Morphologic Assessment of Corpus Callosum in the Patient of Alzheimer Disease using Magnetic Resonance Imaging

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Abstract : The purpose of this study was to evaluate the usefulness of the measurement of corpus callosum (CC) size in the Alzheimer patient by using magnetic resonance (MR) midsagittal image. We performed MR scanning in 20 normal high age group, and in 20 mild cognitive impairment (MCI) group, and in 20 Alzheimer disease (AD) group. The following parameters were employed in AD group: TR/TE/FA 6650ms/66ms/90° , NEX 2, Thickness/Gap 2/0, FOV 220mm. The magnetic field strength was used at 3.0 Tesla. We selected midsagittal image of the brain by using view forum program, measured CC size, which were anteroposterior length, diameter of genu, body, narrowing portion, and splenium. The present study demonstrates that CC size of Alzheimer disease can be useful for clinical assessment concerning the diameter of genu, body, and splenium.
Keyword : Corpus Callosum (CC), Midsagittal Plane, Alzheimer disease (AD), Mild Cognitive Impairment (MCI)

INTRODUCTION

Recently, elderly population is dramatically increasing by the development of modern advanced medicine and improved medical equipment. In particular, Korea's growth rate of the elderly population is faster than other countries concerning by the UN in 2001. Actually, Korea has already entered in an aging society (total proportion of the population aged more than 7% of the population). According to Statistics, aging society (formerly of the population aged more than 14% the proportion of the population) was expected to enter in

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2019 years. Aging of the population which would inevitably cause an increase in diseases associated with old age will come true. One of the most serious diseases, especially Alzheimer's concern will be major social problem [1,2] . Alzheimer's causes were varied over at least 100, which 10-15% of all dementia that could be cured if found early, so a detailed medical history, neurological examination, psychological evaluation, nerve, blood tests and diagnostic imaging, and enforcement should be focused on finding the cause. 80-90% of all dementia, Alzheimer's disease and vascular dementia, so the accounts need to distinguish between these two diseases was well [3,4] . In particular, the cause of dementia, Alzheimer's disease accounts for most, as first described by Alois Alzheimer in 1906, which destruction of brain cells that were more typical of degenerative brain disorder in the west as heart disease, cancer, stroke, aged 65 years or older, with four of the population was one of the leading causes of death [2] . The cause of the disease, but still was not exactly beta-amyloid accumulates a protein on the brain tissue, which were known to atrophy and kill brain cells [5]. For early diagnosis and accurate should be done to treatment.

Recently, the radiological study has used to diagnose dementia with computed tomography (CT), magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT), and positron emission tomography (PET) [6-8] . The MRI screening test were measured quantitatively the size of the hippocampus [9] . However, There was disadvantages that method was accurate knowledge of anatomy and visual neurons in the reconstruction and analysis was more time-consuming disadvantage [10] . Therefore, the purpose of the study was to evaluate the usefulness of the measurement of corpus callosum (CC) size in the Alzheimer patient by using MR midsagittal image.

MATERIALS AND METHODS

Materials

We performed MR scanning in 20 healthy seniors aged 65 and over group (male: 7, female: 13, mean: 67.45 ± 1.15 years), and in 20 mild cognitive impairment (MCI) group (male: 9, female: 11, mean: 71.35 ± 9.10 years), and in 20 Alzheimer disease (AD) group (male: 4, female: 16, mean: 71.35 ± 9.10 years) at Seoul Metropolitan BORAMAE Medical

Center and Soonchunhyang University Hospital (Table 1). MR images were acquired on a GE Signa Infinity HiSpeed 1.5 Tesla and Philips Achieva 3.0 Tesla MRI scanners. Imaging data obtained digital imaging and communications in medicine (DICOM) for medical image transmission system to get a file (picture archiving and communication system, PACS) using the measurements were stored and extracted.

Table 1. General characteristic of a normal, mild cognitive impairment (MCI), and Alzheimer disease (AD) group

	Normal	MCI	AD
N	20	20	20
Sex (M/F)	7/13	9/11	4/16
Age	67.45±1.15	71.3±9.10	76.75±7.37

