HHS Public Access
Author manuscript
Gastroenterology. Author manuscript; available in PMC 2017 November 01.

Published in final edited form as:
Gastroenterology. 2016 November ; 151(5): 789–792. doi:10.1053/j.gastro.2016.09.024.

How to effectively utilize high-resolution esophageal manometry

Dustin A. Carlson and **Peter J. Kahrilas**
Department of Medicine, Division of Gastroenterology and Hepatology, Feinberg School of Medicine, Northwestern University, Chicago, IL, USA

Introduction

Esophageal manometry is the definitive test to evaluate esophageal motility and is indicated in the diagnostic evaluation of patients with non-obstructive dysphagia. Esophageal manometry is also indicated in the preoperative evaluation of patients prior to anti-reflux surgery to gauge the adequacy of peristalsis. Additionally, manometry is used in other clinical scenarios such as in the evaluation of non-cardiac chest pain, in the evaluation of regurgitation, and in symptomatic evaluation *following* anti-reflux or achalasia surgery. Over the past decade, there have been significant advances in manometric device technology, manometric data display, and manometric data analysis. Consequently, high-resolution manometry (HRM) with 36 closely spaced pressure sensors, data display in the format of Clouse plots (color isobaric contours), and the Chicago Classification have become widely adopted into clinical practice representing an update from 'conventional' line tracing manometry. This evolution offers great promise in standardizing the performance and interpretation of esophageal manometric studies[1, 2]. However, it also challenges trainees and practitioners to become sufficiently familiar with HRM to effectively utilize it in their practice environment. That doesn't mean that every practice must learn to *perform* HRM studies; only that they develop sufficient expertise to optimally *manage* patients with primary or secondary motility disorders. In many cases, this may involve referral to a regional center of excellence. Just as with transplant hepatology, endoscopic mucosal resection, complicated inflammatory bowel disease, biliary tract disease, or gastrointestinal cancers, sometimes recognizing the complexity of the problem and making the appropriate referral best serve the patient.

The Motility Laboratory

First and foremost, making an accurate diagnosis of an esophageal motility disorder depends on having or obtaining a high-quality HRM study. Decisions toward or away from foregut surgery (Heller myotomy, Nissen fundoplication), which can be associated with significant

Correspondence: Peter J. Kahrilas, MD, Northwestern University, Feinberg School of Medicine, Department of Medicine, Division of Gastroenterology and Hepatology, 676 St Clair St, Suite 1400, Chicago, IL 60611-2951, p-kahrilas@northwestern.edu, Tel: 312-695-4016.

Disclosures: Neither Dr. Carlson nor Dr. Kahrilas disclose any conflict of interest exist.

Author Manuscript

Author Manuscript

Author Manuscript

morbidity, are often based on HRM studies. These are high-impact, often difficult, decisions and high-quality studies optimize patient outcomes. Additionally, manometry requires trans-nasal intubation, which is uncomfortable and can make patients very averse to repeat procedures so it is incumbent on those making the first attempt to do it properly. When done properly, an HRM study is like an x-ray that can be put on a memory stick or CD and sent to an expert for a second opinion if necessary. However, faxed (black and white) copies of computer-generated automated interpretations or faxed Clouse plots are not very useful.

A high quality esophageal manometry laboratory requires both appropriate equipment and competent, dedicated staff to perform HRM studies. Appropriate equipment is readily obtainable, although those controlling the purse strings must accept that this requires not only a financial commitment up front, but also on-going expenses for dedicated personnel, equipment maintenance, and replacement HRM catheters. The current price of a Sierra-design catheter with a warranty covering 200 uses is approximately $12,000. As for manufacturer, the Sierra Scientific designed catheter (which after several company sales is currently owned by Medtronic, but still manufactured in the original Sierra facility) is the device that was utilized in essentially all of the investigational work done in the development of the Chicago Classification. Although there are now competitors, recognize that they use utilize different catheter technology with different performance characteristics. This is especially true with respect to measuring the completeness of esophagogastric junction (EGJ) relaxation, which is the single most important determination made in an HRM study. Consequently, if studies are done with apparatus other than the Medtronic (Sierra vintage) device, the clinical interpretation should be based upon normative values generated with that apparatus.[3]

