Estimation of perilymph enhancement after intratympanic administration of Gd-DTPA by fast T1-mapping with dual flip angle 3D-spoiled gradient echo sequence

Shinji Naganawa¹, Masahiro Yamazaki¹, Hisashi Kawai¹, and Tsutomu Nakashima²

¹Department of Radiology, Nagoya University Graduate School of Medicine, Nagoya, Aichi, Japan; ²Department of Otorhinolaryngology, Nagoya University Graduate School of Medicine, Nagoya, Aichi, Japan

Purpose: For the objective diagnosis of Meniere’s disease, visualization of endolymphatic hydrops by MR imaging after intratympanic administration of Gd-DTPA (IT-Gd) has been utilized (off-label use of Gd-DTPA). The pulse sequence protocols for the IT-Gd are typically 3D-FLAIR-TSE [1] and 3D-inversion recovery TSE with phase sensitive reconstruction (3D-real IR-TSE)[2]. Each sequence takes about 15 minutes to obtain, therefore 30 minutes is required to obtain both sequences. Unfortunately, in 18% of cases, contrast enhancement of perilymph of inner ear is not enough probably due to poor permeability of round window membrane [3]. In these cases, long scans ends in vain. Fast T₁-mapping by 3D-spoiled gradient echo (FT₁-map) technique allows the high spatial resolution T₁-mapping. This FT₁-map is usually utilized for dGEMRIC of cartilage [4]. FT₁-map parameters are modified and applied to inner ear in this study. The purpose of this study was to evaluate if FT₁-map can predict the poor contrast enhancement of perilymph in the patients who underwent IT-Gd.

Materials and Methods: Medical ethics committee approval and written informed consents from all patients were obtained. Eleven patients (age 22-77, 2 men and 9 women) with the clinical suspect of Meniere’s disease were included. One patients underwent the examination twice, therefore 12 exams were evaluated. 24 hours after IT-Gd, CISS (MR cisternography) and FT₁-map were obtained. The sequence for FT₁-map consisted of two separate 3D-spoiled GRE with 2 different excitation flip angles. Flip angles were modified to measure relatively long T1-values compared to cartilage. The scan parameters were as follows; water selective excitation, TR15, TE3.41 , flip angles of 2 and 15 degree. Matrix size was 256x256 (interpolated to 512 x 512) with 16cm FOV. The T₁-map was then calculated on a pixel-by-pixel basis from the 2 measurements. Scan time for FT₁-map was 6 minutes. Then, 3D-FLAIR-TSE (9000/134/2500, 15 minutes) and 3D-real IR-TSE (6000/182/1500, 15 minutes) was obtained using the previously reported parameters. All scans were performed on 3T MR using 32-ch array head coil. T₁ value of the perilymph of scala tympani in basal turn of cochlea was manually measured referring to the anatomy on MR cisternography. The other radiologist blinded to the results of T₁ measurement reviewed 3D-FLAIR-TSE and 3D-real IR-TSE and scored them separately regarding the recognition of endolymph space in basal turn of cochlea as apparently visible (score=2), slightly visible (score=1), and invisible (score=0).

Results: On 3D-FLAIR-TSE, there were 9 ears for point 2, 2 ears for point 1, and 1 ear for point 0. On 3D-real IR-TSE, There were 8 ears for point 2, 1 ear for point 1, and 3 ears for point 0. In all ears score point of 3D-FLAIR-TSE is not less than that of 3D-real IR-TSE. Scores for 3D-FLAIR-TSE were significantly higher than those for 3D-real IR-TSE (p<0.05). Ear with point 0 on 3D-FLAIR-TSE showed longer T₁ value than 4000ms, and those with point 1 showed the values between 3300-4000ms. Ears with point 0 on 3D-real IR-TSE showed T₁ values longer than 3300ms, however one ear with point 1 showed 3719ms.

Conclusion: From the results of the present study, the tendency described below can be appreciated, although the number of cases with poor Gd distribution in inner ear was small. (1) 3D-real IR-TSE needs higher concentration of Gd to recognize endolymph than 3D-FLAIR-TSE. (2) If the T₁ value of cochlear perilymph on FT₁-map is more than 4000ms, both 3D-FLAIR-TSE and 3D-real IR-TSE fails to visualize endolymphatic space. If the T₁ value is less than 3300ms, both methods will succeed. If the T₁ value is between 3300-4000ms, at least 3D-FLAIR-TSE can visualize endolymphatic space and 3D-real IR-TSE occasionally succeed. FT₁-map might help to avoid unnecessary long MR scans.

References