Ventriculoauriculostomy for Infantile Hydrocephalus Using a Direct Cardiac Approach

Technical Note

Darrel Weinman, F.R.C.S.(Ed), (Eng),* and A. T. S. Paul, F.R.C.S.(Ed), (I), (Eng)†
General Hospital, Colombo, Ceylon

Ventriculoauriculostomy with a Spitz-Holter⁵ or a Pudenz valve⁶ is extensively used for the treatment of infantile hydrocephalus. Nulsen⁷ states that accurate placement of the cardiac tube within the center of the right auricle is an essential part of the operation. The classical method of introducing the tube via either the jugular or the common facial vein requires the use of special techniques to ensure that the tube is in the auricle.

MacNab⁵ recommended special calculations based on preoperative radiography of the chest. The allowances made for magnification and for the difference in the external measurements of the chest wall as compared to the true jugular-auricular distance, however, lead to errors that make accurate placement uncertain. Pudenz, et al.,⁷ and Anderson⁴ recommended x-ray studies during operation using Hypaque injected into the lumen of the tube, after it had been placed at the estimated depth. Robertson, et al.,⁸ have enumerated several objections to this method and have described an electrocardiographic method to ensure accurate placement of the cardiac tube.

A transthoracic direct intra-auricular introduction of the cardiac tube is the technique now used at this hospital for the accurate placement of the tube within the center of the right auricle. This is a combined procedure performed by a neurosurgeon and a thoracic surgeon. The results of 42 cases operated on since January, 1964, have justified the continued use of this method.

Operative Technique

A general intratracheal anesthetic with controlled respiration is used. The patient is in a semilateral position with the right side up and the neck slightly extending over a sandbag (Fig. 1). The skin over the cranium, neck, and front of the chest is prepared. The neurological surgeon makes an inverted "hockey stick" incision on the right, which extends upwards from the mastoid to the posterior parietal region. The scalp including the pericranium is retracted with the aid of two self-retaining retractors. A scalp incision is then made at the summit of the exposure, and a small stab incision made in the dura. The ventricular tube of the shunt apparatus is introduced into the right lateral ventricle and a primed Spitz-Holter or Pudenz valve connected to this ventricular tube. The cardiac tube is connected to the other end of the valve, and cerebrospinal fluid then drips...
through the end of the cardiac tube, ensuring a working mechanism.

Simultaneously, the thoracic surgeon makes a right submammary skin incision extending from the right sternal edge medially to a point between the anterior and mid-axillary lines laterally. The breast and the pectoral muscles are detached from the fifth rib and retracted to expose it. The periosteum on the anterior aspect of the fifth rib is incised longitudinally with diathermy and a curved periosteal elevator used to reflect it upwards. The fourth intercostal space is now opened via the bed of the fifth rib. A rib spreader is used to enlarge the exposure, with the fourth coastal cartilage incised near its junction with the rib, if necessary.

With the aid of a small “step-ladder” cervical incision, a subcutaneous tunnel is then constructed with a blunt dissector from the thoracotomy to the craniotomy wound, and the cardiac tube brought subcutaneously from the cranial to the thoracic wound.

The upper lobe of the right lung is retracted downward and laterally to expose the pericardium over the right atrium. The pericardium is incised longitudinally over the right atrium, anterior to the phrenic nerve. The tip of the auricle is grasped with a pair of Duval’s forceps and a non-crushing auricular clamp (mitral clamp) is applied across the base of the auricle, thus isolating it from the rest of the atrium. A purse-string suture 1 cm in diameter of 0000 braided silk is inserted on a semicircular round bodied needle (arterial suture) into the lateral wall of the auricle, near its tip. A small stab incision is made in the center of the purse string with a tenotomy knife.

