزاء، وذلك بسب نفسية الأسباب FB لوحدة الأدمغة، أولاً وآخرين، في الدراسة واليته. الملاحظات: الأعمدة القليلة وأخرى ماء أخر الانتهاء من العلاقات، الملاحظات

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T he 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

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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.

Shunt malfunction is fairly common with a reported one year failure rate of (30%-40%) of shunts in neonates, but has 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.

The most serious complication that can occur is a subdural hematoma 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.

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 where there is shunt overdrainage.

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.

Collapsed wall of the ventricles (pail-like ventricles) occurring secondary to the over drain puts the ependymal surface of the ventricle in contact with the floor of the ventricular caliper. Stilt like ventricles may occur as frequently as 40% in pediatric series. Siphon central device or flow regulated valves may alleviate this complication.

Intraventricular hemorrhage with post hemoragic hydrocephalus can occur in 11%, also intracerebral and extracerebral hemorrhage may result from shunt complications. Other rare complications like multiple epidural hematoma, collection cyst, (accumulation of CSF in the space between the corpus callosum and lower surface of hemispheres) neoplastic metastasis and pneumocephalus were also encountered.

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 Ibn 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 Ibn 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. OMNIPAGE (iohexol),
2. IOPAMARINO (iopamidol).

Both were 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 1 M.
2. Chloral Hydrate in a dose 5 mg/kg I.V.

The established patients followed -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.
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 7 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 (7.1%) were suffering from overdrainrage that led to slit like ventricle (Fig.1B).

Infection developed in 13 patients (9.3 %), 7 cases (5%) were brain abscess (Fig.1C), 2 cases (1.5%) meningitis 3 (2.1%) were ventriculitis (Fig.1-C), and one case (0.7%) was subdural empyema. Inter ventricular shunt infection, (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%) due to malfunctioning due to shunt tip penetrating the wall of the ventricle with kinking. Table 4.

Table (2): Gender distribution.

<table>
<thead>
<tr>
<th>sex</th>
<th>No of Cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>83</td>
<td>66.4</td>
</tr>
<tr>
<td>female</td>
<td>47</td>
<td>33.6</td>
</tr>
<tr>
<td>total</td>
<td>130</td>
<td>100</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>No. of cases</th>
<th>Functioning</th>
<th>Impaired function</th>
<th>NCG-functioning</th>
<th>Over-drainage</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(26.4%)</td>
<td>(31.4%)</td>
<td>(7.14%)</td>
<td>(100%)</td>
</tr>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
<td>Both</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>49</td>
<td>6</td>
<td>8</td>
<td>23</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>9.2%</td>
<td>17.5%</td>
<td>50.0%</td>
<td>2.1%</td>
<td>6.7%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Type of complication</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Intraventricular collection/cyst</td>
<td>20</td>
</tr>
<tr>
<td>2- Chronic subdural hematoma</td>
<td>20</td>
</tr>
<tr>
<td>3- Infection/ventriculitis, meningitis, abscess&amp;subdural empyema</td>
<td>13</td>
</tr>
<tr>
<td>4- Acute subdural hematoma</td>
<td>11</td>
</tr>
<tr>
<td>5- SIH like ventricles</td>
<td>10</td>
</tr>
<tr>
<td>6- Pneumocereals, aerocoele, gas bubbles</td>
<td>9</td>
</tr>
<tr>
<td>7- Per ventricular oedema</td>
<td>9</td>
</tr>
<tr>
<td>8- Intraventricular hemorrhage</td>
<td>6</td>
</tr>
<tr>
<td>9- Chronic subdural hypomas</td>
<td>4</td>
</tr>
<tr>
<td>10- Acute epidural hematoma</td>
<td>3</td>
</tr>
<tr>
<td>11- Choroid plexus hemorrhage</td>
<td>1</td>
</tr>
<tr>
<td>12- Shunt metastasis</td>
<td>1</td>
</tr>
<tr>
<td>13- Shunt tip penetration with kinking</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
</tr>
</tbody>
</table>

A: Chronic bilateral subdural hematoma.  
B: SIH ventricle, over drainage.  
C: Ventriculitis.  
D: Interventricular collection / cyst.  
E: Intracerebral abscess axial & coronal images.

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

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Discussion
In increasing hydrocephalus among shunted patients, the availability of C.T.
scanners 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 malfunction.) A shunt series should also be done to look for
antinuity of the shunt and optimal placement of the shunt catheter, the presence of
additional fluid collection, etc.; all are essential informations
Adolphsen[16] stated that the peak age incidence of V-P shunt surgery
complications occurred within 24 months of the date of insertion, mounting 61.5% of
22.4% of them were under 12 months old. In our work (13%) were below 12 months of age
and (42%) were below 5 years of age. Tull[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 Zemack[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 Taitano et al (27.6%)[19],
with 31.4% had non-functioning shunts, which is higher than those reported by
Roiger and by Adolphsen[12,13] 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 cephalovascular
haematomata occur in children and young adults. In this series (2.14%) developed
epidural haematomata and that outcome is higher than that in the study done by other
workers which was (0.7%) [2,3,16].
Acute subdural haematomata have been described to the abrupt removal of enlarged
ventricular veins under tension and because of stretching and tearing of the
bridging veins in the subdural space. Carmel et al[21], reported the incidence as
5.1%. In this series it is found (7.85%) which is slightly higher.
Chronic subdural haematomata/hygroma are well known complications. In the study
by Carmel, (> 6.10%) of patients were found to have chronic subdural
haematomata or hygroma[16] in this series (14%) had chronic subdural haematomata
and (3%) had pure hygromas. Tamburini, et al stated the incidence of hygromas as
(3.7%) [19], our result is the same, but in chronic subdural haematomata 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 at long standing cases[16,28].
Tatarani et al found the slit ventricles occurred in 3.54%[21] While in our work this
occurred in (7.14%) which is higher than others; this is because improper valves were
used at the end of the embargo. The use of flow regulated valve can prevent this
complication[22].
Tamburini[22] reported 10-15% of post shunting craniostenosis in our work the incidence
was markedly lowered (0.71%) because their neurosurgeons used Pudenz system with a
tumour hole design reservoir shunt devices (medium pressure) which reduced this complication by relief of intracranial hypertension[23,24], which was not available in our country.
As for pneumocephalus the incidence in other works was 5.1%[16,17,22], while in our
series (6.42%) were found to develop this complication.
Regarding infection, other workers found the incidence was (7.23%)[25]. That result is
similar to ours which was (9.30%), in patients below 5 years of age.
Considering interventricular collection localy, the incidence in other work was
(7.7%)[21] while in our series this complication was (18.6%) 21 patients were
infected, which is remarkably higher than other workers.
Regarding intra ventricular haemorrhage Zemack, showed the incidence of this
complication as (4.5%) (18), While in our work it was (4.3%).
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