Successful detection of multiple communicating holes in multiple spinal extradural arachnoid cysts by using time-spatial labeling inversion pulse magnetic resonance imaging: illustrative case

Yusuke Kagei, MD,1 Tatsuya Ishibe, MD, PhD,1 Yusuke Kanba, MD,2 and Masashi Tanaka, MD, PhD1

1Shiga Spine Center, Hino Memorial Hospital, Shiga, Japan; and 2Center for Spine Surgery, Japan Community Health Care Organization Tamatsukuri Hospital, Shimane, Japan

BACKGROUND Spinal extradural arachnoid cysts (SEACs) communicate with the subarachnoid space through small communicating dural holes. The precise preoperative detection of all communicating holes, followed by minimally invasive dural closure, is the ideal treatment to prevent postoperative spinal deformities, especially in cases of multiple SEACs. However, standard imaging methods often fail to detect communicating hole locations. Although a few cases of successful single-hole detection via cinematic magnetic resonance imaging (MRI) have been reported, this modality’s ability to detect multiple holes has not been demonstrated.

OBSERVATIONS The authors describe the case of a 14-year-old male with myelopathy due to multiple SEACs at T5–8 and T8–12. Myelography revealed a complete block at the T8 level; no cephalic cyst or communicating holes were identified. Time-spatial labeling inversion pulse (T-SLIP) MRI revealed cerebrospinal fluid flow into the cyst at T10 and T7. A limited laminectomy or hemilaminectomy was performed at T7 and T10, and two dural holes were closed without a total cystectomy. The patient’s gait disturbance and rectal disorder disappeared. The cysts were confirmed to have completely disappeared on conventional MRI at 1 year postoperatively.

LESSONS T-SLIP MRI, a cinematic MRI, is useful for detecting multiple communicating holes in SEACs.

https://thejns.org/doi/abs/10.3171/CASE24200

KEYWORDS multiple spinal extradural arachnoid cysts; multiple communicating holes; time-spatial labeling inversion pulse magnetic resonance imaging; time-SLIP MRI; dural hole closure

Spinal extradural arachnoid cysts (SEACs) are rare lesions that can compress the spinal cord and cauda equina.1,2 These cysts usually communicate with the subarachnoid space through small dural holes. Very rarely, multiple cysts can be accompanied by multiple communicating holes.3 The precise preoperative detection of all communicating holes followed by minimally invasive dural closure is the ideal treatment to prevent postoperative spinal deformity, especially in pediatric patients.3,4 Myelography, myelocomputed tomography, and magnetic resonance imaging (MRI) are used to detect cyst locations, but they often fail to detect the locations of the communicating holes, which comprise small dural defects.5–6 Although a few cases of successful single-hole detection using cinematic MRI have been reported,7–10 this modality’s ability to detect multiple holes has not been demonstrated.

Here we report the successful detection of two communicating holes in a case of dual SEACs using time-spatial labeling inversion pulse (T-SLIP) MRI.

Illustrative Case

A 14-year-old male presented with a 4-month history of gait disturbance and rectal disorder. Ankle clonus and Babinski reflexes were bilaterally positive. Conventional MRI revealed dual SEACs at T5–8 and T8–12 that severely compressed the thoracic spinal cord (Fig. 1). Myelography revealed a complete block at the T8 level, and no cephalic cyst or communicating holes could be identified. The patient and his family were referred to our hospital, where T-SLIP MRI was performed (1.5-tesla, Excelart Vantage, Canon Medical

ABBREVIATIONS CSF = cerebrospinal fluid; MRI = magnetic resonance imaging; SEAC = spinal extradural arachnoid cyst; T-SLIP = time-spatial labeling inversion pulse.

INCLUDE WHEN CITING Published June 24, 2024; DOI: 10.3171/CASE24200.

SUBMITTED March 21, 2024; ACCEPTED March 29, 2024.

© 2024 The authors, CC BY-NC-ND 4.0 (http://creativecommons.org/licenses/by-nc-nd/4.0/)
Systems Corp.; repetition time 13 RR, echo time 80 msec, black blood time interval 1,500–4,000 msec, interval 50 msec). Cerebrospinal fluid (CSF) flow into the cyst was detected at T10 (11 of 50 continuous images) and T7 (4 of 50), suggesting intermittent CSF flow into the cysts (Fig. 1, Video 1). Another T-SLIP MRI study targeting the cephalic cyst revealed no additional CSF flow. We planned to surgically close the two communicating holes without requiring a total cystectomy.

