WATER AMOUNT INDEPENDENT ANALYSIS OF FLUCTUATED WATER MOLECULES IN IDIOPATHIC NORMAL PRESSURE HYDROCEPHALUS

Naoki Ohno[1,2], Tosiaki Miyati[2], Mitsuhito Mase[3], Tomoshi Osawa[3], Harumasa Kasai[4], Hirohito Kan[4], Masaki Hara[4], Yuta Shibamoto[4], Akihiro Kitanaka[2], Akihiro Asano[2], Takashi Hamaguchi[1], Hiroji Iida[1], Toshifumi Gabata[5], and Osamu Matsui[5]

[1]Department of Radiological Technology, Kanazawa University Hospital, Kanazawa, Ishikawa, Japan, [2]Division of Health Sciences, Graduate School of Medical Science, Kanazawa University, Kanazawa, Ishikawa, Japan, [3]Department of Neurosurgery and Restorative Neuroscience, Graduate School of Medical Sciences, Nagoya City University, Nagoya, Japan, [4]Department of Radiology, Nagoya City University Hospital, Nagoya, Japan, [5]Department of Radiology, Graduate School of Medical Science, Kanazawa University, Kanazawa, Japan

INTRODUCTION:

We have reported that temporal changes in the brain parenchyma's apparent diffusion coefficient (ADC) during the cardiac cycle (ΔADC) reveal the degree of fluctuation of water molecules likely resulting from arterial inflow (volume loading) during systole, and this information potentially facilitates the diagnosis of idiopathic normal pressure hydrocephalus (INPH) [1]. However, ΔADC depends on both the degree of the fluctuation of water molecules and the water amount. Therefore, the purpose of our study was to determine the degree of fluctuation of water molecules independently of the water amount.

METHODS:

On a 1.5-T MRI, ECG-triggered single-shot diffusion echo planar imaging (b = 0 and 1000 s/mm^2) was used with sensitivity encoding and half-scan techniques to minimize the bulk motion. Then ADC and ΔADC images were created. Moreover, we normalized ΔADC value using the maximum and minimum ADC value during the cardiac cycle to reduce the dependence of the water amount on the determination of water fluctuation over the cardiac cycle. The normalized ΔADC image was calculated from all cardiac phase images (20 phases) on a pixel-by-pixel basis using the following equation: ΔADC rate = $(ADC_{max} - ADC_{min})/(ADC_{max} + ADC_{min})$, where ADC_{max} and ADC_{min} represent the maximum and minimum ADC during the cardiac cycle, respectively. We assessed normalized ΔADC, ΔADC and ADC in white matter in patients with INPH (n=11), atrophic ventricular dilation (n=8), and in healthy volunteers (control group; n=9).

RESULTS AND DISCUSSION:

Normalized ΔADC in INPH were significantly higher than those in the control and atrophic ventricular dilation groups (Fig. 1a and Fig. 2). This result could be explained by the increased "fluctuation" of water molecules in the brain parenchyma because of low compliance in INPH [2]. ΔADC in INPH were also significantly higher than those in the other groups (Fig. 1b and Fig. 2). However, their differences were lower than the normalized ΔADC, indicating the diagnostic utility of the normalized ΔADC analysis more than ΔADC. There was no significant correlation between normalized ΔADC or ΔADC and ADC (Fig. 3).

CONCLUSION:

Water amount independent analysis may render it possible to noninvasively obtain more detailed information on the intracranial condition in INPH, potentially facilitating the diagnosis of this disease.

REFERENCES:

[1] Ohno N et al, Radiology, 261(2), 560-565, 2011.
[2] Miyati T et al, J Magn Reson Imaging, 26(2), 274-278, 2007.

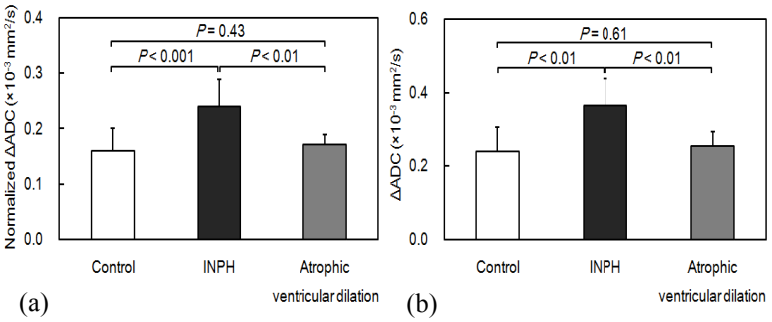

Fig 1. (a) Normalized ΔADC and (b) ΔADC in control, patients with INPH and atrophic ventricular dilation.

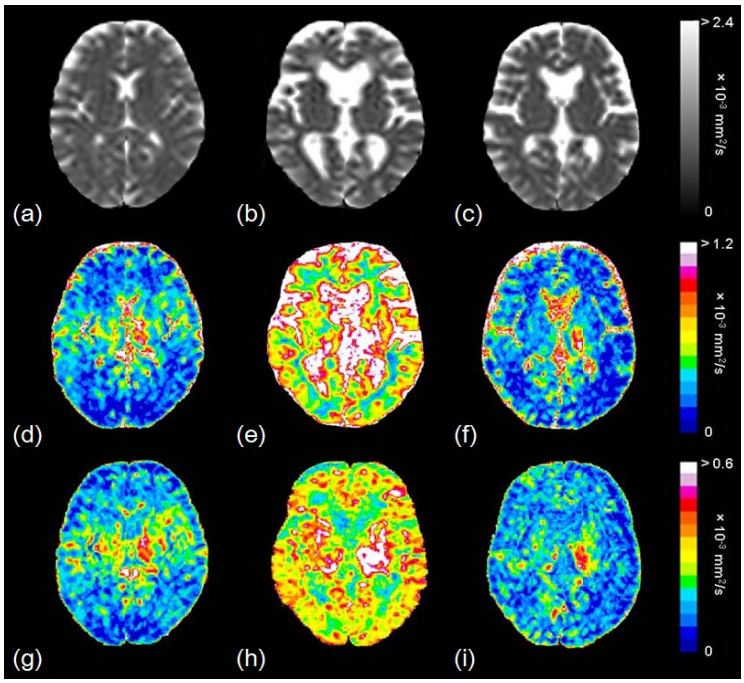

Fig 2. Typical examples of (a - c) ADC, (d – f) ΔADC and (g – i) normalized ΔADC images in (a, d, g) control, (b, e, h) INPH and (c, f, i) atrophic ventricular dilation.

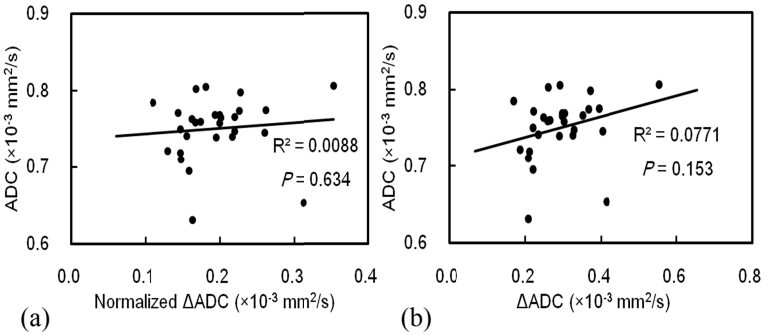

Fig 3. Relations between ADC and (a) normalized ΔADC, and (b) ΔADC.