Purpose:
To segment the cingulum, fornix and the corpus callosum using diffusion weighted images, in order to evaluate the radiation-induced damage on these important white matter structures

Methods:
We propose a seed-based tractography algorithm for segmenting the entire cingulum into the left and right anterior, superior, and posterior subdivisions. In that algorithm, multiple ROIs (regions of interest) for tractography are automatically created from seeded points by a level-set segmentation algorithm. Moreover, we propose new ROI placements for fornix tractography. Furthermore, a new subdividing method is proposed for supporting the possible rotation in the corpus callosum longitudinal axis in presence of glioma tumors. To test the reproducibility of the proposed algorithm for segmenting the cingulum, test-retest diffusion tensor data-sets of twelve patients were chosen from the National Biomedical Imaging Archive database. We calculated the Dice coefficients of the volumetric overlap between the test and retest cingulum segments. Twenty-two patients with low grade brain gliomas underwent 6-week fractionated radiation therapy (RT). The patients prospectively enrolled MRI with diffusion tensor imaging up to 18 months after starting RT. The fornix and subdivisions of cingulum and corpus callosum were segmented.

Results:
The Dice coefficients between test and retest data were 0.878, 0.899, 0.951, 0.954, 0.926, and 0.929 for the anterior right and left, the superior right and left, and the posterior right and left cingulum segments respectively, suggesting our method's high reproducibility. Amongst the fornix and subdivisions of cingulum and corpus callosum, the most significant changes in fractional anisotropy, mean, axial, and radial diffusivity were observed in fornix throughout all dose volumes, indicating that both axonal degradation and dysmyelination are prominent radiation effects in the fornix.

Conclusions:
The proposed seed-based tractography method segments the cingulum accurately and completely with dramatically reducing the operator's interaction time and effort in manual depicting large number of ROIs.

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