

## Large-Scale ADC Histogram Analysis of the Brain Aging: Normal versus Abnormal (667 subjects, 2 days-93.8 years)

M. Watanabe<sup>1</sup>, N. Ward<sup>1</sup>, A. Ozonoff<sup>2</sup>, S. Kussman<sup>1</sup>, K. Tanabe<sup>1</sup>, K. Erbay<sup>1</sup>, N. Saito<sup>1</sup>, H. Jara<sup>1,3</sup>, and O. Sakai<sup>1</sup>

<sup>1</sup>Department of Radiology, Boston Medical Center, Boston University School of Medicine, Boston, Massachusetts, United States, <sup>2</sup>Department of Biostatistics, Boston University School of Public Health, Boston, Massachusetts, United States, <sup>3</sup>Department of Biomedical Engineering, Boston University, Boston, Massachusetts, United States

**Background/Purpose:** The quantitative assessment of apparent diffusion coefficient (ADC) in normal aging and in various diseases have been reported by many groups covering various limited age ranges, and using small region-of-interest measurements (Ref. 1-5). From our large-scale, wide age range whole brain ADC histogram study (Ref. 6), we further investigated differences between normal and abnormal brains. The purpose of this study is to analyze age dependencies of ADC histogram of the brain and the impact of brain abnormalities on the peak value of the ADC histogram in a large-scale and wide age ranged population.

**Materials and Methods:** This retrospective study was approved by the IRB of our institution and included 851 studies of brain MRI for various clinical reasons during 1/1/2007-12/31/2007, and 741 subjects were available for ADC histogram analysis. The subjects with severe artifacts and image distortion were excluded (25 subjects). The 716 subjects were categorized into normal or abnormal groups by MR findings. Among subjects in the normal group, subjects with significant medical histories, such as cancer, human immunodeficiency virus and hepatitis virus infection, and sickle cell disease, were excluded (49 subjects). The normal group consisted of 396 subjects (178 males, 218 females, age range 2 days - 89.3 years, average 33.9 years) and 271 subjects (144 males, 127 females, age range 12 days - 93.8 years, average 63.8 years) for abnormal group. All subjects were imaged at 1.5T (Achieva or Intera, Philips Medical Systems, Cleveland, OH) with our institutional clinical protocol that includes the single shot diffusion weighted echo planar imaging pulse sequence (Key imaging parameters: 3899/74ms TR/TE, 89 EPI-factor and  $b=0$ ,  $1000\text{mm}^{-2}$ ). Scans were DICOM transferred for processing of the ADC histogram using algorithms developed in MathCAD (PTC, Needham, MA). The whole intracranial volume including the cerebrospinal fluid, white and gray matter, was segmented using a two-channel dual-clustering algorithm. ADC histogram of the whole intracranial volume was generated and further modeled with Gaussian functions. ADC peak values were derived from the histograms, plotted as a function of age; median age and ADC peak values between normal and abnormal groups were compared. For between-group and between-gender comparisons, we used the nonparametric Wilcoxon rank sum test.

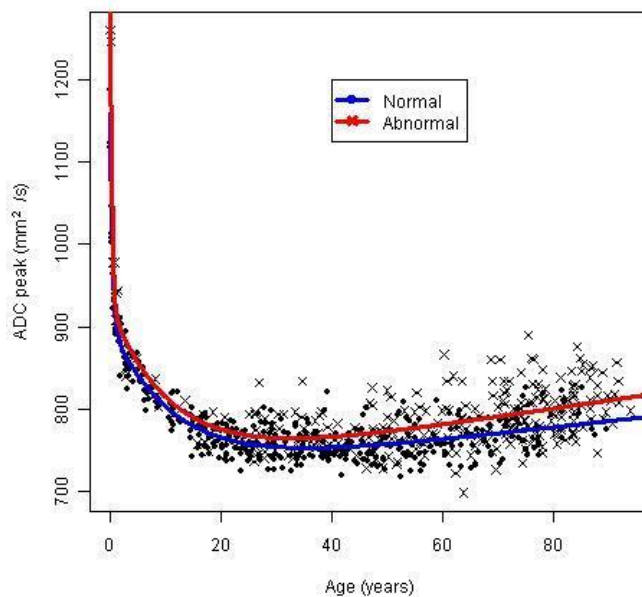


Fig.1 ADC Peak values vs. age

**Results:** The abnormal brain group consisted of older subjects ( $p<0.0001$ ) with higher ADC peak values ( $p<0.0001$ ), and exhibited increased inter-subject variance in older population compared to normal group (Fig. 1). Among the normal group, male subjects showed increased ADC peak values relative to female subjects ( $p=0.005$ ), while there was no significant between-gender difference of ADC peak within the abnormal group.

**Conclusion:** The aging patterns of ADC peak value of normal and abnormal brain groups have been demonstrated and compared. The abnormal brain group consisted of older subjects with higher ADC peak values, and also showed increased inter-subject variance in older population compared to normal group. In conclusion, most abnormalities, other than stroke, tend to increase the brain ADC values.

### References:

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