The Failure of Circumferential Craniotomy in Acute Traumatic Cerebral Swelling

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Many attempts have been made to control traumatic cerebral swelling. Hypothermia, intravenous hypertonic solutions, steroids, and surgical decompression have been, or are being, employed. Some moderate success has been obtained with each of them.

Surgical decompression of the massively swollen brain has included subtemporal decompression, temporal or frontal lobe resection, and splitting of the tentorium. They have all been tried but, by and large, have been abandoned due to several factors. They may be technically difficult or fail to provide adequate room. Occasionally, bony decompression may actually increase edema. If, for instance, the brain becomes incarcerated outside the skull, its venous drainage may be obstructed at the cranial edge with enhancement of the edema. Subtemporal decompression is not too successful for these reasons. Or, as with temporal lobectomy, the procedure itself may increase the neurological deficit, if the patient survives.

The chief problem with surgical decompression, however, is inability to provide adequate room for severe cerebral swelling. Since this swelling is hemispheric, not lobar, an attempt to enlarge the entire cranial cavity in an upward and outward dimension seemed logical.

This report deals with our experience in attempting a radical surgical decompression. The reason for reporting this experience is to warn others from doing similar surgery. More important, it is to point out the fallacy of considering the skull as a single box. Surgical decompression may ultimately prove useful in control of cerebral swelling. If so, the procedure must be designed to open all dural compartments within the skull, as well as the skull itself.

The background for circumferential craniotomy lay in our desire to enlarge the volume of the entire cranial vault. Review of the literature led us to a paper by Bauer in 1932. His concept of surgical decompression was remarkably similar to our own. He operated on one patient, performing what he termed "circular craniotomy." The patient was a blind, mentally retarded adult who apparently had had premature cranial synostosis as an infant. Since the procedure was done long after spontaneous relief of intracranial pressure had occurred, evaluation of the procedure, as treatment, is difficult. However, the technical feasibility, and the lack of postoperative complications, together with the absence of deformity, was encouraging. It seemed promising to evaluate this procedure for the relief of massive cerebral edema. A rigid protocol for patient selection was developed. The concept and the protocol were approved by the Committee on Human Experimentation of the University of Texas Southwestern Medical School at Dallas. In due course, two patients underwent identical procedures after thorough and careful discussion with their families.

Method

The patient was placed in a semi-sitting position with his head supported by a Light-Veley head rest. This allowed access to the entire head. Routine surgical preparation of the scalp and adherent plastic drapes were used.

A linear incision from the glabella over the vertex, to the external occipital protuberance and down the midline of the cervical spine, was made. This incision constructed two equal scalp flaps. Each one-half of the scalp was then reflected subperiosteally downward over the convexity, exposing most of the convexity of the skull. The temporal muscle was detached subperiosteally from the temporal bone, approximately the superior one-third of the muscle being detached.

Burr holes then were placed around the

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skull at appropriate intervals. If a frontal sinus was entered, it was dealt with in the usual way, by stripping the mucosa downward, packing with gelfoam, and filling the sinus with bone wax. Two burr holes were made over the lamboid sutures near the mid-line of the occiput, and the bone rongeured out between them. The other burr holes were connected using a Gigli saw. Thus, the entire calvarium was cut free.

By repeating the saw cuts approximately ½ cm below the initial one, a piece of bone about ½ cm in width was removed completely around the head. This step provided safe access to the dura. The dura was then divided circumferentially, sparing the superior longitudinal sinus at both the anterior and posterior ends. Closure of the scalp flap was then done in anatomic layers. Drains were placed in the subgaleal space for 24 hours.

Postoperative skull films in the two cases (Figs. 1 and 2) demonstrate the size of the craniotomy and the bony separation that occurred.

We realized certain complications had to be anticipated. These included infection and mutilation. As the dura remained attached anteriorly and posteriorly, it also seemed possible that the brain might expand upward and forward and shear some or all of the bridging veins, causing acute subdural hemorrhage.

Case Reports
Case 1. An 18-year-old white boy was riding a motorcycle when he was hit by a truck. On arrival at Parkland Memorial Hospital approximately 40 minutes after the accident he was profoundly unconscious, had spontaneous decerebrate movements, and Cheyne-Stokes respiration. The blood pressure was 160/70, and pulse rate 150. Except for superficial abrasions over the forehead and left cheek, he had no other evidence of injury.

Examination. The pupils were pinpoint in size and unreactive to light; the eyes were fixed and deviated conjugately to the right. Tendon reflexes were hyperactive throughout, with sustained bilateral ankle and patellar clonus and bilateral Babinski responses. X-rays of the chest, skull, and cervical spine, and cerebral arteriography were normal.

Operation. After full and frank discussion with his parents, a circumferential craniotomy was carried out. The operative procedure already described was begun 5 hours after injury and completed 2 hours later. The only operative finding was a left parietal subgaleal hematoma. There was no subdural, epidural, or subarachnoid hemorrhage.

**Fig. 1. Case 1.** Postoperative skull x-ray films showing the size of the craniotomy and bony separation.