Management of esophageal motility disorders in children : a review

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Abstract

Diagnostic criteria for esophageal motor disorders have recently been updated with the advent of high-resolution manometry that gives a precise mapping of peristaltic abnormalities and an indirect view of bolus transit problems. Achalasia, the best-defined motor disorder, is now divided in subsets of manometric phenotypes that predict outcome of treatment and guide our therapeutic approach. Pharmacological therapy using smooth muscle relaxants for spastic esophageal disorders remains poorly effective and used only as a bridge to more effective therapies : endoscopic balloon dilation and surgical myotomy are both effective therapies in achalasia, myotomy being considered as the preferred approach in children because it is aimed to be definitive, while dilations usually have to be repeated. Recently, peroral endoscopic myotomy was introduced as an alternative to surgical myotomy for achalasia, and was rapidly adopted in tertiary referral centers. Showing excellent short-term results, this technique might be also proposed for other esophageal spastic disorders. Gastroesophageal reflux disease and eosinophilic esophagitis, two prevalent diseases in children that may be associated with hypotensive and hypertensive peristaltic abnormalities, have to be searched because specific effective therapies exist for these diseases that may cure the motility disorders. (Acta gastroenterol. belg., **2018**, 81, **295-304**).

Key words : achalasia, distal esophageal spasm, esophageal high resolution manometry, esophageal motility, laparoscopic Heller myotomy, peroral endoscopic myotomy, pneumatic dilation.

Abbreviations : BTI botulinium toxin injection, CVF contractile front velocity, DCI distal contractile integral, DES distal esophageal spasm, DL distal latency, EoE eosinophilic esophagitis, EGJ esophagogastric junction, EHRM esophageal high resolution manometry, EPT esophageal pressure topography, GERD gastroesophageal reflux disease, IRP integrated relaxation pressure, LHM laparoscopic Heller myotomy, PD pneumatic dilation, PFA pressure flow analysis, POEM peroral endoscopic myotomy.

Introduction

Motility disorders of the esophagus, widely described in adults, are also encountered in children. Recognizing these disorders is crucial, since esophageal dysfunction leads to eating difficulties and weight loss and prevents children to keep up at school and to lead a normal life. Severe complications such as respiratory symptoms may also occur. (1) Interest for esophageal motility disorders has recently risen thanks to the technical improvement of esophageal manometry with closely spaced sensors allowing high resolution measurements and fine spatiotemporal visualization of esophageal peristaltic function. (2)

An etiologic approach of pediatric esophageal motor disorders was once proposed (1) but as further explained, the esophageal pressure topography (EPT) study with esophageal high-resolution manometry (EHRM) is nowadays the recommended diagnostic approach.

Symptoms linked to esophageal dysfunction in adolescents and young adults are rather well defined, with the triad of chest pain, dysphagia and regurgitations. In young children, symptoms are less specific, various and sometimes misleading: food refusal, failure to thrive, gagging or choking during meals, vomiting, abdominal pain, and nocturnal cough. Food impaction and recurrent respiratory infections should also evoke an esophageal peristaltic dysfunction in the absence of structural pathologies of the esophagus.

Evidence-based therapeutic approach in children often derives from data obtained in the adult population with esophageal motility disorders. The best-described disorder is achalasia, for which efficacious treatments are available. Currently available treatments range from drugs to endoscopy and surgery, the latter two joining today with the venue of advanced endoscopic techniques like peroral endoscopic myotomy (POEM) (3). However, they are palliative treatments, aimed at relaxing, disrupting or cutting a non-relaxing lower esophageal sphincter (LES). Hopefully, it is possible that in the future, immunomodulatory drugs or stem cell therapy will be able to restore a normal peristaltic function in motility disorders (4,5).

Most of the literature dealing with esophageal motor disorders comes from the adult population, fewer studies being available for the children.