Methods

Head positioning was standardized using canthomeatal landmarks. Healthy seniors aged 65 and over the top of the group were using the 1.5 Tesla MRI. These imaging parameters were repetition time (TR) = 416 ms, time echo (TE) = 9 ms, flip angle = 90°, number of excitations (NEX) = 2, Thickness = 5 mm, Gap = 2 mm, field of view (FOV) = 200 mm^2 in the sagittal plane. The MCI and AD groups imaging parameters were TR = 6650 ms, TE = 66 ms, flip angle = 90°, NEX = 2, Thickness = 2 mm, Gap = 0 mm, FOV = 220 mm^2 with three-dimensional volume in the axial plane using the 3.0 Tesla MRI. Anatomical measurements of the middle sagittal CC included the maximum diameter of the genu, the maximum diameter of the body, the diameter of the narrowing portion, the maximum diameter of the splenium, and the anteroposterior length from T1-weighted MR images (Fig. 1).
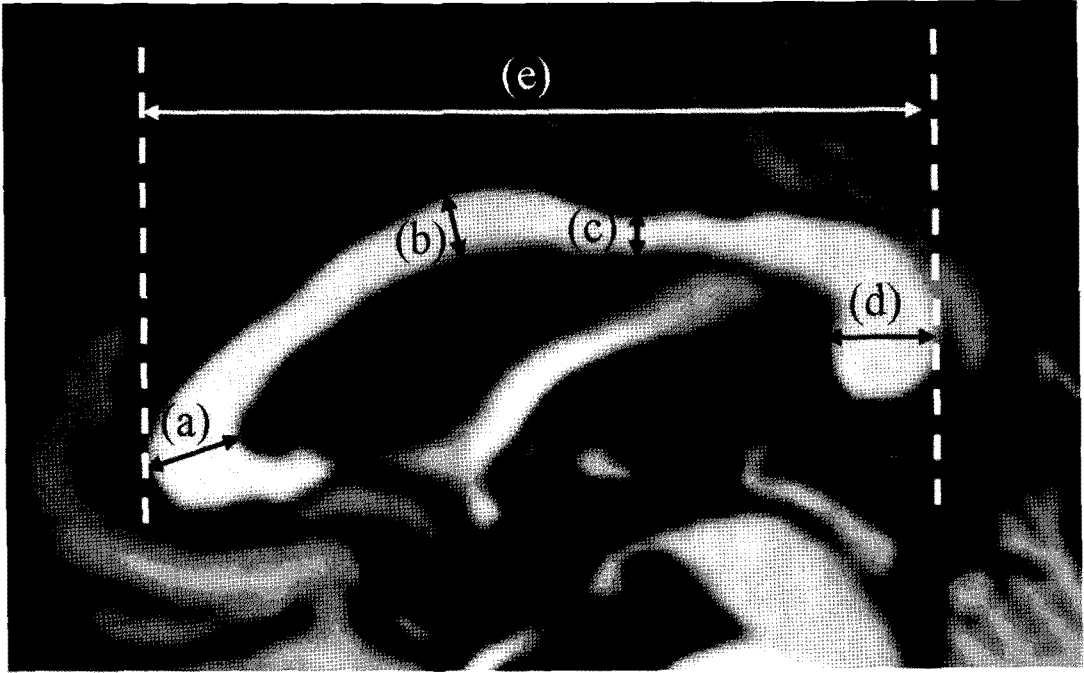
Fig. 1. Measurement showing the size of corpus callosum included the diameter of (a) the genu, (b) the body, (c) the narrowing portion, (d) the splenium and (e) the anteroposterior length.

Morphometric Analysis of the Corpus Callosum

Measuring the size of the corpus callosum of healthy elderly normal group on the PACS side by selecting the midsagittal image directly measured using a caliper.

