OUTCOME OF VENTRICULO-PERITONEAL SHUNTS INSERTED AT THE PARIETO-OCCIPITAL AREA: A ONE-YEAR EXPERIENCE AT MUHIMBILI ORTHOPAEDIC INSTITUTE, DAR ES SALAAM.

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Abstract.

Objectives: The ventricular catheter of a ventriculo-peritoneal (VP) shunt for the management of hydrocephalus (HDC) is usually inserted at the frontal (Kocher's point), parietal (Keen's point) or occipital (Frazier burr hole) area of the non-dominant hemisphere (right side of the patient). In this study we prospectively evaluated the short term outcome of primary VP shunts, the ventricular catheters of

which were inserted at a new location in the parieto-occipital area of the right side (Enoh's point), in terms of ease of procedure and associated complications.

Methods: Patients booked for primary VP shunt insertion by the authors, at Muhimbili Orthopaedic Institute (MOI), Dar es Salaam in a one-year period (from October 2010 to September 2011) had the shunts inserted at Enoh's point. Patients' demographic data, aetiology of HDC and the number of attempts to obtain a good cerebrospinal fluid (CSF) flow on insertion of the ventricular catheter were noted. A descriptive statistical analysis of the complications was made and the outcome at follow up in the outpatient clinic (at up to three months post operatively) was noted. Outcome was recorded as good, fair or poor, according to the general condition of the patient, presence or absent of shunt complications, seizure or worsening vision.

Results: We enrolled 46 patients (all children) in the study, 24 (52.2%) of which were males and 22 (47.8%) were females. The mean age at shunt insertion was 10.8 months (range 2 to 96 months). During surgery, good CSF flow on insertion of the ventricular catheter was obtained in 45 patients (97.8%) at first attempt and in one patient (2.2%) at the second attempt. A total of 9 patients (19.6%) developed complications. The complications encountered were shunt infection (15.2%), obstruction (8.7%), erosion through the skin (6.5%) and protrusion through the anus (4.3%).There was a significant correlation between a younger age and shunt complications, with the latter occurring in children less than six months old ($p< 0.0001$). Outcome was good in 31 patients (67.4%), fair in 6 patients (13.0%) and poor in 8 patients (17.4%).

Conclusion: Insertion of VP shunts at the parieto-occipiatal area (Enoh's point) is safe and easy, with acceptable short term complication rates and outcome.

Key words: Ventriculo-peritoneal shunt, parieto-occipital area, Enoh's point.

Introduction.

Hydrocephalus is an imbalance between cerebrospinal fluid (CSF) production and absorption often leading to excess accumulation of fluid in the ventricular system and an increase in intracranial pressure (ICP) (9). Ventriculo-peritoneal (VP) shunt insertion is the most common procedure in neurosurgery and remains the mainstay of management of hydrocephalus (HDC) (8, 9, 12, 14, 22, 24, 25, 26). A VP shunt is a CSF diversion device, usually a tube, with a pressure-regulating valve that begins in the ventricular system and carries CSF to an absorptive surface outside the brain such as the peritoneum, pleura or vascular system. The aim of VP shunting is, therefore, to relieve excess ICP due to HDC, thereby preventing its complications.

During VP shunting, locations used for placement of the ventricular end (catheter) of the shunt are frontal (Kocher's point), parietal (Keen's point) and occipital (Frazier burr hole and Dandy's point). These points are located using certain landmarks on the surface of the skull in relation to the ventricles with the aim of accurately placing the catheter in the lateral ventricle of corresponding side of the burr hole, away from the choroid plexus (13, 22, 25). Kocher's point is 2 cm to 3 cm from the midline, 1 cm anterior to the coronal suture (approximately the mid-pupillary line with forward gaze). Keen's point is two finger-breaths above and behind the pinna and Frazier burr hole is located at a point 6 cm superior to the inion and 3 cm lateral to the midline. Dandy's point (which is rarely used because of associated damage to visual pathways) is located 3 cm above the inion and 2 cm lateral to the midline.

In this study, we inserted all the shunts at Enoh's point, described as one fingerbreadth posterior and inferior to the parietal boss, on the right (non-dominant) side of the patient (figures 1 to 3).

Figure 1.

Figure 2.

