Surgical outcome and complication differences between frontal and posterior parietal ventriculoperitoneal shunt

Background:
Hydrocephalus is an abnormal expansion of cerebral ventricles caused by the accumulation of CSF, its incidence was estimated in about 3 of 1000 live birth. The peak age incidence was below 10 years, male are more common than female. Hydrocephalus is caused by brain tumors, CNS infection and many other congenital malformation. Ventriculoperitoneal shunts (V-P shunt) is basic diversionary CSF flow channel neurosurgical procedures. It is associated with significant failure rate and complications. Ventriculoperitoneal shunt was done according to place of insertion into frontal and posterior parietal ventriculoperitoneal shunt.

Objectives:
The aim of study is to assess the differences of complications and number of tapping between frontal and posterior parietal ventriculoperitoneal shunt

Patients and methods:
A prospective study of 113 patients with hydrocephalus for various etiology treated at surgical specialties hospital in Baghdad between January 2010 to January 2013; each patient was followed for 6 months after surgery looking for the number of tap to access the ventricle, steps of subcutaneous tunneling, duration, complication rate and incidence of revision between 43 patients treated by frontal V-P shunt and 70 patients treated by posterior parietal V-P shunt.

Results and discussion:
The mortality rate was (1.76%), and post-operative complication (31.85%) for all shunted patients. Those patients with posterior parietal V-P shunt 22(31.42%) developed complications, and those patients with frontal V-P shunt 14(32.55%) developed complication. Revision was required in (25.7%) for posterior parietal V-P shunts, and (20.9%) for frontal V-P shunts.

The most frequent complication was upper end obstruction, 2 patients (4.65%) in frontal V-P shunts procedure, and 8 patients (11.42%) in posterior parietal v-p shunt procedure. This wide difference
in incidence of this complication clear the significance of frontal approach as a method of choice in applying ventricular catheter.

Other complications were also recorded e.g. lower end obstruction, infection, seizure, tube and valve exposure, subcutaneous collection.

**Conclusion:**

Age, sex, and the cause of hydrocephalus were found to have no relation to the development of shunt complication. Upper end obstruction, valve exposure and the incidence of revision were more common in posterior parietal v-p shunt. Lower end obstruction, Infection and Seizure were more common in frontal v-p shunt.

**Keywords:**

Ventriculoperitoneal shunts, posterior parietal v-p shunt, frontal v-p shunt

**Introduction:**

Hydrocephalus is an abnormal expansion of cavities (ventricles) within the brain caused by the accumulation of CSF\textsuperscript{1}.

Pathophysiologically, hydrocephalus is regarded as an imbalance between CSF formation and absorption of sufficient magnitude to produce a net accumulation of fluid within the cerebral ventricles\textsuperscript{2}. Although the true incidence of hydrocephalus is unknown; it is a common problem encountered in neurological practice with an incidence of about 3 in 1000 live births\textsuperscript{1,2,3}

Hydrocephalus can be classified into communicating and non-communicating hydrocephalus. Both these types of hydrocephalus are, in essence, obstructive, although at different sites\textsuperscript{3}.

Hydrocephalus is treated by shunting which means creation of a diversionary CSF flow channel out of the brain ventricles; it is effective in re-establishing the balance between production and absorption of CSF.

Ventriculoperitoneal shunts are one of the basic neurosurgical procedures used to treat hydrocephalus. It has a relatively high complication rate as well as failure rate and is probably the most common operation which has to be redone for either malfunction or infection. Ventriculoperitoneal shunts were done according to place of insertion into frontal and posterior parietal ventriculoperitoneal shunt. Shunt operations are often delegated to the most junior and in experienced member of the neurosurgical team, resulting in suboptimal technique and judgment in the management of shunting. Clearly, one of
the best ways of managing shunt problems is avoiding them in the first place\textsuperscript{(4,5,6)}.

The study aimed to compare complications and number of tapping between frontal and posteriorparietal ventriculoperitoneal shunt.