The place of esophageal high-resolution manometry

Manometry is the best test to evaluate the motor esophageal function if a structural abnormality has been ruled out by endoscopy. When manometry is not available radiology is a useful complementary technique (6). There is a renewal in interest and comprehension of motility disorders with the advent of EHRM. Technical improvement of esophageal manometry with closely spaced sensors that allows a fine spatiotemporal

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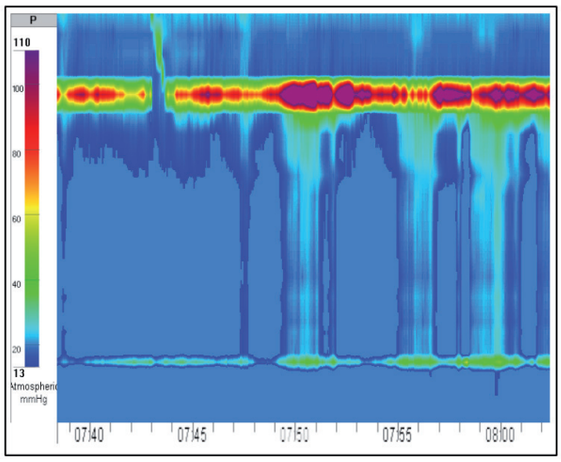

Figure 2 — EHRM tracing of achalasia I patient.

Pharmacological approaches

Smooth muscle relaxants for esophageal achalasia are often poorly effective with side effects that limit their use, like hypotension or headaches, and must be taken several times a day (25). These considerations severely limit their use in children for whom they cannot be offered as a definitive treatment. Drugs might be at best prescribed as a temporary approach while waiting for a more effective and definitive treatment. Many published data on drugs used in esophageal motor disorders come from open uncontrolled studies enrolling a small number of adult patients during a short period of time. Nitrates and calcium channel blockers are the most widely used in clinical practice, mostly in the adult population with some case reports in children with nifedipine (26) and only one pediatric study available (27). However in either children or adults, calcium channel blockers are not a definite therapy and should only be used as a bridge to release symptoms.

Botulinium toxin (BTI) inhibits the release of acetylcholine in nerve terminals. Endoscopically injected in the lower esophageal sphincter (LES) muscle, BTI reduces LES pressure by about 50% and provides a short-term benefit that wanes with months (28,29). Also, it has been reported that LHM was technically more difficult in patients previously treated with BTI because of muscular fibrosis (30). BTI is therefore proposed for patients who are poor surgical candidates, but cannot be recommended as a long-term treatment in children

Pneumatic dilation

Pneumatic dilation (PD) of the cardia improves dysphagia by disrupting the spastic muscle, lowers the LES pressure and esophagogastric pressure gradient. PD of the cardia is performed using a low compliance polyethylene balloon under fluoroscopic guidance (31). Widely used in adults in an ambulatory setting under sedation, PD is an acceptably safe procedure in children, the main complication being esophageal perforation with an estimated rate of 2-6% (32). In a recent pediatric systematic review, an efficacy of 65-80% was reported in a 2-8 years follow up. This confirms that, as in adults, PD is an effective treatment in children, providing the balloon size is appropriate, and the procedure repeated (33). Recommended balloon size in children > 5 years is 30 mm (34). The advantage of this technique are its low cost as well as the fact that it can be repeated if needed and be used before or after myotomy.

