Standards for oesophageal manometry

A position statement from the Gruppo Italiano di Studio Motilità Apparato Digerente (GISMAD)

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Manometry is an important tool in the diagnosis of oesophageal motility disorders, but proper instruments and methods are needed to obtain useful clinical information. The authors reviewed the minimal technical requirements, operative aspects, which information the final report should contain as well as indications and contraindications of the text itself. Technical requirements: At least a three-channel, multiple-lumen catheter perfused with a pneumo-hydraulic capillary infusion system which ensures $\Delta P/\Delta T > 150$-200 mmHg/sec.; data should be recorded at a sampling rate of ≥8 Hz to study the oesophageal body and lower oesophageal sphincter; lower oesophageal sphincter tonic (pressure) and phasic activity (relaxations) and oesophageal body amplitude and peristaltic activity should be recorded. The final report must contain the patient's details, the indication for the test and a manometric diagnosis. Indications for manometry: Dysphagia (after ruling out any organic pathology); non- cardiac chest pain (after ruling out any cardiopulmonary involvement); systemic collagenosis (to investigate oesophageal involvement); gastro-oesophageal reflux disease (if surgery is planned). Contraindications are limited to: pharyngeal or upper oesophageal obstructions, oesophageal bullous disorder, cardiac conditions in which vagal stimulation may not be tolerated, severe coagulopathy and patient non-compliance.

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Introduction

Oesophageal manometry is a fundamental test for the diagnosis of primary and secondary oesophageal motor disorders. In general, it should be employed as a second-level diagnostic tool, after endoscopy and/or barium swallow have been used to investigate organic lesions. Although the methodology and indications for this test have been well established since the late eighties [1], its application was limited (in our country, at least) to a few referral centres. In the last ten years, the introduction of computer-assisted manometry and the consequent elimination of part of the boring manual analysis of the trace and the relatively lower costs of the equipment, has led to a widespread use of this test and manometry is now performed at most first-level, and many second- or third-level hospitals [2].
To perform oesophageal manometry properly and thus obtain a correct diagnosis, however, some fundamental technical requirements must be satisfied and some operator expertise is required.

The following standards for oesophageal manometry have been developed by the Italian Study Group for Intestinal Motor Disorders (GISMAD) to define the minimal technical requirements, the operative aspects, the data that should be included in the final report, and indications and contraindications for the test in order to obtain suitable clinical information from oesophageal manometry.

Technical requirements

Oesophageal manometry records the tonic and phasic pressures generated by the oesophageal muscle; two systems are currently available, namely, a) external transducers connected to the oesophageal lumen by perfused catheters (so-called low-compliance perfused systems) [3] and b) intraluminal micro-transducers (strain-gauge, piezo-electric or electromagnetic transducers). Both transducers should be connected to: c) a recorder (ink or thermal writing polygraphs, computers).
Optional instruments that may be helpful in performing oesophageal manometry are: d) motor-driven catheter extractor, respiratory activity detector, swallow detector, sleeve sensor.
The following material is needed to perform oesophageal manometry (Table I).

Table I. Material needed to perform oesophageal manometry.

A. Perfused systems
- Multiple-lumen catheter
- Hydropneumatic perfusion pump
- Distilled water for perfusion pump
- External pressure transducers (one for each channel)
- Data acquisition and recording system (on paper and/or computer)
- Motor-driven constant speed extractor (optional)
- Teflon catheter extensions (optional)
- Respiratory activity detector (optional)
- Swallow detector (optional)

B. Microtransducer systems

C. Recording system
- Polygraph
- Digital acquisition system

Perfused systems

Material needed for a low-compliance perfused system
Multiple-lumen catheter made of non-expandable material, at least 100 cm long and graduated (at 1 cm intervals) to enable length measurements. The catheter must be easy to clean and be able to be sterilized.
At least 3 channels assembled with an interval diameter of 0.8 mm, with side-holes at 5 cm intervals to enable a study of peristaltic propagation and oriented at angles of 120° to overcome upper and lower sphincter asymmetry.

The use of a catheter with 6 or 8 side-holes is recommended If a 6-hole catheter is employed, 3 side-holes should be positioned at the same depth and oriented radially at angles of 120° and another 3 extending proximally, at 5 cm intervals. If an 8-hole catheter is used, 4 side-holes should be positioned at the same depth and oriented at 90° angles and another 4 extending proximally, at 5 cm intervals.

