Ventriculosagittal-Sinus Shunt

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In an effort to palliate or correct progressive hydrocephalus with its diverse etiologies, numerous and often ingenious methods have been devised to by-pass the obstruction to the passage of cerebrospinal fluid or to divert the fluid to a new bed of absorption. Although some of these procedures are now a part of the history of neurological surgery, many still are being used but often they are limited or restricted to a specific set of factors such as: sex (fallopian-tube shunt); normal or adequate bed for absorption of cerebrospinal fluid after by-passing the block (Torkildsen shunt); two normal kidneys, and an intelligent informed family (ventriculo-ureteral and lumbar subarachnoid ureteral shunts). In addition, a major problem common to almost all shunts utilizing a foreign-body tube for transmission of the fluid has been obliteration or obstruction of its working ends, requiring patience and perseverance on the part of the patient and the surgeon and often terminating in an unsuccessful result. As early as 1908, Payr reported on 3 patients in whom he had connected the lateral ventricle to the longitudinal sinus with a segment of saphenous vein. Even though these patients all died within 4 months, autopsy showed that blood had not refluxed into the ventricle and the sinus was not thrombosed. Haynes, in 1913, reported on connecting the occipital sinus to the cisterna magna in 1 patient and connecting the cisterna magna to an emissary vein. Both attempts were unsuccessful. Cushing referred, in 1926, to an attempted connection of the 3rd ventricle to the longitudinal sinus with a tube passed through the corpus callosum. He observed that blood did not reflux into the 3rd ventricle. In 1948 Ingraham et al. reported their experience with polyethylene shunts from ventricle to sagittal sinus in dogs. When the shunts were observed 6 to 42 days later all tubes were clotted from refluxed blood. However, with the advent of the modern ventriculovenous shunts, a new era has been entered and the treatment of hydrocephalus, regardless of cause, is carried out actively in most clinics. It would appear from the current literature that the utilization of the distal-valve (Pudenz-Heyer) shunt or the proximal-valve (Spitz-Holter) shunt has increased significantly the chances for useful survival of these patients over those for a comparable group of patients and has provided the neurosurgeon with a relatively simple operative technique. It has been pointed out by Strenger that in spite of an almost universal application of ventriculovenous shunting, relatively little has been published pertaining to the complications or difficulties encountered utilizing these procedures. Although the ventricular portion of the shunt, regardless of the type used, may occasionally become obstructed by fragments of brain, blood clot or debris from a previous ventriculitis, or the occasional unusual problem when a tube migrates proximally or distally, the usual source of difficulty is at the delivering end of the shunt. This is usually a result of obstruction by reactive tissue or of dislodgment of the shunt with active linear growth of the patient. The ventriculovenous shunts have presented a number of complications or technical problems during operation or in the postoperative period. These problems have ranged from folding of the tube upon itself, diversion into the subclavian vessels, difficulties in accurate placement into the auricle, formation of atrial ulcerations, mural thrombi, or similar lesions of the tricuspid valve which have led to embolization, or, when infected, to a bacterial endocarditis, as well as the unusual complication

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reported by Strenger,\textsuperscript{24} whereby the cardiac limb of the shunt perforated the ventricle. These shunts have been handicapped by the linear growth of the patient, especially if the procedure was instituted in early infancy with a progressive cephalad migration\textsuperscript{17,18} of the tube.

In an effort to utilize a shunting procedure which would be affected minimally by factors of growth and yet maintain the desirable delivery point of cerebrospinal fluid in the vascular system and utilize available materials for shunts, the ventriculosagittal-sinus shunts were done.

**Procedure**

The hydrocegalphic infant has a complete examination similar to that advocated by Ingraham and Matson.\textsuperscript{9} During this evaluation a sinogram is done by percutaneous technique utilizing a pediatric scalp-vein needle and plastic set-up and one of the contrast media. Anteroposterior and lateral films are made with the injection timed so that the outline and size of the superior sagittal sinus, torcular, lateral sinuses, sigmoid sinuses, and usually the beginning portions of the jugular vein are well visualized. During the course of evaluation, the hydration and nutritional status of the infant are observed carefully and any necessary corrections are made before actual surgical intervention. Of the two, proper hydration of the infant is the more important. On the day of operation, the total head is prepared and the infant is placed on its back on the operating table with a small folded towel placed beneath one shoulder in order to place the head adequately in a three-fourths lateral position without twisting the neck excessively. The procedure can be done adequately under local anesthesia supported by the usual appropriate preoperative medications. A small curved flap is made with its apex directed towards the midline, but 3.0 cm. lateral to this point and posterior to the anterior fontanelle. This flap is planned in such a manner that it will be larger than the underlying flushing device on the infant type of Pudenz-Heyer shunt. This same flap may be placed more posteriorly if a shorter than standard infant type of shunt is used. Pericranium underlying the midpoint of this flap is incised and a small burr hole is placed and adequately enlarged to accommodate the flushing device. The desired length of the ventricular portion of the shunt is cut, tied with ligatures to the flushing device, and after incision of the dura mater and pia mater is carefully inserted into the ventricular system. In order to prevent excessive loss of fluid, a small portion of the cut tubing is placed on the vascular end of the flushing device and clamped with a rubber-shod clamp. A small transverse incision is made overlying the midline, usually at a point 6.0-8.0 cm. anterior from the torcular Herophilus, and careful dissection is carried down to the sagittal sinus. Whatever bone necessary to allow adequate exposure of the sinus is removed at this time. The vascular end of the shunt is checked with normal saline to determine competency as well as the approximate resistance of the valve. This portion of the shunt is then filled with saline or contrast medium and clamped with a rubber-shod hemostat in order to prevent loss of the fluid. The sagittal sinus is incised with a #11 blade, spread carefully with a small curved mosquito hemostat and the valve is placed into the sagittal sinus and advanced to the predetermined distance so that the valve will lie at the torcular Herophilus. This can be checked by lateral roentgenograms and compared with the sinogram when contrast medium is in the shunt. If care has been used upon placement of the valve safely into the sinus, the hemostat usually is removed and the remaining portion of the tube advanced so that there is no bleeding nor any need for suture materials. Any minor ooze can be controlled readily with one of the standard hemostatic agents or muscle. The vascular catheter is passed under the scalp and joined to the flushing device. The flushing device is then fixed by suture to the pericranium. The galea and skin are closed in the usual manner (Figs. 1 and 2). Postoperatively the hydration of the patient is watched carefully to prevent any