Oesophageal manometry in children - interpretation and analysis

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Back ground

Successful swallowing requires orderly propulsion of food from the mouth to the stomach and, as Meltzer noted century ago, it is dependent on the "orderly progress of peristaltic movements in the oesophagus"(1).
Oesophageal manometry measures the rhythmic muscle contractions (peristalsis), coordination and force exerted by the muscles of the oesophagus
Clinical use of oesophageal manometry began way back in 1940s with rudimentary water-filled balloons and since it has evolved into a more complex array of catheters, transducers, data recorders/computers, and analysis software.
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Indication of oesophageal manometry

A primary indication for manometry is the evaluation of dysphagia not definitively diagnosed by means of endoscopy and/or radiology .Manometry may allow formal diagnosis of a primary oesophageal motility disorder in a patient with non-cardiac chest pain and/or dysphagia. (5, 6, 7, 9, 10, 11, 15, 16-23)

Oesophageal manometry is generally undertaken after more routine investigations for oesophageal structural disease (ie. endoscopy and/or contrast radiology). The procedure is reserved for situations where there is diagnostic doubt or where the identification of an oesophageal dysmotility disorder will alter clinical management. (24, 25, 26). Repeat manometry is not recommended as a routine part of the assessment of patient response to pharmacological treatment of non-specific dysmotility.

Clinical indication for Oesophageal Manometry (45)
1) To diagnose suspected primary oesophageal motility disorders (eg. achalasia and diffuse oesophageal spasm)
2) To diagnose suspected secondary oesophageal motility disorders occurring in association with systemic diseases (eg. systemic sclerosis)
3) To guide the accurate placement of pH electrodes for ambulatory pH monitoring studies
4) As part of the pre-operative assessment of some patients undergoing anti-reflux procedures
5) To reassess oesophageal function in patients who have been treated for a primary oesophageal disorder (eg. sub-optimal clinical response to pneumatic balloon dilatation) or undergone anti-reflux surgery (eg. dysphagia following fundoplication)

In patients being considered for anti-reflux surgery, the role for pre-operative manometry prior to fundoplication is controversial. There has been concern about a risk of obstructive complications following total fundoplication in patients with impaired oesophageal motor function. Some authorities have considered impaired peristaltic function to be a relative contra-indication to anti-reflux surgery. However, there are conflicting reports on the ability of pre-operative manometry to predict outcomes (18, 19, 27-31)

Manometric Instruments

With the advancement of science, manometers has evolved from conventional water perfusion system to solid manometers and more recently high resolution manometers (HRM)

Both conventional and HRM systems are available, with the main distinctions between the two being the number of pressure sensors, ease of performing and cost , and graphical representation and analysis.

Conventional manometry uses catheters with 4 to 8 pressure sensors.HRM catheters have multiple sensors (micro transducers composed of either metal diaphragm strain gauges or piezoresistive silicon chips) up to 36 distributed longitudinally and radially separated by short distance as small as one to two millimetres (3,4).. Catheters are available in a variety of configurations, with diameters ranging from 2.7 to 4.7 mm and the number of sensors ranging from 4 to 36 for different age groups and make.
Pressure sensing apparatus detects changes in luminal pressure and converts this to an electrical signal, and a recording device that amplifies and stores this information for subsequent analysis

This allows graphical or topographical analyses with generation of 2- and 3-dimensional contour plots based on simultaneous pressure readings taken at multiple sites

The techniques for data acquisition are similar, but HRM allows more versatility in data analysis (36). As such, HRM systems have been readily adopted and are now the predominant system.

Optimal recording of either pharyngeal or oesophageal motility requires an array of multiple recording points that span the whole region of interest in order to provide an integrated picture of motor function A sleeve sensor which has been designed can overcome difficulties with spinteric movement can effectively records both basal pressure and relaxation of upper and lower oesophagus

Continuous recording of LES with HRM devices have advantage over traditional pull through technique, by providing continuous pressure readings which vary from minute to minute and they are more comfortable.

Manometric results are presented as hard copy readouts of thermal writing polygraphs and contains computer-generated reporting using analog to digital conversion and software analysis.

One should not entirely relay on computerized analysis of pressure recordings analyzing the study on the basis of careful perusal of the actual recording.