Pneumo-hydraulic capillary infusion system (hydropneumatic pump and capillaries) must ensure a constant perfusion rate (0.5 - 1 ml/min). The perfusion rate should be checked periodically by counting the drops per minute (20 drops = 1 ml). The water in the tank is placed under pressure by a gas with a low solubility in water (ideally helium or nitrogen) and brought up to a pressure of 800-1000 mmHg (55-70 psi).The complete system (catheter, perfusion pump, capillaries, taps, etc.) must have a low compliance (0.05-0.08 ml/100 mmHg)[4]; due to the difficulty in measuring real compliance ($\Delta V/\Delta P$), however, the rise in pressure over time ($\Delta P/\Delta t$) that occurs on occlusion of the catheters is to be taken into account: this must be at least 150-200 mmHg/sec. Any extension tubes between the catheter and the transducers must be made of non-expandable material (Teflon) to avoid increasing the system's compliance.
The system must be calibrated periodically using a mercury Riva-Rocci sphygmomanometer or by lifting the manometry tube to a predefined water column level (if the apparatus is used only sporadically, then this should be calibrated before each test). In the event of lower values (systems with a higher compliance, almost always due to perfusion problems), there is a risk of phasic contractions, the rapid ones, in particular, being underestimated (oesophago-cervical and pharyngeal).
Systems using perfusion bags (e.g. the Fenwall bag) are not recommended because the perfusion fluid can only be brought up to a maximum pressure of 300 mmHg, which is not sufficient to ensure precise signal acquisition.
Gravity perfusion systems (drip, bags, etc.), or those supported by peristaltic pumps (e.g. Harvard), or infusion apparatus with syringes, are not acceptable.

Distilled water for perfusion pump For the perfusion fluid, it is best to use sterile distilled water (though sterility is not indispensable), preferably after degassing by aspiration. In the water tank, it is advisable to place a plastic disc above the level of the wa-

ter surface to avoid gas passing into the liquid when it is under pressure.

External pressure transducers Each transducer is connected to a catheter channel; the electric signal is sent to an acquisition/amplification module that subsequently directs the processed signal to an analogue recorder for printing on paper, or to a digital system. The transducer must guarantee linearity from 0 to 400 mmHg.

Microtransducer systems

At least 3 microtransducers spaced at 5 cm intervals (for studying oesophageal peristalsis) and one placed distally for circumferential recording (optional) are needed to study the sphincters (parameters, rest and relaxation). The catheter must be connected by means of a suitable interface to a data acquisition and storage system (see below).
These systems are generally very accurate, but their high cost and fragility [5] make them *unsuitable* for standard apparatus because of their cost/performance ratio. Moreover, some types of catheter with solid state transducers may have structural features that lead to cleaning and sterilizing problems.

Recording systems

Ink or thermal writing polygraphs
The recorder must provide a printout on paper at a rate varying from 2.5 mm/sec for studying the lower oesophageal sphincter (LES) and oesophageal body to at least 10 mm/sec for studying the upper oesophageal sphincter (UES) and the pharynx. It must also be able to display a scale between 0 and 400 mmHg. Ideally, the paper feed rate should be adjustable from 1 mm/sec to 60 mm/sec.

Digital data acquisition systems
If a digital acquisition and storage system (computer-aided manometry) is used, the system must allow a sampling rate of at least 8 Hz (8 samples/sec) for studying the LES and oesophageal body, and at least 50 Hz for studying the UES and pharynx. Here again, the range of pressures that can be recorded must be 0 to 400 mmHg.
The computerized system must also enable a printout to be made of the manometric trace (on-line or after completing the test).

