Original Article
An MRI study of age-related changes in the dimensions related temporal lobe

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Abstract: The aim of this study was to determine the effect age-related changes on the MRI-based parameters related to several measurement of temporal lobe in the lifespan of adult persons. MRI scans of head (n=236) were reviewed retrospectively to identify abnormalities of temporal lobe, third ventricle, and temporal horn of lateral ventricle. Patients were divided into 3 study groups according to their age. Using axial and coronal views of the cerebral hemispheres, interuncal distance, thickness of temporal lobe, Evans’ ratio, and the width of third ventricle, height of hippocampus, width of choroid fissure, and width of the temporal horn were measured. The mean age of study group was 44.2±17.7 (18 to 86). The gender ratio (F/M) of study group was 129/107. There is mild-moderate significant correlation between age and Evans’ ratio (r=0.35, p<0.05). There is mild significant correlation between age and interuncal distances (r=0.24, p<0.05). There was no correlation between age and third ventricle widths, temporal lobe widths, and temporal horn widths of left and right sides of brain (p>0.05). A mild and significant correlation was present between these variables (r=-0.14 and r=-0.19, respectively; p<0.05). Although several parameters including our measurements were developed for the assessment of size and structure of temporal lobe, it is not easy to determine MRI-based markers for the prediction, diagnosis, and follow-up of mild cognitive impairment and Alzheimer’s disease in the elderly.

Keywords: MRI, age-related changes, temporal lobe

Introduction

Temporal lobe as one of the four lobes of brain is located beneath the lateral fissure on both cerebral hemispheres of the mammalian brain and is composed of approximately 17% of the volume of the human cerebral cortex [1]. In the temporal lobe, there are functional areas involved with the auditory, olfactory, vestibular, and linguistic functions. The medial side of the temporal lobe includes regions involved in olfaction as the uncus and nearby cortex and semantic memory as the hippocampal formation. The uncus is a small projection and found on the medial surface of the anterior end of the parahippocampal gyrus. The hippocampal formation is located on the medial side of the temporal lobe and includes the parahippocampal gyrus, subiculum, hippocampus, dentate gyrus [2].

In neuroimaging practice, cerebral atrophy is one of the nonspecific findings developed related to head trauma or degenerative processes and it can occur normally in aging. Pattern and location of atrophic changes differ according to the behavior of the disease processes [3-6]. There is a continuing research related to MRI findings obtained with measurement of several cerebral structures and distances among them in patients with several neurologic diseases such as epilepsy, mild cognitive impairment (MCI), and Alzheimer’s disease (AD) [7-10].

In the literature, although there are studies investigated the place of measurement of several brain structures and distances among them, according to our knowledge, there was no study investigated a population from 18 years old to 80 plus years. There is still no consensus on the clinical application of MRI biomarkers for the differential diagnosis of MCI and AD. The
aim of this study was to investigate the age-related changes in the dimensions of temporal lobe with the measurements of interuncal distance, thickness of temporal lobe, Evans' ratio, and the width of third ventricle, using axial views of the cerebral hemispheres; and with the measurements of height of hippocampus, width of choroid fissure, and width of the temporal horn, using coronal views of the cerebral hemispheres in patients aged from 18 to 80 plus years.

Materials and methods

In this study, 236 MRI scans of the head performed at our Radiology Service from September 2012 to February 2013 were reviewed retrospectively to identify structures of temporal lobe, third ventricle, and temporal horn of lateral ventricle. All MRI scans were reviewed by qualified radiologists. These MRI
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scans were requested by neurologists for the differential diagnosis of headache in the adult patients. Patients with normal MRI scans were included. In the 65-plus patients, we included patients with a preliminary diagnosis of brain atrophy. They have no diagnosis of MCI and AD. Patients with a history of any type of cerebrovascular and traumatic, and structural brain abnormalities were excluded.

For each case, a detailed reviewed was conducted to confirm the absence of any cerebral or cerebrovascular pathology.

