Experimental Observations on Enlarging Skull Fractures*

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Growing fractures of childhood have been described in humans and simulated in an experimental model using puppies. Clinically, these uncommon growing fractures are seen only in infants and children. A thorough review of the world’s literature and discussion of clinical features of this syndrome were presented in 1961 by Lende and Erickson. Other cases subsequently have been reported. Meningeal cysts are frequently found at the enlarging fracture site and have even been implicated etiologically. The following investigation was designed to determine whether experimental traumatic leptomeningeal cysts are in communication with the cerebrospinal fluid.

Materials and Methods

Ten mongrel puppies (seven, 6 days old; three, 17 days old) were used. Each animal was anesthetized with intraperitoneal pentobarbital sodium (Nembutal). A midline vertex scalp incision and bilateral rectilinear osteoplastic parietal bone flaps were made using a dental disc 1 mm in thickness (Fig. 1). The bone flaps were hinged on the temporals muscle. Additional procedures on meninges were carried out in the region underlying the anterior limb of the craniotomy on each side. The other three limbs of each flap served as controls. In the anterior limb, a cerebrospinal fluid-containing pouch was made by incising the dura and arachnoid and suturing pericranium to the dural edges (Fig. 2).

All bone flaps were sutured into normal position after the preparation of the cerebrospinal-fluid-containing pouch. Immediately after operation, x-ray films of the skull were taken (Fig. 3). Later, more were taken at suitable intervals to determine if, in fact, an expanding craniotomy line (“enlarging fracture”) occurred in the experimental limb as compared to the normal healing process which was expected in the control limbs (Figs. 3 and 4).

Fig. 1. Diagram of bilateral rectilinear osteoplastic parietal bone flaps. Lesion in anterior experimental limb is indicated.

Fig. 2. Diagram of method used to produce in the anterior experimental limb a cerebrospinal-fluid-containing pouch by incising the dura and arachnoid and suturing pericranium to the dural edges.
Rosenthal, Grieshop, Freeman and Goldstein

were made. Histological sections were stained with hematoxylin and eosin.

Results

All control limbs healed normally. In 11 of the 20 experimental limbs, an enlarging fracture line occurred, as confirmed by x-ray and histological examination of the specimens. Small cysts were formed within the fibrous tissue connecting the bone edges. These were filled with a clear translucent fluid that stained a very faint pink color with hematoxylin and eosin. In all cases the India ink remained in the subarachnoid space and did not enter or stain the cyst fluid (Fig. 5).

Discussion

In 1953 Taveras and Ransohoff proposed a mechanism for producing expanding fractures:

"Trauma produces a skull fracture and an underlying dural tear. At the same time there is probably sufficient subarachnoid hemorrhage to hinder the local circulation of cerebrospinal fluid. The arachnoid membrane projects out through the dural tear into the fracture site. This trapped arachnoidal hernia, aided by the normal pulsations of the brain, gradually erodes the edges of the bone and at the same time compresses the underlying cortex. There must be some degree of ball valve mechanism at work also, with the cerebrospinal fluid having easier ingress into, than egress from, the cyst. Arachnoidal adhesions about the mar-

Animals that developed an "enlarging skull fracture" were anesthetized, and through a cysternal puncture, 10 cc of India ink was injected into the cerebrospinal fluid. Each animal was placed in the Trendelenberg position for 30 minutes and then sacrificed on postoperative days 11, 12, 16, 17, 20, 48, 48, 48, 101, and 115 respectively.

A cranial cap that included pericranium, bone, meninges, and brain was removed en bloc. The specimen was fixed in 10% formalin, and x-ray films of the cranial cap were taken. After decalcification, coronal sections of the experimental and control sites were made. Histological sections were stained with hematoxylin and eosin.

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