First promising results using Ultra-short Echo time MR imaging for bone tumor diagnosis

Karl-Heinz Herrmann1, Martin Krämer1, Martin Stenzel2, Hans-Joachim Mentzel1, and Jürgen R Reichenbach1

1Medical Physics Group, Institute of Diagnostic and Interventional Radiology I, Jena University Hospital - Friedrich Schiller University Jena, Jena, Germany, 2Pediatric Radiology, Institute of Diagnostic and Interventional Radiology I, Jena University Hospital - Friedrich Schiller University Jena, Jena, Germany

Target Audience – Clinicians interested in diagnostic applications of UTE imaging as new modality for characterization of bony lesions; Researchers interested in UTE applications;

Purpose – For the diagnosis of osseous lesions currently X-ray and CT imaging are used for diagnosis and often an additional MRI scan is performed to assess the involvement of soft tissue. Here we present a case of a skull bone tumor, where one important question for the diagnosis is to either confirm or rule out an infiltration of the tumor into the soft tissues. As the MRI scan is mandatory an additional high resolution ultra-short echo time (UTE) scan was employed to compare its diagnostic value to a standard CT scan. Especially in pediatrics the X-ray exposure of often repeated CT scans (pre/post treatment) can be of concern, and replacing at least one of the CT scans by UTE-MRI would be advantageous. Another benefit of UTE-MRI is to provide excellent soft tissue contrast together with bone structures.

Methods – MR imaging of the patient (age 16, female) was performed on a clinical 3T system (Magnetom TIM Trio, Siemens Healthcare, Erlangen, Germany) using a 3D spoiled gradient echo radial center out acquisition (spikey ball) with the parameters: Isotropic Voxel size of (0.55 mm)3, 1.97 μs dwell time, TR=4.3 ms, TE=70 μs, 10° flip angle, a total of 181154 measured spokes with an acquisition time of 14 min. A fat saturation pulse was applied every 27 spokes (116 ms) to partially suppress the fat signal. The MRI data was acquired directly after administration of 0.1 ml/kg body weight Gadobutrol. Image reconstruction was performed by gradient delay compensated, state of the art 3D gridding using iterative grid weights estimation1. The CT images were acquired on a 64 row General Electrics Lightspeed VCT, using bone reconstruction kernel at isotropic (0.625 mm)3 resolution.

Results – Figure 1 shows a perpendicular cut through the focal lesion, comparing the CT images (a) and UTE MRI (b). The CT image clearly shows a thin white line (arrow 1) between the tumor and the skull contents, indicating a thin, still existing layer of internal tabula separating the tumor from the brain. The MRI images show two separating layers between the brain and the tumor: The hyper intense white line (arrow 2) are the meninges, which are a short T2 tissue and only visible on UTE images3. The thin hypo intense line (arrow 3) is the thin layer of compact bone which is also visible on the CT images (Fig 1a, arrow 1). Figure 2 compares a parallel cut through the cranial tumor. The center image (b) shows an intensity inverted version of the original UTE-MRI image (c). There is a very strong resemblance of the internal structures of the tumor (arrows 1), the bone structure (arrows 2) and the suture (arrow 3) of the skull between the CT image (a) and the inverted MR image (b).

Discussion & Conclusion – In the presented case the UTE MRI images clearly delineate the skull bone tumor from the brain and the thin separating layer of bone can be clearly identified on both CT and the MR images. Additionally the UTE images show the meninges as a hyper intense, unbroken line which is a strong indication of no tumor infiltration. Currently this high resolution UTE-MRI acquisition requires significant scan time. However, improved implementations using acceleration techniques like compressed sensing1 should be able to speed up the data acquisition. To match the gray values of UTE-MRI and resolution UTE-MRI acquisition requires significant scan time. However, improved implementations using acceleration techniques like compressed sensing1 should be able to speed up the data acquisition. To match the gray values of UTE-MRI and resolution UTE-MRI acquisition requires significant scan time. However, improved implementations using acceleration techniques like compressed sensing1 should be able to speed up the data acquisition.

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