SEMI-AUTOMATED HIPPOCAMPAL VOLUMING USING FLUID TRANSFORMATION BRAIN WARPING SOFTWARE BY SURGICAL NAVIGATION TECHNOLOGIES (SNT)

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Semi-automated hippocampal volumetry was carried out using a commercially available high dimensional brain mapping tool (Medtronic Surgical Navigation Technologies (SNT), Louisville, CO), that has previously been validated and compared to manual tracing of the hippocampus (Hsu et al., 2002). The software uses fluid image transformations to match the individual brains to a template brain, as originally developed by Christensen, Joshi, & Miller, 1997. The SNT software has been specifically designed to assist in tracing the hippocampus in the human brain. The procedures for hippocampal tracing using SNT are outlined below.

The program requires four inputs:

- ✓ PATIENT MRI DATA
- ✓ LANDMARKS AROUND THE HIPPOCAMPUS OF PATIENT MRI DATA
- ✓ A BRAIN ATLAS WITH THE HIPPOCAMPUS DEFINED
- ✓ SNT ALGORITHMS

METHOD

1) Landmarking involves using software that displays the patient data in three orientations and the placement of both global and local landmarks.

Global landmarks consist of identifying the anterior commisure (AC) and the posterior commisure (PC) line sagittally and 3-dimensional grid placement around the patient brain.

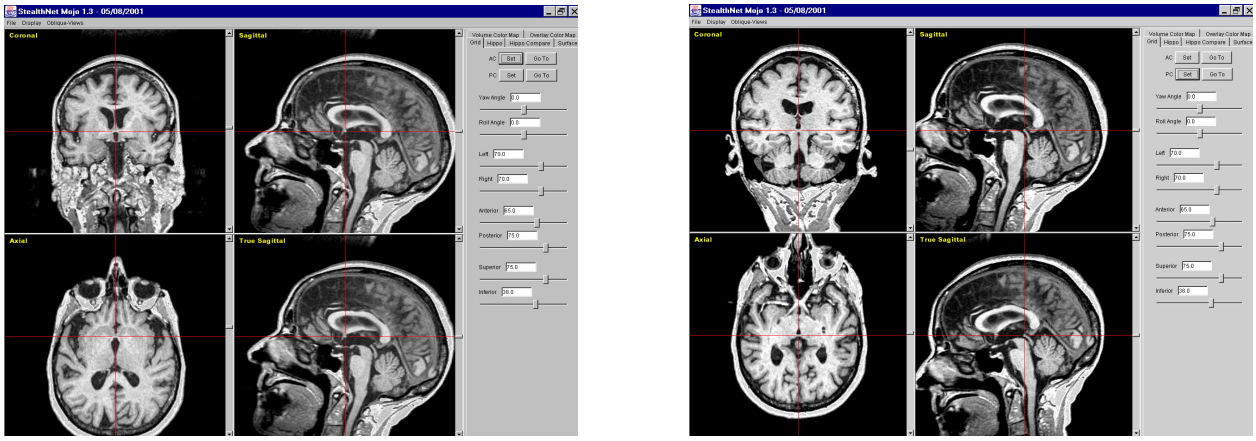

Figure1. Global landmark placement on AC and PC location for data reslice along AC-PC plane

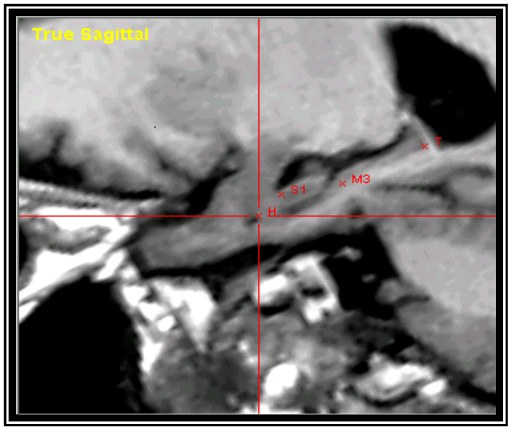

Figure2. Local landmark placement

Local landmarks consist of 44 points surrounding the left and right side of the hippocampus. Two points are placed in the sagittal view corresponding to the head and tail of that side to mark the center of the hippocampus.

Another 20 points are positioned on 5 coronal slices along this long axis. Each slice contains a lateral, medial, superior, and inferior point.

