Free breathing dynamic contrast MR imaging of the pancreas using navigator technique

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Target Audience: The scientists, physicians, and technologists who are involved in abdominal MR imaging with Gd-contrast medium.

Introduction: Dynamic contrast study has provided important information of characterization of the abdominal organs and their lesions. This technique is usually performed under breath-holding following administration of Gd-chelate contrast medium. In elderly people or patient who cannot hold their breaths, information cannot be fully obtained. Thus, if dynamic contrast study can be performed during free-breathing, information for characterization of the lesions and evaluation of the tissue perfusions of the organs may dramatically increase. Navigator technique has been used under free-breathing for the evaluation of the heart[1] or the liver[2] for static imaging. This navigator technique can be also utilized for dynamic contrast studies with continuouslly repeated acquisitions. Accordingly, the purpose of this study was to evaluate the feasibility of dynamic contrast study during free-breathing in combined use of navigator technique for the evaluation of the pancreatic lesions.

Fig1 Navigator technique

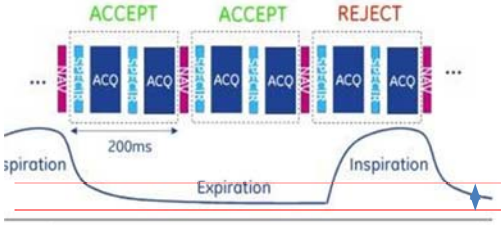


Fig2 Imaging time for each phase

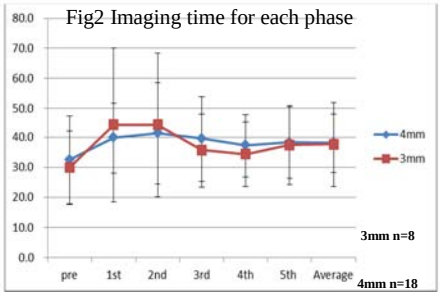


Fig3 Serial changes of contrast ratio after contrast

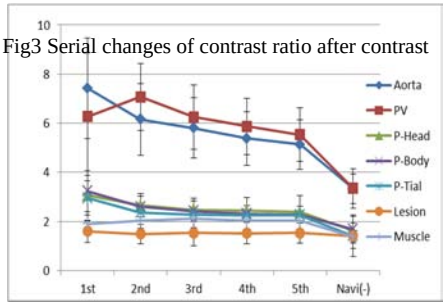
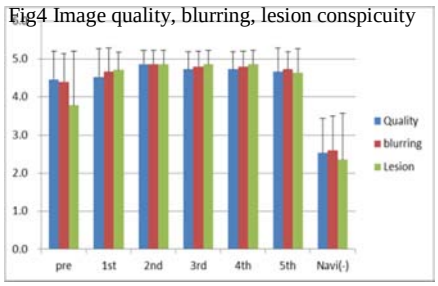


Fig4 Image quality, blurring, lesion conspicuity



Methods: The current study was approved by the institutional review board. *Population:* Twenty-six patients (13 men, 13 women, mean 73.2 years old, 58-87 years old), who underwent Gd contrast enhanced MR imaging for the pancreas at 3T (Discovery MR 750, GEHC) with 32 channel multicoil were included. Informed consent was obtained from all the patients. Pathologies were cystic lesions in the pancreas, 19 cases 40 lesions; solid lsions, 2 cases 2 lesions; normal 5 cases. *MR imaging:* The cylindrical navigator tracker (10cmx1cm) was placed at the top of the right hemidiaphragm to monitor the motion of the hemidiaphragm. Navigator echo was acquired at every 200ms using one of the fixed receiver coils during dynamic study, and imaging data were acquired around at upper highest level of the right hemidiaphragm with acceptance window for +/- 1mm or 2 mm (Fig1, arrow). Pilot precontrast imaging was performed to set imaging time within 30 seconds by adjusting acceptance window and slice thickness in each patient. Pre and 5 phases of postcontrast images (Gd-chelate, 0.1mmol/kg, injection 3ml/sec) in the axial plane were obtained using fatsat 3D FSPGR (LAVA) under free-breathing with navigator technique. The following parameters were used; TR 3.1ms, Matrix 256x160, FOV350mm, slice thickness 3 or 4mm, a number of slices 60-96, slice overlap 50%, ARC factor 2. The start of the 1st phase was determined by fluoro-triggering technique (GEHC) to monitor an arrival of the contrast medium at the level of the abdominal aorta. Additionally, the same acquisition under free-breathing without navigator technique was obtained. *Data analysis:* Evaluation: Imaging time for each phase in dynamic study was measured. Image quality, blurring, recognition of each organ, and its lesions were evaluated using a five-point scale (1 undiagnostic-5 excellent). Region of interest (ROI) was set at the aorta, portal vein, pancreas (head, body, tail), spleen and lesions in the pancreas when identified and their signal intensities (SIs) were measured. Contrast ratio was defined as SI of each ROI on postcontrast image/ that on precontrast image. On the second phase of images, sizes of lesions in the pancreas were measured and a number of the lesions in the pancreas were evaluated when identified. And, existence or absence of septa and nodules in lesions was also evaluated.

Results: Imaging time tended to prolong in the postcontrast phases (38 to 46sec, Fig2). The enhancement was observed initially in the aorta followed by the spleen, and the pancreas (Fig3). All images in dynamic contrast phases with navigator technique were diagnostic (Image quality; 4.4-4.7, Blurring 4.3-4.7, Lesion recognition 4.5-4.6, Fig4). On images without navigator, SIs were all decreased and blurring was prominent (Fig3, 4). All cystic (19 cases, 40 lesions), and solid lesions (2cases, 2 lesions) were identified (mean diameter 13.7mm, ranged from 1mm to 52mm). Septa in cysts were recognized in 10 of 19 cases. There was no nodule in cystic lesions.

Discussion: With navigator technique, dynamic contrast MR imaging of the pancreas can be successfully obtained with acceptable image quality and lesion recognitions under free-breathing. Free-breathing technique may be useful for the elderly patients, unconscious patients or children who cannot hold their breaths. With this technique, static and dynamic image acquisitions for pancreatic study can be performed under free-breathing. In comparison, ultrashort imaging technique can be also considered under free-breathing, resulted in obtaining fairly large amount of imaging data. One of the benefits with navigator technique might be to suppress the data volume by collecting data at critical timing. The temporal resolution of each phase in the current study was not sufficient to evaluate all the solid lesions in the pancreas and faster imaging technique should be considered in combined use of sophisticated k space trajectory, parallel imaging and/or compressed sensing.

Conclusion: With navigator technique, dynamic contrast MR imaging of the pancreas can be successfully obtained with acceptable image quality and lesion recognitions under free-breathing. Shorter acquisition times for each phase may be required and should be developed.

References 1 Nagel E, Bornstedt A, MRM. 1999;48:544–549, 2 Nagel SK, Busse RF, JMRI, 2012;36:890-899

Fig5 Intraductal papillary mucinous neoplasm