Automated hippocampal volumetry in Alzheimer's disease, mild cognitive impairment and normal aging

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Background and rationale

Various studies have demonstrated that MR volumetry of the hippocampus can help distinguish patients with Alzheimer's disease (AD) from elderly control subjects with a high degree of accuracy (80% to 95%) [1]. However, manual segmentation of the hippocampus is time consuming (about 2 hours per structure) and subjective. We previously developed a method that automatically segments the hippocampus using MRI [2]. This method is accurate and requires only minimal user input [2]. Here, our purpose was to evaluate the discriminative ability of hippocampal volumes obtained using this automated method to distinguish between patients with AD, patients with mild cognitive impairment (MCI) and elderly controls.

Methods

We included 20 patients with AD (age±SD=72±6, 7 males, MMSE=24.2±2.5) and 20 patients with amnestic MCI (age=72±7, 8 males, MMSE=27.2±1.5) from the database of subjects recruited at the CHU of Caen. The diagnosis for probable AD was made according to the NINCDS-ADRDA criteria. The diagnosis of MCI was made based on Petersen et al.'s criteria [3]. AD and MCI patients were compared to 20 elderly healthy control subjects (age=64±9, 10 males). In all subjects, 3D high-resolution T1-weighted MRI (128 axial slices, voxel size 0.93x0.93x1.5mm^3) were acquired at 1.5T. Hippocampal segmentations were performed using the automated method (Figure 1). In brief, this method relies on a 3D competitive region deformation constrained by anatomical priors. All processing was performed by a trained rater (Author 1) who was blind to all clinical data. For each subject, left and right hippocampal volumes were averaged. Group differences between AD, MCI and controls were assessed using Student's t-test. To assess the accuracy of individual classifications between groups, we computed sensitivity and overall classification rate at a fixed specificity of 80%.

Results:

Intergroup differences and individual classification results are presented in **Table 1**.

	Volumes	Volume reduction	Statistical significance	Overall classification	Sensitivity	Specificity
AD *vs* controls	1.91 cm^3 *vs* 2.83 cm^3	-33%	p<0.0001	83%	85%	80%
MCI *vs* controls	2.32 cm^3 *vs* 2.83 cm^3	-18%	p<0.001	65%	50%	80%
AD *vs* MCI	1.91 cm^3 *vs* 2.32 cm^3	-17%	p<0.01	70%	60%	80%

Table 1: Intergroup differences and individual classification results between AD patients, MCI patients and control subjects.

Discussion

Using automated segmentation of the hippocampus, significant volume reductions were found between all groups. 83% of AD patients and 65% of MCI patients were correctly classified based on hippocampal volume only. This is in concordance with published studies based on manual segmentation, which report classification rates of about 80%-95% for AD patients and 60%-74% for MCI subjects.

Conclusion

Using automated hippocampal volumetry, we were able to individually classify AD, MCI and control subjects with a degree of accuracy that is comparable to published data based on manual measurements. Being faster (about 10 minutes) and more feasible than manual tracing, this new method may thus become a useful tool to assist the diagnosis of Alzheimer's disease.

References:

[1] Xu et al., *Neurology*, vol. 54, pp. 1760-1767, 2000
[2] Anonymous (omitted for blind reviewing process).
[3] Petersen et al., *Arch Neurol* 2001; 58:1985-1992.

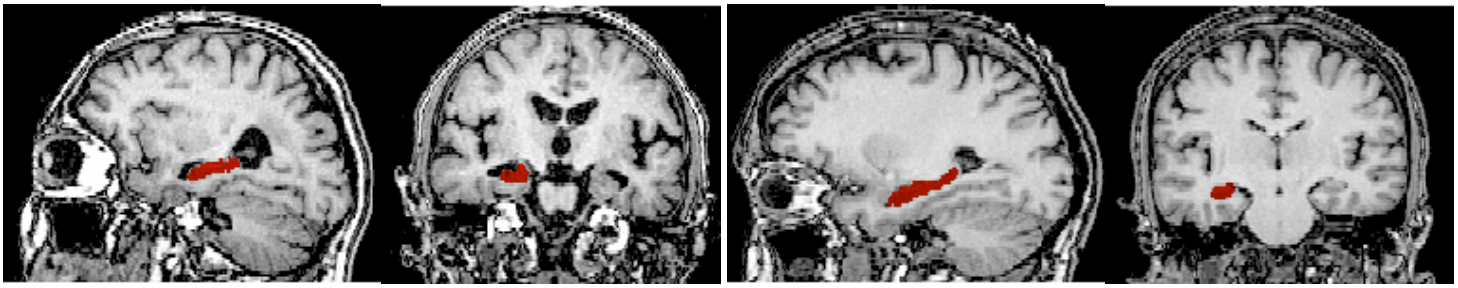

Figure 1: Automated segmentation of the hippocampus (sagittal and coronal slices). Left panels: AD patient. Right panels: control.