Feasibility of Gd-enhanced lymph node MR imaging for the integrated MR endoscope system

Y. Matsuoka[1], Y. Morita[1], H. Yoshinaka[1], D. Obata[1], S. Fujiwara[1], M. Matsumoto[2], E. Kumamoto[3], H. Kutsumi[1], K. Kuroda[4], and T. Azuma[1]

[1]Department of Gastroenterology, Kobe University Graduate School of Medicine, Kobe, Hyogo, Japan, [2]Graduate School of Engineering, Kobe University, Kobe, Hyogo, Japan, [3]Information Science and Technology Center, Kobe University, Kobe, Hyogo, Japan, [4]Center for Medical-Facility Clustering, Foundation of Biomedical Research and Innovation, Kobe, Hyogo, Japan

Introduction

The purpose of this study is to develop an integrated MR endoscope system, which can perform MR imaging during endoscopy and provide superimposed MR image on the scope view. Endoscopic ultrasound (EUS) creates the anatomical images with real time; however, it is inferior to MRI in the contrast of the soft tissue, which is important for precise diagnosis. In order to provide a new function in the integrated MR endoscope system, the feasibility of lymph node MR imaging was examined with an animal experiment in vivo. In addition, the intragastric RF coil was developed to create a three-dimensional (3D) stomach image with outer region.

Materials and Methods

We used a 1.5-T MR scanner (Signa EXCITE Twin Speed 1.5T ver.11, GE Healthcare, Milwaukee, WI, USA). The lymph node MR imaging, in which the target was in the right region of neck, was performed with a healthy swine weighed 37.1 kg. In order to visualize the lymph node in MRI, the oligomannose-coated liposome[2] incapsulated the gadolinium (Gd-DTPA-BMA) and the fluorescien isothiocyanate (FITC) (Gd-FITC-OML) was prepared. The gadolinium and FITC were used to enhance the MR signal intensity and label for the fluorescence observation of the lymph node after the MR experiment, respectively. The Gd-FITC-OML was injected into the right auricle after identifying the lymphatic vessel with the indigo carmine. The MR imaging was executed with 3-inch surface coil placed on the right region of neck and the following T1W imaging sequence; FSE with TR, 300 ms; TE, 13.1 ms; ET, 6; FOV, 10 × 10 cm; slice thickness, 3 mm; slice gap, 0 mm; signal acquisition, 4; acquisition matrix, 256 × 128, with fat suppression. The MR scans were performed at the following times; before the injection as the reference, during the injection, every 10 minutes until 60 minutes, and every 60 minutes until 360 minutes after the injection. After the MR experiment, the lymph node in the neck was resected and the fluorescence imaging was performed. The intragastric RF coil (Fig.1) to obtain higher SNR images was designed as 4-turn surface shape and a flexible structure[1]. The coil size was 40 × 40 mm, and the capsules including 5-mM gadolinium were placed on the coil to identify the coil position in stomach cavity by MR image. For the gastric wall imaging, a healthy swine weighed 22 kg was used. The coil was inserted perorally into the stromach with the endoscope, and then, fixed on the stomach surface by endoscopic tools. The MR images were obtained by Fast Spin Echo (FSE) with TR, 300 ms; TE, 13.2 ms; ET, 4; FOV, 8 × 8 cm; slice thickness, 3 mm; signal acquisition, 6; acquisition matrix, 256 × 128 as T1W image. During imaging, the breath holding was applied. The 3D image was created with T1W images by the image processing software (Virtual Place, Aze Ltd., Japan). In both of experiments, the animals were controlled under the general anesthesia.

Results

As the result of the lymph node imaging, the enhancement of signal intensity (SI) after the injection of Gd-FITC-OML was verified in T1W images. Fig.2 shows the temporal change of SI in one slice within the lymph node. The ratio of SI at 360 minutes after the injection to that before the injection, which is shown in Fig.3, was evaluated with eight slices including the lymph node in which five ROIs were set. The SI in the lymph node increased about 20 % by injecting the oligomannose-coated liposome with gadolinium and FITC, and the distribution of SI increment was not homogenous. The histological observation of this lymph node (Fig.4), which detected the FITC, could indicate the intake of the oligomannose-coated liposome with gadolinium.The cross-sectional gastric wall with high spatial resolution of 0.156 × 0.156 × 3 mm with the zero-filled interpolation was depicted in T1W image. The 3D image of the gastric wall was created with multi-slice T1W images (Fig.5). The layers in the gastric wall; the mucosa, the muscularis, and the serosa could be distinguished. However, it was difficult to identify the submucsal layer, which should be important for the endoscopic submucosal dissection (ESD) procedure.

Conclusion

The 3D image of gastric wall obtained by the developed intragastric RF coil could be shown with any direction and applied for the image fusion function[3] of the integrated MR endoscope system; therefore, it could help the endoscopy and the endoscopic surgery. In addition, the feasibility of visualizing the intake of the oligomannose-coated liposome with gadolinium and FITC in the lymph node was verified in the region of neck with an animal experiment in vivo. This ability would be useful to examine the lymph node around the gastrointestinal tract precisely, for example, the sentinel lymph node metastasis, by using the optimally designed intraluminal RF coil. The integrated MR endoscope system having above functions in additions to abilities reported previously would be superior to EUS. The lymph node imaging around the gastrointestinal tract should be examined as the next step.

Acknowledgement

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Reference

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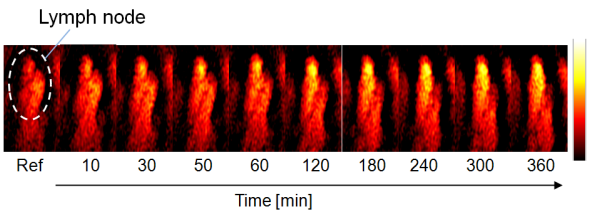

Fig.2 Temporal change of SI in one slice within the lymph node

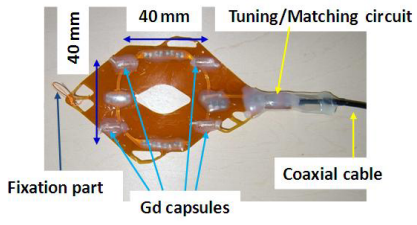

Fig.1 Intragastric RF coil

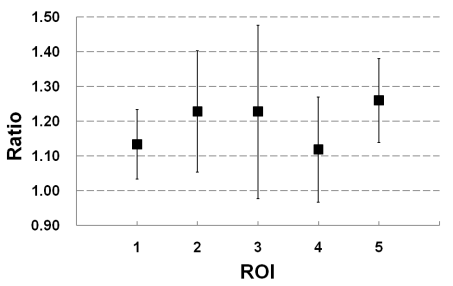

Fig.3 Ratio of SI in the lymph node at 360 min after injection to that at pre-injection of the Gd-FITC-OML

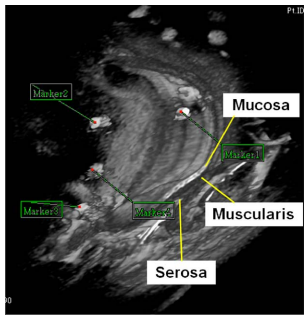

Fig.5 3D image of gastric wall

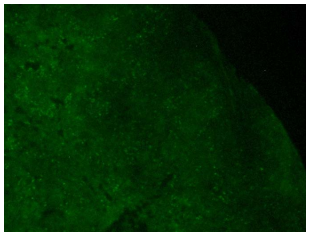

Fig.4 Microscopic appearance of the neck lymph node