JOURNAL OF NEUROSURGERY:
Case Lessons

J Neurosurg Case Lessons 5(1): CASE22464, 2023
DOI: 10.3171/CASE22464

Three-dimensional phase-contrast magnetic resonance imaging for the detention of a small communicating defect in a patient with a spinal extradural arachnoid cyst: illustrative case

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BACKGROUND Spinal extradural arachnoid cysts are thought to be pouches that communicate with the intraspinal subarachnoid space through a dural defect. The treatment for these cysts is resection of the cyst wall followed by obliteration of the communicating defect, which is often elusive.

OBSERVATIONS The authors report the case of a 22-year-old man with an extradural arachnoid cyst with claudication and progressive motor weakness. Regular magnetic resonance imaging (MRI) and computed tomography did not reveal the location of the defect in the cyst. However, three-dimensional (3D) phase-contrast MRI clearly indicated the location of the defect and the flow of cerebrospinal fluid into the cyst. These findings allowed the authors to perform the least invasive surgery; the patient recovered motor function and could walk more smoothly.

LESSONS 3D phase-contrast MRI can reveal a subtle dural defect in patients with spinal extradural arachnoid cysts.

https://thejns.org/doi/abs/10.3171/CASE22464

KEYWORDS spinal extradural arachnoid cyst; 3D phase-contrast MRI; minimally invasive surgery; communicating defect; hemi-laminectomy

Spinal extradural arachnoid cysts are rare clinical entities and are thought to be pouches that communicate with the intraspinal subarachnoid space through a small dural defect. These cysts most commonly occur in the middle to lower thoracic spine (65%), but they have also been reported in the lumbar and lumbosacral (13%), thoracolumbar (12%), sacral (7%), and cervical spine (3%) regions.[1]

Cyst enlargement can occur because of active secretion from the internal cell lining, creation of an osmotic gradient between the subarachnoid space and cyst, pulsatile cerebrospinal fluid (CSF) dynamics, or a one-way valve mechanism, and it can result in symptomatic spinal cord compression.

In most symptomatic cases, a total laminectomy is performed to remove the cyst, with or without closure of the dural defect.[2] However, surgery is often invasive, and preoperative instability from the bony scalloping may result in postoperative kyphosis and back pain.[3] Accurate preoperative identification of the defect location is necessary to perform the least invasive surgery, such as a minimal hemilaminectomy and closure of the communicating defect. Three-dimensional (3D) phase-contrast magnetic resonance imaging (MRI) is a useful technique/sequence that can be used to assess the flow of CSF or of blood through the cardiac valves. Therefore, this technique is useful for the diagnosis of multiple disorders, such as cardiac valvular disease, normal-pressure hydrocephalus, and Chiari malformations.[4] Herein, we report a case of a large thoracolumbar extradural arachnoid cyst detected using 3D phase-contrast MRI and treated by performing a minimal hemilaminectomy and closure of the fine communicating defect.

Illustrative Case

A 22-year-old man presented with a history of low back pain, gait disturbance, and paralysis (mainly in his left leg) for the previous 4 months. A neurological examination revealed weakness with a manual muscle testing grade of 0–1 in his left leg quadriceps and tibialis anterior muscles. In addition, the patient's bladder and bowel

ABBREVIATIONS 3D = three-dimensional; CSF = cerebrospinal fluid; CT = computed tomography; MRI = magnetic resonance imaging.

INCLUDE WHEN CITING Published January 2, 2023; DOI: 10.3171/CASE22464.
SUBMITTED October 28, 2022. **ACCEPTED** November 18, 2022.

