Physiology of Swallowing and Anti-Gastroesophageal Reflux-Mechanisms: Anything new from a radiologist’s view?

C. Kulinna-Cosentini

Medical University of Vienna
Department of Radiology

Christiane.Kulinna-Cosentini@meduniwien.ac.at
Normal Swallowing is a fundamental function for living and joy
Swallowing

A *Symphony* of coordinated voluntary and involuntary activities, sending oral contents to stomach

Cerebrum
Brainstem
5 cranial nerves
50 muscles
Salivary glands
Oral cavity
Pharynx
Esophagus....
1. Physiology of swallowing
2. Physiologic anti-reflux-mechanisms
3. NEW: Future aspects of dynamic MRI
4 Phases

- Oral preparation phase
- Oral phase → max. 1s
- Pharyngeal phase → max. 10s
- Esophageal phase
7 Function Units

1. Oral cavity
2. Soft palate
3. Epiglottis
4. Hyoid/Larynx
5. Pharyngeal constrictors
6. PE-segment
7. Esophagus
Oral Phase

- Oral cavity sealed by tongue/soft palate
- Bolus loaded onto tongue
- Bolus propelled posteriorly by the tongue
- Elevation of soft palate
Pharyngeal Phase

- Elevation of soft palate: nasopharynx sealed
- Elevation/anterior movement of hyoid & larynx
- Contraction of pharyngeal constrictors
- Opening of PE-Sphincter
Esophageal Phase

- Propulsive contractions
- Opening/closure of the lower esophageal sphincter (LES)
1. Physiology of swallowing

2. Physiologic anti-reflux-mechanisms

3. NEW: Future aspects of dynamic MRI
Influence on Antireflux Mechanism

- Lower esophageal sphincter (LES)
- Crural diaphragm
- Phrenoesophageal ligament
- Angle of His
- Esophageal peristalsis
- Saliva
Angle of His

- Lower esophageal sphincter (LES)
- Crural diaphragm
- Phrenoesophageal ligament
- Angle of His
- Esophageal peristalsis
- Saliva
Lower Esophageal Sphincter

- Intrinsic muscle of distal esoph/prox stomach
  - 4cm long, 2cm intraabdominal
  - Functional barrier without anatomic landmarks
  - Manometrically distinct entity
  - Pressure ~20 mmHg (GERD < 6mmHg)
  - Flap valve mechanism

LES

- GEJ is visible
- LES itself can NOT be seen
- NON-opening of LES is visible i.e. Achalasia

Courtesy to P. Pokieser, W. Schima
Crural Diaphragm

- Sling around GEJ (external sphincter)
- Contracts during increased abdominal pressure (inspiration, coughing, straining)

Talwar V: Hiatus hernia and GERD. 2007
**Crural Diaphragm**

- Diaphragm can be detected well.
- Sphincter - function can not be detected, only down/upwards movement.
Phrenoesophageal Ligament

- Inserts circumferentially into esophageal musculature
- Formed by fused endothoracic and endoabdominal fascia
- Can not be seen in barium study

Angle of His

- Acute angle between axis of the esophagus and line between GEJ / top of fundus
- Flap valve function
- Less acute → reflux

Peristalsis

- Esophageal acid clearance:
  - Acid volume is emptied by peristaltic sequences
  - Residual acid is neutralized by saliva
- Impaired esophageal peristalsis increases esophageal acid exposure
- Debate: abnormal peristalsis as primary abnormality or consequence of GERD?
- Domaine of manometry

Moayyedi P: Gastroesophageal reflux disease. Lancet 2006; 367: 2086-100
Anggiansah A: Primary peristalsis is the major acid clearance mechanism in reflux patients. GUT 1994; 1536-42
Hiatal Hernia

Courtesy to P. Pokieser
Free reflux seen on barium esophagram is specific (>90%), but insensitive (<30%)!

Thompson: Detection of gastroesophageal reflux: value of barium studies compared with 24-hr pH monitoring. AJR 1994; 162:621-6

1. Physiology of swallowing ✓

2. Physiologic anti-reflux-mechanisms ✓

3. NEW: Future aspects of dynamic MRI ?
Technique

- 1.5 T - 3 T
  - Phased-array body coil
  - Swallowing in supine position
  - 1:40 Gadolinium : buttermilk
  - Dyn. B-FFE/ True-FISP sequences: axial, coronal, sagittal
    TR 2.9, TE 1.5, Flip 60°, matrix 256x256, 1-4 image/s
Position
Normal
Hernia with GERD

- M; 41y
- Heartburn, DeMeester Score 28
Disruption of Crural Sutures and Displacement of Wrap

- W; 56y
- St.p.lap.Nissen Fundoplication 2004
- Presented with recurrent heartburn
- Gastroscopy: no pathology
- pH-metry: DeMeester score 22
Crural Sutures too tight

- M; 35y
- St.p.Nissen Fundoplication 2005
- Dysphagia for 1 year
- Gastroscopy + Barium-esophagram: stenosis
- Question to MRI: Tumor?
Leiomyoma

- M; 34y; HIV
- Dysphagia
Conclusion Swallowing-MRI

+ Simple
+ Quick to perform (20 min)
+ Surrounding structures
+ No ionizing radiation ⇒ repetition
  - Limited temporal resolution (1-4p/s)
  - Depiction entire esophagus
  - Expensive

⇒ Problem solver
Take Home Message

- Swallowing: 7 function units
- Antireflux mechanism
- Barium esophagram:
  - Reflux - no!
  - Hernia - yes!
- Future: MRI?
- Today: Problem solver