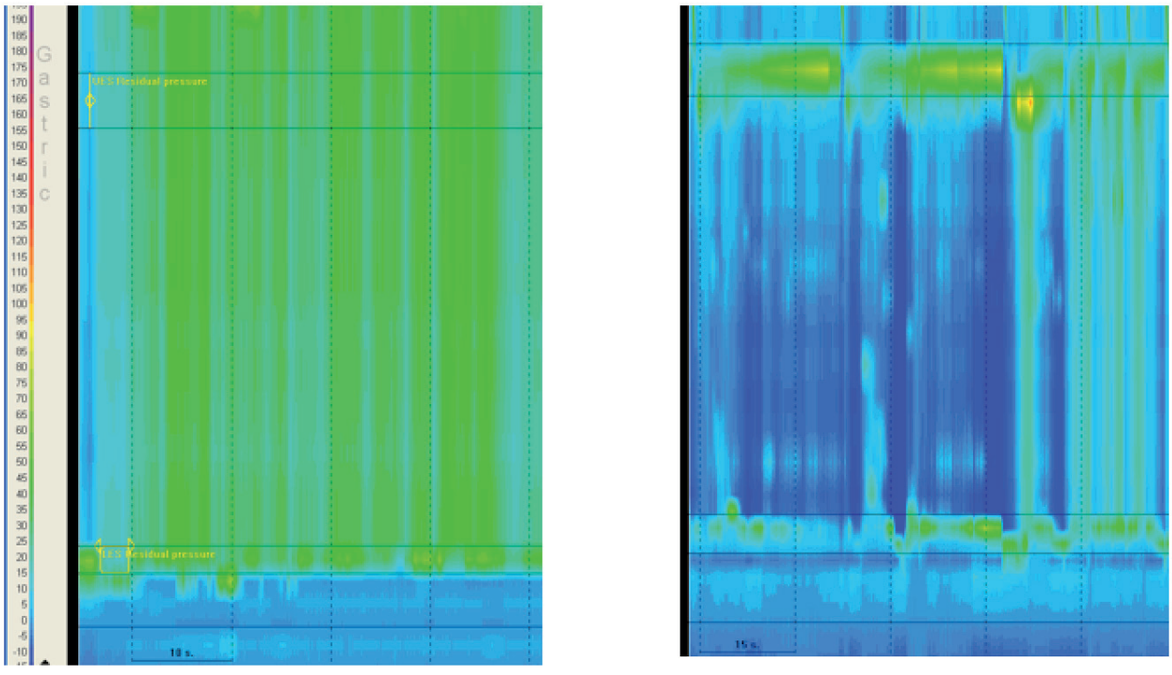

Figure 3. — Type II achalasia before and after PD.

visualization of esophageal peristaltic function, simplifies the test and its interpretation. (7). EPT enables a fine mapping of peristaltic disorders and assesses intrabolus pressure as a surrogate marker for bolus transit problems (2,6). Classification of esophageal motor disorders has been revised in the Chicago Classification (Fig. 1), allowing identification of achalasia, esophagogastric junction (EGJ) outflow obstruction and other motility disorders, namely distal esophageal spasm (DES), hypercontractile esophagus and absent peristalsis, which are distinct from non specific peristaltic borderline abnormalities not always associated with symptoms.

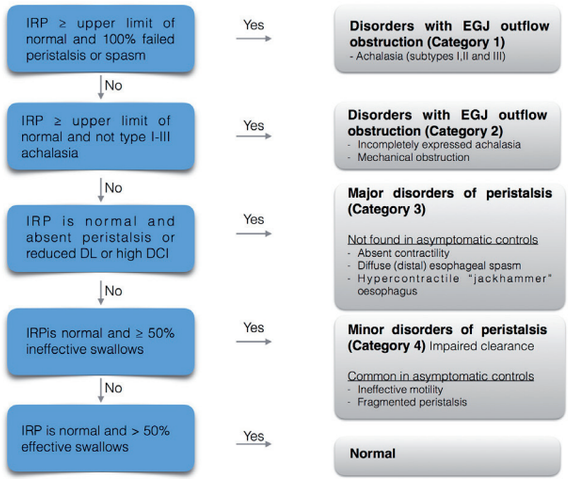

Figure 1. — Flow diagram illustrating the hierarchical analysis of EPT studies according to the Chicago Classification (adapted from (8)).

In children EPT parameters are also studied although EHRM still needs to be validated (9,6). The spectrum of motility disorders that can be classified by HRM resembles that seen in adults but pediatric data are still scarse. In addition, pediatric normative ranges for EPT metrics are not yet established and some metrics have shown to be significantly influenced by age and size. Performance of pediatric EHRM studies is also more challenging (more swallows, crying, moving) (10,11). Singendonk et al noted a trend of increased IRPs and shortening of DL's leading to an over diagnosis of EGJ outflow obstruction or DES. Age/size adjusted Chicago classification is not yet validated and it matters when analyzing EHRM in children especially for the equivocal category 2-4 diagnoses. Category 1 diagnosis (achalasia) is for the most part an unequivocal diagnosis.

