Ventriculo-Subgaleal Shunt: The Need for Temporary Diversion?

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Date of Submission:27 th April 2026 Date of Acceptance: 1st May 2026 Date of Publication: 15th June 2026

Abstract

Objective: Ventriculo-subgaleal shunt is an internal CSF diversion technique, communicating the dilated ventricles to the subgaleal pouch developed in the scalp. In infants due to infection or hemorrhage in the brain, hydrocephalus can develop due to multifactorial causes. These infants, predominantly present with failure to thrive. This leads to high rates of patient and procedure related complications following ventriculo-peritoneal shunt, with an overall increase in hospitalization and shunt failure. ventriculo-subgaleal shunt is a less invasive procedure and provides sufficient time for the child to improve their nutritional status. We aim to study the effectiveness of ventriculo-subgaleal shunts in infants with post-hemorrhagic/ post infectious hydrocephalus.

Methodology: The infants who underwent ventriculo-subgaleal shunt between January 2021 and June 2023 at Christian Medical College, Vellore were retrospectively analyzed.

Results: Four infants were managed with VSG shunt as a temporary means of CSF diversion. All these four infants weighed less than 2500 grams and presented with progressive head growth and failure to thrive. Three of them were female and the mean age was 3.5 months. Three infants were pre-term in our series. Post infectious hydrocephalus was the most common etiology found in our series. All the infants were followed up for 2 months at which time they improved symptomatically. All the infants underwent ventriculo-peritoneal shunt as definitive procedure later.

Conclusion: Ventriculo-subgaleal shunt is an easy and safe procedure. It is suited for infants who are preterm or low birth weight, to avoid the morbidity and failure rates of regular ventriculo-peritoneal shunt.

Key words: Ventriculo-subgaleal shunt, hydrocephalus, post-hemorrhagic hydrocephalus, post-infectious hydrocephalus.

Introduction

Hydrocephalus is an abnormal accumulation of cerebrospinal fluid in the ventricles of the brain. The main treatment is to divert the CSF by using a shunt system, either ventriculo-peritoneal (VP) or ventriculo-atrial (VA)[1]. But these procedures can have their own problems. There is a 10-20% risk of shunt infection, in the normal population, but in case of neonates the risk increases by 5-fold[2]. The shunt infection is associated with long term mortality of more than 30%[2]. Sometimes, a temporary way to divert CSF is needed, till the child's nutritional status, child's age and body mass increases, to improve the chances of a subsequent successful VP/VA shunt procedure later. A ventriculo-subgaleal (VSG) shunt is a temporary internal CSF diversion technique in which the shunt tube is placed connecting the ventricles and the subgaleal pouch created in the scalp. In this case series, we share our experience with ventriculo-subgaleal shunts as a temporary solution for managing hydrocephalus, focusing on the reasons for use, technical aspects, and results of this method.

Access this article online

Website: https://www.nepjol.info/index.php/NJN

DOI: https://doi.org//10.3126/njn.v23i2.92037

HOW TO CITE
Makkina, C., Panicker, T. V., & Joseph, B. V. Ventriculo-Subgaleal Shunt: The Need for Temporary Diversion. NJNS. 2026;23(2):10-13

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ISSN: 1813-1948 (Print), 1813-1956 (Online)

Methodology

The present (Retrospective observational) study includes a case series of 4 infants who underwent ventriculo-subgaleal shunt between January 2021 and June 2023 at Christian Medical College, Vellore with a minimum follow up of 2 months. Socio-demographic data, clinical indications, operations performed, complications and prognosis of these patients were reviewed retrospectively and are discussed in this paper.

Hydrocephalus was diagnosed clinically in all the patients with signs of tense and bulging anterior fontanelle, up gaze restrictions, and sixth cranial nerve paresis. In addition to clinical examination, trans-fontanellar ultrasound and CT scans were used for confirmation of hydrocephalus and the etiology. For assessing the progression of hydrocephalus, serial head

circumference measurements were done.