**Patients and methods:**

All patients with hydrocephalus and in need for shunting were included in this study with no exclusion regardless the etiologies' from January 2010 to January 2013. One hundred thirteen consecutive patients [64 male and 49 female] were included in the present study, each patient were followed for 6 months after shunt insertion. Proper examinations of patient were done. Including, general and nervous system. Investigations were performed including blood tests, ECG in older patients, CSF analysis was done in cases suspected of having infection. Chest x-ray, skull x-ray, and brain ultrasounds in some infants. All patients send for brain CT scan, M.R.I in some patients. Our patients were divided in two groups, First group include 43 patients the site of cephalic incision was in the right frontal region. Second group include 70 patients, the site of cephalic incision was in the right posterior parietal region.

**RESULTS**

Patients' age in the present study ranged between [1 month to 64 years], Males were 64 (56.63%), females were 49 (43.36%). See table [1].

**Table (1):** sex distribution of the shunted patients

<table>
<thead>
<tr>
<th>Sex</th>
<th>No. of patients</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>64</td>
<td>56.63</td>
</tr>
<tr>
<td>female</td>
<td>49</td>
<td>43.36</td>
</tr>
<tr>
<td>total</td>
<td>113</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure (1): Frequency distribution regarding the age and sex. Show age and sex distribution; 45% of cases below age of one year.

The incidence of non-communicating hydrocephalus was seen in 77%, while communicating type was seen in 23%. Intra tentorial tumors [35.39%], and congenital hydrocephalus [32.74%] were the main causes of hydrocephalus in the present study, followed by Supra tentorial tumor, Post meningitis, Idiopathic, Dandy walker cyst, Post subarachnoid hemorrhage, and Post traumatic [see table 2].
Table (2) causes of hydrocephalus that has been shunted according to their pathology.

<table>
<thead>
<tr>
<th>Causes of Hydrocephalus</th>
<th>Communicating</th>
<th>Non-Communicating</th>
<th>No. of patients</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Infra tentorial tumor</td>
<td>-</td>
<td>40</td>
<td>40</td>
<td>35.39</td>
</tr>
<tr>
<td>2 Congenital</td>
<td>8</td>
<td>29</td>
<td>37</td>
<td>32.74</td>
</tr>
<tr>
<td>3 Supra tentorial tumor</td>
<td>-</td>
<td>14</td>
<td>14</td>
<td>12.38</td>
</tr>
<tr>
<td>4 Post meningitis</td>
<td>7</td>
<td>3</td>
<td>10</td>
<td>8.85</td>
</tr>
<tr>
<td>5 Idiopathic</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>4.42</td>
</tr>
<tr>
<td>6 Dandy walker cyst</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>3.53</td>
</tr>
<tr>
<td>7 Post subarachnoid hemorrhage (SAH)</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>1.76</td>
</tr>
<tr>
<td>8 Post traumatic</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>0.88</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26 (23%)</td>
<td>87 (77%)</td>
<td><strong>100%</strong></td>
<td></td>
</tr>
</tbody>
</table>

Number of tap to access the ventricle from the first time was done in 77.14% of posterior parietal (V-P) shunt operations, while it was done only in 62.79% of frontal (V-P) shunt operations [see table 3]

Table (3) a comparison between frontal and posterior parietal (V-P) shunt in relation to numbers of tapping to access the ventricle including senior and junior surgeon.

<table>
<thead>
<tr>
<th>Site of burr</th>
<th>Surgeon</th>
<th>No. of operations</th>
<th>No. of tapping to access the ventricles</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Once</td>
</tr>
<tr>
<td>Frontal</td>
<td>Senior</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>24</td>
<td>12</td>
</tr>
<tr>
<td>Posterior parietal</td>
<td>Senior</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Junior</td>
<td>52</td>
<td>38</td>
</tr>
</tbody>
</table>
36 patients out of 113 patients (31.85%) operated upon developed complications.

