

Single breath-hold quadruple arterial phase dynamic MRI of the liver using LAVA FLEX sequence and 32 channel coil at 3T

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Introduction: Liver acquisition with volume acquisition (LAVA) contrast-enhanced 3D T1W GRE technique acquires 3 phases of whole organ coverage with high speed and resolution during a single breath hold. LAVA FLEX allows acquisition, in one scan, of four different contrasts, with output images including in-phase, out-of-phase, water only and fat only. Using a 3.0T MRI system is advantageous for contrast-enhanced imaging due to higher SNR than at 1.5 T, which enables faster scanning by using a higher parallel imaging factor. We describe a technique enabling quadruple arterial phase 3D acquisition through the liver, while preserving a diagnostic spatial resolution necessary for hepatic imaging. The complex flow dynamics in the liver necessitate optimization of arterial phase enhancement for the accurate detection of hypervascular lesions. We would like to assess the feasibility of acquiring four arterial phases into routine dynamic 3T MRI examinations of the liver.

	ART1	ART2	ART3	ART4
Edge delineation*	3.7 ± 0.5	3.5 ± 0.6	3.6 ± 0.6	3.6 ± 0.5
Artifacts*	3.0 ± 0.6	3.0 ± 0.6	3.2 ± 0.7	3.2 ± 0.6
Lesion conspicuity*	2.4 ± 1.0	3.0 ± 0.9	2.5 ± 0.7	2.0 ± 0.9
Lesion CR**	0.18 ± 0.06	0.22 ± 0.08	0.19 ± 0.08	0.15 ± 0.09

Image quality and qualitative/quantitative lesion conspicuity observed during a quadruple arterial phase acquisition. *4 is best, **1 is highest

Methods: We evaluated 42 patients (M/F 18/24, mean age 54 y), including 16 with cirrhosis. A 3T system (Discovery 750, GE Medical Systems) equipped with a 32 transmit-receive torso coil was used. Sequence parameters were: TR/TE 4.1-4.5/1.9, FA 10°, average slice thickness 4.2 mm (range, 3.2-5 mm), matrix 128x320, number of averages 0.73, sequential k-space filling, parallel imaging factor 3.20-3.97, acquisition time 5-6 sec per phase. A pre-contrast acquisition was followed

by 4 post-contrast arterial phase acquisitions, using Gd-DTPA (n=32) or Gd-EOB-DTPA (n=10) and timing bolus or bolus tracking method. Water-only post contrast T1W LAVA FLEX images were assessed qualitatively by 2 observers in consensus: liver/vessel edge sharpness and image artifact for each arterial phase (1 worse-4 best). Hypervascular lesion conspicuity was also evaluated (0-4 scale). In patients with hypervascular lesions, ROIs were placed on liver parenchyma and lesions to measure signal intensity (SI) used to measure lesion contrast ratio (CR) for the 4 post-contrast phases calculated as: (SI lesion - SI liver)/(SI lesion + SI liver).

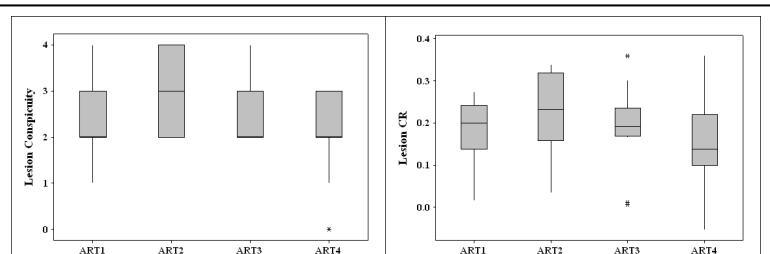


Fig. 1: Box plot distribution of qualitative lesion conspicuity (left) and lesion contrast ratio (right) in 12 patients with 16 hypervascular lesions. ART2 showed the best lesion conspicuity and contrast ratio.

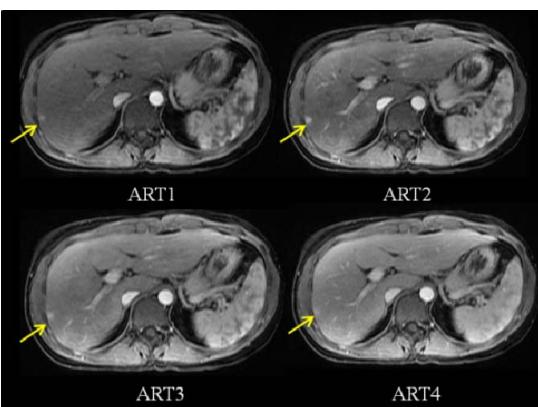


Fig. 2: Patient with autoimmune hepatitis and arterioportal shunt. 4 ART phases obtained with LAVA FLEX water suppressed images after injection of Gd-DTPA, using 32-channel torso coil and 3T with high parallel imaging factor (3.28) in a single breath-hold are shown. Images are of good diagnostic quality, with sharp liver edges, and no major artifact.

Results: Image quality scores, lesion conspicuity scores and lesion CR values are shown in the Table, and Fig. 1. 36 patients had excellent liver and vascular edge delineation in at least one ART phase. Image artifacts were present in 37 cases, mostly consisting of ghosting artifact secondary to parallel imaging. None of the patients had a non diagnostic quality study. 12 patients had 16 hypervascular hepatic lesions with a size ≥ 8 mm evaluated (HCC n=4, FNH n=3, arterioportal shunt n=3 Fig. 2, metastases n=3, hemangioma n=1, confluent hepatic fibrosis n=1, adenoma n=1). Lesion conspicuity and lesion CR was highest during ART2 and lowest during ART4 (p=0.021 for qualitative score between ART2 vs. ART4, and p=0.004 for lesion CR between ART2 vs. ART4).

Conclusion: Based on our experience, multiple arterial phases can be performed in a single breath-hold during a liver MRI exam at 3T, with acceptable image quality, at the expense of increased parallel imaging artifacts, for which further solutions should be implemented. Hypervascular lesion conspicuity was best during the 2nd post-contrast arterial phase, and worse during the 4th ART phase.

References:

1. Hong HS, et al. JMRI 2008; 28: 396-402; 2. Mori K, et al. AJR 2005; 184: 63-69; 3. Goncalves NJ, et al. JMRI 2010; 28: 47-55.