



Proposal of a Cleanable VP Shunt for Hydrocephalus

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Abstract

The aim of this paper is to propose a cleanable ventriculoperitoneal shunt (VP shunt) system that uses simple methods to reduce shunt replacement operations due to obstructions.

Keywords: Ventriculoperitoneal shunt; Obstruction; Hydrocephalus; Siphon shunt

Introduction

Cerebrospinal fluid (CSF) is produced by choroid plexus normally a 500 cc / day. The flow of the CSF in hydrocephalus is disturbed wither by an over production of CSF, or an obstruction in the pathways, or a weak absorption of the CSF in the arachnoid granulations in the superior sagittal sinus (SSS). The hydrocephalus can be communicated (i.e. the ventricular system connected with the subarachnoid space) or non-communicated (i.e. the ventricular system is not connected with the subarachnoid space due to an obstruction). One of the treatments for hydrocephalus is using a Ventriculoperitoneal Shunt (VP shunt). A VP shunt can work in best cases for two years, then the patient will need to undergo a surgery to remove the shunt and replace it with a new one [1]. Usually, a VP shunt will malfunction due to an infection or an obstruction [2]. The aim of this paper is to propose a new VP shunt design that will decrease the chances of needing to go to a shunt replacement surgeries.

A Proposal of the Shunt Design

The shunt is design to allow a full access to the entire shunt length by placing two accesses that allow going to one direction. One of the accesses is opened cranially and one is opened caudally. The tube is passing subcutaneously until it opens with two accesses behind the ear. The cleaning accesses must be in a rubber or plastic box behind the ear which has the same skin color

of the patient. The hygiene of this area (i.e. access area) is very important for the patient's health. The area must be kept dry and clean especially after taking showers or swimming. The skin on the edges of the access must be regularly checked and cleaned with a disinfectant. The abdominal part of the VP shunt has multiple openings, one is the main big two opening and the rest of them are accessory openings that are design to allow more flow. There are two cleaning wires; one for the cranial tube and one for the abdominal tube. Each tube's wire has a red mark showing the length of the tube. During cleaning the insertion of the cleaning wire should not cross the red mark. Crossing the red mark on the wire can allow the wire to hit the brain parenchyma (i.e. in cleaning the cranial part of the tube) and cause bleeding or cause penetration of the abdominal wall or intestinal perforation (i.e. in cleaning the abdominal part of the tube). The catheter is made from stainless steel which is thick, flexible, and strong to be impenetrable, while using the cleaning wire. Cleaning the tube will help in cleaning and removing the accumulating protein on the tube's wall. Sometime, a broken part of the choroid plexus is vacuumed into the VP shunt which causes shunt obstruction which can be removed by the cleaning wire. The catheter is coated with poly methyl methacrylate (PMMA) inner and outer surface of the tube which prevent infection & inflammation in the tube and works to prevent adhesion of the CSF protein to the catheter wall which will lead to obstruction. Practically, stainless steel can be coated with plastic. The whole shunt is one part so no

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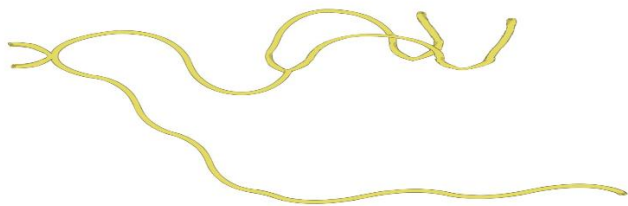


Figure 8: An illustration of the VP shunt which has no devices or battery attached to it.

The “S” shaped siphon filter will prevent air from entering the tube until it has a high pressure to overcome the CSF which will prevent any Airlock in the tube. The tip of the ventricular part of the shunt is placed in a superior location at the roof of the lateral ventricle to prevent siphon effect which will lead to subdural hematoma. The tube can have two cranial heads or one based on the necessity. The two heads will decrease the chances of an obstruction to occur. The siphon shape will prevent any siphon effect “over-drainage” of the CSF because the tip of the tube is placed in a superior position in both lateral ventricles which will work in a standing or supine position. Both tubes are fixed to the skull firmly to prevent any displacement of the tube. The neurosurgeon who is placing the VP shunt must make sure of the accurate position of the shunt and the fixation of the shunt to the skull very well to avoid displacement of the shunt. The VP shunt has a one way valve in the abdominal part of the shunt to prevent any return of any fluid from the abdominal cavity to the brain. The one way valve will allow cleaning of the abdominal part of the shunt. In cases of shunt obstruction of the cranial part, a trendelenburg position must be applied which may remove the obstruction. If that did not work, a cleaning wire of the shunt is required. The one way valve will prevent of any fluid return from the abdomen in the trendelenburg position. Flushing of normal saline might be used in trendelenburg position. If that maneuver did not work, the neurosurgeon in charge can start using the wire cleaning technique. The benefit of this shunt is decreasing the risk of having any cranial part obstruction by 50%. The cranial part of the shunt usually is the most obstructed part. As well, due to presence of too many holes on the distal part of the abdominal part, it will decrease the percent of having an obstruction in the abdominal part of the shunt. The shunt is very cheap because it has no technology, digital devices, or battery see (Figures 1-8).

Conclusion

This design needs to be tested, evaluated in a clinical trial, then get approved by the Food and Drug Administration (FDA). The design theoretically will decrease the chances of tube obstruction in the cranial part by 50% by placing two cranial parts. The cleaning process of the VP shunt will require a thorough

cleaning process to prevent any infection. A firm fixation of the shunt to the skull will prevent any shunt-malposition. The shunt will be very cheap and it has no technologies or digital devices.

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