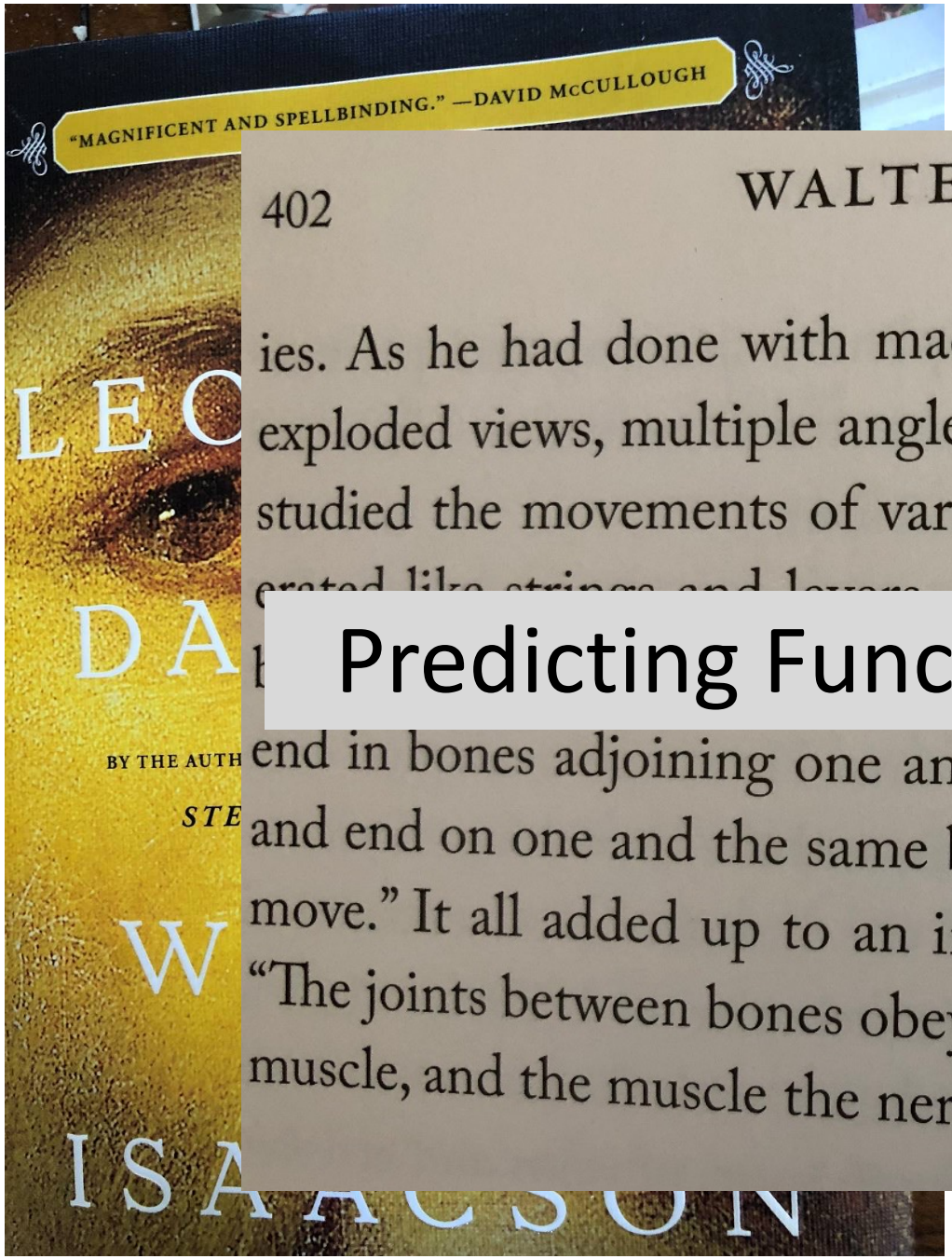
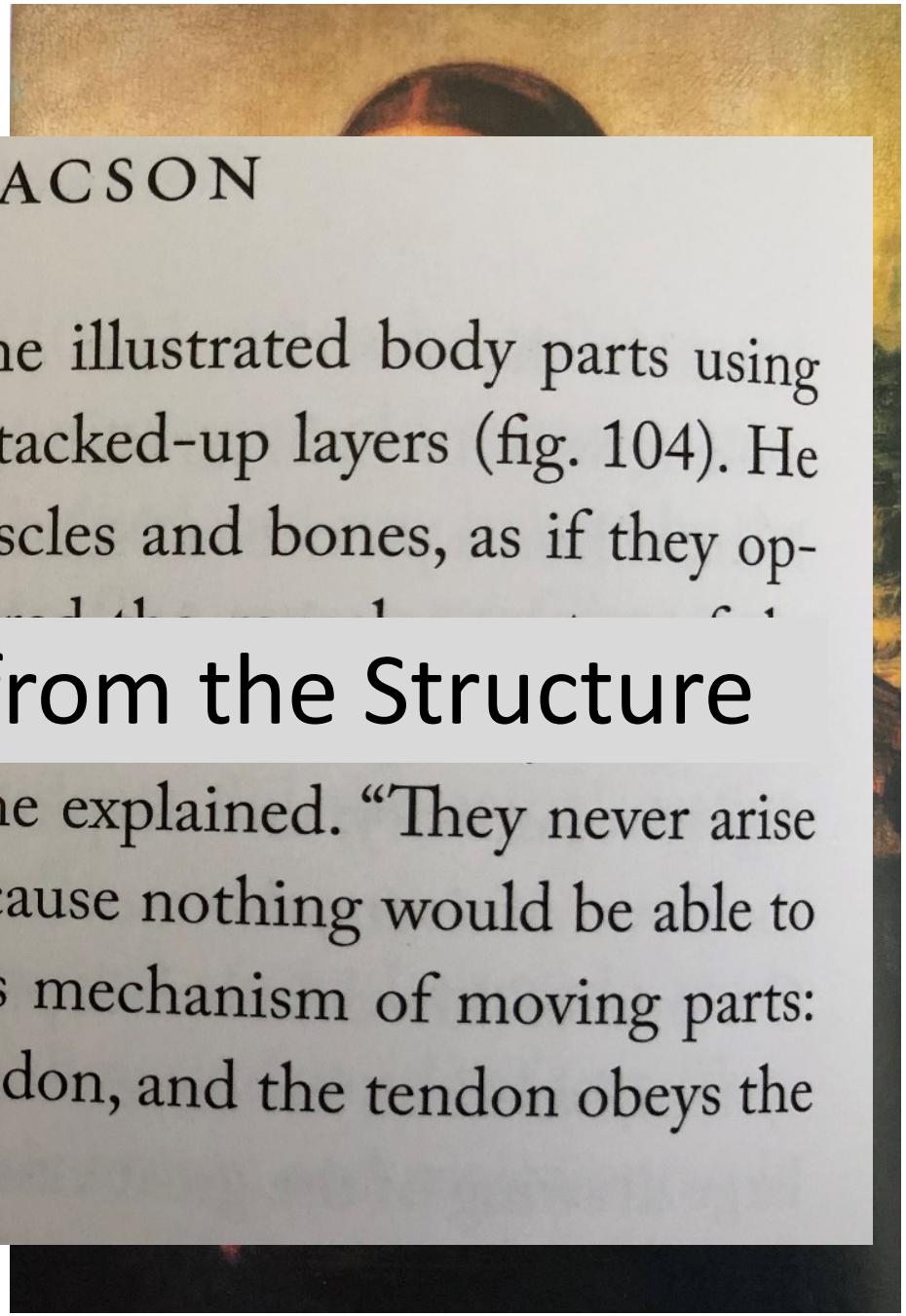
Mechanical Factors in the Reflux Barrier

Ravinder K. Mittal MD

Professor of Medicine
University of California San Diego

UC San Diego
HEALTH SCIENCES





ies. As he had done with machines, he illustrated body parts using exploded views, multiple angles, and stacked-up layers (fig. 104). He studied the movements of various muscles and bones, as if they op-

Predicting Function from the Structure

end in bones adjoining one another," he explained. "They never arise and end on one and the same bone because nothing would be able to move." It all added up to an ingenious mechanism of moving parts: "The joints between bones obey the tendon, and the tendon obeys the muscle, and the muscle the nerve."[14]

PHYSIOLOGICAL REVIEWS

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Esophageal Motility

FRANZ J. INGELFINGER

An incompetent EGJ (low tone and intermittent relaxations) leads to GERD and overtly competent sphincter (impaired relaxation) leads to Achalasia. Most of benign & even some malignant (Barrett's esophagus and adenocarcinoma) disorder of the esophagus are due to dysfunctional sphincter.

The barrier has been credited to several entities, acting independently or in concert. In general, three categories of mechanisms have been postulated;

1) **Pinching of angulation of the esophagus by diaphragmatic action (Crural Diaphragm)**

2) Valvular structure created by the oblique entry of esophagus into stomach or my mucosal redundancy (Flap Valve)

3 Function Does Not Match with Anatomy

The importance of each of these mechanism can be supported – or challenged-on the basis of evidence, that is voluminous but inconclusive.

Ironically enough, inferential evidence drawn from anatomical realities (or supposed realities) suffers from insufficient physiologic study; controversy, the nicest function phenomenon lack morphological basis

Pathophysiology of Gastroesophageal Reflux Disease

Jan Tack[1] *John E. Pandolfino*[2]

Under normal circumstances, reflux into the esophagus is prevented by the anti-reflux barrier, which is a complex anatomic zone made up of multiple components, including the lower esophageal sphincter, the extrinsic crural diaphragm, and the supporting structures of the gastro-esophageal flap valve. When these protective components are compromised, the deleterious effects are additive, resulting in increasing numbers of reflux events and