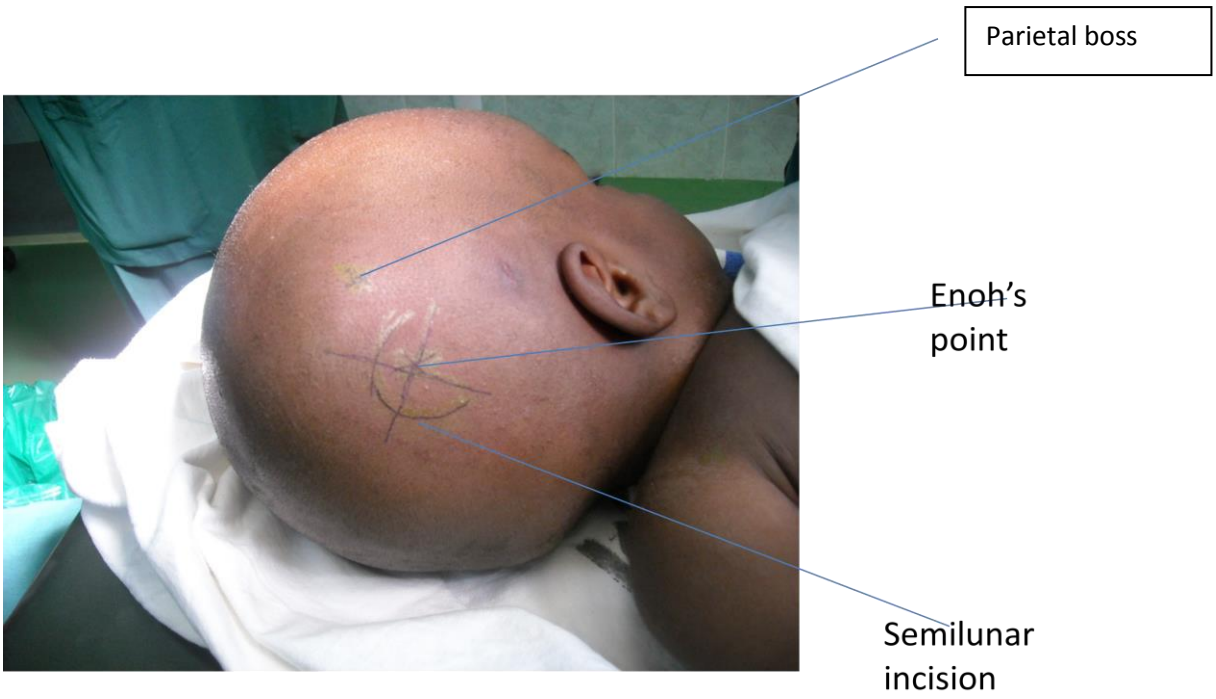

Figure 3.

Figures 1 to 3: Location of Enoh's point.

Insertion of VP shunt at the parieto-occipital area rather than the frontal area is advantageous in that the frontal lobe has a lower seizure threshold than the parietal or occipital lobe. Therefore, catheter irritation of frontal lobe brain tissue may lead to post-operative seizures, irrespective of the underlying cause of the HDC. In addition, the distance between the parieto-occipital area and the peritoneal cavity where the distal end of the shunt is implanted, is shorter and non-tortuous, avoiding the need for an additional incision on the head (4, 8, 22).

Patients and Methods

Patient population and selection

Children diagnosed as having HDC (clinically as well as by using cranial ultrasound and brain computed tomography scans) and booked for primary VP shunt insertion at our institution (MOI) during a one-year period (from October 2010 to September 2011) were enrolled in the study. A routine informed consent was obtained from their parents and the demographic data and aetiology of HDC were noted in their case files. The HDC was categorized based on aetiology as post-infectious hydrocephalus (PIHC), non-post infectious hydrocephalus (NPIHC) and obstructive hydrocephalus due to posterior fossa tumour (OHCPFT). Selection of patients as

either having PIHC or NPIHC was based on criteria described by Esther Gathura et al (12). Patients with HDC due to spina bifida were not enrolled in the study.

Every patient had the VP shunt inserted at Enoh's point (one fingerbreadth posterior and inferior to the parietal boss) on the right (non-dominant) side. During surgery, the number of attempts made by the surgeon in order to obtain a good CSF flow on insertion of the ventricular catheter was noted. The presence or absence of shunt complications in the first week post-surgery was noted and outcome of each patient at a three-month follow up in the outpatient clinic (in terms of the general condition, shunt complications, presence or absence of seizure, or worsening of vision) was also noted.

Operative technique.

Ventriculo-peritoneal shunting is usually done to divert the excess CSF in the ventricles to the peritoneum, where it is reabsorbed, in order to relieve the increased ICP and avoid complications of raised ICP (9, 10).

