The Diffusion Tensor Imaging Study on Profound Sensorineural Hearing Loss Patients

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Introduction

Diffusion tensor imaging (DTI) is a new *in vivo* tool not only for the assessment of white matter structural integrity but also for diagnosis and assessment of disease conditions which disturb tissue structural coherence [1]. In this study, we investigated the integrity of auditory pathway in patients of profound sensorineural hearing loss (SNHL) by means of fractional anisotropy of water diffusion to see any subtle changes of auditory pathways resulting from SNHL.

Material and Methods

Subjects: We studied seven profound SNHL patients (5 females, 2 males; 8-85 years of age; mean age 33.7 years) according to the following criteria, (1) no anatomic abnormality of inner ear and auditory pathway; (2) no previous otological surgery or systemic ototoxic drug therapy affecting the CNS. Hearing level was measured in a sound proof booth using a calibrated pure tone audiometer (GSI 10, USA). The ten normal hearing subjects (5 females, 5 males; 22-34 years of age; mean age 26.5 years) were also included in this study. All subjects gave written informed consent prior to the study. An independent institutional ethical committee approved the protocol used in this study.

Diffusion Tensor MR Imaging: All subjects were imaged on a 3.0-T clinical whole body magnet (VHi; General Electric Medical, USA). Diffusion tensor imaging was performed with the use of a single-shot spin-echo, echo-planar imaging technique, with Stejskal-Tanner diffusion-sensitizing pulses. The DTI imaging parameters were as follows: 220×220-mm field of view, 128×128 matrix size, 12 to 16 axial slices, 5-mm slice thickness, repetition time=8000 ms, echo time = 71 ms. Diffusion was measured along 24 non-collinear directions. For each slice and each gradient direction, two images with no diffusion weighting (b = 0s/mm^2) and diffusion weighting (b = 1000s/mm^2) were acquired. All tensor analysis and image processing were carried out on independent workstation (Advantage Window, GE Medical, USA). The mean and standard deviation (SD) of the D pixel values were computed in each ROI in each of the 10 patients. The mean D values in the ROIs were compared across patients and normal subjects with a paired two-population two-tailed student *t*-test.

Results

Fractional anisotropy (FA) was found to be reduced at least in one of five principal regions on central auditory pathway in all 7 patients. Depending on patients, however, the involved auditory regions were different. Figures showed the anatomical T2-weighted FSE image (a), isotropic diffusion-weighted image (b), fractional anisotropy image (c) and colored orientation map (d) in one of the patients. No sign of abnormality was found on both T2-weighted image (a) and isotropic diffusion-weighted image (b). However, fractional anisotropy image (c) demonstrated the signal loss at the superior olivary nucleus and thus suggested the reduced diffusion anisotropy. In addition to reduced FA value, the orientation map of the patient (d), which reveals the eigenvector direction represented in color, showed the abnormality of fiber direction at the superior olivary nucleus.

Discussion

Our study revealed that the FA index on central auditory pathway is lower in patient group within statistical significance. The reduction in anisotropy can be interpreted as suggesting either the axonal dysfunction or structural breakdown of white matter fibers. In addition, the fact that the specific locations with significantly reduced fractional anisotropy are different among patients reflects that the sites of neural damage are different. Among locations, our results showed that the inferior colliculus is most common site of involvement. Therefore, it seems that inferior colliculus, which is a major site of convergence for ascending and descending tracts in the auditory pathway, is most sensitive to neuronal damage. In conclusion, the present study provides preliminary data suggesting that diffusion tensor imaging is a sensitive measure for evaluating functional changes of central auditory pathway in patients with profound SNHL.

References

[1] Le Bihan D, Mangin JF, Poupon C, et al. JMRI 2001; 13:534-546.