

The Comparative Research of Different Sequences on Lumbosacral Nerve Roots with 3.0T MR

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Purpose The purpose of this research is to find the difference between normal lumbosacral nerve roots and lumbar disc herniation nerve roots by comparing the IDEAL and FIESTA technologies.

Introduction The low back pain is mainly caused by the symptoms of nerve root compression, and stimulation introduced by lumbar disc herniation and facet joints disorder. MRI examination is the major diagnostic method but can't provide the specific location and the characteristics of nerve compression. Besides, the herniated disc is not the only reason for causing lumbosacral nerve roots compression and damage, lumbar spinal stenosis, hyperosteoegeny. And the hypertrophy of ligamentum flavum can also lead to the change of the contort and compression of nerve roots because of the complexity of adjacent structures and nerve contorts. Thus it plays a great clinical significant role in demonstrating the anatomic information and the whole contort well in lumbosacral nerve roots. The IDEAL sequence of 3.0T MR scanner (Discovery MR750, GE Company) has a new Dixon's method for fat suppression^[1,2]. The IDEAL acquisition and reconstruction methods can generate a water-only, fat-only, in-phase and out-phase data sets for clear tissue differentiation in a single series. We use this technique to find the difference between normal lumbosacral nerve roots and lumbar disc herniation nerve roots.

Materials & Method Twenty-two patients with low back pain caused by lumbar disc herniation were examined on 3.0T MR scanner (8-channel CTL Target Array Coil, Discovery MR750, GE Company). All had performed routine scanning, 3.0T MR IDEAL sequence and FIESTA sequence thin-layer coronal scanning. The following imaging parameters were used for IDEAL sequence: (TR/TE=6453/120ms, FOV=32x32cm, ETL=16, NEX=3, slice-thickness=1.2mm, slice-gap=0mm, matrix=320x224, bandwidth=83.33). The following imaging parameters were used for FIESTA sequence: (TR=4.6ms, TE=Min-Full, FOV=35X35cm, NEX=1, slice-thickness=1.0mm, slice-gap=0mm, matrix=288x320). Post-processing techniques worked on AW4.5 workstation, the source images were post-processed using maximum intensity projection (MIP), multi-planar-reformation (MPR), and curved-planar reconstruction (CPR). The lumbosacral nerve roots were evaluated on the raw images and 3D images by scores of image quality, contrast noise ratio, definition of compressed nerves.

Results Both the two sequence could display the anatomic structure and the whole contort of spinal nerve roots well in primary images and post-processing images. The CNR value of Nerves-CSF of FIESTA (283.24 ± 117.97) was significantly higher than IDEAL sequence (96.28 ± 39.29), with statistical significance ($P=0.028$). The result of image quality evaluation of FIESTA (4.66 ± 0.33) was also higher than IDEAL sequence (4.22 ± 0.68), with statistical significance ($P=0.028$). The definition evaluation of compressed nerves of IDEAL (2.78 ± 0.45) was higher than FIESTA (2.19 ± 0.83), the difference had statistical significance ($P=0.023$). There was no statistical difference in CNR value of Nerves-Centrum between FIESTA and IDEAL sequence. FIESTA sequence combined with Post-processing reconstruction image could show the dural sac compression caused by herniated disc from different angles, its main manifestation was filling defect impression of dural sac. Besides, IDEAL sequence could show the imaging characteristics of the spinal nerve on the canals of lumbar spinal nerves, and the relationship between compressed nerve and adjacent structures. IDEAL sequence improved the rate of nerve root, especially the part segments of the posterior to the ganglions and their branches, which could demonstrate the anatomical structure and its details more clearly with uniform fat suppression technology. By adjusting different perspectives, IDEAL imaging technology has more advantage on showing relationship among compressed nerves, protruded nucleus pulposus and the adjacent structures.