Optional instruments
1. Motor driven constant-speed catheter extractor (with the speed modifiable from 1 mm/sec to 5 mm/sec) for studying the sphincter zones using the pull-through method [6].
2. Respiratory activity detector and swallow detector The system may be fitted with an apparatus for detecting respiratory activity (a belt pneumograph for recording diaphragm excursions or a thermistor) and a microphone (or manual marker) for recording swallows.
3. Sleeve sensor This device enables the recording of a pressure along the length of the 6 cm long silicone membrane that forms the sensor itself [7]. This sensor can be used to overcome the problem of the rapid movements of the sphincters (especially the UES), since pressures are recorded along the sensor's entire length. This device enables the recording of the so-called inappropriate relaxations of the LES (i.e., relaxations without a previous swallowing) that are probably involved in the pathogenesis of GERD. The main drawbacks of the sleeve sensor are that it requires three recording channels for the sleeve alone [8], it misrecords the duration of sphincter relaxation and skilled personnel are needed for its use. That is why, in our opinion, the sleeve catheter is not recommendable for routine clinical use.

Methods

Oesophageal manometry should be performed on a patient who has fasted for 8 hours and all medication affecting the gastrointestinal tract must be suspended at least 24 hours before the test.
The various phases of the test are summarized in Table II.

Table II. Phases of oesophageal manometry.

- Study of LES tonic activity
- Study of LES phasic activity after swallowing
- Study of oesophageal body motility
- Study of UES tonic activity (SPT, RPT or MPT) (optional).
- Study of UES phasic activity after swallowing (optional)
- Study of pharyngeal motility (optional)

Abbreviations: see list at end of paper.

Study of LES tonic activity
This phase begins with the insertion of all the catheters in the stomach: the pressure recorded (at the end of expiration) is used as reference zero.
The catheter is then withdrawn in 1 cm steps (SPT) or at a constant, low speed (~1 mm/sec-MPT or RPT-5 mm/sec-) until all the test holes are in the oesophagus. The passage can be repeated in the event of artifacts

(too many swallows), or to increase the number of measurements upon which to calculate mean values.
If an RPT is performed, patients are asked to hold their breath in order to avoid the influence of respiratory movements on the LES pressure.
During this phase the following measurements are made[9] (Fig. 1):

- *Identification of the inferior margin of the LES* at the point where the pressure trace rises steadily by at least 2-3 mmHg with respect to the intragastric pressure and measurement of its distance from the nostrils.
- *Identification of the pressure inversion point (PIP)*, defined as the point where the positive deflections of the sphincter pressure profile, in phase with those induced by breathing (pressure increase in inspiratory phase), become abruptly negative (pressure drop in inspiratory phase) in the counterphase with respect to the respiratory deflections.
- *LES resting pressure* The LES pressure, expressed in mmHg, is measured at the PIP, mid-way through the respiratory cycle with respect to the intragastric pressure, assumed as a value of 0. Alternatively, the maximum value reached at the end of expiration can be assumed as the resting LES pressure. Either way, it is essential to use the same method as that used to assess the volunteers and establish the normal range of values. If an RPT is performed, the maximum pressure recorded is assumed as the LES pressure.
- *Identification of the superior margin of the LES* at the point where the pressure trace reaches the intra-oesophageal pressure and measurement of its distance from the nostrils.
- *LES length* Given the nature of the method, the measurement can be obtained with an approximation of ±1 cm when using the SPT. With the MPT, the measurement is accurate to within 1 mm. For the accurate measurement of this parameter, therefore, only the rapid pull-through (RPT) method is recommended, preferably with the extractor controlled by the recording system. Using a paper feed of 1 mm/sec and the same rate for extracting the catheter, the length in mm on the paper trace coincides with the actual length of the LES.
- (Optional) *Length of the abdominal portion of the LES*, measured from the beginning of the LES to the PIP.

Study of LES phasic activity

For this part, the last test hole, which was initially situated in the gastric cavity (the pressure of which is taken as reference zero), is withdrawn until it comes inside the LES, on a level with the PIP. The other test points will thus be 5, 10 and 15 cm above the LES, thus enabling a valid map of the oesophageal body motility and monitoring of swallowing activity.
On the other hand, if a catheter with radial holes is used, the latter is positioned with the holes inside the LES, at the same level as the PIP.
Wet swallows must be performed (consisting of 5 ml water at room temperature), since dry swallows

