



Ventriculosubgaleal shunting—a comprehensive review and over two-decade surgical experience

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Received: 29 May 2018 / Accepted: 25 June 2018 / Published online: 12 July 2018
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Abstract

Introduction The subgaleal space is the fibroareolar layer found between the galea aponeurotica and the periosteum of the scalp. Due to its elastic and absorptive capabilities, the subgaleal space can be used as a shunt to drain excess cerebrospinal fluid from the ventricles. A subgaleal shunt consists of a shunt tube with one end in the lateral ventricles while the other end is inserted into the subgaleal space of the scalp. This will allow for the collection and absorption of excess cerebrospinal fluid. Indications for ventriculosubgaleal shunting (VSG) include acute head trauma, subdural hematoma, and malignancies.

Discussion VSG shunt is particularly advantageous for premature infants suffering from post-hemorrhagic hydrocephalus due to their inability to tolerate long-term management such as a ventriculoperitoneal shunt. Complications include infection and shunt blockage. In comparison with other short-term treatments of hydrocephalus, the VSG exhibits significant advantages in the drainage of excess cerebrospinal fluid. VSG shunt is associated with lower infection rates than other external ventricular drain due to the closed system of CSF drainage and lack of external tubes.

Conclusion This review discusses the advantages and disadvantages of the VSG shunt, as well as our personal experience with the procedure.

Keywords Subgaleal space · Hydrocephalus · Ventriculosubgaleal shunt · Complications · Indications

Introduction

The subgaleal space is an anatomically and clinically significant area of the scalp that can be used in the short-term treatment of hydrocephalus for primarily infants and children [1]. In 1896, von Mikulicz (Fig. 1) [12] performed the first ventriculosubgaleal shunting (VSG) (Fig. 2). Later in 1981, shunting CSF into the subgaleal space for acute head trauma was reported [7]. In this review, we will discuss how the subgaleal space can be utilized for temporarily shunting

CSF, i.e., VSG, along with its various indications, techniques, complications, and longevity.

Anatomy

The scalp is divided into five layers, skin, dense connective tissue, galea aponeurotica, loose areolar connective tissue, and the periosteum. The subgaleal space is just deep to the galea. This layer is mainly avascular [8]. The subgaleal space is known to have absorptive qualities.

The region that contains the subgaleal layer begins from the superior nuchal line to the forehead and ends laterally where the galea extends with the temporalis fascia down to the zygomatic arches. Some areas of the scalp lack the subgaleal fibroareolar layer and consist only of skin, subcutaneous tissue, and deep fascia.

Indications

Although a VSG shunt is not a definitive treatment for hydrocephalus, it does serve as an effective mechanism for temporarily reducing the increased intracranial pressure until a permanent

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Fig. 1 Portrait of Jan Mikulicz-Radecki (1850–1905)

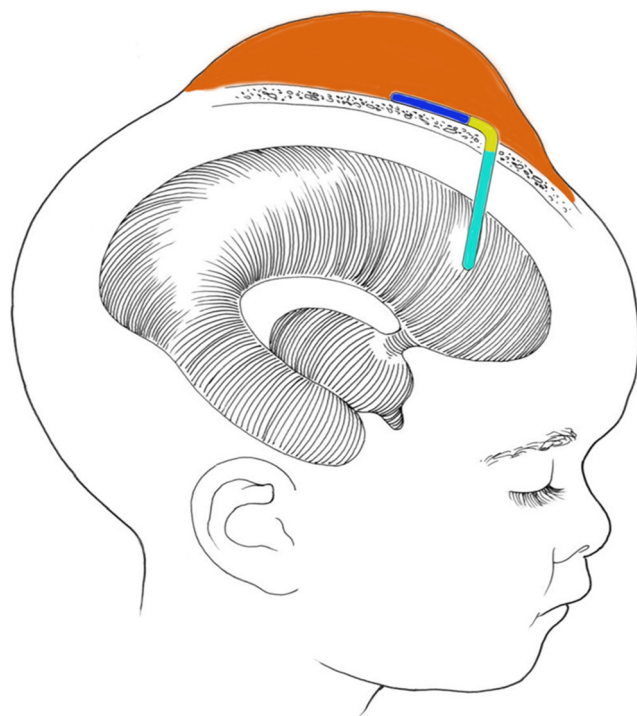


Fig. 2 Schematic drawing of a child with a VSG. Note the hydrocephalus, enlarged subgaleal space (orange), and components of the VSG shunt; intracranial catheter (teal), right angled connector (yellow), and distal slit tubing (blue)

