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Review

Understanding the Chicago Classification: From Tracings to Patients

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Current parameters of the Chicago classification include assessment of the esophageal body (contraction vigour and peristalsis), lower esophageal sphincter relaxation pressure, and intra-bolus pressure pattern. Esophageal disorders include achalasia, esophagogastric junction outflow obstruction, major disorders of peristalsis, and minor disorders of peristalsis. Sub-classification of achalasia in types I, II, and III seems to be useful to predict outcomes and choose the optimal treatment approach. The real clinical significance of other new parameters and disorders is still under investigation. **(J Neurogastroenterol Motil 2017;23:487-494)**

Key Words
Chicago classification; Esophageal achalasia; Esophageal motility disorders; High-resolution manometry

Introduction

High-resolution manometry (HRM) provides an intuitive and panoramic view of the proximal digestive physiology from the pharynx to the stomach (Fig. 1). As compared to conventional manometry, HRM determines more comfort and speediness to the test, reduces inter-observer variability, and compensates movements' artefacts. These improvements allow a better evaluation of sphincters relaxation, and the identification of segmental defects of peristalsis not covered by the spacing of sensors in conventional systems.[1,2]

The more comprehensive and more appealing to the eyes HRM plots provoked the imagination of esophageal physiologists to create new investigative parameters and reclassify esophageal motility disorders. This led to the development of an algorithmic scheme for the diagnosis of esophageal motility disorders in esophageal pressure topography plots, under the name of the Chicago classification.[3] This allowed for improved recognition of motility disorders, and easier interpretation than conventional manometry line tracings.

The Chicago classification was recently revised (version 3.0) to exclude some previous parameters without clear clinical application, define parameters to be used, and classify esophageal motility disorders.[4]

The aim of this study was to review the Chicago classification version 3.0, and assess the clinical implications of the parameters and disorders defined by this classification.

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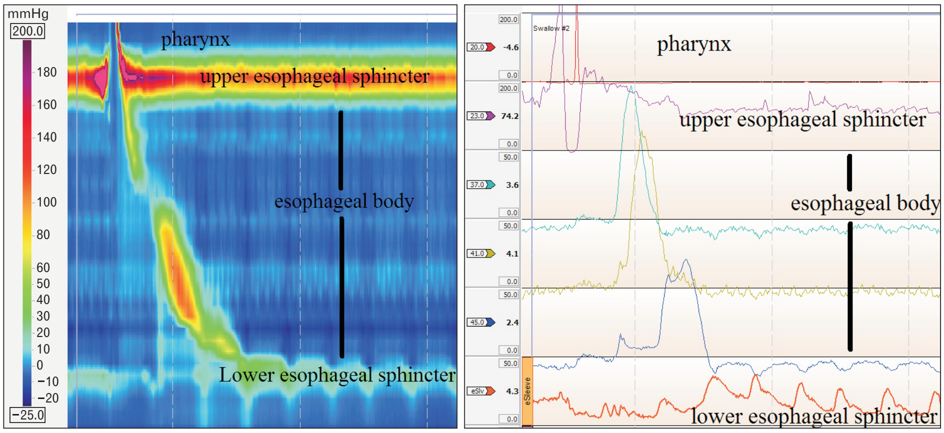

Figure 1. Normal high-resolution manometry plot (left) compared to the same swallow at the conventional manometry (right).

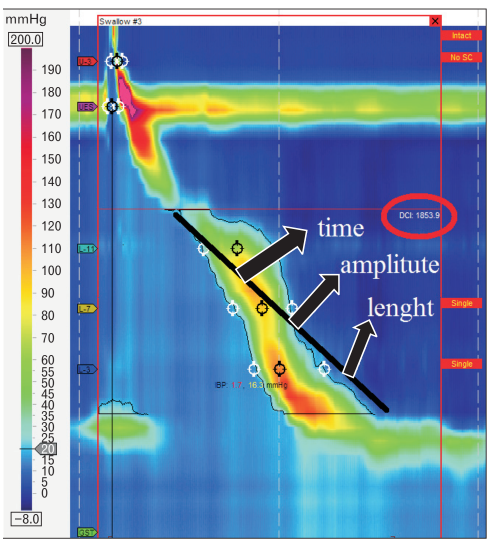

Figure 2. Distal contractile integral (DCI). DCI value is calculated as the product of the mean amplitude of contraction in the distal esophagus (mmHg) times the duration of contraction (seconds) times the length of the distal oesophageal segment (cm) exceeding 20 mmHg for the region spanning from the transition zone to the proximal aspect of the lower esophageal sphincter.

