Evaluation of CSF flow alteration in patients with idiopathic spinal cord using SPAMM technique

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Objective

Magnetic resonance (MR) imaging has been the most effective modality in the diagnosis of spinal disorders because of its powerful soft tissue contrast and capability to offer more detailed anatomic structures. In spinal canal, there exist not only fixed structures but also continuous moving content, cerebrospinal fluid (CSF), which represent as a signal void on conventional MR technique when it has enough velocity. In idiopathic spinal cord herniation that alters hydrodynamics of CSF, such as flow disturbance or flow separation of CSF, understanding of CSF flow is very important in the diagnosis. Spatial modulation of magnetization (SPAMM) technique can be used in the evaluation for any kind of continuous moving object including delicate flow of CSF in the spinal canal. SPAMM technique is helpful in showing a CSF flow separation due to herniated spinal cord. Objective of this study is to describe a characteristic CSF flow of idiopathic spinal cord herniation using SPAMM technique, which is helpful for diagnosis.

Method

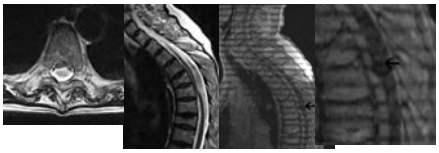
Five patients with idiopathic spinal cord herniation and one patient with spinal arachnoid cyst, who took the SPAMM MRI, were reviewed retrospectively. The SPAMM MRI was obtained on a 1.5T system using the electrocardiogram-triggered multiphase image technique with repetition time/time to echo/diffusion time/flip angle = 42 milliseconds/7.2 milliseconds/0 to 600 milliseconds/20 degrees. Additional T2 weighted spin echo sagittal and axial images were obtained for the evaluation of adjacent structures and precise diagnosis. Two radiologists analyzed the tagging band shifting of the flow motion around herniated spinal cord on the SPAMM MRI. Compared to the thickness of presaturation band stripe of CSF, motion index of CSF flow around herniated spinal cord was measured (motion index = maximal downward distance of CSF flow/thickness of presaturation band stripe of CSF).

Result

With the downward displacement of presaturation band stripes of CSF, all patients with idiopathic spinal cord herniation showed no CSF flow ventral to the herniated spinal cord on the SPAMM MRI. Four of 5 patients showed a characteristic downward band shift (Figure 1, 2). The other patient showed downward movement of CSF flow similar to the CSF flow around normal spinal cord, which was due to poor quality images. Downward band shifts near to the herniated spinal cord showed the faster movement (motion index = 2.1), compared to the CSF flow (motion index = 1.2) around normal spinal cord. All patients showed a focal anterior kink of the spinal cord with an enlargement of the dorsal subarachnoid space on T2 weighted sagittal images and adherence of the cord to the ventral dura on T2 weighted axial images. One patient with spinal arachnoid cyst showed parabolic downward band shift on the SPAMM MRI unlike idiopathic spinal cord herniation.

Conclusion

SPAMM technique can be used for diagnosis of idiopathic spinal cord herniation, showing a characteristic CSF flow due to flow disturbance and separation.



A **B** **C** **D**

Figure 1. Images of a 82-year-old female patient who had spinal cord herniation. Axial (**A**) and sagittal (**B**) T2-weighted magnetic resonance images showed an anterior displacement of spinal cord and widening of the dorsal subarachnoid space at T6 level. On the SPAMM MRI (**C**), downward shift of tagging band near to herniated spinal cord (arrow) showed the faster movement than normal CSF flow. Magnified view of portion indicated by arrow of **C** was shown in **D.**

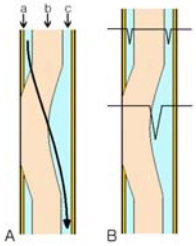
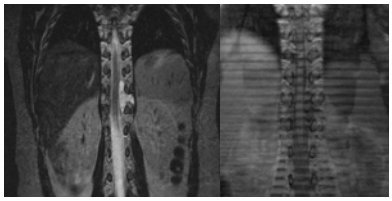


Figure 2. Schematic views of CSF flow around herniated spinal cord. **A,** CSF flow (arrow) is disturbed and separated in the both side of herniated spinal cord. Flow speed is increased due to narrow space around herniated spinal cord. **B,** Downward band shift near to the herniated spinal cord is more increased than normal CSF flow. (a, dura mater; b, spinal cord; c, subarachnoid space)



A **B**

Figure 3. Images of a 28-year-old female patient who had spinal arachnoid cyst. **A,** coronal T2-weighted magnetic resonance image showed left lateral arachnoid cyst in T11-T12 level. On the SPAMM MRI (**B**), downward shift of tagging band in the arachnoid cyst showed paravolic shape with velocity similar to CSF flow around normal spinal cord.