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# Ventriculosubgaleal shunt versus External Ventricular Drain in the treatment of Acute Hydrocephalus in Adults

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## Abstract

Hydrocephalus is caused by subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH), Infection or by a tumor compressing the CSF passages is mostly temporary and can resolve with treatment. We have many methods to assure cerebrospinal fluid (CSF) diversion, no method is considered more preferable than others; so, to choose a method depends on the causes or other factors.

Ventriculosubgaleal shunt (VSGS) is one of those temporary ways in which we can assure a simple and rapid CSF decompression method and not causing electrolytes or nutritional losses.

To study the effectiveness of using VSGS compared to external Ventricular Drain (EVD) in adult hydrocephalus for temporary CSF conversion and to find out the results that help us avoid putting a permanent shunt, and last, to find the possibility of occurrence of complications.

A retrospective observational study.

**Materials and Methods**: The data were taken from Hospital Admission notes of fifty patients with acute hydrocephalus: 26 caused by IVH, 10 from ruptured aneurysm, 8 post-traumatic, and 6 were due to infection. In all the patients we did CSF conversion in Hospital Queen Elizabeth II, Sabah, Malaysia, from 2012 to 2015. The patients' follow-up started from the date of surgery till the hydrocephalus is treated completely Parameters used are the dependency to the shunt and the occurrence of complications.

Statistical Packages for the Social Sciences Version 22.0. Chi squared test, Fisher's exact test.

**Results**: A total of 21 (42%) patients, EVD inserted and 29 (58%) VSGS inserted. Thirty-seven (74%) patients did not need a permanent shunt; 24 (64.8%) of them were from the VSGS group (P = 0.097). EVD patients developed more complications (44.1%) in comparison to VSGS (23.5%), with a statistically significant difference P = 0.026.

**Conclusions**: VSGS is a safe and a dependable way for adult hydrocephalus patient's treatment, with the ability to continue the treatment for such patients in non-neurosurgical centers or even discharge the patient home, as compared to patients with EVDs. This method does not have a statistical difference to avoid putting a ventriculoperitoneal shunt, VSGS has a significant less complications than EVD.

**Keywords:** Ventriculosubgaleal shunt (VSGS), intraventricular hemorrhage (IVH), External Ventricular Drain (EVD)

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## Introduction

Hydrocephalus is an excessive intraventricular collection of cerebrospinal fluid (CSF) in the brain as a result of increased rate of production and circulation or lower rate of absorption of CSF. The management may be challenging and complicated, depending on its underlying cause. Different management ways should be taken, ranging from temporary to permanent. Temporary ways, which are usually used in the treatment of acute hydrocephalus, like external ventricular drainage (EVD), Putting Ommaya reservoir, repeated lumbar punctures or ventriculosubgaleal shunt (VSGS). Every way of treatment has its advantages & disadvantages; to decide the way to choose depends on different variables, such as environmental, medical & patient factors. This retrospective study of acute hydrocephalus in adult patients, that is caused by different causes, patients treated by two kinds of treatments (VSGS and EVD), as a temporary method, in Hospital Queen Elizabeth between 2012 and 2015. We analyze the outcome according to avoidance of putting a permanent shunt, how many procedures needed, and what complications happened as a result of each treatment option.

## Methods and Materials

In our retrospective study, the data were taken from case notes of patients who were treated with temporary CSF conversion method using either EVD or VSGS during the period from June 2012 to December 2016 in the Neurosurgical Unit, Hospital Queen Elizabeth, Sabah, where the patients primarily treated with EVD as the first method, and clinically improved by checking Glasgow Coma Scale (GCS) or computed tomography (CT) brain findings. After putting EVD, we treated their causative pathology while trying to remove the EVD. As we know some hydrocephalus patients need longer time for the causing disease to resolve, the need for a VP shunt was yet to be considered. For patients who were still in need of EVD, we considered them for a second operation either by re-sitting of EVD (control group) or change to VSGS (study group).

## Patients Involved in the study

Adult patients were found to have acute hydrocephalus from clinical findings and confirmed by brain CT brain, who need a temporary CSF conversion and have a high expectancy to need a Ventriculoperitoneal shunt (VPS) in the future, such as:

1. Spontaneous intracerebral hemorrhage (ICH) with intraventricular extension (IVH)
2. Spontaneous subarachnoid hemorrhage (SAH) with or without IVH due to ruptured aneurysm diagnosed by CT angiogram
3. Hydrocephalus caused by infection that were considered by clinical findings & confirmed by CSF examination before doing surgery and
4. Hydrocephalus caused by severe head trauma.

