Real-time MRI of Oropharyngeal Swallowing Function: Initial Clinical Results

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Target Audience

Researchers working in the fields of swallowing function, otorhinolaryngology, dynamic MRI, gastrointestinal MRI, neck

Introduction

Swallowing disorders, commonly evaluated with videofluoroscopy or endoscopy, overlap frequently with neurological diseases and result in deglutitive malfunctions. In particular, these two methods either are invasive or have ionizing radiation and limited visualization planes. 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 oropharyngeal function during swallowing.

Materials and Methods

Ten healthy volunteers (28±3 y, 26-35 y) and ten patients suffering from inclusion body myositis, IBM (73±5 y, 58-83 y) were investigated at 3T (Tim Trio, Siemens Healthcare, Erlangen, Germany) in supine position using a combination of a small flexible coil and a bilateral 2×4 array coil (NORAS MRI Products, Hoechberg, Germany). Highly undersampled MRI signals were acquired by spoiled radial FLASH (FOV 192 mm, in-plane resolution 1.5 mm, slice thickness 10 mm, 19 spokes, TR/TE 2.17/1.44 ms, flip angle 5º, acquisition times 41.23 ms corresponding to a temporal resolution of 24.3 frames per second, scan time 28 s). T1-weighted real-time MRI movies were obtained using regularized nonlinear inverse reconstruction. For each measurement the subject was instructed to swallow 5 ml thickened pineapple juice, which caused a high signal in the T1-weighted images due to its high concentration of manganese. Individual swallowing events and their quantitative timings (start and end times, durations) were calculated based on the real-time MRI movies.

Results and Discussion

Twelve distinct swallowing events could be quantified by real-time MRI. These included, for example, oro-velar opening (OOT), velo-pharyngeal closure (VCT), epiglottic retroflexion (ERT), esophageal opening (EOT) and pharyngeal transit (PTT), shown in **Fig. 1A**. The timing analysis unraveled a well-orchestrated temporal pattern of physiological swallowing events, which is referenced to the start of the OOT (not shown here). Patient results indicated abnormalities in the pharyngeal phase including, in particular, decreased epiglottic deflection and pharyngeal muscle propulsion at the upper esophageal sphincter (arrows in **Fig. 1B**). In addition, durations of OOT and PTT are significantly longer (unpaired *t*-test $P < 0.05$) than that from the healthy subjects (**Fig. 2**).

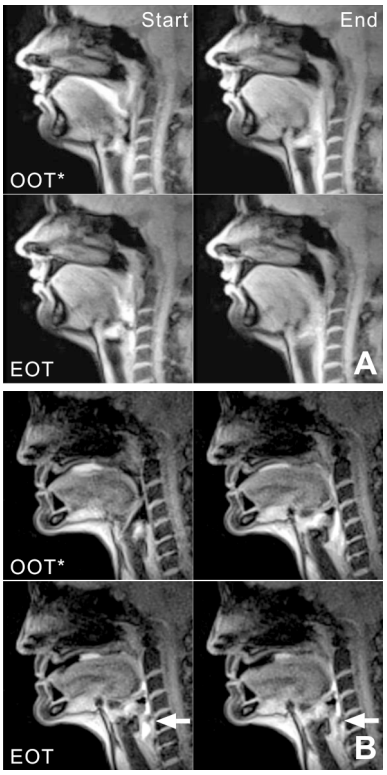

Figure 1. Real-time MRI of swallowing function: 2 out of 12 characterized swallowing events (details see text).

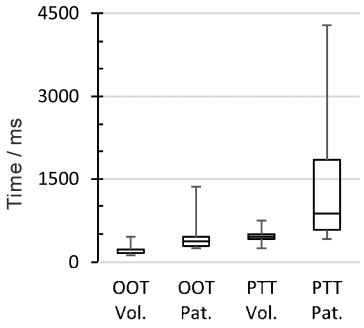

Figure 2. Timing comparisons of swallowing events for OOT (**left**) and PTT (**right**) between healthy volunteers (Vol.) and patients (Pat.) based on real-time MRI.

Conclusion

The proposed real-time MRI method demonstrates unique potential for anatomical and functional study of swallowing process and diagnosis of, for example, oropharyngeal dysphagia.

References

1. Uecker M, Zhang S, Voit D, et al. NMR Biomed 2010;23:986-994.
2. Zhang S, Olthoff A, Frahm J. J Magn Reson Imaging 2012;35:1372- 1379.