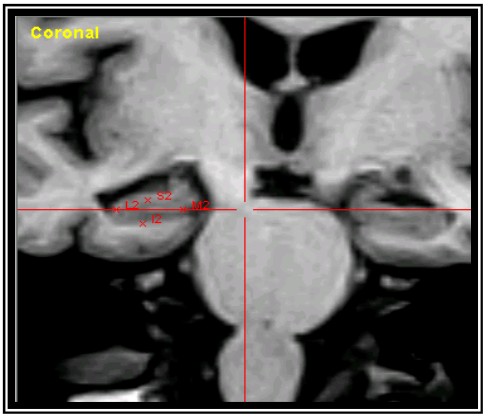

Figure3. Local landmark placement

2) Once scans are fully landmarked on both sides, all 44 points are processed using Medtronics algorithms, producing hippocampal boundaries and volumes.

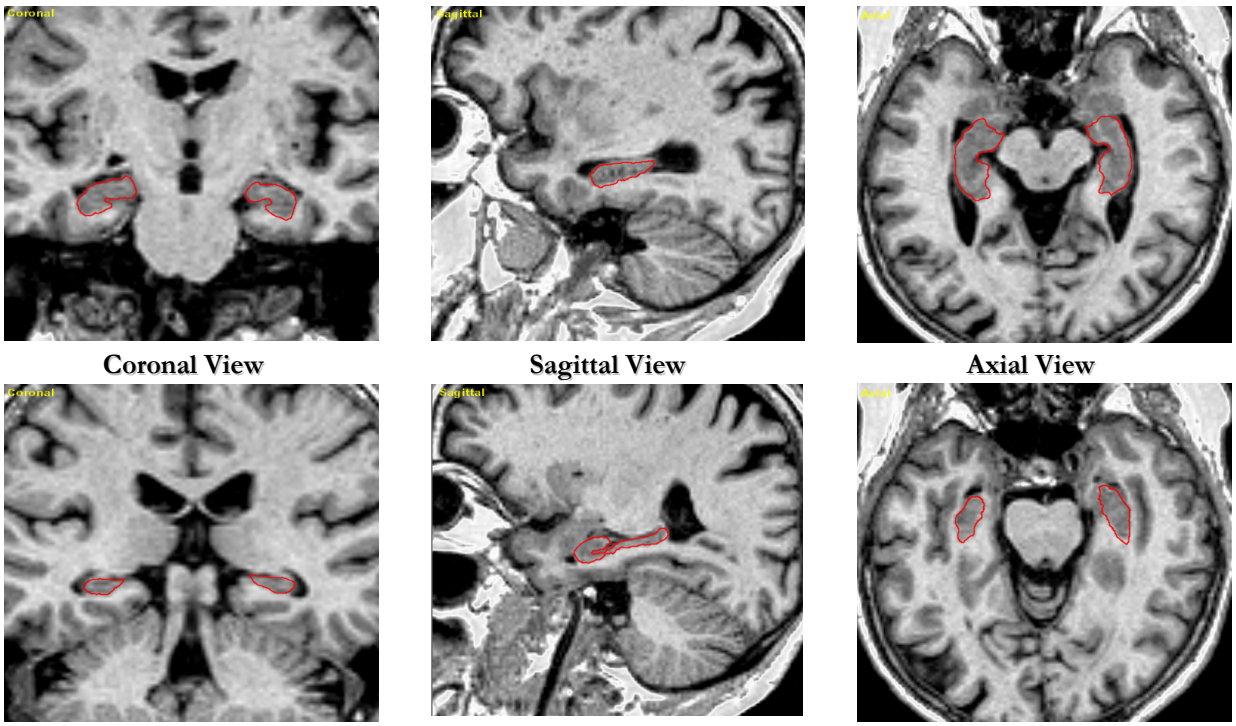

Figure4. Hippocampal boundaries

3) Because SNT is semi-automated, the boundaries created by SNT may for a number of reasons overestimate or underestimate the hippocampus. All scans are checked by qualified reviewers who determine whether a given boundary "fails". When a boundary fails, there is the option to manually edit the boundaries to more accurately reflect the hippocampus. After manually editing, volumes and boundaries are reformulated.

