The enduring and costly complication of CSF leaks has led to novel developments in synthetic materials to assist neurosurgeons in repairing dural defects. Primary closure has been the technique of choice, but it does not always result in good closure. In such cases neurosurgeons may choose from adjunctive methods including the use of dural patches, fibrin glue products, and autografts such as fat and pericranial grafts, and involving a variety of synthetic and protein-based compounds. A recently approved hydrogel is now also available (DuraSeal, Confluent Surgical, Inc.). It is labeled for use as an adjunct to sutured dural repair/closure to reduce the risk of postoperative CSF leaks. As a completely synthetic material, it carries no risk for disease transmission, and it is absorbed over time.

To date, there have been no published reports indicating an increased rate of wound infections, poor wound healing, or other complications linked to the use of this material. However, in canine models it has been shown that the hydrogel exhibits an increasing in vivo expansion and mass effect in the first 2 weeks after placement followed by progressive resorption and hydrolysis. We present the case of a 13-year-old girl who underwent foramen magnum decompression for a CM-I involving the use of a hydrogel dural sealant, but whose course was complicated by worsened quadriaparesis as a result of mass effect and cervicomedullary compression from hydrogel expansion.

**Case Report**

*History and Presentation.* This 13-year-old girl was initially admitted to the pediatric neurology service with complaints of changes in her voice, mild swallowing difficulties, gait disturbance, and falls progressing over a several-week period. An MR imaging study revealed a CM-I (Fig. 1), with ectopia of the cerebellar tonsils 20 mm below the level of the foramen magnum, and a cervical syrinx. Cervical spine radiography and CT scanning of the craniocervical junction revealed normal cervical alignment and ossification of the dens.

*Examination.* The patient was awake, alert, and cooperative during physical examination. The results of cranial nerve examination were significant for dysphagia, dysarthria, and a decreased gag reflex. The motor examination was remarkable for spastic quadriaparesis with severe gait disturbance; the patient used a wheelchair at the time of admission.

*Abbreviations used in this paper:* CM-I = Chiari malformation Type I; CSF = cerebrospinal fluid; CT = computed tomography; FLAIR = fluid attenuated inversion recovery; MR = magnetic resonance.
First Operation and Postoperative Course. The patient underwent an urgent posterior fossa decompression with resection of the C-1 posterior arch and rostral half of the C-2 lamina. The dura mater was incised in a Y fashion, and the caudal portions of the tonsils were mobilized and coagulated until free flow of CSF was observed out of the fourth ventricle. Dural closure was performed with a dural patch (Durepair, TEI Biosciences), followed by a hydrogel dural sealant (DuraSeal) and a final layer of dry Gelfoam (Pharmacia & Upjohn). The fascia was closed in a standard fashion.

Postoperatively the patient had persistent gait difficulties and little improvement from her preoperative neurological baseline. A repeated MR imaging study performed on postoperative Day 2 revealed a small extraaxial fluid collection and some prolongation of T2 signal in the cervical cord around the syringomyelia (Fig. 2). Intravenous dexamethasone was administered for several days but failed to improve the patient’s neurological condition. While undergoing inpatient rehabilitation, the girl had an increase in her weakness and bulbar symptoms. An additional MR imaging study performed on postoperative Day 15 demonstrated a significantly enlarged extraaxial mass collection causing cervicomedullary compression (Fig. 3).

Second Operation and Postoperative Course. The patient underwent an attempted percutaneous aspiration of the suspected fluid collection. This procedure yielded no fluid. The patient then underwent operative exploration of the surgical site. On opening of the fascia, there was spontaneous expression of a gelatinous material. Further dissection and deep exposure revealed a thick coagulum of hydrogel dural sealant material, approximately 15 mm in thickness. There was no appreciable fluid collection or hematoma. The dura was well healed and there was no CSF leak.

Over the next 2 weeks, the patient made a rapid neurological recovery. At the 12-month follow-up examination, she had only mild residual spasticity, was able to walk without assistance, and displayed a normal gait. Her bulbar symptoms had completely resolved and the syrinx had improved (Fig. 4).

Discussion

To our knowledge, there have been no reported complications associated with the use of hydrogel dural sealant. In vivo studies in canines and humans have shown an ability to establish watertight seals even with poor dural closure. Operative exploration at 8 weeks has revealed that the material had been completely resorbed with satisfactory dural healing and the benefit of decreased bone to dura adhesions.

In a canine study, Kacher and colleagues evaluated the MR imaging and CT characteristics of the sealant and found an increasing mass effect secondary to expansion. This expansion peaked at 2 weeks and had decreased significantly by 4 weeks. There was no residual evidence of the gel on CT or MR images obtained 10 weeks postoperatively. In FLAIR sequences, the gel appeared hyperintense compared...
with CSF and isointense compared with cortex. The imaging characteristics of the gel were otherwise similar to those of CSF.

The difficulty in determining the nature of an expanding epidural collection was evident in our case. The collection was initially suspected to be a CSF-containing pseudomeningocele, and percutaneous aspiration was attempted prior to surgical reexploration. Although FLAIR imaging has been shown to be useful, we did not perform sagittal FLAIR imaging as part of our MR imaging protocol. Our axial FLAIR images were difficult to interpret and showed some slight hyperintensity compared with CSF, but the level of intensity was not on the order of that of the cortex (Fig 3).

In our patient, the liberal use of hydrogel dural sealant after CM-I decompression led to a significant mass effect in the suboccipital epidural space. As predicted by imaging findings described by Kacher et al., the gel increased in size through postoperative Day 15, necessitating operative exploration. Intraoperatively, there was no evidence of hematoma or pseudomeningocele, and the epidural space was dry. Instead a thin dissolving layer of gelatin sponge overlying a thickened, clear gelatinous hydrogel was discovered. In published cases, gelatin sponges have also been associated with mass effect complications, although in our case the complication resulted from hydrogel expansion. On the basis of this experience, we encourage the deliberate and thoughtful application of hydrogel, as with gelatin sponges, noting the possibility for expansion with hydration and the development of clinically significant mass effect.

Conclusions

The expansion of hydrogel dural sealants is a potential problem when they are applied in locations sensitive to mass effect, particularly in cases in which decompression is the operative goal. The use of a thicker layer of hydrogel is not known to further reduce the risk of a CSF leak, and a thin layer may be equally effective.

Disclaimer

The authors have no financial interests to disclose regarding technologies or methodologies described in this article.

References


S. L. Blackburn and M. D. Smyth

Manuscript submitted November 9, 2006. Accepted December 21, 2006. Address reprint requests to: Spiros Lee Blackburn, M.D., Barnes-Jewish Hospital, Department of Neurosurgery, 660 South Euclid Street, Campus Box 8057, St. Louis, Missouri 63110. email: blackburns@nsurg.wustl.edu.