Gastroenterology 2018;154:277–288

Techniques to Measure LES Pressure

Balloons (oncometry) air filled balloon – Kronecker H, Meltzer S

Open tip catheters – Charlie Code - high pressure zone identification

Infusion manometry – Lauren D Harris - LES pressure, not HH important GERD

Sleeve Sensor – John Dent – Transient LES relaxation

Electrode Sleeve Sensor – Ravinder Mittal – Crural diaphragm

High Resolution Manometry/Color topography – Ray Clouse

3D LES manometry – Peter Kahrilas

Functional Luminal Imaging Probe – Hans Gregersen

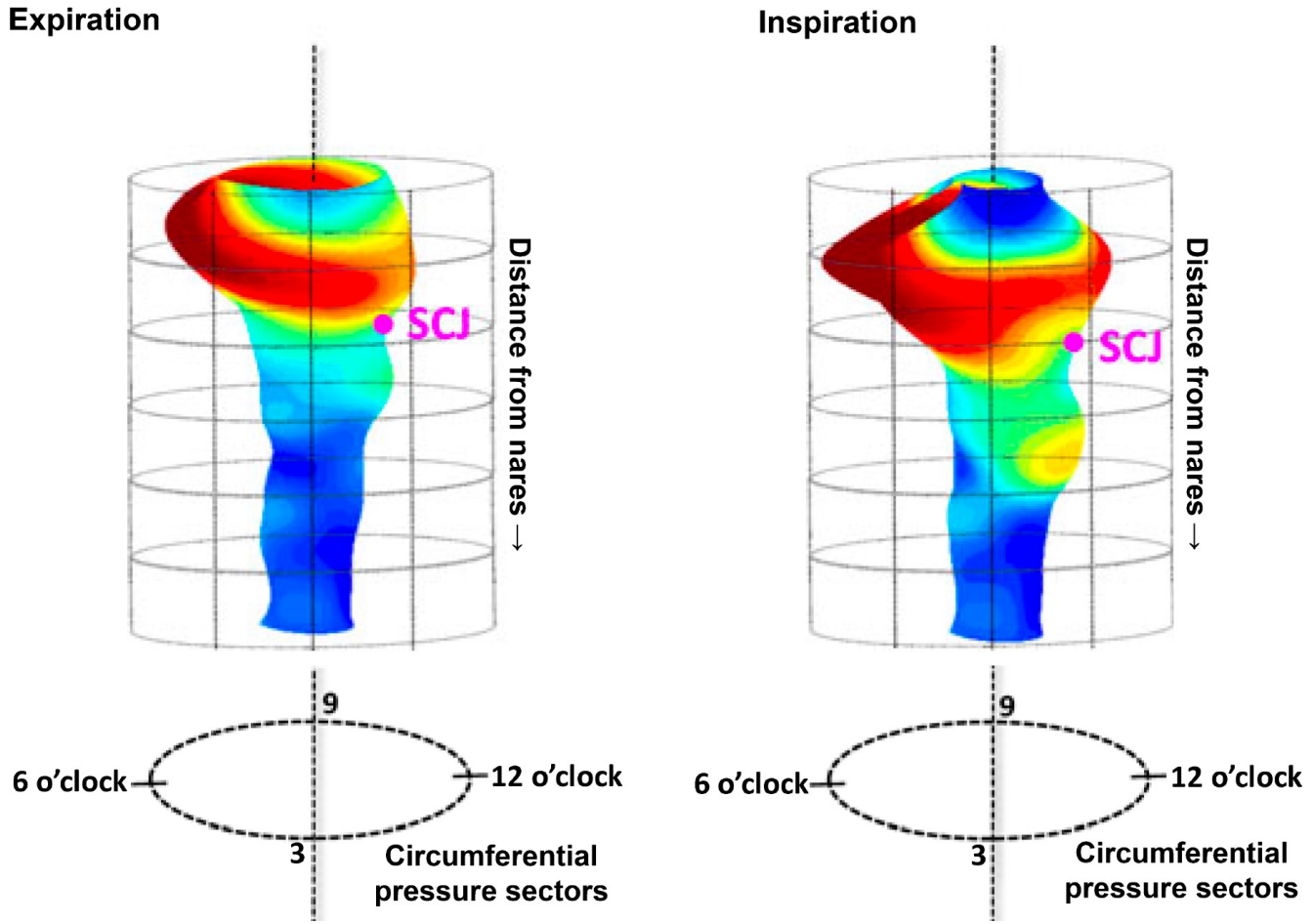
Neurogastroenterology & Motility

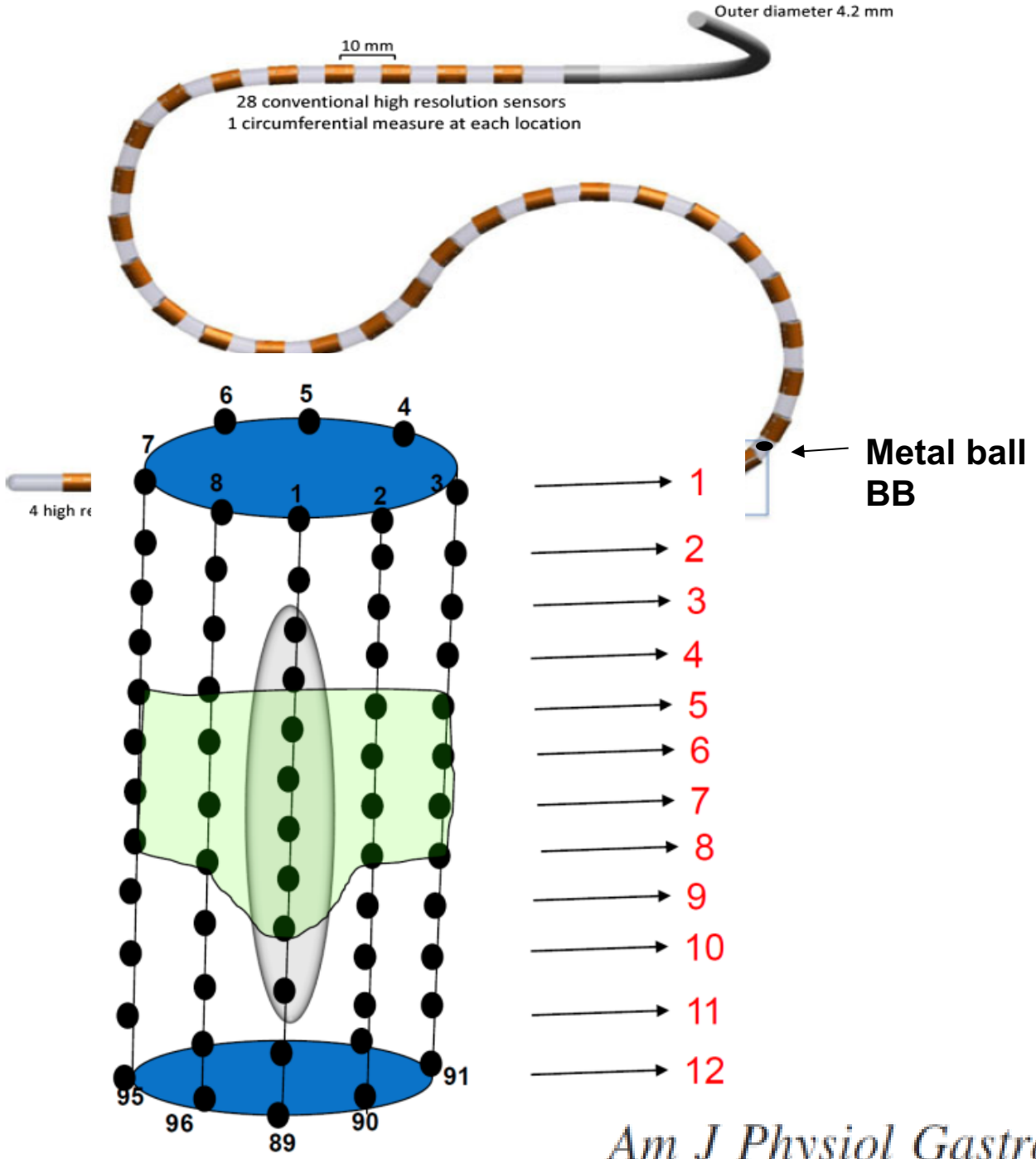
Neurogastroenterol Motil (2011) **23,** e461–e469 doi: 10.1111/j.1365-2982.2011.01733.x

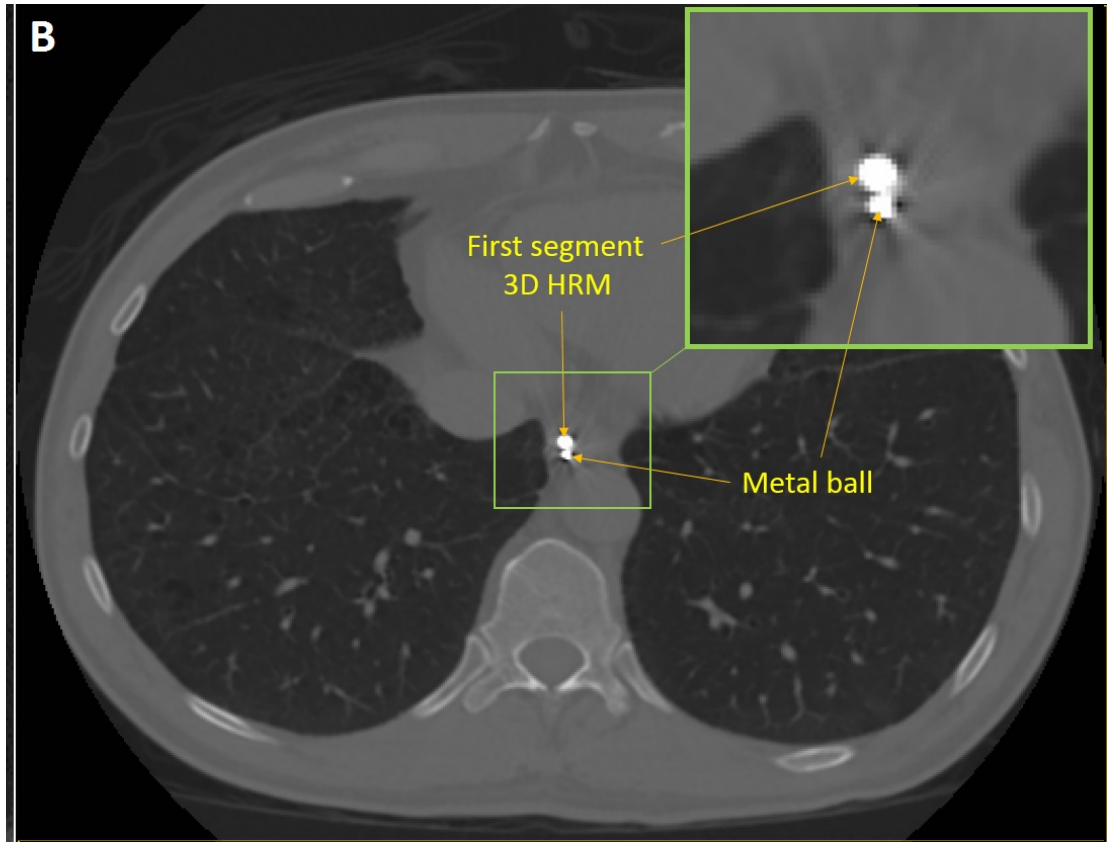
3D-high resolution manometry of the esophagogastric junction

M. A. KWIATEK, J. E. PANDOLFINO & P. J. KAHRILAS

- Circumferential Asymmetry of LES
- Circumferential Asymmetry of Crural Diaphragm (EGJP)
- EGJ High Pressure Zone is longer on one side

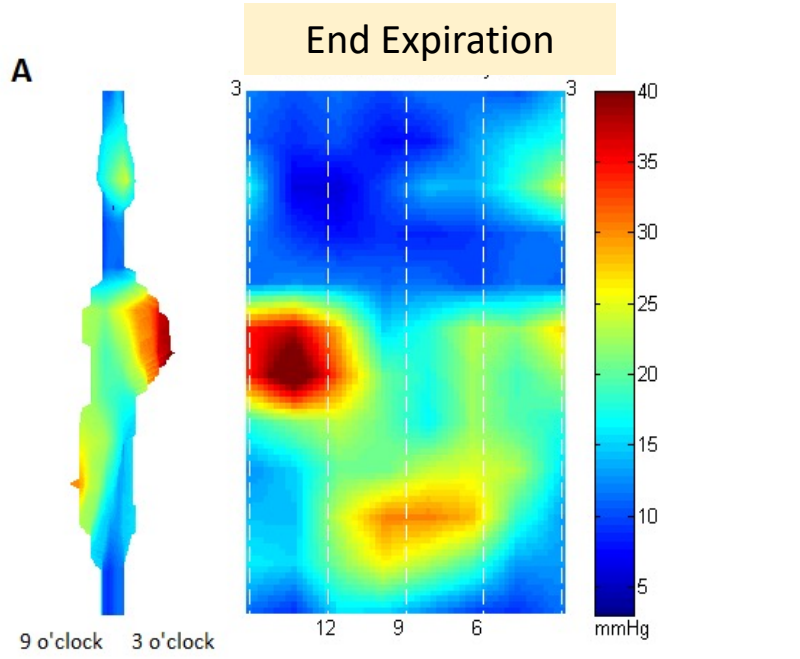


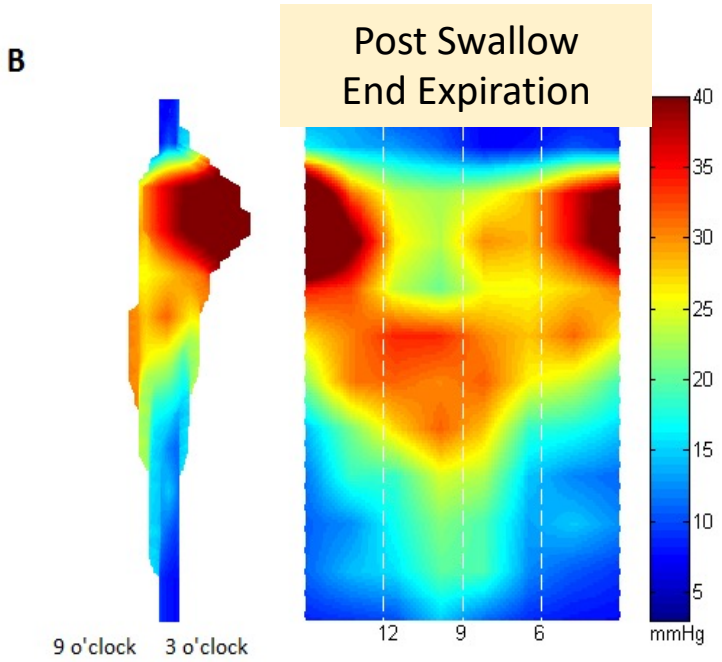


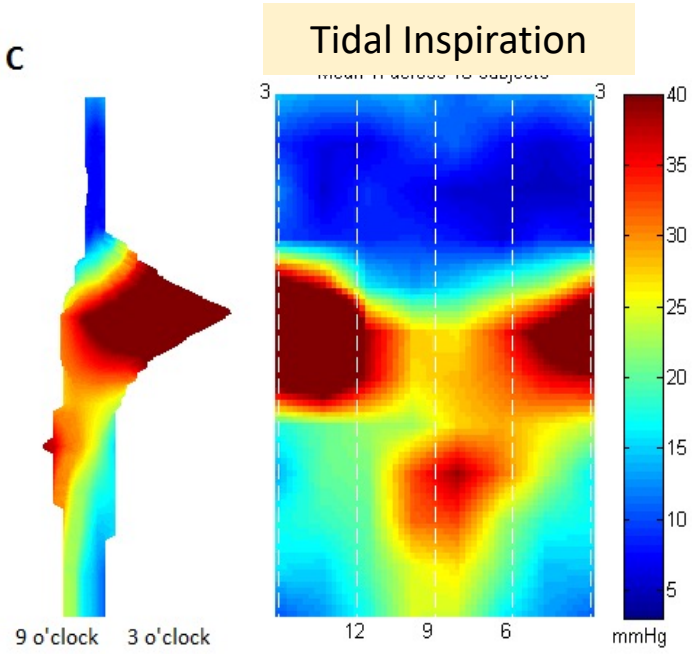


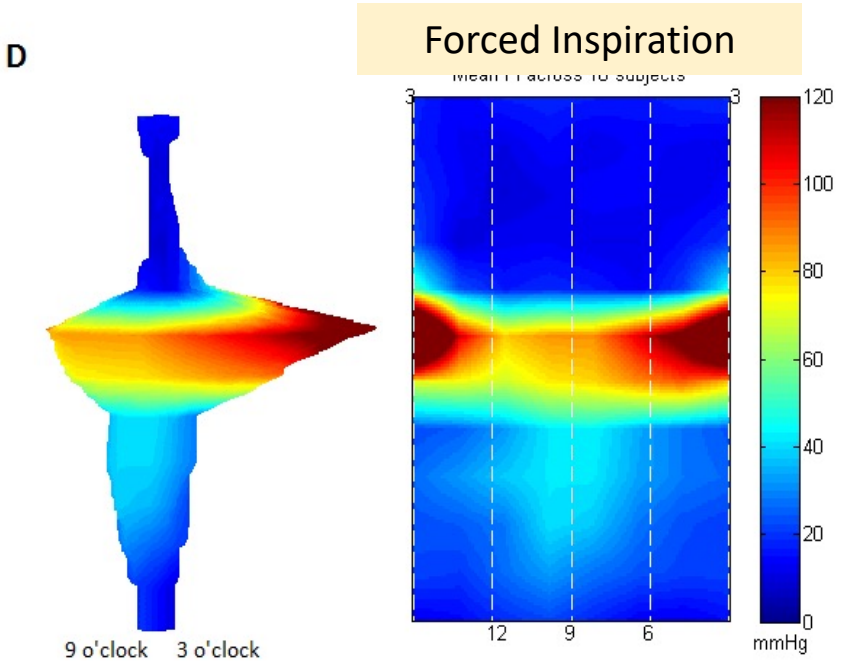
Am J Physiol Gastrointest Liver Physiol 313: G212–G219, 2017

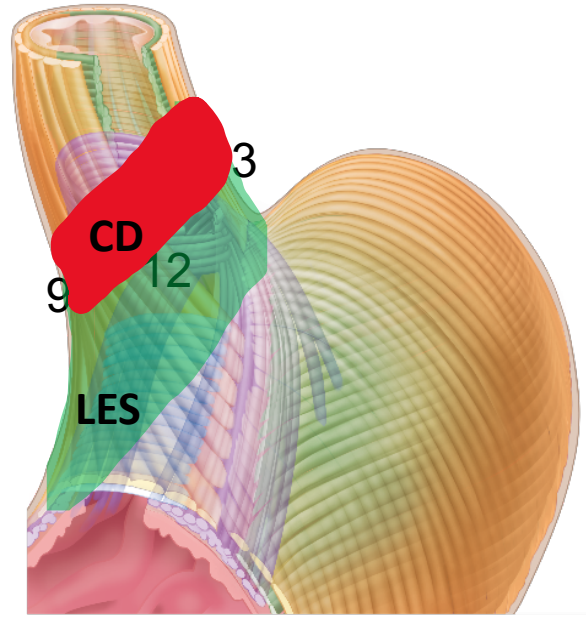
n EGJ Pressure Profile (n=10)