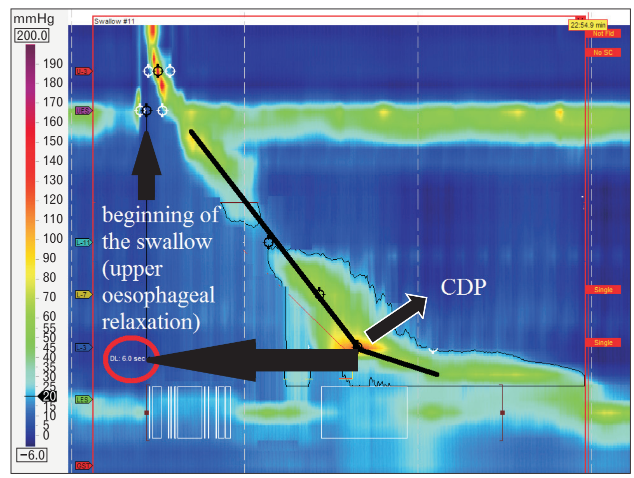

Figure 3. Distal latency (DL) measures objectively the time frame of the wave from the beginning of the swallow (upper esophageal relaxation) to the contractile deceleration point (CDP).

Parameters Evaluated by High-resolution Manometry

Esophageal Body

Contraction vigour

HRM allows the evaluation of contractility not only by amplitude measurement at fixed points, but through a combination of amplitude, time and length of the whole peristaltic wave. This parameter is the *distal contractile integral* (DCI). DCI value is calculated as the product of the mean amplitude of contraction in the distal esophagus (mmHg) times the duration of contraction (seconds), times the length of the distal esophageal segment (cm) exceeding 20 mmHg for the region spanning from the transition zone to the proximal aspect of the lower esophageal sphincter (LES) (Fig. 2). DCI classifies waves as failed (DCI $<$ 100 mmHg·sec·cm), weak (DCI 100-450 mmHg·sec·cm), ineffective (failed or weak), normal (DCI 450-8000 mmHg·sec·cm), or hypercontractile (DCI $>$ 8000 mmHg·sec·cm).[5]

Peristalsis

HRM evaluates peristalsis by the *distal latency* (DL) which measures objectively the timeframe of the wave from the beginning of the swallow (upper esophageal sphincter relaxation) to an inflection of the peristaltic axis known as the contractile deceleration point (Fig. 3). Premature contractions are defined with a DL < 4.5 seconds.

Fragmented contractions are considered segmental defects (break in the 20 mmHg isobaric contour > 5 cm) with normal contraction vigour.

Table summarizes esophageal body parameters evaluated with HRM.

Lower Esophageal Sphincter

Lower esophageal sphincter pressure

The Chicago classification did not define parameters for LES length or basal pressure, but simply recommended assessment of pressure as an average of inspiratory and expiratory values for 3 normal respiratory cycles. Relaxation, however, is measured not by the nadir pressure as previously done with conventional manometry, but with the integrated relaxation pressure (IRP) that corresponds to the mean pressure of 4 seconds of greatest post deglutitive relax-

Table. Characterization of Esophageal Contractility

	Contraction vigour
Failed	DCI < 100 mmHg · sec · cm
Weak	DCI 100-450 mmHg · sec · cm
Ineffective	Failed or weak
Normal	DCI 450-8000 mmHg · sec · cm
Hypercontractile	DCI > 8000 mmHg · sec · cm
	Contraction pattern
Premature	DL < 4.5 sec
Fragmented	Break > 5 cm in the 20 mmHg isobaric contour with normal DCI
Intact	Not achieving the above criteria

DCI, distal contractile integral; DL, distal latency.