**VIDEO 1.** Clip showing preoperative T-SLIP MRI with an inversion pulse targeting the caudal cyst. Fifty images were serially connected to a video. CSF flow into the cyst was detected at T10 (11 of 50 continuous images) and T7 (4 of 50). Click here to view.

A T10 laminectomy was performed using the spinous process splitting approach, followed by partial cyst resection. Subsequently, a 12-mm dural defect was identified medial to the right T10 pedicle. The defect was sutured, followed by reinforcement with polyglycolic acid mesh and fibrin glue (Fig. 2). Next, a left hemilaminotomy and partial cyst resection at T7–8 were performed, and a 5-mm dural defect was identified medial to the left T7 pedicle. Two nerve fibers were found in the cyst (i.e., outside the dural tube), with a connecting thin fiber running into the dural hole. The connecting fiber was cut, and the dural defect was closed (Fig. 2).

The patient’s gait disturbance and rectal disorder gradually improved and disappeared by 6 months postoperatively. The cysts were confirmed to have completely disappeared on conventional MRI at 1 year postoperatively (Fig. 3). Thoracic kyphosis and the sagittal vertical axis before and 1 year after surgery were 38° versus 57° and −58 versus −15 mm, respectively (Fig. 4). Although the patient’s degree of kyphosis slightly increased postoperatively, his sagittal balance was maintained.

**Patient Informed Consent**

The necessary patient informed consent was obtained in this study.

---

FIG. 1. Preoperative conventional T2-weighted MRI in the midsagittal plane (A) and the axial plane at T7 (B) and T10 (C). No communication holes are visible. Preoperative T-SLIP MRI (D) and schematic drawing (E). Two high-intensity lines indicating flow through the holes were detected in the inversion pulse (IP) area.

FIG. 2. Intraoperative photographs taken after a partial cystectomy at T7 (A and B) and T10 (C and D). A dural hole (arrow, A) located medially to the left pedicle. Nerve filaments located outside the dura with a thin fiber into the hole (arrowhead, A). Dural hole located medially to the right pedicle (arrow, C). Closed holes (B and D).
Discussion

Observations

T-SLIP, a cinematic MRI technique, was initially applied to CSF flow imaging in 2008.11 Briefly, a designated area is spin-labeled in an inverted manner; that is, high-intensity CSF is inverted to low-intensity in the designated area only. When nonlabeled CSF flows into the labeled area, the high-intensity flow is directly visible and provides good contrast. The detection of a single communicating hole in a single SEAC using cinematic MRI, including T-SLIP MRI, has been reported.7–10 To the best of our knowledge, this is the first report to detect multiple CSF flows. Although the preoperative detection of the flow enabled a less invasive surgery, only slight thoracic kyphosis without sagittal imbalance was observed. Therefore, a longer follow-up period was required.

One disadvantage of T-SLIP MRI is that the inversion pulses must be linear. Extensive SEACs require additional T-SLIP MRI slices owing to the presence of kyphosis or lordosis. Communicating holes cannot always be identified using T-SLIP MRI because CSF flow through them is often intermittent. A combination of radiological examinations is recommended.6,10 Although we agree with the importance of multimodal preoperative imaging evaluations, T-SLIP MRI is indispensable in cases with a complete contrast block, such as that described here.

Lessons

We successfully used T-SLIP MRI to visualize CSF flow through two communicating holes in a case of dual SEACs. These findings suggest that T-SLIP MRI is a potential diagnostic tool for detecting multiple communicating holes in SEACs.

Acknowledgments

The authors thank Kengo Maruyama, RT, and Tomoyuki Nagami, RT, for useful discussions on MRI settings.

References


Disclosures
The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author Contributions
Conception and design: Ishibe, Kagei, Kanba. Acquisition of data: Ishibe, Kagei, Kanba. Analysis and interpretation of data: all authors. Drafting the article: Ishibe, Kagei, Kanba. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Ishibe. Administrative/technical/material support: Kanba. Study supervision: Ishibe.

Supplemental Information
Videos

Correspondence
Tatsuya Ishibe: Hino Memorial Hospital, Shiga, Japan. taishibe@gmail.com.