Personnel performing HRM studies can be nurses, technicians, or physicians; the necessity being a level of training and continued experience required to perform studies in a high-quality manner. The person performing the study needs to be able to assess the adequacy of the study *as they are doing it*. They must have sufficient knowledge to determine proper trans-diaphragmatic catheter positioning, recognize common artifacts, and recognize equipment malfunction. Again, because the manometry study is uncomfortable and typically disliked by patients, technical competence is essential to avoid the need for repeat studies.

Finally, HRM should ideally be done in a practice environment with therapeutic expertise in treating motility disorders. This is especially true for achalasia and EGJ outflow obstruction. Optimal management of these patients requires that there be *regional expertise in all of the effective therapies*: pneumatic dilation, laparoscopic Heller myotomy, and per-oral esophageal myotomy (POEM). Given the multitude of variables involved in deciding among these therapies, having the full spectrum available is appealing. A regional referral network of experienced practitioners should be established to provide comprehensive high-quality patient care.

Performance of a high-quality HRM study

Briefly, performing an HRM study first involves obtaining informed consent, catheter calibration, and application of topical anesthetic to the patient's nostril. The HRM catheter is placed trans-nasally and positioned by observing the recording, adjusting it such that the distal two or three cm is sub-diaphragmatic. This is not always possible with large hiatal hernias, but it is desirable. Also desirable, but not always achievable, is to have 2 to 3 cm of catheter above the upper esophageal sphincter (UES) to serve as a reliable swallow marker. Correct catheter placement is necessary to assess EGJ relaxation and can be confirmed by identifying the pressure inversion point; the point at which the negative intra-thoracic pressures associated with inspiration inverts to positive intra-abdominal pressure. Alternatively, the pre-calibrated catheter can be placed with endoscopic guidance and the study done in the recovery area after the patient awakens; this technique requires training.

Once the catheter is in place and after allowing for patient acclimation, a baseline resting EGJ pressure should be obtained with normal respiration and without swallows. The duration of this varies among patients, but the person conducting the study needs to see that there is a swallow-free 30-second period of recording suitable for analysis. When not readily obvious, proper catheter positioning can be confirmed by having the patient take several deep breaths to accentuate the pressure inversion point and augment EGJ pressure. At a minimum, the manometry study should include 10 swallows of a 5-ml liquid bolus in the supine position; this forms the basis for diagnosis according to the Chicago Classification[4]. Patients should be instructed to swallow only a single time for each test swallow and swallows should be performed at intervals of about 30 seconds. If the patient is unable to tolerate the supine position, swallows can be performed in the sitting position, but it should recognized that peristaltic and EGJ pressures are lower in the sitting compared to the supine position.[3]

HRM interpretation

Although computer-generated automated analysis of the HRM study is a useful aid, the ultimate interpretation needs to be performed by an experienced and competent clinician. The software is much better at interpreting normal studies than it is at distinguishing among pathologies. The Gastroenterology Core Curriculum suggests two levels of training for HRM interpretation: 1) a basic level required for all gastroenterologists and 2) enhanced clinical training for those seeking to provide HRM studies to patients.[5] This is analogous to liver disease; every gastroenterologist needs to recognize complications of cirrhosis, but only transplant hepatologists need know the subtleties of candidacy for transplant. While the stakes may be lower than with liver transplant, interpretation of HRM as it applies to directing patient management has significant implications for patient morbidity and quality of life. A benchmark for competency in HRM interpretation has been suggested as interpreting 50 studies[1, 5]. However, a recent study of gastroenterology trainees found that <50% of trainees actually achieved competency at that experience level[2]. Obviously, it is more than just a matter of numbers. Achieving a competency to provide high-quality HRM interpretation requires some degree of hands-on training in a center of excellence. Interpretation of HRM beyond the basics is complex and nuanced and requires training and experience in a tertiary care environment enriched with esophageal pathology. Opportunities for advanced motility training are offered at a few tertiary centers as well as through the American Neurogastroenterology and Motility Society.[6]

