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FRACTAL ANALYSIS OF BRAIN MAGNETIC RESONANCE IMAGES: A QUANTITATIVE ASSESSMENT OF BRAIN AGING IN MEN AND WOMEN

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ABSTRACT

In the present study, we aimed to quantitatively evaluate age-related brain changes in men and women using fractal analysis of the outer linear contours of cerebral hemispheres. The study involved 100 relatively healthy individuals (44 males and 56 females) aged 18-86 years. T2-weighted magnetic resonance (MR) images were studied. For each participant, we selected and studied four coronal MR images located at specific anatomical landmarks: the most anterior point of the temporal lobes, the level of the mammillary bodies, the quadrigeminal plate, and the splenium corporis callosi. Fractal analysis was conducted using our own modification of the Caliper method called "contour smoothing." The value of the fractal dimension (FD) was determined based on the analysis of the four coronal sections.

The average FD value for the entire sample was 1.402±0.005 (min – 1.266, max – 1.490). The average FD value for males was 1.394±0.008 (min – 1.266, max – 1.490), and for females, it was 1.408±0.006 (min – 1.288, max – 1.483). The difference in FD values between males and females was not statistically significant ($P>0.05$, T-test). We observed a decrease in FD values with age, indicating a strong negative correlation between FD and age in the entire sample ($R=-0.709$, $P<0.001$, T-test), as well as in males ($R=-0.712$, $P<0.001$) and females ($R=-0.729$, $P<0.001$). The linear regression equations (FD=y and age=x) did not differ significantly between males and females ($P>0.05$, F-test), suggesting that age-related changes in the brains of males and females were not significantly different.

Thus, fractal analysis can reveal and quantify age-related changes in brain shape. This method can be used in clinical practice to evaluate atrophic changes in cerebral hemispheres and differentiate between normal and abnormal brain aging, such as in Alzheimer's disease.

Keywords: brain, aging, magnetic resonance imaging, fractal analysis, fractal dimension.