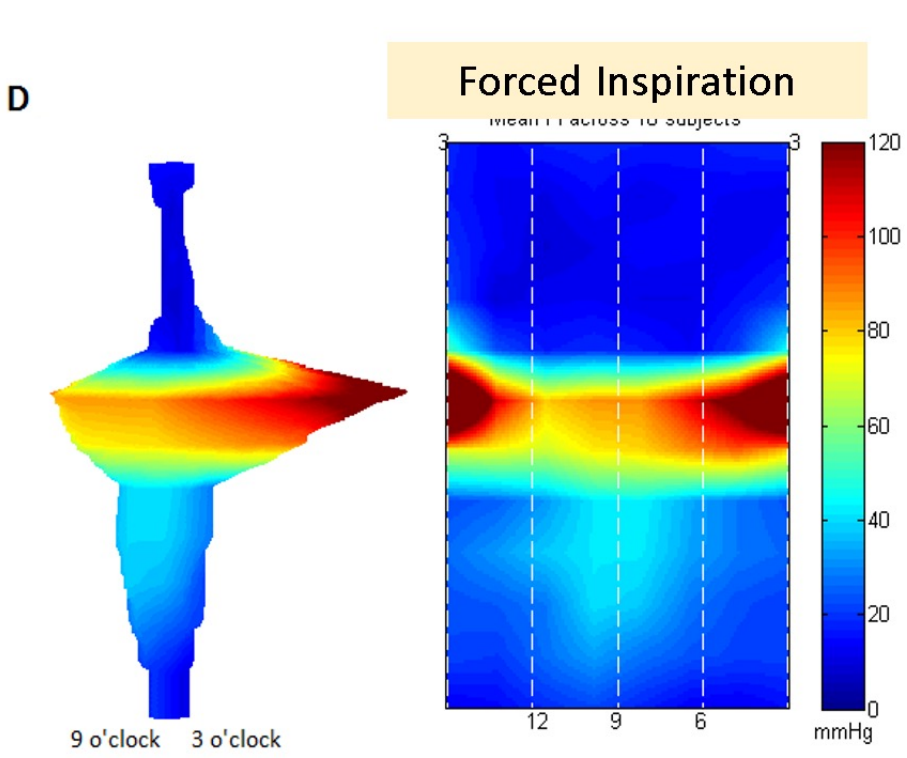


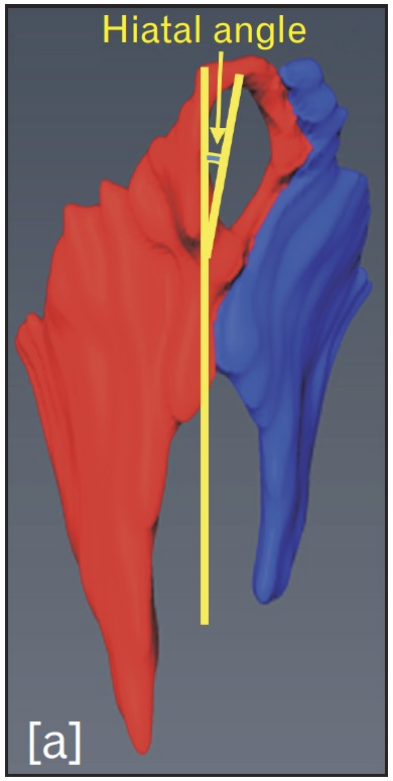


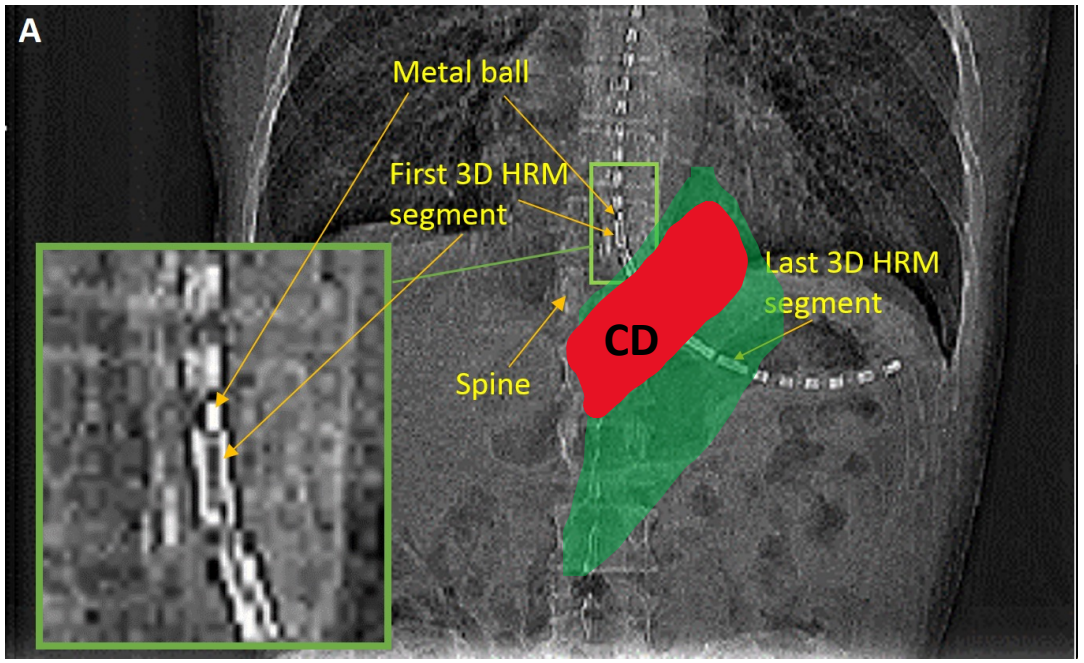
Circumferential Orientation

12 O' clock – anterior
6 O' clock – posterior
9 O' clock – lesser curvature
3 O' clock – greater curvature

How can the EGJ HPZ be Horizontal Esophagus Enters Stomach at a Right Angle





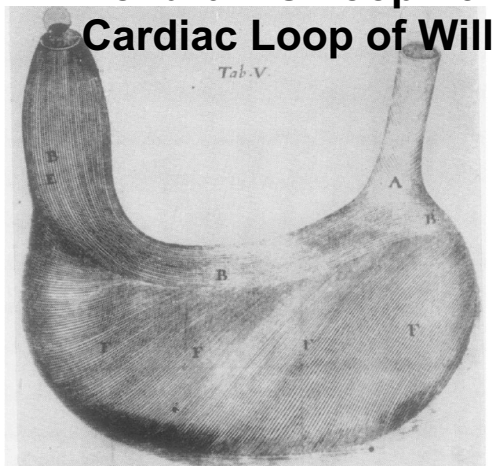


Catheter & High-Pressure Zone are at Right Angle to Each Other

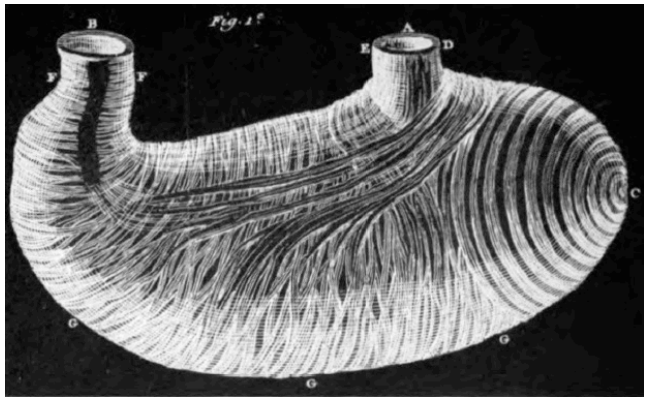
Am J Physiol Gastrointest Liver Physiol 313: G212–G219, 2017

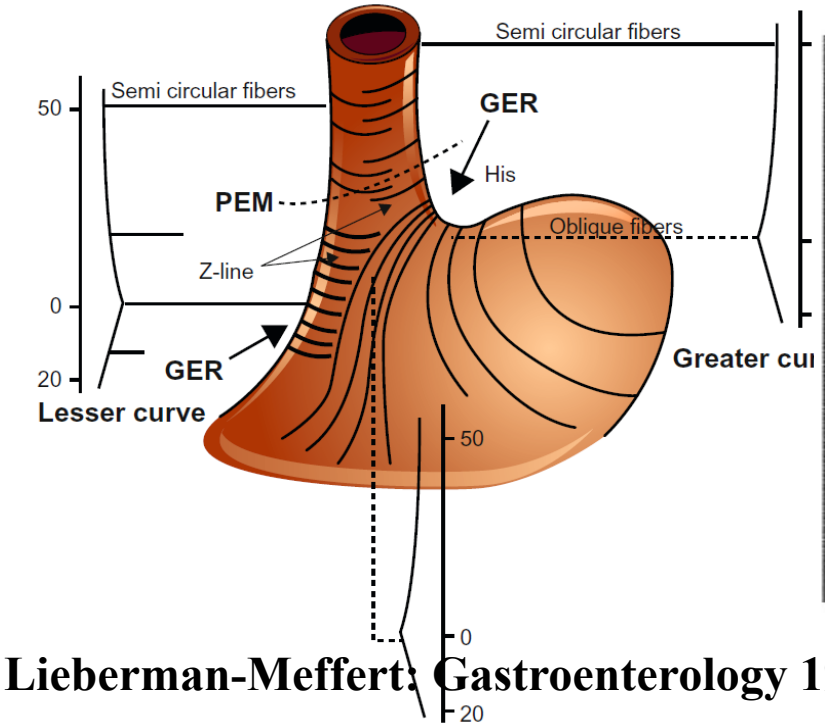
Myoarchitecture of the Lower Esophageal Sphincter

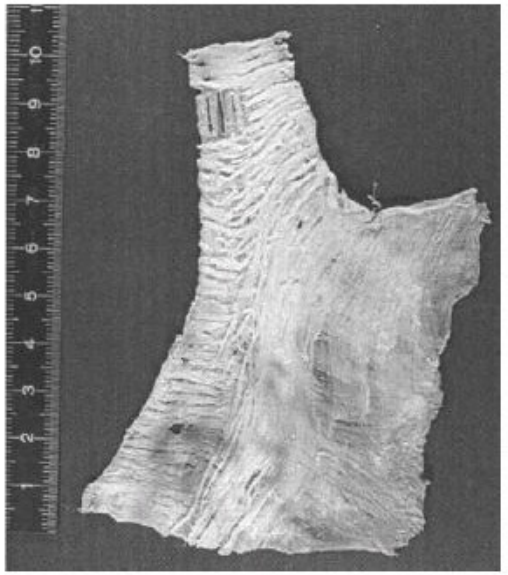
Lendrum's Loop-1674
Cardiac Loop of Willis

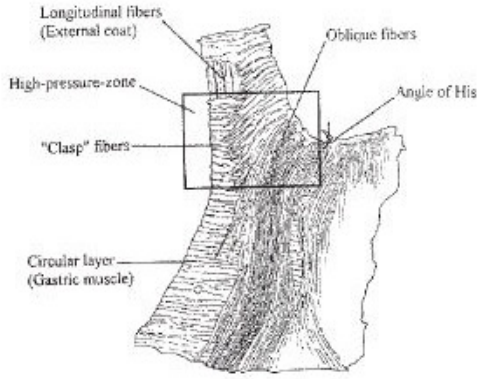


Collar of Helvitus 1719









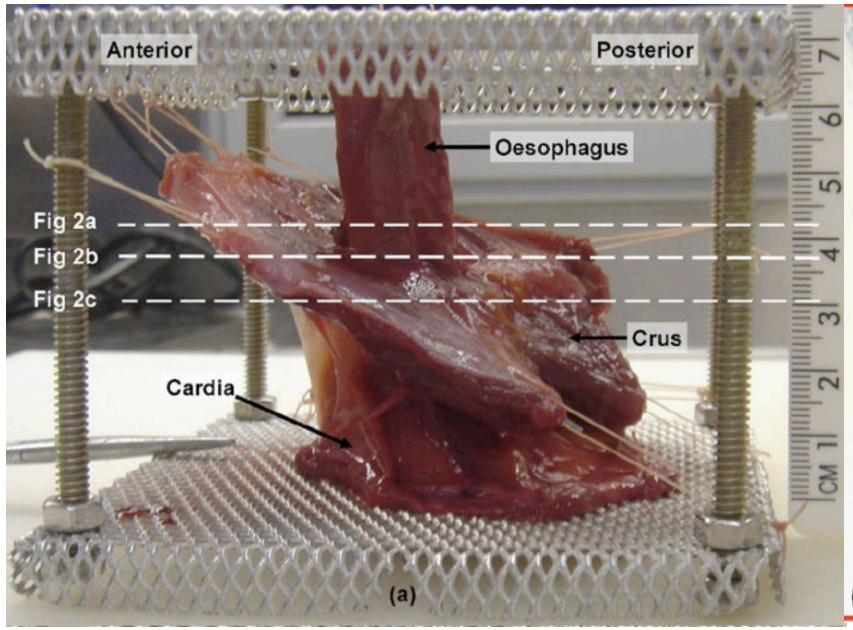
Lieberman-Meffert: Gastroenterology 1979; 76:31-38

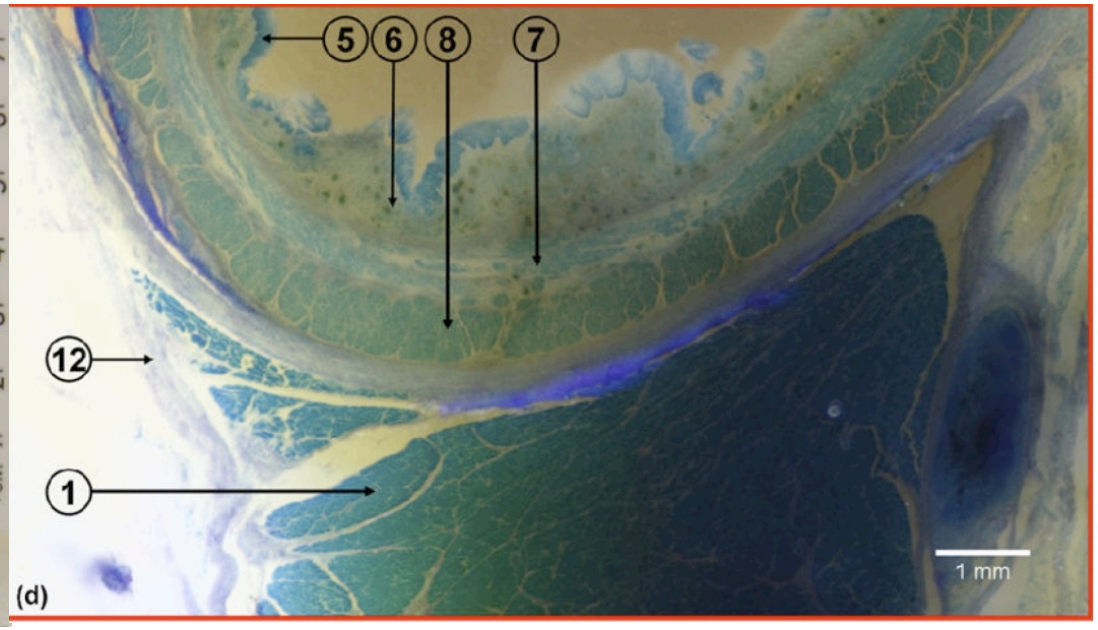
O. Korn, A. Csendes

Three-Dimensional High-Resolution Reconstruction of the Human Gastro-Oesophageal Junction