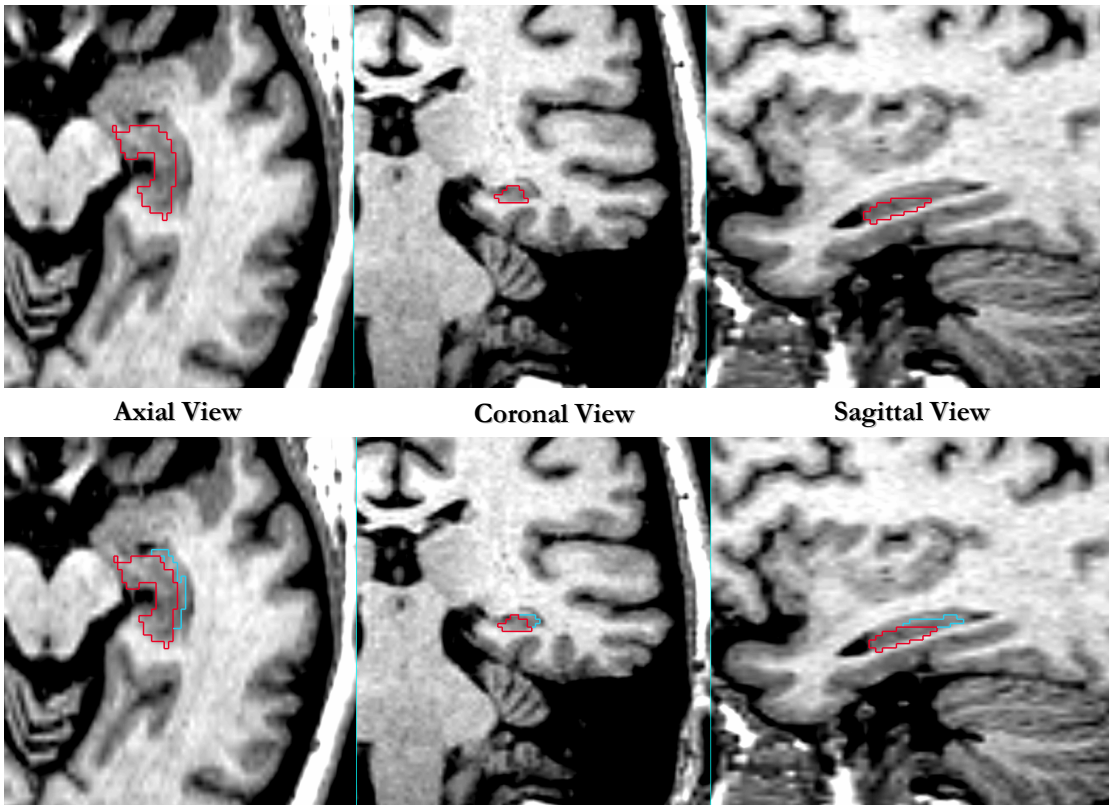

Figure5. Boundary review and edit

Suggested Citation for publications using SNT:

Semi-automated hippocampal volumetry was carried out using a commercially available high dimensional brain mapping tool (Medtronic Surgical Navigation Technologies, Louisville, CO), that has previously been validated and compared to manual tracing of the hippocampus (Hsu et al., 2002). Measurement of hippocampal volume is achieved first by placing manually 22 control points as local landmarks for the hippocampus on the individual brain MRI data: one landmark at the hippocampal head, one at the tail, and four per image (i.e., at the superior, inferior, medial and lateral boundaries) on five equally spaced images perpendicular to the long axis of the hippocampus. Second, fluid image transformation is used to match the individual brains to a template brain (Christensen, Joshi, & Miller, 1997). The pixels corresponding to the hippocampus are then labeled and counted to obtain volumes. This method of hippocampal voluming has a documented reliability of an intraclass coefficient better than .94 (Hsu et al., 2002).

References:

1) Hsu, Y. Y., Schuff, N., Du, A. T., Mark, K., Zhu, X., Hardin, D., Weiner, M. W. (2002). Comparison of automated and manual MRI volumetry of hippocampus in normal aging and dementia. Journal of Magnetic Resonance Imaging, 16, 305-310.

2) Christensen, G. E., Joshi, S. C., Miller, M. I. (1997). Volumetric transformation of brain anatomy. IEEE Transactions on Medical Imaging, 16, 864-877.