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## Patients not involved

1. Congenital hydrocephalus 2. Hydrocephalus caused by old VPS with failure or nonfunctioning shunts 3. Infected hydrocephalus caused by old VPS 4. Hydrocephalus secondary to brain masses or tumors 5. Hydrocephalus resulted from ventriculitis that needed intraventricular antibiotics.

## Surgical Maneuver

The technique used for putting both EVD & VSGS were taken from the standard maneuvers usually done by most neurosurgeons & written in literature EVD [1] & VSGS. [2,3]. The EVD tubes for both EVD and VSGS were identical, using Codmann ventricular set, containing a (30 cm) ventricular catheter, a guide wire and a connector, no valve used. In Pictures (1) and (2) we can see some intraoperative procedures: the formation of good size subgaleal (10 cm × 10 cm) pouch and putting the VSGS tubes without any valve or connector sutured to periosteum. In Picture (3) we can see the normal functioning VSGS with formation of the subgaleal pouch.

Picture (1) Formation of subgaleal space

Picture (2) Suturing the tube to periosteum

Picture (3) The CSF pouch, bulge to the back to avoid frontal area for cosmetic reason

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The follow up findings after each treatment method for six-month period were collected and documented till the final decision to stop treatment as hydrocephalus was treated or the need to a permanent VPS. The end results findings by avoidance of VPS, modified Rankin scale (mRS) ((scale for stroke)), Intracranial complication like ventriculitis due to device itself, intracranial bleeding, blocked or felled tubing, leaking of CSF, and fits, also we have some Extra cranial complications like hospital related, ventilators related or IV-line related septicemia, cardiovascular complications and severe hypertension. The data then implicated in SPSS version 22.0, Chi squared test or Fisher's exact test was used as. The $P < 0.05$ was considered statistically significant.

## Results

Our study have involved cases of 50 patients. The data taken from case notes of patients with acute hydrocephalus admitted to Hospital Queen Elizabeth, between June 2012 and December 2016. We have 21 cases using EVD and other 29 using VSGS.

**Table (1)** shows medical specifications for each method of treatment. The patients were divided according to the cause of hydrocephalus & GCS, both had no statistical significance between the two treatment groups.

Table (1): Summary of demographic, medical specifications of each treatment option

| | EVD (%) | VSGS (%) | Total | P |
|---|---|---|---|---|
| **Total** | 21 (42.0) | 29 (58) | 50 | (100.0) |
| **Sex** | | | | |
| Male | 11 (22.0) | 20 (40.0) | 31 (62.0) | 0.233 |
| Female | 10 (20.0) | 9 (18.0) | 19 (30.0) | |
| Mean age (SD) | 46.6 (15.50) | 47.4 (16.32) | 0.887 | |
| **Cause** | | | | |
| Aneurysm | 4 (8.0) | 6 (12.0) | 10 (20.0) | 0.938 |
| Infection | 2 (4.0) | 4 (8.0) | 6 (12.0) | |
| IVH | 11 (22.0) | 15 (30.0) | 26 (52.0) | |
| Trauma | 4 (8.0) | 4 (8.0) | 8 (16.0) | |
| **GCS on arrival** | | | | |
| Mild (14-15) | 5 (10.0) | 4 (8.0) | 9 (18.0) | 0.344 |
| Moderate (9-13) | 6 (12.0) | 11 (22.0) | 17 (34.0) | |
| Severe (3-8) | 10 (10.0) | 14 (28.0) | 24 (48.0) | |

SD – Standard deviation; GCS – Glasgow coma scale; EVD – Extraventricular drainage; VSGS – Ventriculosubgaleal shunt; IVH – Intraventricular hemorrhage

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**Table (2)** shows the end results difference between these two treatment methods. In the VSGS group, we removed ventricular drainage from the patients without the need to put a VPS (13 from 21 patients who had EVD and 24 from 29 patients who had VSGS).

Even though there was no statistical significance (P = 0.097). Results in form of operations frequency needed to achieve the resolution of the hydrocephalus or the shifting to a permanent shunt were not significant for both treatment methods also. But, if we compare depending on the presence of complications between the two treatment methods, we can find a statistically significant difference, at a P = 0.008. In comparison between intracranial versus extra cranial complications we can find a significant difference for intracranial complications, in which the EVD patients developed a higher complication in comparison to the VSGS group (P = 0.022). Patients in whom we put EVD, 15 had intracranial complications as compared to 4 who had extra cranial complications. While the VSGS group, we found that 8 patients had intracranial complications, and other 12 patients had extra cranial complications.

