

Functional evaluation of the postoperative gastrointestinal tract using kinematic MR imaging: Quantitative assessment of peristaltic activity

M. Nishino^{1,2}, S. Iwata³, K. Hayakawa², S. Kanao², T. Morimoto³, S. Mukaihara³, H. Hatabu¹

¹Radiology, Beth Israel Deaconess Medical Center, Boston, MA, United States, ²Radiology, Kyoto City Hospital, Kyoto, Kyoto, Japan, ³Surgery, Kyoto City Hospital, Kyoto, Kyoto, Japan

1. Purpose

Assessment of peristaltic activity in the reconstructed gastrointestinal tract is important but difficult due to the variety of reconstruction methods, decreased accessibility of invasive procedures and poor performance status of patients. Conventional upper gastrointestinal series, fluoroscopy and scintigraphy have been used to evaluate peristaltic function in reconstructed gastrointestinal tracts. A conventional upper gastrointestinal series and fluoroscopy require oral contrast administration and ionizing radiation, and are limited to qualitative observation. Scintigraphy cannot visualize peristaltic waves due to the limited temporal and spatial resolution. MR is a noninvasive and safe modality free from ionizing radiation. Moreover, recent advances in fast scanning techniques have enabled demonstration of kinematic changes of the gastrointestinal tract. In this study, we aim to demonstrate the feasibility of kinematic MR imaging in visualization and quantitative evaluation of peristaltic activity in the reconstructed gastrointestinal tract.

2. Materials and methods

Sixteen patients with gastrointestinal reconstruction surgery including esophageal reconstruction with retrosternal gastric tube (n = 5), gastric cardiectomy (n = 1), distal gastrectomy with Billroth I reconstruction (n = 7) and pancreatoduodenectomy with gastrojejunostomy (n = 3) were recruited for this study. Informed consent was obtained in all patients prior to MR studies. MR studies were performed using a 1.5 T magnet (Magnetom Symphony, Erlangen, Germany) with a phased-array coil. In patients with esophageal reconstruction with retrosternal gastric tube, HASTE (TR = 2000 ms, effective TE = 84 ms, FOV = 300 mm, slice THICKNESS = 10 mm, MATRIX = 256 × 256) was used to obtain T2-weighted coronal images of the retrosternal area of the thorax. The single imaging plane that best represented the coronal view of the tube was chosen. A series of 60 coronal images was obtained every 2 s over 2 min, under quiet respiration. No cardiac or respiratory gating was used. In patients with partial gastrectomy or pancreatoduodenectomy, true FISP (TR = 4.8 ms, TE = 2.4 ms, FOV = 300 mm, slice THICKNESS = 10 mm, MATRIX = 256 × 256) was used to obtain T2-weighted coronal images of the upper abdomen. The single coronal imaging plane that best represented the course of the reconstructed tract including anastomosis and residual stomach was chosen. Twenty to thirty serial images were obtained every second under breath-holding for each patient. The images were displayed in cine mode at a speed four times faster than the actual time frame. No premedication or oral contrast agents were administered.

3. Results

In all patients, the kinematic MR studies were performed without complications. Time required for each study was approximately 20 min. In six patients with retrosternal gastric tubes, the peristaltic waves were observed in the distal part of the gastric tube, which corresponded to the antrum of the original stomach. The direction of peristalsis was antegrade. The frequency of the peristaltic motion ranged from 2.5 to 3.5 times/min; 3 times/minute on average. The velocity of the peristaltic waves was measured, and ranged from 2.0 to 3.3 mm/s; 2.6 mm/s on average. In one patient MR study was repeated a week after the first study and demonstrated peristaltic movements of increased frequency and velocity (Fig. 1). In a patient with gastric cardiectomy, peristaltic waves were observed in the antrum with a frequency of 3 times/min and a velocity of 4.0 mm/s. In patients with distal gastrectomy with Billroth I reconstruction, morphological changes of the fundus were observed; however, no apparent peristaltic waves were observed. In patients with reconstructed jejunum after pancreatoduodenectomy and gastrojejunostomy, marked decrease in wave-like movements were noted in the reconstructed proximal jejunum compared to the intact distal small intestine.

4. Conclusion

Kinematic MR imaging is feasible for the visualization and evaluation of peristaltic activity in the reconstructed gastrointestinal tract, allowing quantitative assessment of peristaltic activity in the reconstructed gastrointestinal tract, and providing a novel and simple technique for evaluating the surgical effect of gastrointestinal peristaltic function.

Fig.1A

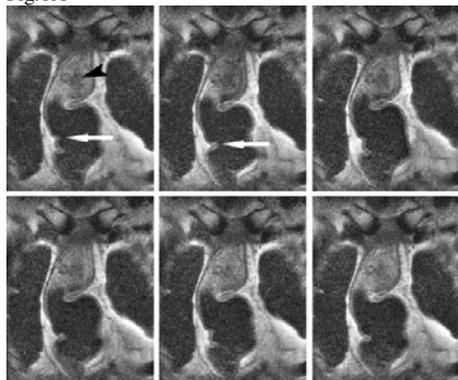


Fig.1B

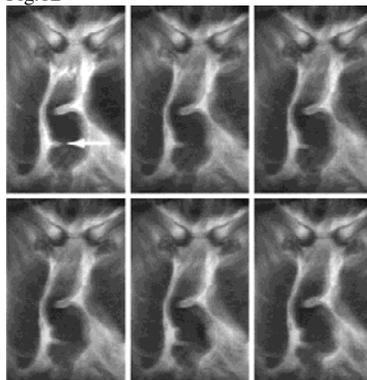


Fig. 1. A 64-year-old man with esophagectomy with gastric pull through for esophageal cancer. Series of six coronal HASTE images in coronal plane of retrosternal gastric segment are shown. (The first three figures are sequentially displayed in the top row from left to right, and the next three figures are in the bottom row from left to right). (A) Kinematic MR imaging was performed 3 weeks post surgery, with complaints of poor food passage. Peristaltic waves were noted in distal right wall of retrosternal gastric segment (arrows), with a frequency of 3 times/min and a velocity of 2.0 mm/s. Retained food was noted in the dilated upper part of the gastric segment (arrowhead). (B) Kinematic MR imaging conducted 4 weeks post surgery, when the patient's complaint of poor food passage was improved. Peristaltic waves were noted in distal right wall of retrosternal gastric segment (arrow), with a frequency of 3.5 times/min and a velocity of 3.3 mm/s. The previously observed retained food within the dilated retrosternal gastric segment was no longer seen.