How to do a DTI multi-center neuroimaging study

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Diffusion tensor MRI (DTI) is a useful tool for assessing structural and architectural features of the brain. Multi-center clinical research studies including a DTI component are becoming increasingly common. DTI is a quantitative technique, i.e. diffusion tensor derived quantities are measured on an absolute scale and have a well-defined physical meaning. Quantitative techniques provide data that ideally suited for studies including multiple centers. On the other hand, DTI results are profoundly affected by experimental and methodological aspects. Without careful planning and coordination across participating centers there is a high risk of collecting diffusion MRI data that are highly variable across centers. The goal of this tutorial is to review the most important aspects that need to be taken into consideration when designing multi-center DTI studies and analyzing the data collected. We will try to point out strategies that have already proven successful but also address open questions and challenges that need further research. Below is a list of topics that will be addressed in this talk.

- Examples of large multi-center DTI initiatives that put emphasis on protocol standardization: (See for example: http://www.nbirn.net/ www.NIH-PediatricMRI.org http://www.na-mic.org/)
- Need of phantoms suitable for DTI calibration.
- Experimental design: i.e. how to make the best use of the available scanning time. Optimal number of directions, Optimal choice of b-values.
- Addressing heterogeneous system conventions and data format with magnets form different manufacturers.
- Procedures to ensure quality control across sites and within site for longitudinal studies
- Robust and standardized data processing. Importance of centralized processing.
- Desired features of the data processing pipeline: importing data with minimal user intervention, motion and eddy-current distortion correction, registration to structural templates, EPI distortion correction, rotation of b-matrices, production of “corrected” raw images with a minimum number of interpolation steps, tensor computation with proper weighting, robust tensor estimation, computation of tensor derived variables, production of tensor data in a standardized space.
- Appropriate tools for data analysis, identification of confounds and artifacts, statistical inferences for the population, creation of population specific atlases.