A Contrast-ENhanced Timing Robust Acquisition order with a Preparation of the LongitUdinal Signal Component, CENTRA+, for 3D Contrast Enhanced Abdominal Imaging

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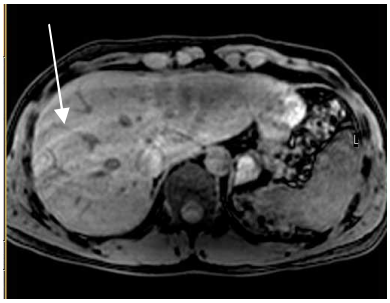
Introduction

The detection and characterization of hypervascular masses in abdominal organs like liver and pancreas is greatest during a short transient period of early perfusion. The transit time from initiation of contrast infusion in an arm vein and arrival to the organ of interest is variable over patients. An incorrectly timed arterial phase acquisition may render a study non-diagnostic. Hence for contrast-enhanced MR imaging of abdominal organs, a precise timing of the contrast enhancement and accurate sampling are crucial in order to catch the arterial phase. The use of a 3D elliptical centric profile ordering technique provides an opportunity for contrast-enhanced applications as has been shown for 3D high-resolution contrast enhanced MR angiography [1]. In combination with a contrast bolus timing method it allows a precise timing of data acquisition during selected periods of enhancement.
This has been also demonstrated recently for 3D T1 weighted fat suppressed sequences in contrast enhanced abdominal applications [2, 3]. All these approaches use variable shot length with an adaptive small number of profiles per fat suppression preparation in the central k-space and successive larger number of profiles in the peripheral k-space. It is the objective of current work to investigate a more efficient elliptical centric sampling strategy – **C**ontrast **EN**hanced **T**iming **R**obust **A**cquisition order with a **P**reparation of the **L**ongit**U**dinal **S**ignal component CENTRA+ - sharing the fat suppression prepulse over a constant, large number of profiles.

Methods

A prospective study was performed on a 1.5 T and 3.0 T scanners (Achieva, Philips Medical Systems, Best, The Netherlands[1]). A commercially available phased-array coil (SENSE Torso coil[1]) was used. The new sampling strategy was applied to a contrast-enhanced high resolution 3D T1 weighted fat suppressed turbo gradient echo sequence with a SENSE reduction factor of 2 and a turbo factor of 60 (TR 3.1 ms, TE 1.4 ms, α 10°, slab thickness 200 mm, FOV 400 mm, voxel size 1.5 x 1.5 x 2.0, elliptical k-space shutter, scan time 20 sec).

The proposed CENTRA+ sampling strategy uses a segmented centric approach similar to CENTRA [4]. Hereby ky-kz space is segmented in a central and peripheral k-space sector. In the initial phase the central k-space sector is acquired. After the complete filling of the central sector the peripheral k-space sector is then continued towards the peripheral k-space.
In magnetization prepared scans that intends to maximize the number of profiles per preparation step it is essential to avoid artifacts from signal and phase variations sharing a single prepulse within a shot. Hence in our work, segmentation has been applied to the central and peripheral k-space sector. Signal discontinuities has been minimized by congruently ordering the segments of the central k-space sector with respect to associated peripheral k-space sector segments. CENTRA+ hence segments the central k-space sector in the phase encode direction and the peripheral k-space sector in a homogeneous radial segmentation.



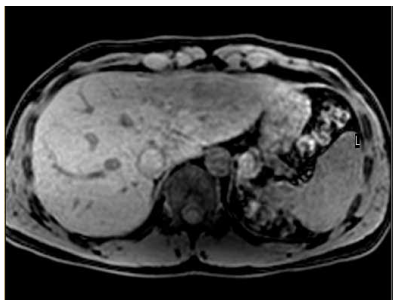


Fig. 1 a) Slice of a 3D turbo gradient echo sequence with conventional CENTRA profile order and b) CENTRA+ profile order

Results

Performing a 3D T1 weighted fat suppressed turbo gradient echo sequence with a conventional CENTRA profile order [4] reveals the difficulties when no congruent ordering of the large number of profiles that share fat saturation is spend. Ghosting artifacts, as indicated in Figure 1a (arrow), are prominent in the non-ordered CENTRA profile order. Applying a homogeneous segmentation, CENTRA+ effectively improves overall image quality (Figure 1 b).

Conclusions

With the use of fluoroscopy triggering that reliably establish the arrival of contrast material, the acquisition of the contrast-determining central k-space lines are precisely timed to optimal enhancement of the contrast material. This timing precision is vital both to the detection of lesions that are visible only during short periods of enhancement like in liver and pancreas and to a better lesion characterization.

Literature

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