**MRI assessment**

MRI examinations were performed using a 1.5 T MRI machine (Excelart, Toshiba, Tokyo, Japan) using standard head coils. The MRI examination included axial and sagittal spin-echo (SE) T1-weighted [repetition time (TR) 550 ms, echo time (TE) 15 ms, flip angle 90°], axial and coronal enhanced T1-weighted (TR 550 ms, TE 15 ms, flip angle 90°), axial and coronal fast SE (FSE) T2-weighted (TR 5000 ms, TE 94 ms, flip angle 90°), axial proton-density T2-weighted (TR 5000 ms, TE 94 ms, TI 2200, flip angle 90°) images. Mucosal swelling in paranasal sinuses is defined as sinusitis on T2-weighted MRI.

All linear measurements were performed on magnified images with the built-in distance measurement software, who was blinded to the diagnosis, age, and sex of the subject, as previously described [11-14]. Inter- and intra-observer reliabilities were determined as Kappa coefficient ranged from 0.72-0.88. Using axial views of the cerebral hemispheres, interuncal distance, thickness of temporal lobe, Evans’ ratio, and the width of third ventricle were measured. Using coronal views of the cerebral hemispheres, height of hippocampus, width of choroid fissure, and width of the temporal horn were measured.

**Interuncal distance**

Interuncal distance was measured from the T1-weighted axial images and defined as the distance between the unci of the temporal lobes, measured on a plane parallel to the bicommissural plane at the level of the suprasellar cistern (Figure 1).

**Thickness of temporal lobe**

The minimum thickness of the medial temporal lobe, measured on a plane parallel to the temporal lobe plane, as the thickness of the medial temporal lobe considered at its narrowest point on the scan section that best represents the medial temporal lobe between its superior and inferior limits [11] (Figure 1).

**Evans’ ratio**

From the T1-weighted axial images, Evans ratio was calculated by dividing the maximum width between the tips of the frontal horns of the lateral ventricles, as measured on a plane parallel to the temporal lobe plane, to the maximum transverse intracranial diameter, as the maximal distance between the inner tables of the skull on the two sides. It is assumed to reflect frontal horns ventricular enlargement (Figure 2).

**Width of third ventricle**

The maximum width of the third ventricle was obtained from the images at the level of the section where Monro’s foramen was visible. It is assumed to reflect third ventricle enlargement (Figure 2).

**Hippocampal, choroid fissure, and temporal horn measurements**

The hippocampal height, measured on a plane parallel to the brain stem axis plane where the
hippocampal formation was highest, and defined as the greatest height of the hippocampal formation (dentate gyrus, hippocampus proper, and subiculum, together with the parahippocampal gyrus). The width of the choroid fissure, measured on the same plane used for hippocampal height measurement, and defined as the vertical width of the choroid fissure centered on the midpoint of the hippocampal formation. This point usually lies on the line where hippocampal height is taken. Then, the width of the temporal horn, measured on the same plane used for hippocampal height measurement [2] (Figure 3).

**Statistical analysis**

We recorded the age, sex, and cerebral measurements. Data were expressed as percentage or mean ± SD as appropriate. The data were analyzed with correlation test. Significance was determined at the p<0.05 level.

**Results**

The mean age of study group was 44.2±17.7 (18 to 86). The gender ratio (F/M) of study group was 129/107.

**Figure 4** shows the correlation of age and Evans’ ratio. There is mild-moderate significant correlation between age and Evans’ ratio (r=0.35, p<0.05).

**Figure 5** shows the correlation of age and interuncal distances. There is mild significant correlation between age and interuncal distances (r=0.24, p<0.05).

There was no correlation between age and third ventricle widths, temporal lobe widths, and temporal horn widths of left and right sides of brain (p>0.05).

**Figure 6** shows the age and choroid fissure widths of left and right sides of brain. A mild and significant correlation was present between these variables (r=0.14 and r=0.17, respectively; p<0.05).

**Discussion**

In order to examine the relationship between the age and Evans’ ratio, interuncal distances, third ventricle widths, temporal lobe widths, temporal horn widths, choroid fissure widths, and hippocampal heights, the age was correlated with all study parameters. Overall, minimal-mild correlations were found significant.
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Dementia impairs of memory and at least one other cognitive activity such as aphasia, apraxia, agnosia, executive function at a severity enough to interfere with daily function and independence [15]. MCI is an intermediate state between normal cognition and dementia [16]. AD is the most common form of dementia in the elderly, accounting for 60 to 80 percent of cases. Brain imaging, preferably with MRI, is indicated in the differential diagnosis of patients with suspected AD. According to MRI findings of studies related to AD, generalized and focal atrophy, as well as white matter lesions is found but generally not conclusive [17, 18].