Pressure Flow Analysis (PFA) (12,13,14) could be of use in the pediatric setting, helping to overcome the problem of over-diagnosing EGJ outflow obstruction. Pressure flow analysis allows assessment of esophageal bolus transport in relation to esophageal pressures by combining EHRM and impedance measurements. Using PFA one could differentiate pediatric patients with dysphagia in relation to either weak peristalsis (poor bolus clearance) or over pressurization (abnormal bolus resistance – EGJ outflow obstruction) (15). In addition, in patients with Category 3 and 4 abnormalities, abnormal PFA findings may elevate motor patterns of otherwise unclear significance to clinically relevant ones. Despite normal findings on conventional analysis PFA findings may also help distinguish patients with hypersensitivity from those with an underlying motor disorder (16).

In other words, esophageal manometry, once a research tool, has evolved to a more widely available investigation, and Chicago classification will be used in this review to cover management of esophageal motor disorders in children. In our pediatric tertiary center in Brussels, Belgium, we use EHRM and the Chicago classification since 2013 and the figures shown in this article are from our patient's database.

Achalasia

Achalasia is the most common primary motor disorder described in children with an estimated incidence from 0,1 to 1,6/ 100.000 (17,18). The pathophysiology of this rare disease is not definitively established, although it is postulated that in genetically predisposed subjects, an autoimmune reaction triggered by a viral infection results in the loss of inhibitory enteric neurons (19,20,21). Three distinct phenotypes have been described in the Chicago Classification of EHRM, classical achalasia without peristalsis (type I) (Fig. 2), panesophageal pressurization (type II) (Fig. 3), and achalasia with premature distal contractions (type III) (22). In children, several syndromes associating achalasia with extra-digestive conditions have been described. The most frequent ones are the triple A or Algroove syndrome (achalasia, alacrymia, adrenal insufficiency) and the Rozycki syndrome (deafness, short stature, vitiligo, achalasia, muscle wasting).

Achalasia is a chronic condition evolving and leading to progressive dilation of the esophagus with potential respiratory complications such as recurrent pneumonia, nocturnal cough, and aspiration. In children, evolution can be rapid, not only in terms of respiratory complications, but also in terms of severe feeding difficulties with impact in growth and development. Usually present with progressive dysphagia, vomiting and weight loss, achalasia is often misdiagnosed as GERD (23).

Recent data from patients treated with laparoscopic Heller myotomy (LHM) suggest that loss of esophageal peristalsis can be at least partially reverted when the functional outflow obstruction has resolved, which pleads for not delaying treatment once achalasia has been diagnosed (24). There is no curative treatment for achalasia, only palliative measures that will relax, disrupt or cut the spastic muscular layer of the EGJ or the inferior esophagus, removing the outflow obstruction and improving esophageal clearance. Experimental data in animal models have shown that nerve cell replacement therapy could be able to restore a functional esophageal motor function in achalasia, (4,5).

Laparoscopic Heller myotomy

Heller surgical myotomy used for decades has become more popular with the laparoscopic approach and is also a safe and effective procedure in children (35).

Usually, laparoscopic Heller myotomy (LHM) is associated with a Dor or a Toupet fundoplication to prevent reflux of gastric content, as gastro-esophageal reflux is frequently observed following myotomy (36). However, in children, whether an anti-reflux procedure is needed together with a cardiomyotomy is still a matter of debate, because fundoplication can theoretically also provoke postoperative dysphagia (37).

Pneumatic dilation or laparoscopic Heller myotomy?

In adults, endoscopic PD and LHM are both considered effective techniques. It is often considered that surgery is the preferred option in children, because it offers a definitive treatment while PD most of the time has to be repeated to afford long-term success (38,31). In adults, both treatments offer similar results in term of symptomatic remission at 3 years of follow-up (39).