From the intracranial complications, infection in form of meningitis or ventriculitis related to the device found in 8 (38.1%) cases in the EVD group, while only 1 (3.4%) came from the VSGS group. The organism found in the CSF cultures were Acinetobacter spp. for 7 cases, while the other 1 was Aerococcus spp. Other complication was EVD blockage in 3 cases (14.3%) and fell of tube in 3 cases (14.3%). One patient developed GCS deterioration, caused death after falling of the EVD. For the VSGS group, intracranial complications were fit in 3 cases (10.3%) and CSF leak from the operation sites in 2 cases (6.9%). One patient developed infection of the ventricular system (3.4%), one patient developed collection of CSFs in the posterior fossa after posterior fossa craniectomy and didn't respond to VSGS, it only treated with a permanent shunt. One patient developed failure as a result of tube kinked by surgical suture.

**Table 2: Summary of outcome in each treatment modality**

| | EVD (%) | VSGS (%) | P |
|---|---|---|---|
| Shunt requirement | | | |
| No VPS | 8 (38.1) | 5 (17.2) | 0.097 |
| VPS | 13 (61.9) | 24 (82.8) | |
| Total | 21 (100.0) | 29 (100.0) | |
| Number of procedure | | | |
| <4 | 14 (66.7) | 22 (75.9) | 0.475 |
| 4 or >4 | 7 (33.3) | 7 (24.1) | |
| Total | 21 (100.0) | 29 (100.0) | |
| mRS | | | |
| Favorable (0-3) | 5 (23.8) | 13 (44.8) | 0.126 |
| Nonfavorable (4-6) | 16 (76.2) | 16 (55.2) | |
| Total | 21 (100.0) | 29 (100.0) | |
| Cx | | | |
| Nil | 2 (9.5) | 9 (31.0) | 0.008 |
| Intracranial | 15 (71.4) | 8 (27.6) | |
| Extracranial | 4 (19.1) | 12 (41.4) | |
| Total | 21 (100.0) | 29 (100.0) | |

EVD – Extraventricular drainage; VSGS – Ventriculosubgaleal shunt; VPS – Ventriculoperitoneal shunt; Cx – Complications; mRS – Modified Rankin Scale

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## Discussion

In our study, the end result to shift to a permanent VPS are found to be more in the EVD patients in comparison to the VSGS patients; meanwhile this difference has no statistical significance. The need to a permanent VPS depends mainly on the causing factor of the hydrocephalus rather than on the way of CSF conversion that we used. The number of operations we use for the patients in our study was related to the cause of hydrocephalus and as well as the complications related to the EVD or VSGS. Even though, complications in patients with EVDs were much more than VSGS, more specifically for intracranial complications, in which tube-related meningitis was the most common. Extra cranial complications for both treatment methods were mostly the same and didn't give any statistical significance. Meningitis or ventriculitis caused by the device used was as high as 38.1% in the EVD patients as compared to only 3.4% in the VSGS patients. Our study showed a more significant rate of EVD-related infection in comparison with Hospital Kuala Lumpur (32.2%), [4] and 16.6% in University Medical Center Utrecht, Netherlands. [5] while, we observed a less frequent rate of VSGS-related infection in comparison to other studies. The infection rate in VSGS was found to be 66.7% by Willis et al., [6] 8.0% by Köksal and Öktem, [3] 5.9% by Tubbs et al., [7] 0% by Fulmer et al., [8] and Rahman et al. [9] the higher Infection rate in EVD was found to be higher than VSGS because EVD externalize the intraventricular space to the outside.

Meningitis related to the type of device used also makes higher number of operations frequencies for re-sitting of EVD, also needs a long period of hospitalization. It will make higher morbidity and mortality rate in an already ill patient in our neurosurgical ward. The other problem found in our follow up to our patients with VSGS was CSF leak from the operation site. The CSF leak has been found to be 16.6% by Willis et al., [6] 4.7% by Tubbs et al., [7] 5% by Fulmer et al., [8] and 29% by Köksal and Öktem. [3] our results give the frequency of CSF leak to be 6.9%, almost similar to the results in other literature. This problem may be controlled by being stricter to the suturing technique. [3] Leaking of CSF was found in two patients with EVD, in which the leak was from the EVD tube exit site not from the operation site. Leaking of CSF in EVD or VSGS may also give us a hint to increased intracranial pressure (ICP) or it's too bad suturing of the surgical wound. When CSF leaking is found, we need to find out if it is caused by increased ICP or it is due to tube dysfunction. Regarding the EVD, we can find out increased ICP by connecting the EVD directly to the ICP monitor machine. While in case of VSGS, it is more difficult to find out the patency & functioning of the device depends on clinical situation of the patient alone & will need a CT scan of the brain as by inspecting or examining the subgaleal pocket is not very accurate & may differ from person to person. That's why our hospital we used to put an EVD as the first method for CSF conversion, especially for patients came with a lower GCS. Other rare complications written in literatures were the formation of post-operative ICH. No ICH found in our VSGS

