Postoperative Infection After Duraplasty With Expanded Polytetrafluoroethylene Sheet

Setsuko NAKAGAWA, Takashi HAYASHI, Shigetaka ANEGAWA, Susumu NAKASHIMA, Shoko SHIMOKAWA, and Yoshihiko FURUKAWA

Department of Neurosurgery, Institution of Neurosciences, St. Mary’s Hospital, Kurume, Fukuoka

Abstract

Dural reconstruction is a significant problem in many cases of decompressive craniotomy and dural defect. Expanded polytetrafluoroethylene (ePTFE) sheet have been used as a dura mater substitute for duraplasty. The outcomes of 83 consecutive patients at our institution were reviewed who underwent external decompression and closure with the ePTFE sheet between August 1995 and December 2000. Eight cases of infection occurred. Seven patients had infection with subdural empyema after cranioplasty with autologous bone. Three patients improved after removal of only the infected bone. One patient improved after removal of the infected bone and ePTFE sheet. One patient experienced wound infection after the original operation. Four patients subsequently developed local and severe inflammation with skin erythema until the ePTFE sheet was removed. Four patients had severe recurrent infections which required subsequent therapy such as vascularized free rectus abdominis muscle flap transfer. Duraplasty with ePTFE sheet might promote infection and poor circulation in the skin flap. The ePTFE sheet should be removed at an early stage in a patient with infection.

Key words: duraplasty, expanded polytetrafluoroethylene sheet, vascularized rectus abdominis muscle flap

Introduction

Several dura substitutes have been used to cover dural defects, including fascia lata which is autologous but requires an additional incision at the thigh, and cadaveric dura mater which was widely used but may be associated with the transmission of Creutzfeldt-Jakob disease.12) We have used expanded polytetrafluoroethylene (ePTFE) sheet since August 1995, which may be as safe and effective as artificial dura mater.1,13) However, we report our contrary experience in duraplasty operations using the ePTFE sheet.

Patients and Methods

We retrospectively studied the medical records of 83 consecutive patients who underwent decompressive craniotomy for trauma and cerebrovascular disease with subsequent dural closure with ePTFE sheet (Gore-Tex Dura Substitute; WL Gore & Associates, Flagstaff, Ariz., U.S.A.) from August 1995 to December 2000. We used a running stitch with 3-0 silk suture and placed an epidural drain for 24 hours in every case. Twenty-seven patients died within 60 days after surgery and were excluded from the study. Fifty-six patients aged from 1 to 85 years were analyzed.

Results

The disease distribution and infection rate are listed in Table 1. A total of eight cases of severe infection occurred, or 14.3% of all decompressed craniotomies with duraplasty with the ePTFE sheet. Recur-

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. of patients with infection</th>
<th>No. of all patients</th>
<th>Infection rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma</td>
<td>2</td>
<td>18</td>
<td>11.1</td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Cerebral infarction</td>
<td>2</td>
<td>12</td>
<td>16.7</td>
</tr>
<tr>
<td>Subarachnoid hemorrhage</td>
<td>4</td>
<td>13</td>
<td>30.8</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>56</td>
<td>14.3</td>
</tr>
</tbody>
</table>
rent severe infections occurred in four cases and required further intervention such as vascularized free rectus abdominis muscle flap transfer. Seven patients developed subdural empyema after cranioplasty that utilized autologous bone. Three patients improved after removal of the infected bone and one patient improved after removal of the bone and the ePTFE sheet.

Three patients subsequently developed severe and local inflammation with skin erythema, despite treatment that consisted of removal of the bone flap and irrigation of the epidural space with antibiotics. One patient had a wound infection after the original operation that progressed to cause skin ulcers and exposure of the implant sheet at the middle of the skin flap. These four patients required vascularized free rectus abdominis muscle flap transfer after removal of the ePTFE sheet. Methicillin-resistant Staphylococcus aureus was detected in three of these four patients.

Twenty-four consecutive patients at our institution underwent external decompression surgery for trauma and cerebrovascular disease with subsequent dural closure with cadaveric dura mater before July 1995. Twelve patients died within 60 days after surgery and were excluded. We retrospectively studied the medical records of the other 12 patients. A total of two cases of infection occurred, or 16% of all decompressed craniotomies with duraplasty with cadaveric dura mater. We could treat both of these patients with infection without the need for complicated operations such as muscle transfer and vascular anastomosis.

Representative Case 1: A 50-year-old man suffered a blow to the head. Computed tomography showed traumatic hemorrhage in the left cerebellar hemisphere and right frontal lobe. A right decompressive frontotemporal craniotomy was then performed. After the hematoma was removed, an ePTFE sheet was implanted to close the dura. The patient tolerated the procedure well and his neurological condition improved after surgery. After one month, cranioplasty was performed using cryopreserved autologous bone flap. The surgical wound was well approximated, with no swelling, erythema, or discharge. He had no perioperative complications and was transferred to rehabilitation. However, after 7 months, his surgical wound separated with discharge. He was admitted to our department again.

Magnetic resonance imaging showed dural and bone enhancement at the operation site. The infected bone was removed. A thick fibrous membrane had developed on the surface of the ePTFE sheet. The central part of the sheet was distorted and projected prominently from the cranial bone. The bone next to the ePTFE had an osteolytic hole. Two months later, he developed a skin ulcer and discharge from epidural empyema (Fig. 1).