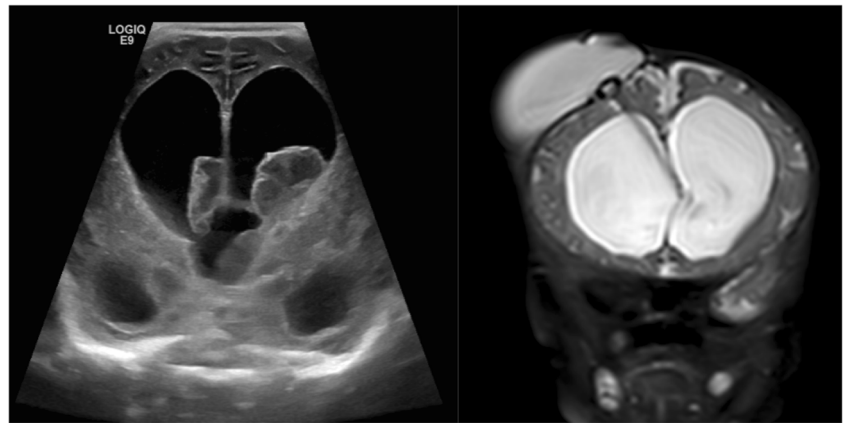
treatment is available. One indication is post-hemorrhagic hydrocephalus (Fig. 3) where low birth weight combined with bloody CSF can lead to complications if a ventriculoperitoneal shunt were performed as the initial treatment [6]. A weight of 2 kg and a CSF protein load of less than 1 g/dL are usually the minimal requirements for a ventriculoperitoneal shunt placement, although these are subjective [14]. Other indications include hydrocephalus from head trauma (Fig. 4), subdural hematoma, malignancy, and subarachnoid hemorrhages [9].

Surgical technique

This type of shunt is beneficial for especially infants suffering from post-hemorrhagic hydrocephalus as it leaves less of a footprint, is quickly executed and for critically ill neonates, can be performed at the bedside. In the supine position, the first step is placement of a ventricular catheter into the frontal horn. Next, the ventricular catheter is connected to either a reservoir or via a right angled connector to a short piece of tubing (Fig. 2) where slits have been made in order to offer some mechanical resistance and establish unidirectional flow from the ventricle into the subgaleal pocket [3]. We have routinely tied the intracranial catheter to the right angled connector with a 3.0 silk suture and have not sutured on the subgaleal catheter to the right angled connector. This allows an easier conversion to the definitive shunt by simply removing the subgaleal catheter and connecting, for example, the valve and distal shunt tubing. A subgaleal pocket is formed with blunt dissection and we normally use blunt tipped Metz scissors with curved ends. Care must be given to dissecting the subgaleal space and not a more superficial or deeper layer as, based on our experience, these typically do not absorb fluid as well. The VSG shunt is often secured to the periosteum with sutures to prevent migration intraventricularly or into the subgaleal pocket, which although uncommon, has been seen by us. Lastly, care is given to provide a water-tight closure with as little trauma to the skin, which can be exquisitely thin in premature infants. Based on over two decades of performing this procedure, this is absolutely the most critical detail of the procedure. In fact, with premature infants, the surgeon is usually afforded only one attempt at the initial subcutaneous tissue purchase due to the incredibly thin layers seen in these patients.

There are important factors that need to be considered in order to ensure proper placement of the VSG shunt. Proper creation of slit valves is important in order to ensure one-way flow of CSF from the ventricles into the subgaleal space. Another consideration is to create a subgaleal pocket large enough to collect sufficient amounts of CSF. It has also been shown that larger subgaleal pockets can prolong the longevity of the VSG shunt [3]. We typically try to dissect out laterally toward each ear taking care when crossing the midline, elevating the space posteriorly over the occiput and avoiding button holing the skin, which based on our experience, might

Fig. 3 Left: premature child with intraventricular hemorrhage and resultant hydrocephalus. Right: Coronal MRI of patient following placement of VSG



not be realized until postoperatively, as seen by a leaking scalp wound. Such complications can result in CSF infections. Other factors include ensuring that there are no kinks in the VSG shunt during placement and proper post-operative care of the shunt. One cosmetic consideration is to not dissect the subgaleal space onto the forehead. Based on our experience, the VSG shunt can be performed at the bedside, which is especially beneficial for critically ill infants that should not be exposed to unnecessary movement.

