Objectives: The effortful swallow was designed to improve posterior mobility of the tongue base and increase intra-oral pressures. We characterized the effects of this maneuver via dynamic magnetic resonance imaging (dMRI) in healthy subjects.

Methods: A 3-T scanner was used to obtain dMRI images of subjects swallowing pudding using normal as well as effortful swallows. Ninety sequential images were acquired at the level of the oropharynx in the axial plane for each swallow; three series were obtained for each swallow type for each subject. Images were acquired every 113ms during swallowing. The images were analyzed with respect to oropharyngeal closure duration, anteroposterior and transverse distance between the oropharyngeal walls, and oropharyngeal area before and after closure.

Results: Pre-swallow reduced pharyngeal area was observed (p<0.02; mean=212.61mm² for effortful, mean=261.92mm² for normal) as well as prolonged pharyngeal closure during the swallow (p<0.0001; mean=742.18ms for effortful, mean=437.31ms for normal). No other differences were noted between swallow types. Inter- and intra-rater reliability of all measurements was excellent.

Conclusion: This preliminary investigation is the first to evaluate the effects of effortful swallows via dMRI. In our cohort, consistent physiologic changes were elicited, consistent with clinical dogma regarding this maneuver.

ABSTRACT

Swallowing disorders commonly affect patients, with a prevalence of 22.6% among primary care patients and significantly higher rates among at-risk populations, including the elderly, those with neurological injury, and head and neck cancer patients. Given the significance of swallowing disorders and current knowledge of the complex swallowing mechanism, techniques such as the effortful swallow were developed as a therapeutic strategy. Though the physiologic effects of the effortful swallow technique have been studied using videofluoroscopy and manometry, results have varied and the imaging modalities have offered a limited view of the involved anatomic structures. To date, the physiologic effect of the effortful swallow has not been studied using dMRI imaging which offers the benefit of examining the swallowing mechanism temporally without exposure to ionizing radiation.

INTRODUCTION

Swallowing disorders commonly affect patients, with a prevalence of 22.6% among primary care patients and significantly higher rates among at-risk populations, including the elderly, those with neurological injury, and head and neck cancer patients. Given the significance of swallowing disorders and current knowledge of the complex swallowing mechanism, techniques such as the effortful swallow were developed as a therapeutic strategy. Though the physiologic effects of the effortful swallow technique have been studied using videofluoroscopy and manometry, results have varied and the imaging modalities have offered a limited view of the involved anatomic structures. To date, the physiologic effect of the effortful swallow has not been studied using dMRI imaging which offers the benefit of examining the swallowing mechanism temporally without exposure to ionizing radiation.

METHODS

Twenty healthy subjects 18 to 30 years of age were included based on the following exclusion criteria: any current or previous swallowing complaints, cranial neuropathy, and claustrophobia. After obtaining informed consent, subjects underwent an oral-motor examination to rule out any abnormalities.

Dynamic MRI of swallowing was performed with the subject in the supine position with a 3.0-T scanner with a 4-channel head coil and a dual-channel neck coil. Ninety sequential images were acquired at the level of the oropharynx (mid-C2 cervical vertebrae) in the axial plane for each swallow. Images were obtained every 113ms during swallowing.

All subjects were trained outside the scanner on bolus delivery via syringe prior to data acquisition. A technician adjacent to the scanner administered each subject with 5mL of a high-protein pudding from a 10mL syringe. Each subject performed three identical swallows when cued. The swallows were then repeated as the subjects were instructed to perform an effortful swallow. Therefore, a total of six swallows were recorded per subject.

The dependent variables for each swallow were: the duration of pharyngeal closure (ms), the pre and post-swallow anteroposterior length (mm), the pre and post-swallow transverse length (mm), and the pre and post-swallow area (mm²). Measurements were recorded for each frame of the swallow, starting from a point just before arrival of the bolus and continuing until just after bolus passage. Median values of the three swallows were included in the analyses. Descriptive analysis was conducted regarding differences between the two swallowing types, normal versus effortful. Mixed effect models were fitted to the data to determine if the dependent variables differed significantly during the two swallow types and if they were consistent as the subjects performed three swallows for each type.

DISCUSSION

This study is the first time that dMRI has been used in the assessment of the effects of an effortful swallow; this technique continues to yield reproducible and reliable information regarding the mechanics of swallowing. The effortful swallow was associated with a significant reduction of pharyngeal area pre-swallow, likely associated with preparatory tongue base contraction, as well as increased pharyngeal closure time during effortful swallowing. Our findings are consistent with previous dMRI studies as well as prolonged dynamic imaging and prolonged duration of pharyngeal closure (p<0.0001) compared to the normal swallow.

No significant differences in anteroposterior or transverse lengths for the post-swallow measurements were observed. The post-swallow pharyngeal area also was not significantly different between the swallows. Finally, no significant differences were observed between the three consecutive swallows for all dependent variables.

REFERENCES