Closure of cerebral incisions following intraventricular operations

Technical note

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Ventricular collapse following intraventricular surgery is a formidable complication. In patients with significant dilation of the lateral ventricles, the operative mortality may exceed 40%. In the current report, a technique for closing cerebral incisions is described which has prevented this complication in 18 intraventricular operations in which it has been used. The essential steps include: 1) linear incision of a cerebral gyrus; 2) closure of the incision using bordering vessels for traction; 3) inflation of the ventricles with saline; and 4) attachment of the incision to the overlying dura.

KEY WORDS • ventricles • hydrocephalus • cerebral incision • cerebral wound • cerebral suturing

ONE of the more serious complications attending intraventricular operations, and an occasional cause of sudden death, is the escape of ventricular fluid out through the cerebral incision and subsequent collapse of the ventricular system. This is especially likely to occur when the cerebral mantle is thin and when the ventricles are enlarged or under increased pressure. In the past, for example, when the choroid plexuses of the lateral ventricles were routinely removed for hydrocephalus, even the most skillful surgeons reported high operative mortalities: 75% in Dandy’s experience with four patients,1 43% in Davidoff’s series of 32 cases,2 and 46% in Sach’s series of 90 cases.4 Although such operations are rarely done today, numerous other operations are still performed in which the ventricles are entered by design or error. In such cases, if the ventricles are enlarged, it may become desirable to close the cerebral incision to reduce the risk of ventricular collapse. The following account describes a simple technique for closing cerebral incisions which enter the ventricular system.

Clinical Material
The technique reported herein was used in 18 intraventricular operations on 10 patients with severe hydrocephalus. In one patient, a 4-month-old child with tuberous sclerosis, a tumor obstructing the right foramen of Monro was excised through a right frontal craniotomy. In another patient, a 9-year-old boy with precocious puberty, a third ventricle tumor was removed through a similar exposure. In both cases, the right lateral ventricle was entered through the middle frontal gyrus. In the remaining eight patients, a bi-
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lateral choroid plexectomy was performed for progressive hydrocephalus (most of the patients had ventriculitis and were not candidates for ventricular shunts). An occipital craniotomy was carried out and the lateral ventricle of one side was entered through a posterior occipital gyrus. At a second operation, usually 1 week later, the choroid plexus of the opposite ventricle was removed.

All 10 patients had pronounced hydrocephalus. The cerebral mantles varied in thickness from 0.8 to 2.5 cm at the point of the incision, and intraventricular pressures varied from 80 to 270 mm of water. With one exception (the patient with tuberous sclerosis), enlargement of the two lateral ventricles was symmetrical.

**Technique**

Whereas cerebral tissue has little tensile strength and will not hold an ordinary surgical suture, cerebral vessels can frequently be used to approximate opposing sides of a cerebral wound. Sulcal veins, for example, are usually of such size and strength that they can be used for traction when closing an incision through a cerebral gyrus. With this in mind, it is important initially to select a cerebral incision which is bordered on two sides by vessels of sufficient dimensions to make a complete closure of the wound feasible.

**Cerebral Incision**

In our series, the most satisfactory incision was one through a cerebral gyrus, between the sulcal vessels and parallel to them (Fig. 1). The length of the cerebral incision did not seem to increase the difficulty of the subsequent closure, although the width did. It was easier, for example, to close a long narrow incision than a short, wide one. Hence, a linear incision through a gyrus, rather than a "core" incision, was favored. Allowing for an ample margin of tissue on the incision-side of the sulcal vessels also produced a better seal when the vessels were eventually approximated.

Once the cerebral incision was made, care was taken to prevent ventricular collapse upon evacuating the ventricle of cerebrospinal fluid. Retractors were placed at convenient intervals so that the cerebral mantle was held gently but firmly against the undersurface of the skull. Once in place, the retractors were held immobile by surgical assistants to avoid undue trauma to the margins of the wound.

