Duraplasty in the Posterior Fossa Using a Boat-Shaped Sheet of Expanded Polytetrafluoroethylene

—Technical Note—

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Abstract

Application of sutures between expanded polytetrafluoroethylene (ePTFE) dural substitutes and the dura mater is often frustrating in posterior fossa surgery because of the difficulty in holding the elastic graft in a deep and narrow field. To resolve this problem, we have developed a boat-shaped graft made from a triangular ePTFE sheet by pinching each angle using a suture. Formation of standing edges of the sheet facilitates holding of the flaps for secure and more rapid suturing than the conventional approach using a flat sheet.

Key words: duraplasty, expanded polytetrafluoroethylene, posterior fossa, technique

Introduction

Expanded polytetrafluoroethylene (ePTFE) sheet is commonly used as a dural substitute, but is occasionally associated with cerebrospinal fluid leakage through the suture line, especially in posterior fossa surgery. Such problems arise due to inexact closure, largely because of difficulties in manipulation in deep and narrow operative fields. Methods to prevent leakage include sealing with fibrin glue, mesh-and-glue approaches combining fibrin glue and absorbable polyglycotic acid mesh, and ePTFE suturing with a fine needle corresponding to the diameter of the thread. Despite these technical modifications, secure sutures with adequate flaps for fastening are still essential to obtain appropriate sealing. To improve handling in the posterior fossa, we propose a simple modification of the shape of the artificial material.

Materials and Methods

This technique was applied to 15 adult patients requiring duraplasty during midline posterior fossa procedures for removal of posterior fossa tumors in 10 patients, four gliomas and four metastatic tumors in the cerebellar hemisphere, one brainstem glioma, and one choroid plexus papilloma, and foramen magnum decompression for Chiari malformation in five patients. Patients with cerebellar swelling at closure were not included.

Following manipulation of the intradural structures, a sheet of ePTFE (Preclude® Dura Substitute; WL Gore & Associates, Flagstaff, Ariz., U.S.A.), 0.3 mm in thickness, was prepared. The following procedures are illustrated in Fig. 1. The sheet was trimmed to form an isosceles triangle corresponding to the triangular opening of the dura mater created by a Y-shaped incision. The height and width of the sheet should be much greater than those of the dural opening to obtain sufficient width of flaps for suturing and wide subdural space. The size of the graft was approximately 4 cm in height and 3 cm in width for standard foramen magnum decompression including removal of the posterior arch of atlas.

Next, sutures using ePTFE nonabsorbable monofilament thread of 0.307 mm diameter (Gore-Tex® Suture; WL Gore & Associates) were applied to each angle to turn up the neighboring edges and form a boat-shaped graft. The sutures were located 3–4 mm proximal to the tip of each angle, and after penetrating the two edges and knotting, an additional knot surrounding the corner was made to obtain water tightness. The corners of the graft were put under the angles of the dural opening, and stay su-
sutures were applied to the dura using the sutures previously made. Knotting or running sutures using ePTFE thread were applied between the stay sutures to hold the standing graft edge and dura mater together. Looseness of the retrotonsillar space was confirmed by ultrasonography if necessary. Finally, following application of fibrin glue (Bolheal®; Kake-suken, Kumamoto) to the suture line for reinforcement, water tight dural closure was confirmed with positive airway pressure (30 cmH₂O) by the anesthetist.

Results

The standing edges of the sheet facilitated the almost horizontal manipulation of the flaps and handling of the suture needles, a safe course to avoid damage to the underlying brain tissue. Therefore, secure and more rapid suturing was achieved than with the conventional approach using a flat sheet. Complications related to the method, such as cerebrospinal fluid leakage and dural constriction in the cervicomedullary junction, were not observed in the follow-up periods of 10–24 months (mean 15.5 months).

Illustrative Case

A 32-year-old woman presented with a 3-month history of nuchal pain and dysesthesia in the left upper extremity. Her pain was exacerbated by coughing. Neurological examination revealed only markedly increased tonus and hyper-reflexia in all extremities. Magnetic resonance imaging revealed Chiari malformation with a syrinx extending from C-1 to T-1 (Fig. 2A). She underwent foramen magnum decompression consisting of partial removal (approximately 3 × 3 cm) of the occipital bone adjacent to the foramen magnum, removal of the posterior arch of atlas, and duraplasty using a boat-shaped ePTFE sheet (Fig. 3). All symptoms resolved soon after the surgery and the syrinx disappeared (Fig. 2B). She has been followed up without complications related to the procedure for 16 months.

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Discussion

Holding the edge of an ePTFE sheet by forceps is difficult, because the elasticity retains the flatness of the sheet, in deep-seated dural planes such as the operative field of posterior fossa surgery, especially in young women who want small skin incisions for cosmetic reasons. Therefore, surgeons may face great difficulties in application of sutures without damaging the brain tissue hidden by the sheet. Such experiences prompted us to realize the present idea.

Formation of standing edges of the sheet facilitates holding of the flaps for secure and more rapid suturing with safe horizontal orientation of the suture needle than with the conventional approach using a flat sheet.

References


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Commentary

The authors evaluate the use of ePTFE and technical modification of duroplasty in the posterior fossa. As the authors point out, ePTFE sheet is used as a dural substitute, but is fairly often associated with CSF leakage in posterior fossa surgery. Inexact closure arises due to the difficulties in manipulation in the narrow operation field. Secure sutures with adequate flaps are essential to obtain appropriate sealing.

They showed complete duroplasty using boat-shaped ePTFE, that is, a boat-shaped ePTFE sheet is applied to the dura and the corners of the graft are placed under the angles of the dural opening. They also illustrated a case with Chiari malformation with a syrinx. After foramen magnum decompression and removal of the posterior arch of the atlas, duroplasty using a boat-shaped ePTFE sheet was performed. Subsequently, all symptoms resolved without CSF leakage and dural constriction in the cervicomedullary junction.

This article is an important contribution to posterior fossa decompressive surgery and avoidance of CSF leakage.

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This paper on how to perform duroplasty in deep-seated dural planes, such as the cervico-occipital junction, to enlarge posterior fossa capacity, is a useful technical note. We think that such an ingenious tool which aims at lessening the risk of damaging the underlying pia-mater and brain tissue and at achieving better tightness, can also be applied for duroplasties performed with autologous material, namely fascia lata or periosteum that can be harvested for posterior fossa surgery through an extended supraoccipital midline skin incision. We designed an almost similar procedure to enlarge the retrotonsillar space after surgery in the posterior fossa when one can fear cerebellar swelling or edema, especially after removal of so-called “difficult” tumors or AVMs, or to increase the size of the cisterna magna for the treatment of Chiari malformation.1) For this, we advocated preparation of a triangular-shaped piece of periosteum to apply on the dural Y-shaped retro-tonsillar opening. We recommended suturing in two steps: first with single stitches at each of the three angles, i.e., so-called triangulation method, then with running sutures in between. The authors of the present paper have to be acknowledged for bringing colleagues’ attention to their useful adjunct to neurosurgical techniques, especially by naming their method “boat-shaped” duroplasty, which stresses the method to improve the safety and effectiveness of surgery.

Reference


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