Magnetic Resonance Imaging for the Assessment of Gastro-Esophageal Junction

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Introduction:

Gastro-esophageal reflux disease (GERD) is present when repeated backflow of gastric contents into the esophagus causes chronic symptoms or damages the esophageal lining. In recent years, the prevalence of GERD has increased and there is a strong correlation between acid reflux and the increasing incidence of esophageal cancer [1]. The gastro-esophageal junction (GEJ) is the key defense against acid reflux. Its most important structural components are - the lower esophageal sphincter (LES), the crural diaphragm and the insertion angle of the esophagus into the stomach acting as a flap valve mechanism (Figure 1). Early developments in manometry measurements revealed that most reflux events occur during transient lower esophageal sphincter relaxations (TLESRs) [2]. More recently it was found that the frequency and duration of the TLESRs in GERD patients and healthy volunteers is similar, however in GERD patients TLESRs are more likely to be associated with acid reflux while in health they are associated with gas or liquid without acid [3]. These findings indicate that although most reflux events occur during functional relaxations of the GEJ it is the structure of this area that increases the frequency of the reflux events. The aim of this study is to non-invasively assess structure and function of the GEJ in healthy volunteers and GERD patients using magnetic resonance imaging.

Methods:

Magnetic resonance imaging (MRI) combined with high-resolution manometry (HRM) as reference technique was applied to analyze the structure and function of the GEJ. MRI measurements were performed using 1.5T whole-body MRI system (Philips Healthcare, Best, NL) and HRM measurements using water-perfused HRM system (Advanced Manometry Systems, Melbourne, AUS). 12 healthy volunteers (5 women) and 6 GERD patients (3 women) were examined before and after ingestion of a high-caloric solid/liquid meal. *Solid meal:* cheeseburger with French fries; *liquid meal:* chocolate-milkshake. Anatomic and dynamic scans were performed alternately every 30 minutes over 2 hours to assess the structure of the GEJ and to detect reflux events, respectively. Scan parameters: *anatomic scan:* 30 transverse slices, bFFE sequence, FOV=360x285mm^2, scan matrix=192x190, slice thickness=4mm, scan time=15s (breath hold); *dynamic scan*: 3 oblique coronal slices, 3x380 dynamics, 330ms/dynamic, bFFE sequence, FOV=360x285mm^2, scan matrix=192x190, slice thickness=8mm, SENSE factor=1.6. Stomach and esophagus were contoured semi-automatically on every image of the *anatomic scans* (Figure 2) and reconstructed in three dimensions (3D). Based on these 3D reconstructions the esophagus insertion angle into the stomach was calculated (Figure 3). Intra-luminal pressure activity in the esophagus and proximal stomach was recorded continuously using HRM.

Results:

On dynamic MR images, reflux events were observed in 9 volunteers and all 6 GERD patients (Figure 4). The occurrence of reflux events correlated with intra-luminal pressure events recorded by HRM. The average number of reflux events over all volunteers was 2 (range 0-5) with the average duration of 10.7s (range 3-23s). In GERD patients the average number of reflux events was 4 (range 2-7) with the average duration of 24.4s (range 10-129s). The results for the insertion angle are given in Table 1.

Discussion:

The applied MRI technique allowed non-invasive assessment of the structure and function of the GEJ in healthy volunteers and GERD patients. Results showed increase in number and duration of reflux events for GERD patients compared to healthy volunteers. However the insertion angle was not different for health and disease (not statistically tested). A more detailed assessment of the structural composition of the GEJ is mandatory to gain more detailed insight and the understanding of the pathophysiology of GERD. In conclusion, MRI has the potential to become a valuable non-invasive technique in clinical routine for assessing GEJ disorders.

References:

[1] Fox M. et al. BMJ 332:88-93 (2006)
[2] Holloway R. H. et al. Gastroenterology 89(4):779-84 (1985)
[3] Trudgill N. J. et al. AmJGastroenterol 96(9):2569-74 (2001)

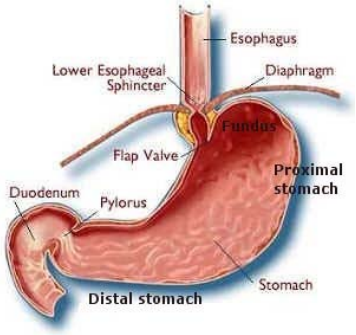


Figure 1: GEJ area and its structural components: the lower esophageal sphincter (LES), the crural diaphragm and the insertion angle of the esophagus into the stomach – flap valve mechanism.

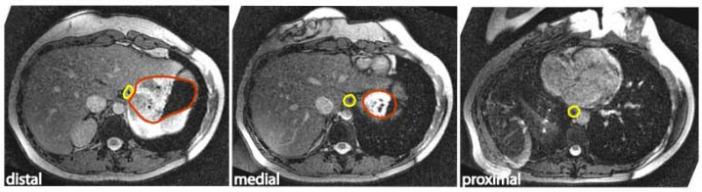


Figure 2: Three transversal MR image slices showing outlined distal, medial and proximal esophagus (yellow) and stomach (red).

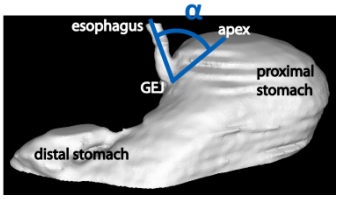
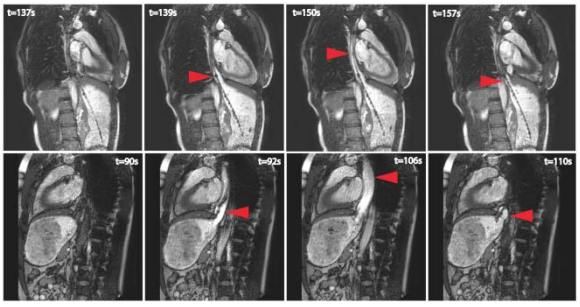


Figure 3: 3D reconstruction showing the esophagus insertion angle α at the GEJ.

Figure 4: Four representative dynamic MR image slices of one reflux event at four different timepoints. Healthy volunteer (upper panel), GERD patient (lower panel). Detected reflux event is indicated by red arrow.



Insertion angle	Empty stomach		Full stomach	
	Inspiration	Expiration	Inspiration	Expiration
Volunteers	69°(52°-81°)	72°(55°-88°)	71°(53°-88°)	72°(57°-91°)
GERD Patients	65°(48°-94°)	64°(40°-92°)	74°(65°-89°)	69°(62°-83°)

Table 1: Average insertion angles with range in healthy volunteers and GERD patients during inspiration and expiration in empty and full stomach.