Complications

Similar to any procedure, the surgeon should be aware of the complications that can potentially arise. In an earlier study

[11], we found that infection was the most common complication (5.9% infection rate) in a retrospective study of infants and children. *Staphylococcus aureus* and *Staphylococcus epidermidis* were found to be the main culprits. Another study found that shunt blockage, requiring shunt revision, occurred in 45.2% of premature children with post-hemorrhagic hydrocephalus [5]. Other complications of VSG include leakage, kinking of the shunt tubing, and wound breakdown. Patients and their parents should be made aware of the significant scalp swelling caused by the CSF collection in the subgaleal space. It should be noted that infants should have their head turned every couple of hours in order to avoid skull deformation, which can be severe. We have seen large pockets and even when behind the hairline, these can be cosmetically unappealing. Some parents of our patients have even placed various types of hats to conceal the subgaleal pocket from others.



Fig. 4 Adolescent with closed head injury with intraventricular hemorrhage and resultant hydrocephalus. Sagittal MRI demonstrates the grossly enlarged subgaleal space following placement of VSG

Longevity

The survival duration of the VSG shunt is variable depending on several factors; however, it is usually a sufficient time period until contraindications for a permanent treatment, e.g., intraventricular hemorrhage has been resolved. Based on our retrospective study of 185 VSG shunt placement in pediatric patients, it was found that the average longevity of the primary VSG shunt was 37.4 days, while the secondary VSG shunt was 32.4 days [10]. This duration of function, which is approximately 1 week shorter for revisions, provides adequate time for permanent therapy. An important factor that improves longevity is the absorptive capacity of the subgaleal space and the creation of an ample space during dissection. Drapkin et al. [2] revealed that in some cases the ventricles might re-enlarge due to the large collection of CSF exceeding the absorptive capacity of the subgaleal space. This is an indication for a shunt conversion into the peritoneum, pleura or right atrium.

Discussion

Several other temporary treatments for CSF decompression exist and these include ventricular reservoir taps, lumbar puncture, external ventricular drain, and medications that slow the rate of CSF production [11]. Lumbar puncture is also another short-term method for draining CSF when no contraindications are present. Repeated lumbar punctures are invasive procedures which also increase the risk of infection and risk of possible injury to the spinal cord. Similar to the lumbar puncture, a ventricular reservoir tap requires daily access for drainage of the CSF. On the other hand, a VSG shunt allows for constant drainage of CSF due to the absorptive qualities of the subgaleal space. Wang et al. [13] revealed in a study comparing VSG shunts and ventricular reservoirs, that the VSG shunt group had statistically significant fewer CSF tap rates prior to ventriculoperitoneal shunt placement than the ventricular reservoir group, with 1.6 tap vs 10 taps, respectively. Wang et al. [13] also showed that VSG shunt patients had a longer time interval before placing of the ventriculoperitoneal shunt than the ventricular reservoir (80.8 versus 48.8 days). This emphasizes the previously mentioned advantage in the pediatric population, that the VSG shunt allows for adequate CSF drainage until these infants mature enough to be able to handle the ventriculoperitoneal shunt.

One advantage of the VSG shunt over external ventricular drains is the lower infection rate due to the closed CSF drainage and easier nursing care due to lack of manipulation of drains and tubes. These have been major reasons for performing these procedures at our hospital and allow the patients to go home while waiting on a definitive shunt. Moreover, Nee et al. [4] revealed greater infection rates from external ventricular drains (38.1%) compared to VSG shunts (3.4%).

Conclusion

This review highlights the advantages and disadvantages of the VSG shunt in managing hydrocephalus, particularly in the pediatric patient. Over two decades of experience with the VSG shunt has made it a go-to in the treatment of patients who need a temporizing method for their hydrocephalus.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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