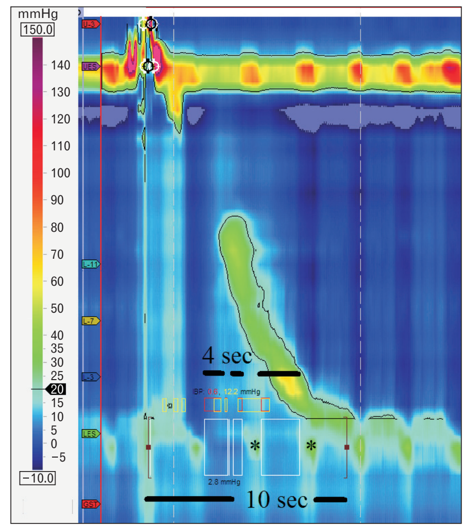

Figure 4. Integrated relaxation pressure (IRP) corresponds to the mean pressure of 4 seconds of greatest post deglutitive relaxation in a 10 seconds gap, triggered at the beginning of a swallow. Note diaphragmatic contraction pressure (*) during relaxation excluded from analysis.

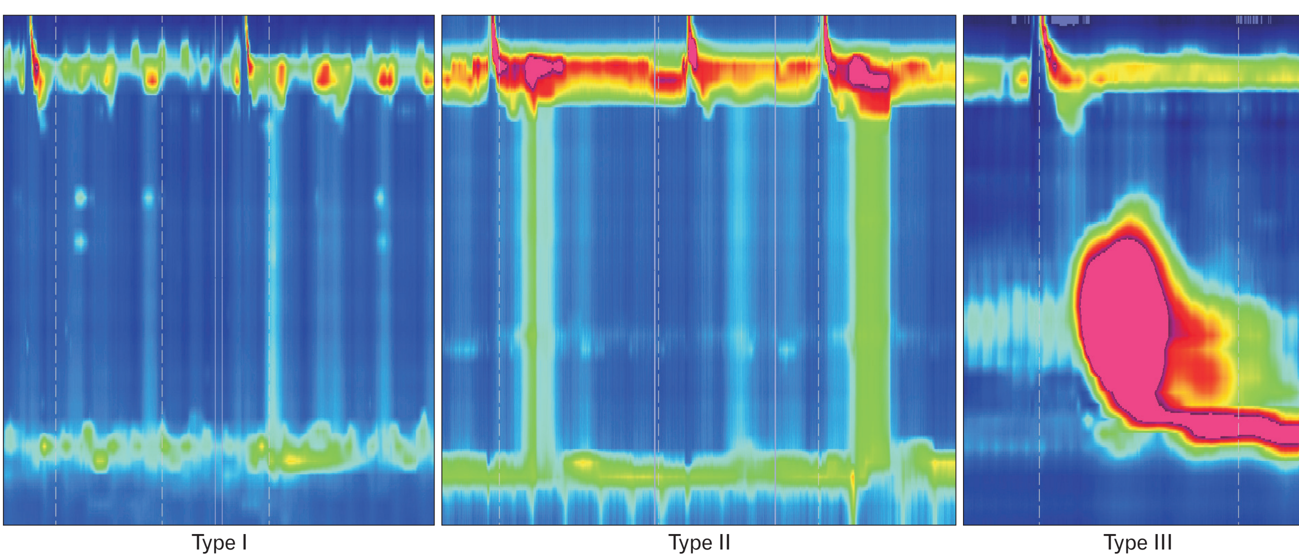

Figure 5. Achalasia subtypes. Type I: absence of esophageal pressurization; Type II: panesophageal pressurization; Type III: premature contractions (distal latency < 4.5 seconds).

ation in a 10 seconds gap, triggered at the beginning of a swallow (Fig. 4). This metric compensates for diaphragmatic contraction during LES relaxation, and eliminates pseudo-relaxation due to movement artefacts.