Pre-operative antibiotic prophylaxis (intravenous Ceftriaxone 50mg/kg) is given at induction of general anaesthesia. The child is placed supine with the head (on head ring) turned 90 degrees to the opposite side of shunt placement. A small roll is placed under the shoulder of the ipsilateral side of shunt placement.

After shaving the parieto-occipital area, the skin is cleaned from head to below the umbilicus with Betadine. Drapes are applied and Enoh's point and an abdominal site for peritoneal access (midline upper abdominal incision or a horizontal incision, 2 cm lateral and 2 cm superior to the umbilicus) are marked with a sterile needle.

After verifying the shunt system (Chhabra-Sugiwear^{R}) for patency, a small semilunar or hockey stick shaped scalp flap is raised around Enoh's point such that the point is at the centre of the flap. A small self-retaining retractor is placed in the incision so as to expose the skull and a small burr hole made with a scapel, exposing the dura. A small incision is then made at an abdominal site (either at the midline in the upper abdomen or at a point 2 cm superior and 2 cm lateral to the umbilicus) and carried down to the level of the anterior layer of the rectus sheath. A shunt passer is tunneled subcutaneously from the abdominal incision to the incision on the head and the distal aspect of the shunt system (the shunt valve and peritoneal catheter with a connector already attached to it) is passed through the hollow of the shunt passer, taking care not to let the shunt system come in contact with the exposed skin. The shunt passer is withdrawn from the patient and the ventricular catheter is introduced into the ventricles (after incising the dura with number 11 blade) then connected to the rest of the shunt system using the connector, reinforced with silk

3/0 sutures. The ventricular catheter is then anchored to the pericranium and muscle with silk 3/0.

The abdominal incision is revisited, anterior layer of the rectus sheath incised, the muscle dissected and peritoneum opened. The abdominal catheter is inserted into the peritoneal cavity and the peritoneum is closed with vicryl 3/0. The abdominal skin and scalp are closed with nylon 3/0.

During the procedure the number of attempts by the surgeon to obtain a good CSF flow on insertion of the ventricular catheter was noted. We used the Chhabra (Surgiwear^{R}) shunt in all the patients because of its lower cost and ready availability, comparative to other shunts systems. Double gloves were also worn by the surgeon and the first pair of gloves removed before handling of the shunt system.

Post-operative follow up

In the ward each patient is given an antibiotic (Ceftriaxone) for 72 hours. The patient is monitored each day and any symptoms and signs of shunt infection or malfunction are noted. On the third or fourth day, if there is no fever, the child is discharged home and the parent is instructed to return with him/her, one week later, at the neurosurgical outpatient clinic for stitch removal and follow up.

After the first outpatient visit, each patient is then given another appointment of two weeks, followed by four weeks, then six weeks, to return for follow up at the outpatient clinic.

At the outpatient clinic, the presence of shunt complications is determined through a thorough history (usually with the mother as informant) and clinical examination for symptoms and signs of sepsis, meningitis, intestinal obstruction, etc, with particular attention placed on the history of any seizure attack while the patient was away from the hospital. The patient's vision is assessed by clinical examination of the eyes and comparison made with the notes recorded in the case file. Vision is then recorded as same, worsened or improved.

Statistical analysis

A descriptive statistical analysis of the data was done using SPSS version 16. The chi-square test was used to analyze the relationship between shunt complications and age with statistical significance set at $p< 0.05$.

Results

Out of 46 patients (all children) enrolled in the study, 24 (52.2%) were males and 22 (47.8%) were females. The mean age at shunt insertion was 10.8 months (range 2 to 96 months). However, most of the patients (86.9%) were below 12 months old.

A majority of the patients (89.1%) had PIHC which was communicating. Five patients (10.9%) had NPIHC with 2 of the five patients (4.3%) having congenital aqueductal stenosis. Four of the patients (8.7%) with age ranging from 36 to 96 months had obstructive HDC due to posterior fossa tumour (HCPFT).

During surgery, good CSF flow on insertion of the ventricular catheter was obtained in 45 patients (97.8%) at first attempt and in one patient (2.2%) at the second attempt.

In the first week post-surgery, 3 children (6.5%) developed fever due to shunt infection. A total of 9 patients (19.6%) developed complications with an overall rate of 34.7% consisting of shunt infection (15.2%), obstruction (8.7%), erosion through the skin (6.5%) and protrusion through the anus (4.3%). All the complications encountered developed in children below 6 months of age (see table 1 below) and all 3 children who had shunt erosion through the skin were less than 4 months old and malnourished. The occurrence of complications correlated significantly with a younger age (all complications occurred in children less than six months old, $p< 0.0001$).