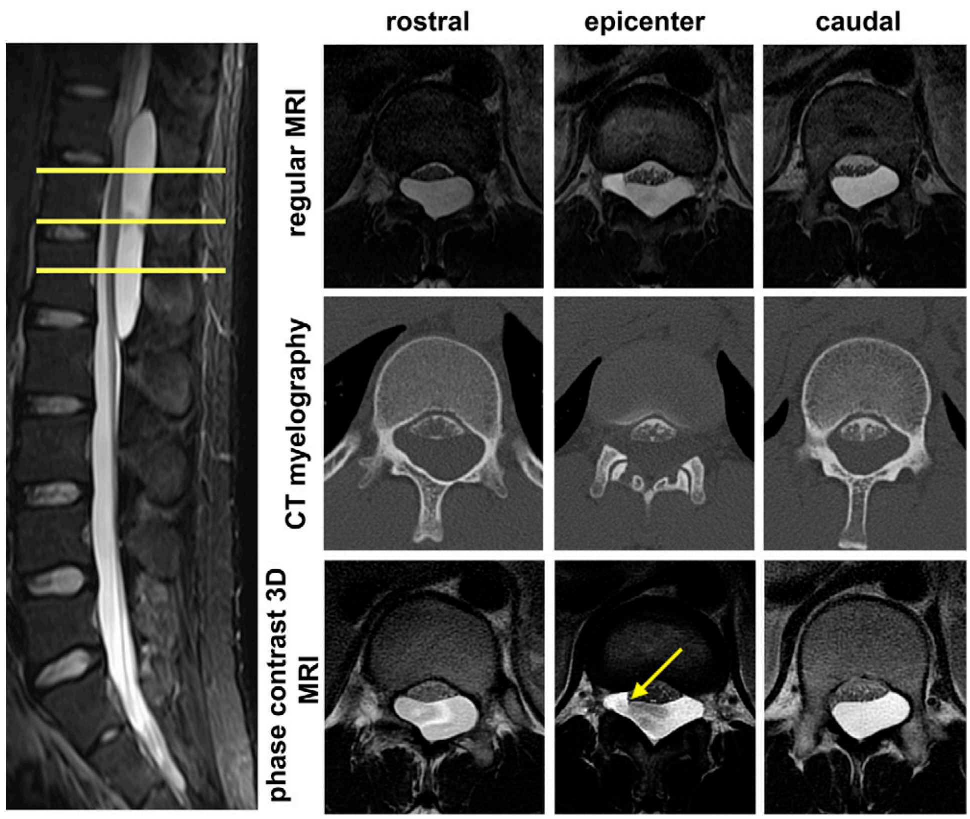

FIG. 1. Left: Preoperative sagittal T2-weighted MRI scan showing a large spinal extradural arachnoid cyst from T10 to L1 (*yellow lines*). **Upper right**: Axial regular MRI. **Center right**: Axial CT myelography. **Lower right**: 3D phase-contrast MRI scans obtained at each sagittal cutline. Regular MRI and CT myelography show no obvious communication between the cyst and the intrathecal subarachnoid space. The rostral view of the CSF wave and phase-contrast MRI scan show a clearer view of the CSF flow, suggesting that the communicating hole (*yellow arrow*) is at the T12 level.

functions were slightly impaired. Plain radiographs of the thoracolumbar spine showed bony scalloping of the vertebrae and pedicles. Regular MRI showed a large extradural cystic lesion at the T10–L1 level (Fig. 1). However, the location of the communication defect could not be identified using normal MRI and computed tomography (CT) myelography. In contrast, 3D phase-contrast MRI clearly showed CSF flow at the right T12 level, suggesting leakage into the posterior dural space. The parameters of the phase-contrast images were as follows: field of view 280 mm, matrix 256 $\times$ 160, section thickness 5.0 mm, flip angle 20 degrees, echo time 8.744 msec, repetition time 11.4 msec, and velocity encoding 5.0 cm/sec. We performed a right T12 hemilaminectomy, and after removing the cyst wall, we detected and ligated the 2-mm communicating defect on the right side of the T12 vertebra (Fig. 2). Postoperative MRI showed the involution of the cyst and no sign of spinal cord compression (Fig. 3). The patient recovered motor function in his left leg and was able to walk more smoothly. He returned to heavy labor without back pain 3 months after surgery.

