Ultra-fast time resolved contrast enhanced abdominal imaging using an elliptical centric fat suppressed 3D profile sharing acquisition technique, SENSE and partial Fourier

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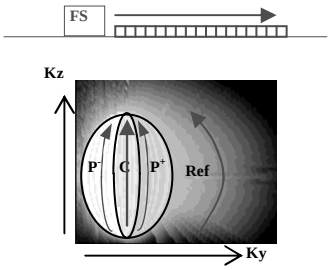
Introduction

The detection and characterization of hyper-vascular lesions and masses in abdominal organs like liver and pancreas is greatest during the hepatic arterial phase. For conventional contrast enhanced dynamic liver imaging, the period of hepatic arterial phase will overlap with enhancement of blood coming from the portal vein in the duration of the 20 seconds breath-hold acquisition time. Other abdominal organs like pancreas and kidneys have a fast uptake of contrast agent in the arterial phase similar to hyper-vascular lesions and masses in those organs. Hence for contrast-enhanced MR imaging of abdominal organs, short acquisition times that allows following the contrast enhancement is crucial. 3D time resolved imaging provides an opportunity for these types of applications as has been demonstrated recently [1]. It is the objective of current work to investigate a novel elliptical centric profile sharing acquisition technique that combines a fat suppressed turbo gradient echo sequence [2], SENSE, keyhole imaging and an alternating viewsharing technique integrated in the keyhole part [3]. The acquisition was performed in several breath-holds with an update of the higher Ky-Kz profiles (Keyhole **Ref**erence) per breath-hold. To further reduce scan time, partial Fourier was applied in phase and slice encoding.

Methods

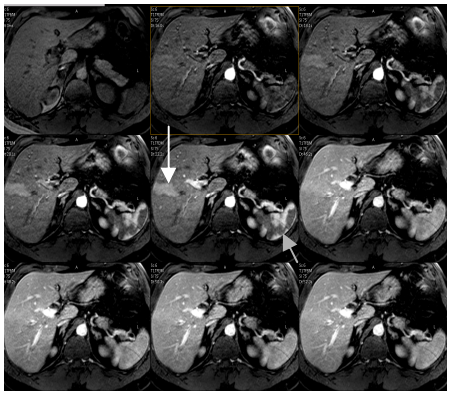
A prospective study was performed on a 3.0 T scanner (Achieva, Philips Medical Systems, Best, The Netherlands[1]). A commercially available phased-array coil (SENSE Torso coil[1]) was used. The 3D time resolved sequence consists of a 3D T1 weighted fat saturated turbo gradient echo pulse sequence combined with SENSE (reduction factor 2), elliptical centric keyhole and an alternating viewsharing technique. A spectral selective inversion pre-pulse (SPAIR[1]) is applied for fat saturation.



A central Ky-Kz disk defined by the keyhole percentage hereby is subdivided in three regions, P^+, C and P^-, where P^+ and P^- covers positive and negative peripheral regions in this central disk and C, the central region, as shown in Fig. 1. The central region C is acquired every dynamic scan while regions P^+ and P^- are shared with subsequent dynamic scans according to an alternating viewsharing scheme: **P^+-C-P^--C-P^+-C-P^--C-P^+-Ref**.

Figure 1 Schematic depiction of the elliptical centric profile sharing acquisition scheme. The arrow indicates the Ky-Kz order of the profiles applied per fat saturation (FS) preparation pulse (shot). The gray scale values depict the acquisition order in time for the last dynamic part, **P^--C-P^+-Ref**.

The keyhole percentage was 25% and the viewsharing percentage, $Vp = C/(P^+ + C + P^-)$, was 20% leading to a speed-up factor of 7 with respect to the high spatial resolution scan. The sequence used a turbo factor of 45 (TR 3.1 ms, TE 1.4 ms, α 10°, 133 slices, FOV 400 mm, voxel size 1.5 mm x 1.5 mm x 1.5 mm, partial Fourier (62.5% in phase encoding direction, 80% in slice encoding direction) leading to a temporal resolution of 2 sec. After intravenous injection of Gd-Bopta (MultiHance®, Bracco, Milan, Italy) (1 ml/10 kg body weight followed by saline (NaCl 0,9%) both at a speed of 3ml/s) the bolus was timed at the arrival of the abdominal aorta (BolusTrak[1]). 4 dynamics were acquired during the 20 sec breath-hold.



Results and Conclusion

Fig. 2 shows a dynamic image series of a patient with suspicious metastatic lesion. Note the perfusion difference in the liver (white arrow) that is clearly visible 4 and 6 sec after contrast arrival. Note also the expected perfusion difference in the spleen (gray arrow). Initial results reveal the strength of the method. The extreme short temporal resolution in combination with a high spatial resolution that covers the complete organ under study enables ultra-fast contrast uptake processes to be followed in those organs. This technique allows the detection of perfusion differences that might allow an improved detection and characterization of hypervascular liver lesions apart from the classic visual classification.

Figure 2 Pre- and post contrast dynamic image series acquired at 0, 2, 4, 6, 30, 32, 34 and 36 sec after contrast arrival.

Literature

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3. G. M. Beck, Magnetic resonance profile sharing technique, WO-2004079386 A1, 2004-09-16.