Kinematic Evaluation of the Abdomen:
Multiphase MR Hydrography and Multiphase-multislice MR imaging

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Introduction: Recently, MR imaging has an important role in the evaluation of the abdomen. It is mainly dependent on development of fast MR technique, which can facilitate breath holding for the elimination of respiratory motion artifacts. With ultra fast MR imaging such as single shot type of fast spin echo (FSE) technique, single slice image can be obtained within one second, which is fast enough to freeze various motions including respiration, intestinal peristalsis and unpredictable patients' movements. This hydrographic imaging can be also applicable to the abdomen when fluid collection occurs in such as ileus. However, without fluid collection, evaluation of the kinematic motions is difficult in MR hydrography. Multiphase-multislice medium T2 weighted may be valuable to evaluate abdominal abnormalities which may cause or result from unphysiological motions in the abdomen. The purpose of the study was to evaluate the usefulness of kinematic imaging with MR hydrography and multiphase-multislice medium T2 weighted images in the evaluation of the abdominal pathology.

Subjects: Fifty-five patients, who underwent whole abdominal MR imaging for suspect of ileus, inflammatory bowel disease, or tumors, were included. They were from 19 years old to 78 years old (mean 58.7 years old).

MR Imaging: MR imaging was performed on a 1.5 T magnet (Horizon LX echo-speed, GE medical system) with a Torso phased array multicoil (GE medical system) or body coil. As a part of abdominal protocols for the evaluation of the whole abdomen, Two types of T2 weighted imaging using single shot type of half Fourier FSE (SSFSE, GE medical system, Milwaukee, WI) were performed. 1) Multiphase single thick slice heavily T2 weighted imaging as MR hydrography was obtained in a coronal plane. Imaging parameters were as follows: repetition time (TR) of approximately 4sec (because of multiphase acquisitions, every 4 sec, each image was acquired), effective echo time (TE) of 184ms, echo train length (ETL) of 135, slice thickness of 80-100mm, receiver band width (RBW) of 6kHz, matrix of 256x256, field of view (FOV) of 35x31cm-45x40cm, and half number of excitation (NEX). Imaging time for one acquisition was approximately one sec, and 15 sequential acquisitions were performed under free breathing. 2) Multiphase-multislice medium T2 weighted imaging was performed to cover the whole abdomen in a coronal plane. Imaging parameters were as follows; TR of 20-30sec, TE of 92ms, ETL of 85, slice thickness of 5-6mm with a 2mm interslice gap, RBW of 6kHz, matrix of 256x160, FOV of 35x31cm-45x40cm, and half NEX. Imaging time for one acquisition was 20-30sec for 16-22 slices, respectively. Sequential 15 acquisitions were performed without breath holding maneuver. In other words, at each location, every 20-30sec, 15 consecutive images were acquired.

Display
Both SSFSE images were loaded into a workstation (Advantage Windows 3.1, GE Medical Systems, Milwaukee, WI.). 1) MR hydrography was displayed in a cine loop at 10 frames per second on a screen monitor. 2) Multiphase-multislice SSFSE images were sorted according to location and at each location, images were sorted according to time. These images were sequentially displayed on a screen monitor with a cine loop mode at 10 frames per second.

Evaluations:
1) MR hydrography: The following features were evaluated on a cine display by two experienced radiologists by consensus: Image quality (rated from poor (1) to excellent (4)), presence of absence of distention of small or large bowel, obstruction or stricture changes, respiratory motion, peristaltic motion. When diameter of small and large bowels were larger than 3 and 7 cm, respectively, distention of bowels were called. Abdominal pathological diagnosis was made.
2) Multiphase-multislice MR imaging: Image quality was evaluated with the same way as on MR hydrography. The same features of findings were evaluated. Additionally, presence and absence of air, intestinal wall thickening and abnormal structures were also evaluated.
3) MR hydrography and Multiphase-multislice MR imaging: Both kinematic imaging may sequentially displayed and whether complementary information was obtained or not was evaluated.

Statistical analysis: Comparison of ranks from image quality was made with Wilcoxon signed rank test. Probability of less than 0.05 was regarded as significant.

Results:
1) All hydrography and Multiphase-multislice MR imaging were excellent (Both ranks=4). Distention of the small and large bowel was observed in 8 and 11 patients, respectively. When fluid existed in the intestine, obstruction or adhesions were well documented. 2) In all cases except two, the air was observed in the bowels, especially, anterior part of bowels, of which visualization with MR hydrography was difficult.

Multiphase-multislice MR imaging constantly visualized all structures. 3) In 36 cases, multiphase-multislice MR imaging added new information, such as existence of the tumor (n=6) or fibrotic adhesions (n=5), thickening of the bowel wall (n=5). Peristaltic and respiratory motions were better demonstrated in 29 patients with multiphase-multislice images because of visualization of solid or soft tissue structures and no overlap or summation. On the other hand, in 8 patients, recognition of the intestinal fluid distribution was better on hydrographic MR imaging.

Conclusion:
When distention of the small or large bowel with fluid, existed, MR hydrography demonstrates the site of distension and cause of its obstructive lesions with information of respiratory and peristaltic motions. Without fluid collection in the abdomen, MR hydrography is less informative. Multiphase-multislice Kinematic images can provide anatomy as well as kinematic information such as obstruction or adhesions even without fluid-filled bowels. Both kinematic imaging may play an important role in the whole abdominal evaluations in a complementary manner.