For children, two articles proposed LHM as best first-line treatment (38,40), one was in favour of PD (41), and one showed equal results with LHM and PD (32) Three articles concluded that appropriate treatment should be determined by the age of the patient (42,43,44). In 2016, a systematic review based on 165 children treated for achalasia concluded that adequate comparative data are lacking to determine the ideal treatment (33). Moreover, children requiring subsequent intervention due to recurrent symptoms ranged from 0 to 60% when initially treated by PD and from 0 to 25% when treated by HM.

Predictors of success or failure of treatment

In adults, predictors of treatment failure of PD are young age and an inadequate balloon diameter (45,46). In children also, young age (younger than 7 years) was found to be an independent negative predictive factor for successful clinical outcome (37).

One of the advantages of EHRM in adult patients with achalasia is the ability to predict treatment outcome. Indeed, the best therapeutic response is observed in achalasia with esophageal pressurization (type II), the most frequently encountered type, with 90-100% success rate for LHM and PD (22). Success rate is a little less impressive in patients with classical achalasia. In type III, associated with premature spastic and obstructive contractions in the lower esophagus, the clinical response is better with LHM than with PD. However, success of LHM is less favorable in type III subtype compared to the other subtypes. The difference in outcome based on achalasia subtypes diagnosed with EHRM has been demonstrated since then by other centers in adults (47,48,49).

Peroral endoscopic myotomy

Peroral endoscopic myotomy (POEM) was introduced by Inoue in Japan with the development of natural orifice transluminal endoscopic surgery (NOTES), to provide less invasive natural office "scarless" endoscopic versions of surgical procedures (3). POEM immediately gained a great enthusiasm among both esophageal surgeons and advanced therapeutic endoscopists. The principle of POEM is to perform a myotomy of the circular muscular layer (the one that is responsible for the occlusion of the lumen of the esophagus), while trying to preserve the longitudinal layer (the one that is responsible for esophageal shortening and may participate in esophageal clearance). Whether the longitudinal muscle layer should be preserved during the procedure is still a matter of debate, but cutting both muscular layers does not seem to alter results of POEM (50).

In a systematic review published in 2015, a total of 1,045 patients underwent POEM in 29 studies (51). There was a significant reduction in symptoms of achalasia, as assessed by Eckhart's score, and in LES pressure after POEM treatment. Five studies compared POEM and LHM and found no differences in reduction in Eckhart's score, post-operative pain scores and analgesic requirements, length of hospital stay, adverse events, and symptomatic gastroesophageal reflux/reflux esophagitis. Operative time was significantly lower for POEM.

Two-year and longer outcome data demonstrated a durable symptomatic improvement after POEM in approximately 90% of patients, with an incidence of GER in approximately one-third, GERD being usually moderate and easily managed with proton pump inhibitors. Complications after POEM are comparable or even better than LHM with risk of adverse events being approximately 14%, and the chance of requiring additional surgery for complications around 0.2%.

Also, POEM is feasible and does not seem to be technically more difficult to perform in patients previously treated by PD (52), and for patients who were not treated successfully by prior HM. (53,54).

Up to now 107 children treated successfully with POEM have been reported in 8 studies (Table 1).

Published results which are excellent on short term follow-up, come from centers of excellence, because POEM is clearly an advanced endoscopic therapeutic procedure performed in tertiary referral centers, with a sufficient volume of cases same as for LHM. It remains to be established if POEM can be proposed as first line therapy or as a second line therapy after failure of PD. For type III achalasia, POEM is the only one to be effective. In the future, POEM will probably largely replace LHM, because of the advantages of POEM: [1] an easy extension of the myotomy to any length, determined by EHRM, [2] lesser risk of injury to the vagus nerve, [3] potentially less GERD and [4] less pain and a shorter recovery (31).