While high-level, high-quality interpretation of esophageal HRM may not be for all practicing gastroenterologists, there are some basic concepts that should be understood. HRM provides standardized, quantifiable metrics derived from Clouse plots of test swallows that guide interpretation. These include (Figure 1):

- Integrated relaxation pressure (IRP): The IRP is a measure of deglutitive EGJ relaxation and is the primary metric to define an EGJ outflow obstruction. It is expressed as a median of the ten test swallows in mmHg with 15 mmHg being the upper limit of normal for Sierra-design catheters.
- Distal contractile integral (DCI): The DCI is a measure of peristaltic (contractile) vigor, the determinant of hypercontractile swallows (DCI> 8,000), weak swallows (DCI<450) and failed peristalsis (DCI<100). Units are mmHg•s•cm.
- Distal latency (DL): The DL evaluates for premature contractions, the basis for defining distal esophageal spasm and type III achalasia. The DL is the time interval (in seconds) from UES relaxation to the contractile deceleration point (CDP), the inflection point in the wavefront velocity proximal to the EGJ. Identification of the CDP can be one of the more challenging components of HRM interpretation, especially in the presence of c*ompartmentalized pressurization* (Figure 1B).
- Peristaltic breaks: These are spatial gaps in the peristaltic contraction defined by examining the UES to EGJ integrity of the 20-mmHg isobaric contour. Peristaltic breaks are considered significant if they are > 5cm in axial length.
- Pressurization pattern: Pressurization occurs when the swallowed liquid becomes trapped between two contracting segments of the esophagus and is identified by a vertical isobaric pressure band. Pressurization of >30 mmHg that spans from the UES to the EGJ is termed pan-esophageal pressurization and is the defining feature of type II achalasia (Figure 1C). Compartmentalized pressurization, i.e. pressurization between a peristaltic contraction and the EGJ is indicative of outflow obstruction (Figure 1B).

After analyzing the ten test swallows, the Chicago Classification is applied to determine the manometric diagnosis (Figure 2).[4] Additionally, HRM can be utilized to evaluate whether or not a hiatal hernia is present and basal EGJ pressure. Although often referred to as the lower esophageal sphincter (LES), the distal high-pressure zone is more accurately termed the EGJ, inclusive of both the LES and crural diaphragm.

In the hierarchical scheme of the Chicago Classification, identification of *EGJ outflow obstruction* (defined by a median IRP of >15 mmHg with the Sierra-design catheter) is paramount in managing esophageal disease. Presence or absence of an EGJ outflow obstruction is the initial decision point in the diagnostic algorithm. If EGJ outflow obstruction is accompanied by 100% failed swallows or 20% premature swallows, a diagnosis of achalasia is achieved. Achalasia is sub-classified according to the pattern of contractility that accompanies the EGJ outflow obstruction: type I (classic) is associated with negligible contractility; type II (pan-esophageal pressurization) carries the greatest likelihood of treatment success; while type III (spastic) is associated with the lowest successful outcome rate.[7, 8] An elevated IRP associated with a contractile pattern that does not meet criteria for an achalasia subtype defines EGJ outflow obstruction. This diagnosis is heterogeneous with a differential diagnosis that includes evolving achalasia, mechanical obstruction, hiatal hernia, and pressure artifact. Thus, additional evaluation, such as imaging with barium esophagram or endoscopic ultrasound, should be considered prior to a therapeutic intervention.

