A semi-automatic method for the quantification of spinal cord atrophy

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Due to its high flexibility, the spinal cord is a particularly challenging part of the central nervous system for the quantification of nervous tissue changes. In this paper, a novel semi-automatic method is presented that reconstructs the cord surface from MR images and reformats it to slices that lie perpendicular to its centerline. In this way, meaningful comparisons of cord cross-sectional areas are possible. Furthermore, the method enables to quantify the complete upper cervical cord volume. Our approach combines graph cut for presegmentation, edge detection in intensity profiles for segmentation refinement, and the application of starbursts for reformatting the cord surface. Only a minimum amount of user input and interaction time is required. To quantify the limits and to demonstrate the robustness of our approach, its accuracy is validated in a phantom study and its precision is shown in a volunteer scan–rescan study. The method's reproducibility is compared to similar published quantification approaches. The application to clinical patient data is presented by comparing the cord cross-sections of a group of multiple sclerosis patients with those of a matched control group, and by correlating the upper cervical cord volumes of a large MS patient cohort with the patients' disability status. Finally, we demonstrate that the geometric distortion correction of the MR scanner is crucial when quantitatively evaluating spinal cord atrophy.
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