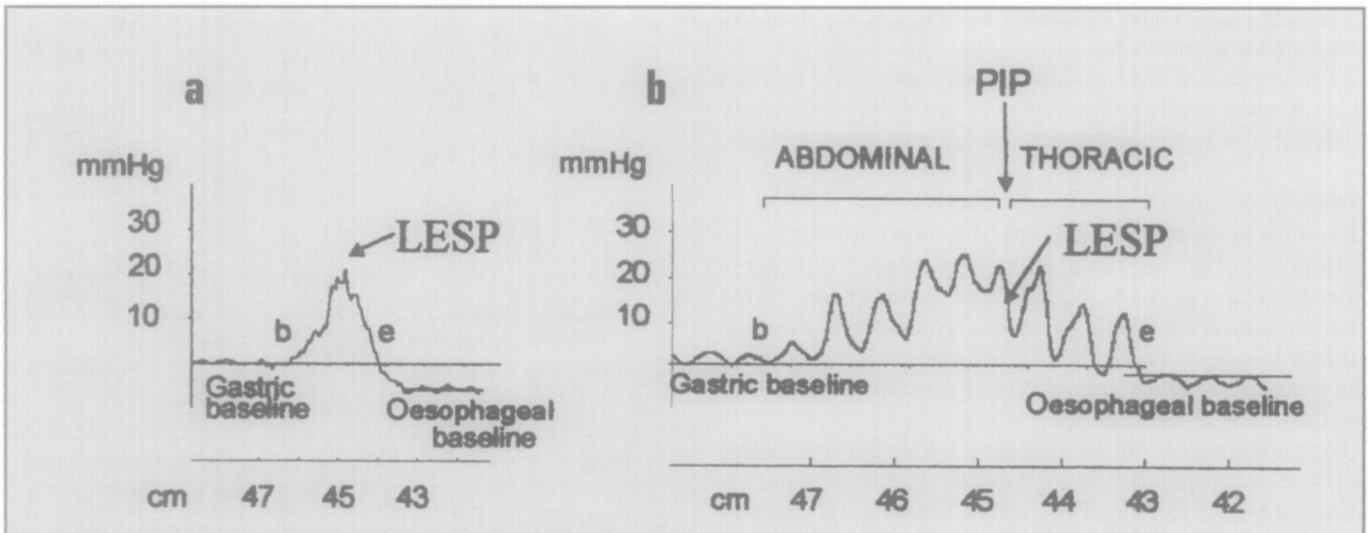

Fig. 1. Manometric recordings of a RPT (A) and a SPT (B) across the LES. With the RPT technique, LES pressure (LESP) is measured as the maximum pressure recorded, whereas with the SPT technique the pressure of LES (LESP) is measured at the PIP, mid-way in the respiratory cycle. Computerized system can also calculate mean average pressure of entire high pressure zone of LES. Length of LES can be calculated with both techniques, from the beginning of LES (b) to its ending (e). With the SPT, length of the LES abdominal component (from b to PIP) can also be measured (abbreviations: see list at end of paper).

(i.e.,with a bolus of saliva) have proved not only less reproducible but also less reliable[10].
It is advisable to have the patient perform a few test swallows; then at least 10 swallows are assessed.
During this phase the following measurements are made [11 12]:

- *Percentage of complete post-swallowing relaxations* (essential) Complete relaxation is when the minimum residual pressure (or nadir) in the LES during inhibition after swallowing drops to 5 mmHg or less above the intragastric pressure. In the case of catheters with radial holes, only one channel needs to reach the required pressure for relaxation to be classified as complete.
- *Mean duration of relaxation in seconds* (optional) This is measured in the LES from the start of the rapid negative deflection after swallowing to the point where the pressure trace returns to the original value.
- *Mean percentage of relaxations* (optional) calculated as: basal pressure/residual pressure x 100.
- *Mean residual pressure* (optional) calculated as the mean pressure remaining at post-swallow LES relaxation
- *Percentage of relaxations coordinated with overlying oesophageal contraction* (optional). A relaxation is classified as coordinated when it lasts long enough to encompass the positive deflection related to the overlying oesophageal contraction wave, recorded 5 cm away.
- *Percentage of incomplete relaxations* (optional) defined as the post-swallow deflection of the LES that remains at a value at least 5 mmHg higher than the intragastric pressure.
- *Percentage of absent relaxations* (optional), defined as when a swallowing action is not followed by any deflection in the high-pressure zone of the sphincter.