R. YASSI[1], **L.K. CHENG**[1], **S. AL-ALI**[2], **G. SANDS**[1], **D. GERNEKE**[1], **I. LEGRICE**[1,3], **A.J. PULLAN**[1,4], and **J.A. WINDSOR**[5]

[1]Auckland Bioengineering Institute, The University of Auckland, New Zealand [2]Department of Anatomy with Radiology, The University of Auckland, New Zealand [3]Department of Physiology, The University of Auckland, New Zealand [4]Department of Engineering Science, The University of Auckland, New Zealand [5]Department of Surgery, The University of Auckland, New Zealand

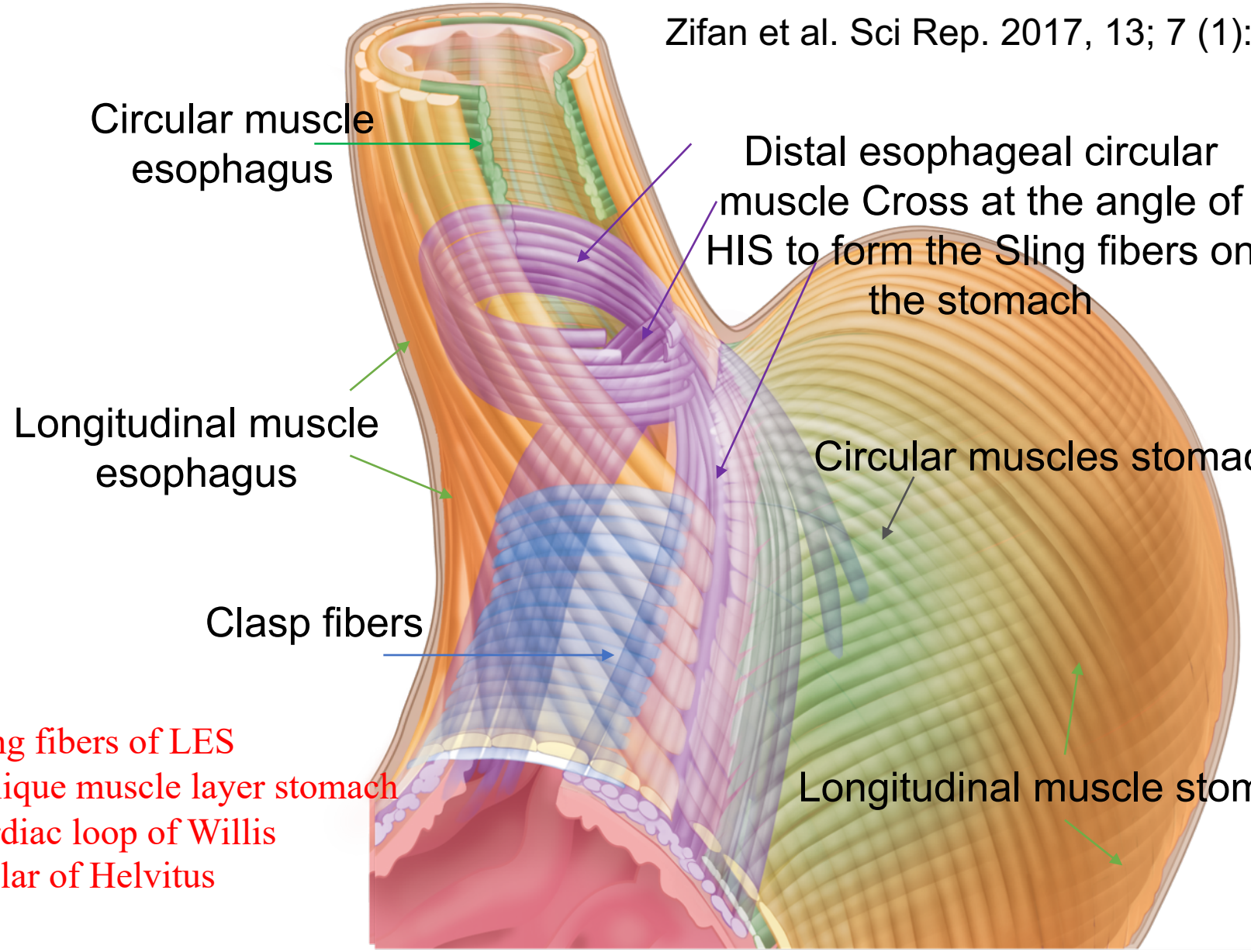




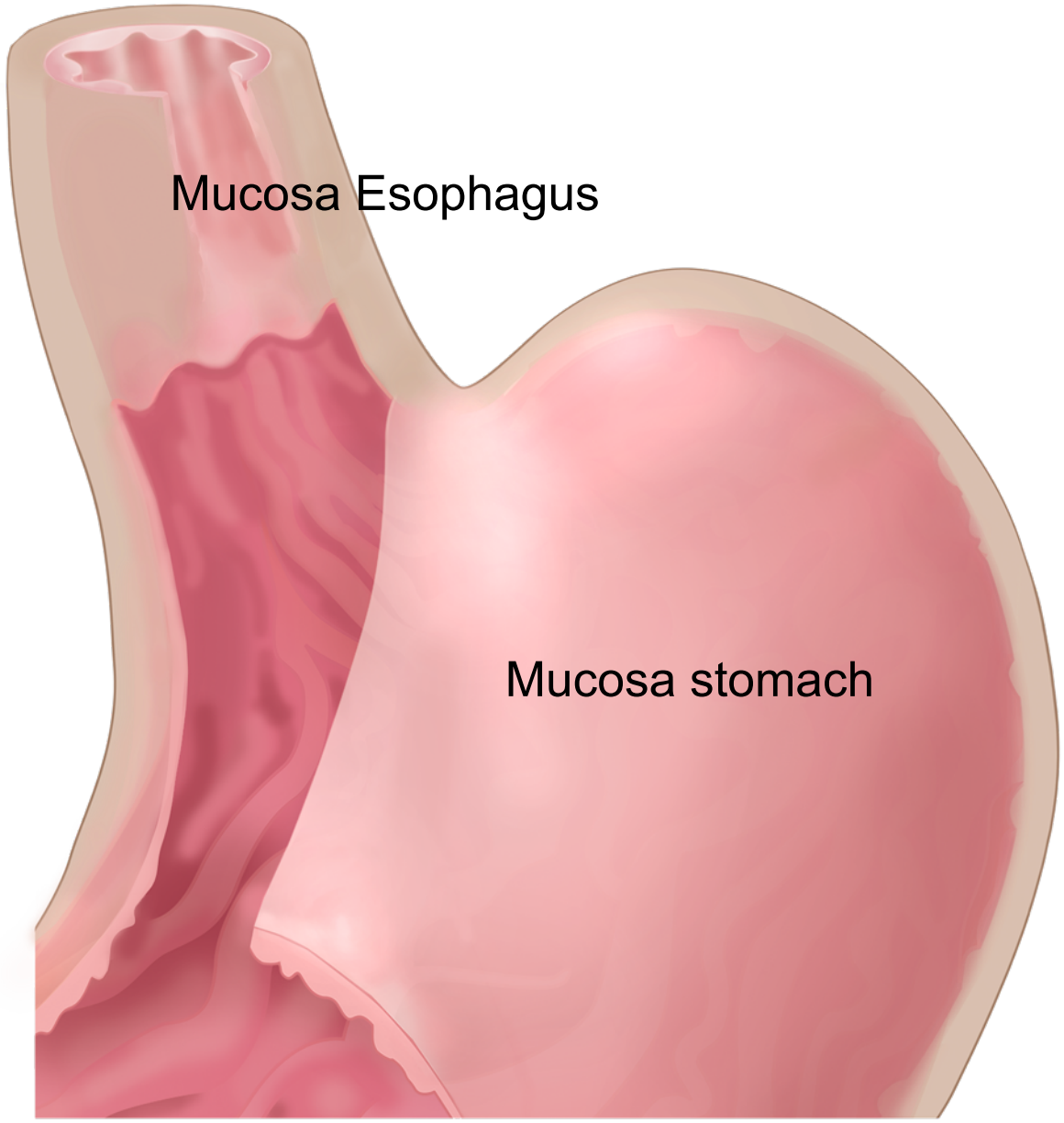
652 Axial Sections – each 25 MB

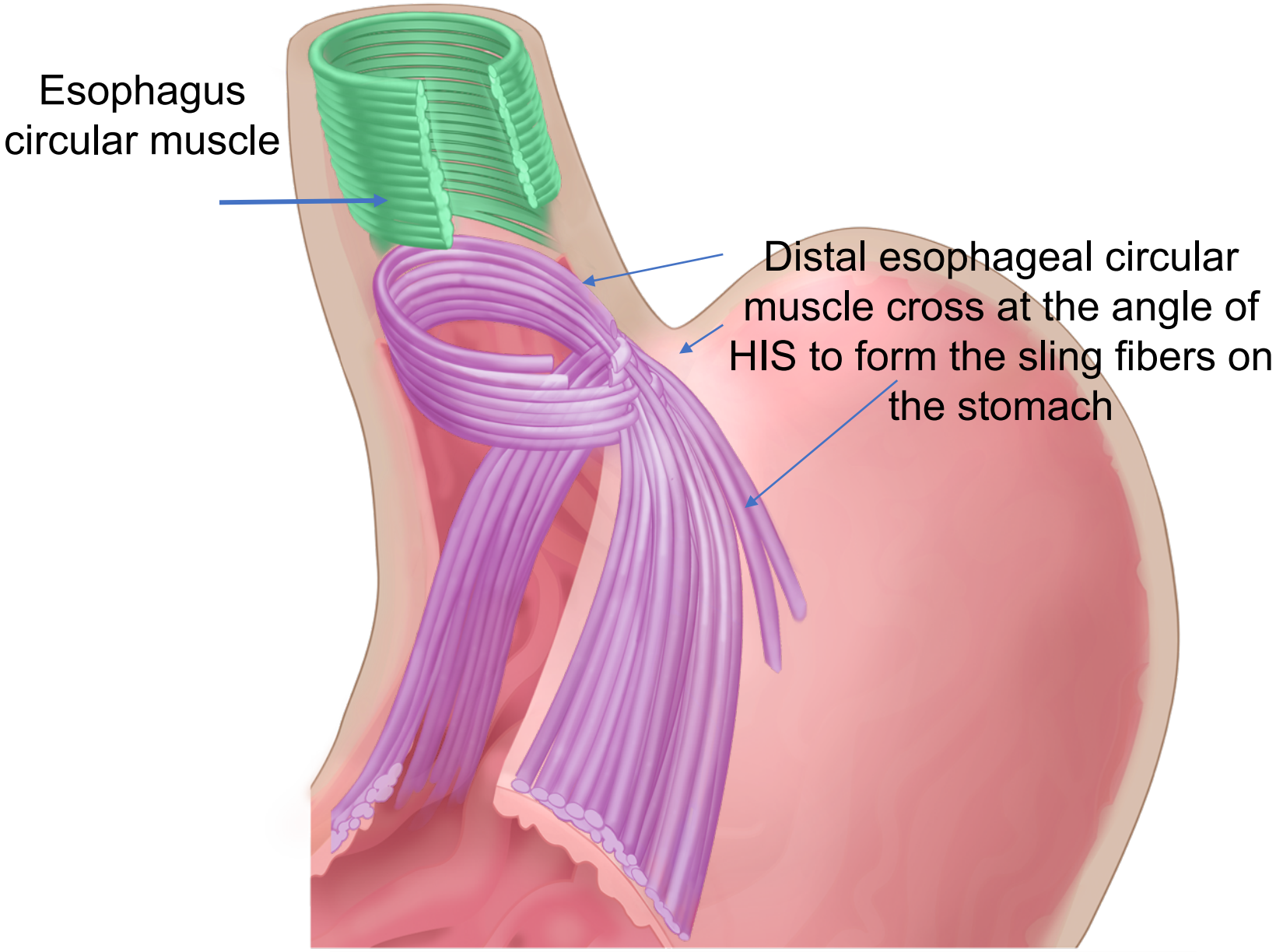
Myoarchitecture of Lower Esophageal Sphincter

