Craniospinal subdural hygroma postdecompression for Chiari malformation: the slit valve mechanism

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DESCRIPTION
A 52-year-old woman presented with a headache and ataxic gait. MRI of the cranial and cervical spine showed Chiari malformation type 1, for which she underwent suboccipital decompression and duroplasty without arachnoid opening (figure 1). Four weeks after surgery, she presented with a severe headache and vomiting. MRI of the brain and spine showed a large subdural hygroma involving the supratentorial and infratentorial spaces and spine (figures 1 and 2). Urgent bilateral burr holes and subdural drain placement were performed, and she was treated with diuretics and dexamethasone. Her symptoms improved for 1 week and then recurred. MRI of the brain and spine revealed a reaccumulating subdural hygroma without hydrocephalus. Re-exploration of the Chiari decompression and wide fenestration of the arachnoid membrane resulted in the resolution of the subdural hygroma and patient symptoms. At the last follow-up, 4 years after treatment, the patient remained asymptomatic and no subdural hygroma was found with MRI (figure 2).

Subdural hygroma development after Chiari type 1 decompression is rare, with only a limited number of reported paediatric and adult cases in the literature.1–4 Different mechanisms have been proposed as likely causes, such as a one-way valve mechanism at the foramen magnum arachnoid membrane, a reduction of cerebrospinal fluid (CSF) absorption, overdrainage of CSF flow through the Magendie foramen and increased intracranial blood vessels’ permeability. Here, we describe a single mechanism by which a small puncture in the arachnoid membrane at the foramen magnum results in a slit valve mechanism and accumulation of CSF in the subdural space and disturbance of CSF flow. In our case, re-exploration and wide opening of the arachnoid membrane resulted in resolution of the subdural hygroma, which supports the aforementioned mechanism (video 1). Overall, the treatment of this condition is variable. The literature includes conservative therapy with diuretics and steroids, lumbar drain, external ventricular drains, ventriculoperitoneal shunts and re-exploration with arachnoid wide opening.5–6 Zakaria and colleagues described 12 adult and paediatric patients with increased intracranial pressure including subdural

Figure 1 Neuroimaging. (A) Preoperative MRI brain T2-weighted image, sagittal view, showing the Chiari malformation feature with tonsillar herniation. (B–D) Immediate postoperative CT brain showing suboccipital decompression without any subdural hygroma. (E) MRI brain T2-weighted image, sagittal view, showing development of subdural hygroma and suboccipital pseudomeningocele during follow-up. (F and G) CT brain featuring the subdural hygroma and a degree of supratentorial and infratentorial compression of neural structures. (H) CT brain, coronal view, showing bilateral burr holes and subdural drain placement after the urgent surgical management of increased intracranial pressure with clinicoradiological features.

Video 1 Intraoperative video showing the initial suboccipital decompression and duroplasty surgery for Chiari malformation. The blue arrow features the site of the arachnoid membrane small opening that acts as a slit valve mechanism, seen during brain pulsation.

Figure 2 Neuroimaging. (A–D) Presubdural hygroma definitive treatment MRI brain T2-weighted and T1-weighted images, axial and sagittal views showing the craniospinal subdural hygroma and compression of the upper cervical spinal cord (red arrow). (C). (E–H) MRI brain T2-weighted and T1-weighted images, axial and sagittal views after treatment, featuring resolution of the subdural hygroma and Chiari malformation features.
Subdural hygroma development after decompression.\textsuperscript{2} External ventricular drain and conservative management were adequate in resolving patients’ symptoms. Recently, Vivas and colleagues reported on five paediatric cases who were treated successfully with steroid and acetazolamide therapy.\textsuperscript{3} Bahl and colleagues reported on three adult cases of Chiari type I malformation who underwent arachnoid-preserving suboccipital decompression that was complicated by subdural hygroma, requiring re-exploration and wide arachnoid opening.\textsuperscript{4} Similar findings and treatment strategies are supported by other reports where the re-exploration and wide opening of the arachnoid membrane are considered valid therapeutic options.\textsuperscript{5} Two other adult cases showed similar findings and mechanisms; however, these patients were managed by subdural hygroma drainage and CSF shunt.\textsuperscript{6} Our case demonstrates that the likely aetiology is the one-way valve mechanism at the foramen magnum arachnoid membrane (video 1), with wide membrane opening recommended in the prevention and treatment of this condition.

### Learning Points

- Subdural hygroma postdecompression for Chiari malformation is rare. The likely mechanism is related to the one-way valve mechanism at the foramen magnum arachnoid membrane.
- Re-exploration and wide opening of the arachnoid membrane are effective treatments.

### Contributors

All the authors were involved in the conception, design and approval of the work. JA, HQ, HA were involved in data collection and drafting. FA treated the patient and involved in the manuscript design, review and approval.

### REFERENCES