TIME-RESOLVED ECHO-SHARING ANGIOGRAPHIC TECHNIQUE USED IN CONJUNCTION WITH VOLUME-INTERPOLATED BREATH-HOLD EXAMINATION MRI (TREAT-VIBE): Feasibility of a 3-D Technique for Evaluation of the Liver with High Temporal Resolution using a Triple- Arterial Phase Acquisition

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Introduction:

Fat-suppressed interpolated 3D gradient echo imaging (VIBE) is an established method of evaluating the abdomen during a breath-hold acquisition[1]. When combined with TREAT, a view-sharing approach in which some parts of k-space are updated more often than others and with parallel imaging[2], TREAT-VIBE enables a triple-arterial phase 3-D acquisition through the liver, whilst preserving the spatial resolution necessary for hepatic imaging. The complex flow dynamics in the cirrhotic liver necessitate optimization of arterial phase enhancement for the accurate detection and characterization of liver lesions, particularly hepatocellular carcinoma and arterio-portal vascular shunts[3]. Our objective was to assess the feasibility of a triple-phase arterial acquisition during a single breath-hold using a TREAT-VIBE technique with parallel imaging (GRAPPA) factor 2.

Methods:

We retrospectively evaluated 19 consecutive patients (13 men, mean age 54.9 +/-14 yrs, 7 cirrhotics/12 non-cirrhotics) referred for MRI of the liver or MRCP, on a 32-channel 1.5 T system (Magnetom Avanto, Siemens Medical Solutions). Sequence parameters were: TR/TE 3.6/1.5, flip angle 12°, matrix 256 x 96 -125, FOV 275-400 mm x 275-325 mm, interpolated partition thickness 2.6-3.0 mm, 72-96 partitions, acquisition time 6.7-11.8 sec, bandwidth 390 Hz/pixel., parallel imaging (GRAPPA) factor 2, partial Fourier off, time-to-center 2.0 seconds. Region of interest analysis was performed using Syngo Workstation (Siemens Medical Solutions) over the aorta, portal vein, and right lobe hepatic parenchyma.. Contrast injection was via a 20-22 G cannula in antecubital vein of 20cc Gd-DTPA (Magnevist, Berlex) with 20cc saline at a rate of 2 cc/second using a power injector. The start of the first of three arterial phase acquisitions was timed using a test injection (scan delay = time-to-peak). The three acquisitions required a breath-hold of 21 sec in total, with k-space data from the last of the three copied backward to the first two acquisitions in this TREAT implementation. These were followed by portal venous and equilibrium phases at one and three minutes post injection, respectively, using parallel imaging, but no TREAT.

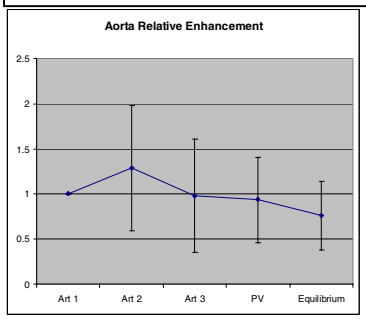
Relative enhancement for liver, aorta, and PV were recalculated based on percentage of peak enhancement using the following formula: $\mathbf{((Post\text{-}pre)/pre)_{phase}/((Post\text{-}pre)/pre)_{reference}}$, where aorta relative enhancement was assessed relative to the first arterial phase, and liver and portal vein enhancement were assessed relative to the PV phase.

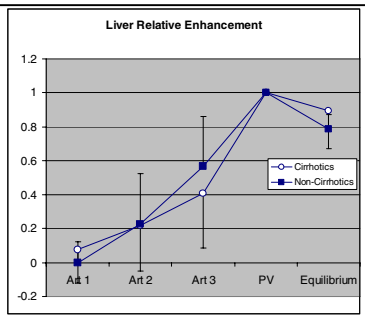
Results:

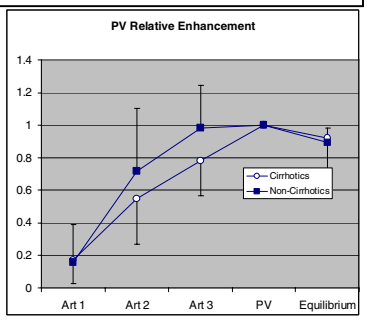
With the timing strategy used, the overall arterial enhancement peaked during the second arterial phase (Fig 1).

Non-cirrhotics showed higher contrast enhancement of hepatic parenchyma during both the second and third arterial phases than cirrhotics, when analysed separately (Fig 2). Correspondingly, there was higher portal vein enhancement during the second and third arterial phases for the non-cirrhotics compared with the cirrhotics, consistent with the known arterial buffer response in cirrhosis (Fig 3). For cirrhotics, the liver parenchymal enhancement ranged from 7.4% to 21.6% to and 40.9% of maximal enhancement during the three arterial phase acquisitions. In our preliminary assessment, we observed differences in enhancement patterns across lesions through each of the arterial phases, see figures 4 and 5.

Figure 1 Figure 2 Figure 3







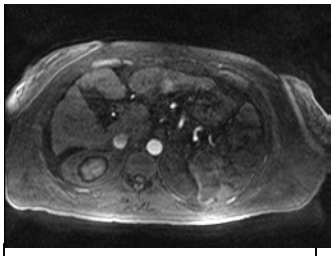


Fig 4: 57 year old female with cirrhosis: Stable AP shunt in cirrhotic liver on first arterial phase; not visualized on subsequent arterial phases

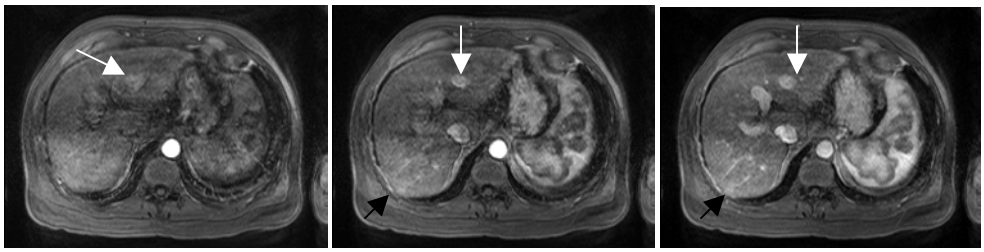


Fig 5 a-c: 63 year old male with cirrhosis. Three arterial phases images, earliest on the left, show progressive enhancement of a HCC (white arrow) in the left lobe which washed out on the equilibrium phase and an arterioportal shunt in the right lobe (black arrow), is seen on the second and third phase,which become isointense on later phases.

Conclusion:

TREAT-VIBE acquisition is a feasible technique in triple-arterial phase imaging during a single breath-hold, achieving high temporal resolution and incorporating optimal arterial phase enhancement of the liver parenchyma during contrast infusion. This may have important implications in detection of arterially enhancing lesions in the altered contrast kinetics of the cirrhotic liver.

References:
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