Discussion

Observations

Spinal extradural arachnoid cysts are uncommon, accounting for 1% of all primary spinal cord tumors and expanding spinal canal lesions. The mechanism underlying the pathogenesis of these cysts remains unclear. A one-way valve at the communicating defect may play a role in cyst expansion, with nerve roots herniating through a small dorsal dural defect acting as a ball valve.

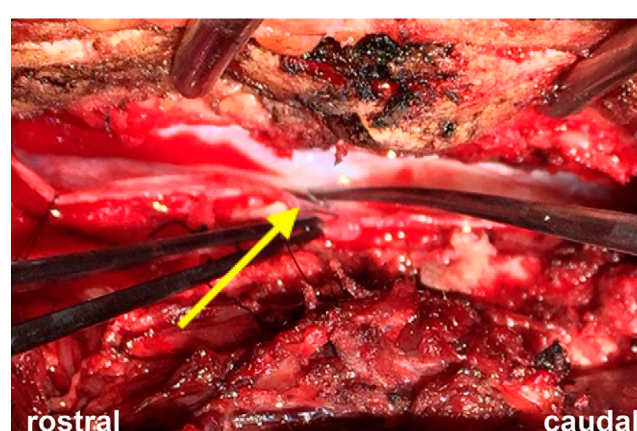

FIG. 2. Intraoperative view of the spinal extradural arachnoid cyst after the T12 hemilaminectomy, showing the communicating defect (*arrow*) and its attachment to the nerve root.

FIG. 3. Postoperative sagittal (**left**) and axial (**right**) T2-weighted MRI showing sufficient decompression of the spinal cord and no recurrence of the cyst.

Currently, the standard surgical treatment for these cysts is total resection and closure of the communicating defect. Closure alone through a selective laminectomy has also been reported.[5] Regardless of the treatment selected, it is important to identify the communicating defect, although it is often difficult to do so preoperatively. MRI is useful for detecting cysts because the signal characteristics are consistent with those of CSF. However, although CT myelography and cine MRI are better for detecting dural defects, they are often unable to locate the communicating defect.[6,7]

Phase-contrast MRI plays an important role in modern diagnostic imaging because this velocity-measuring technique allows diagnostic evaluation of CSF disorders. Parmar et al.[8] reported that phase-contrast MRI scans, which show CSF flow in the subarachnoid space posterior to the herniated spinal cord, may be helpful for excluding an associated posterior arachnoid cyst. However, to the best of our knowledge, there are no previous reports describing the use of this technology to diagnose spinal extradural arachnoid cysts.[4] In the present case, we used 3D phase-contrast MRI to reveal the location of the cyst's communicating defect because regular MRI and CT myelography failed to identify the site. The 3D MRI provided visual detail of the communicating defect, allowing us to choose the least invasive surgical option.

Lessons

Spinal extradural arachnoid cysts cause spinal cord compression enlarging the spinal canal space. During surgical treatment, it is important to identify the location of the communicating defect of spinal extradural arachnoid cysts. 3D phase-contrast MRI can define the pathophysiology of spinal extradural arachnoid cysts preoperatively, allowing better surgical planning and clinical outcomes.

Acknowledgments

We thank Drs. Kazuhiro Chiba, Osamu Sekiguchi, Soya Kawabata, Hiromasa Nagahari, and Yu Suematsu for participating in the case management presented in this paper, including the systemic examination, follow-up visits, and advice regarding the clinical approaches.

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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: Takano, Kamata. Acquisition of data: Takano, Nishimura. Analysis and interpretation of data: Takano. Drafting the article: Takano, Hikata. Critically revising the article: Hikata. Reviewed submitted version of manuscript: Hikata. Approved the final version of the manuscript on behalf of all authors: Takano. Administrative/technical/material support: Nishimura. Study supervision: Ishikawa, Kamata.

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