Real-time MRI of Esophageal Function at a Resolution of 50 ms: Initial Results in Healthy Subjects

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Target Audience

Researchers working in the fields of dynamic MRI, gastrointestinal MRI, esophageal function, gastroesophageal junction

Introduction

Esophageal abnormalities and diseases, commonly evaluated with manometry or videofluoroscopy, overlap frequently with other gastrointestinal disorders and are incompletely understood. In particular, these two methods are either time consuming, invasive, or have ionizing radiation and limited soft-tissue contrast. In this work, a recently introduced real-time MRI technique [1, 2] was applied to overcome these problems and to demonstrate the feasibility to assess esophageal function during swallowing.

Materials and Methods

Normal healthy volunteers (n = 6), 20-35 y, were investigated at 3T (Tim Trio, Siemens Healthcare, Erlangen, Germany) in supine position using a 32-channel body coil. Highly undersampled MRI signals were acquired by spoiled radial FLASH (FOV 192 mm, in-plane resolution 2 mm, slice thickness 8 mm, 25 spokes, TR/TE 2.0/1.3 ms, flip angle 8º, acquisition times 50 ms corresponding to a temporal resolution of 20 frames per second, scan time 28 s). T1-weighted real-time MRI movies were obtained using regularized nonlinear inversion reconstruction. For each measurement the subject was instructed to swallow 20 ml pineapple juice, which caused a high signal in the T1-weighted images due to its high concentration of manganese. Consecutive measurements were carried out with position based on the previous one along the esophagus at different orientations, from thoracic to the abdominal part and until gastroesophageal junction or sphincter.

Results and Discussion

Preliminary applications demonstrate a high quality of real-time MRI movies that monitor the bolus transport process. The images are free from susceptibility and motion artifacts. Different stages of the esophageal swallowing could be well visualized. These include, for example, peristaltic lowering of the bolus at thoracic and abdominal part of esophagus (**Fig. 1a**), bolus accumulation before gastroesophageal junction and sphincter opening (**Fig. 1b**), and sphincter opening as indicated by the bolus passage (**Fig. 1c**). Bolus transport velocity was measured by real-time phase-contrast MRI [3] (n = 6, data not shown). In addition, gastroesophageal reflux was observed in one case (**Fig. 2**).

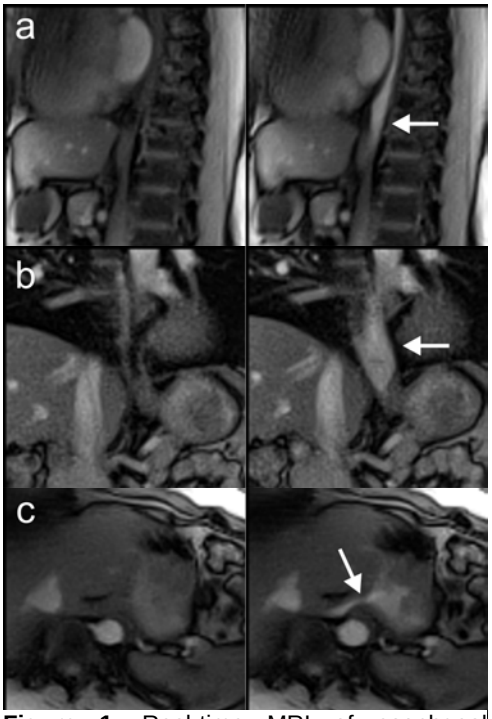

Figure 1. Real-time MRI of esophgeal function during swallowing in **(a)** sagittal, **(b)** oblique coronal, and **(c)** oblique transversal planes. Arrows indicate the bolus transport.

Conclusion

The proposed real-time MRI method demonstrates unique potential for anatomical and functional study of esophageal function and diagnosis of, for example, motility disorder or gastroesophageal reflux disease.

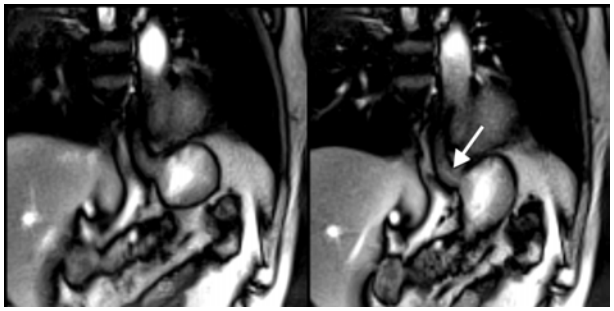

Figure 2. Real-time MRI showing gastroesophageal reflux (arrow) during a Valsalva maneuver (**right**) compared to normal free breathing status (**left**).

References

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