Introduction

- The cerebellum is heavily involved in motor control and coordination. The cerebellar peduncles establish connectivity to the cerebrum and other supratentorial structures through the brainstem.
- The peduncles demonstrate atrophy in many diseases, including ataxia [1] and stroke [2], and their sizes may be a useful surrogate measure for disease.
- Existing methods for cerebellar structure assessment typically rely on measurements on planes aligned with cardinal directions (axial, sagittal, coronal) in a reference coordinate system [3,4]. Tract orientations may be oblique to slices, so cross-sectional areas can be erroneously increased. Furthermore, measurement errors are subject-specific due to individual differences in paths relative to the fixed reference coordinates.
- Practical considerations with existing user interfaces preclude tract-specific realignment due to the difficulty of efficiently re-aligning a 3D volume in an environment suitable for delineation.

We present ViPAR (Visualization, Paint, And Rotation), a MRI visualization and manipulation tool that enables efficient real-time 3D transformation of MR volumes and delineation of regions of interest.

We propose a protocol to delineate cross-sectional areas of cerebellar peduncles perpendicular to local orientation, which results in improved accuracy and reliability of manual measurements.

ViPAR Comparison with Previous Method

- ROIs were delineated on diffusion tensor colormaps derived from three acquisitions of 32 diffusion encoding directions and a scanner average of five minimally weighted volumes on a 3T MR scanner (Intera, Philips Medical Systems, The Netherlands). Written informed consent was obtained.
- Cross-Sectional Area of the Middle Cerebellar Peduncle

ViPAR Method

Delineation on Cardinal Planes

Delineation Method

- ViPAR was developed as a plug-in for MIPAV (Medical Image Processing, Analysis, and Visualization), a freely available medical image analysis software package published by the NIH written in Java.
- ViPAR augments the “triplanar” volume visualization (right) with a control panel (top left) which allows arbitrary rigid body transformations (rotation and translation) that are updated in real time. A detailed control panel (lower left) is available for fine adjustments.
- The MIPAV region of interest (ROI) delineation tool (“paint”) is adjusted so that it is consistent with transformed volume. ROIs may be saved, loaded or processed either within MIPAV or by an external program.

Intra- and Inter-Rater Validation

- To assess the intra- and inter-rater reliability of the ViPAR method, two blinded raters repeated three measurements of ten ROIs in four subjects. Two subjects were normal controls and two were ataxia patients.
- There were no significant differences between raters (mean 0.24±3.1 mm², p<0.1). Intra-rater reliability depended on the size of the region of interest, and was approximately 4.7% of the cross-sectional area. No significant subject or disease state differences were observed (p>0.1).

ViPAR, the delineation protocol, and sample data are freely available at: http://iacl.ece.jhu.edu/resources/

References

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