QUANTITATIVE ANALYSIS OF LATERAL GENICULATE NUCLEUS (LGN) IN GLAUCOMA USING 7.0T MRI

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Purpose

Glaucoma is characterized by progressive degeneration of retinal ganglion cells (RGC) and their axons.[1] ex vivo primate and human neuropathological studies has demonstrated degenerative change in the visual pathway of brain including lateral geniculate nucleus (LGN).[2,3] High resolution 7T MR image were able to show markedly improved images of the LGN. In this study, we were directly investigated height and volume changes in the LGN between the normal controls and glaucoma patients by using 7.0T MRI and correlation with retinal nerve fiber layer (RNFL) thickness.

Method

Subject : We studied 44 subjects who were obtained on 25 glaucoma patients and 19 age-matched normal controls. The glaucoma group included 25 patients (15 male and 10 female) aged 48.4 ± 9.8. The control group included 19 subjects (10 male and 9 female) aged 45.6 ± 8.2.

MRI acquisition : We used a 7 tesla research-prototype MRI scanner (Magnetom 7T; Siemens) using 7Tesla-optimized 8-channel radiofrequency (RF) coil designed specifically for use in this study. The specific MR imaging parameters used were as follows : coronal proton density (TR/TE = 35.3 / 3.75 ms ; flip angle = 6° ; slice thickness = 0.6mm; 320 x 320 matrix; total acquisition time 4min 4sec).

Measurement of LGN height and volume : The data were processed by using Matlab (version 7.8.0 .347 MathWorks, Natick, MA), and statistical tests were done by using SPSS for Windows, version 15.0. LGN height and volume were measured by 2 blinded experimenters. LGN height measurements from MRI scans were determined by drawing a line from the apex of the convexity to the base of the nucleus in a perpendicular fashion. **(Fig.1 A)** LGN volume measurements were performed by using a 3D Slicer (http://www.slicer.org). On each scan section on which the LGN was visible, the area of the LGN was segmented by using 3D slicer as shown in **Fig.1 B**.

Results

Compared with controls, LGN height in glaucoma were decreased in right (4.99 vs 4.55 p=0.001) **(Fig.2 A)** and left LGNs (4.60 vs 4.41 p=0.011). **(Fig.2 B)** The combined LGN height were 9.59 and 8.96, respectively. (p=0.022) **(Fig.2 C)** Fig2. E-F shows a group difference which is calculated by LGN volume. Right and left LGN volume in glaucoma was significantly decreased compared with normal controls (Right : 96.61 vs 83.55 p=0.013), (Left : 83.68 vs 61.30 p=0.015). The combined LGN volume were 180.30 and 144.86, respectively. (p=0.012) **(Fig.2 G)** Consequently, LGN height and volume were significantly smaller in the glaucoma group than in the control group. In addition to LGN height and volume correlation, we have also measured RNFL thickness dependent correlation, and theresult is shown in **Fig.2 D, H.** LGN heights and volumes were found to be significantly correlated with RNFL thickness. We found RNFL thickness positively correlated with LGN height and volume. (height : $r2$=0.536, P=0.020, volume : $r2$=0.126, P=0.023)

Discussion

This study demonstrates the potential of the 7.0T MRI for the quantification of height and volume changes in LGN. The comparison of LGN height and volume between glaucoma patients and normal controls revealed significantly difference. LGN height and volume in glaucoma was decreased compared with that observed in controls. These statistical results would obviously be useful in setting the criteria for diagnosis of digression of glaucoma patients. Longitudinal study is needed to define the correlation between stage of disease and degree of LGN height and volume change.