Irrigation of the epidural empyema was performed and the implanted ePTFE sheet was removed. A thick fibrous membrane had developed on the surface of the ePTFE sheet. The central part of the sheet had bulged out (Fig. 2). The muscle adjacent to the ePTFE sheet was atrophied. After surgery, his skin flap incorporated an almost incurable ulcer caused by disruption of its vascular supply. A vascularized rectus abdominis skin flap was then placed extradurally on the right frontotemporal region (Fig. 3). The inferior epigastric artery and vein were end-to-end anastomosed to the superficial temporal artery and vein. After the operation, his wound remained in good condition. After one year, cranioplasty was performed with ceramic artificial bone.

Histological examination of the specimens obtained at each operation showed inflammatory granulation tissue with accumulations of inflammatory cells and hyperplasia of capillary vessels.

Representative Case 2: A 50-year-old man underwent a decompressive craniotomy and duraplasty...
with an ePTFE sheet for subarachnoid hemorrhage. After one month, cranioplasty was performed using cryopreserved autologous bone flap. His surgical wound separated with discharge after the operation. The bone was removed. After resolution of the infection, cranioplasty using ceramic artificial bone was performed. The surgical wound was well approximated, but he suffered from facial swelling 10 months later. The ceramic bone was then removed, but his skin flap incorporated an incurable ulcer caused by infection despite antibiotic therapy. Further procedures consisted of removal of the ePTFE sheet, placement of autologous fascia lata, and vascularized rectus abdominis skin flap transfer. No cranioplasty using autologous bone or artificial bone was performed.

**Discussion**

ePTFE is one of the most widely used biomaterials and has been used in surgery for nearly four decades. ePTFE is easily sterilized, retains its functional characteristics for long periods, and is relatively inert, causing only mild localized foreign-body giant cell reactions. ePTFE is usually not rejected by the host and has not been found to cause any malignancies in humans. Medical uses of ePTFE include vascular grafts, knitted fabrics for the treatment of aneurysms, heart valves, aortic implants, shunts in hemodialysis equipment, bone cartilage and ligament replacement, sutures, and tissue replacement patches. ePTFE sheet is occasionally used in neurosurgery.1,14)

ePTFE sheet is considered safe for human implantation because of its low reactivity, pliability, and ease of use, but there are some conflicting reports. Foreign body granulomatous reaction occurred after lip augmentation using ePTFE,6) and complications were found in ePTFE facial implants.2) The most frequent postoperative complications were extrusion, movement, infection, and swelling. The infection rate of ePTFE is approximately 0% to 2% for nasofacial augmentation, and implant removal was required only in 1% of cases.11) Complications with ePTFE implants have occurred in plastic surgery, cardiovascular surgery,3) hernia surgery,10) and orthopedics.4) ePTFE sheet may be used as a dura sub-
stitute in neurosurgery. ePTFE sheet is associated with leakage of cerebrospinal fluid through the suture line, but any infection was not related.\textsuperscript{1,14}

Repair of dural defects with ePTFE sheet relies on covering the artificial dura with connective tissue. A single layer reactive membrane without inflammatory change is seen in the acute stage. A thin fibrous membrane develops surrounding the ePTFE sheet in the chronic stage.\textsuperscript{5} In our Case 1, the ePTFE sheet was not entirely covered by connective tissue, as the central part of the PTFE sheet protruded from the skin layer. This protrusion might aggravate infection and poor circulation in the skin flap. In our Case 2, the ePTFE sheet was also not covered by connective tissue. Exposure of the ePTFE sheet might promote severe infection and foreign body reaction to the duraplasty.

Three of our patients improved after removal of only the infected bone. Their ePTFE was closely covered by connective tissue before the cranioplasty. However, our cases of severe infection of duraplasty material a few months later. In some cases, plastic surgery may be necessary to repair the defect in the soft tissue with local rotation flaps. However, our cases of severe infection of duraplasty with the ePTFE sheet after external decomplicative craniotomy were not all curable without removal of the ePTFE sheet. The skin flaps were characterized by an almost incurable ulcer caused by disruption of the blood flow, so vascularized rectus abdominis muscle transfer was necessary.

Free muscle flap is widely used to treat large defects after radical resection of skull base tumors.\textsuperscript{7–9} Rectus abdominis muscle flap also provides adequate volume to fill all paranasal sinuses or a large frontal lobe defect. Free muscle flap was used to treat two cases of recurrent traumatic cerebrospinal fluid rhinorrhea.\textsuperscript{13} Vascularized rectus abdominis muscle transfer is difficult and leaves a cosmetic deformity, but has been proven successful in such difficult cases.

ePTFE sheet and cadaveric dura mater are associated with high rates of infection. Our experience confirms that the ePTFE sheet should be removed immediately if the infection occurs. Newer implant materials, which are removable or be absorbed if complications occur, may further improve the long-term clinical utility of synthetic materials. The surgeon should inform patients that the ePTFE sheet might cause severe inflammatory reactions when used for duraplasty.

**References**

13. Tokoro K, Fuji S, Kubota A, Yamamoto I, Maegawa J, Saito M, Yoshida T: Successful closure of recurrent...


Commentary

This paper by Nakagawa et al. reports on their experience with dural repair using PTFE sheets after craniotomy. Fifty-six patients were analyzed giving an infection rate of 14.3%. They have not stated how many of these had open wounds from the original trauma for which the surgery was done. They have also not indicated their antibiotic prophylaxis regimen for such operations. Given these limitations, this rate appears quite high and would recommend against using this material as a dural graft. There are certainly other materials currently available that appear to be better than PTFE.

Chandranath Sen, M.D.
Department of Neurosurgery
St. Luke's Roosevelt Hospital Center
(University Hospital of Columbia University
College of Physicians & Surgeons)
New York, N.Y., U.S.A.