Experimental and Clinical Observations on the Use of Pericranium in Inhibiting Bone Regrowth and Fusion*

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The usual surgical treatment of craniosynostosis involves a simple linear craniectomy followed by wrapping of the bone edges with some material to inhibit bone regrowth and fusion. Fibrin film, oxidized cellulose gauze (Oxycel), tantalum, methyl methacrylate (Lucite), rubber, and polyethylene (Polythene) have been used in an attempt to inhibit bone regrowth and fusion after linear craniectomies. Anderson and Johnson described the use of Zenker's acetate solution or 7% tincture of iodine on the surgically exposed dura mater, with favorable results. Linear craniectomy followed by the application of polyethylene and/or Zenker's solution is now the commonly accepted treatment for this condition.

Complications that can occur with this method of treatment are foreign body reactions, infections, and the late possibility of neoplasm production. Sorour in 1961 was the first to use pericranium interposed in craniectomies done for craniosynostosis. He used this in conjunction with an initial “four-flap operation” and, most recently, a “bilateral flap operation.”

This experimental study was undertaken to determine if pericranium interposed between the fracture edges inhibits bone regrowth and fusion in the first year of life in dogs.

Experimental Study

Method. Ten unweaned puppies 4 weeks old were used. Each animal was anesthetized with intraperitoneal Nembutal; a midline vertex scalp incision was made, and both skin edges were retracted laterally. Bilateral rectilinear bone cuts were made with a 1 mm dental disc. Pericranium was interposed between the edges of the medial limbs of the bone flap and sutured to the dura (Fig. 1). The other three limbs served as controls.

Following the preparation of the bone incisions, baseline x-ray films of the skulls were taken at suitable intervals to determine the degree of healing in the medial limb as compared to that in the control limbs. After sacrifice by an overdose of Nembutal, an en bloc cranial cap was made, which included pericranium, bone, meninges, and brain. The specimen was fixed in 10% formalin, and x-ray films of the cranial cap were taken. Following decalcification, longitudinal sections were cut from the experimental and control sites, and stained with hemotoxylin and eosin, van Gieson's, and Gomori's trichrome stains.

Results. All 10 dogs survived the operation without complications. X-ray studies indicated that the control limbs of the craniectomy (without interposed pericranium) were well healed within 2 months after surgery. Eight of the 10 experimental limbs with interposed pericranium remained radiologically patent up to 12 months following surgery. Histological examination of the operated areas showed the fibrous tissue of pericranium separating the bone edges in eight animals (Fig. 2). In early specimens (sacrificed 11 to 18 days after surgery) no bone regeneration was noted, and in the older specimens (sacrificed 2 months to 12 months after surgery) the fibrous separation of bone edges was still complete. In one case (age 3 months) small islands of bone did form between the bone edges (Fig. 3). In another case (age 6½ months) a bony connection was established at the bottom of the defect.

Received for publication October 17, 1969.

* Supported in part by U.S.P.H.S. Grant SOL-FRS5434 05. Address reprint requests to: Frank P. Goldstein, M.D., Department of Neurosurgery, Marquette School of Medicine, 8700 West Wisconsin Avenue, Milwaukee, Wisconsin 53226.
Clinical Study

On the basis of the excellent experimental results, pericranium was interposed between linear craniectomies in three patients. A longitudinal midline skin incision was made in the usual manner. Over the sagittal suture the pericranium was incised and dissected laterally (Fig. 1). The pericranium was then everted; parasagittal linear craniectomies were performed and the pericranium sutured to the outer layer of the dura along the lateral aspect of the craniectomy on either side. Care was taken to insure that all parts of the bone edge were covered with pericranium. There was always enough pericranium to completely cover the bone edges.

Case Reports

Case 1. A 3½-month-old child had a sagittal suture synostosis confirmed by x-ray. A pericranial procedure was done without complication. Follow-up films showed partial fusion at 3 months and complete fusion at 9 months (Fig. 4).

Case 2. A 6-month-old child had a sagittal synostosis confirmed by x-ray. A pericranial interposition procedure was done without complication. Follow-up films showed partial fusion at 7 months and complete fusion at 11 months.
Case 3. A 5-month-old child had a sagittal synostosis confirmed by x-ray. A pericranial interposition procedure was done. Follow-up films showed midline bone regeneration at 5 months and complete fusion at 11 months (Fig. 5).

Discussion

Virchow first described a case of craniosynostosis in 1851. In 1890 Lannelongue advocated the use of simple linear craniectomies for the treatment of this condition. It soon became apparent, however, that rapid regeneration of the bone usually occurred, producing solid fusion of the linear craniectomy channel in 4 to 6 months. To improve this surgical technique, Ingraham, et al., noted that bone regrowth was retarded if its periosteum was removed and the bone edges encased with polyethylene film. Polyethylene film, being a foreign body, increased the incidence of infection and was not always tolerated due to foreign body reaction. This stimulated Anderson and Johnson to introduce Zenker's acetate solution, the use of which is limited, however, to cases with an intact dura.

Sorour in 1961 was the first to use pericranium interposed in craniectomies done in craniosynostosis cases. Sorour reported patent linear craniectomies up to 22 months in four of his 20 cases, all of which were operated on after the age of 3 years. In 1968 Samra and Sorour stated: "The use of the periosteum between the bone edges instead of foreign material to retard union has a sound physiological basis and proved its validity in the four-flap operation as well as in the present modification." Again all patients with interposed pericranium were over 3 years of age.

In puppies, even though the rate of skull growth is greatly accelerated as compared to that in the human, craniectomy lines were kept open for as long as 12 months by the interposed pericranium, despite the fact that the original experimental gap between the bone edges was as little as 2 mm in width.

Despite encouraging experimental results in dogs, craniectomies with interposed pericranium in three infants under the age of 1 year failed to remain open for 12 months. Although it is true that interposed pericranium does not have the hazards associated with the introduction of a foreign material,
Craniosynostosis

**Summary**

Pericranium interposed between the bone edges of a craniectomy was effective in preventing bone fusion for more than 1 year in eight out of 10 puppies. However, when used in three infants less than 6 months old, evidence of bone fusion appeared within 12 months in all cases.

References