Intrabolus Pressure Pattern

Abnormal intrabolus pressure corresponds to regions of esophageal pressurization > 30 mmHg. It may be panesophageal (whole esophageal body), compartmentalized (from the contractile deceleration point to the esophagogastric junction [EGJ]) or EGJ pressurization (between the LES and the diaphragm).

Esophageal Motility Disorders

Achalasia

Achalasia is defined by aperistalsis and abnormal LES relax-

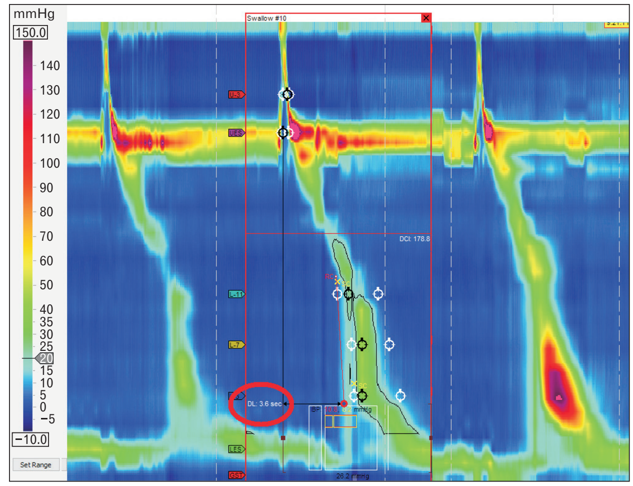

Figure 6. Distal esophageal spasm. Premature contractions (distal latency [DL] < 4.5 seconds) in at least 20% of swallows.

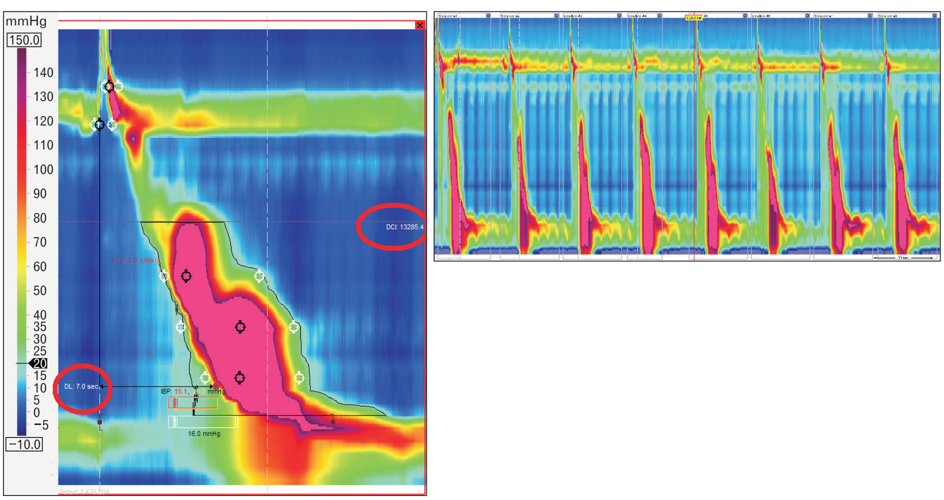

Figure 7. Hypercontractile esophagus (jackhammer esophagus). Distal contractile integral (DCI) > 8000 mmHg·sec·cm in at least 20% of swallows and normal distal latency (DL).