For the MCI and AD groups with View forum (Philips medical system) program, three-dimensional volume data obtained from multi planar reconstruction (MPR) reconstruction after the callosal sulcus, cerebral aqueduct, pineal gland and the brain on the basis of respect to median sagittal were selected (Fig. 1). MRI of the brain in each group, the size of the corpus for the analysis of the quantitative form of technical testers to reduce the error of one person for 24 hours at intervals were measured in all three doses.
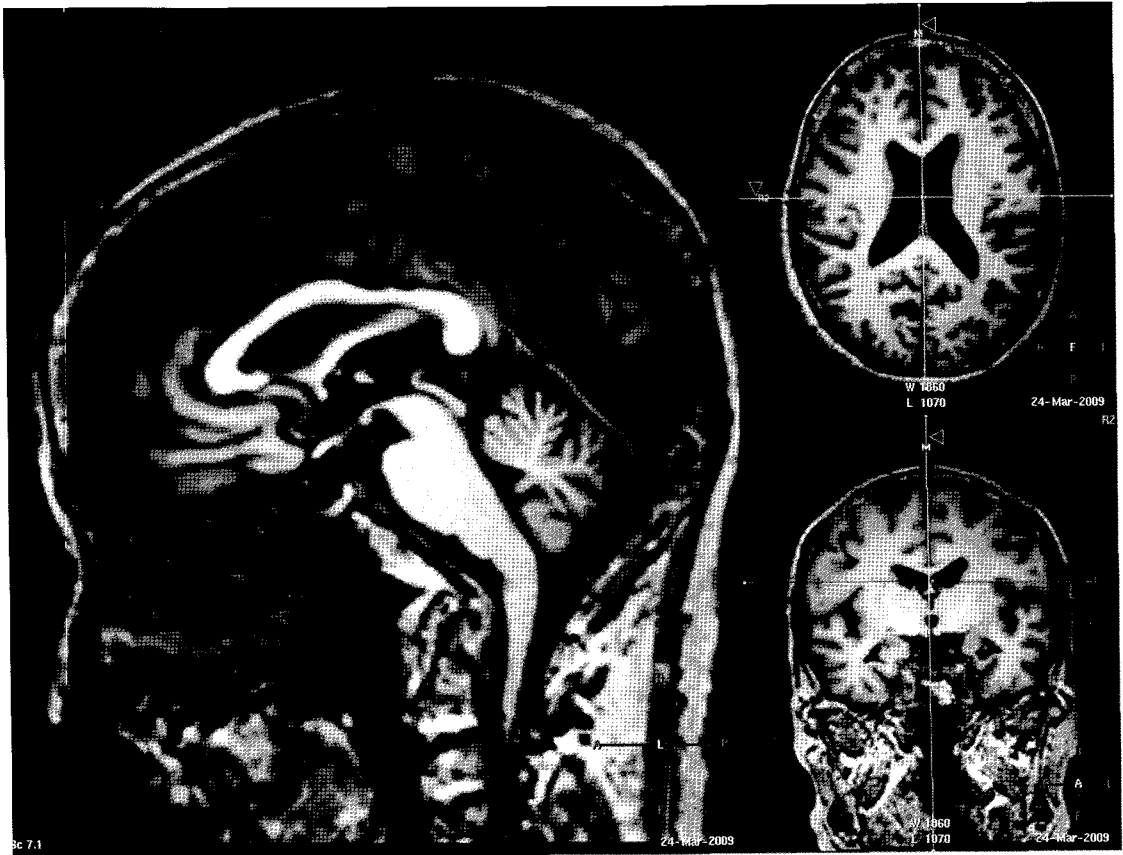
Fig. 2. T1-weighted MR image in the midsagittal plane of corpus callosum using software view forum by 3- dimension MR volume data

Statistical Analyses

All statistical procedures were performed with the use of SPSS software (SPSS 15.0 for Windows, SPSS, Chicago, IL USA). To investigate differences in the mean for the normal group with the MIC and AD group of the CC size included the diameter of the genu, the body, the narrowing portion, the splenium, and the anteroposterior length, we used an One-Way ANOVA analysis. Differences were considered significant when the P value was less than 0.05. And then, the average difference between groups that may be causing some independent Samples T-test analysis was considered significant when the P value was less

than 0.05. The normalization of observer was analyzed larger than the P value of 0.05 comes with no significant differences.

