MR IMAGING OF DEGENERATIVE DISC DISEASE IN THE LUMBAR SPINE WITH ULTRASHORT TE (UTE) PULSE SEQUENCES

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Introduction

Clinical MR imaging of the lumbar spine usually combines T_1 and T_2 weighted spin echo pulse sequences. The shortest echo times generally employed are in the range of about 8 – 12 ms. As a consequence tissues or components of tissues with short T_2s typically show little or no signal. It is possible to use sequences with echo times 20-50 times shorter than those routinely used in clinical practice and detect signal from tissues with short T_2s such as ligaments, periosteum and cortical bone (1-4). In this study we report our initial experience in imaging degenerative disease of the lumbar spine with UTE pulse sequences.

Subjects and Methods

All studies were approved by the Institutional Review Board. The basic pulse sequence employed a half radiofrequency (rf) excitation followed by radial imaging of k-space in one direction as described previously (2,4).

Fields of view (FOVs) of 30 - 35 cm were employed with a slice thickness of 4-6 mm. 6-12 multiple slices were obtained simultaneously with flip angles of 80^o and slice gaps of 10 - 100%. Studies were conducted using a dedicated two coil spine array on a Sonata 1.5T MR system (Siemens, Erlangen, Germany).

Results

Five adult normal controls and 12 patients mean age 43.9 (29-72 years; 6 males, 8 females) with clinical diagnoses of degenerative disc disease were examined with different types of UTE sequence. Gadodiamide 0.3 mole/kg was administered to 11 of the patients. Their diagnoses were disc bulge at one or more levels (6), disc protrusion at one or more levels (6), canal stenosis (3), post-operative changes(2). Normal Findings: The anterior and posterior longitudinal ligaments were demonstrated as high signal structures on subtraction images. The ligamentum flavum was also seen as a high signal structure extending laterally to merge with the capsule of the facet joints. Perivertebral ligaments were observed passing between vertebral bodies across discs. The supraspinous ligament was readily observed as a high signal structure. Interspinous ligaments were observed with high signal particularly adjacent to bone at the site of their insertion. Other insertions of ligaments could be seen on the spinous and transverse processes and were best seen when situated close to the spinal array receiver coil. Subtraction images showed signal from the annulus fibrosus adjacent to the vertebral end-plates. The nucleus pulposus was of low signal on subtraction images consistent with its long T_2. Vertebral bodies showed significant short T_2 components in their marrow. The signal from these was reduced, but still present following fat suppression.

The dura had a relatively high signal on subtraction images. Nerve and nerve roots were best seen on original images without subtraction.

Periosteum had a high signal intensity on subtraction images and was best seen in the spinous and transverse processes in close relation to the receiver coil. Articular cartilage showed a high signal on original and subtraction images.

Normal contrast enhancement was seen in short T_2 tissues or tissue components on subtraction images in ligaments, the annulus fibrosus, vertebral bodies and periosteum. Enhancement in nerve roots was seen without subtraction.

Abnormal findings: Enhancement was seen in discs, thickened anterior and posterior ligaments, scar tissue and discs. The use of subtraction or long T_2 suppressed images reduced the signal from blood and made the signal in scar tissue more obvious.

The interspinous ligaments also showed marked enhancement in three cases. Marked enhancement was seen in the thickened ligamentum flavum.

In severe degenerative disease marked thickening of the anterior and posterior ligaments was seen together with increased scar tissue adjacent to the disc. Enlargement of the ligamentum flavum was apparent. There was marked loss of disc height with better preservation of the annulus fibrosus than of the nuclei pulposus. Areas of enhancement were apparent in some discs (probably a result of neovascularization). Localised areas of enhancement were also seen.

Discussion

Using UTE sequences the lumbar spine was visualised with high signal in the anterior and posterior ligaments, ligamentum flavum, interspinous and oblique ligaments as well as the periosteum and dura depending in detail on the type of pulse sequence used. Scar tissue and ligamental thickening was more obvious with UTE imaging and enhancement was more clearly seen. More extensive enhancement was seen in disc disease, spinal stenosis and disease of the interspinous ligaments.

References

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