

DTI vs. HARDI for Presurgical Fiber Tracking of the Motor Pathways Session: Advanced Neuroimaging 1 – Brain & Spinal Cord

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Highlights:

- Conventional diffusion tensor imaging (DTI) is not able to cope with complex white matter or voxels containing crossing fiber tracks.
- High angular resolution diffusion imaging (HARDI) is capable of depicting crossing white matter fibers. HARDI fiber tracking can delineate a larger portion of the motor tract than DTI fiber tracking.
- HARDI fiber tracking can be integrated with a surgical navigation system for surgical planning along with other brain mapping techniques.

Target audience: This course is intended for researchers or clinicians interested in integrating advanced diffusion tractography with surgical planning.

Objectives: At the completion of the lecture, attendees will be able to

- 1) Understand the motivation for translating HARDI into a clinical tool for surgical planning.
- 2) Describe the fundamentals of HARDI acquisition and post processing techniques including probabilistic fiber tracking
- 4) Understand the logistics of integrating an investigational HARDI fiber tracking routine into a clinical presurgical data pipeline.
- 5) Learn the limitations of HARDI tractography and understand why HARDI must be used in conjunction with other presurgical and intra-operative mapping techniques.

Purpose: – A goal of neurosurgery is to preserve both functionally important cortices and the underlying white matter tracts. Diffusion MR tractography remains the only non-invasive method of determining the 3D course of white matter tracts. Traditional DTI fiber tracking is widely used for surgical planning, but fails to accurately represent the microstructure of crossing white matter tracts. The DTI model is restricted to a single fiber population. The insufficiencies of DTI have motivated the development of advanced diffusion MR techniques capable of accurately describing the microstructure and connectivity of complex white matter tracts.

Methods: High angular resolution diffusion imaging (HARDI) requires a diffusion acquisition at high b-value with a large number of diffusion gradient directions to provide angular resolution of crossing fibers. The acquisition time is significantly longer than the requirements for DTI. However, HARDI is capable of depicting complex white matter architecture and HARDI fiber tracking can potentially depict a larger portion of the motor pathway than DTI fiber tracking. HARDI fiber tracking can be visualized during brain surgery and used as a guide to prevent damage to the motor pathway.

Discussion and Conclusion: It is critical that the capabilities and limitations of HARDI be understood so the technique can be safely used for surgical planning. It is important to remember that that diffusion MR is an imperfect tool that must be used in conjunction with other functional mapping techniques and can never be relied upon alone.

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