18 patients [16%] had developed shunt malfunction, which are either upper or lower end malfunction. [See table 4]

**Table (4):** shows comparison between frontal and posterior parietal (V-P) shunt in relation to shunt obstruction.

<table>
<thead>
<tr>
<th>Site of burr hole</th>
<th>No. of operations</th>
<th>No. of malfunction</th>
<th>%</th>
<th>Etiology</th>
<th>No. of upper end obstruction</th>
<th>%</th>
<th>No. of lower end obstruction</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>43</td>
<td>7</td>
<td>16.27%</td>
<td>Infection</td>
<td>1</td>
<td>2.32%</td>
<td>3</td>
<td>6.97%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2.32%</td>
<td>2</td>
<td>4.65%</td>
</tr>
<tr>
<td>Posterior parietal</td>
<td>70</td>
<td>11</td>
<td>15.71%</td>
<td>Infection</td>
<td>2</td>
<td>2.85%</td>
<td>2</td>
<td>2.85%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6</td>
<td>8.57%</td>
<td>1</td>
<td>1.42%</td>
</tr>
<tr>
<td>Total</td>
<td>113</td>
<td>18</td>
<td>15.92%</td>
<td></td>
<td>10</td>
<td>8.84%</td>
<td>8</td>
<td>7.07%</td>
</tr>
</tbody>
</table>

2 of our patients died because of reverse conning. Upper end obstruction is more in the posterior parietal (V-P) shunt 8 (11.42%), in comparison to frontal (V-P) shunt 2 (4.65%). Incidence of lower end obstruction is greater in frontal (V-P) shunt 5 (11.6%), in comparison to posterior parietal (V-P) shunt 3 (4.28%).

Incidence of tube and valve exposure is less in frontal (V-P) shunt 1 (2.3%) than in posterior parietal (V-P) shunt 3 (4.28%).

Subcutaneous collection develops in 2 (2.85%) patients treated by posterior parietal (V-P) shunt. In our series shunt infection was seen in 8 (7%) out of total 113 patients, infection was seen in 4 (9.3%) out of 43 patients treated by frontal ventriculoperitoneal shunt and 4 (5.71%) out of 70 for posterior parietal shunts. Wound infection is nearly equal in both groups.
Table (5): Comparison between frontal and posterior parietal (V-P) shunt complications.

<table>
<thead>
<tr>
<th>Site of burr hole</th>
<th>Obstruction</th>
<th>Wound infection</th>
<th>Tube and valve exposure</th>
<th>Reverse conning</th>
<th>Subcutaneous collection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upper end</td>
<td>%</td>
<td>Upper end</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Frontal</td>
<td>2</td>
<td>4.65</td>
<td>5</td>
<td>11.62</td>
<td>2</td>
</tr>
<tr>
<td>Posterior parietal</td>
<td>8</td>
<td>11.42</td>
<td>3</td>
<td>4.28</td>
<td>4</td>
</tr>
</tbody>
</table>

Table (6): Comparison between the number and percent of revision using different site of implantation

<table>
<thead>
<tr>
<th>Approach</th>
<th>No. of revision</th>
<th>%</th>
<th>No. of patients without revision</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal</td>
<td>9</td>
<td>20.9%</td>
<td>34</td>
<td>43</td>
</tr>
<tr>
<td>Posterior Parietal</td>
<td>18</td>
<td>25.71%</td>
<td>52</td>
<td>70</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>23.89%</td>
<td>86</td>
<td>113</td>
</tr>
</tbody>
</table>

Discussion:

The majority of shunted patients in the present study occur below the age of 10 years, and with increase age the number of hydrocephalic patients decrease. Male to female ratio was 1.3:1.

The incidence of non-communicating hydrocephalus was 87 (77%) the major cause was tumor (infra tentorial 40 patients, supra tentorial 14 patients). Followed by congenital hydrocephalus 29 patient and the incidence of communicating hydrocephalus was 23% (26 patients).

In our series the majority of our patients were shunted because of infra tentorial tumors comprising 40(35.39%), and tumor as general comprising 54(47.78%). this result is in accordance with Micheal G and Albright L studies which found Tumors of the posterior fossa were the most common cause of acquired hydrocephalus in children and
adults\(^9\). Approximately 20% of cases of hydrocephalus in children are related to a mass lesion. The most common cause of mass lesion with secondary hydrocephalus are posterior fossa tumors\(^{9,10}\). Congenital hydrocephalus was next in frequency (32.74%), Aqueduct stenosis comprising 67.56% of congenital hydrocephalus in our series; this result is similar to Milhorat study in which 66% of all cases with congenital hydrocephalus had aqueduct stenosis \(^{11}\), and it was found to be higher than other study’s NOUE et al. Found 14% of their patients were due to aqueduct stenosis \(^{12}\), in Warf series 17\(^{13}\), and in Albright 18\(^{14}\).

