Diffusion-weighted MR imaging (DWI) has become very soon after its introduction one of the routine imaging techniques in the evaluation of brain disorders. Due to the technical difficulties DWI has been rarely performed in the spine and spinal cord, and the experience and knowledge is limited.

The first enthusiastic article describing the use of DWI imaging for differentiation of benign from malignant vertebral fractures was published by Andrea Baur et al. from Munich in 1998 (Baur A et al. Radiology 1998). All malignant fractures in that study were hyperintense on DWI, whereas benign (osteoporotic) fractures showed low signal. Studies with quantitative measurements that followed in the literature have also shown significant difference between benign and malignant fractures (Herneth A et al. Radiology 2002).

A critical point in clinical use of DWI in vertebral body fractures is the patient inclusion or exclusion criteria (Baur A et al. J Magn Reson Imaging 2006). In advanced healing process of a fracture soft callus forms with decrease of water mobility leading to false positive results. Patients with fractures older than two weeks should be excluded, as well as metastases which have undergone therapy. Necrotic tumour shows increased diffusivity and leads to false negative result.

Two major technical problems in obtaining DWI of the human spinal cord are: the size of the cord and motion. Spinal cord can move independently of surrounding structures;
swallowing, CSF pulsation, and breathing will cause problems and disturbing artefacts.

Several techniques have been introduced in the last ten years, such as: single-shot echo-planar imaging (EPI), interleaved echo-planar imaging (IEPI), fast spin-echo (FSE), diffusion-weighted line scan imaging (LSDI), steady-state free procession (SSFP) sequence, and sense/parallel imaging single/multi-shot echo-planar DTI. Each technique has advantages and disadvantages.

Gass A. was the first to describe DWI findings in spinal cord infarction (Gass A et al. Neurology 2000). In his case high signal was detected on DWI 30 hours after the onset of symptoms. Although the largest number of patients with described DWI findings is six, the data and current experience suggest that DWI has a potential to develop in useful and feasible technique in early detection of the acute spinal infarction, and diffusion abnormality can be found after few hours (Thurnher MM et al. Neuroradiology 2006).

Clark CA. et al. have used DWI to measure ADC in normal subjects and in Multiple Sclerosis (MS) lesions in the spinal cord, and found decreased anisotropy in MS plaques (Clark CA et al. Mag Reson Med 2000). This is probably due to the loss of myelin, expansion of extracellular space and perilesional edema.

DTI was used in a recently published study to investigate changes in different regions of the spinal cord in 24 MS patients (Hesseltine et al. Am J Neuroradiol AJNR 2006). The results were compared with those in 24 age/matched controls. Significantly lower FA values were found in lateral, dorsal parts of the normal appearing spinal cord (NASC) in MS patients. The results of the study have shown that significant changes in DTI metrics are present in the cervical spinal cord of MS patients, in the absence of spinal cord signal abnormality at conventional MR examination. Van Hecke W. et al. have shown that the spinal cord may still be affected by MS, even when lesions are not detected on a conventional MR scan. The authors demonstrated that diffusion tensor tractography is a
robust tool to analyze the spinal cord of MS patients (Van Hecke W et al. *J Magn Reson Imaging* 2009).

DTI measurements were also performed in 23 asymptomatic human immunodeficiency virus (HIV) positive patients in collaborative study of Vienna University and Mount Sinai Medical Center in NY (Müller-Mang C et al in press). FA and ADC measurements were performed at three different levels of the cervical spinal cord. Asymptomatic HIV+ patients demonstrate changes in DTI metrics in cervical spinal cord compared to controls in the absence of abnormalities on conventional MRI. Differences found may represent early HIV-related changes. Predominance of changes in MD, E2 and E3 in lateral spinal cord may reflect the distribution pattern of VM.

An inflammatory myelitis (ATM) is characterized by decreased FA values in the region of T2-weighted lesion and increased FA values in the lesion’s boundaries (Renoux et al. *Am J Neuroradiol AJNR* 2006).

Findings on conventional MRI in degenerative cord compression are not specific to the severity of cord damage and are unable to discriminate potentially reversible edema and ischemia from irreversible myelomalacia and gliosis. Clinical symptoms precedes abnormal cord signal on conventional MRI. Early detection of myelopathy would be of benefit for patients who are potential candidates for decompressive surgery. Demir A et al. have found increased ADC values in 80% of patients with cervical spondylotic myelopathy (Demir A et al. *Radiology* 2003). Hesseltine and colleagues obtained several measurements using DTI in patients with cervical spondylosis and have shown that transverse eigenvalue is significantly higher in severe spondylosis, but longitudinal eigenvalue is not appreciably changed (Hesseltine et al. ISMRM 2006). Changes in transverse eigenvalue represent edema/extracellular space and more responsive to decompression. Changes in longitudinal eigenvalue (axonal integrity) precede T2 signal change and represent irreversible changes.
DWI has the potential to profoundly impact the ease and confidence of spinal disease interpretation and offer more efficient diagnostic work-up of patients suffering from spinal disease.