

Syringomyelia Associated with Chiari I Malformation Treated with Foramen Magnum Decompression and Duraplasty Using a Polyglycolic Acid Patch and Fibrin Glue: A Case Report

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Abstract

A 31-year-old woman presented with worsening numbness and pain in the arms and chest. Neurological findings at admission were decreased pain sensation and temperature sensation in the arms and chest. Magnetic resonance demonstrated a large cervical syrinx from the level of C4 to Th4 associated with Chiari I malformation. Occipital craniectomy and C1 laminectomy were performed for foramen magnum decompression. Intraoperative ultrasonography, performed after removal of the outer membrane of the dura mater at the level of the foramen magnum, revealed insufficient decompression. Therefore, the dura mater was completely opened and duraplasty was performed with a polyglycolic acid patch and fibrin glue. Sufficient decompression was thus achieved. The neurological symptoms and signs improved within the first postoperative month, and magnetic resonance showed a decrease in the size of the syrinx and no cerebrospinal fluid leakage. In patients undergoing foramen magnum decompression with duraplasty, the use of a polyglycolic acid patch and fibrin glue renders suturing unnecessary and avoids the common complications associated with suture duraplasty.

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Introduction

The optimal surgical treatment for patients with syringomyelia associated with Chiari I malformation remains unclear. Surgical approaches include

foramen magnum decompression (FMD) with or without plugging of the obex, syringosubarachnoid shunting, syringoperitoneal shunting, and endoscopic third ventriculostomy^{1–11}. FMD has become a widely accepted treatment for Chiari I malformation. In some cases, duraplasty, performed to achieve

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sufficient FMD, is associated with postoperative complications such as cerebrospinal fluid (CSF) collection, pseudomeningocele, meningitis, and intradural adhesion, whereas FMD without duraplasty presents the risk of insufficient decompression^{7,12}.

We report on a patient with syringomyelia associated with Chiari I malformation who could not be treated by FMD without duraplasty. Successful treatment consisted of nonsuture duraplasty with a polyglycolic acid (PGA) patch and fibrin glue.

Case Report

This 31-year-old woman presented at a local hospital 7 years earlier with progressively worsening numbness in both arms. A diagnosis of syringomyelia was made, and she underwent syringosubarachnoid shunting. Although the symptoms improved, they worsened again 1 year after the syringosubarachnoid shunting. On the basis of magnetic resonance (MR) findings, syringomyelia recurrence was diagnosed, syringosubarachnoid shunting was performed again. However, the symptoms failed to improve, her condition deteriorated, and she was referred to our hospital for further treatment.

On admission, we noted decreased pain sensation and temperature sensation in the arms and chest. Motor weakness and urinary or bowel dysfunction were absent. Skull and cervical X-ray studies demonstrated no abnormalities. An MR examination revealed a large cervical syrinx from the level of C4 to Th4 (**Fig. 1**). There was herniation of a portion of the cerebellar tonsil into the foramen magnum; narrowing of the cisterna magna was also noted (**Fig. 1**). On the basis of these findings, syringomyelia associated with Chiari I malformation was diagnosed, FMD was scheduled.

Occipital craniectomy and C1 laminectomy were performed. A Y-shaped incision was carefully made at the outer layer of the dura mater at the level of the foramen magnum, and the outer layer was separated from the inner layer; the outer layer was then removed. However, subsequent intraoperative ultrasonography revealed poor CSF pulsation at the



Fig. 1 Preoperative T1-weighted MR demonstrated a large syrinx from C4 to Th4. The cerebellar tonsils were between the foramen magnum and the C1 level.

subarachnoid space and narrowness of the space between the cerebellar tonsil and the dura mater. Therefore, the degree of decompression achieved by removal of the outer layer was judged to be insufficient, and the inner layer of the dura mater was opened without the arachnoid membrane being opened. The development of a marginal sinus rendered opening of the dura both necessary and time-consuming. Because of marked swelling of the arachnoid membrane due to pressure from the subarachnoid space, difficulties in avoiding damage to the arachnoid membrane were anticipated, and suture duraplasty with a graft was considered problematic.