Procedure

Equipment should be checked and calibrated before commencing each study. Patients should fast for a minimum of four hours for solids and two hours for liquids prior to the procedure. A longer period of fasting may be appropriate for patients with evidence of fluid or food residues at endoscopy/radiology (eg. in achalasia) (5-12).
Medications known to affect oesophageal motor function should be avoided for 24 hours prior to the test where clinically appropriate (eg. Beta blockers, nitrates, calcium channel blockers, anticholinergic drugs, prokinetics, nicotine, caffeine, opiates) (5, 45). Any concurrent medication or local anaesthetic use should be documented.
A brief history and review of the patient’s case records should alert the technician to any contra-indications to performing oesophageal studies or to the existence of conditions that may hinder the performance or interpretation of the test (eg. large hiatus hernias, previous oesophageal surgery)(45).

After an informed written consent catheter may be placed via either the trans-nasal or trans-oral route. Once the catheter has been inserted, the patient should be placed in the recumbent position if a water perfused catheter is used and allowed a period of 5-10 minutes to accommodate to the catheter. Water-perfused systems exhibit an upward shift of pressure baseline when the subject moves into an upright position, such that studies are best performed supine. Although this shift in pressure doesn't occur with solid state systems, many published values for either type of system are based on studies performed in the traditional supine position (45). Perfusion rates needs to be slower in infants and children in order to accommodate small size of oesophagus

At the beginning of the manometric assessment, one or more (preferably three) of the most distal recording sites should be in the stomach. This can be verified by asking the patient to take a deep breath. Intra-abdominal pressure readings go up with inspiration and down on expiration.

Peristalsis and LES relaxation are normally assessed in response to 5-mL water swallows .At least 10 swallows should be tested to provide an adequate sample (13). At least 20-30 seconds should be allowed between swallows as rapid repetitive swallowing inhibits peristalsis. (10,14). If the patient has dysphagia for solids , administration of viscous or solid boluses helps to uncover the motor disturbances .natural reflux swallow may be initiated in young infants and neurologically abnormal child by blowing air on the face (Santymer swallow) (42)

Most difficult technical aspect in children for manometry is cooperation .Co-operation can be improved by age appropriate relaxation technique (42). Older children should be talked about the procedure. Oesophageal manometry is best performed without sedation. But if sedation is required, it has shown to be minimal or no influence on measure measurement. (43, 44)

If peristalsis appears absent, the function of the sensors should be checked by asking the patient to cough. Available data suggest that water swallows provide a more consistent and vigorous peristaltic response than simple saliva swallows, so the latter are not recommended

Oesophageal manometry and ambulatory oesophageal pH monitoring are associated with minor morbidity, largely vasovagal episodes, discomfort from the catheter and a runny nose, and restrictions affecting diet and activity tracheal intubation. Patients with a heart valve replacement or a previous episode of bacterial endocarditis should receive antibiotic prophylaxis

Contraindication for oesophageal manometry

Oesophageal manometry and pH monitoring should not be performed in cases of suspected or confirmed pharyngeal or upper oesophageal obstruction, in patients with severe coagulopathy (but not anticoagulation within the therapeutic range), bullous disorders of the oesophageal mucosa, and cardiac conditions in which vagal stimulation is poorly tolerated, or in individuals who are not able to comply with simple instructions.
Patients with peptic strictures, oesophageal ulcers, oesophageal or junctional tumours, varices or large diverticulae are at increased risk of complications from blind oesophageal intubation and such conditions are a relative contra-indication to performing manometry

Analysis
(i) Conventional manometry

The major elements of the analysis of oesophageal manometry include analysis of oesophageal motor functions, the integrity of oesophageal peristalsis and the degree of lower oesophageal relaxation. A structured and systematic assessment of these elements should lead to a manometric diagnosis. Specific behaviour like crying, coughing should be taken into consideration during interpretation

Conventionally keeping above parameters in mind, oesophageal motility disorders were classified as per table below.

CLASSIFICATION OF PRIMARY ESOPHAGEAL MOTILITY DISORDERS (2, 32-35)

Primary oesophageal motility disorders	**Manometric tracings**
Achalasia	Absent oesophageal peristalsis ** Abnormal LES relaxation Can have raised LES pressure (>45mmHg)
Diffuse oesophageal spasm	Simultaneous contraction >20% of wet swallows Intermittent peristalsis Can have repetitive or multipeak contractions (>two peaks) Can have contraction hot associated with swallows Contraction amplitude >30 mmHg but usually not high
Hypercontracting oesophagus	Hypertensive oesophagus - "nutracker" Increased mean distal amplitude (>180mmHg) Normal peristalsis Can be of increased distal duration (>6s) Hypertensive LES Resting LES pressure >45mmHg May be incomplete LES relaxation
Hypocontracting oesophagus	Ineffective oesophageal motility >30% low distal amplitude (<30 mmHg) or failed non transmitted contractions Hypotensive lower oesophageal sphincter Resting LES pressure <10mmHg
Nonspecific oesophageal motility disorders	Incomplete LES relaxation Non transmitted contractions >20% Retrograde contractions Low amplitude contractions <35 mmHg