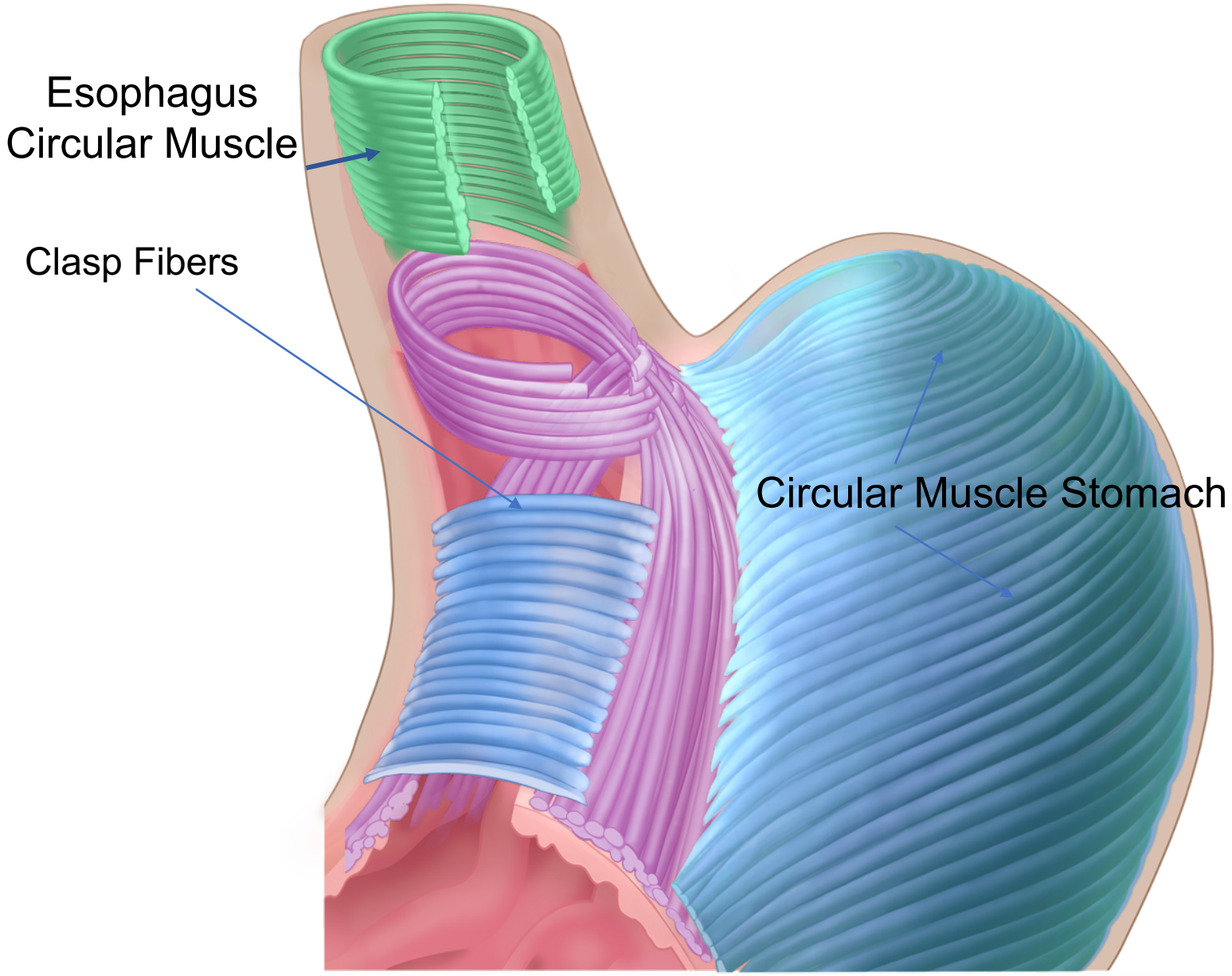
Zifan et al. Sci Rep. 2017, 13; 7 (1):13188

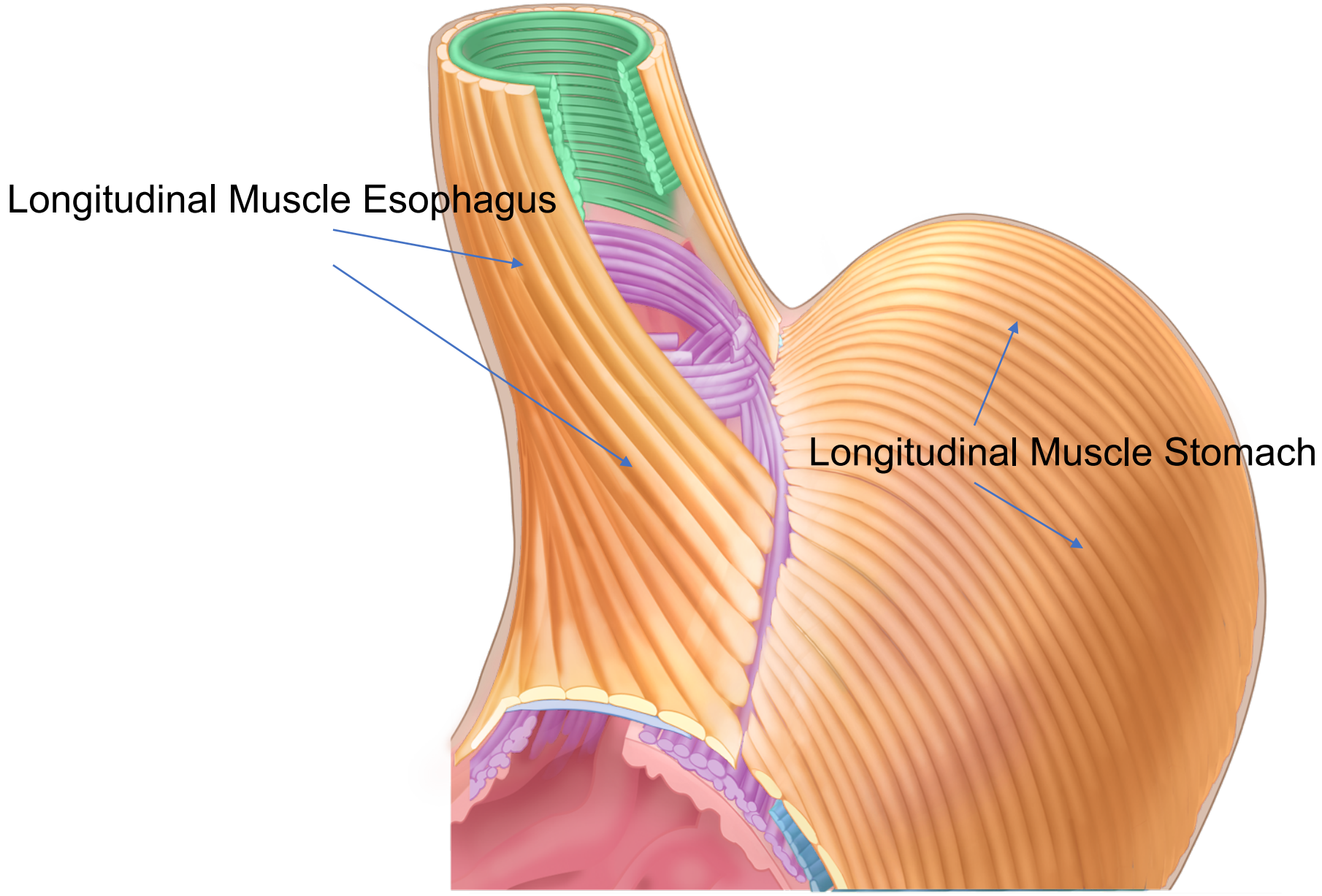


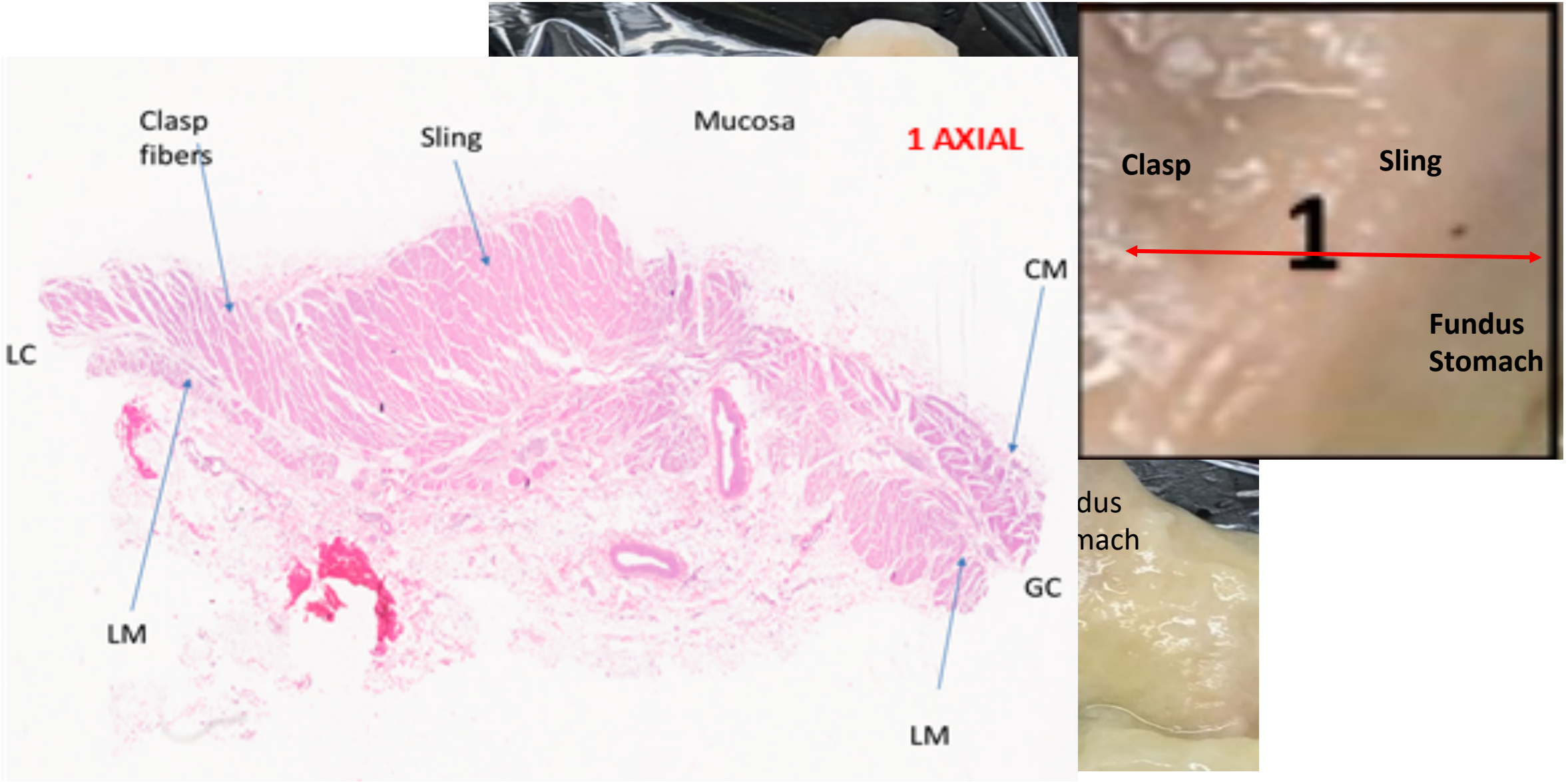
Sling fibers of LES
Oblique muscle layer stomach
Cardiac loop of Willis
Collar of Helvitus


Mucosa Esophagus
Mucosa stomach


Esophagus
circular muscle
Distal esophageal circular
muscle cross at the angle of
HIS to form the sling fibers on
the stomach

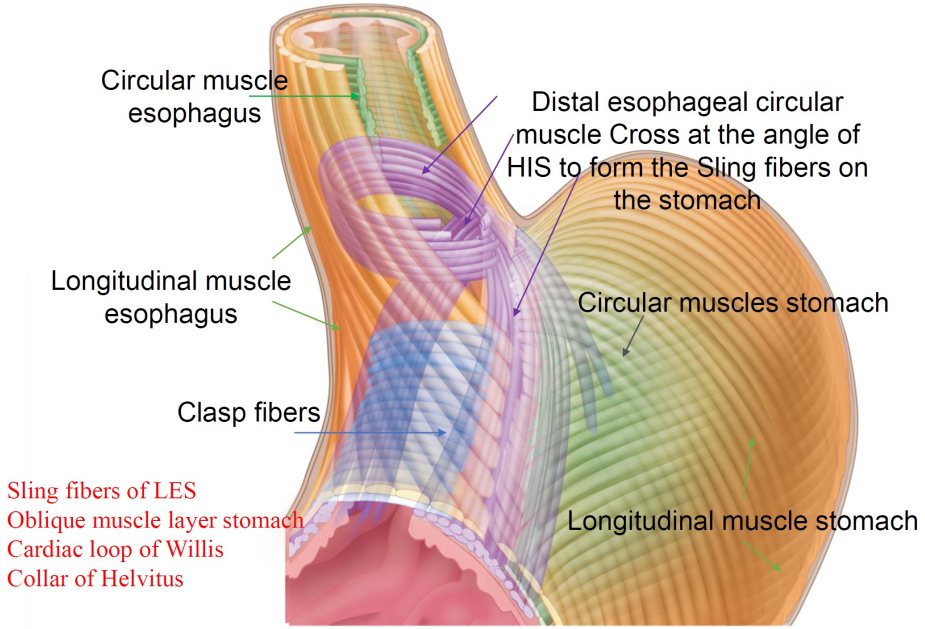

Esophagus
Circular Muscle
Clasp Fibers
Circular Muscle Stomach

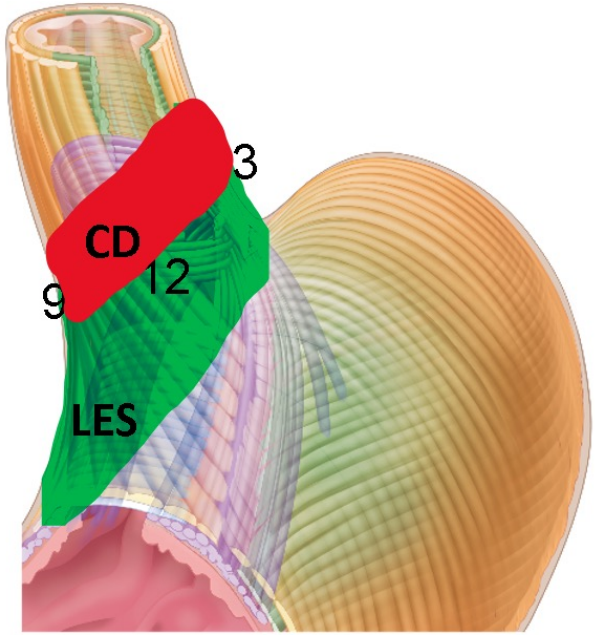

Longitudinal Muscle Esophagus
Longitudinal Muscle Stomach



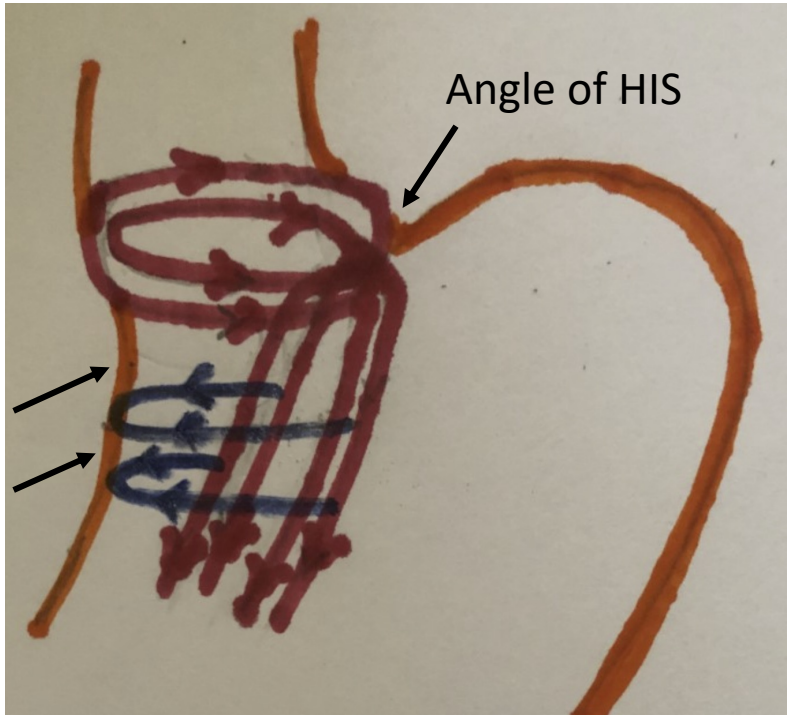
Axial Section across the Sling Fibers of the Stomach

