Dynamic State of Water Molecular Displacement of the Brain During the Cardiac Cycle in Idiopathic Normal Pressure Hydrocephalus

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INTRODUCTION:

To evaluate the dynamic state of water molecular displacement of the brain during the cardiac cycle in normal pressure hydrocephalus (I-NPH), we determined the change in regional displacement of the water molecules using q-space diffusion analysis, because there were many unsolved problems with this syndrome in terms of the diagnostic criteria and selection of appropriate patients for shunt surgery [1].

METHODS:

On a 1.5-T MRI, ECG-triggered single-shot diffusion EPI was used with sensitivity encoding and half-scan techniques to minimize the bulk motion (b=0 to 1000 s/mm^2) [2]. Displacement of the water molecules was obtained from the displacement probability profile (full-width at half-maximum) calculated by Fourier transform of the signal decay fitted with exponential curve as a function of the reciprocal spatial vector q. Then maximum minus minimum displacement (delta-displacement), i.e., change of the water molecular displacement of the brain, of all cardiac phase images (20 phases) was calculated on a pixel-by-pixel basis. We assessed the delta-displacement in white matter (except periventricular high intensity area on T2-weighted image) in patients with I-NPH (n=7), brain atrophy or asymptomatic ventricular dilation (VD; n=4) and in healthy volunteers (control group; n=10).

RESULTS AND DISCUSSION:

Delta-displacement values in I-NPH were significantly higher than those in the VD and control groups (Fig. 1, 2). This result shows that water molecules of the deep white matter in I-NPH are easily fluctuated by blood volume loading of the cranium during the cardiac cycle, due to the decrease the intracranial compliance [3], i.e., the delta-displacement depends on the degree of water fluctuation. However, there was no significant difference in only displacement values between these groups (Fig. 3). In addition, there was no significant correlation between delta-displacement and displacement (Fig. 4), thus the delta-displacement and the displacement do not necessarily yield the same kind of information.

CONCLUSION:

Delta-displacement analysis makes it noninvasively possible to obtain dynamic state of the water molecular displacement in brain during cardiac cycle and thereby assist in the diagnosis of I-NPH.

REFERENCES:

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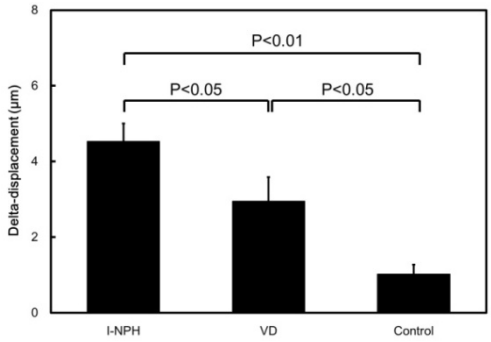

Fig. 1 Delta-displacement in patients with I-NPH, VD and control.

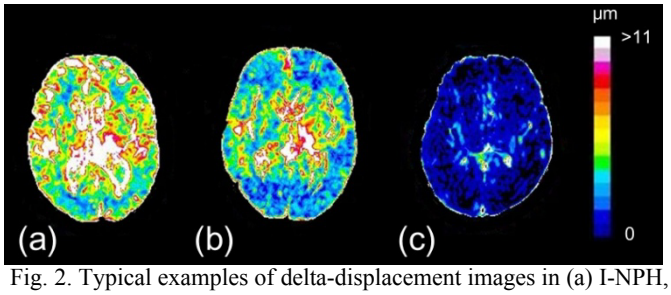

Fig. 2. Typical examples of delta-displacement images in (a) I-NPH, (b) VD and (c) control.

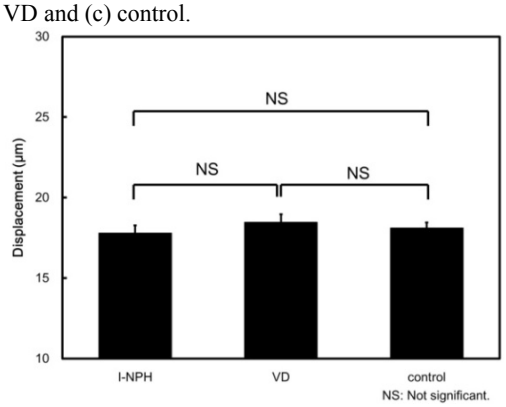

Fig. 3 Displacement in patients with I-NPH, VD and control.

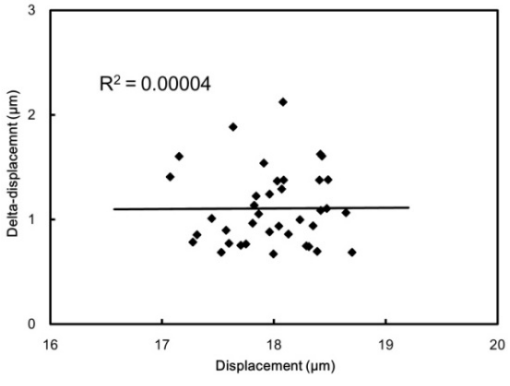

Fig. 4 Relation between displacement and delta-displacement.