Ultrashort echo time imaging of the middle ear ossicle: a pilot study

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Introduction

Ultrashort echo-time (uTE) imaging is an MR imaging method that allows for direct visualization of tissues with very short T2s (<1ms) that are invisible on any other types of MR images. This unique imaging method has been used to evaluate bones and other connective tissues such as tendons, ligaments, and menisci, and new clinical applications are being discovered. Our purpose was to assess the feasibility of uTE imaging in the visualization of the middle ear ossicles in normal subjects.

Materials and Methods

Twelve young adult volunteers (M/F= 6/6, age 25 to 44 years, mean 30.3 years) with normal hearing levels underwent MRI studies using a 3.0 T clinical unit (Achieva Nova Dual, Philips Medical Systems) with an 8-channel SENSE head coil. For each subject, the whole-head was imaged using a 3D dual-echo uTE imaging sequence with radial trajectory and the following parameters: FOV=240×240×240mm^3, matrix=320×320, flip angle=7°, TR/TE1/TE2=8.0ms/0.14ms/1.8ms, acquisition voxel size=0.75×0.75×0.75mm^3, NSA=1, imaging time=27min20s. Subsequently, subtraction images were obtained by subtracting long TE (1.8ms) images from short TE (0.14ms) images. By using these three images, the visibility of the bilateral middle ear ossicles was evaluated. Moreover, as a reference for the uTE findings, CT images of the temporal bone were obtained in one volunteer.

Results

In all subjects, the middle ear ossicles were clearly visualized as a high signal intensity spot surrounded by a signal void of air on short TE images bilaterally, while they were not visible in long TE images in any of the subjects (Fig. 1). The subtraction images provided better contrast of the ossicles (Fig. 1). Moreover, the CT images and the CT-MRI fusion images confirmed that the high-signal-intensity structure on the short TE images coincided with the middle ear ossicles (Fig.2):-more specifically, the complex of the malleus and incus at the incudomalleolar joint. The stapes was not identifiable in any subject.

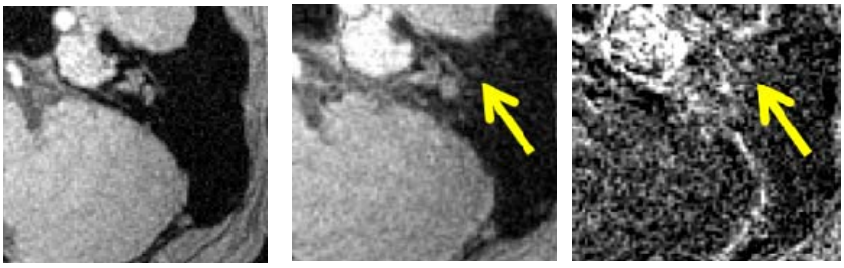

Fig.1: Left middle ear ossicle (arrows) are visible in a short TE image (TE=0.14ms) while they are invisible on the corresponding long TE image (TE=1.8ms). The subtraction image (short TE image minus long TE image) provides higher contrast.

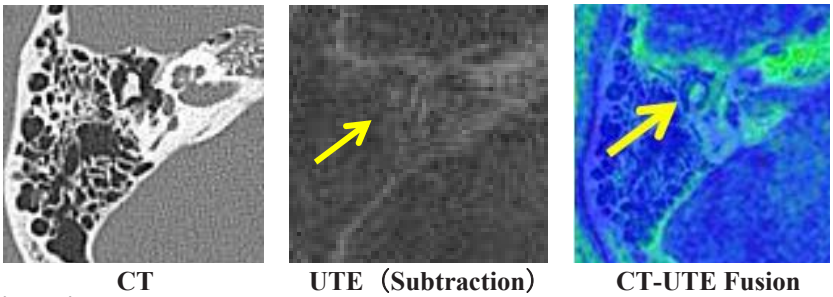

Fig.2: Comparison with CT image (left) confirms that the high-signal-intensity spot on the short TE images (middle) corresponds to the complex of the malleus and incus at the incudomalleolar joint. The CT-MRI fusion image (right) further confirmed their spatial agreement.

Discussion

We demonstrated the feasibility of uTE imaging of the middle ear ossicle in normal subjects. To our knowledge, this is the first report of MR visualization of the middle ear ossicles. Currently, high-resolution CT is the only imaging modality available for evaluation of the middle ear ossicles. Our results revealed that the middle ear ossicles could be visualized without radiation exposure, and may lead to a new era of diagnostic MR imaging of the temporal bone.

References

1. Robson MD et al. J Comput Assist Tomogr. 2003. 825-846. **2.** Tyler DJ et al. Magn Reson Imaging. 2007. 279-89