Dandy-Walker malformation, is one of a congenital cause of hydrocephalus\(^{10,5,15}\). Approximately 80% of patients with Dandy-Walker malformation develop hydrocephalus with in the first 3 months of life\(^{10}\). The incidence of Dandy-Walker in patients with hydrocephalus in our series was 3.5%, nearly similar to Sasakietal study 2.4\(^{16}\).

Post meningetic hydrocephalus was 8.85% in our series; this is higher than in most series\(^{13,14,15,16,17}\), in Keucher it was 5.6\(^{15,16}\). This may be due to delay in the diagnosis and treatment of meningitis in our country.

Communicating hydrocephalus is now well recognized complication of Subarachnoid Hemorrhage due to rupture intracranial aneurysm. In our series 2(1.76%) of all hydrocephalic patient caused by subarachnoid hemorrhage. In Abood series it was 5% of all hydrocephalic patients\(^{18}\).

The overall shunts related complications in our series were 36(31.85%), 14 patients (32.55%) develop complication in frontal V-P shunt, and 22(31.42%) in posterior parietal V-P shunt.

The incidence of post shunt epilepsy was 8.1% (3 patients) for frontal and 1 patient (1.66%) for posterior parietal V-P shunt. The above result were different from Venes and Dauser study who reported that only 7.2% of their patients who were seizure free develop seizure after insertion of frontal shunt\(^{19}\), De Amorimet al, found that epilepsy developed in 16% of 56 child when operated with V-P shunt (frontal and posterior parietal)\(^{20}\).

Villani-R, performed a study of 78 patient with aqueductal stenosis (13%) develop epilepsy after ventricular shunt surgery\(^{21}\). Another study done by Bourgeois-M et al for 802 patient with hydrocephalus due to varying causes, who were treated by ventriculoperitoneal V-P shunt placement found that 32% develop seizure, and it is 5% more in frontal V-P than in posterior parietal V-P shunt\(^{20}\). The frequency of convolution in our series was low because about two-third
of our patient was treated by posterior parietal (V-P) shunt which is less epileptogenic than the frontal lobe of the brain.\[^{20}\].

**Shunt malfunction** due to occlusion of the proximal ventricular catheter was reported \(^{55.55\%}\) in our series in comparison to the distal occlusion which represented \(^{44.44\%}\). In our series 7 patients (70\%) of upper end obstruction are due to choroid plexus adhesion, and 3 patients (30\%) were due to infection. The proximal catheter can be blocked by adherent choroid plexus in \(^{80\%}\), or by debris or blood in the ventricular system which occludes the catheter lumen, by brain tissue, or in certain cases by another pathologic process such as tumor tissue growing around the catheter tip. Infection is a common cause of shunt blockage (by pus or inflammatory debris, or by increase protein in CSF)\(^{(9,6,23)}\). Sainte-Rose-C-found that mechanical shunt complication account for more than half of all shunt failures\(^{(24)}\). This shunt complication is not easily avoided standard teaching dictates that the shunt tip should be placed in the frontal horn anterior to the choroid plexus. This objective is probably more easily reached with a catheter placed via a frontal burr hole as mentioned by Albright\(^{(14)}\).

In our series 2 patients (4.64\%) of 43 patients with frontal shunt develop upper end obstruction, compared to \(^{8}\)(11.42\%) of 70 patients with posterior parietal V-P shunt develop upper end obstruction.

In our series lower end obstruction is greater in frontal V-P shunt \(^{5}(11.6\%)\), in comparison to posterior parietal V-P shunt \(^{3}(4.28\%)\) because of longer subcutaneous tract that may fray and crack secondary to trauma and are more susceptible to infection because additional skin incision is required for frontal V-P shunt during subcutaneous tunneling\(^{(13,23)}\); this is in accordance to Ignelzi and Kirsch had to correct a distal catheter obstruction in 43\% of their primary V-P shunt placement, while stalk et al, found that 56\% of their V-P shunt complication were related to distal catheter\(^{(25)}\).