Outcome was good in 31 patients (67.4%), fair in 6 patients (13.0%) and poor in 8 patients (17.4%). Two of the patients (4.3%) who had HCPFT developed poor outcome which was not related to the shunt procedure but to the effect of the posterior fossa tumour. None of the children had seizure, significantly improved or worsened vision after surgery.

Age(months):	2-12	13-24	25-36	32-48	49-60	61-72	73-84	85-96
Shunt infection	15.2%	0.0%	-	0.0%	0.0%	0.0%	-	0.0%
Shunt obstruction	8.7%	0.0%	-	0.0%	0.0%	0.0%	-	0.0%
Skin erosion	6.5%	0.0%	-	0.0%	0.0%	0.0%	-	0.0%
Anal protrusion	4.3%	0.0%	-	0.0%	0.0%	0.0%	-	0.0%
Poor outcome	13.0%	0.0%	-	2.2%	0.0%	0.0%	-	2.2%
Fair outcome	13.0%	0.0%	-	0.0%	0.0%	0.0%	-	0.0%
Good outcome	58.6%	4.4%	-	0.0%	2.2%	2.2%	-	0.0%
PIHC	89.1%	0.0%	-	0.0%	0.0%	0.0%	-	0.0%
NPIHC	10.9%	0.0%	-	0.0%	0.0%	0.0 %	-	0.0%
HCPFT	0.0%	0.0%	-	4.4%	0.0%	2.2%	-	2.2%

Table 1. Shunt complications and outcome in relation to age group.

Discussion

In our study, there was a greater number of male than female children presenting with HDC, the majority of children being below one year old, consistent with other studies (2, 12, 19). Post infectious hydrocephalus (PIHC) was the most common amongst the children, in line with other reported studies in low income countries (29).

Obtaining a good CSF flow at a single attempt, on insertion of the ventricular catheter in a majority of the patients, helped shorten the time of operation. Reduced time of operation, double gloving and strict adherence to aseptic technique during VP shunting have been proven to be intra-operative factors associated with reduced risk of shunt complications, especially infections (5, 6, 23, 25, 28).

The overall shunt complication rate in our study within a short term follow up period of up to three months was 34.7% with infections rate of 15.2%. This lies within the range reported in most of the studies carried out in low income countries (15, 17, 18, 19, 21, 27). Most of the complications occurred in patients less than 6 months of age in line with studies which had suggested a younger age as risk factor for VP shunt complications (11, 12), probably as a result of the immature immune system of the very young. All the patients who had shunt erosion through the skin were below 4 months old and malnourished. Malnutrition has been demonstrated to be associated with decreased immunity and skin integrity (30). Two of the patients in our study had protrusion of the abdominal catheter of the shunt through the anus, a rare but reported shunt complication (1, 3, 16, 20) which could be due to chronic irritation of the bowel by the shunt device or silicone allergy (16, 20).

The overall outcome in most patients was good. Two patients had a poor outcome due to posterior fossa tumours which caused deterioration in their general condition. No seizures, worsening vision or death occurred in any of the patients after surgery, contrary to outcome reported in one retrospective study in a low income country (12).

Limitations of the study

Despite the fact that spina bifida is a common cause of HDC in low income countries (12), we did not include patients with HDC caused by spina bifida in this study because they were placed in another study.

In this study, surgery was carried out by all the authors and one surgeon inserted the peritoneal catheter of the shunt system in the midline upper abdomen while the other surgeons inserted it supero-lateral to the umbilicus. In addition, the distal slits of some shunts were trimmed off during surgery, in some patients and not others. This involves some bias in preventing shunt complications in some patients more than others as these factors (insertion of abdominal catheter in the midline upper abdomen and trimming of distal slits) have been reported to be associated with decreased risk of distal VP shunt obstruction (7, 26).

The follow up period was short term (up to 3 months) and given the fact that most shunt complications occur in the first 6 months post-surgery (12), more follow up and other studies have to be carried out before strong conclusions can be made on the outcome of patients having VP shunts inserted at Enoh's point.

Conclusion

Ventriculo-peritoneal shunt insertion is the principal method of management of hydrocephalus and fast performance of the surgical procedure (with adherence to aseptic principles) is important in limiting complications, especially infections. This can be achieved through the insertion of the ventricular catheter at Enoh's point, a procedure which is safe, easy and fast with acceptable short term complications and outcome.

Disclosure

The authors have no personal financial or institutional interest in any of the drugs, materials or devices mentioned in this article.

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