Nice Function Matches Morphological Basis





High Pressure Zone – Longer towards Lesser Curvature



LES is not a ring or donut like muscle,

It is a purse string

Three-Dimensional Myoarchitecture of the Lower Esophageal Sphincter and Esophageal Hiatus Using Optical Sectioning Microscopy

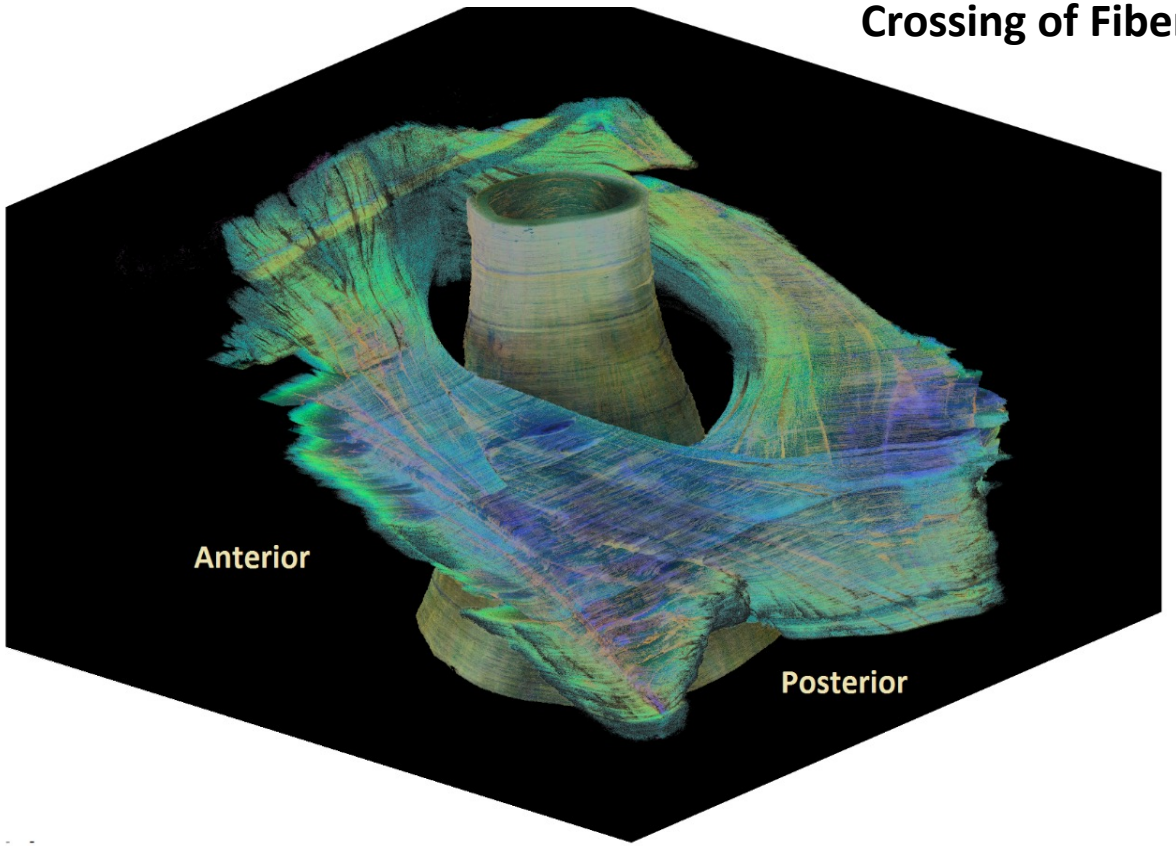
Ali Zifan[1], Dushyant Kumar[1], Leo K. Cheng[2] & Ravinder K. Mittal[1]

Sci Rep. 2017 Oct 13;7(1):13188

CD is not a ring or donut like muscle

Crural Diaphragm: Double Purse String

Anterior Crossing of Fibers



Right Crus Crossing of Fibers

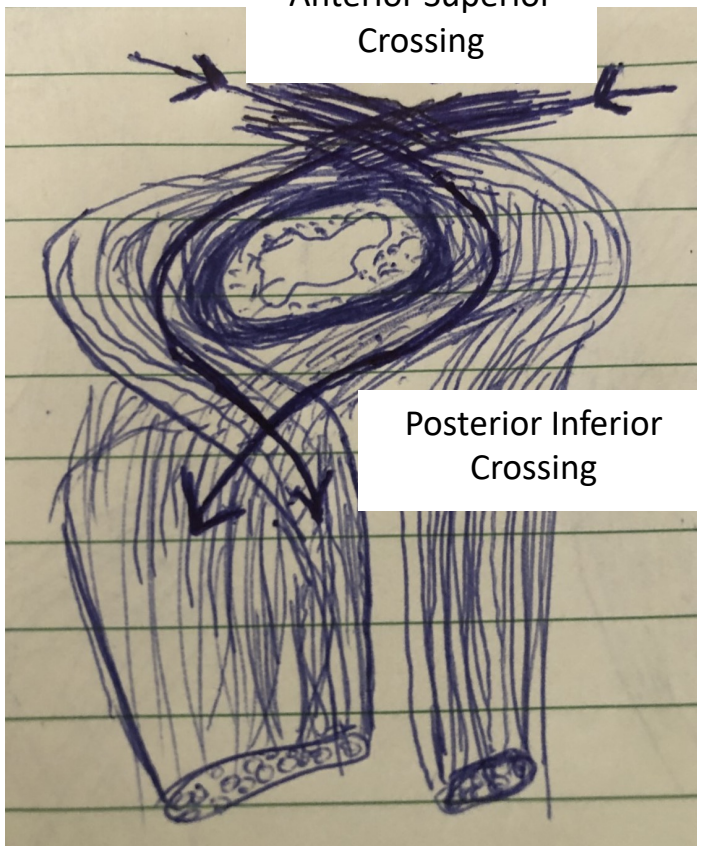
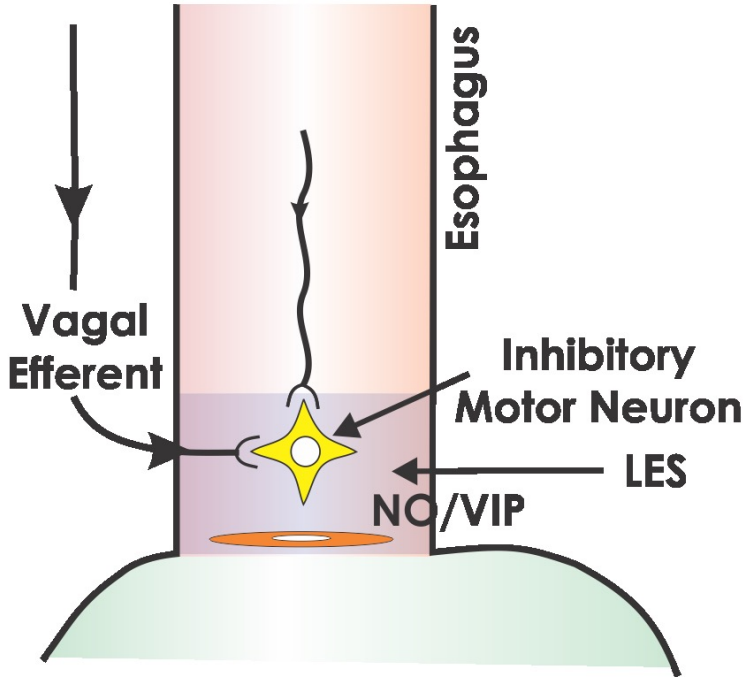


Illustration by Ravinder Mittal

RAJ K. GOYAL MD.

Lower Esophageal Sphincter - LES



Myogenic Tone – Unique property of LES

Modulatory influence by excitatory (cholinergic) and inhibitory (NO and VIP nerves)

LES is goldmine of receptors but their physiological role unknown

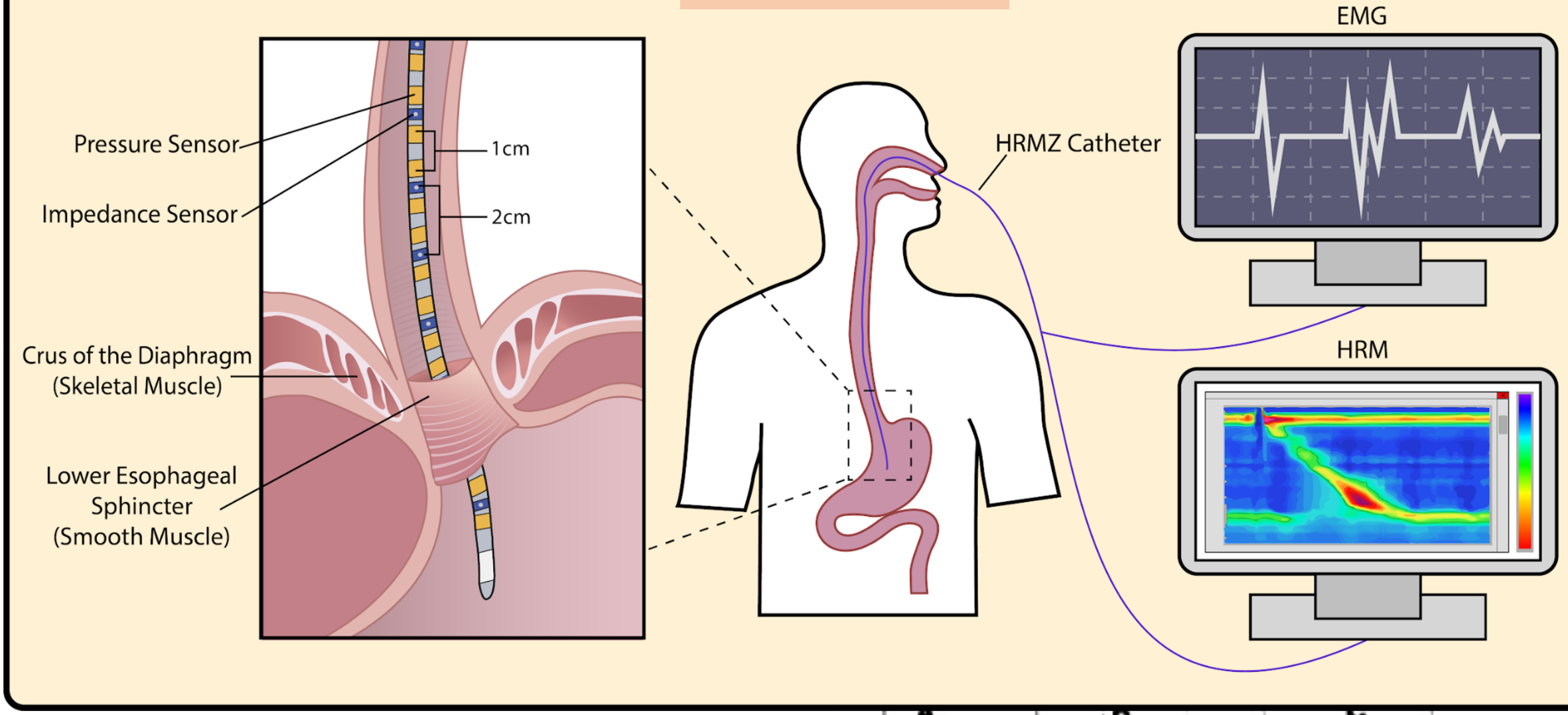
Vagus nerve stimulation causes LES relaxation through NO nerves

Sympathetic nerve stimulation causes LES contraction

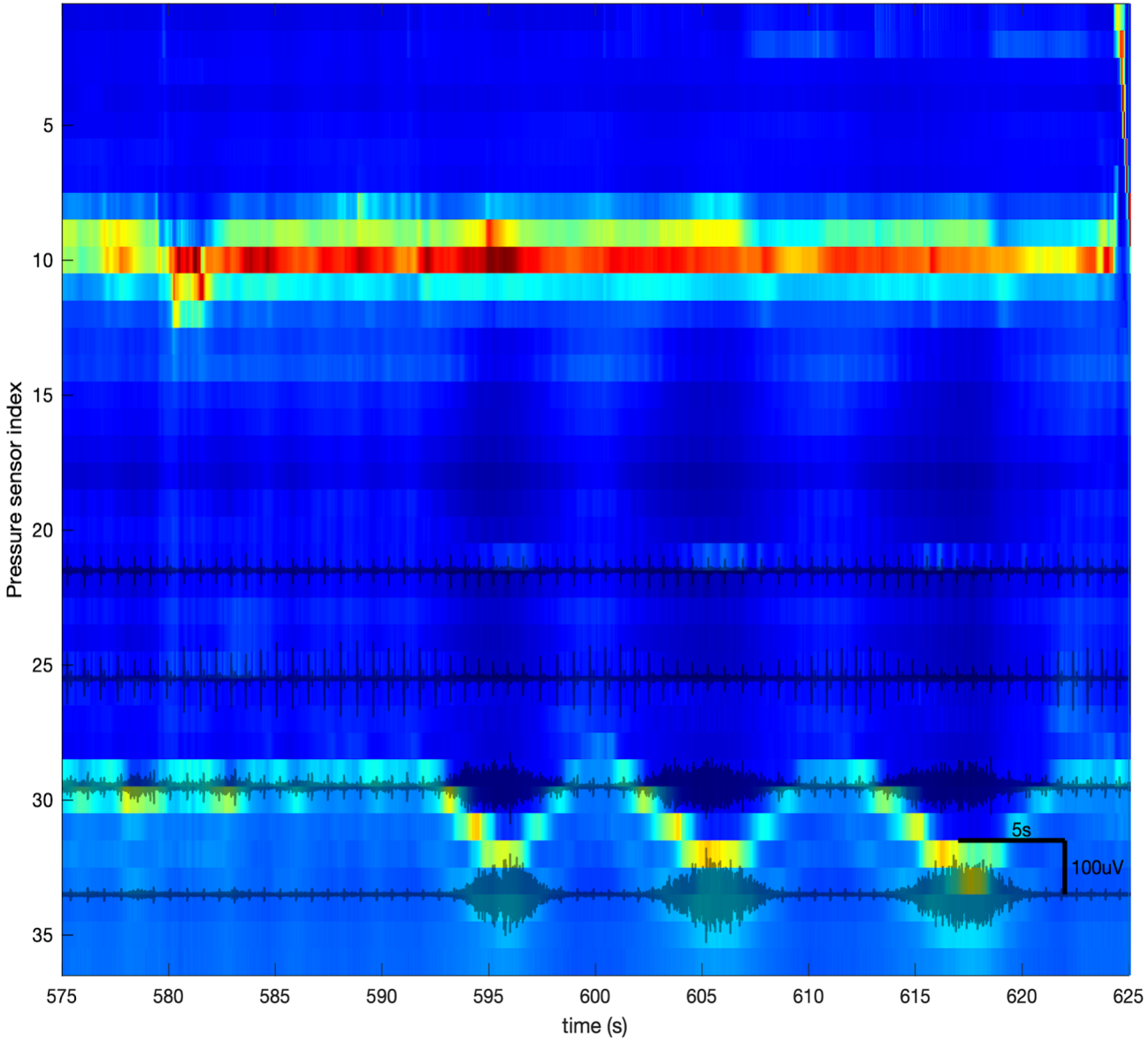
Electrical and Mechanical Activity in the Human Lower Esophageal Sphincter during Diaphragmatic Contraction

