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3. Jahrestagung der Deutschen Gesellschaft für Computer- und Roboterassistierte Chirurgie e.V.

Intraoperative Identifizierung von Bahnsystem mit Hilfe Diffusions-Tensor-Bildgebung basierter Neuronavigation

Intraoperative identification of major white matter tracts by diffusion tensor imaging based neuronavigation

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OBJECTIVE

Identification of major white matter tracts by integrating diffusion tensor imaging (DTI) into navigational datasets.

METHODS

A single-shot spin-echo diffusion weighted echo planar imaging sequence on a 1.5 T MR scanner was used for DTI. Color-encoded fractional anisotropy (FA) maps of the principal eigenvector rendered as a boxoid within each voxel were used for segmentation of major white matter tracts, such as the pyramidal tract. The segmented images were rigidly registered with a T1-weighted gradient echo 3-D dataset for navigation in 13 patients. Alternatively in 15 additional patients we implemented 3-D tractography by a knowledge-based multiple-ROI (region of interest) approach applying user-defined seed regions in the color-encoded FA maps. Tracking was initiated in both retrograde and orthograde directions according to the direction of the principal eigenvector in each voxel of the ROI. The tractography results were also assigned color applying the convention used in color-encoded FA maps. The tractography data were integrated into the navigation by a co-registration of the B0 images with the 3-D T1-weighted dataset.

RESULTS

The whole DTI processing lasted about 25-30 minutes. In all 28 cases DTI data on major white matter tracts could be integrated into the navigational dataset. Navigational accuracy measured as target registration error was 1.39 ± 0.9 mm.

Registration of FA maps or B0 images with the 3-D navigational dataset was possible with an error of less than 2 mm. Co-registration with fMRI was consistent with the DTI data. Only in one patient (3.6%) we observed a neurological deterioration.

CONCLUSIONS

DTI can be reliably integrated into navigational datasets. Microscope-based neuronavigation can be used for an intraoperative visualization of major white matter tracts. fMRI and magnetoenecephalography allow identification and preservation of eloquent cortical brain areas; DTI on the other hand identifies major white matter tracts allowing to preserve also deep seated eloquent brain areas. Integrating these modalities into the navigational setup enables resections of tumors adjacent ot these eloquent brain regions with low morbidity. However, possible brain shift of major white matter tracts during surgery has to be taken into account after major tumor parts are removed.