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New Technique for Decompressive Duraplasty Using Expanded Polytetrafluoroethylene Dura Substitute

—Technical Note—

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Abstract

A new technique for decompressive craniectomy with duraplasty was developed for cases in which brain swelling was present at dural closure. Expanded polytetrafluoroethylene (ePTFE) membrane is placed under the dura, covering the brain surface, without the use of sutures. The dura is then loosely sutured. The procedure was used in 13 patients. No leakage of cerebrospinal fluid into the epidural space or signs of infection were observed. Sutureless insertion of an ePTFE membrane at external decompression may increase the ease of duraplasty, decrease operating time, and avoid injury to the brain resulting from suturing the dura. The technique might be especially useful in emergency cases.

Key words: duraplasty, expanded polytetrafluoroethylene, external decompression

Introduction

Dural reconstruction is time-consuming in many patients who have undergone decompressive craniectomy. A membrane form of expanded polytetrafluoroethylene (ePTFE) (PRECLUDE® Dura Substitute; W. L. Gore & Associates, Inc., Flagstaff, Ariz., U.S.A.) can be used as a substitute for the dura mater at duraplasty.[2–4] Use of this dura substitute is sometimes associated with leakage of cerebrospinal fluid (CSF) through the suture line,[4] so meticulous closure has been recommended. Here we describe a new technique using ePTFE sheet with no CSF leakage after external decompression for marked brain swelling in 13 patients.

Patients and Operative Technique

External decompression was performed in 13 patients, including seven with acute subdural hematoma and cerebral contusion, three with nontraumatic intracranial hemorrhage, two with cerebral infarction, and one with subarachnoid hemorrhage. The brain surface was distended above the level of the dura at closure in all patients. ePTFE membrane was trimmed to be about 1 cm larger than the cranial window. The membrane was then placed, without sutures, under the dura to cover the brain surface and extend beyond the edges of the bone (Fig. 1). Care was taken not to injure the bridging vein during insertion of the ePTFE material. The dura was sutured loosely without the use of fibrin glue. No leakage of CSF into the epidural space was observed perioperatively or

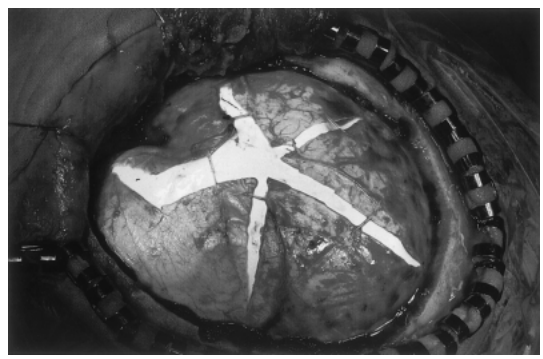

Fig. 1 Photograph obtained during decompressive craniectomy showing the expanded polytetrafluoroethylene membrane trimmed about 1 cm larger than the cranial window and placed under the dura so that the material extends beyond the edges of the bone and covers the brain surface. The dura was sutured loosely without the use of fibrin glue. The brain surface was distended above the level of the dura.

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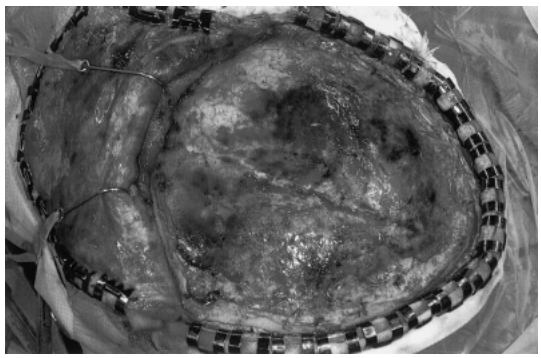

Fig. 2 Photograph obtained during cranioplasty showing the expanded polytetrafluoroethylene membrane entirely covered with connective tissue extending from the muscle-skin flap and edge of the dura.

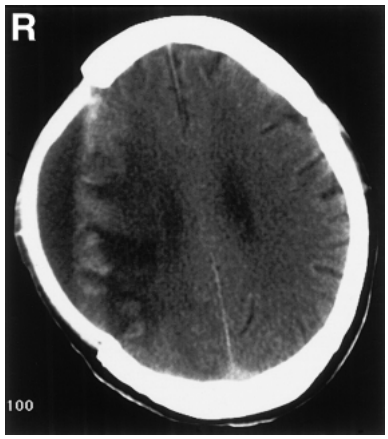

Fig. 3 Computed tomography scan obtained about 3 weeks after decompressive craniectomy showing postoperative subdural effusion with mass effect. However, no cerebrospinal fluid leakage was observed.

postoperatively, and no signs of local infection developed in any patient.