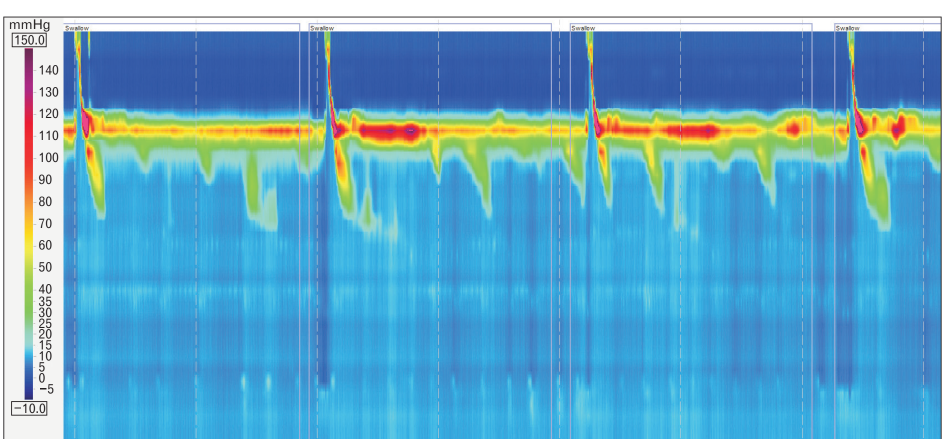

Figure 8. Absent contractility. Aperistalsis in the setting of normal lower esophageal sphincter relaxation (integrated relaxation pressure < 10 mmHg).

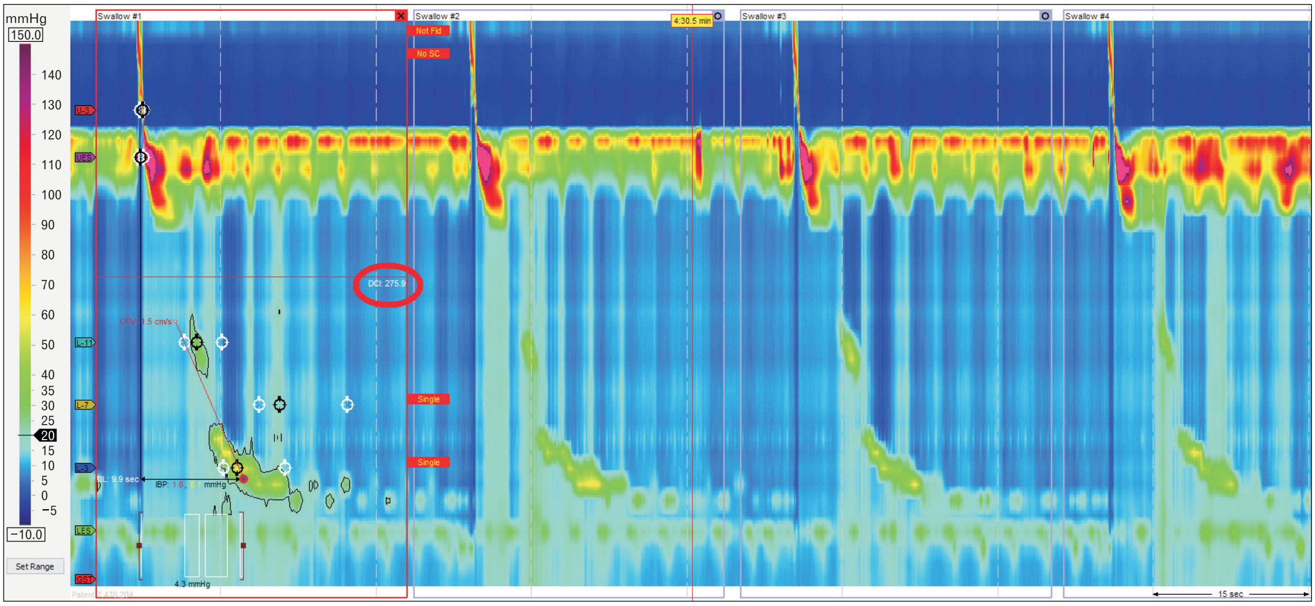

Figure 9. Ineffective esophageal motility. Failed or weak peristalsis in at least ≥ 50% of swallows. DCI, distal contractile integral.

ation (IRP > 15 mmHg). The disease is further classified into 3 subtypes (Fig. 5).

Type I: incomplete LES relaxation, aperistalsis and absence of esophageal pressurization.

Type II: incomplete LES relaxation, aperistalsis and panesophageal pressurization in at least 20% of swallows.

Type III: incomplete LES relaxation and premature contractions (DL < 4.5 seconds) in at least 20% of swallows.

Esophagogastric Junction Outflow Obstruction

EGJ obstruction is characterized by an impaired LES relaxation (IRP > 15 mmHg) with normal or weak peristalsis.