Aperistalsis in the oesophageal body **defined where all wet swallows are followed by simultaneous identical contractions (isobaric or “mirror images”). Generally, these contractions are of low amplitude (10-40 mmHg) and may be repetitive
Aperistalsis may occur with normal or increased amplitude contractions in some patients, so-called “vigorous achalasia
LES pressure varies from 18 mm Hg in term infant to 10-40 mm Hg in adults

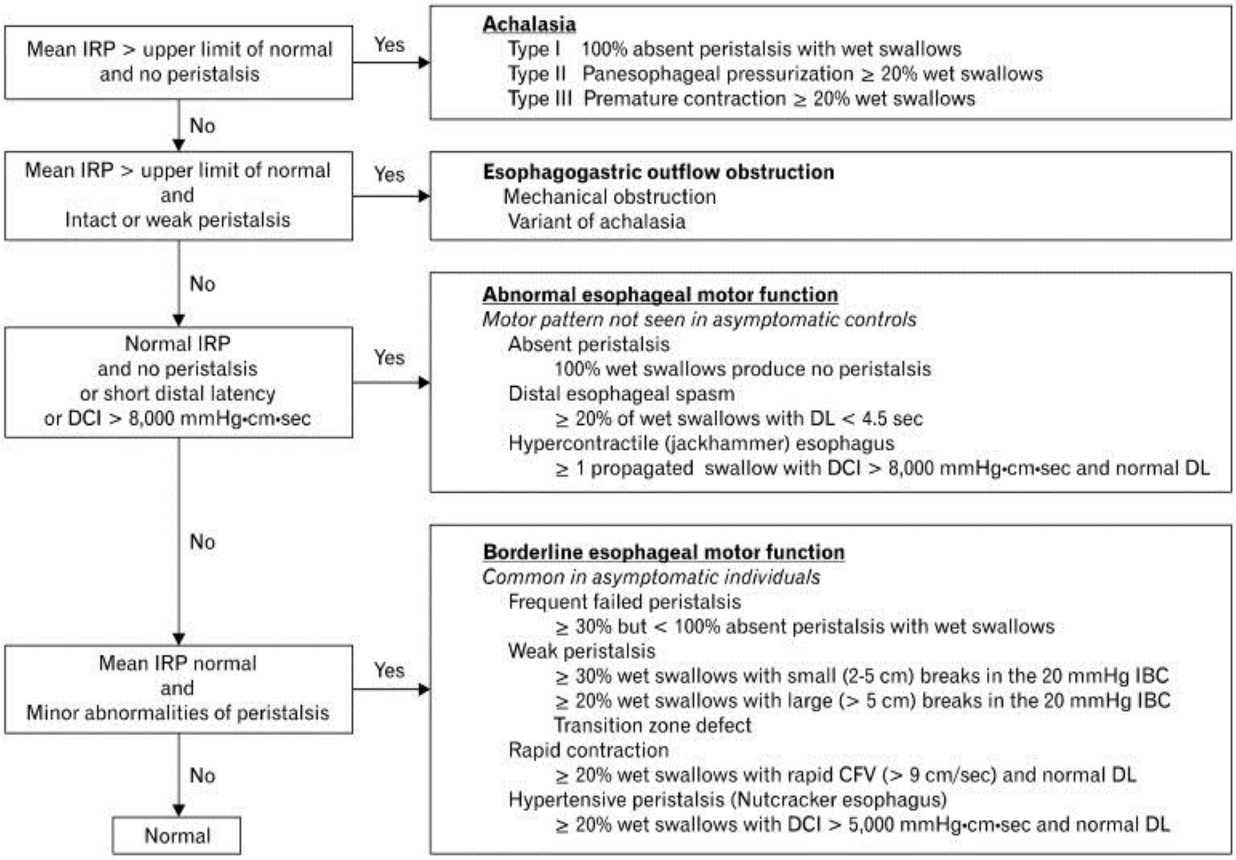
The clinical significance of non-specific motility disorders is therefore uncertain. Available data suggest that neither symptom severity nor clinical course correlate closely with non-specific manometric findings and these manometric abnormalities may be inconsistent over time

(ii) HRM manometry

Presentation of pressure data as colour contour plots or oesophageal pressure topography using HRM led to the development of new tools for analyzing and classifying oesophageal motor patterns. The current standard and still developing approach to do this is the Chicago classification.