Cranioplasty was performed 29 to 78 days after the external decompression in nine patients, when the brain swelling had subsided and the patient's condition had stabilized. The ePTFE membrane was observed to be entirely covered with connective tissue that extended from the muscle-skin flap and the edge of the dura in all nine patients (Fig. 2). Moreover, no evidence of CSF leakage was found, even in a patient with postoperative subdural effusion (Fig. 3).

Discussion

ePTFE is one of the most widely used biomaterials with low reactivity, pliability, and ease of use, and has been employed in surgical procedures for nearly four decades. The material is easily sterilized, retains its functional characteristics for long periods, and is relatively inert, causing only mild localized foreign-body giant-cell reaction. ePTFE is usually not rejected by the host and has not been observed to cause malignant disease.

ePTFE membrane is extensively used as a dura mater substitute in duraplasty.[1,3,4] ePTFE membrane as a dura substitute is sometimes associated with CSF leakage through the suture line,[4] but this did not occur in our patients, who underwent external decompression for marked brain swelling. The ePTFE membrane was inserted without the use of sutures. Leakage of CSF probably did not develop because the brain surface was in tight contact with the ePTFE membrane and pressed the prosthetic material against the dura from the inside. In addition, the swelling of the brain left little space for CSF.

Good ePTFE repair of a dural defect depends on the prosthetic material becoming covered with connective tissue. Insertion of an ePTFE dura substitute is followed by acute development of a single-layer reactive membrane without inflammatory characteristics. Subsequently, a thin fibrous membrane develops around the ePTFE material.[1,2] The ePTFE membranes were entirely covered by connective tissue and no CSF leakage was observed at cranioplasty in our patients.

Sutureless insertion of an ePTFE membrane at external decompression may increase the ease of duraplasty, decrease operating time, and avoid injury to the brain resulting from suturing the dura. Although additional investigations of this technique are required to confirm its benefits, our experience indicates that the procedure may be especially useful in emergency cases of severe brain edema requiring decompression.

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Commentary

The authors described the usefulness of ePTFE membranes placed suturelessly under the dura to cover the brain surface during external decompression surgery in 13 patients with marked brain swelling. The ePTFE membranes were observed to be entirely covered with connective tissues that came from the muscle-skin flap and the edge of the dura in 9 patients, and thus, operating time was decreased, and injury to the brain was avoided resulting from suturing the dura. Moreover, no patient showed signs of CSF leakage or infection.

I congratulate the authors on their methods for refining decompression duraplasty with ePTFE, which is one of the most widely used biomaterial substitutes, in a simple, convenient way. This kind of dural substitute could be used to prevent CSF leakage, infection and adhesion.[1] However, some authors reported cases of infections with ePTFE for prevention of adhesion in patients undergoing external decompression and subsequent cranioplasty.[2] Moreover, the number of cases reported in this paper is small, and more investigations into this technique are required to confirm its benefits. Certainly, there are other materials as a dural graft currently available applied also in external decompression surgery.

References

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The purpose of using dural substitute in external decompression is to prevent adhesion between the overlapping skin and underlying swelling brain, and to avoid CSF leakage that occurs later due to shrinkage of the swelling brain. However, it is difficult for neurosurgeons to tightly close the dura mater in the case of external decompression. Indeed, I believe that most neurosurgeons are not fond of tailoring the size and shape of the dura substitute to fit the dural defect since they know that it is really tricky and time consuming work. In addition, suturing the dura mater and dural substitute is also meticulous work, and unfortunately it is often incomplete so CSF leakage takes place.

In this technical note by Miyake et al., a fascinating alternative to overcome these annoying issues is presented. They showed a practical and useful technique of decompressive duralplasty using e-PTFE without suture. The outcome was excellent and neither CSF leakage nor infection due to this dural substitute was seen in their series.

As far as I know, similar non-suturing duralplasty technique using dural substitute such as gel-film and other material has been successfully performed. Therefore, many experienced neurosurgeons can empirically accept the usefulness of the technique and excellent result revealed in this paper.

As discussed in this paper, infection due to this dural substitute is not something that can be ignored. In my personal experience, several cases of refractory infection were well controlled after removal of the e-PTFE. In principle, this technique is acceptable when the dural defect is extensive and duralplasty using galeal flap is not practical.

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