**Cerebral Closure**

For closure of the cerebral incision, No. 5-0 silk on fine dural needles was used. The needle was passed through the cortex lateral to a sulcal vein and was recovered through the incision. As the needle was passed through the cortex, it was coagulated with electrocautery to avoid bleeding from subcortical vessels and to establish an eschar for the tract of the suture. In cases where the cerebral mantle was especially thin (less than 1.5 cm), the needle was carried down through the ependyma. From within the wound, the needle was then passed up through the cortex (or ependyma and cortex), and around the sulcal vessel of the other side of the wound. It was generally evident that both coagulation of the needle tract and inclusion of the ependymal layer in the bite of the needle added to the over-all strength of the closure.

Once the cerebral incision was closed as completely as possible, one suture, usually from the central portion of the wound, was brought up through the dura as a tacking suture (Fig. 2). The ventricular system was then reinflated with saline through a long,
FIG. 2. A tacking suture from the cerebral incision is brought up through the dura and tied down just before completion of dural repair.

thin-bore needle and the dura was closed routinely. Just before completion of the dural closure, the dural tacking suture was tied down to maintain the hemisphere up against the undersurface of the skull.

Discussion

The foregoing technique has now been used in 18 intraventricular operations for severe hydrocephalus. To date there have been no operative deaths, and as far as can be determined, there have been no neurological deficits related to the surgery. (In patients undergoing bilateral choroid plexectomy, it is assumed that a visual deficit was produced; such deficits, however, cannot be distinguished at this time because of the patients' ages.) The current experience stands in contrast to the high operative mortality of similar operations in which ventricular collapse has been a frequent complication.\textsuperscript{3,4}

Evidence of Effectiveness

On the basis of the following evidence, we conclude that the surgical closure of transventricular cerebral incisions is an effective and reasonably safe way to reduce the risk of ventricular collapse. In six patients of this series, \textsuperscript{123} RISA ventriculograms were performed before and after bilateral choroid plexectomy (2 to 5 weeks later).\textsuperscript{3} In each patient the postoperative scan demonstrated full expansion of the ventricular system, and in no patients were significant changes in ventricular contour or volume evident following surgery. In particular, the postoperative scans revealed no evidence of extravasation or abnormal uptake of RISA in the area of the cerebral incisions. In five of these patients, air ventriculograms were performed postoperatively (5 days to 6 months later). These studies confirmed the findings of RISA ventriculography although in two cases there was some irregularity of the ventricular surface of one or both occipital horns. Over-all, there was no inordinate scarring and no evidence of porencephaly. One patient undergoing bilateral choroid plexectomy for severe hydrocephalus and ventriculitis (\textit{Pseudomonas aeruginosa}) succumbed to her infection 5 weeks later. Autopsy revealed complete expansion of the cerebral hemispheres and well-healed cerebral incisions. The vessels of the cortex adjacent to the wounds appeared normal and the two sacrificed gyri, including the bordering sulcal veins, were reduced to fibroglial scars measuring less than 0.5 cm in width. The thickness of the cerebral mantle was uniform throughout, and as far as could be determined, there was no vascular compromise to neighboring gyri.

Comments on Technique

In performing intraventricular operations through a thinned-out mantle, several steps in the procedure deserve emphasis. The cortical incision must be carefully planned. Before evacuating the ventricles of cerebrospinal fluid, retractors should be placed around the wound to hold the cerebral mantle securely against the inner table of the skull. Failure to do this may result in "fracture" of the cortex and extend the cerebral incision unnecessarily. Finally, the closure of the cerebral wound should include, if possible, a tacking suture to the dura.

It should be emphasized that the surgical repair of cerebral incisions is not proposed as a routine procedure. In cases in which collapse of the ventricles is unlikely to occur, closure of the cerebral wound is unnecessary. It should also be admitted that the long-term consequences of cerebral suturing...
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have not been assessed. Although cerebral seizures have not been reported as a postoperative complication (two patients who had seizures before surgery continue to have them), the follow-up interval in most cases is less than 2 years. Whether approximation of a cortical wound reduces the likelihood of cerebral seizures by virtue of reducing the reparative gliosis is unknown.

References

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