Diffusion Imaging: From Physics to Physiology

ESMRMB Educational Program

14-16 October 2010
Worcester College, Oxford, UK

Thursday, 14 October 2010
Diffusion Imaging Techniques

09:00-10:00
Introduction to diffusion imaging
*Derek K Jones, Cardiff*
- Diffusion in tissue: a qualitative description
- ADC, b-value and the diffusion tensor
- Basic experiment types: trace, multiple directions, multiple diffusion times
- Examples of key applications

10:00-11:00
Basic acquisition techniques
*Karla L Miller, Oxford*
- Diffusion-encoding gradients
- Single-shot, multi-shot & navigated sequences
- Parallel imaging
- Eddy-current compensation

Coffee/Tea (30 minutes)

11:30-12:30
Data in practice: Artifacts, confounds and pitfalls
*Derek K Jones, Cardiff*
- Artifacts: ghosting, distortion, chemical shift, eddy currents, cardiac pulsation
- Optimizing diffusion measurements: b-value, directions, resolution, SNR
- Pitfalls in analysis: pre-processing, parameter estimation
- Pitfalls in interpretation: what can be inferred from diffusion data?

Lunch (1 hour)

13:30-14:30
Advanced acquisition techniques
*Klaus Scheffler, Basel*
- Stimulated echoes, SSFP and hyperechoes
- Double wave vector encoding
- Influence of diffusion on sequences not intended for diffusion imaging

Coffee/Tea (30 minutes)

15:00-16:30
Exercises: Data acquisition

Day 1 Lecturers

16:30-17:30
Plenary: Diffusion and microstructure: What are we measuring?
Christian Beaulieu, Alberta
- White matter microstructure: key players in diffusion
- Sources of diffusion anisotropy
- Restricted and hindered diffusion: the tissue perspective

Welcome Dinner

Friday, 15 October 2010
Diffusion Modeling and Analysis

09:00-10:00
Models of tissue orientation
Saad Jbabdi, Oxford
- The tensor model and its limitations
- Higher order and multiple tensors
- “Model-free” methods

10:00-11:00
Fibre tractography
Geoffrey Parker, Manchester
- Deterministic tractography
- Uncertainty and probabilistic tractography
- Multi-fibre methods
- Validation

Coffee/Tea (30 minutes)

11:30-12:30
Exercises: Orientation and tractography
Day 2 Lecturers

Lunch (1 hour)

13:30-14:30
Models of tissue microstructure
Valerij Kiselev, Freiburg
- The diffusion propagator, diffusion time and q
- Non-Gaussian diffusion and cumulants
- Models of restricted and hindered diffusion
- Lessons from Monte Carlo simulations

14:30-15:30
Extracting microstructural parameters
Daniel Alexander, University College London
- Microstructure models in practice
- Experimental requirements
- Sequence optimization
Coffee/Tea (30 minutes)

16:00-17:00
Exercises: Diffusion and microstructure
Day 2 Lecturers

17:00-18:00
Plenary: What unique insights can diffusion MRI offer?
Denis Le Bihan, Orsay
- Water transport: what can it tell us about the brain?
- The role of water in neuronal architecture and function
- Perspectives and future possibilities for diffusion MRI

Saturday, 16 October 2010
Diffusion Imaging in the Neurosciences

09:00-10:00
Voxel-wise analysis of diffusion data
Stephen M Smith, Oxford
- Voxel-wise regression analysis and registration confounds
- Local estimation of diffusion-derived parameters
- Interpretation, confounds and future directions

10:00-10:30
Diffusion imaging in basic neuroscience
Timothy EJ Behrens, Oxford and University College London

10:30-11:00
Diffusion imaging in anatomical investigations
Marco Catani, Institute of Psychiatry

Coffee/Tea (30 minutes)

11:30-12:00
Diffusion imaging of development, learning and recovery
Heidi Johansen-Berg, Oxford

12:00-12:30
Diffusion imaging in clinical neuroscience
Chris Clark, University College London

12:30-13:00
Panel discussion: The present and future role of diffusion in neuroscience
Day 3 Lecturers

Adjourn