Major Disorders of Peristalsis

Distal esophageal spasm

Distal esophageal spasm (DES) is defined by premature contractions (DL < 4.5 seconds) in at least 20% of swallows with a normal IRP (Fig. 6).

Hypercontractile esophagus

Hypercontractile esophagus (jackhammer esophagus) is characterized by DCI > 8000 mmHg·sec·cm in at least 20% of swallows and normal DL (Fig. 7).

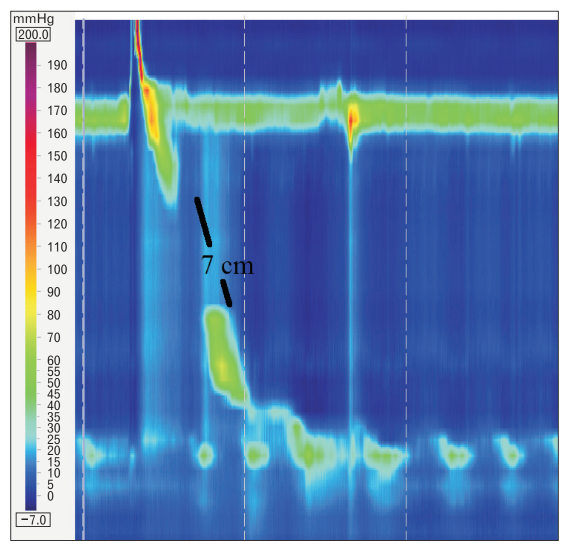

Figure 10. Fragmented peristalsis. ≥ 50% fragmented contractions with distal contractile integral (DCI) > 450 mmHg·sec·cm.

Absent contractility

Absent contractility is characterized by aperistalsis in the setting of normal LES relaxation (IRP < 10 mmHg) (Fig. 8).

Minor Disorders of Peristalsis

Ineffective esophageal motility

Ineffective esophageal motility is defined by ≥ 50% ineffective swallows (failed or weak—DCI < 450 mmHg·sec·cm) (Fig. 9).

Fragmented peristalsis

Fragmented peristalsis is defined by ≥ 50% fragmented contractions with normal contraction vigour (Fig. 10).

Impact of High-resolution Manometry on the Management of Esophageal Motility Disorders

The Chicago classification reclassified motility disorders previously defined by conventional manometry.[6] The clinical value of this new classification is under scrutiny. A recent publication claims that the Chicago classification has a higher threshold for abnormality, resulting in fewer patients classified as abnormal motility.[7] On the other hand, a recent study that randomized patients with dysphagia to undergo either HRM or conventional manometry, found a higher proportion of manometric diagnosis in the HRM arm.[8]

Achalasia

The current main therapeutic options for achalasia include pneumatic dilatation (PD), peroral endoscopic myotomy (POEM), and laparoscopic Heller myotomy (LHM).[9]

The Chicago classification may help to predict the result of treatment. Pandolfino and colleagues[10] reported that type II achalasia patients were significantly more likely to respond to PD (91%) or LHM (100%), as compared to type I (56% overall) and type III (29% overall). Concordantly, Salvador et al[11] evaluated 246 consecutive patients who underwent LHM and found that treatment failure rates were significantly different among the subtypes of achalasia: type I (14.6%), type II (4.7%), and type III (30.4%) (P = 0.0007). A recent meta-analysis encompassing 9 studies and 727 patients also showed that type II achalasia was associated with the best prognosis after PD and LHM, while type III achalasia had the worst prognosis.[12]

The Chicago classification may also help selecting the best initial approach for patients with achalasia. Kumbhari and colleagues[13] reported that in patients with type III achalasia, clinical response was achieved more frequently after POEM (98.0%), as compared to LHM (80.8%) (P = 0.01). Recently, Khashab et al[14] reported their experience with POEM for the treatment of 54 patients with type III achalasia refractory to medical therapy, and showed a 96.3% clinical success rate. Hence, while in type I and II achalasia both PD and LHM remain as good treatment alternatives, type III achalasia seems to be better managed with POEM, probably due to the ability to a longer myotomy of the thoracic esophagus.

