Evaluation of Syringomyelia with Three-dimensional Constructive Interference in Steady State (CISS) Sequences

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Introduction

Syringomyelia is a cystic cavitation of the spinal cord communicating with or without the central canal. It is caused by certain congenital or neoplastic conditions, spinal trauma, arachnoiditis, or unknown etiology. Although some theories based on hydrodynamic mechanisms have been proposed to explain the formation of the cystic cavity, the exact pathophysiology is not completely understood (1-3). MR imaging is useful for visualization of the extent of syringomyelia and the surrounding cord abnormality. Recently, constructive interference in steady state (CISS) sequence that can provide high-resolution images with good contrast between the CSF and solid structures has been developed. The usefulness of CISS sequence has been described in various pathological conditions of the central nervous system (4-6). However, to our knowledge, there have been no clinical reports of CISS images for syringomyelia. The purpose of this study is to evaluate the value of 3-D CISS sequences with a special attention to internal structures of the syringomyelia.

Materials and Methods

Ten patients with syringomyelia were studied with a 1.5-T superconductive unit (Magnetom Vision; Siemens, Erlangen, Germany) that used a spinal phased-array coil. They were eight females and two males aged 7 to 78 years, with the mean age of 41 years. The cause of syringomyelia included idiopathic (n=3), tethered cord (n=2), Chiari I malformation (n=2), traumatic (n=1), arachnoiditis (n=1), and diastematomyelia (n=1). Scoliosis was seen in six patients. After the sagittal T1-weighted SE and T2-weighted fast SE imaging sequences were obtained, the 3-D CISS sequence was performed in the coronal slab to reduce motion artifacts from the heart and large vessels. All sagittal images were acquired with a rectangular field of view (FOV) to obtain finer spatial resolution in the phase-encoding direction. The parameters for the 3-D CISS sequence were 1.2-17/6-8/1 (TR/TE/excitations), 0.7-mm-thick sections, and a flip angle of 70°. For all the sequences, a 18- to 38-cm FOV and a 256 x 512 matrix were used. The 3-D CISS images were reconstructed with a multplanar reconstruction (MPR) technique, yielding images in all three orthogonal planes.

For analysis, two radiologists independently evaluated the image quality and artifacts on the sagittal T2-weighted fast SE and 3-D CISS images for the following: contrast between spinal cord and CSF, delineation of spinal cord from CSF, motion artifacts, and artifacts induced by pulsatile CSF flow. The radiologists then evaluated the appearance of the syrinx on the sagittal T2-weighted fast SE, 3-D CISS, and MPR images. On a set of MR images, the extent of the syrinx was compared as same, longer than SE, shorter than SE. Then, septation and communication between the septated syrinx were cored as present, absent, or questionable. The final interpretation was obtained by consensus. The statistical significance was determined by the chi-square test. The results of the detection for internal structures of syrinx in 10 patients with syrinx. Thirty-two syrinx ranked as present on the T2-weighted fast SE images and three questionable septations on the 3-D CISS images were clearly depicted on the MPR images and ranked as present. Communications between the septated syrinx were detected only by the MPR images. The 3-D CISS MPR images could also clearly demonstrate the relation between syrinx and cord in all six patients with syrinx and scoliosis.

Discussion

We sometimes encounter a septated appearance of the syringomyelia on MR imaging. The septation in the syrinx has been reported by using endomyelography, CT myelography, and MRI. The communication between the individual cavities has been proved by endomyelography and CT myelography. Association between the septation and significant increased intrasyrinx pressure, which has been described. However, the significance of the internal structures is still controversial (7).

Several authors have applied the CISS sequence to demonstrate the fine anatomical structures of the inner ear or cerebrospine angle (4-6). In our study, the septations were more clearly demonstrated on the 3-D CISS images than on the T2-weighted fast SE images. While the communication between the septated syrinx was detected only by the 3-D CISS MPR images. The reasons for these high visualization of the 3-D CISS images are considered to be as follows: 1) cerebrospinal fluid flow artifacts are significantly fewer with the 3-D CISS images; and 2) small internal structures of the syrinx can be depicted by high-resolution images and good contrast between spinal cord and syrinx.

Conclusion

The T2-weighted fast SE and 3-D CISS images are complementary imaging methods in the evaluation of syringomyelia. It is recommended to add CISS sequences which provide more detail information about syringomyelia.

References

2. Williams R, Lancet 1977, 1, 142
5. Cassleman JW, Majoor MHJM, et al., AJNR, 1994, 15, 131

TABLE 1: Results of detectability for internal structures of syrinx on T2-weighted fast SE and 3-D CISS sequences in 10 patients

<table>
<thead>
<tr>
<th>Imaging Sequence</th>
<th>Septation</th>
<th>Communication between the septated syrinx</th>
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<tbody>
<tr>
<td>T2-weighted fast SE</td>
<td>8 Questionable 32 Present</td>
<td>0 Questionable 0 Present</td>
</tr>
<tr>
<td>3-D CISS</td>
<td>3 Questionable 40 Present</td>
<td>3 Questionable 0 Present</td>
</tr>
<tr>
<td>3-D CISS + MPR</td>
<td>0 Questionable 47 Present</td>
<td>0 Questionable 15 Present</td>
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Note.-MPR, multiplanar reconstruction images