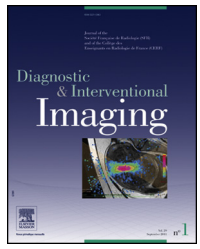
Diagnostic and Interventional Imaging (2014) **95**, 63—68



ORIGINAL ARTICLE / *Neuroradiology*

Clinical relevance of diffusion tensor imaging parameters in lumbar disco-radicular conflict

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KEYWORDS
Spine;
Lumbar;
Discoradicular conflict;
Diffusion tensor imaging;
Tractography

Abstract
Purpose: To measure the fractional anisotropy (FA) and the mean diffusivity (MD) values of L4, L5 and S1 nerve roots using diffusion tensor imaging (DTI) and to correlate them with four different clinical patterns.
Patients and methods: Fifty-six human participants were prospectively included and divided between four groups: healthy subjects, patients with clinical symptomatic nerve root pain with and without anatomical discoradicular conflict and patients with incidental anatomical disco-radicular conflict seen on magnetic resonance imaging (MRI). MRI protocol included anatomical sequences (sagittal T1- and T2-weighted, axial T2-weighted) and a 25 directions DTI sequence. FA and MD values were measured in consensus by two readers and compared between the four groups.
Results: Mean FA and MD values were significantly different for patients with clinically symptomatic nerve root pain ($n = 27$) both with ($n = 16$) (FA = 0.187 ± 0.015; MD = 510 ± 40) and without ($n = 11$) (FA = 0.193 ± 0.011; MD = 490 ± 30.5) anatomical discoradicular conflict compared

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2211-5684/$ — see front matter
http://dx.doi.org/10.1016/j.diii.2013.08.019

to healthy subjects ($n = 29$) (FA = 0.221 ± 0.011; MD = 460.9 ± 35.5) including 2 subjects with incidental anatomical discoradicular conflict (FA = 0.211 ± 0.013; MD = 450.8 ± 41.2) on MRI ($P = 0.003$).

Conclusion: Measurement of FA and MD values of L4, L5 and S1 nerve roots using DTI could be useful in lumbar nerve root pain assessment. Further studies with different image processing methods are needed.

Abbreviations

DTI	Diffusion tensor imaging
FA	Fractional anisotropy
MD	Mean diffusivity
VAS	Visual analogic scale

Introduction

Degenerative discal herniation in the mobile lumbar spine is a common pathology, mostly explored by MRI. However, discordance between clinical nerve root pain and lumbar spine MRI findings is not rare and may be an issue for diagnostic and therapeutic management [1].

Diffusion tensor imaging (DTI) has been widely used in brain imaging for tracking of white matter tracts and the evaluation of brain connectivity [2—5]. This technique explores the anisotropic microscopic Brownian motions of water molecules along the preferential orientation of nervous fibres. In each voxel, the diagonalization of the diffusion tensor allows the calculation of eigen values, which are used to characterize the anisotropy and diffusivity, as reflected by two parametric values: fractional anisotropy (FA) and mean diffusivity (MD), respectively. The degree of anisotropy and the average diffusion lead to the determination of the main diffusion direction, which reflects the orientation of the tissular components, e.g. white matter tracts or nerve roots [3]. This technique has also shown interest in carpal tunnel syndrome and acute transverse myelitis assessment [6—8].

Few preliminary studies reported fibre tracking of the lumbar nerve roots using DTI. Studies measuring FA and MD in healthy subjects at different intersomatic space levels of the mobile lumbar spine and different segments of L4, L5 and S1 nerve roots seems to allow the determination of reliable and reproducible normal values [7,9]. However, according to MRI field, acquisition parameters and software, using these values data can be variable [10].

Significant changes in compressed lumbar nerve roots diffusion parameters have been reported for patients suffering from disc herniation or lumbar foraminal stenosis [7,9].

Thereby, the modification of diffusion parameters of lumbar nerve roots according to clinical symptoms or MRI findings may be considered as a potential diagnostic tool to treat precisely pathologic nerve root pathway, based on parametric rather than anatomical information in case of clinical and imagery unconformity.

To our knowledge, no previous study has assessed the relation between FA and MD values of lumbar nerve roots, anatomical discoradicular conflict seen on MRI and symptoms of nerve root pain. Consequently, the aim of this study was to measure FA and MD values of L4, L5 and S1 nerve roots using DTI and to correlate them with different clinical patterns: clinically healthy subjects, including patients with anatomical incidental discoradicular conflict seen on MRI, and patients with clinical symptomatic nerve root pain with or without anatomical discoradicular conflict.

Materials and methods

Patients

We conducted a monocentric prospective study on a cohort counting 56 human participants (38 men and 18 women) consecutively included from April 2011 to January 2012. Informed consent was obtained from each participant before inclusion. Twenty-seven (19 men and 8 women) were patients presenting with a L4, L5 or S1 nerve root pain confirmed by clinical examination and DN4 score ≥ 4 [11]. Those were then classified in two groups according to the anatomical MRI results: (1) no anatomical discoradicular conflict concordant with the nerve root pain; and (2) anatomical discoradicular conflict concordant with clinical symptoms. Twenty-nine healthy subjects (18 men and 11 women) without prior history of low back pain or nerve root pain and with DN4 score ≤ 4 [11] were also included. Those were also classified in two groups according to anatomical MRI results: (1) no anatomical discoradicular conflict; and (2) clinically asymptomatic incidental discoradicular conflict seen on MR images. Anatomical discoradicular conflict was defined as mass effect due to disc herniation with deviation or non-visualization of a compressed nerve root segment. Mean age was 63 years (range, 43—86). Pain was also evaluated using a visual analogic scale (VAS) for each study participant. Exclusion criteria for both groups were a previous history of spinal trauma, surgery, or neurological disease and classical contraindication to MRI (pregnancy, metallic implants, and claustrophobia).

MRI

MRI scans were performed on a single 1.5 T GE system (GE Healthcare, Chalfont St. Giles, United Kingdom) the day of the inclusion. We used a six elements phased array spine coil. Images were acquired in supine position. A standard MRI protocol was performed, which included T1-weighted TSE (TR, 660 ms; TE, 9.5 ms; number of averages (NEX), 1; field of view (FOV), 380 × 380 mm; matrix, 512 × 512; slice count, 12; slice thickness, 4 mm; slice gap, 0.4 mm; acquisition time 2 min 53 s) and T2-weighted TSE (TR, 2960 ms; TE, 70 ms; NEX, 2; 380 × 380 mm; matrix, 512 × 512; slice count,