A quantitative magnetic resonance imaging study of changes in brain morphology from infancy to late adulthood.

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A Quantitative Magnetic Resonance Imaging Study of Changes in Brain Morphology From Infancy to Late Adulthood

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Abstract

Objective: To model in vivo the dynamic interrelations of head size, gray matter, white matter, and cerebrospinal fluid (CSF) volumes from infancy to old age using magnetic resonance imaging (MRI).

Design: Cross-sectional, between-subjects using an age-regression model.

Setting: A Veterans Affairs medical center and community hospitals.

Participants: There were 88 male and female subjects aged 3 months to 30 years whose clinical MRI film had been read as normal and 73 healthy male volunteers aged 21 to 70 years who had an MRI performed specifically for this study.

Main Outcome Measures: These MRI data were quantified using a semiautomated computer technique for segmenting images into gray matter, white matter, and CSF compartments. The cortex was defined geometrically as the outer 45% on each analyzed slice, and the volumes of cortical white matter, gray matter, and CSF were computed. Subcortical (ventricular) CSF volume was computed for the inner 55% of each analyzed slice.

Results: In the younger sample, intracranial volume increased by about 300 mL from 3 months to 10 years. The same patterns of change in volume of each compartment across the age range were seen in both sexes: cortical gray matter volume peaked around age 4 years and decreased thereafter; cortical white matter volume increased steadily until about age 20 years; cortical and ventricular CSF volumes remained constant. In the older sample, brain volumes were statistically adjusted for normal variation in head size through a regression procedure and revealed the following pattern: cortical gray matter volume decreased curvilinearly, showing an average volume loss of 0.7 mL/y, while cortical white matter volume remained constant during the five decades; complementary to the cortical gray matter decrease, cortical CSF volume increased by 0.6 mL/y and ventricular volumes increased by 0.3 mL/y.

Conclusions: These patterns of growth and change seen in vivo with MRI are largely consistent with neuropathological studies, as well as animal models of development, and may reflect neuronal progressive and regressive processes, including cell growth, myelination, cell death, and atrophy.

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