Title: Application of a novel retrospective method for liver 4D-MRI

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Introduction: Liver imaging is challenging due to its constant movement with breathing. In Magnetic Resonance Imaging (MRI), different strategies have been developed for organ movement consideration [1-3]. These methods are limited by the temporal resolution, as well as image quality. A novel retrospective gating method for dynamic 3D MR imaging during free breathing was developed [1] and further improved by Celicanin et al [4]. This work aims of assessing the method and the reconstruction technique for liver cases. The final clinical application is to improve liver lesion delineation for Stereotactic Body Radiation Therapy (SBRT).

Methods: The innovative 4D MRI approach has been evaluated for liver motion estimation during entire respiratory cycle on a healthy volunteer. It is based on simultaneous acquisition of 2D images and a navigator set using acceleration CAIPIRINHA technique [4] providing no temporal divergence between them. During the entire acquisition time, the navigator is fixed in the same position, while the image position is changing, in order to cover the entire organ during free breathing [1]. The entire respiratory cycle is acquired, using a modified balanced Steady State Free Precession sequence (bSSFP) and is reconstructed in a retrospective manner (figure 1).Images are acquired with a 1.5T MRI (MAGNETOM Aera; Siemens Medical Solutions, Erlangen, Germany), using an 18-channel design body flex coil. The 3.5 mm 2D axial slices are obtained, using the following sequence parameters: TE = 2.27 ms, TR = 591.97 ms, FA= 70 °, FOV = 37 x 37 $cm^{2,}$ matrix = 256 x 246. Total acquisition time is 33.175 s (0.83 s per slice).

Results: The preliminary results obtained on a healthy volunteer are shown in figure 1. Images are characterized by high resolution and great contrast, making this method promising for liver lesion examination. The reconstruction of 4D MRI and the sequence optimization to cover the entire respiration cycle with the appropriate time sampling is ongoing work.

Conclusions: The benefit of MRI acquisition in treatment position to improve lesion contouring for liver SBRT has already been demonstrated [5]. The presented 4D MRI method represents a highly time efficient technique for the free breathing liver motion registration, giving the possibility to sort and reconstruct the images according to the respiratory phases. It will allow registration with 4D CT planning, likely to improve delineation accuracy. The same approach can be applied to study moving organs others than liver.

References:

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