Table 1. — **Pediatric cases of POEM reported**

Study	Number of cases	Age (years)	ES before treatment	Length of tunnel (cm)	Length of myotomy (cm)	Duration of procedure (min)	Postoperative complication	GERD	Follow up (months)	ES at Follow up
Li C et al 2015 [55]	9	14.1 (10-17)	7 (5-10)	11.3 (9-13)	8.3 (7-9)	56.7 (45-105)	1 subcutaneous	1 esophagitis	16.3 (3-30)	0.8 (0-2)
							emphysema			
Tang et al 2015 [56]	5	15 (12-17)	NA	12.6 (7-15)	8 (6-11)	50 (40-90)	0	0	18	< 3
Caldaro et al 2015 [57]*	9	12.2(6-17)	7 (4-10)	NA	7±1.5	62 ±12.7	1 pneumoperitoneum	1 GERD	12.7 (5-28)	0
							1 mucosal perforation			
Chen et al 2015 [58]	26	13.8 (6-17)	8.6 (6-12)	NA	9.6 (7-11)	39.4 (21-90)	1 pneumothorax	1 GERD (clinical)	24.6 (15-38)	0.7 (1-2)
							5 mucosal injury	2 esophagitis		
							5 GERD or	2 GERD and		
							esophagitis	esophagitis		
Nabi et al 2016[59]	15	14 (9-18)	7.32 ± 1,42	NA	12 (6-16)	100 (38-240)	2 subcutaneous	2 esophagitis	14	1.74 ± 0,67
							emphysema			
							1 pneumoperitoneum			
							1 mucosal injury			
Kethman et al 2017[60]	10	13.4 ±3,3	7 (SD=2,5)	NA	NA	142 (60-259)	1 pneumoperitoneum		1	2.4 (SD=2)
							1 mucosal injury			
							1 pneumothorax			
Shijian et al 2017 [61]	21	5.5 (0.9-18)	NA	10 (8-15)	9 (6-11)	40 (30-55)	4 subcutaneous	6 GERD	13.2 (3-24)	0.75 (0-2)
							emphysema	2 esophagitis		
							1 pneumoperitoneum			
							1 mucosal injury			
							1 pneumonia			
							4 mediastinal			
							emphysema			
Tan et al 2016 [62] **	12	13.7 ± 2.6	6.9 ± 1.7	NA	NA	NA	1 subcutaneous	2 esophagitis	26	0.75 ± 62
							emphysema			

ES Eckardt score, LES low esophageal sphincter, GERD gastroesophageal reflux disease. IRP integrated relaxation pressure NA not available 4 Case reports < 5 patients are excluded.
* Caldaro et al comparison of POEM and LHM: the efficacy and complications between POEM and HM was comparable in a midterm follow-up, but POEM has an inferior execution timing compared to HM.
** Tan et al reporting comparison of POEM and PD with 12 cases of POEM. Short-term efficacy of POEM and EBD for primary treatment of pediatric achalasia was comparable, how-ever POEM could result in a better intermediate and long-term efficacy.

Follow-up

It is probably reasonable to assess objectively esophageal emptying using EHRM and/or radiology that will detect which patients have to be retreated or proposed another therapeutic option. Indeed, symptoms are not always severe and not always the best indicator of an esophageal bolus transit problem, because patients adapt their eating habits when symptoms are progressive. Impaired esophageal emptying on timed barium esophagogram, the height of the barium column measured at 1 and 5 min, and the absence of normalization of LES relaxation at EHRM are both negative predictive factors for success outcome in adults (63,64,65,66). So, it might be advised to make a timed barium esophagogram and to see patients 3 months and 1 year after treatment, and then on a regular basis i.e. every 3 years. Treated children should also be followed on a regular basis at adulthood for that purpose, and to rule out complications linked to GERD.

Other esophageal motor disorders

Esophagogastric outflow obstruction

Besides achalasia, EGJ outflow obstruction can be observed with intact esophageal peristalsis, and corresponds to a variant of achalasia, an infiltrative process due to malignancy, or a postoperative manifestation of a tight fundoplication (67). In case of persisting post fundoplication dysphagia, balloon PD can sometimes help to resolve symptoms in adults (68) and children (69).