Reference1. Weber AJ, Chen H, Hubbard WC, et al. Invest Ophthalmol Vis Sci 2000;41:1370–79P.2. Gupta N, Greenberg G, de Tilly LN, et al. Br J Ophthalmol 2009;93:56–60 3. Dai H, K.T. Mu, et al. AJNR Am J Neuroradiol 2011;32:1347–53.
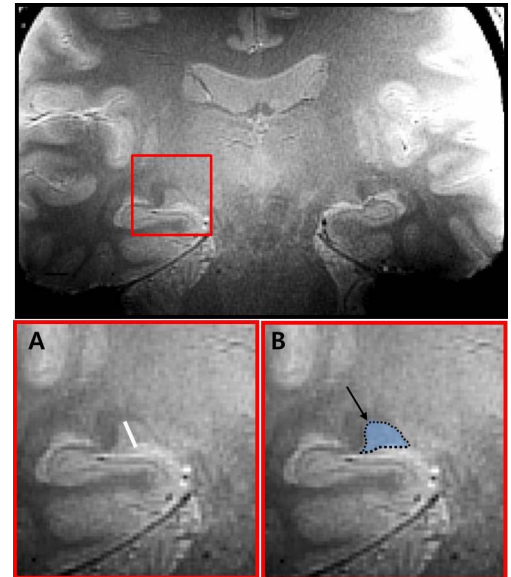
Fig 1. LGN image using 7.0T MRI(top). (A) White lines used for LGN height measurement. (B) The black arrows indicate segmented LGN (blue area).
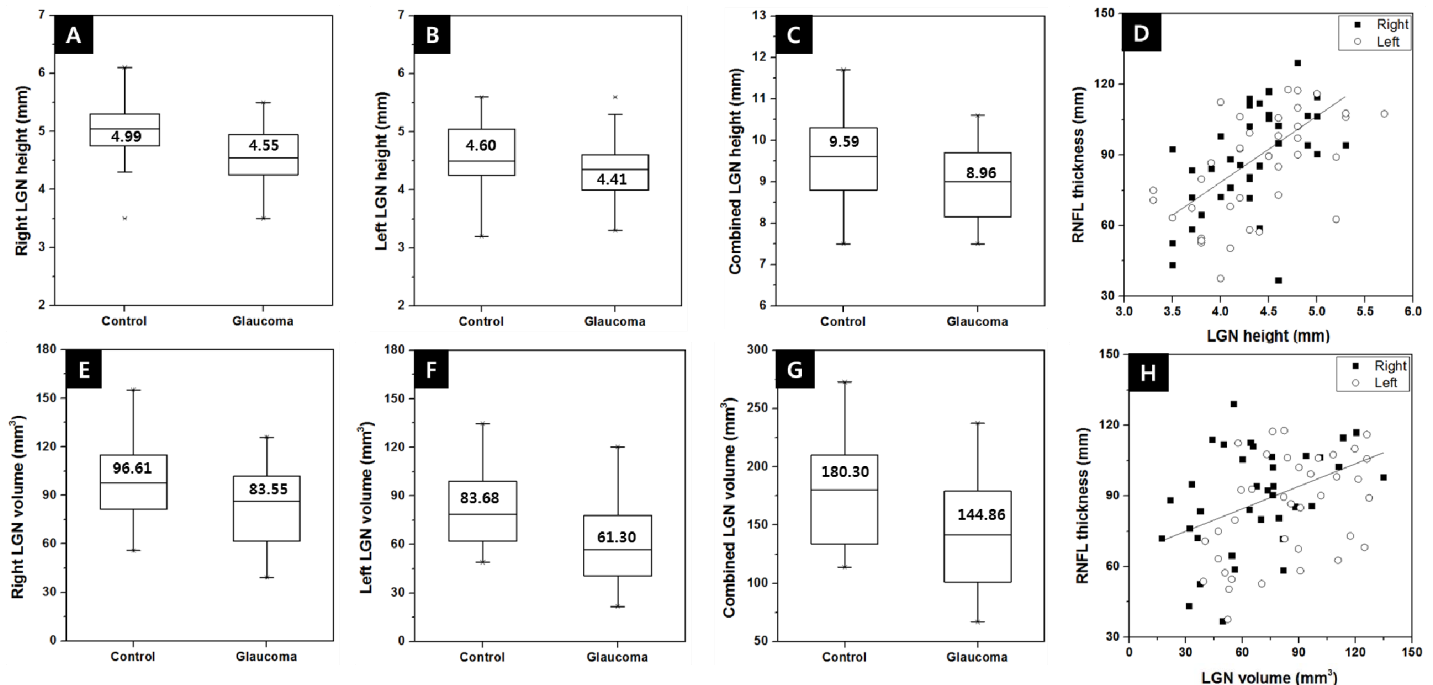
Fig 2. Graphs illustrate comparisons of LGN height (A-C) and volume (E-G) between normal controls and glaucoma patients. Significant correlation RNFL thickness and LGN height and volume. (D, H) Black squares and hollow circles indicate RNFL right and left thickness, respectively.