MRI of the lumbar spine at 7 Tesla in healthy volunteers and a patient with spina bifida

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Purpose:

The aim of this study was to demonstrate the feasibility of lumbar spinal imaging with 7 Tesla MRI. For this purpose four sequences, which are established at lower magnetic field strengths or assumed to be applicable [1,2], were applied, and different anatomical structures of the lumbar spine were evaluated.

Methods:

Five healthy volunteers and one patient with spina bifida and meningocele received a MRI examination of the lumbar spine with a 7 Tesla whole body scanner (Magnetom 7T, Siemens Healthcare, Germany) and a custom-built 8 channel transmit-receive spine coil [3], including a T2-TSE (TR = 3500, TE = 88, TA = 1:50, FA = 180, voxel size = 0.57 x 0.57), a 3D-DESS (TR = 10.75, TE = 4.01, TA = 5:39, FA = 20, voxel size = 0.78 x 0.78), a 3D-CISS (TR = 5.74 , TE = 2.78, TA = 10:45, FA = 25, voxel size = 1.04 x 1.04) and a 3D-VIBE (TR = 20, TE = 3.06, TA = 12:59, FA = 30, voxel size = 0.57 x 0.57) sequence. Depictability of different anatomical structures and imaging limitations were described.

Results and Discussion:

A combination of CISS and VIBE sequences provides visualization of the vertebrae, the intervertebral discs, the bony neural foramina, the facet joints, the dural sac, and the intraspinal portions of the spinal nerves (Fig. 1 a&b). Furthermore bony malformations and the menigocele in the patient could be well depicted with these sequences (Fig. 3). The T2-TSE suffered from severe loss of signal homogeneity in most of the volunteers depending on the thickness of the subcutaneous fat tissue (Fig. 2 b). DESS provided only little contrast between spinal nerves and CSF, the contrast between vertebrae and discs was inferior to the CISS and the VIBE (Fig. 2 a). Differentiation of intraforaminal structures was difficult with all mentioned sequences.

Conclusion:

These preliminary results indicate that bony spine and dural sac anatomy in healthy volunteers, as well as complex spinal malformations can be visualized with 7 Tesla MRI. However this study provides an important basis for further clinical applications in the spine at 7 Tesla.

References:

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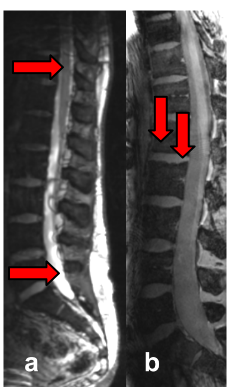

Fig. 1: CISS (a) and VIBE (b): Excellent differentiation between dural sac and CSF (arrows) in the CISS, although this sequence suffers from banding artifacts. VIBE allows differentiation between vertebrae and discs (arrows) but provided only little contrast between dural sac and CSF.

Fig. 2: DESS (a) and T2-TSE (b) in a healthy volunteer: DESS showed no contrast between the dural sac and CSF and only moderate contrast between vertebrae and discs. T2 suffered from severe signal loss in most of the volunteers, most likely depending on the thickness of the subcutaneous fat tissue.

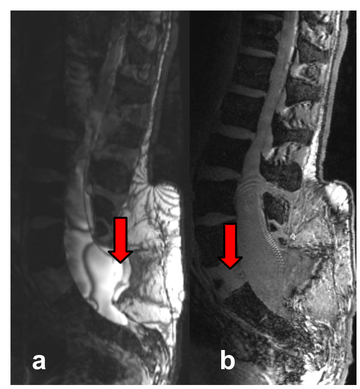

Fig. 3: CISS (a) and VIBE (b) in the patient with spina bifida and meningocele: In the CISS the dimensions of the meningocele can be visualized (arrow), in the VIBE bony present malformations can be seen (arrow).