Brief Communication

Evaluation of human brain volume by the tracing technique

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The aging process is marked by irreversible anatomical alterations. The age-related volumetric differences in the brain anatomy of individuals or volumetric brain analyses in many disorders such as Alzheimer's, schizophrenia, alcoholism, bipolar disorder, brain injuries, and tumors have gained importance. In this study, volumetric analysis of cerebrum-diencephalon, cerebellum, and TIV were determined using the manual tracings method by MRI according to decade and gender using a computer based software program. The study population included individuals admitted to Hacettepe University Medical Faculty, Ankara, Turkey in 2002 with mild disturbances like headache, nausea, vomiting, and sleep disturbances aged between 10-86 years. The right-handed healthy individuals were included in the study. The study was performed between January 2003 and December 2004. Eighty-four healthy randomly selected individuals (42 male, 42 female) were divided into 6 groups (10-19, 20-29, 30-39, 40-49, 50-59, and over 60 years) according to decades and their MRI images were analyzed by semi automated procedures, which were validated by comparison with manual tracings. The individuals who gave their informed consent before entry into the study, which had been previously approved by the ethics committee, participated in the study.

Magnetic resonance imaging was used for volumetric determination of cerebrum-diencephalon, cerebellum, and TIV using the 1.5 T Picker Instrument (Phillips, DA Best, Netherlands) on the sagittal plane. The sections (0.5 cm thickness) were magnified 3-4 times by way of Osiris 4.18 (Digital Imaging Unit, Radiology Department, University Hospitals of Geneva, Geneva, Switzerland) software program. Borders of the cerebrum-diencephalon, cerebellum, and the total intracranial area were determined via the manual tracings method. All mathematical calculations were based on Cavalier principle.[1] Homogeneity of variables was controlled by Levene's test. Kolmogorov-Smirnov normality test, which generates a normal probability plot and performs a hypothesis test to examine whether the observations follow a normal distribution, was used to test the normality of the distributions of the variables. Statistical analyses were performed by SPSS 11.5 statistical program (Student's-t test, Mann-Whitney U test, Pearson correlation coefficient, Spearman's rho correlation coefficient), and p-value less than 0.05 was considered to be significant. The values are shown in **Table 1**. Additionally, there was a negative correlation between cerebrum-diencephalons and age (r=-0.950, p=0.00082), cerebellum volumes and age (r=-0.930, p=0.00025), and TIV and age (r=-0.934, p=0.00041). When we compared male and females in the same age groups, we detected that female cerebrum-diencephalons, cerebellum volumes, and TIV were smaller than males for each decade. These results indicate that if the age has increased, the volume is decreased.

There was limited knowledge of the importance of volumetric volume data of the brain structure in the literature. There was a significant decrease in normalized brain volume between the ages of 20 and 60 years in males by 1.6% per decade.[2] In our study, gender related measurements were found to be statistically significant. There was a negative correlation between TIV with cerebellum, and the cerebrum-diencephalon according to decade parameter. The volume values were found to be decreased by nearly 5% with increasing age. Murphy et al,[3] also reported that the subjects were divided into young and old groups. Andreasen et al[4] compared the

Table 1 - Cerebrum-diencephalon, cerebellum, and TIV measurement values are represented as mean ± standard error according to gender and age.

Years	Cerebrum and diencephalon mean ± sd (min-max)			Cerebellum mean ± sd (min-max)			Total intracranial mean ± sd (min-max)		
	Male	Female	*P*-value	Male	Female	*P*-value	Male	Female	*P*-value
10-19	1100±2	1086±3	0.0063	137±1	134±1	0.0028	1389±6	1379±4	>0.05
20-29	1066±6	1056±2	>0.05	135±1	132±1	0.00052	1367±3	1309±3	0.0026
30-39	1019±4	1002±1	0.0031	132±1	129±1	0.00037	1302±1	1302±2	>0.05
40-49	921±1	887±7	0.00023	127±1	124±1	0.0056	1158±1	1112±5	0.00081
50-59	865±3	820±2	0.00045	123±1	118±1	0.0074	998±1	994±2	>0.05
≥60	806±2	800±1	>0.05	116±1	115±1	0.00039	981±3	944±1	0.00072

TIV - total intracranial volume

volumes produced by "traced" and "automatic" methods. The automatic atlas-based method for measuring the volume of regional brain produces results that are similar to manual techniques. The method is rapid, efficient, unbiased, and not subject to the problems of rater drift or potentially poor interpreter reliability that exists in the manual tracing methods. However, the traced measurements were considered to be the "gold standard" against the automatic measurement. Previous reports have suggested that brain atrophy is associated with aging and that there are gender differences in brain atrophy with aging. Courchesne et al[5] found that whole-brain volume decreased in elderly volunteers, similar to our results. They claimed that approximately a 5% decrease was observed in each decade, similar to our results.

Our findings showed that there was age-related atrophy of cerebrum-diencephalon, TIV, and cerebellum. The results indicate that if the age has increased, the volumes are small. Our results may provide anatomic information, guidance, and clinical contribution for diagnosis and therapy. Further studies can be designed to compare between the semi automated manual tracings method and full automated tracing or stereological methods to increase the confidence level.

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