A 3D interactive atlas of cerebral vasculature from 7T

Purpose

The cerebral vasculature on 7T is superior to acquisitions on 1.5T and 3T. To enhance our understanding of the cerebrovasculature and its correlation to the surrounding neuroanatomy, an interactive atlas is constructed with a very detailed, highly parcellated, three-dimensional (3D) model of the cerebral vasculature derived from 7T multi-modal scans, correlated with the surface and sectional neuroanatomy.

Materials and methods

SWI, TOF and SPGR scans were acquired on 7T with the 512x512 matrix, 0.4x0.4 mm pixel size, and 0.9 mm slice thickness. In addition, MPRAGE and 3D TOF scans of the same specimen were acquired earlier on 3T (RSNA 2006). The 7T scans were mutually co-registered and, to reduce the influence of geometric distortions, warped against the 3T TOF scan by applying an affine transformation. The vessels were extracted by employing a dedicated and sophisticated vascular editor (see our informatics exhibit LL-IN1112). All the vessels were labeled with names and diameters. The 3T MPRAGE (T1W) scan was used to construct the surface hemispheric and ventricular neuroanatomy as well as sectional neuroanatomy presented as a 3D orthogonal triplanar. The sulci were open to expose the vessels. A user interface was developed with an elegant and user-friendly interface for real-time exploration of the cerebrovasculature along with the surrounding neuroanatomy.

Features

- An interactive 3D atlas of cerebrovascular with the surrounding neuroanatomy
- A highly parcellated, very detailed and 3D cerebrovascular model derived from 7T multi-modal (SWI, SPGR, TOF) scans with above 660 vessels, the smallest of 0.1mm diameter
- The 3D cerebrovascular model comprises both the arterial and venous systems further subdivided into groups and individual branches
- The completely segmented (uniquely color-coded) and fully labeled cerebrovasculature with names and diameters at any location
- The cerebrovasculature correlated with the surface hemispheric and ventricular neuroanatomy as well as sectional imaging neuroanatomy presented as a 3D orthogonal multi-modal triplanar
- Novel exploration and real-time manipulation (zoom/rotate/pan/set view) of the cerebrovascular and neuroanatomical models with the scan triplanar
- The 3D cerebrovascular model electronically dissectible
- Localization and quantification (vessel diameter, stereotactic coordinates, distances)

Summary

This cerebrovascular atlas has great usefulness in education and training. It enables the student to quickly grasp the 3D cerebrovascular anatomy and the educator in preparing teaching materials. It may be useful in medical research by providing the reference cerebrovascular atlas. The cerebrovascular model is easily deformable and editable which enables its application for atlas to scan warping, variant generation, and modeling of hemodynamics. The atlas also may potentially assist in diagnosis and treatment by providing vessel identification and quantification.
Main view for model/triplanar viewing, manipulation, and labeling (R/L – right/left mouse click). Manipulation: rotate (R), zoom (wheel) or +/− keys, pan (L+/−R) or arrow keys; alternatively use model/triplanar manipulation panel. Labeling: point – displays name; L press and drag – draws a line and places label (with name, location, and diameter).