Study of oesophageal body motility
To study oesophageal body motility, the catheter is positioned so that the distal hole is situated 3 cm above the superior margin of the LES and the other test points are consequently 8 and 13 cm above the LES, thus enabling the motility of most of the oesophageal body to be studied. To study the proximal portion, the catheter position has to be changed.
Using catheters with 3 radial and 3 longitudinal holes, LES and oesophageal body motility can be studied simultaneously; in fact, if the radial holes are positioned at the same level as the PIP, the three proximal holes will be 5, 10 and 15 cm above the PIP, enabling the motility of most of the oesophageal body to be evaluated.
The basal pressure detected in the oesophageal body mid-way through the respiratory cycle is assumed as reference zero pressure. The pressure of the gastric fundus as reference zero may also be used. Either way, it is essential to adopt the same method as that used to assess the volunteers and establish the normal ranges.
As for the study of the LES, wet swallows must be performed, i.e., consisting of 5 ml water at room temperature, since dry swallows (i.e., with a bolus of saliva) have proved not only less reproducible but also less reliable. It is advisable to have the patient perform a few test swallows first; then at least 10 swallows can be assessed.
During this phase the following measurements are made, the first two concern the tonic activity, the others the phasic activity. In the evaluation of the phasic activity, each measurement should be calculated for each recording level (5, 10 and 15 cm above the LES) [11 12] (Fig. 2).

- *Resting pressure of the oesophageal body* (optional) is calculated, assuming the intragastric pressure as reference zero[13].
- *Total length of the oesophageal body* (optional) calculated as the distance from the upper border of the LES to the lower border of the UES.
- *The mean amplitude of contractions* (essential) calculated from the oesophageal baseline pressure to the maximum pressure peak.
- *Percentage of swallowing sequences causing peri-*

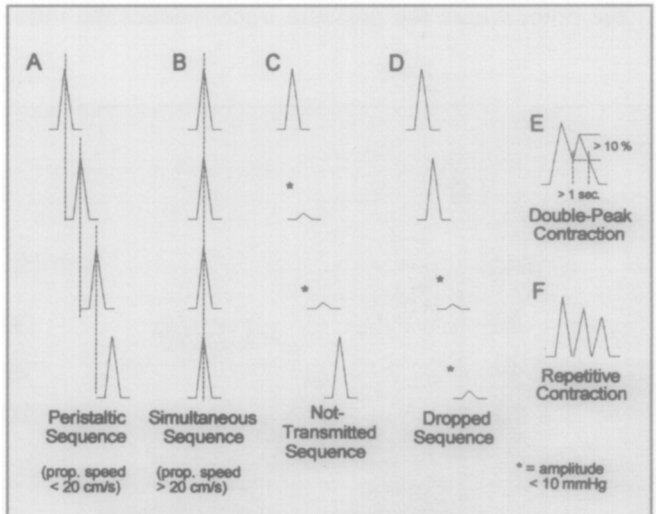

Fig. 2. A normal peristaltic sequence is represented (A): propagation speed must be lower than 20 cm/sec. If propagation speed exceeds 20 cm/sec, contractions are defined as simultaneous (B). Absence of contractions between two normally propagated waves is defined as "not-transmitted" peristalsis (C). If contraction fails to appear in distal part of oesophagus, peristaltic sequence is "dropped" (D). Contraction wave may have two or more peaks "multipeaked contraction" (each peak must have an amplitude not less than 10% of the overall contraction amplitude of at last ≥1 sec) (E). If peaks reach baseline, contraction wave is defined as "repetitive" (F).

staltic contraction waves (essential) A swallowing sequence is defined as peristaltic when it appears in all channels in a temporally sequential manner in the aboral direction. Each motor complex is characterized by the sequential onset of a pressure event along the oesophageal test points.
- *Percentage of swallowing sequences that cause simultaneous contraction waves* (essential) A swallowing sequence is defined as simultaneous when it appears in all channels in a temporally synchronous manner without any progression; the pressure event is recorded simultaneously and non-sequentially on all test points.
- *Percentage of contraction waves not transmitted* (essential) Failure to record the motor event at the level of the oesophageal test points.
- *Percentage of contraction waves suspended* (essential) Motor event recorded only at a level of the distal test point(s), with no pressure activity in the proximal point(s), or a motor event normally propagated only on a level with the distal test points and synchronous in the proximal test point(s).
- *Percentage of contraction waves "dropped"* (essential) Motor event recorded only on a level with the proximal test points, or a motor event normally propagated only on a level with the proximal test points and synchronous in the distal test point(s).
- *Percentage of swallowing sequences causing retrograde contraction waves* (essential): a swallowing sequence is defined as retrograde when it appears in all channels in a temporally sequential manner, but in the oral direction.

