Rekonstruktion neuronaler Bahnen basierend auf Diffusions-Tensor Bildgebung

Reconstruction of Neural Pathways based on Diffusion Tensor Imaging

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Purpose

Diffusion tensor imaging (DTI) provides information about the location of neural pathways within the human brain. To achieve maximal tumor resection while avoiding postoperative neurological deficits this information is of major importance. DTI exploits the fact that water diffusion within neural fibers known as Brownian motion is anisotropic since the cell membrane restricts diffusion. This imaging modality thus reveals tissue structure and architecture at the microscopic level.

Material & Methods

All diffusion tensor images were acquired using a Siemens MR Magnetom Sonata Maestro Class 1.5 Tesla scanner equipped with a gradient system with a field strength of up to 40 mT/m (effective 69 mT/m) and a slew rate of up to 200 T/m/s (effective 346 T/m/s). The imaging parameters were TR = 9200, TE = 86 ms, b_high = 1000 s/mm^2, b_low = 0 s/mm^2, field of view 240 mm, voxel size 1.875 x 1.875 x 1.9 mm^3, 1502 Hz/Px bandwidth, acquisition matrix 128 x 128. Sixty slices with no intersection gap were measured, the diffusion-encoding gradients for the six diffusion weighted images were directed along the following axes: (+/-1,1,0), (+/-1,0,1) and (1,+/-1,0).

A standard PC (Intel 2.4 GHz) with NVidia GeForce4 graphics card providing 128 MB graphics memory was used for the fiber tracking and the visualization of the pathways.

To obtain information about the location of white matter fiber tracts several processing steps were performed. In a first step, diffusion tensors were computed from the directional diffusion images. To account for inherent imaging, noise filtering techniques were applied to the tensor data. Streamline computation techniques commonly referred to as tractography were then applied to the vector field derived by determining the dominant eigenvector.
The resulting curvilinear paths most likely represent the course of fibers within the brain. Tracking was either performed for the whole brain or between regions of interest (ROIs) which were specified by the user.

Results

Fiber tracking allows visualizing neural pathways within the human brain which is of high value for neurosurgery. Tractography was successfully used for neurosurgical planning and intraoperative application. Thereby, the inherent risk of tumor resection could be considerably reduced.

Discussion

The presented approach contributes significantly to a better understanding of the spatial relation between white matter fiber tracts and space occupying lesions. It is therefore of high value for clinical application in neurosurgery.

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