RESULTS

The normalization of observer was analyzed the P value of 0.184 with no significant differences. In the normal high age group, the anteroposterior length was 69.72 $\pm$ 4.08 mm, the diameter of genu was 10.42 $\pm$ 1.42 mm, the diameter of body was 6.14 $\pm$ 0.71 mm, the diameter of narrowing portion was 2.78 $\pm$ 1.13 mm, the diameter of splenium was 11.12 $\pm$ 1.44 mm.
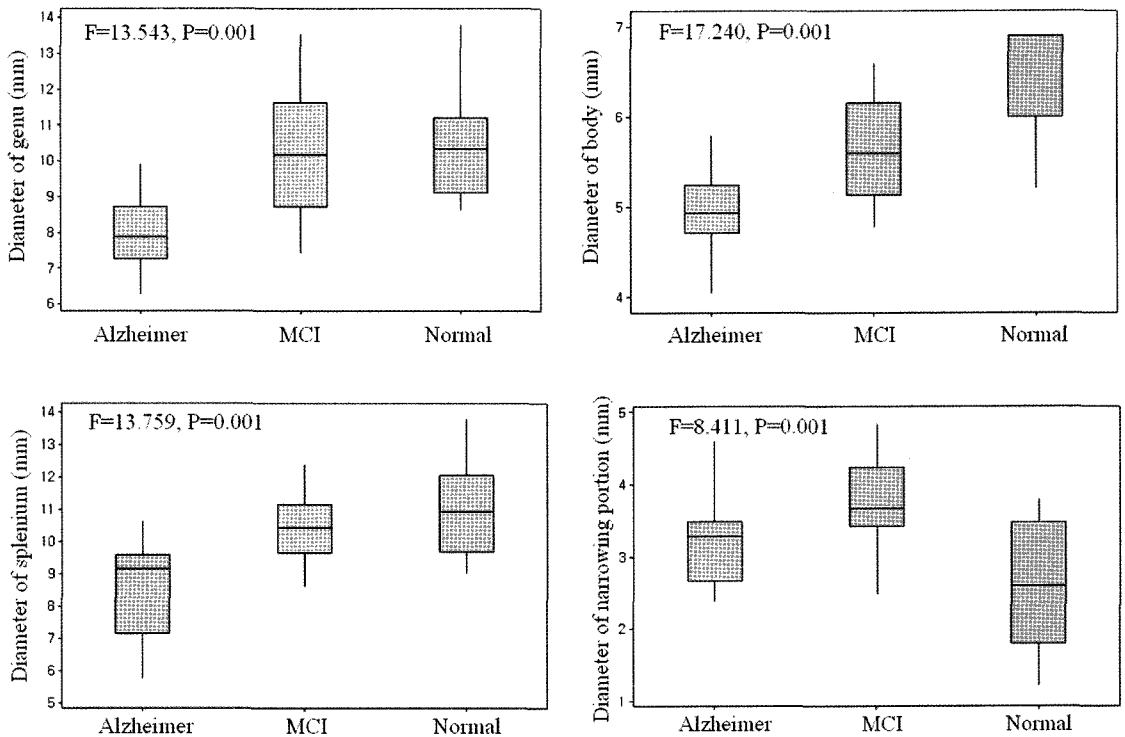
In the MCI group, the anteroposterior length was 71.42 $\pm$ 4.62 mm, the diameter of genu was 10.25 $\pm$ 1.86 mm, the diameter of body was 5.64 $\pm$ 0.57 mm, the diameter of narrowing portion was 3.68 $\pm$ 0.70 mm, the diameter of splenium was 10.46 $\pm$ 1.03 mm.

In the AD group, the anteroposterior length was 70.36 $\pm$ 0.32 mm, the diameter of genu was 8.00 $\pm$ 1.05 mm, the diameter of body was 4.85 $\pm$ 0.51 mm, the diameter of narrowing portion was 3.17 $\pm$ 0.61 mm, the diameter of splenium was 8.52 $\pm$ 1.45 mm (Table 2).

Table 2. Data from MR measurement. Morphometric measurement in region of corpus callosum and normal, mild cognitive impairment (MCI), and Alzheimer disease (AD)

Region	Normal	MCI	AD	P-value
diameter of genu (mm)	10.42 ±1.42	10.25 ±1.86	8.00 ±1.05	0.125
diameter of body (mm)	6.14± 0.71	5.64 ±0.57	4.85 ±0.51	0.099
diameter of narrowing portion (mm)	2.78± 1.13	3.68 ±0.70	3.17 ±0.61	0.306
diameter of splenium (mm)	11.12 ±1.44	10.46 ±1.03	8.52 ±1.45	0.305
anteroposterior length (mm)	69.72 ±4.08	71.42 ±4.62	70.36 ±0.32	0.966

Based on the use of ANOVA for the analysis of normal group with the MIC and AD group, statistically no significant results were determined about the anteroposterior length (F = 1.478, P = 0.229). But, there were statistically significant results in the diameters of genu (F = 13.543, P = 0.001), the diameter of body (F= 17.240, P =0.001), the diameter of narrowing portion (F = 8.411, P = 0.001), and the diameter of splenium (F = 13.759, P = 0.001) (Fig. 3).
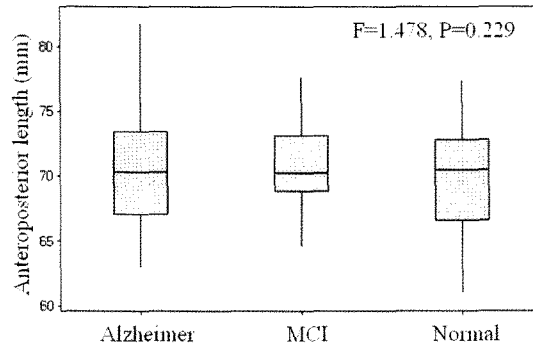
Fig. 3. The comparison of the diameter of genu, body, narrowing portion and splenium with the anteroposterior length in corpus callosum by ANOVA analysis