Journal of Clinical Investigation 1988

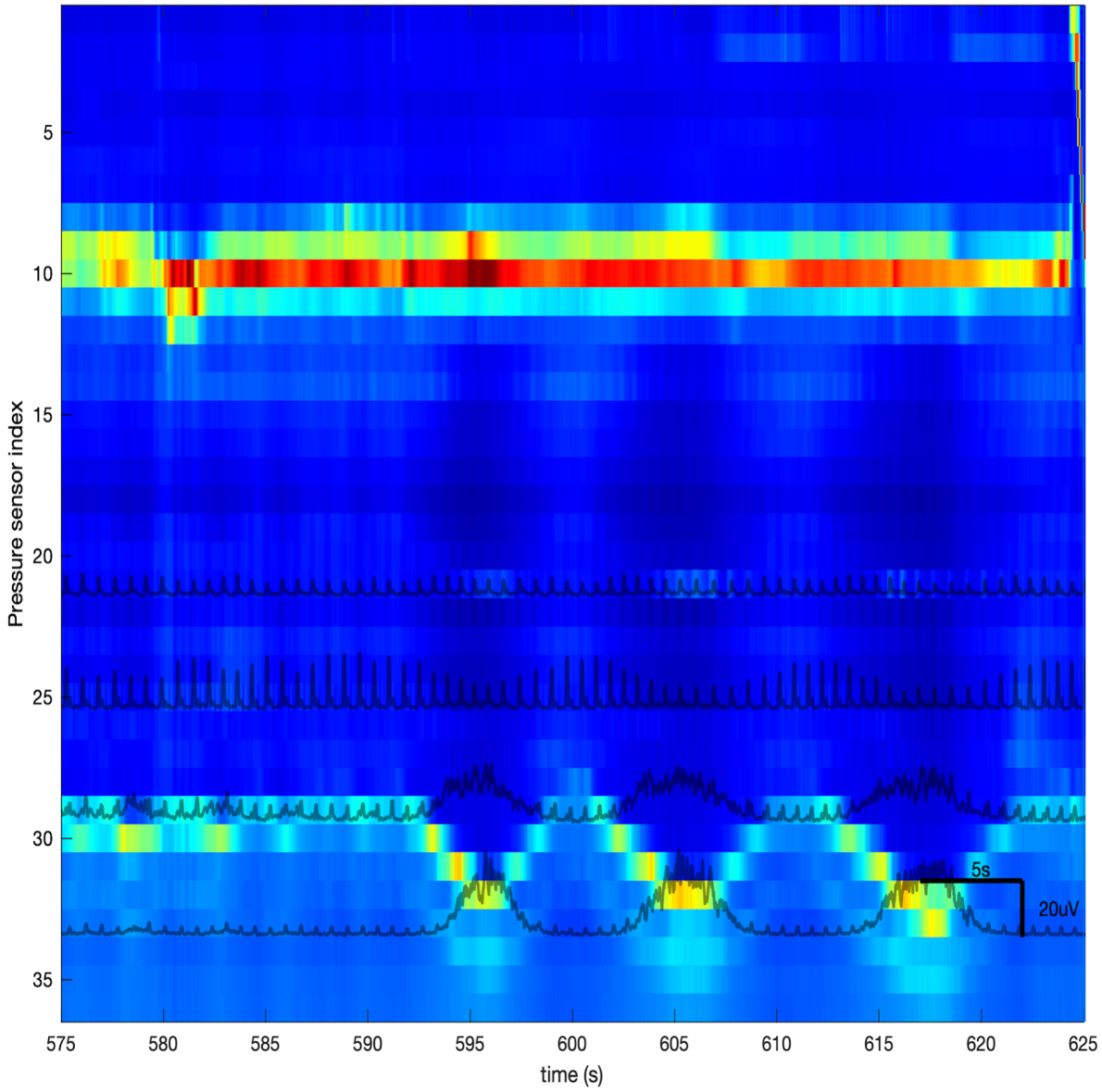
2021



Skeletal Muscle Filter 2: 100-200Hz



Skeletal 100-200Hz Filter and RMS 100msec



Crural Diaphragm/Hiatal Function at EGJ

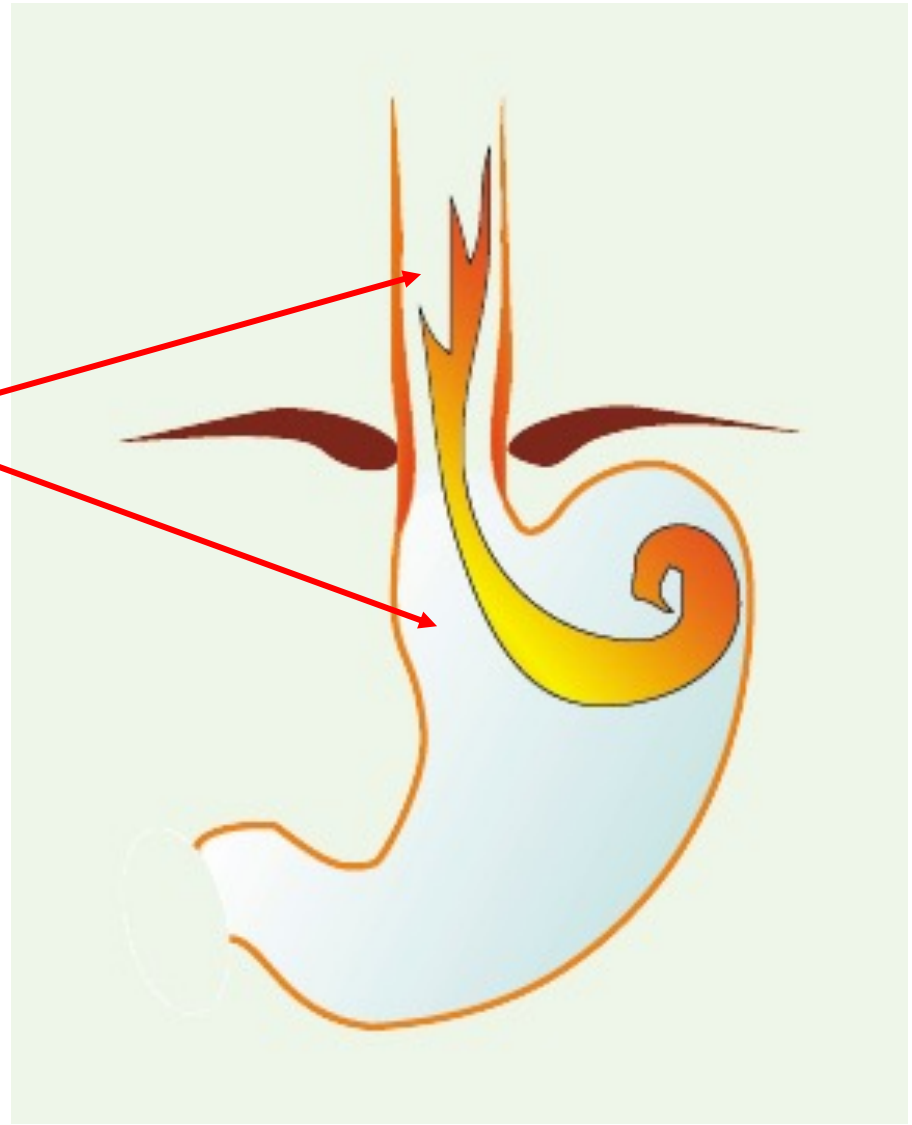
Increase in EGJ pressure

With inspiration, the amplitude of increase is related to the depth of inspiration/force of diaphragmatic contraction

With abdominal compression, straight leg raise, coughing, Valsalva and all those maneuvers that increase abdominal pressure, and pressure gradients between the esophagus and stomach

Trans diaphragmatic Pressure (Gastric - Esophageal Pressure - pdi)
Driving Force of GER & EGJ the Barrier

pdi

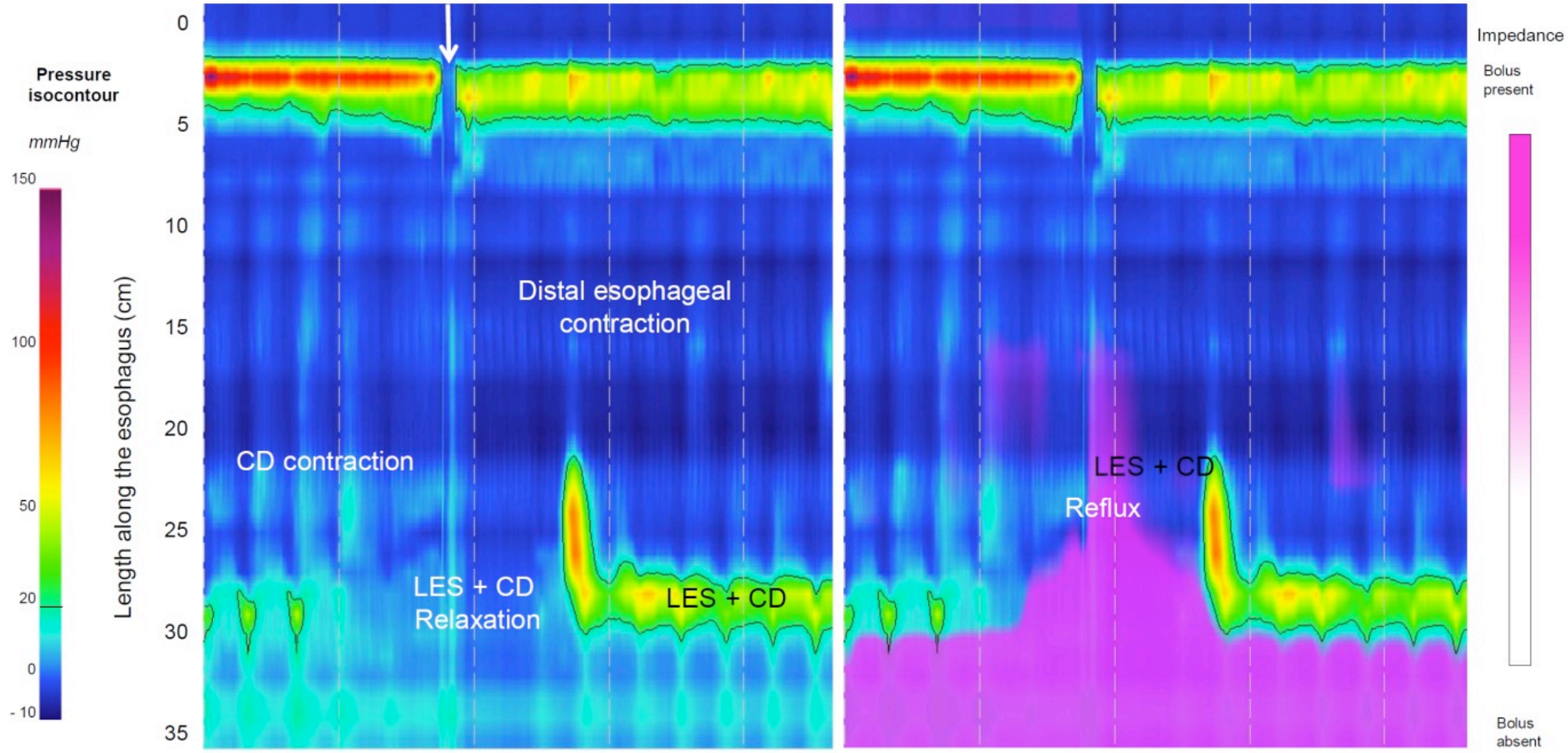


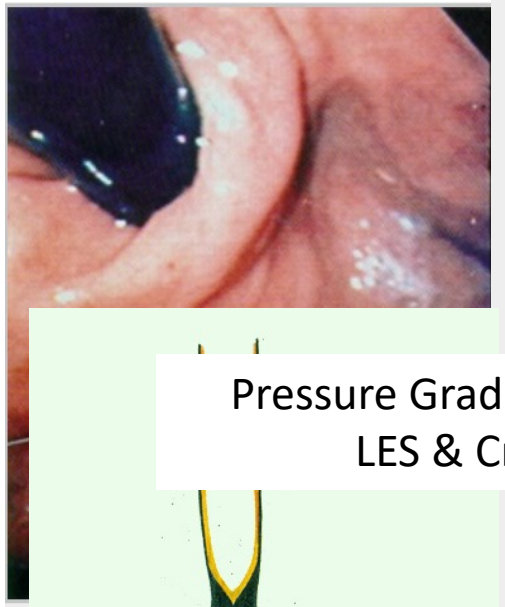
Dynamic EGJ Barrier Function

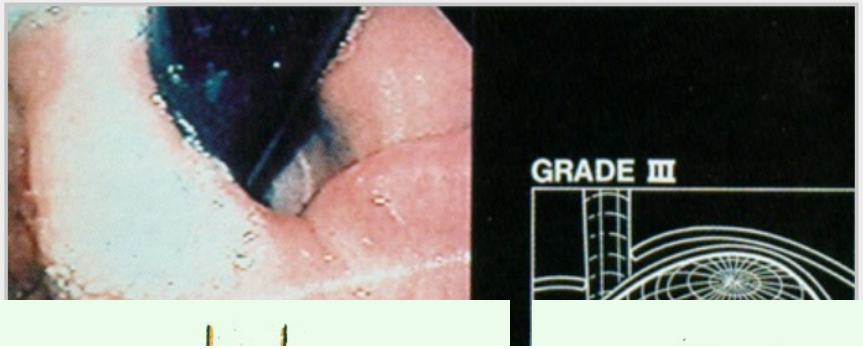
End expiratory pressure under resting condition is due to LES