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patients while only one patient complained of ICH in the EVD. from literatures review, VSGS patients, the development of a new ICH was found in two cases (1.1%) by Tubbs et al. [7] and 5% by Fulmer et al., [8] whereas it was found in 1.1% of EVD cases by Daniel Sciubba. [1]. Our patient who had ICH after EVD was due to excessive drainage of the EVD that observed by a sudden increase in CSF flow to 200 mls in 4 h because the patient was moving and sits without clamping or changing the height of the EVD. After that, the patient developed a disturbed level of consciousness and pupils' changes that needed the evacuation of clot. Because of this dangerous & life-threatening complication, patients with EVDs must be strictly observed at the neurosurgical unit. While in case of patients with VSGS we can transfer them to other departments or hospitals to continue their care; that can even make the hospital stay less. In our place, VSGS we usually use it as the second option after we insert EVD or after craniotomy for the removal of clot or clipping of aneurysm. If the patient needs a longer CSF conversion of more than 8 days or in case the trial to remove the EVD failed, the second procedure is done, either by put back EVD or change from EVD to VSGS depending on surgeon opinion, because there are no clear-cut rules to find out which method is preferred for the patient. After we put the VSGS, our patients can continue treatment at other hospitals or even can discharge home with the VSGS put in place for a period of 3 months, as it is usually the needed time to clean the ventricles from blood, infection, or postoperative debris. After 3 months of putting the VSGS, and hydrocephalus is still found by clinical examination, and radiological indicaions, the VSGS is taken out and replaced by a VPS, as described by Sklar et al. [10].

In case that the hydrocephalus was found to be progressing clinically even by the presence of a functioning VSGS, then a permanent VPS is used even earlier than 3 months. while, if the hydrocephalus seen to be cured, the VSGS is left in site and taken out later as elective measure using local anesthesia only, or taken out at the same time when doing of cranioplasty.

To compare our study with other literature, in form of shifting to permanent VPS for the treatment of acute hydrocephalus, our study had 5 from 29 (17.2%) VSGS patients, excluding the two patients died. We compared to other studies: Sklar et al. had 90%, [10] Nagy et al. had 87.5%, [11] Rahman et al. had 80%, [9] and Fulmer et al. had 75%, [8] while in Köksal and Öktem had 60%. [3]

The reason why our lower number of permanent shunts needed in our study may be caused by our longer time of using VSGS of up to 3 months that gives time to the causative problem of hydrocephalus to settle. Also, the lower frequency of need for VPS for neonatal age group is a causing factor as the previous studies were taken in neonatal age group only. A review of the previous studies for VSGS & their complications & outcome for the need of permanent VPS is shown in Table 3, that is taken from Nagy et al. [11]

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**Table 3: Summary of results in the reported literature with >10 ventriculosubgaleal shunts**

| References | Causes PHH/all | Mean age (weeks) | Total Cx (%) | Infection Cx (%) | Mean duration of VSGS (days) | Mortality | VPS (%) |
|---|---|---|---|---|---|---|---|
| Andrea et al. | 72/102 | 27.3 | 15.2 | 8.3 | 87.9 | 4.2 | 87.5 |
| Fulmer et al. | 20/32 | 33/37.2 | 9.3 | 0 | 35.1 | 25 | 75 |
| Köksal and Öktem | 25 | 29.32 | 36 | 8 | 44 | 28 | 60 |
| Rahman et al. | 15 | 29 | NA | 0 | 9.16 week | NA | 80 |
| Sklar et al. | 62 | 29.8 | 42 | 10 | NA | 1.6 | 90 |
| Tubbs et al. | 71/185 | NA | 11.7 | 5.9 | 37.4 | 9 | NA |
| Our report | 21/29 | 47.3 years | 27.6 | 3.4 | 85.8 | 6.9 | 17.2 |

Cx – Complications; NA – Not available; PHH – Posthemorrhagic hydrocephalus; VSGS – Ventriculosubgaleal shunt; VPS – Ventriculoperitoneal shunt

## Conclusion

in Our study we found out that there was no significant difference in the form of avoiding putting a permanent ventriculoperitoneal shunt, but we found that the use of VSGS is more significant and has less intracranial complication.

**Conflict of Interests.**

**There are non-conflicts of interest .**

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