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CLINICAL IMAGE

Identification of a Dural Defect with Cine Phase Contrast MR Imaging

Genki Fukumoto[1*], Mitsunori Kanagaki[1], Takeshi Ishimoto[2], Kazuya Kitazumi[2], Atsushi Hara[3], and Hiroaki Kimura[4]

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"Duropathy" is a clinical disease spectrum caused by dural disorder.[1] Dural defect-related epidural cerebrospinal fluid (CSF) collection is associated with intracranial hypotension, superficial siderosis, and myelomalacia. It is important to identify CSF leakage sites for surgical repair.

Cine phase contrast MRI (PC-MRI) techniques have been used to investigate the flow characteristics of CSF. To our knowledge, this is the first report to describe the usefulness of PC-MRI for duropathy.

We present the case of a 46-year-old man with a 1-year history of progressive upper limb weakness. Initially, MRI demonstrated epidural fluid collection from the second cervical vertebra (C_2) to the third lumber vertebra (L_3), myelomalacia of the spinal cord from C_2 to the second thoracic vertebra (T_2), and hemosiderin deposition along the cerebellar folia (Fig. 1a–1c). Accumulation of CSF in the epidural space was confirmed by CT myelography, but the location of the dural defect was not identified (Fig. 1d). Sagittal PC-MRI examination was performed using a 1.5T scanner (Ingenia, Philips Healthcare, Best, The Netherlands) with an acquisition time of 4 min 48 s. The imaging parameters were as follows: TR 21.00 ms; TE 6.60 ms; slice thickness 15 mm; echo number 1; FOV 28 × 28 cm^2; matrix size 288 × 288; flip angle 10°; velocity encoding (VENC) 10 cm/s; flow direction feet–head; heart phase 15. CSF flow through the dural defect was suspected at $T_{1–2}$ (Fig. 1e and Movie 1). Subsequently, oblique coronal PC-MRI examination was performed with an acquisition time of 4 min 34 s. The imaging parameters were as follows: TR 13.89 ms; TE 8.63 ms; slice thickness 5 mm; FOV 15 × 15 cm^2; matrix size 256 × 256; flip angle 15°; VENC 12 cm/s; heart phase 12. The acquisition plane was selected perpendicular to the presumed direction of CSF flow through the dural defect (Fig. 1f). The oblique coronal PC-MRI clearly visualized anteroposterior dot-like flow (Fig. 1g–1i, and Movie 2). The peak CSF flow velocity was 11.74 cm/s. Axial balanced fast field echo imaging also revealed the dural defect at $T_{1–2}$ (Fig. 1j), which was surgically confirmed and closed (Fig. 1k).

Several previous reports have described PC-MRI findings, mainly the CSF flow dynamics through the cerebral aqueduct, in patients with intracranial hypotension.[2,3] However, there is no report in which CSF flow through the dural defect was directly observed by PC-MRI. This case demonstrated the usefulness of PC-MRI to identify CSF leakage sites. In this case, the acquisition time of oblique coronal PC-MRI was <5 min. If CSF flow through a dural defect is suspected on sagittal PC-MRI, oblique coronal PC-MRI can be subsequently performed due to the short acquisition time. When PC-MRI is performed, VENC should be selected close to the maximum expected CSF flow velocity. Although the mean VENC value is 5–8 cm/s for standard CSF flow imaging, we considered that CSF flow may be faster at the dural defect in the case of a small defect. Therefore, we selected 10–12 cm/s as the VENC value. The VENC value can be changed on a case-by-case basis. Due to difficulties in selection of the acquisition plane and satisfactory VENC value, four-dimensional flow MRI or dual-VENC scan may be useful. Dynamic CT myelography or digital subtraction myelography can also identify dural defects,[4,5] but they are more invasive. Therefore, we suggest PC-MRI as a good initial choice for investigating CSF leakage sites.

[1]Department of Diagnostic Radiology, Hyogo Prefectural Amagasaki General Medical Center, 2-17-77 Higashinaniwa-cho, Amagasaki, Hyogo 660-8550, Japan
[2]Division of Clinical Radiology Service, Hyogo Prefectural Amagasaki General Medical Center, Hyogo, Japan
[3]Department of Neurology, Hyogo Prefectural Amagasaki General Medical Center, Hyogo, Japan
[4]Department of Orthopedic Surgery, Hyogo Prefectural Amagasaki General Medical Center, Hyogo, Japan
*Corresponding author, Phone: +81-6-6480-7000, Fax: +81-6-6480-7001, E-mail: fukumoto0707@gmail.com

