Purpose
Glaucoma is characterized by progressive degeneration of retinal ganglion cells (RGC) and their axons.\textsuperscript{1} \textit{Ex vivo} primate and human neuropathological studies has demonstrated degenerative change in the visual pathway of brain including lateral geniculate nucleus (LGN).\textsuperscript{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 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.

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 the result 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 different. 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 glaucoma patients. Longitudinal study is needed to define the correlation between stage of disease and degree of LGN height and volume change.

Reference

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