AN INVESTIGATION OF LATERAL GENICULATE NUCLEUS (LGN) VOLUME IN PATIENTS WITH GLAUCOMA USING 7T MRI.

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Introduction

Retinal ganglion cell (RGC) degeneration is the major pathogenetic characteristic of glaucoma. [1] Most RGCs synapse the next neurons in the lateral geniculate nucleus (LGN), which serves as an important relay station to visual cortex.[2,3] High resolution 7T MR image were able to show markedly improved images of the LGN. In this study, to investigate lateral geniculate nucleus (LGN) volume of glaucoma patients compared with age-matched controls using 7.0T MRI and correlation with ganglion cell layer and inner plexus layer (GC-IPL) thickness

Methods.

Subjects **:** We studied 36 subjects who were obtained on 18 glaucoma patients and 18 age-matched normal controls. The glaucoma group included 18 patients (10 male and 8 female) aged 47.6 ± 13.3. The control group included 18 subjects (8 male and 10 female) aged 45.2 ± 10.9.

MRI Acquisition **:** A 7 Tesla research prototype MRI scanner (Magnetom 7T; Siemens, Erlangen, Germany) was used with an optimized eight-channel radiofrequency coil designed specifically for this study. The specific MR imaging parameters used were as follows: coronal PD-weighted imaging (TR/TE=35.3 / 3.75 ms; flip angle=68; slice thickness=0.6 mm without gap; 320x320 matrix; total acquisition time 4 minutes, 4 seconds)

Measurement of LGN volume : 2 experimenter blinded to the information on subjects measured the volume of LGN using a 3D slicer (http://www.slicer.org). On each scan section on which the LGN was visible, its area was manually segmented using 3D slicer as shown in **Figure 1.** Data were processed using MATLAB (version 7.8.0.347 ; The MathWorks, Natick, MA, USA) and statistical tests were done by using SPSS for Windows, version 15.0.

Volumetric analysis **:**As brain size varies across subjects, it is necessary to normalize individual LGN volumes with respect to ICV.[4] Several morphological studies have used already ICV as useful normalizing factor. We were calculated 'normalized LGN volume ratio' using the following formula.

$$\text{Normalized LGN volume ratio} = \frac{\text{Raw LGN volume}}{\text{ICV of the same subject}} \times 1000\ (\text{mm}^3)$$

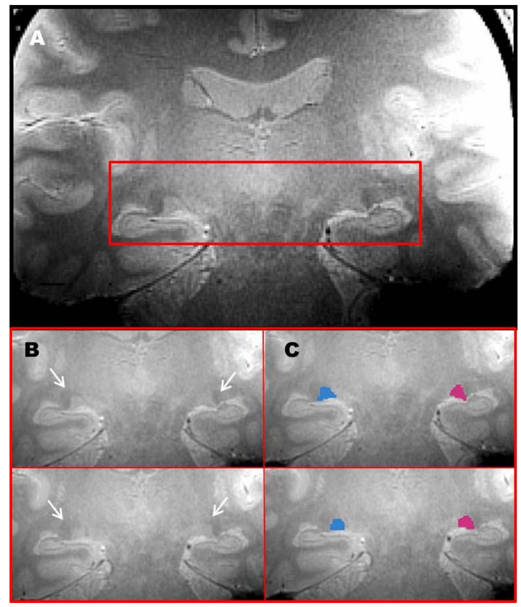

Figure 1. LGN image using 7.0T MRI (*top*). (B) White arrows indicate LGN. (C) Manual segmentation of the LGN in selected slices by 3D slicer.

Results

Fig 2. (A,B) shows group difference which is calculated by normalized LGN volume ratio of the individuals who participated in the experiment. Compared with controls, LGN volume in glaucoma were decreased in left (49.69 vs 37.99, *p*=0.005) **(Fig.2 A)** and right LGNs (45.54 vs 36.53, *p*=0.001). **(Fig.2 B)** Peripapillary retinal nerve fiber layer (pRNFL) thickness, optic nerve and thickness of the ganglion cell layer and inner plexus layer (GC-IPL) were measure d by Cirrus high-definition optical coherence tomography (OCT). Correlations between OCT parameters and LGN volume were investigated. In the glaucoma group, LGN volume was significantly correlated with average GC–IPL thickness of the contralateral eye. (Left LGN : r=0.471, p=0.049; Right LGN : r=0.605, p=0.008). **(Fig.2 C.D)** However, there was no correlation between LGN volume and average pRNFL thickness or optic nerve p arameters in the glaucoma group.

Discussion

This study demonstrates the potential of the 7.0T MRI for the quantification of volume changes in LGN. On 7T MRI, LGN volumes in glaucoma patients are significantly smaller than those of normal controls. Furthermore, in patients, LGN volume was found to be significantly correlated with GC–IPL thickness of the contralateral eye. 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 volume change.

References : [1] 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 [4] J. Eritaia, et al., *Magnetic Resonance in Medicine* 44:973-977 (2000)

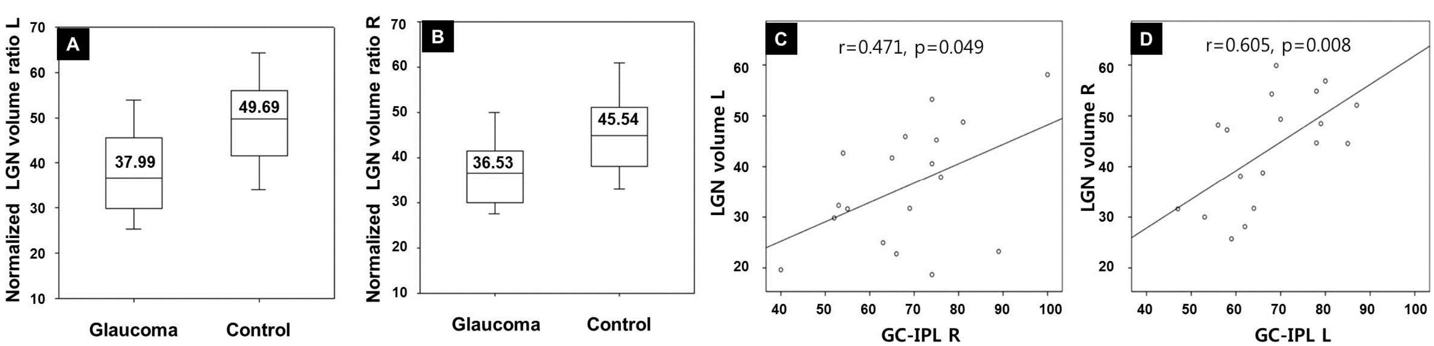

Figure 2. Graphs illustrate comparisons of LGN volume (A, B) between normal controls and glaucoma patients. Significant correlation GC-IPL thickness and LGN volume. (C, D)