Diffusion-weighted MR imaging (DW-MRI) in the body: Techniques and Optimisation

Dr. Dow-Mu Koh, Royal Marsden Hospital, UK

Introduction

For almost two decades, DW-MRI has been used to evaluate diseases in the brain. In recent years, advances such as parallel imaging; higher gradient performance and improvement in receiver coil technology have enabled high quality DW-MRI images to be acquired in the body. DW-MRI is an imaging technique that derives its image contrast based on differences in the mobility of protons (primarily associated with water) between tissues.

Techniques of DW-MRI in the body

Imaging strategies for DW-MRI in the body reflect the need to overcome the effects of motion. DW-MRI in the body is usually performed using the single or double spin-echo echo-planar imaging in breath-hold or free-breathing. These techniques have their advantages and disadvantages (see Table). Free-breathing DW-MRI is a versatile technique that can be applied across different MR imaging platforms.

	Breath-hold DW-MRI	Free-breathing DW-MRI
Acquisition time	Short (typically < 1 min)	Longer (typically 4 to 6 mins)
Signal-to-noise	Lower (single-shot)	Higher (multiple averages)
Artifacts	Higher sensitivity	Lower sensitivity
Section thickness	Thicker partitions to maintain signal-to-noise	Thinner partitions because of high signal-to-noise
Anatomical detail	Good	Some image blurring
b-values	Fewer b-values	More b-values if required
Combination	None	May be combined with respiratory/ cardiac triggering

Typical imaging parameters used for breath-hold and free-breathing DW-MRI will be discussed. Whole body imaging can be performed using diffusion-weighted imaging with background suppression (DWIBS). DWIBS utilizes a free breathing DW-MRI technique, acquiring images at multiple anatomical stations in the body, and the images are ordered and displayed using an inverted grey scale.

Optimisation of Image Acquisition and Display

Although DW-MRI is an imaging technique that is quick and relatively easy to perform, imaging optimisation is worthwhile to ensure that high quality images are consistently attained. It is helpful to engage the assistance of a physicist or vendor application specialist to maximize the signal-to-noise of the acquired DW-MRI images and to minimise artefacts that degrade image quality.

Strategies to optimise signal-to-noise will be discussed. Artefacts that can significant degrade image quality may arise from motion, chemical shift, eddy currents, Nyquist ghosting, susceptibility effects and G-noise. Practical tips to aid the radiologists in reducing these artefacts will be highlighted.

Optimisation of image display facilitates radiological evaluation DW-MRI images may be displayed using the standard grey-scale or by using an inverted grey-scale. When thinner partition sections are acquired (e.g. 4 – 5 mm), multi-planar reformats can be useful; as is fusion imaging of the DW-MRI image or ADC map with the morphological T1 or T2-weighted MR image.