

The Relationship of Brain Atrophy and Age to aid in Subdural Hematoma Injury Risk Prediction

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Elderly persons are more susceptible to subdural hematoma (SDH). Increasing brain atrophy, characterized by decreasing brain parenchymal fraction (BPF), may lead to an increase in SDH risk with age. BPF is the ratio of brain volume to intracranial volume, and its relationship to age is needed to quantify how the risk of SDH changes with age. Previously, Good et al. (2001) and Chard et al. (2002) published distributions of BPF by age. However, the absolute magnitude of BPF cannot be compared among studies or with individual patients unless consistent image collection and analysis techniques are used, and the MRI acquisition parameters and imaging software used in these studies differ from currently available methods. Additionally, data in these previous studies were sparse for older patients, the age group of particular interest for SDH prediction. Therefore, the objective of the current study is to quantify the relationship between age and BPF using reproducible, previously established imaging conditions so that it can be used in studies in which a prediction of BPF as a function of age is required. Additional goals were to quantify effects of sex and image processing techniques on the modeled relationships of BPF vs. age. Statistical Parametric Mapping (SPM12) was used to obtain BPF from 197 healthy (103 female, 94 male, ages 57-95 years) subjects' corrected 3.0T T1-weighted MRIs from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database. The relationship between BPF and age was modeled with linear regression in Minitab (Version 17, Minitab Inc., State College, PA). BPF decreased with age, at a rate that was significantly different from zero ($p < 0.05$). Across all MR images in the dataset, BPF decreased by 0.0032 per year ($p < 0.001$). When analyzed separately by sex, male subjects showed a decrease in BPF of 0.0037 per year ($p < 0.001$) and female subjects showed a BPF decrease of 0.0026 per year ($p = 0.003$). Analysis of Variance techniques (ANOVA) were applied to determine the effects of sex on the predicted relationship between age and BPF. An interaction term (Age*Sex), introduced into the regression equation to determine if the effect of age on BPF was significantly different for male and female subjects, was not statistically significant ($p = 0.28$). Therefore, while BPF decreased with age at a faster rate for males than for females, this difference in rate was determined to be statistically insignificant suggesting that BPF can be modeled as a function of age independent of sex. Preliminary analysis of a subset of the MR images with another software package (FreeSurfer, Version 6.0) showed higher decreases in BPF with age than did the SPM analysis. All 197 subjects will be analyzed in FreeSurfer by the symposium. Future work will investigate biases in calculation of BPF between SPM and FreeSurfer. Ultimately, the results of this study will quantify the effect of age on BPF using documented and reproducible MRI collection and analysis techniques. This relationship is essential to defining the increasing risk of SDH with age, but will also be valuable for any research involving brain atrophy and aging.

References

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