The cardiac tube enters the thorax through the medial end of the thoracotomy incision. The length of cardiac tube is now estimated and a loop allowance made for growth. The length of the loop is such that it equals the diameter of the right auricle. When the tube is trimmed to the desired length, a ligature (black silk) is used to mark a distance from the end of the cardiac tube, which is half the anteroposterior diameter of the right atrium. This is the estimated intracardiac length of the tube, which ensures that it will lie in the center of the right auricle. The cardiac tube is now introduced into the auricle through the stab incision, up to the estimated depth; the purse string is tightened and ligated around the tube. The ends of the suture are wrapped around the cardiac tube and ligated again to prevent the tube from being pulled out of the auricle (Fig. 2).

The flow of cerebrospinal fluid is checked at this stage by pumping the valve. The pericardium is sutured with interrupted silk sutures, with large gaps left for the free escape of postoperative exudates from the pericardial cavity. The lung is expanded by the anesthetist, and the intercostal muscles are approximated with continuous catgut except for the medial corner where the cardiac tube will enter the thoracic cavity through the anterior intercostal membrane; this will avoid constricting the tube. The pectoral muscles and subcutaneous tissues are sutured separately with interrupted catgut.

The valve is anchored to the pericranium of the cranial wound; it is then checked
once again by pumping it. The cranial, cervical, and thoracic wounds are closed with interrupted skin sutures. No intercostal drainage tube is used.

Postoperatively, no drainage is necessary, and antibiotics are not usually required. Sutures are removed in 6 days. A postoperative chest x-ray in 24 hours ensures the absence of pneumo- or hemo-thorax.

Discussion

Accurate placement of the cardiac tube in the center of the right auricle is essential in ventriculoauriculostomy for hydrocephalus. Nulsen observed that thrombosis was likely if the end of the tube lay too high in the auricle, near the caval junction or in the superior vena cava or jugular vein. This not only led to failure of the shunt mechanism but also facilitated pulmonary embolism; moreover, if the tube was too low, near the point of entry of the portal blood stream into the auricle, septicemia was likely to develop.

Even with an accurate placement, continued growth of the infant leads to displacement of the tube upward into the vena cava and a late failure of the shunt. To combat the problem of growth, Nulsen recommended the elective annual removal of the cardiac tube and its replacement by a longer tube. In infants particularly, the jugular vein rather than the common facial vein may have to be used as the site of entry of the cardiac tube into the venous system; ligation of the jugular vein around the tube interrupts a major route of venous drainage from the cranial cavity.

The thoracic route we use for the introduction of the cardiac tube under direct vision into the center of the right auricle has several advantages over the methods previously described:

1. The tube is placed exactly in the center of the right auricle.
2. Allowance can be made for growth by leaving a loop of the cardiac tube within the pleural cavity (Fig. 3).
3. There is no interference with venous return from the cranial cavity.
4. There is no possibility of either immediate or late jugular or caval thrombosis.

Of the 42 patients treated by this method, two died (4.5% operative mortality) from postoperative pulmonary infections. One other case developed a pneumothorax, probably due to accidental pulmonary trauma, which was easily treated by aspiration. The other 39 patients in the series (95%) tolerated the procedure well.

In the late follow-up, which has ranged from 6 months to 2 years after operation, only one case has needed a revision of the shunt. This was an infant who had a hydro-thorax 10 months after the operation. The shunt was working satisfactorily, but a collection of cerebrospinal fluid was seen in the right pleural cavity. At re-exploration the cardiac tube was found to have been pulled out of the auricle because suitable allowance had not been made for growth. Cerebrospinal fluid was draining freely into the

Fig. 3. A diagrammatic representation of the trans-thoracic direct cardiac shunt, demonstrating the loop allowance made for growth.
pleural cavity, forming a collection of 500 cc which showed no signs of absorption. Withdrawal of the tube from the auricle had produced no hemopericardium or hemothorax. A longer cardiac connection with a loop allowance for growth was reintroduced into the right auricle with good results. None of the other cases, of which 18 have now been followed for over 1 year, has needed reoperation.

**Summary**

Accurate placement of the cardiac end of a ventriculauricular cerebrospinal fluid shunt can be ensured by the use of a transthoracic direct cardiac approach. The results obtained in 42 cases with this method have justified continued use. So far, annual revisions have been unnecessary when a sufficiently large loop has been left in the cardiac tube to accommodate future growth of the child.

**References**