If the median IRP is normal, the percentage of premature, hypercontractile, and failed swallows can be applied to identify a *major disorder of peristalsis*, which are patterns not observed in asymptomatic control subjects. Distal esophageal spasm is defined by premature swallows, hypercontractile (or "jackhammer") esophagus is defined by hypercontractile swallows, and absent contractility is designated if 100% of swallows are failed.

A *minor disorder of peristalsis* is established if the median IRP is normal, a major disorder of peristalsis is excluded, and either ≥50% of swallows are weak or failed (ineffective esophageal motility, IEM), or ≥ 50% of swallows have large peristaltic breaks (fragmented peristalsis). Both of these motility diagnoses can be seen in patients presenting with dysphagia or reflux-symptoms. However, these diagnoses can also be observed in asymptomatic controls, thus, the clinical relevance of these *minor disorders of peristalsis* remains unclear. Finally, if another motility diagnosis is not achieved and ≥ 50% of swallows are normal, a diagnosis of normal motility is reached.

Conclusions

High-quality performance and interpretation of HRM is essential for high-quality clinical management of esophageal motility disorders. While basic competency in HRM can be achieved through study and practice, high-level competency for HRM requires more than just experiential numbers. Rather, it implies acquiring sufficient expertise to perform, interpret, and apply esophageal manometry to patient care. Basically, it requires some degree of training at an expert center. Though *accredited* advanced training programs in gastrointestinal motility are currently lacking, opportunities for advanced training are offered through several tertiary centers, as well as through gastrointestinal motility societies. Ultimately, performance and interpretation of HRM may not be for all gastroenterologists or all gastroenterology practices. Thus, recognition of resource limitations and the development of appropriate referral networks to expert centers is an essential component of a high-quality gastroenterology practice.

References

1. Yadlapati R, Gawron AJ, Keswani RN, et al. Identification of Quality Measures for Performance of and Interpretation of Data From Esophageal Manometry. Clin Gastroenterol Hepatol. 2016; 14(4): 526–34. e1. [PubMed: 26499925]
2. Yadlapati R, Keswani R, Ciolino JD, et al. Development of a High Resolution Esophageal Manometry (HREM) Training System Identifies Significant Variation in HREM Learning Curves. Gastroenterol. 2016; 150(4 s1):s460–s1.

3. Herregods TV, Roman S, Kahrilas PJ, et al. Normative values in esophageal high-resolution manometry. Neurogastroenterol Motil. 2015; 27(2):175–87. [PubMed: 25545201]

4. Kahrilas PJ, Bredenoord AJ, Fox M, et al. The Chicago Classification of esophageal motility disorders, v3. 0. Neurogastroenterol Motil. 2015; 27(2):160–74. [PubMed: 25469569]

5. American Association for the Study of Liver D, American College of G, American Gastroenterological Association I et al. The Gastroenterology Core Curriculum, Third Edition. Gastroenterology. 2007; 132(5):2012–8. [PubMed: 17484892]

6. Rao SS, Parkman HP. Advanced training in neurogastroenterology and gastrointestinal motility. Gastroenterology. 2015; 148(5):881–5. [PubMed: 25805422]

7. Pandolfino JE, Kwiatek MA, Nealis T, et al. Achalasia: a new clinically relevant classification by high-resolution manometry. Gastroenterology. 2008; 135(5):1526–33. [PubMed: 18722376]

8. Rohof WO, Salvador R, Annese V, et al. Outcomes of treatment for achalasia depend on manometric subtype. Gastroenterology. 2013; 144(4):718–25. quiz e13–4. [PubMed: 23277105]

