The retrograde ventriculosinus shunt: concept and technique for treatment of hydrocephalus by shunting the cerebrospinal fluid to the superior sagittal sinus against the direction of blood flow

Preliminary report

Introduction

On theoretical and experimental bases [4, 6], it has been concluded that the most nearly physiological way of treating hydrocephalus is to establish a watertight connection that will deliver the CSF into the upper end of the internal jugular vein (IJV) or into a dural sinus against the direction of blood flow, i.e. to establish a retrograde ventriculoujugular (RVJ) or a retrograde ventriculosinus (RVS) shunt, respectively.

During the 8th and 9th decades of the twentieth century, RVJ shunts were implanted [5, 7]. There were no problems related to incorrect CSF drainage or the thromboembolic complications that beset ventriculovenous (VV) shunts with particular frequency. However, implantation of the RVJ shunt was very difficult, and quite often impossible, in infants and young children, because of the small caliber of the neck veins. Further more, in the young patients in whom an RVJ shunt could be implanted, shortness of the intravenous catheter segment, together with rotatory movements of the head and the rapid rate of longitudinal body growth, predisposed to slippage of the shunting catheter out of the vein. It became obvious that infants and young children were not suitable candidates for implantation of RVJ shunts, and it was decided to implant RVS shunts and not RVJ shunts in all patients.

Patients, materials and methods

Patients and methods

This study was carried out on 56 hydrocephalic patients, 35 of whom were under 1 year of age. The cranium was considered compressible in 30 patients and rigid in 26. The RVS shunt was implanted regardless of cause, type, degree, or duration of the hydrocephalic process. Patients suffering from associated congenital anomalies were excluded from this study. The patients were evaluated before and after surgery by clinical examination and computed tomography (CT) scans. Ultrasonography, transcranial Doppler (TCD) and measurements of Pourcelot’s resistive index (RI) were done before and after the operation, and also in the follow-up studies in the case of patients with compressible craniums. The RI was recorded after surgery in 7 of the patients with rigid craniums. Magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) were performed at variable intervals after shunt
implantation in 8 and 6 patients, respectively. Valveless shunting catheters (Fig. 1B) were used to establish the connection. Histoacryl Blau was used around the shunting catheter to insure hermetic sealing of the dural hole in 25 of the patients. The longest follow-up period is 8 years so far.

Surgical technique

Reference to Fig. 1 is important for clear understanding of the operative technique. Under general endotracheal anesthesia, the patient is placed in the supine position and the table is tilted to raise the head through 30–40°. The skin flap is mapped to expose the SSS and the site of the dural hole for catheter insertion into the ventricle. In infants and young children less than 6 months old, the skin flap is placed in the posterior parietal region so that the shunting catheter can be introduced into the more capacious posterior part of the SSS. In older patients, a frontal skin flap may be used to introduce the catheter into the SSS anterior to the coronal suture.

The skin and periostium are reflected backward as separate flaps, exposing 1–2 cm of the SSS roof. In infants and young children the outer fibrous layer of the sinus roof is split longitudinally (S.O.F.L.S.R. in Fig. 1A) for 1 cm to expose the endothelium lining the sinus roof, and a ligature (Lig. in Fig. 1A) is passed in the split leaves of the outer fibrous layer of the sinus roof and is left untied. The dura mater (DM in Fig. 1A) is exposed 3 cm to the right of the exposed sinus roof. A small hole (D.H. in Fig. 1A) is made in the center of the exposed dura mater, which should have a smaller diameter than the shunting catheter. The stylet (St. in Fig. 1B) is introduced into the catheter to lodge in the depression (D in Fig. 1B) on the inside of its ventricular end. The catheter is stretched over the stylet to make it thinner during its passage through the small dural hole. The stretched catheter is introduced into the anterior horn of the lateral ventricle, and when its tip is seen on intraoperative ultrasonography to be well placed, the catheter is released to allow it to re-coil and regain its original diameter, so that it fits snugly in the small dural hole and hermetically seals it. Fibrin glue may be used to insure hermetic sealing of the dural hole around the catheter. The stylet is then removed and saline is injected into the ventricle to raise the intraventricular pressure (IVP) and make sure that there is no CSF leakage from around the catheter. A bulldog clamp is applied to the catheter to prevent loss of CSF and to maintain the high IVP. The catheter is passed in a smooth curve to the exposed sinus roof. A small hole is made in the endothelial lining of the sinus roof, anterior to the untied ligature in the leaves of the split outer layer of the sinus roof. The catheter is introduced into the sinus and is advanced into it for a distance of 4–5 cm. Bleeding from around the catheter is controlled by Gel-foam. The bulldog clamp on the catheter is removed, allowing CSF to flow from the ventricle, where the pressure is high, into the sinus. The untied ligature (Lig. in Fig. 1A) is tied under the catheter, not over it, as otherwise the catheter may compress the endothelial lining of the sinus roof and occlude the sinus. The periosteal flap is sutured back over the catheter, and the skin is closed in layers.

Observations and results

The shunt was improperly implanted in 6 patients. It was revised in 4 infants during the 1st postoperative week. In 3 of these infants, CSF leaked and collected under the scalp because of imperfect sealing of the dural hole around the catheter; blood was regurgitated and clotted into the sinus end of the shunting catheters. In the 4th infant the manifestations of high intracranial pressure (ICP) persisted and the RI remained high after shunt implantation, because the ligature drawing together the leaves of the split outer layer of the sinus roof (Lig. in Fig. 1A) was wrongly tied over the catheter, and not under it as it should be, which compressed the endothelium lining the sinus roof and occluded the sinus. The shunt was revised in a 5th infant 2 months after its implantation because the manifestations of high ICP recurred, the RI increased, and a soft localized swelling appeared over