CLINICAL USE OF FREEZE-DRIED HUMAN DURA MATER*
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The necessity for closure of dural deficits that develop in conjunction with trauma, neoplasms, and congenital malformations has prompted surgeons to substitute various materials.1,3,4,5,6,8,9,12,16,17,20,21,24 The continuing succession of reports in the literature over the years heralding new technics, indicate that there has never been an ideal solution to the problem. Since each dural substitute has had theoretical or practical disadvantages, the search goes on. This communication will record success with the use of preserved human dura mater.

The freeze-dried dura mater was made available through the kindness of Commander George W. Hyatt, MC, USN, who, with his associates in the Tissue Bank of the Naval Medical School at Bethesda, Maryland, tested its efficacy in animal experiments.22 Previously this group had developed a technic of freeze-drying for processing and storage of dura mater and other tissues removed from acceptable cadavers.15 Dura mater is removed under aseptic conditions, and rapidly frozen at temperatures ranging from −78°C. to −196°C. While still frozen the tissues are placed in a vacuum chamber until dried by sublimation, and then stored in bottles under vacuum. Tissues preserved by this method may be stored for years at room temperature as long as the vacuum is maintained. When a freeze-dried tissue is immersed in sterile normal saline for a short interval, there is sufficient return of normal physical characteristics to permit surgical handling.

One patient currently being reported required such extensive replacement of cranial dura mater that commonly used substitutes were considered impractical. On the basis of the assuring results of the use of freeze-dried dura mater as a substitute in dogs,22 banked human dura mater was first used clinically in this case in June, 1954. Since then, 10 dural implants have been made in 5 individuals in our series, and 3 freeze-dried dural implants have been used in 3 patients in Brown’s series.5 The follow-up times in this study range from 6 months to 2½ years. In one instance, a dural defect in the region of the cribiform plate was closed with a banked homograft. This individual had sustained a comminuted fracture of the right frontal and

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parietal bones, which was compounded via the cribriform plate, and frontal and ethmoid air sinuses. Despite implantation into this potentially contaminated field, cerebrospinal fluid rhinorrhea was checked, and all wounds healed per primam. In 3 other individuals, the material was used to compensate for defects in the spinal dura mater, two of which developed in conjunction with meningoceles, and the other resulted from a gunshot wound. In each instance, water-tight closures were achieved, and there has been no untoward reaction, judged by clinical observation. All these persons are improved, except for the man with laceration of the cauda equina, secondary to a gunshot wound.

Periodic biopsies have been made of the dural implants placed in the first patient recorded above. Therefore, the history of this child will be reported in detail.

**CASE REPORT**

The patient, a 4-year-old child, was admitted in 1953 to the Babies Hospital by Dr. John Caffey because of a massive skull tumor (Fig. 1), which involved a major portion of the frontal bones, crossed the coronal sutures, and extended into the parietal bones, to within a short distance of the lambdoid sutures. The bony lesion, together with its outer periosteal covering, was resected in one piece, after biopsy and angiography. The underlying dura mater, overlying galea and scalp remained to cover the bony defect.

The lesion promptly recurred and approached preoperative proportions within 6 months. It was postulated that the osteogenic layer of the dura mater was contributing to the bony regeneration, and that if the dura mater could be removed, a cure might be effected. Therefore, in June 1954, an oval biopsy, measuring 5×7 cm., was made in the left frontal region, and the underlying dura mater was removed and replaced with a piece of freeze-dried banked dura mater (Fig. 2). A similar procedure of lesser proportions was carried out on the right.

Five months later, physical and roentgenographic examination showed that the lesion had not recurred at the site of the implant, but regrowth of the lesion had continued elsewhere. Accordingly, a two-stage resection was carried out in November and December 1954. At the first operation, the junction between the patient’s dura mater and the implant was invisible, and the overlying galea was easily separated by blunt dissection. The freeze-dried dura mater appeared to have the same elastic quality as the surrounding tissue. Upon incision (Fig. 3) it was noted that a thin grey pseudomembrane separated the banked dura mater from the subdural space. The underlying arachnoid was normal in color and free from adhesions. By gross observation, the implant was vascularized and oozed blood from its outer surface and cut edges. Since there was no evidence of bony recurrence, the dura mater underlying the lesion was resected and replaced by freeze-dried dura mater in two stages. At the beginning of the second stage, it was noted that the 2-week-old implant was greyish-white and elastic, and early union with host dura mater was evident at its margins.

Approximately 2½ years have elapsed since dural replacement without signs of recurrence. A small amount of calcific scar and osseous tissue have appeared in the midline overlying the superior longitudinal sinus, which was not resected, but covered with two overlapping layers of freeze-dried dura mater.