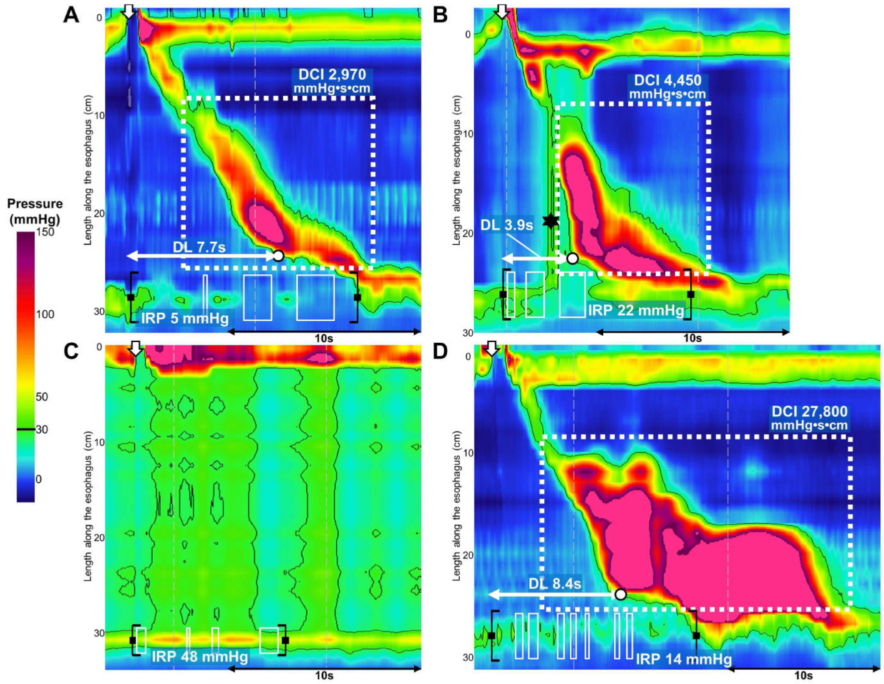

Figure 1.

High-resolution manometry metrics and swallow types. Examples of a (A) normal swallow, (B) a premature swallow, (C) a failed swallow with pan-esophageal pressurization, and (D) a hypercontractile swallow are displayed. Swallow onset (relaxation of the upper esophageal sphincter) is represented by a white arrow. The contractile deceleration point is represented by a white dot. Compartmentalized pressurization (✶) can be appreciated in B. DCI – distal contractile integral. DL – distal latency. IRP – integrated relaxation pressure.

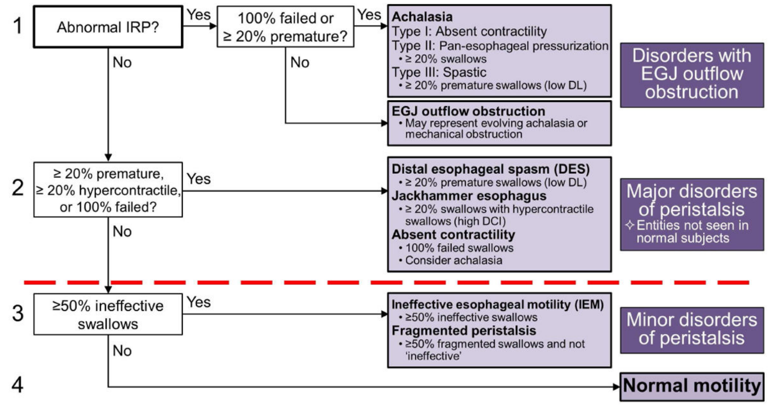

Figure 2. The Chicago Classification of esophageal motility diagnoses

An esophageal motility diagnosis can be determined by a hierarchical classification scheme that 1) evaluates for esophagogastric junction (EGJ) outflow obstruction and then 2) applies esophageal contractile and pressurization patterns. Both 'failed' and 'weak' swallows are consider 'ineffective' swallows. Esophageal motility diagnoses above the dashed red line indicate motor patterns not observed in asymptomatic controls and thus are considered *major esophageal motility disorders.* DCI – distal contractile integral. DL – distal latency. IRP – integrated relaxation pressure.