When performing VSG shunt placement, our approach was a curvilinear incision in the pre-coronal region over the frontal bone at the mid pupillary line. A small perforation was made on the frontal bone using a handheld perforator. Care was taken to leave a layer of pericranium over the bone to facilitate the anchorage of the tube at the end of surgery. Dura mater was coagulated and incised at the lateral part of the anterior fontanelle, which was normally present in most of the infants who underwent shunt. Before tapping the ventricle, a large subgaleal pocket was made in the scalp with a blunt curved artery forceps, from anterior to the coronal suture and all the way back to the lambdoid suture posteriorly. The ventricle was tapped with a ventricular end of the medium pressure Chhabra shunt (Surgiwear Chhabra Hydrocephalus Shunt System, Sh202) and the short distal tube containing the slit valves was placed into this pouch after confirming proper CSF drainage. A plastic connector was used to connect the ventricular and sub-galeal tubes. The tube and plastic connector junction was fixed to the pericranium snugly, to secure the tube. The goal was to allow the CSF to drain into the subgaleal pouch. The slit valves ensure unidirectional flow from the ventricle to the sub-galeal space (Fig 1). Great care was taken during scalp closure by approximating the galeal layers together and closing skin with sub-cuticular sutures.

No pressure dressing was applied on the scalp. The mother was instructed to nurse the child with the surgical side non-dependent, to prevent pressure over the surgical area, and obliteration of the subgaleal pouch.

Results

Of the four infants, three were females. All infants presented with progressive increase in the size of their heads, failure to thrive and weight less than 2500 grams (range:, mean:). The mean age of presentation was 3.5 months (range). Of the 4 cases, 3 were pre-term. Three of the infants had post infectious etiology and one had post germinal matrix hemorrhage. All these infants were managed with VSG shunt as a temporary means of CSF diversion. (Table 1, Fig 2 and Fig 3).

Table-1: Comparison of the four cases of VSG shunt children. HC- Head Circumference, AF- Anterior Fontanelle.

	1st Child	2nd Child	3rd Child	4th Child
Age (Months)	4	2	3	2
Sex	Female	Male	Female	Female
Etiology	Infection	Infection	Infection	Hemorrhage
Weight (kgs)	2.3	1.9	2.4	1.8
HC (cms)	48.5	41.5	41	43
AF	Full	Full	Full	Full and tense
Conversion time to VP shunt (Months)	4	5	2	2 1/2
Preterm	Yes	Yes	Yes	No

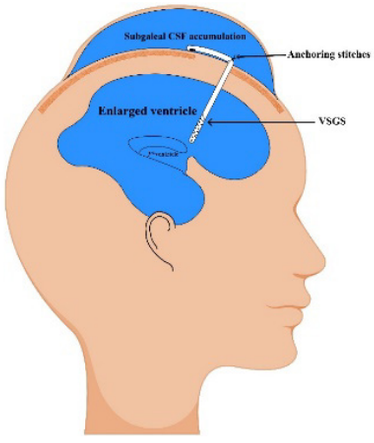

Figure-1. Schematic diagram showing the placement of the ventricular end of the ventriculo-subgaleal shunt end into the lateral ventricle through a small perforation in the frontal bone. The shorter subgaleal shunt is shown placed in the subgaleal space with slit valves. These two segments are connected to each other with a plastic connector and held to the bone with anchoring stitches.

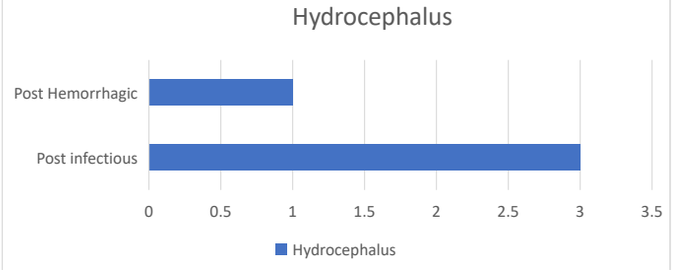

Figure-2 Etiology of the hydrocephalus in the case series

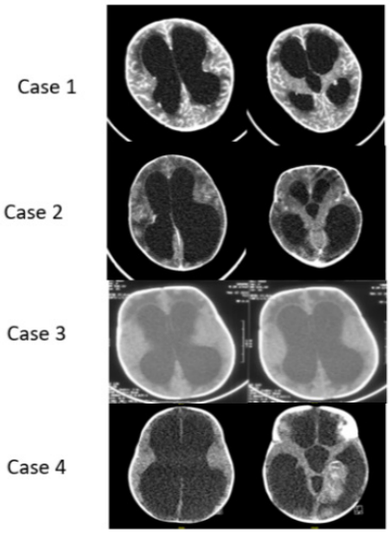

Figure-3 Cases who underwent VSG shunt.