In addition, we taken to be determined the average difference between groups with the use of the paired t- test for normal versus MCI group, MCI versus AD group, and normal versus AD group. As a result, anteroposterior lengths showed statistically no significant, which were T = 1.234 and P = 0.225 for normal versus MCI group, T = −0.731 and P =0.469 for MCI versus AD group, and T = 0.465, P =0.645 for normal versus AD group. The diameter of genu showed statistically no significant, which were T = -0.311 and P = 0.758 for normal versus MCI group, but had a significant with T = -4.716 and P = 0.001 for MCI versus AD group and with T = -6.105 and P = 0.001 for normal versus AD group. The diameter of body showed statistically significant, which were T = -2.427 and P = 0.020 for normal versus MCI group, T =−4.611 and P =0.001 for MCI versus AD group, and T = 6.551, P =0.001 for normal versus AD group. Also the diameter of narrowing portion showed statistically significant, which were T = 4.473 and P = 0.001 for normal versus MCI group, T =− 2.481 and P =0.001 for MCI versus AD group, and T = 2.517, P =0.016 for normal versus AD group. The diameter of splenium showed statistically no significant, which were T = -1.652 and P = 0.107 for normal versus MCI group, but had a significant with T = -4.867 and P = 0.001 for MCI versus AD group and with T = -5.675 and P = 0.001 for normal versus AD group.

DISCUSSION

The CC is the major axonal commissural white matter that connects the two cerebral hemispheres. The thickness of the CC is believed to depend on a myelinated process and the growth of axons. Based on the thickness of the CC, it is possible to predict the presence of clinical neurological disorders, including hypoxic ischemic encephalopathy (HIE), attentiondeficit/hyperactivity disorder (ADHD), and a fine lesion of the white matter, a brain congenital malformation, and other abnormalities of the CC [11]. Important implications from determination of the size of the CC for diagnostic radiology include hydrocephalus, physical damage, brain tumors, vascular disease, atrophy of the brain and congenital abnormalities [12-14]. The sizes of the genu, the body, the narrowing portion, the splenium, and the anteroposterior length of the CC have been measured. Previously, the use of MRI has been used to discriminate between the peripheral structure and the edge by using morphometric observation and has allowed measurement of the length and the width of the CC [15]. In Korea, as well as the size of the normal CC for each age in the form of morphometric Analysis was also done researched, the 60s than any other age group tend to atrophy was reported [16]. It has been reported that a decreased ratio of the width of the narrowing portion and body to the total length of the CC in children with spastic diplasia, and especially the width of the narrowing portion to the total length of the CC, was related to the degree of motor dysfunction [17]. The atrophy mechanism of the CC was affected by the axonal number by means of direct injury of axons, demyelination, and microcirculation failure. A decrease in the area of the CC has been reported for a decreased number of axons caused by Wallerian degeneration [18].

As the size or shape of the CC was very useful for the determination of the volume or degree of myelination for brain white matter, the measured volume of the CC was very useful for the evaluation of brain development [19]. But in brain tissue atrophy and encephalopathy associated with AD was the lack of research on changes in the size of the CC. Therefore this study was to evaluate the usefulness of the measurement of CC size in the normal, the AD, and the MCI group by using MR midsagittal image.

In conclusions, there were not significant differences between the normal and MCI groups for the diameter of the genu and the splenium. Whereas MCI group were thicken

statistically a significant for the diameter of narrowing portion than normal group, but became thinner a significant for the diameter of the body than normal group. In general, dementia due to normal aging were the loss of cognitive function from any point beyond the normal aging process, loss of cognitive function that were visible [20]. This can be explained by death of brain tissue caused by brain shrinkage. Consequently, MCI can not be called dementia impairment, Outside of normal cognitive function, was judged partially to be atrophy of the CC. We can assert evidence to support them as between the MCI and AD group and between the normal and AD group showed significant differences for the diameter of the genu, the body, and the splenium. So the CC of Alzheimer's disease was estimated to be the most affected for the diameter of the genu, the body, and the splenium. However, the diameter of narrowing portion showed the thickest significantly difference, this will be needed an indicator of MCI that can be viewed as being more detailed studies.

SPECT or PET for early diagnosis of dementia are being developed, these modalities can be used for the tracking of the healing process and improve symptoms of dementia and the performance evaluation in passage of the drug [21]. However, The disadvantages were still expensive and possible only with a limited authority. Therefore, this study had a merit that could easily evaluate the size of the CC in Alzheimer's disease. In addition, all groups were not significantly for the anteroposterior length. This demonstrated that magnetic field was no relationship measurement of the CC.

Nevertheless, the present study has four important limitations. Even though data was normal distribution, this was a small sample of limitations. Future studies will be required as the MR diffusion tensor imaging (DTI) in such a sensitive screening test will be made more detailed studies.

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