

Clinical application of 3D VIBE CAIPIRINHA-DIXON for non-enhanced imaging of the pancreas compared to a standard 2D fat-saturated FLASH

Stefan Haneder¹, Katrin Koziel¹, John N Morelli², Philipp Riffel¹, Stefan O Schoenberg¹, and Henrik J Michaely¹

¹Institute of Clinical Radiology and Nuclear Medicine, University Medical Center Mannheim, Mannheim, Baden-Württemberg, Germany, ²Scott and White Memorial Hospital and Clinic, Texas A&M University Health Sciences Center, Temple, Texas, United States

Target audience: Clinicians specializing in body imaging

Purpose: To compare a fast 3D VIBE sequence with Dixon fat saturation and CAIPIRINHA¹ (Controlled Aliasing In Parallel Imaging Results IN Higher Acceleration) acceleration techniques (3D VIBE_{CAIPI-DIXON}) to a standard 2D FLASH sequence with spectral fat saturation and conventional GRAPPA acceleration technique (2D Flash_{GRAPPA-fs}) for non-enhanced imaging of the pancreas.

Methods & Materials: In this retrospective, IRB-approved intra-individual comparison study, 29 patients (7 female, 22 male; mean age 60.4 ± 20.9 years) examined on a 48-channel 3.0T MR system (MAGNETOM Skyra VD 13, Siemens Healthcare Sector, Germany) were included. The clinical indications for pancreatic MRI included characterization or follow-up of pancreatic lesions and oncologic follow-up after tumor treatment or partial pancreatectomy. 3D VIBE_{CAIPI-DIXON} (TR / TE - 3.95 / 2.5 + 1.27 ms; spatial resolution - 1.2 x 1.2 x 3.0 mm³; CAIPIRINHA 2x2⁽¹⁾, acquisition time - 0:12 min) and 2D Flash_{GRAPPA-fs} (TR / TE - 195 / 3.69 ms; 1.2 x 1.2 x 3.0 mm³; GRAPPA 2, 3 x 0:21 min) sequences were performed in each subject in random order prior to the administration of an intravenous contrast agent. Two radiologists evaluated the images independently with regard to diagnostic preference. Parallel imaging techniques prevent conventional calculation of SNR in the clinical data set. Therefore a semi-quantitative approach was used for the *in vivo* measurements and signal ratios were calculated for the pancreas versus the liver, spleen, muscle, and visceral fat. Inter-reader agreement was calculated using unweighted Cohen's kappa. Signal ratio results were analyzed using a univariate ANOVA analysis. Additional quantitative signal-to-noise (SNR) measurements were performed using a standard, cylindrical MR phantom filled with NiSO₄ (volume approximately 9L: T1w relaxation time = 260ms). Both sequences were repeated in the phantom study 20 times.

Results: 3D VIBE_{CAIPI-DIXON} was preferred in 72.4% (both readers) and 2D Flash_{GRAPPA-fs} in 3.4% / 6.9% (reader 1 / 2) of cases with a kappa value of 0.756. The main reasons for this preference were homogenous fat saturation with 3D VIBE_{CAIPI-DIXON} and reduced motion artifacts due to a faster acquisition, leading to improved delineation of the pancreas. Signal ratios of pancreatic to fat signal for 3D VIBE_{CAIPI-DIXON} (10.08 ± 3.48) and 2D Flash_{GRAPPA-fs} (6.53 ± 3.07) were statistically different (p < 0.001). However, no additional statistically significant differences in signal ratios were identified in comparison to the other organs (Range: 0.73 ± 0.18 to 1.37 ± 0.40; 0.514 < p < 0.961). SNR did not statistically significantly differ between the sequences (p = 0.107).

Discussion: 3D VIBE_{CAIPI-DIXON} enables robust pancreatic imaging with an acquisition time of 12 seconds, providing homogenous fat suppression and a higher pancreas to fat signal ratio than conventional 2D Flash_{GRAPPA-fs} while preserving signal ratios to other organs.

Conclusion: This combination between a new acceleration technique (CAIPIRINHA) and advanced fat saturation approach (Dixon) allows robust non-enhanced T1 weighted imaging of the pancreas in a clinical setting.

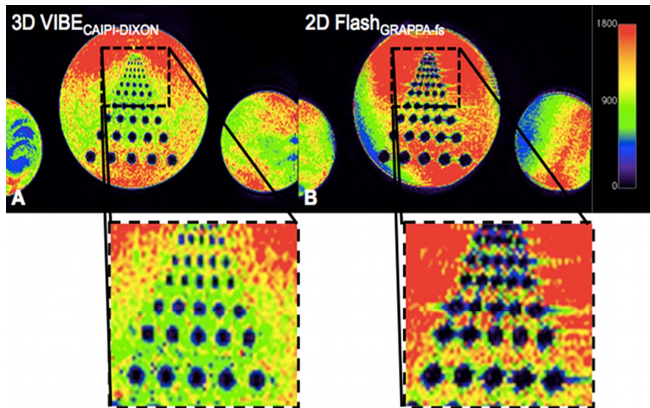


Figure 1. This figure shows color-encoded SNR maps of phantom measurements with **A.** 3D VIBE_{CAIPI-DIXON} and **B.** 2D Flash_{GRAPPA-fs}. Additional partial views of the upper part of the phantom are shown. 3D VIBE_{CAIPI-DIXON} shows a more homogenous SNR distribution compared to 2D Flash_{GRAPPA-fs} and improved image quality (less blurring) in the zoomed-in image. Higher overall SNR values were observed for 2D Flash_{GRAPPA-fs}.

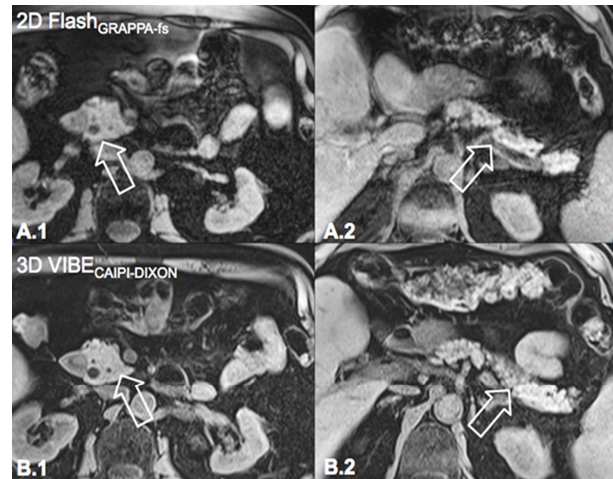


Figure 2. 62 year old female patient with a suspected pancreatic lesion. The upper row (**A.1/A.2**) of this image panel is comprised of axial 2D Flash_{GRAPPA-fs} and the lower row (**B.1/B.2**) 3D VIBE_{CAIPI-DIXON} Images. Although quality is high with both images, the pancreatic parenchyma is better delineated than with the 3D VIBE_{CAIPI-DIXON} acquisition, and due to the three breathhold periods in 2D Flash_{GRAPPA-fs}, not all parts of the pancreatic body are visible. The head of the pancreas is well-delineated on both sequences.

Reference: ¹ Breuer FA, Blaimer M, Heidemann RM, Mueller MF, Griswold MA, Jakob PM. Controlled aliasing in parallel imaging results in higher acceleration (CAIPIRINHA) for multi-slice imaging. Magn Reson Med 2005;53(3):684-91.