Overall, sub-classification of achalasia in types I, II, and III with the Chicago classification seems to be useful to predict outcomes and choose the optimal treatment approach for this motility disorder.

Esophagogastric Junction Outflow Obstruction

The definition of EGJ outflow obstruction based solely on the IRP with the exclusion of achalasia allows this diagnosis to be superimposed to other diagnoses dependent of the esophageal body motility. It may be caused by an anatomical abnormality at the cardia (hiatal hernia, diseases of the esophageal wall, etc) or be idiopathic with normal anatomy.

Similar to achalasia, treatment is directed towards relief of the obstruction and can be accomplished by botulinum toxin injection, PD, LHM, or POEM. Both botulinum injection and PD showed good relief of dysphagia but with ephemeral duration.[15] Scherer and colleagues,[16] among 1000 HRM diagnosed 16 patients (1.6%) with EGJ outflow obstruction and treated them with botulinum toxin injection, PD or LHM. Only the 3 patients treated with LHM responded well.[16] Interestingly, Pérez-Fernández et al[17] reported that over one-third of the patients with EGJ outflow obstruction presented a spontaneous resolution of the symptoms, concluding that surgical treatment should be considered with special caution in these patients. In the setting of an anatomic abnormality such as a hiatal hernia, surgical correction is associated with long-lasting and excellent results.[18]

EGJ outflow obstruction is now recognized as a distinct entity in the Chicago classification. However, the real clinical significance of this diagnosis is still uncertain. In fact, it could be an early or incomplete expression of a variant of achalasia. Thus, the exact significance and clinical management of these patients remains unclear.

Major Disorders of Peristalsis

As the symptoms and the manometric picture of esophageal motility disorders can be due to gastroesophageal reflux disease (GERD), it is of paramount importance to rule out abnormal reflux by pH monitoring. If GERD is present, either medical or surgical treatment should be directed towards the control of the reflux.[19]

The management of DES remains elusive. The Chicago classification defines this disorder with a new parameter: the DL. Previous reports showed good results in patients with "diffuse esophageal spasm" (Richter classification)[6] who underwent LHM with an extended myotomy.[20,21] However, scarce data are available after the new classification defined DES. A review of the publications after this definition became publicized showed that botulinum toxin injection in the esophageal body was superior to placebo to relieve dysphagia in patients with DES, and that POEM is a promising treatment for these patients.[22]

The definition of *hypercontractile esophagus* (*jackhammer*) was updated in the last version of the Chicago classification to include only cases with ≥ 20% of swallows with a DCI > 8000 mmHg · sec · cm, excluding a single altered swallow from the definition. Pharmacological relaxation of the smooth muscle with phosphodiesterase-5 inhibitor or anticholinergic agents has shown symptomatic improvement.[23] Studies focusing on surgical therapy for hypercontractile esophagus based on the new classification are not available. Previous reports not using HRM or the Chicago classification, however, showed acceptable outcomes after surgical myotomy.[24,25]

Absent contractility is mostly diagnosed in patients with connective tissue diseases. There is no specific treatment to restore or improve peristalsis in these patients. Associated GERD is usually the target of therapy.[26]

Minor Disorders of Peristalsis

Therapeutic options for *ineffective esophageal motility* are still limited, as no effective treatment is available to restore impaired esophageal smooth muscle contractility.[27] Treatment directed towards GERD is helpful when dysmotility is secondary to this disease.

The concept of *fragmented peristalsis* changed radically from previous versions to the version 3.0. Only large breaks (> 5 cm) with normal peristalsis are included. This is more clinically relevant, since incomplete bolus transit is observed in 100% of the cases of large breaks but only in 16% of small breaks.[28] It is unclear how to treat this finding since there are no studies focusing on the treatment for this disease under these criteria. There are no studies evaluating changes in the motility pattern after therapy for GERD as well, since both conditions are frequently associated.

Conclusions

HRM and the Chicago classification certainly contributed to a better definition of esophageal motility disorders. Particularly for achalasia, sub-classification in types I, II, and III seems to be useful to predict outcomes and choose the optimal treatment approach. The real clinical significance of other new parameters and disorders is still under investigation.

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