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.

Method

Subject : We studied 34 subjects who were obtained on 19 glaucoma patients and 15 age-matched normal controls. The glaucoma group included 19 patients (11 male and 8 female) aged between 35 to 64 years (mean age, 48.4 ± 9.8).The control group included 15 subjects (6 male and 9 female) aged between 33 to 61 years (mean age, 45.6 ± 8.2) without known neurological disorder or glaucomatous ocular disease.

MRI acquisition : We used a 7 tesla research-prototype MRI scanner (Magnetom 7T; Siemens, Erlangen, Germany) using 7 Tesla-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**. As brain size varies across subjects, it is necessary to normalize individual LGN heights and volumes with respect to AC (anterior commissure) - PC (posterior commissure) line. We were calculated 'normalized LGN height and volume ratio' using the following formula.

$$\text{Normalized LGN height (mm) ratio} = \frac{\text{LGN height (mm)}}{\text{AC-PC line of the same subject}} \times 100$$

$$\text{Normalized LGN volume(mm}^3\text{) ratio} = \frac{\text{LGN volume (mm}^3\text{)}}{\text{AC-PC line of the same subject}} \times 100$$

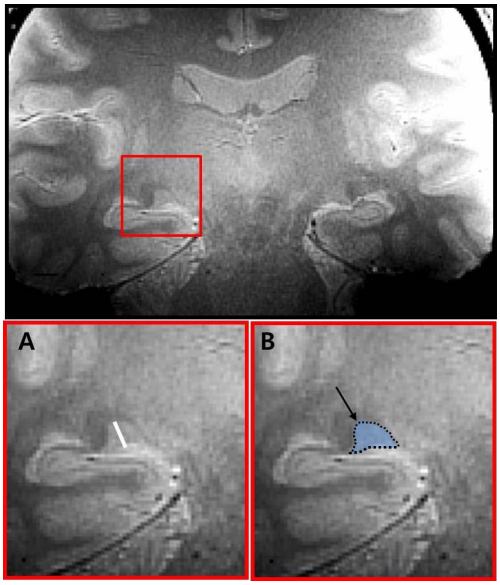

Fig 1. LGN image using 7.0T MRI (*top*). (A) White lines used for LGN height measurement. (B) The black arrows indicate segmented LGN (blue area).

Results

Compared with controls, normalized LGN height ratio in glaucoma were decreased in left (13.47 vs 14.84 p=0.001) **(Fig.2 A)** and right LGNs (13.67 vs 15.72 p=0.014). **(Fig.2 B)** The combined LGN height were 27.14 and 30.57, respectively, and this difference was statistically different (p=0.024) **(Fig.2 C)** Normalized right and left LGN height ratio in glaucoma was decreased compared with that observed in controls. **Fig2. D-F** shows a group difference which is calculated by normalized LGN volume ratio. Normalized left and right LGN volume in glaucoma was significantly decreased compared with normal controls (Left : 36.53 vs 45.54 p=0.015), (Right : 37.99 vs 49.69 p=0.035). The combined LGN volume were 74.52 and 97.24, respectively, and this difference was statistically different (p=0.012) **(Fig.2 F)** Consequently, LGN height and volume were significantly smaller in the glaucoma group than in the control group.

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. Normalized LGN height and volume ratio 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.

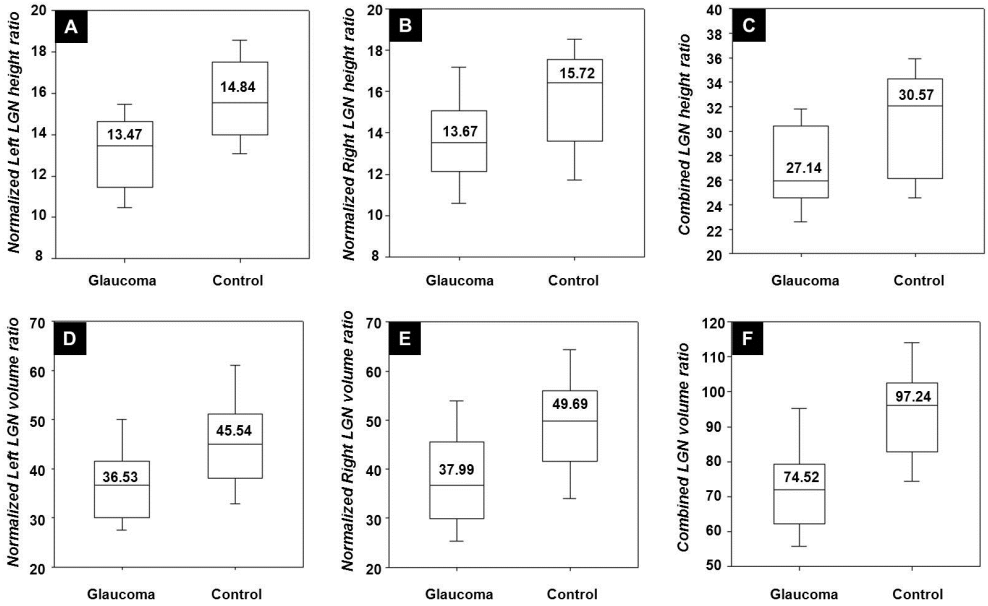

Fig 2. Graphs illustrate comparisons of LGN height (A-C) and volume (D-F) between glaucoma patients and normal controls.

Reference

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