Discussion The scanning time of FIESTA sequence was short, with the high imaging spatial resolution and SNR, it could provide a stark contrast to the nerve with low signal intensity and the CSF with high signal intensity, and display the characteristics of neural structures clear and intuitive, especially the nerve in vertebral canal. But it was poorer to display the DRGs and lacked of soft tissue contrast. IDEAL sequence has a good fat suppression technology, and with high SNR, it had been shown to have excellent anatomic capability, and had more advantages to show the DRGs and part segments of the posterior to the ganglions and the assessment between compressed nerve roots and adjacent structures. Findings of nerve local compression including the local defect impression, the changes of the trunk and contort of nerve root, local swelling, unclear displayed, even manifests discontinuity or breaking, unclear limit between adjacent tissue, local conglutination, edge blur, and narrowing or disappearing of CSF spaces.

Conclusion FIESTA sequence could provide effective image data and diagnostic value if we need to observe the degree of nerve root compression and the changes of before and after treatment. But if we want to make the accurate positioning and diagnostic assessment of compressed or damaged nerve through the analysis of lumbosacral nerve roots imaging and the relationship between nerve and adjacent structures, IDEAL sequence is a better choice. Lumbosacral nerve roots imaging with IDEAL sequence can provide a significant value in the clinical diagnosis to estimate the nerve compression or nerve injury, and provide detail information for the right treatment at early-stage and for the observation of clinical efficacy. It will bring forward bright developing prospects.

Reference [1] Rybicki FJ, et al. ARJ, 2001, 177 (5) : 1019-1023.

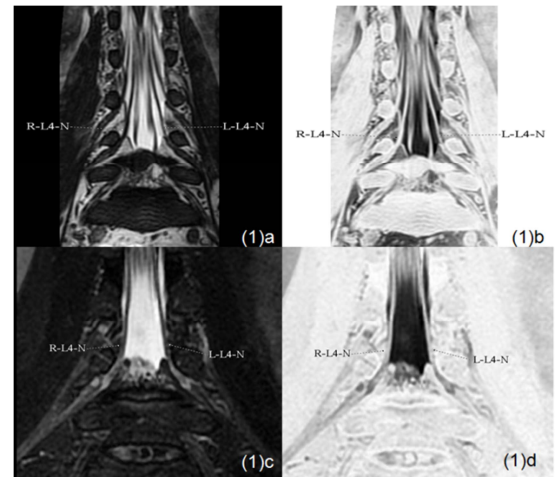


Figure.1: On the CPR imaging of bilateral L4 nerve, a and b is FIESTA in-phase and out-phase imaging, c and d is FIESTA in-phase and out-phase imaging, the nerve in vertebral canal on the FIESTA imaging can be showed more clear and with smooth edge. However, IDEAL sequence can display the anatomic structure and the whole contort of the lumbosacral nerve roots excellent as well as the nerve in vertebral canal.

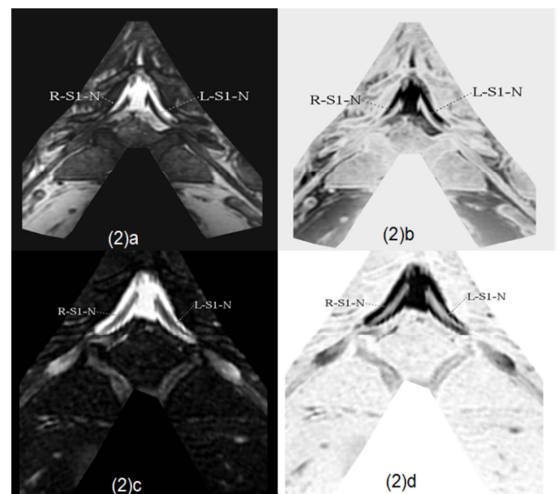


Figure.2 Both two sequence can display the bilateral S1 nerve compression, FIESTA (a and b) has a good value in image quality and the sharpness of nerve roots, but IDEAL (a and b) can make the accurate positioning and diagnostic assessment of compressed or damaged nerve and the relationship between nerve and adjacent structures.