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

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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 T_1-mapping by 3D-spoiled gradient echo (FT_1-map) technique allows the high spatial resolution T_1-mapping. This FT_1-map is usually utilized for dGEMRIC of cartilage [4]. FT_1-map parameters are modified and applied to inner ear in this study. The purpose of this study was to evaluate if FT_1-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 FT_1-map were obtained. The sequence for FT_1-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 T_1-map was then calculated on a pixel-by-pixel basis from the 2 measurements. Scan time for FT_1-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. T_1 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 T_1 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 T_1 value than 4000ms, and those with point 1 showed the values between 3300-4000ms. Ears with point 0 on 3D-real IR-TSE showed T_1 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 T_1 value of cochlear perilymh on FT_1 map is more than 4000ms, both 3D-FLAIR-TSE and 3D-real IR-TSE fails to visualize endolymphatic space. If the T_1 value is less than 3300ms, both methods will succeed. If the T_1 value is between 3300-4000ms, at least 3D-FLAIR-TSE can visualize endolymphatic space and 3D-real IR-TSE occasionally succeed. FT_1-map might help to avoid unnecessary long MR scans.

Fig. Circle on FT_1-map is ROI for cochlear perilymph. This patient shows significant Gd-distribution. Endolympahtic hydrops can be apparently appreciated on both 3D-FLAIR and 3D-real IR (arrows).

References
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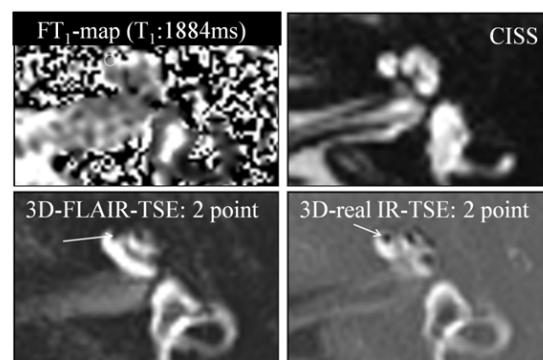[4] Sur S, et al. JMRI 30:896-900, 2009