N.B. The total of these last 6 values must amount to 100%.
- *Mean duration of contractions* (optional): (from beginning of rapid rise on the trace until its return to baseline).
- *Percentage of repetitive and multi-phase contractions with double peak* (optional).
- *Percentage of repetitive and multi-phase contractions with triple peak* (optional).
- *Percentage of hypotonic waves* (optional). Number of contraction waves with an amplitude lower than the 10th percentile of the values defined by the oesophageal motility laboratory concerned as normal.
- *Percentage of hypertonic waves* (optional) Number of contractions with an amplitude exceeding the 90th percentile of the values defined by the oesophageal motility laboratory concerned as normal.

Motility should also be assessed in relation to the swallowing action, thus distinguishing post-swallow activity from spontaneous activity.

Study of UES

The minimum standard for oesophageal manometry does not include studying UES motility, which is considered optional. Although perfusion manometric systems are not ideal for studying this district, they can provide some useful information.

To overcome the well-known lack of symmetry of the UES's, it is essential to use all the side-holes (oriented in the various spatial planes) and to calculate the mean values of the measurements [14].

The SPT is used in this case. If an MPT is used, the withdrawal rate must be increased to 5 mm/sec because it is difficult to prevent the patient from swallowing.

Study of UES tonic activity

The SPT is used also in this case.

During this phase the following measurements are made:
- *Identification of the inferior margin of the UES* at the point where the pressure trace rises steadily above the oesophageal basal pressure by at least 3 mmHg.
- *UES resting pressure* Measured in mmHg and calculated with reference to the basal oesophageal pressure.
- *Identification of the superior margin of the UES* at the point where the pressure trace reaches the endopharyngeal pressure and measurement of its distance from the nostrils.
- *UES length*, measured as the difference between the inferior and superior margins.

Study of UES phasic activity after swallowing

To overcome the mobility of the UES and study the activity of the UES after swallowing, the last but one test point (at the distal end) is positioned on the upper margin of the UES, so that the distal sensor is at level of the cervical oesophagus and the two proximal sensors are at level of the proximal and distal pharynx. In this way, the 2 cm upward movement of the UES during swallowing is compensated and the test point remains in the sphincter zone during the swallow, as suggested by Nelson and Richter [15] and Castell and Dalton [16]. The sleeve sensor or a catheter with side holes at 1 cm intervals may also be useful to measure UES activity: although they are probably more accurate, these methods are less practical and are not deemed suitable for routine clinical use. Here again, wet swallows must be used, but with 10 ml boluses of water in order to further stimulate the pharynx.

At least 5 swallows are recommended. In the case of recordings on paper, the paper feed rate must be increased to at least 10 mm/sec; in the case of digital data acquisition the sampling frequency must be at least 50 Hz in order to amplify the trace and assess the rapid events occurring at this level.

During this phase the following measurements are performed:

- *Percentage of complete relaxations* (percentage of relaxations in which the minimum residual pressure (or nadir) in the UES drops (during inhibition after swallowing) to values of no more than 10 mmHg with respect to the basal oesophageal pressure.
- *Percentage of relaxations coordinated with the pharyngeal contraction*, defined as relaxations in which the pressure drop lasts long enough to encompass the positive deflection relating to the overlying pharyngeal contraction wave.
- *Mean duration of relaxation* (optional) measured in seconds; this is the interval between the beginning of the rapid negative deflection in the UES after swallowing and the return to the original value.
- *Mean percentage of relaxation* (optional), calculated as the basal pressure-residual pressure x 100.
- *Mean residual pressure* (optional), defined as the mean pressure remaining at each post-swallow relaxation of the UES

Study of pharyngeal contractions
The minimum standard for oesophageal manometry does not include studying pharyngeal motility, which is considered optional.
The test is usually divided into a distal and a proximal part.
For each level, the following measurements are made:
a) Mean amplitude of contractions.
b) Mean duration of contractions.
For the distal pharynx (5 cm above the LES), the mean amplitude of the "shoulder" of pharyngeal precontraction must also be measured. (i.e., the slow increase in pressure before the rapid upstroke of pharyngeal contraction, which is related to the compliance of the UES with the passage of the bolus) [17].

