CrossMark

ORIGINAL ARTICLE

Hippocampus, caudate nucleus and entorhinal cortex volumetric MRI measurements in discrimination between Alzheimer's disease, mild cognitive impairment, and normal aging

Rasha Elshafey [a,*], **Omar Hassanien** [a], **Mohamed Khalil** [b], **Mina Rizk Allah** [c], **Sameh Saad** [c], **Michael Baghdadi** [c], **Magdy El Zayady** [c]

[a] *Radiodiagnosis Department, Tanta University Hospital, Egypt*
[b] *Neuropsychiatry Department, Tanta University Hospital, Egypt*
[c] *Bachelor of Medicine (M.B.B.CH), Tanta University Hospital, Egypt*

Abstract *Background:* Structural neuroimaging MR volumetric changes can predict progression of MCI to AD. Early effective treatment of MCI has been shown to delay institutionalization and improve cognition and behavioral symptoms.

Aim of the work: To evaluate the role of volumetric MRI to identify a pattern of regional atrophy characteristic in differentiation between Alzheimer's disease, Mild Cognitive Impairment, and Normal elderly control.

Material and methods: The regional ethics committee approved the study and written informed consent was obtained from all participants. Between April 2012 and May 2013, prospective study was conducted on 25 patients (18 males and 7 females) and 15 healthy elderly controls (9 males and 6 females) referred to the Radiodiagnosis Department from the Neuropsychiatry Department that had clinical manifestations of suspected cognitive impairment, we used the Mini Mental State Examination (MMSE) as a measure of general cognitive function and the total learning from the

---

Auditory Verbal Total Learning Test (AVTOT) as a measure of memory performance. One year follow up of patients was done to assess the disease progress.

Results: Twenty-five patients were included in this study {Alzheimer disease (10 cases), MCI (15 cases)} and 15 healthy elderly controls. Mean MMSE scores were significantly lower in patients with Alzheimer's disease compared with MCI and control cases ($P < 0.001$). Positive correlation (except left caudate nucleus) between gray matter volume reduction in MCI and AD in relation to elderly control and MMSE score was observed. The Auditory Verbal Learning Test (AVTOT) was significantly lower in patients with Alzheimer's disease compared with MCI and control cases ($P < 0.001$). No significant differences were found between groups as regards age, sex, education or dominant hand. Significant gray matter volume reductions were found in both AD and MCI compared to healthy elderly control however no significant differences were found among MCI patients or AD patients. Sensitivity, specificity, PPV and NPV of caudate nucleus and hippocampal volume reduction in AD and MCI in relation to elderly control were higher than entorhinal cortex.

Conclusion: Semi-automated MR volumetric measurements can be used to determine atrophy in hippocampus, caudate nucleus and entorhinal cortex which aided in discrimination of healthy elderly control subjects from subjects with AD and MCI and predict clinical decline of MCI leading to increase the efficiency of clinical treatments, delay institutionalization and improve cognition and behavioral symptoms.

1. Introduction

Alzheimer disease (AD) is the most common cause of dementia in the elderly with a progressive course, beginning with neuronal dysfunction and irreversible loss of neurons, while MCI can represent a transitional state between normal aging and AD with the density and distribution of the tau-associated neurofibrillary and beta-associated amyloid for a long time before the clinical onset of AD (1).

Mild Cognitive Impairment (MCI) is associated with an increased risk of progression to a diagnosis of probable Alzheimer disease (AD). Rates of progression vary; some individuals with MCI deteriorate rapidly, others remain stable for many years, and some revert to normal cognitive status. Improved ability to predict risk of imminent decline in patients with MCI could aid in the efficiency of large scale clinical trials and will become increasingly important for individual patient risk stratification as aggressive new treatments are developed (2).

Magnetic resonance imaging (MRI) is a reliable supportive tool for the diagnosis of dementia and can reveal cortical atrophy, sulcal and ventricular dilatation, decreased parenchymal and hippocampal volume and changes in parenchymal intensity (2,3).

Investigators in recent studies have reported that the brain volumes derived from magnetic resonance (MR) images, particularly those obtained in the temporal and parietal lobes, enable accurate differentiation between individuals with Mild Cognitive Impairment (MCI) and probable AD and those who are cognitively healthy (4,5). In addition, brain volumes and cortical thicknesses have been shown to be predictive of which individuals with MCI will eventually develop AD. All of these studies, however, involved analyses focused on the medial temporal lobe and the use of semiautomated or manual delineation of volumes (6–8).

Volumetric measurements of the medial temporal lobe have been shown to reveal a typical sign of AD (9–13). The hippocampus is the most extensively studied structure in AD

reaching correct classification rates of 88.14% by discriminant function analysis of AD patients and controls (14).

Thus, the purpose of our study was to evaluate the role of volumetric MRI to identify a pattern of regional gray matter atrophy characteristic in differentiation between Alzheimer's disease, Mild Cognitive Impairment, and Normal elderly control.

2. Patients and methods

Approval of Research Ethics Committee (REC) of Tanta University and informed written consent were obtained from all participants in the study.

From April 2012 to May 2013, 25 patients were included in this study {10 patients with Alzheimer disease (7 men, 3 women; mean age ± [SD], 73 years ± 6), 15 patients with MCI (11 men, 4 women; mean age ± SD,71 years ± 5)}, 15 control subjects with normal healthy aging who were confirmed to be healthy by neuropsychological tests (9 men, 6 women; mean age ± SD, 68 years ± 6), those patients were referred to the Radiodiagnosis Department from wards and clinics of the neuropsychiatry department that have clinical manifestations of suspected cognitive impairment. We used Mini Mental State Examination (MMSE) (15) as a measure of general cognitive function and the total learning from the Auditory Verbal Learning Test (AVTOT) (16) as a measure of memory performance.

Total learning from the Auditory Verbal Learning Test (AVTOT) (16) was selected as the measure of memory performance which has a list of 15 words, which an examiner reads aloud at the rate of one per second. The patient's task is to repeat all the words he or she can remember, in any order. This procedure is carried out for a total of five times.

All individuals of the study were subjected to: full history taking, thorough clinical examination and routine laboratory investigations in the form of: CBC, liver and kidney function test, fasting and 2 h postprandial blood glucose, ESR, LDH, CRP with 1 year follow up for all the patients.