Comparison of DTI Data in 5-year old children acquired using Standard and Navigated DTI Sequences

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Target Audience: This study is relevant to researchers and clinicians who perform DTI in young children and restless subjects.

Purpose: Head motion and motion correction may introduce positive or negative bias in DTI. Data. This bias may be undetectable and affect findings of group analyses. The aims of this study were: (1) to evaluate patterns of head motion in children aged 5-6 years using the navigated diffusion sequence to measure motion, (2) to explore differences in whole brain FA due to prospective and retrospective motion correction, and (3) to investigate the effect of rotating the diffusion table following retrospective motion correction.

Methods: A twice-refocused two-dimensional diffusion pulse sequence that minimizes the effects of eddy current was previously modified to perform prospective motion correction with reacquisition of a specified number of corrupted diffusion volumes. Eighteen children (5.1±0.5 years) were scanned on a Siemens Allegra 3 T. All procedures were approved by the Faculty of Health Sciences Human Research Ethics Committee of the University of Cape Town; parents/guardians provided written informed consent and children provided oral assent. DTI data were acquired using both the standard (basic) and navigated (Nav) diffusion sequences at the end of a lengthy scanning protocol. Parameters were TR 9500 ms or 10026 ms for the basic and navigated sequences, respectively; TE 86 ms, 72 slices, resolution 2 x 2 x 2 mm³, FOV 224 mm, single channel birdcage coil, 30 diffusion directions with b = 1000; four b=0 acquisitions; five reacquisitions. The diffusion data from all subjects were quantified using Diffusion Toolkit (http://trackvis.org/), which generates all the diffusion maps. The whole brain histogram (WBH) of FA was calculated and normalized for the total number of tracks. DTI maps were registered to each subject’s T1-weighted structural image. Since there was no way to monitor head pose inside the scanner when using the standard diffusion sequence in this study, DICOM volume images were inspected visually for the presence of motion. The navigated acquisitions were inspected for the presence of motion by analyzing the log files of the motion estimates that are generated by the navigated sequence. Retrospective motion correction (retro) using ‘mcflirt’ with a mutual information cost function and 6 degrees of freedom was implemented with and without rotating the diffusion table only for data acquired using the standard sequence (basic).

Results: Children in this age range predominantly displayed translation along the superior-inferior axis and rotation around the left-right axis which corresponds to nodding motion. Retrospective motion correction not only failed to recover DTI data in the presence of motion, but corrupted DTI data in scans with no motion. Rotation of the diffusion table following retrospective motion correction affected data negligibly (Fig. 2d). These changes are consistent with those reported previously.

Discussion: The results of this work demonstrate the risk of misinterpreting DTI findings in pediatric studies in the presence of motion and retrospective motion correction. This study also highlights that motion and corrupted diffusion volumes should be prospectively dealt with to ensure valid DTI results.

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