Increase with inspiration, abdominal compression, cough, Valsalva and other maneuvers is due to CD

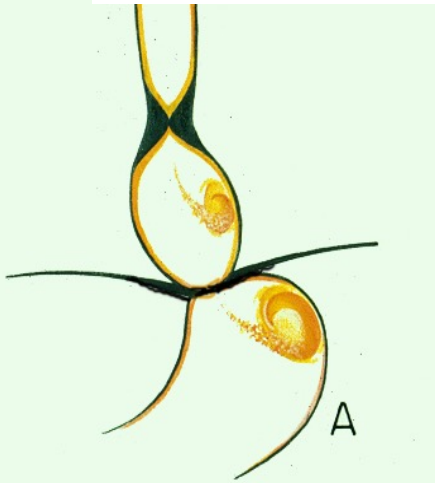
Transient Lower Esophageal Sphincter Relaxation

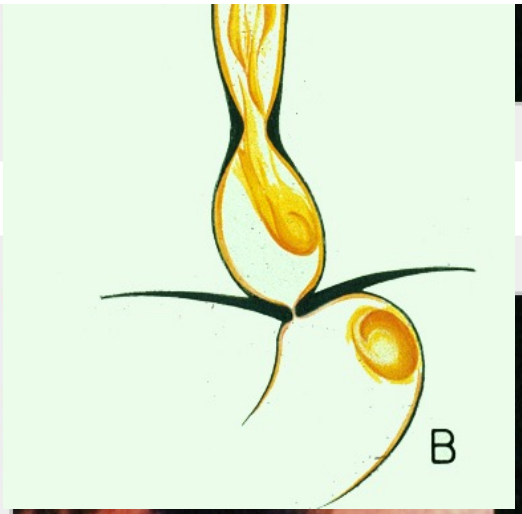


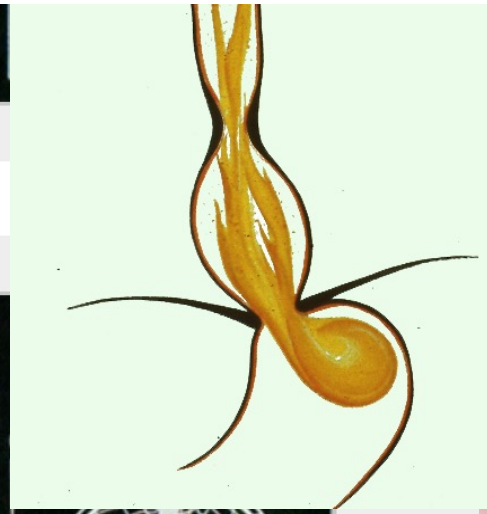


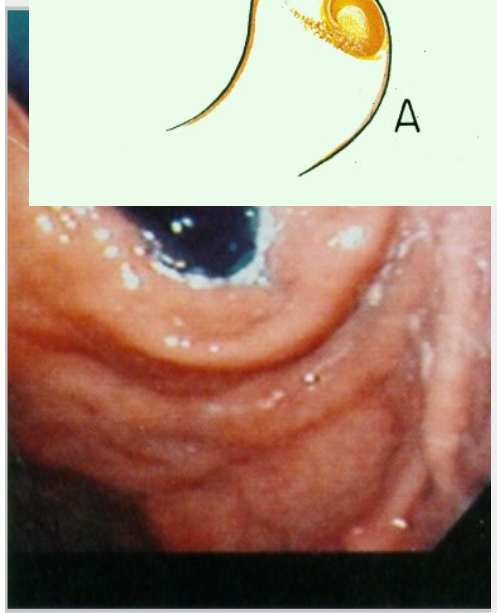


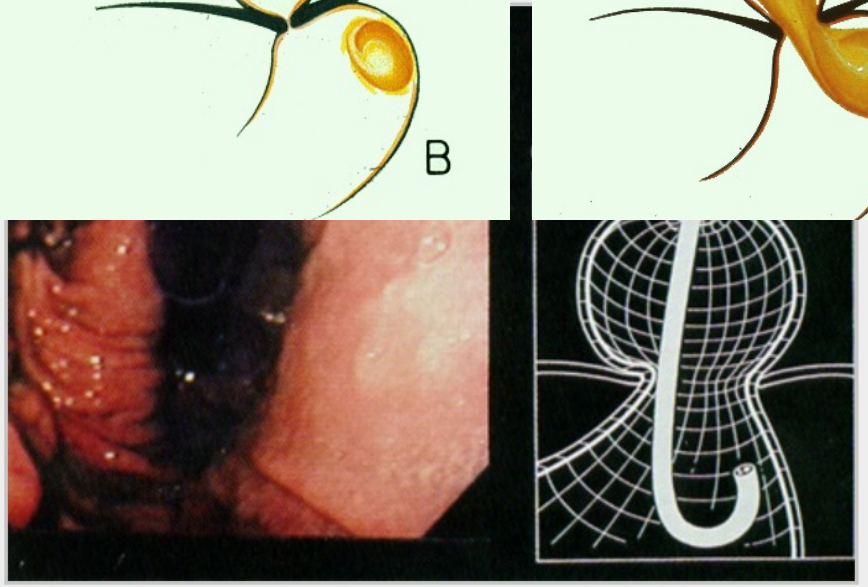
Pressure Gradient between Esophagus, Hiatal Hernia & Stomach
LES & Crural Diaphragm Pressure – Barrier of Reflux



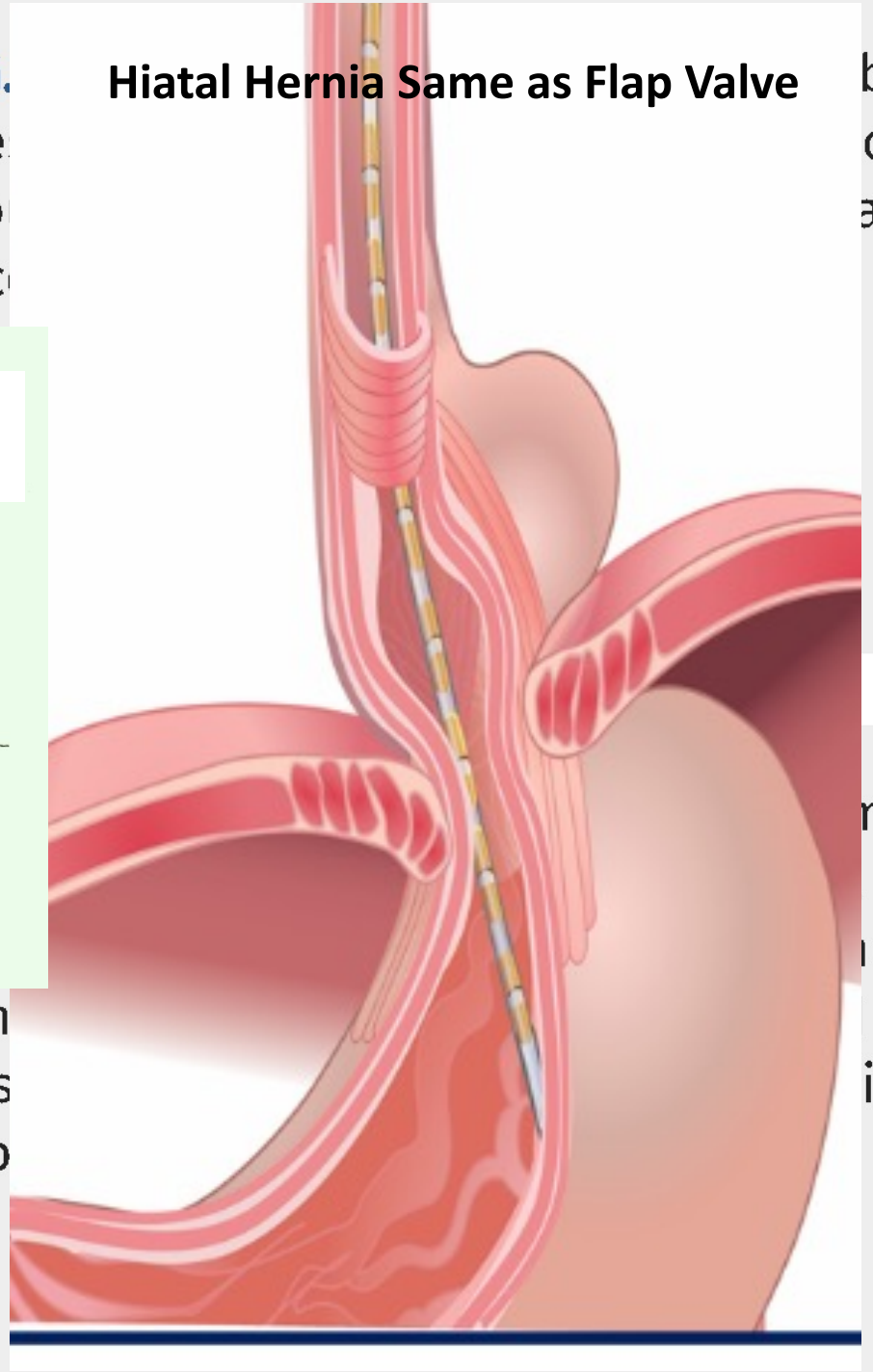


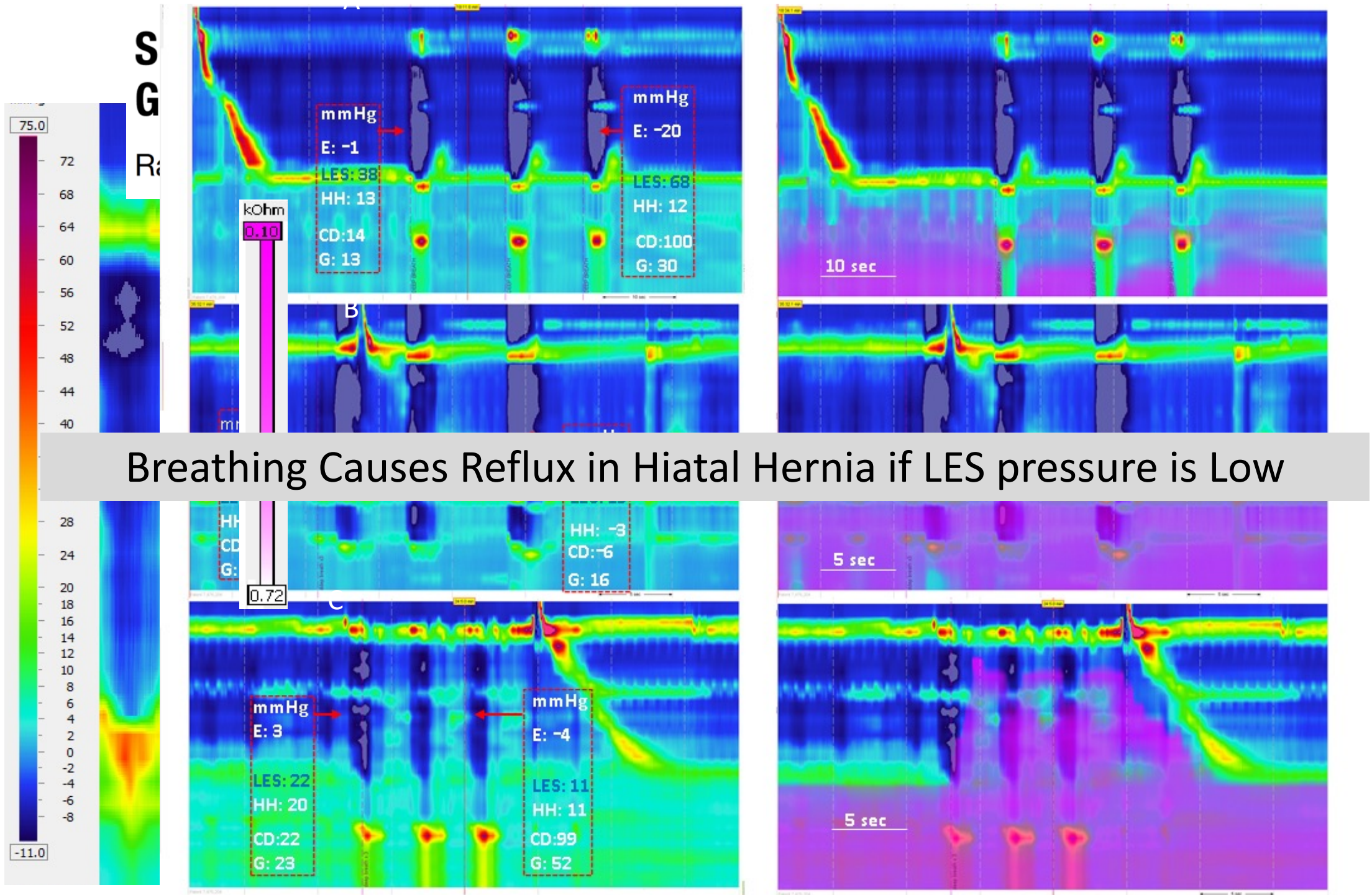






Hiatal Hernia Same as Flap Valve





Breathing Causes Reflux in Hiatal Hernia if LES pressure is Low

Antireflux Barrier – 2021

Better Measurement Techniques Have Allowed to Delineate

- **Structure & function of smooth muscle lower esophageal sphincter**
- **Structure and function of crural diaphragm (Hiatus)**
- **Flap valve/same as Hiatus Hernia – Separation between the LES and Hiatus**

Function Matches with Anatomy

Challenges in Antireflux Barrier Function Understanding – 2021

- Not all Heartburn is GERD or the Spectrum of GERD
- Cause of low LES pressure in GERD
- Cause of Hiatal Dysfunction in GERD
- Cause of Hiatus Hernia