There were no post procedure complications like CSF leak, wound dehiscence and infection. In all the infants the symptoms subsided, and children were actively feeding 2 months post VSG shunt. All the children subsequently underwent VP shunt

as a definitive procedure (mean of 13.5 weeks, median of 13 weeks and range from 8 to 20 weeks)

Discussion

VSG shunt was first performed by von Mickulicz in 1896. It was later popularized by Perret and Graf 3 by publishing a case series of 173 patients in 1977, studying both tumor and subdural collections. In neonates and infants, hydrocephalus can be addressed by external and internal diversion techniques. As anterior fontanelle is open during this period, external diversion techniques such as frequent ventricular taps can be done. It is useful if the cause of the hydrocephalus is either hemorrhage or infection, as the CSF is highly proteinaceous in these cases, increasing the risk of shunt blockade and dysfunction. The associated risk of these frequent ventricular taps is the introduction of hospital acquired drug resistant organism into the ventricles. There is also a risk of cortical injury and gliosis leading to the development of seizure focus[9].

Previously lumbar punctures were done in case of communicating hydrocephalus but now it is not recommended 4 as it can lead to focal arachnoiditis causing tethering of the spinal cord. External ventricular drainage is another temporary external diversion technique, but it has its own risks of infection and hemorrhage. It has to be handled meticulously and needs intensive nursing care and monitoring to avoid over drainage or disconnection[5]. Endoscopic third ventriculostomy in neonates and infants, is associated with high failure rate6. Repeated aspirations from a ventricular reservoir (Ommaya) have an infection rate which ranges from 4-22%[7]. The other rational option was to do permanent internal diversion technique either ventriculo-peritoneal shunt or ventriculo-atrial shunt, these procedures are associated with higher risk of postoperative complications such as infection and malfunction, in small infants and premature babies[8]. There is a 5-fold increase of shunt infection in premature neonates, the likely cause might be due to poorly developed immune system, general poor skin condition, high skin bacterial density. In premature neonates with low birth weight the risk of complications is even higher, as the peritoneum is not well formed and possible gut infections, make the procedures high risk[9]. As mentioned earlier in infectious cases, the high CSF protein content makes CSF flow slow and more prone to blockage. The abdominal end of the shunt tube also can cause irritation of the peritoneum leading to ileus. These factors lead to increased shunt infection and dysfunction with subsequent increased morbidity and cost of hospitalization.

VSG shunts provide a better alternative, as a temporary measure to manage the hydrocephalus, while waiting for the nutritional status, and weight of the child to improve. As the distal tube is not placed in the peritoneum, the risk of shunt infection is reduced. It is also an easy procedure, that can be done at bedside if required, 10 and is less time consuming.

The outcome of VSG shunt in 10 studies were pooled and it showed around an average of 10% rate of obstruction and infection, 12.2% requiring revision. In 13.9% there was arrest of hydrocephalus and 58.7% had good neurodevelopmental outcome11. The main advantage of VSG is its longevity. The average duration in our setting was 13.5 weeks. Allowing sufficient time for the child to improve in nutrition. It was 7.7 weeks, in the study by Chatterjee et al.12 Eid et al.[13] in their review of 185 VSG shunts found an average longevity of 5.3 weeks. The major issues with these shunts were due to pocket-related problems and not due to catheter blockade. In the study by Fulmer et al[14]. Most of the failures were due to decreased CSF absorption (pocket too full) and not because of the catheter blockade. The other complication involved with these shunts was infection, Tubbs et al.[15] had 5.9%, Chatterjee et al. had 7% but none in our group had infection. There was also no CSF leak in our series, which was 10% in Chatterjee group.

In our series all four infants underwent definitive VP shunt procedure later. But in the study done by Chatterjee et al, they found that 40% of the children did not require further shunts, which is another advantage of the VSG shunt.

Conclusion

Ventriculo-subgaleal shunt is an easy procedure that can be used as a temporary diversion procedure in management of hydrocephalus. This allows delayed placement of a VP/VA shunt till, the child is bigger with improvement in nutritional status and body weight, and has reached sufficient body size for placement of permanent shunt, with reduction in risk of shunt infection and subsequent mortality.

Financial Support and Sponsorship:
Nil

Conflict of interest:
There are no conflicts of interest.

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