Reporting

The report must contain the following general information: date and type of test, name of patient and name of operator, reasons prompting manometry, description of manometric findings, signature of the person responsible or operator. A manometric diagnosis should be expressed in the final report.
To better understand the test, a table should be prepared with the numerical findings measured in the patient for the following parameters (Table III) and with the normal reference values for comparison.

Indications and contraindications for the test

Oesophageal manometry is considered as a second-level diagnostic technique and is used after methods, such as X-ray or endoscopy have assessed the existence and/or severity of organic lesions of the oesophagus and the oesophago-gastric junction. It is usually requested by a gastroenterologist to confirm or rule out any oesophageal motility disorder. It may be requested, however, by the general practitioner or by other specialists (cardiologists, pneumologists, otorhinolaryngologists, etc.). It is, therefore, advisable to establish proper indications for the clinical use of oesophageal manometry to obtain greater benefits in diagnostic terms.

Oesophageal manometry is advisable in the following conditions:

Patients with dysphagia, after ruling out any organic pathology, to formulate the diagnosis of an oesophageal motility disorder (achalasia, diffuse oesophageal spasm, etc.)
Dysphagia, i.e., the sensation of obstruction to the passage of food from the oral cavity to the stomach, strictly related in time with the act of swallowing, is a highly specific symptom.
Considering patients who have undergone oesophageal motility assessment, excluding those with inflammatory or neoplastic organic oesophageal disorders, it becomes clear that dysphagia is very rare in individuals with normal oesophageal motility (≤10%), whereas it is almost always detected in patients with a proven motility disorder, the frequency ranging from 18% (for specific motility anomalies)[18] to 85% (for achalasia)[19].
Standard manometric assessment can detect oesophageal motility disorders in a large proportion (≥90%) of patients with dysphagia with no organic causes and is, therefore, a test with a high diagnostic sensitivity in such cases [20]. It is worth adding, however, that only some of these manometric anomalies can be

Table III. Essential information that the final oesophageal manometry report should contain.

Lower oesophageal sphincter	Oesophageal body
- Basal pressure - Total length - Percentage of complete relaxations	- Mean amplitude of distal oesophageal body motor waves - Percentage of swallows followed by normally-propagated motor waves

classified in the context of a primary or secondary motility disorder, whereas about 20% of cases fall into the group of so-called non-specific motor disorders. The latter do not allow diagnosis, but may nonetheless suggest the need for clinical or manometric monitoring [21].

Patients with chest pain, after ruling out any cardiopulmonary origin and after performing gastro-oesophageal morphological investigations (X-ray, endoscopy)

It is calculated that the oesophagus is responsible for symptoms in about 60% of patients with angina-like chest pain revealing no cardiac causes. The most common oesophageal cause of chest pain is peptic or infectious oesophagitis and motility disorders should be investigated only after endoscopy has ruled out any mucosal abnormality. In about 50% of patients with a proven oesophageal origin of the pain, motility abnormalities are found to be associated with the symptom and thus considered responsible for the pain.

Standard manometry is capable of revealing motility disorders in a fairly high percentage of patients with non-cardiac chest pain (70-80%)[22].

In the event such anomalies are classifiable in the context of primary motility pathologies (achalasia, DES, nutcracker oesophagus), manometry provides a sufficiently reliable diagnosis as far as concerns the origin of the pain, since the anomaly frequently occurs with painful symptoms in these patients (in 50-80% of cases)[23].

On the other hand, if the manometric test reveals non-specific motility disorders, as found in more than half of these patients [24], the diagnosis is not very useful from the clinical standpoint because it does not adequately clarify the origin of the pain.

