THE USE OF ORLON FOR DURAL REPLACEMENT

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THE continuity of the dura mater is a prime necessity. Various processes may interrupt this continuity, such as a tumor growing in its inner surface, a fracture of the skull associated with a gross laceration of the dura mater, and certain surgical procedures that may destroy part of this membrane.

The herniation of the brain and the leptomeninges through the dural defect may have undesirable consequences. Sometimes meningoencephaladhesions are formed; even craniocerebral erosions may occur. If the arachnoid breaks and there is an underlying fracture of the cribiform plate or of the petrous portion of the temporal bone, the cerebrospinal fluid will leak, and rhinorrhea or otorrhea may result. These fistulas connecting with the pneumatic cavities of the face may give passage of the air into the skull, and pathogenic agents may spread into the cranial cavity causing infections such as meningitis or brain abscesses.

As the dura mater does not regenerate with ease, any of the above complications may occur with undesirable sequelae. Therefore, the closure of a dural defect is of paramount importance in neurosurgery. In the past many methods have been tried:

(a) Grafting.2

(b) Use of albumin as a base substance for the regeneration of the dura mater: products prepared from human fibrinogen and human thrombin; fibrin foams and films—Gelfoam-fibrin.

(c) Prostheses. Replacements of the dura mater have been attempted in different ways using metal foils, polyethylene, celluloid, cellophane, rubber tissue, etc.7

All these methods have brought a great advance in the treatment of dural defects, but each method can be seriously criticized. The grafts may deteriorate. Fibrinogen and thrombin sometimes encourage the formation of septic foci. Metal foils are too rigid to take over the functions of a flexible dura mater. Most prosthetic appliances thus far have acted as a foreign body producing a tremendous reaction with formation of a membrane or an increase of the scar tissue.

The ideal material would be one of nonbiotic origin which would have the advantages of being readily available in all sizes, without the necessity of meticulous processing, which would protect the brain without producing reaction of the glial tissue or meningoencephaladhesions, and which would keep the normal shape of the hemispheres and spinal cord.
FIG. 1. Orlon prosthesis after removal of the bony calvarium. The dura mater has proliferated over the edges of the Orlon and sealed them.

FIG. 2. Extent of dural replacement in 2 of the monkeys.
The qualities of this ideal material should be as follows: (i) It should resemble the dura mater in flexibility, thickness and strength. (ii) It should be biologically inert. (iii) Its internal surface must be extremely smooth so it will not harm the delicate surface of the brain. (iv) It must be waterproof.

The idea of using a cloth-type prosthesis for dura mater came to us by observing the experimental work on prosthesis of arteries. The best known cloth-type plastic materials are Vinyon, Nylon, Orlon, and Dacron.

**MATERIAL AND METHODS**

Vinyon leaks excessively; therefore, it is undesirable for our purposes. It has been observed that Nylon precipitates the proteins and thus causes an ever-thickening membrane when embedded in living tissue. Dacron and Orlon are two materials that seem to offer good possibilities for prosthesis. As strands of Orlon are very uniform and smooth and produce a minimum reaction of tissue, we chose this material for our experiments, using 75 to 100 weave of type 81 Orlon fiber (DuPont).

It is always desirable to wash the cloth thoroughly because as the fibers are processed, a certain amount of oil and foreign matter may accumulate on the surface of the fibers. The material is autoclaved.
Seven adult *Macaca mulatta* monkeys were used in our experiments.

*Group 1.* In 5 monkeys under Nembutal anesthesia and sterile technique, a hemicraniotomy was performed exposing the dura mater. An oval dural defect measuring about 4 cm. was made. With a fine needle the brain was lacerated in 2 animals and a prosthesis of Orlon was placed over the defect. It was sewn by separate stitches of silk, and care was taken to fold the edges so that the fibers of the fabric would not rip apart. The bone was placed back into position with steel wire. The skin was sewn with separate stitches of braided Nylon.

Two of these monkeys were sacrificed a week later. No great difference was found in the prosthesis or the brain as compared with their appearance on the day of operation. Three monkeys were sacrificed 5 months later. The Orlon was loosely adherent to the bone to the same degree that the dura mater normally would be attached to the bone. Small adhesions were present (Fig. 1). Care was taken to remove the bone flap without injuring the preparation. The edges of the prosthesis were covered by tissue hiding the stitches completely. The rest of the skull was removed with rongeurs. Then the dura mater was sectioned around the Orlon (Fig. 2) in order to observe it *in situ.* The inner surface was completely free. The brain appeared healthy and on microscopic examination it showed no reaction whatsoever. There was no attempt to form an envelope around the prosthesis. The neighboring tissues did not show any foreign body reaction.
Group 2. In the other 2 monkeys a frontal craniotomy was performed. The frontal lobe was lifted, and the cribriform plate was broken. As there was not enough space to sew the prosthesis about the dura mater, it was fixed by a few separate stitches.

These monkeys were under observation for 15 months, and no abnormality was seen. Particular attention was paid to any nasal discharge. The cerebrospinal fluid was checked at 8 months in 1, and it was normal in appearance, and contained no cells. At autopsy the general appearance of the graft did not vary much from the appearance of the grafts previously described. The surface of the brain appeared clean and neat (Figs. 3 and 4). However, the material was firmly attached to the bone, and it was impossible to scrape it out without causing further damage.

Both groups of our animals were alert and active. No neurological deficit was observed in any of them. Electroencephalograms were normal.

On the basis of these experimental findings a dural prosthesis and repair were performed on a 37-year-old woman who had a frontal abscess. She has been followed for 3 months. No abnormality has been noticed thus far.9

SUMMARY

1. Orlon seems to be an ideal fabric for prosthesis of the dura mater. It is readily available, easy to handle and to store, it is strong and waterproof, and produces a minimum reaction.

2. This material has been tried on 7 monkeys. Two of them were observed for 15 months, and no abnormality, neither clinically nor pathologically, was observed.

3. One 37-year-old woman with a brain abscess had an Orlon dural prosthesis. No abnormality has been observed after 3 months.

REFERENCES