Distal esophageal spasm and hypercontractile esophagus

DES and hypercontractile esophagus (also named jackhammer esophagus) are two disorders accounting for dysphagia and chest pain (70,71,72). In these disorders, premature or prolonged and vigorous contractions and failure of deglutive inhibition account for impaired drinking and eating. It is reported that DES (formerly named diffuse esophageal spasm) is not so rarely encountered in children sent for a manometric evaluation (73). However, prevalence of DES might have been overestimated with previously used standard esophageal manometry, diagnostic criteria evolving with EHRM (74). Chief complaints in children diagnosed with DES are food refusal in patients younger than 5 years and chest pain in older patients with commonly associated comorbidities. Pharmacological therapies are poorly effective in patients with esophageal spastic disorders and can be viewed only as a transient approach or as palliative measure. However, oral nifedipine is administered in children, improving manometric abnormalities and clinical symptoms (73) and might be a useful drug despite its unclear efficacy data in adult trials. BTI in the lower esophagus has shown some transient moderate efficacy in adult patients with non-achalasia spastic disorders (75). Seemingly very safe, it should be kept in mind that BTI, like other endoscopic techniques, is invasive and not riskless (76). PD in esophageal spasm is poorly effective, because the spastic disorder is not limited to the EGJ as in achalasia, but involves a long segment of the inferior esophagus. Surgical esophageal myotomy and even esophagectomy has been sometimes helpful, although beneficial results were observed in only 70% of the patients, clearly less than in achalasia patients, and at the price of a significant morbidity (77). Recently, POEM was proposed in a few adult patients suffering from non-achalasia esophageal hypertensive peristaltic disorders resistant to myorelaxant drugs, with an excellent outcome, suggesting that POEM may not only apply to achalasia but also to DES and hypercontractile esophagus where it would fulfill an area of unmet therapeutic needs (78,79,80).

Comorbidities and disorders like GERD or eosinophilic esophagitis (EoE) can be associated with esophageal spastic disorders and have to be looked for and treated appropriately. Indeed, motility disorders can occur secondarily to esophageal wall inflammation and will improve or resolve once inflammation is treated, as recently shown for two patients with EoE and achalasia or jackhammer esophagus who recovered a normal esophageal peristalsis after treatment (81,82). Eosinophils have been observed surrounding enteric neurons in experimental models of eosinophil-mediated diseases, and release toxic cationic proteins and other inflammatory mediators that are harmful for enteric neurons.

Absent peristalsis

Absent peristalsis is another disorder that can contribute to dysphagia. Most frequently, and especially in case of EGJ patency and low LES pressure, GERD will be the chief problem for the patient and will be adequately controlled with proton pump inhibitors. In case of severe GERD with debilitating regurgitations or pulmonary complications, a partial fundoplication can be proposed to control reflux. (83,84)

In children, the most frequent congenital defect of the esophagus is esophageal atresia, with a survival that steadily improved during the last decades (85). Long-term follow-up of operated children has revealed that many have GERD-related problems or dysphagia. Esophageal aperistalsis and signs of esophageal pressurization due to strictures are frequently observed at EHRM (86,87). Treatment of GERD with antisecretory medications, and endoscopic dilation of strictures or surgery in case of failure of repeated dilations, will help the majority of those young patients (88).

Minor disorders of peristalsis

Peristaltic borderline abnormalities, not always associated with symptoms, were previously labeled non-

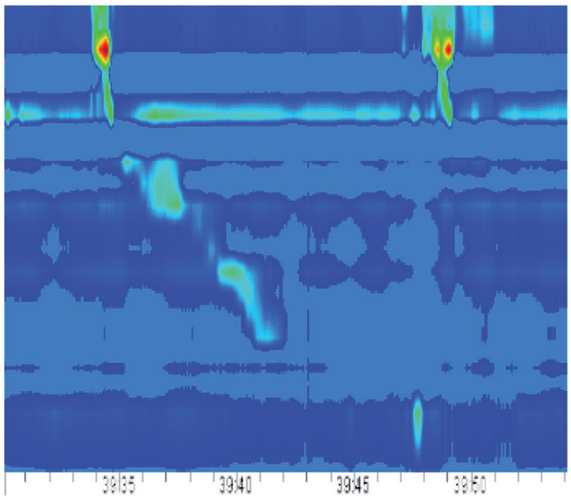

Figure 4. — EHRM of a patient with ineffective motility.