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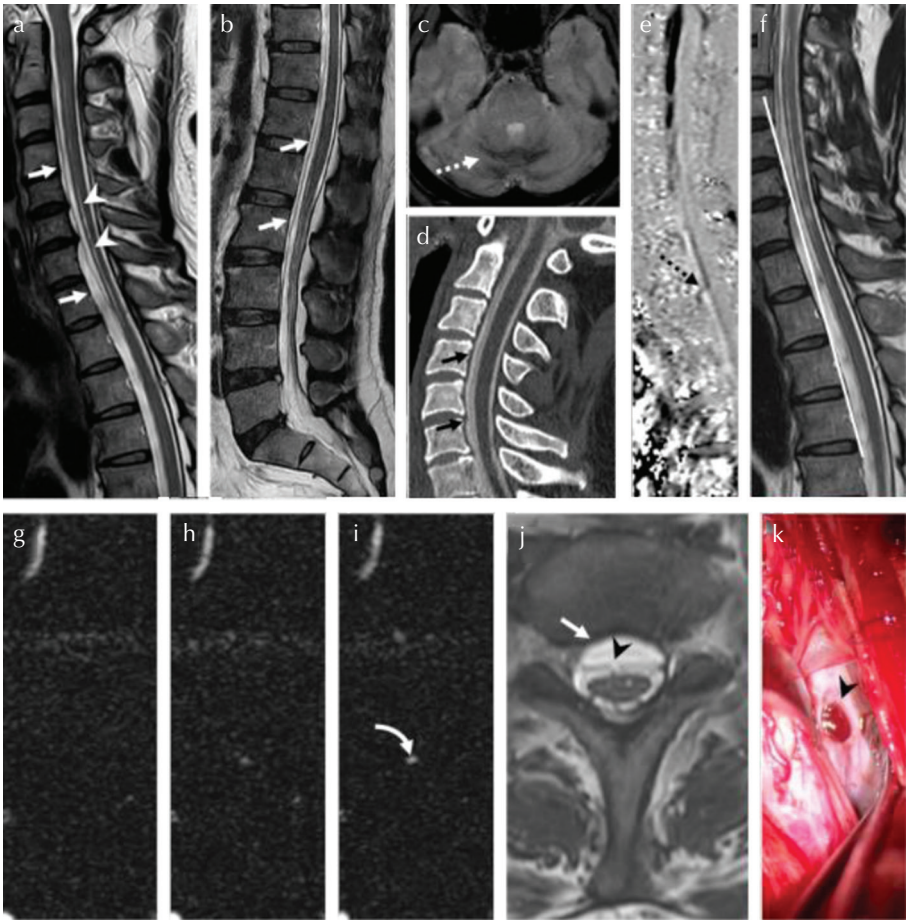
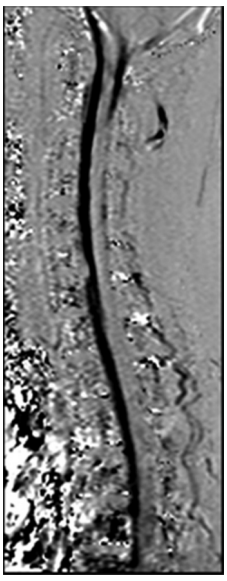
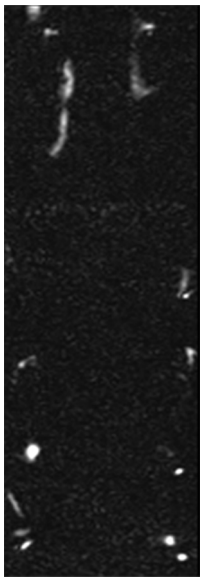


Fig. 1 Epidural fluid collection from the second cervical vertebra (C_2) to the third lumber vertebra (L_3) (**a** and **b**: white arrows) and myelomalacia of the spinal cord from C_2 to the second thoracic vertebra (T_2) (**a**: white arrowheads) on the sagittal T_2-weighted image. Hemosiderin deposition along the cerebellar folia on the T_2^*-weighted image (**c**: white dotted arrow). CT myelogram demonstrated cerebrospinal fluid (CSF) leakage into epidural fluid collection (**d**: black arrows), but the location of the dural defect was not identified. Sagittal phase contrast MRI (PC-MRI), on which the flow direction was feet–head, indicated CSF flow through the dural defect at T_{1-2} (**e**: black dotted arrow). The acquisition plane of oblique coronal PC-MRI was selected to contain the CSF flow (**f**: white line). An oblique coronal phase contrast MRI (PC-MRI) series (**g**–**i**) clearly demonstrated anteroposterior dot-like flow at the dural defect (**i**: white curved arrow). The peak CSF flow velocity was 11.74 cm/s. Axial balanced fast field echo imaging revealed the dural defect (**j**: black arrowhead) between the epidural fluid collection (**j**: white arrow) and intradural CSF. The dural defect was surgically confirmed (**k**: black arrowhead).



Movie 1 Sagittal phase contrast MRI (PC-MRI) indicated cerebrospinal fluid (CSF) flow through the dural defect at T_{1-2}. The imaging parameters were as follows: TR 21.00 ms; TE 6.60 ms; slice thickness 15 mm; echo number 1; FOV 28 × 28 cm^2; matrix size 288 × 288; flip angle 10°; velocity encoding (VENC) 10 cm/s; flow direction feet–head; heart phase 15. (This movie is available online.)



Movie 2 Oblique coronal phase contrast MRI (PC-MRI) clearly demonstrated anteroposterior dot-like flow at the dural defect. The peak cerebrospinal fluid (CSF) flow velocity was 11.74 cm/s. The imaging parameters were as follows: TR 13.89 ms; TE 8.63 ms; slice thickness 5 mm; FOV 15 × 15 cm^2; matrix size 256 × 256; flip angle 15°; velocity encoding (VENC) 12 cm/s; heart phase 12. (This movie is available online.)

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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