Hippocampus volumetry currently is one of the best-known marker of AD obtained with neuroimaging [19]. Because hippocampal volumes decline in normal aging also, age-specific criteria are needed these measurements to be diagnostic for AD [20-22]. In neurological practice, the differential diagnosis of the early stages of mild cognitive impairment (MCI) and Alzheimer’s disease (AD) is challenging. MCI has been regarded as the pre-clinical form of dementia, a high-risk condition that may precede AD, and for the prevention of AD, the reliable diagnosis of MCI is considerable important [23, 24]. Saka et al. [23] evaluated the place of interuncal distance for the differential diagnosis of MCI and AD. They concluded that interuncal distance could be used in the discrimination of MCI and AD in patients with at least one white matter lesion. Cheon et al. [25] conducted a study to assess the diagnostic value of interuncal distance measurement in patients with MCI and AD. They noted that interuncal distances of MCI and AD patients were found similar and although in AD patients, the interuncal distance is more compared to healthy controls but not to

between age and Evans’ ratio, interuncal distances, choroid fissure widths, hippocampal heights. Small increases in the correlation coefficients of these study parameters were also observed in patients aged 50-60 plus years. No meaningful relationship was present between age and third ventricle widths, temporal lobe widths, and temporal horn widths.
MCI. Whitwell et al. [26] assessed dementia related changes in the brain with MRI-based measurements of hippocampal formation to determine the differences in the patterns grey matter atrophy in patients with or without a progress from MCI to AD with long follow-up. They found that MCI subjects that progress to a diagnosis of AD within 18 months has a greater degree of grey matter loss at baseline than MCI subjects that do not progress to AD within three years.

Bracco et al. [27] evaluated the cerebral dimensions obtained with brain MRI in the diagnosis and staging of AD. They measured corpus callosum width, ventricular size, right and left temporal lobe areas, interuncal distance, and assessed the degree of cortical atrophy. They suggested that these findings could be helpful in the management of AD patients. Frisoni et al. [28] studied the sensitivity of linear measures of regional frontal, medial temporal lobe (interuncal distance, minimum thickness of the medial temporal lobe), and hippocampal atrophy in the differential diagnosis of AD cases. They found that interuncal distance could discriminate patients with mild AD from control subjects with 86% sensitivity. They suggested that linear measures of hippocampal atrophy could be a useful adjunct in the routine diagnosis of AD, even in its early stages. Frisoni et al. [29] noted that although atrophic changes in the medial temporal lobe detected by neuroimaging were in the most accurate findings of AD; however, their use in routine clinical practice was limited. They found that the radial width of the temporal horn could be a useful in routine clinical practice.

The use of MRI modalities for the assessment of dementia has gaining importance since MRI broadens our understanding of the pathophysiology dementia with the evaluation of structural and functional basis of normal cognition [30-32]. Hippocampal volumetry is one of the best-known marker of AD obtained with neuroimaging [19]. Although it has a potential to be used for the diagnosis and follow-up of MCI and AD patients, according to available knowledge related to atrophy of temporal lobe obtained by neuroimaging, as stated by Teipel et al. [19], screening of cognitive dysfunction according to available MRI markers has not enough background and specification.

In conclusion, this study was conducted to contribute to the knowledge related to the use of MRI for the assessment of atrophy in the temporal lobe. Since MRI-identified hippocampal structural changes were measured in the whole lifespan of adults, we think that it may provide solid information for the researchers trying to develop new MRI markers for routine clinical use. Overall, according to our findings, there is not a strong relationship and its relevance to ageing among the several clinical parameters measured as seen from the data of this study. We think that it can considerably difficult to choose a temporal-lobe-related measurement as a MRI marker for any type of MCI and AD since this parameter is always be under the effect of ageing alone. Further research is needed to determine new MRI panels including multiple measurements for the diagnosis and management of dementia in in carefully select-ed patients with or without dementia.

Disclosure of conflict of interest

The authors declare that there is no conflict of interest with regard to the publication of this manuscript.

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