specific abnormalities. They comprise weak, frequently failed or rapid peristalsis, and nutcracker esophagus in the Chicago classification (7). In the most recent version of the Chicago classification, only fragmented persistalsis and ineffective motility were kept (8). None of these abnormalities is specific of any disease, and an underlying disease must always be searched in case of symptoms suggestive of esophageal dysfunction. In children, the leading cause of food impaction and dysphagia is EoE (89). In EoE, the compliance of the esophagus is reduced with time due to inflammation leading to fibrosis and strictures are the main long-term complication (90). However, EHRM will be normal in the majority of patients with EoE, peristaltic abnormalities like weak or frequently failed peristalsis are rarely observed (91). Interestingly, these authors described at EHRM indirect signs of reduced esophageal compliance and outflow obstruction (pan-esophageal or compartmentalized pressurization) in patients with EoE complaining of dysphagia. Another way to study esophageal compliance is impedance planimetry, although being currently more a research tool and far less available than EHRM (92). There are several options for the treatment of EoE: restriction diets and/or swallowed corticoids and pneumatic dilations of strictures are the care standard (93,94).

Weak or frequently failed peristalsis has also been linked to GERD, and may impair esophageal acid clearance (95). Therefore, GERD treatment with proton pump inhibitors will be given as a therapeutic test in patients diagnosed with these abnormalities and complaining of esophageal or extra-esophageal symptoms of GERD (96).

Finally, it would be tempting to improve peristalsis by a cholinergic stimulation in this setting to restore a failed peristalsis. However, treatment with betanechol never proved any clinical efficacy in case of hypomotility (97).

In the absence of a pathological correlation with the manometric abnormality that would ideally lead to the correction of the mechanism underlying symptoms, the treatment will be directed to the dominant symptom, obstructive or perceptive. In case of chest pain, several pharmacological and non pharmacological options (psychological intervention, cognitive behavioral therapy, hypnotherapy) might be offered. (98,99).

Table 2. — **Overview of proposed treatment options for esophageal motor disorders in children**

Diagnosis (according to Chicago Classification)		**Proposed Treatment Options**
Disorders **Achalasia** *with EGJ outflow obstruction*		• **Pharmacological approaches** (poor efficacy, only as bridge) • **BTI** (inferior to other choises, not recommended) • **PD** (safe, good results often needs to be repeated) • **LHM** (tends to be prefered to PD but evidence isn't that clear in pediatrics) • **POEM** (proven safety and efficacy in adults, promissing in children, awating pediatric trials May be the treatment of choice for type III achalasia)
	EGJ outflow obstruction (achalasia variant or post fundoplication)	• **PD** is a solution post fundoplication. • Re-evaluate before 'permanent' measures (given possibility of over – diagnosis in children)
Major disorders of peristalsis (not found in asymptomatic)	**Absent Peristalsis**	• Look for and treat comorbidities (EoE, severe GERD) • If atresia and strictures, **PD** should be considered
	DES / Hypercontractile (Jackhammer esophagus)	• **Pharmacological approache** (weak evidence but used) • **POEM** seems promissing in adults • **POEM** seems promissing in adults • **BTI** (moderate efficacy) (PD poorly effective, as a long esophageal segment is involved)
Minor disorders of peristalsis (also found in asymptomatic)	**Borderline abnormalities**	• Search for/ treat **underlying disease** : EoE, GERD. • Treatment directed to the **dominant symptom** • Think also about **non pharmacological** options (cognitive behavioural therapy, hypnotherapy)

Abbreviations: BTI botulinium toxin injection, PD pneumatic dilation, LHM laparoscopic Heller's myotomy, POEM peroral endoscopic myotomy, EoE eosinophilic esophagitis, GERD gastroesophageal reflux disease, DES distal esophageal spasm, EGJ esophagogastric junction.

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