Feasibility of an automatic software for medial temporal structures resected patients

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Target audience: MR scientists and physicians interested in automatic MR Hippocampal segmentation volume.

Purpose :

Quantitative measurement of brain volumes using structural MRI plays a major role in neuroscience studies. Segmentation using manual methods could be operator depending, poorly reproducible and unreliable. Freesurfer has already shown its efficiency for the automatic segmentation of cortical and deep structures. In this study we try to access Freesurfer feasibility when studying medial temporal structures resected patients compared to controls

Methods

A prospective study was performed on two different 3T MR scanners. Structural scans were based on T1 gradient echo 3D acquisitions with a voxel size of 0.75*0.75*1.2mm3. MRI data were available for 45 subjects (22 females and 32 males) from three categories: 22 healthy volunteers and 23 epileptic with temporal resection (12 right hippocampus resected; 11 left side resected). Subjects were between 20 and 45 years old. Informed consent was obtained from every participant. Anatomic scans were analyzed with the fully automatic Freesurfer software version 5.2[1]. One fellowship trained radiologist with 3 years of clinical experience in neuroradiology checked all images from the automated
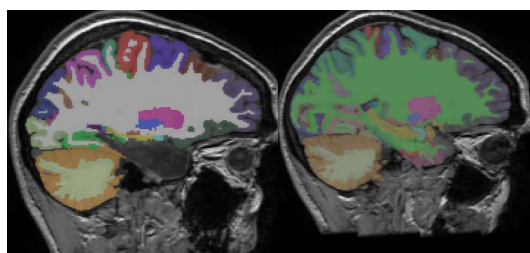

Fig 1: Segmented volumes for one control subject

Fig 2: Segmented volumes for one left resected patient white arrow. Sagittal plans for left and right segmented volumes.

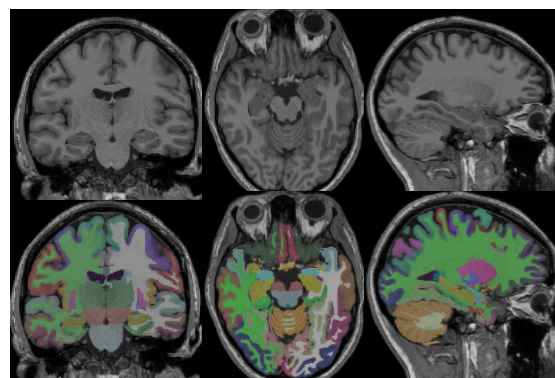segmentation. Statistical analysis was performed with R software version 3.0.1 [2]. A pairwise Wilcoxon test was used (pvalue less than 0.05 was considered as significant). In order to correct for multiple comparisons Holm adjustment method was used. Mean, standard deviation and coefficient of variation (CV) are presented in the table1. We analyzed brut and normalized (over the Brain Segmented Volume without Ventricles) volumes.

Results

An example of segmented volumes for one control subject is displayed in Fig1. The Fig2 shows segmentation in presence of a left resected part.

<u>Segmentation accuracy</u>: all data where generally well segmented. No major failures where noticed. We did not notice errors segmentations for the deep structures.

<u>Group difference:</u> CV was found to be around 10% excepted for the resected volumes where the CV was 4 times greater. Significant differences were found between controls and right resected patients and between right and left resected for the right hippocampus.

	Mean +/-SD in mm3 CV in % *Controls*	Mean +/-SD in mm3 CV in % *Left Resected*	Mean +/-SD in mm3 CV in % *Right Resected*
Right.Hippocampus	4174.39+/-498.49 11.94%	4211.48+/-484.88 11.51%	1079.12+/-587.77 54.47%
Left.Hippocampus	4178.52+/-414.01 9.91%	1439.49+/-674.33 46.84%	4283.23+/-444.97 10.39%
Right.Hippocampus/ BrainSegVolNotVent	3.73e-3+/4.35e-4 11.66%	3.81e-3+/-5.05e-4 13.27%	9.78e-4+/-5.41e-4 55.37 %
Left.Hippocampus/ BrainSegVolNotVent	3.74e-3+/-3.74e-4 10.01%	1.29e-3+/5.80e-4 44.99%	3.91e-3+/-4.29e-4 10.91%
Table1 : Volumes measurements			

For the left one, difference was significant between controls and left resected patients and between right and left resected patients. These results were obtained for both considered volumes (brut and normalized).

Discussion: These promising results will be used to study cortical thickness associated with volumes changes of deep structural volumes especially with the hippocampus one (Freesurfer QDEC group analysis). Further work will focus on fiber track changes by using diffusion tensor imaging data in correlation with neuropsychological tests.

Conclusion:

Automatic hippocampus segmentation is possible even for resected patients. Results are in good agreement with previous 3T results [3,4].

References [1] Fischl et al. Neuron 2002;[2] R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.[3] Pardoe et al. Epilepsia 2009.[4] Morey et al. NeuroImage 2009.