Distal shunt obstructions particularly during the early days of this shunt technique, when the shunting materials often caused intense peritoneal reactions that led to occlusion\(^{(26)}\). In cases where a suspected distal malfunction is present infection is an important cause\(^{(27)}\), one should look carefully at the CSF prior to the shunt revision to make sure an infection is not present. The presence an abdominal pseudocyst detected on abdominal ultrasound or CT scanning should be considered a shunt infection until proven otherwise\(^{(5)}\).

In our series infection was \(^{(7\%),(9.3\%)\) for frontal v-p. shunt and \(^{(5.7\%)}\) for post. Parietal shunts which is similar to most series\(^{(9)}\); Wound infection rate in our series \(^{2}(4.65\%)\) for frontal and \(^{4}(5.7\%)\) for posterior
parietal V-P shunt which is lower than most other series\(^{(27,28)}\). In other series 5 to 15% of shunts can be expected to become infected over the life of the shunt. 70% of these infections are diagnosed within one month after surgery and close to 90% by six months. There are, however, late shunt infections which can occur after six months of a shunt procedure. Shunts infections can present with signs of meningitis and ventriculitis, as well as with external signs showing redness along the path of the shunt and subcutaneously\(^{(25,26)}\). Distal shunt malfunctions frequently accompany shunt infections. The most common agents are staphlococci, but grown positive bacilli and enterobacilli can also contaminate shunts\(^{(5)}\).

The experience of the surgeon and use of peri-operative and post-operative antibiotics with minimal handling of the shunt apparatus by an experienced two person surgical team, and the scheduling of all shunts and shunt revisions early in the day, prior to other scheduled procedures appear to be the most important factor in preventing such infection. Shunt infection increase in proportion to length of procedure, operating room traffic\(^{(6,28)}\).

Reverse conning develop in 2 patient, one with frontal and the other with posterior parietal V-P shunt in patients having posterior fossa tumor with hydrocephalus. In both patients low pressure valves were used. This complication occurred due to sudden decompression of the ventricular system which causes upward displacement of the posterior fossa contents due to high pressure that pressing the contents into the low pressure region.

Valve and tube exposure occur in 3(4.28%) patient treated with posterior V-P shunt, other series shown 2% incidence of tube and valve exposure\(^{(18)}\).

Two of our patients (2.85%) that were treated by posterior parietal V-P shunt develop subcutaneous collection, both had congenital hydrocephalus. One improved by conservative treatment by tight bandaging. While the other patient required shunt revision and a new burr hole made at right frontal area because the cortex was quite thin at the parietal area and there was a relatively thick cortex frontally. In which the cortical thickness will help to form a seal around the catheter, lessening the tendency for subcutaneous collections of CSF to form around the ventricular catheter and proximal shunt\(^{(6)}\).

In our study out of the 43 patient that were treated by frontal V-P shunt 9 patient (20.9%) required revision, in comparison to posterior parietal V-P shunt 18 patients (25.71%) required revision so the revision rate in
frontal V-P shunt is less frequent than in posterior parietal V-P shunt, which is similar to the result of most series\(^{[16]}\).

The overall revision rate in our series was 27 patient (23.89%), which is lower than the results of Borgbjerg-BM, et al who perform a retrospective study of 884 patient of hydrocephalus of various etiology from 1958 till 1989, the revision rate for ventriculo-peritoneal shunt was 38.5\(^{[29]}\).

In conclusion the Lower end obstruction is more frequent in frontal V-P shunt than in posterior parietal shunt. Infection rate is more frequent in frontal V-P shunt than in posterior parietal shunt. Seizure occurs more frequent with frontal V-P shunt. Tube and valve exposure occur more frequent with posterior parietal V-P shunt. The overall complication rate is more in frontal V-P shunt than in posterior parietal V-P shunt. The incidence of revision is less in frontal V-P shunt than in posterior parietal shunt. Tumors of the posterior fossa are the most common cause of acquired hydrocephalus in children and adults. It is better to use frontal V-P shunt, because it has less incidence of revision in comparison to posterior parietal one especial when the patient already has fits. Posterior parietal V-P shunt is better than frontal one, in treatment of congenital hydrocephalus with large anterior fontanel. When posterior parietal V-P shunt is chosen the tip of the ventricular catheter should be placed in the frontal horn of the lateral ventricle anterior to the foramen of Monro with the aid of endoscopy to avoid misplacement and catheter obstruction.

**References:**

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