Two strengths of HRM with pressure topography plots compared with conventional manometric recordings are (1) accurately delineating and tracking the movement of functionally defined contractile elements of the oesophagus and its sphincters, and (2) easily distinguishing between luminal pressurization attributable to spastic contractions and that resultant from a trapped bolus in a dysfunctional oesophagus

Chicago classification (37,



One needs understand the various terminologies used in HRM analysis in order to interpret the findings (38, 39, 40, 41, fig 1)

Oesophago gastric junction function during swallowing (abnormal resistance to bolus movements across EGJ) is determined by a measurement called integrated relaxation (residual) pressure (IRP).The upper limit of normal IRP is 15 mm Hg

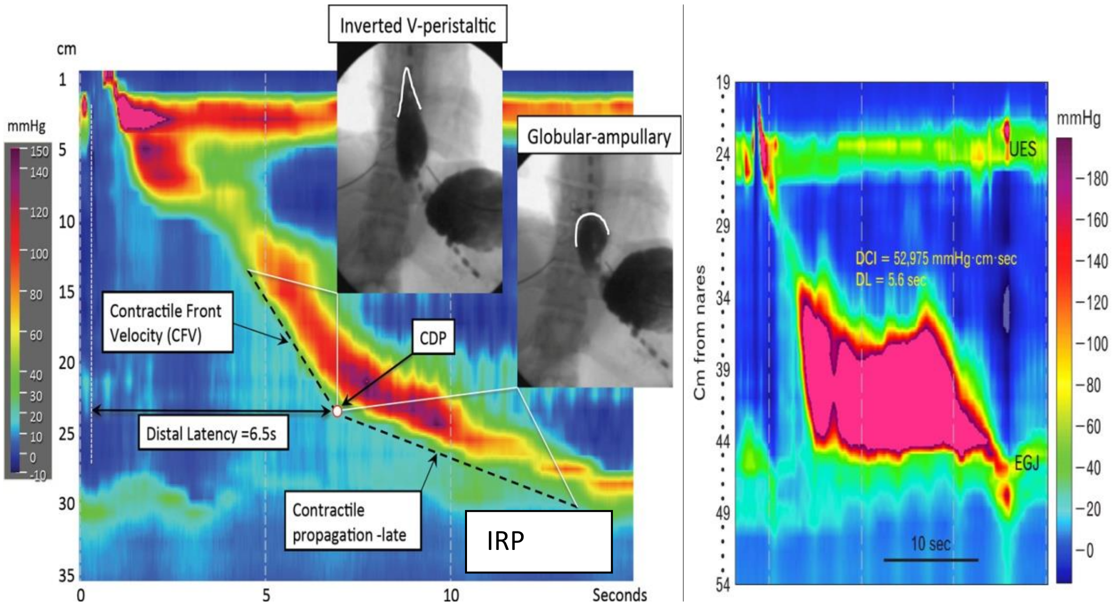
Contraction front velocity (CFV) and distal latency are tools used to evaluate propagation of oesophageal pressure waves. The normal CFV does not exceed 9 cm/sec.

A short distal latency (DL) indicates early arrival the oesophageal contraction in the distal oesophagus(eg oesophageal spasm). The lower limit of normal for DL is 4.5 seconds

CDP is the time at which oesophageal peristalsis terminates, and the lower oesophageal sphincter descends to its resting position in association with emptying of the phrenic ampulla

Distal contractile integral (DCI) is a measure of how robust peristalsis is in the smooth muscle oesophagus. Normal DCI <8000 mm Hg

Fig 1



Amplitude represented on the y-axis and time on the x-axis..Colours are assigned to depict High pressures represented by warmer colours (reds and yellows) and low pressures by cool colours (blues and greens)

Conclusions

For several decades oesophageal manometry continues to be the test of choice to evaluate disorders of oesophageal motor function.

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HRM may be easier to perform and interpret than conventional manometry. The mean procedure time is decreased with HRM compared with conventional manometry (11) because of easier catheter positioning and no need for LES pull-through.. HRM has revealed previously unidentified patterns of normal and abnormal oesophageal motor function.

A meaningful summary should be provided from a manometry studies .There should be a manual review of any automated reports with the aim of providing a clinically interpretable result.

A manometric diagnosis should be given where possible, though it is important to emphasise that the final diagnostic formulation for an individual patient should be based on a careful consideration of clinical features, radiological and/or endoscopic findings in addition to the manometric information. Treatment decisions should not be based solely on manometric findings

Acknowledgement

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