In this case, the use of provocative tests is recommended, such as the administration of edrophonium (80 mg/kg iv), which enables the painful symptoms and motility anomalies to be reproduced in 33% of these patients [25 26]. Alternatively, an ambulatory 24-hour manometric investigation may be suggested with a view to assessing the timing and consequently the causal relationship of the painful episodes with any motility disorder of the oesophageal body. According to the literature, this method reveals the oesophagus as being responsible for the pain in about 50% of cases and this probably represents the maximum diagnostic sensitivity that manometry can achieve in this type of patient [27].

Patients with systemic disease (e.g. collagenoses) if we need to establish any oesophageal involvement (multiple-organ pathologies)

Oesophageal motility disorders are frequently associated with systemic disease, and with collagenoses in particular. It is calculated that 50-70% of patients with a diagnosis of scleroderma present manometric alterations in the form of a reduced or absent peristalsis in the distal half of the oesophageal body and a more or less marked LES hypotonia. Such anomalies are considered typical of systemic sclerosis [28], but cannot be considered pathognomonic, albeit with a lesser frequency, of other collagenoses (e.g. CREST syndrome, polymyositis, dermatomyositis) [29]. Moreover, manometry is not suitable as a tool for diagnosing collagenoses because the latter are confirmed in no more than 40% of patients with typical manometric anomalies.

Manometry consequently plays a role in assessing the degree of functional impairment of the oesophagus in patients with a confirmed collagenosis. The clinical value of this finding lies mainly in contributing towards reaching decisions for conservative or surgical treatment in patients with complicated reflux disease. The outcome of surgical treatment in such patients is thought to be less satisfactory and burdened with a greater frequency of complications (post-operative dysphagia). However, the only substantial report on the topic suggests that the surgical outcome in scleroderma is comparable with that of other patients with reflux [30].

Patients with GERD, as a complementary test prior to any anti-reflux surgery

In patients with GERD, manometry is not used for diagnostic purposes. It is proposed as a means for assessing the pathogenic role of the oesophageal motility disorder in such patients (defective peristalsis, LES dysfunction).

Manometry is, therefore, performed in patients who fail to respond to medical treatment (to rule out any other pathologies, such as collagenosis) and in view of any surgical correction. Though there is no proof in the literature, it is commonly assumed that the presence of certain documented manometric anomalies (hypotonic LES, severe peristaltic defect) may help to confirm the indication for anti-reflux treatment[31] or predict the incidence of unwanted side effects of such surgery (post-operative dysphagia)[32].

Patients needing the placement of an intra-oesophageal catheter (e.g. a pH-metering probe) that must be positioned precisely with respect to the sphincter areas

24-hour pH-monitoring in GERD is performed by placing the electrode in a "conventional" position situated 5 cm above the proximal margin of the LES. There is no doubt that of the various methods proposed (pH-meter pull-through, endoscopy, fluoroscopy, manometry), manometry is the most accurate[33 34].

It is generally believed, however, that in the absence of anatomical variants (hiatus hernia) there is a fair corre-

Table IV. Contraindications for oesophageal manometry.

Absolute	Relative
Pharyngeal or upper oesophageal obstruction	Oesophageal tumours or ulcers
Bullous disorders of oesophageal mucosa	Large oesophageal varices
Cardiac conditions in which vagal stimulation is poorly tolerated	Large oesophageal or crico-pharyngeal diverticula
Severe coagulopathy	
Patient non-compliance	

lation between the different positioning methods and that any variations in the position of the electrode of up to 2 cm do not significantly affect the diagnostic value of pH-monitoring.

On the other hand, manometry becomes absolutely necessary in those cases in which the electrode has to be positioned near the UES (immediately below or immediately above it) to assess the existence of any proximal reflux responsible for symptoms in the oropharyngeal district or upper airways. In this case, the outcome of pH-monitoring can be strongly influenced by the positioning of the electrode with respect to the cricopharyngeal sphincter.

There are few situations (Table IV) in which oesophageal manometry is absolutely contraindicated, mainly related to oesophageal obstruction, bullous disorder of the oesophageal mucosa, patients' non-compliance, etc.

List of abbreviations used

LES: lower oesophageal sphincter; UES: upper oesophageal sphincter; PIP: pressure inversion point; SPT: slow pull through; MPT: motorized pull through; RPT: rapid pull through; DES: diffuse oesophageal spasm; GERD: gastro oesophageal reflux disease.

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