I. Introduction

The benefits of fine-tuned pressure adjustments for the post-surgical management of normal pressure hydrocephalus (NPH) patients are well known and made possible by using the CODMAN HAKIM Programmable Valve (CHPV). The CHPV, despite being called a “programmable valve,” is actually a differential pressure valve (DPV) that brings about complications of overdrainage (OD) which are difficult to adjust.

Our hospital acquired the SiphonGuard® (SG) from Codman/Johnson & Johnson. The SG was designed with the objective of preventing this siphoning effect inherent in the DPV. We predominantly use SIPHONGUARD for idiopathic NPH cases and would like to report our experiences with its use.

II. Characteristics of the CHPV with SIPHONGUARD

1. CHPV with SG Series

The SG can be acquired as a stand-alone unit and attached to an already existing shunt system (Figure 1A). In some units, the SG is attached to the outlet of a traditional CHPV system (in-line and right-angle type systems) (Figure 1B), allowing for options according to your environment.

This system is structured so that the flow-control device (the SG) is attached to the pressure-control device (the CHPV). By attaching the SG, the CHPV’s opening pressure will not be affected.

2. Basic Functions of the SIPHONGUARD

Within the SG there is a flow-control device that differs from the traditional anti-siphon device. There are two internal flow pathways in the SG: in a normal recumbent position the cerebrospinal fluid (CSF) passes through both the primary and secondary pathways, and in a standing position, when the CSF flow drastically increases, the primary pathway is closed, limiting the flow volume by only allowing passage through the secondary pathway. This is designed to prevent excessive CSF excretion (Figure 2A – D).
The pressure flow relationship for this system, in which the SG acts as a flow-control device, is shown in Figure 3. The flow-control is activated by the ruby ball when the CSF flow exceeds 40mL/hr within the system’s primary pathway, and is closed off at around 125mL/hr. This volume secures over twice the minimum normal CSF production volume, sufficiently guaranteeing the optimal CSF excretion volume.

Furthermore, after the primary pathway is closed, the secondary pathway becomes the only excretion pathway with approximately ten times the resistance. However, by using the necessary excretion volume as a standard based on the physiological CSF production, it assures a minimum of 20 – 30mL/hr, with a maximum of 40mL/hr of CSF excretion.

While the CHPV is merely a pressure control device, the SG solves the possibility of causing overdrainage from a flow-control standpoint, and is designed to assure the excretion of physiological CSF production volume even after the flow is restricted.

III. Experiences with Using the CHPV with the SIPHONGUARD

There are 3 points that need to be taken into consideration during surgery. ① In order to enable a small amount of normal saline solution into the system, we use a 1cc syringe. The injection speed according to the instructions is 0.5cc/min. ② In order to keep the secondary pathway from closing during the surgery, while puncturing the ventricle we attach the valve, after confirming the CSF excretion does not contain red blood cells, etc. ③ After attaching the unit, with the stand-alone CHPV, the CSF excretion can be confirmed by a pumping action, however, the natural excretion needs to be checked with the system with the SG attached.
2. A: SIPHONGUARD Schematic. SIPHONGUARD as flow-control device is a unique new device for preventing excessive CSF flow during positional changes. B: Flow through Primary pathway shown here in Yellow. C: Secondary pathway: The inlet to the 2nd pathway is always open. D: CSF travels down an outer spiral then flows upward along an inner spiral and exits just below the ball.

3. Pressure-Flow relationship in CHPV with SG. Each line shows SG operating resistances when CHPV is set at 30 & 200mmH₂O.
We have used the CHPV system with the SG for VP shunt treatments in 25 cases of iNPH. As a rule, we have generally set the initial pressure settings at 100mm H\textsubscript{2}O, but depending on the circumstances we have altered this. We have not yet encountered a case where the patient reported headaches upon standing, as was often experienced traditionally.

The actual pressure setting range is from 150 – 40mm H\textsubscript{2}O, but one can safely set the pressure to 40-60mm H\textsubscript{2}O without concern. However, we had one case of a subdural hygroma without any symptoms in a slim patient where the pressure change from 100 to 150mm H\textsubscript{2}O kept the patient from having problems (Figure 4).

As can be seen, it seems that the graphical OD signs do not disappear with the use of the SG. However, this cannot be avoided because the DP valve is a non-physiological OD system.

IV. Summary

Most DP valves, including the CHPV valves, inevitably bring about OD problems due to their siphoning effect. The optimum pressure setting for the CHPV is the apparent equilibrium point of the counterbalance between the decreased flow rate of the supine position and the overabundant flow rate of the standing position encountered in the patient’s daily activities. With a SG attached CHPV, by preventing OD when standing, the pressure setting is based on the CSF pressure when supine.

At first we worried about underdrainage when using the SG, but as of yet this has not been a problem. This leads us to conclude that the shunt flow rate when supine is sufficiently secured even while using an estimated value. The unit is relatively low profile, presenting no limitations to attachment locations, and in clinical use, giving the impression of being rather user-friendly.

The SIPHONGUARD as a flow-control device resolves the overdrainage problem inherent with standing, and is expected to improve the quality of life for patients with headaches and anxiety arising from everyday activities. We find the SIPHONGUARD to be a safe physiological shunt system that is easy to use with NPH cases.