Therefore, the decision was made to perform nonsuture duraplasty with a PGA patch (Neoveil; Gunze, Kyoto, Japan) and fibrin glue (Beriplast P Combi-Set; ZLB Behring, Tokyo, Japan). The edge of the dura mater and the PGA patch were soaked in fibrinogen solution, the patch was placed over the dural defect, and the area was sprayed with fibrin glue to fix the patch to the dura mater (**Fig. 2**). The increased CSF pressure was shown to not have resulted in leakage, and ultrasonography confirmed sufficient FMD and CSF pulsation.



Fig. 2

- A: The dura mater was incised without tearing the arachnoid membrane.
- B: The PGA patch was placed on the dural defect.
- C: The patch was sprayed with fibrin glue to fix it to the dura mater.
- D: Sagittal view. PGA: polyglycolic acid.

After surgery, the patient's neurological symptoms improved gradually. The pain and numbness resolved within the first postoperative month, and MR, performed 6 months after her surgery, showed a decrease in the size of the syrinx and no CSF leakage (**Fig. 3**). One year after surgery, there were no other complications, such as allergic reaction, adhesion, or infection.

Discussion

FMD is useful for the surgical treatment of syringomyelia associated with Chiari I malformation. However, this procedure is occasionally accompanied by complications, such as CSF leakage, pseudomeningocele, meningitis, and subdural adhesion¹³⁻¹⁵. Postoperative meningitis can also caused CSF circulation disorders. At our institution,



Fig. 3 An MR scan 6 months after the operation demonstrated a decrease in the size of the syrinx.

we usually complete FMD by removing the outer layer of the dura mater without opening the dura⁷. This procedure is advantageous because it prevents intraoperative and postoperative CSF leakage because the dura mater remains intact. Although our technique avoids liquorrhea meningitis, and subdural adhesion, there is the possibility of insufficient decompression⁷. Therefore, we stress the importance of intraoperative ultrasonography to confirm the adequacy of FMD. In fact, in the patient reported on here, inadequate FMD necessitated opening of the dura and duraplasty.

Because conventional duraplasty requires suturing, it may elicit the above-cited complications. Even if the arachnoid membrane remains intact, it must host sutures and the increase in CSF pressure after opening of the dura mater may elicit complications. In addition, sutures near the sinus may result in bleeding and the development of complications. Terasaka et al.¹⁶ have reported a nonsuture duraplasty procedure in which a PGA patch, originally used as artificial pleura, provided tight closure and prevented adhesion¹⁷. Their application of fibrin glue further reduced the incidence of CSF leakage. Because the PGA material

consists of a homopolymer (MW 100,000) that is absorbable, it can be used as a surgical patch that is eventually hydrolyzed via pyruvic acid to water and carbon dioxide. Used in this manner, it serves as a frame to reinforce the fibrin clot membrane in the early stage, and the PGA fibers are a matrix for collagen fiber synthesis in the late stage¹⁸. Within 2 months of its introduction, the PGA patch has mostly been absorbed, the dural substitute has been replaced by collagenous fibers, and the interface with the autogenous dura mater is histologically and clinically indistinguishable¹⁶.

Application of a PGA patch in patients undergoing FMD by means of duraplasty renders complex suturing unnecessary and avoids common preoperative and postoperative complications. This is especially important in cases such as ours in which the development of a marginal sinus makes dural opening necessary, thereby further raising the risk of complications in patients undergoing suture duraplasty for FMD. Although their follow-up period was short, Hida et al.¹⁸ reported no instances of allergic reaction, infection, or adhesion in patients treated with nonsuture duraplasty. Terasaka et al.¹⁶ introduced the use of fibrin glue and a PGA material as a dural substitute; they encountered no adhesion between the brain surface and the arachnoid, arachnoid thickening, reactive astrocytes in the gray matter, or exfoliation or degeneration of nerve cells just beneath the dural substitute. However, because the occurrence of cerebral adhesion cannot be ruled out after the placement of a PGA patch, we advise that the arachnoid be left intact. Although long-term follow-up studies are required to confirm that the use of PGA patches and fibrin glue is a safe and effective substitute for the dura mater, our technique was useful in a patient in whom FMD necessitated opening of the dura.

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