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Author(s)	**Chiu, PW; Mak, HKF; Chan, Q; Yau, KKW; Chu, LW**
Citation	**The 19th Annual Meeting and Exhibition of the International Society for Magnetic Resonance in Medicine (ISMRM 2011), Montreal, QC., 7-13 May 2011. In Proceedings of the 19th ISMRM, 2011, v. 19, p. 4046**
Issued Date	**2011**
URL	**http://hdl.handle.net/10722/140195**
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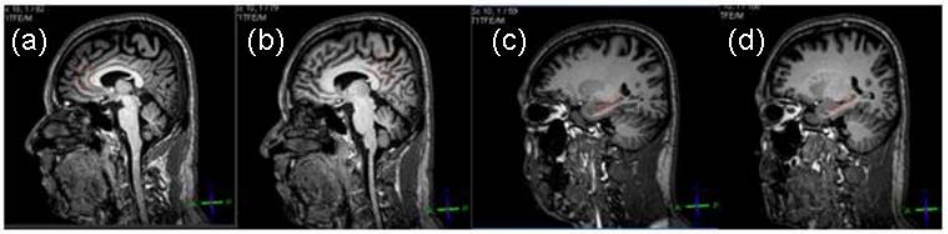
Proton(1H) Magnetic Resonance Spectroscopy: Absolute metabolite concentrations in normal aging human brain at 3Tesla

P. Chiu[1], H. K. Mak[2], Q. Chan[3], K. K. Yau[4], and L. Chu[5]

[1]Department of Diagnostic Radiology, The University of Hong Kong, HK, HK, Hong Kong, [2]Department of Diagnostic Radiology, The University of Hong Kong, [3]Philips Healthcare, Hong Kong, [4]Department of Management Sciences, City University of Hong Kong, [5]Department of Medicine, The University of Hong Kong

Objectives: Absolute quantitation of metabolite levels of normal aging human brain has rarely been done. But using a 3T scanner, which provides better signal-to-noise ratio, spectrum with higher resolution can be obtained. MRS can explore aging at a molecular level but controversial findings had been reported in previous frontal lobe studies [1,2] In this study, we investigate in the relationship between regional concentrations of metabolites and normal aging in Chinese using quantitative ^{1}H spectroscopy.

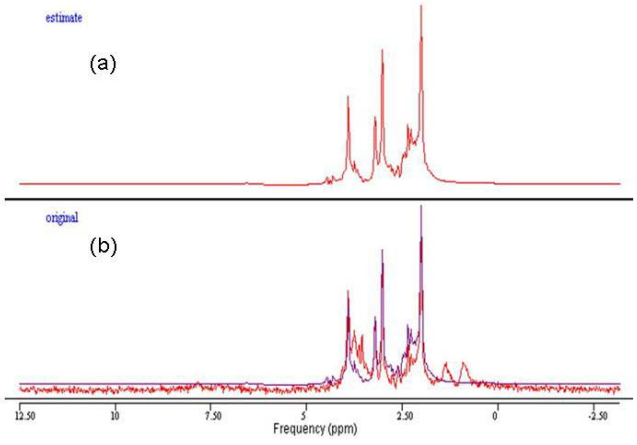
Material and methods: Experiments were performed on thirty cognitively normal (Mini-mental-state-examination ≥28) subjects (mean=49.87±18.33 years) using 3.0T MR scanner (Achieva, Philips Healthcare). 8-channel SENSE head coil was used. Single-voxel-spectroscopy (SVS) with short echo-time (TE) 38ms, repetition time (TR) 2000ms were employed. Single voxels with size of 2cmx2cmx2cm were placed in anterior cingulate, posterior cingulate, 2.5cmx1.5cmx1cm in left and right hippocampi with point resolved spectroscopy (PRESS) as volume selection method. MRS data was analyzed with offline software jMRUI version 4.0 using quantitation based on quantum estimation (QUEST) for absolute quantitation. Choline (Cho), creatine (Cre) and N-acetylaspartate (NAA) levels were investigated. Internal water was used as reference. Cerebrospinal fluid (CSF) normalization was done using voxel based morphometry (VBM5). Bivariate linear regression in SPSS version 18.0 was used for statistical analysis.



Positions of voxels placed: (a) anterior cingulate, (b) posterior cingulate, (c) left hippocampus and (d) right hippocampus

Results: The mean absolute concentrations of metabolites in different limbic structures are expressed in millimoles per kilogram per brain tissue (mmol/kg). In anterior cingulate, Cho 3.31±0.72, Cre 6.43±1.52 and NAA 7.70±1.55. In posterior cingulate, Cho 2.32±0.37, Cre 6.14±0.67 and NAA 7.44±0.83. In left hippocampus, Cho 3.38±0.61, Cre 6.57±0.91 and NAA 7.67±1.00. In right hippocampus, Cho 3.52±0.56, Cre 6.34±1.03 and NAA 7.59±1.39.Using bivariate linear regression, anterior cingulate revealed a significant correlation of absolute concentration of Cho [Pearson correlation(r)=0.441; p=0.015], Cre (r= 0.531; p=0.003) and NAA (r=0.425; p=0.019) with age. Posterior cingulate also showed a significant correlation of Cho(r=0.561; p=0.001), Cre(r=0.434; p=0.017) and NAA(r=0.529; p=0.003) with age. Left hippocampus only showed significant correlation with age for Cre(r=0.425; p=0.019) and NAA(r=0.435; p=0.016). Other SVS values show no significant results.

Discussion:Previous studies [1] reported significantly decreased NAA or no significant change [2] with age in healthy subjects. However, our study revealed significantly increased NAA with age in anterior cingulate, posterior cingulate and left hippocampus in healthy subjects. We postulate this difference to be due to either one or a combination of followings: (i)CSF normalization employed in present study; (ii) . neuronal hypertrophy [3] compensating for the neurons lost or damaged.; (iii) regional differences since limbic structures were evaluated in our study. Cho and Cr increase might be explained by phospholipid and phosphate metabolism using 31P-MRS.



Spectrum of a 41 year-old subject's posterior cingulate. (a) estimate spectrum from jMRUI using QUEST, (b) estimate spectrum (blue) superimposed on original spectrum (red)

Reference:

1. Brooks JCW, et al. Cerebral Cortex (2001) Jul 11:598-605, 2. Chang L, et al. Life Sciences (1996) 58(22):2049-56, 3. O'Brien RJ, et al. Journal of Alzheimer's Disease 18(2009):665-675