Summary: A hitchhiker's guide to diffusion tensor imaging

Basic fundamental of DTI:

When water diffuse in the brain, its motion will be influenced by lots of factor, such as tissue type, integrity, architecture. So the path of water molecule diffusion will show the construction information of the brain tissue.

When water though White Matter (WM), it can only through the direction along the axon. So water motion is anisotropic in WM.

When water though Gray Matter (GM), it can through all direction. So water in GM is isotropic.

Technology for obtaining diffusion motion information of water:

Magnetic resonance (MR) images can be made sensitive to this motion.

The application of DTI:

Promising tool to study WM microstructure in vivo

Explore WM anatomy and structure in vivo, especially abnormalities in WM. Such as patients with acute stroke or brain tumors ……

Expected to apply to disease treatment planning, detection of preclinical markers, and microstructural abnormalities and so on.

The workflow of DTI:

1, Artifacts and data acquisition techniques

Two main artifacts: eddy current distortions and head motion

Ways to solve eddy current: based on twice-refocused spin echo pulse, bipolar gradients, field maps, and preprocessing approaches.

Ways to solve head motion: by synchronizing the acquisition with the source of motion, monitoring using "navigator echoes", using specific protocols, applying real-time prospective motion and outlier detection methods and so on.

2, Quality control and preprocessing

The function of Quality control and preprocessing is to detect and correct artifacts in DWI and to exclude those that could not be corrected, providing consistency to reliable tensor estimation.

3, Processing visualization

Three main method are used to estimate the tensors: Ordinary Least Squares(OLS), Weighted Linear Least Squares(WLLS), and Non-linear Least Squares(NLLS)

4, Quantitative analysis

5, Multimodal studies

6, Results interpretation