Oesophageal manometry and pH-impedance studies in gastro-oesophageal reflux disease

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Introduction

Gastro-oesophageal reflux disease (GORD) is probably the most common disease encountered by the gastroenterologist physician and surgeon. Its diagnosis is mainly clinical and based on symptoms of heartburn and reflux. Upper gastrointestinal endoscopy when done may show evidence of reflux oesophagitis. Oesophageal pH and manometry are used mainly for a specific group of patients who are resistant to routine medication and prior to surgery. Ambulatory reflux monitoring is the only test that can assess reflux symptom association. On the other hand, oeosophageal manometry is recommended for preoperative evaluation, but has no role in the diagnosis of GORD.

The first attempts at measuring the pH changes in GORD were made by Tuttle et al, who in 1960 used a glass pH electrode to demonstrate a gradual sloping gradient in the gastro-oesophageal pH in patients with oesophagitis in contrast to a sharp one in normal subjects [1]. Later, Johnson and DeMeester developed a dependable external electrode in 1974, successfully using it to measure oesophageal pH changes for up to 24 hours [2]. During the last decade, further studies demonstrated that the use of combined pH-impedance monitoring was more effective compared to pH monitoring alone in clinical practice.

Kronecker and Meltzer performed the first oesophageal manometric studies using a balloon kymograph in 1894, but its clinical use was demonstrated by an atlas of oesophageal manometry published by Code et al in 1958 [3]. When optimally utilized, a manometric evaluation provides an accurate description of oesophageal contractile function, and is useful in characterizing a variety of oesophageal motility disorders.

These rapidly evolving and highly technical fields of study have provided major insights into our understanding of the pathophysiology of GORD, and have become an integral part of its evaluation in the modern era.

Technical details

pH monitoring

Intra-oesophageal acidity can be measured via a trans-nasal catheter with a pH sensitive electrode placed in the oesophagus (for 24h) or a telemetry capsule (for 48h). Detection of periods of oesophageal acidification allows for a direct diagnosis of episodes of gastro-oesophageal reflux and quantification of the exposure of the distal oesophagus to acid [2]. For ambulatory monitoring, the basic equipment should include a data logger and an event marker to signal symptoms and other events during the period of recording. Reflux is defined as a drop in pH below 4. The number of episodes of reflux and the acid exposure time (the % of time with the pH <4) is recorded. The acid exposure time has been shown to positively correlate with the degree of mucosal damage. Although routine studies are performed with one distal pH sensor, experimental studies using multiple pH sensors allow evaluation of the proximal extent of the reflux [4]. However, pH studies do not give a measurement of the volume of the reflux. Wireless pH monitoring using a capsule is a fairly recent advancement which is more tolerable to the patient, but is limited by cost.

Intraluminal impedance monitoring

Impedance monitoring includes the concurrent measurement of impedance from multiple intraluminal recording segments of an impedance catheter positioned

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within the oesophageal body [5]. The different patterns of electrical conductivity of gas, liquid or mixed content allows their distinction. It is also possible to distinguish between resting states, bolus transit, and wall contraction. The sequence of impedance changes allow recognition of flow in either aboral (swallow related) or oral (reflux) directions [6]. Gastro-oesophageal reflux is demonstrated as a liquid or mixed bolus moving in the oral direction during impedance studies, without any measurement of the pH. The most distal electrode is placed 2-3cm from the lower oesophageal sphincter (LOS) to detect restricted reflux episodes not reaching 5cm beyond the LOS [5].

Combined pH-impedance electrodes allow measurement of both parameters and their structure combines the two principles (figure 1). With the combination, reflux can be categorized as acid (nadir pH<4) or non-acid (nadir pH>4). In ambulatory subjects off proton-pump inhibitor (PPI) therapy, approximately two-thirds of reflux episodes are acidic and one-third is weakly acidic [7]. Conversely, if patients are on PPI therapy, approximately 90% of reflux episodes are weakly acidic (nadir pH 4-7) and are still responsible for the majority of symptoms [8].

Ambulatory reflux monitoring (pH or impedance-pH) is the only test that allows for determining the presence of abnormal oesophageal acid exposure, reflux frequency, and symptom association with reflux episodes.

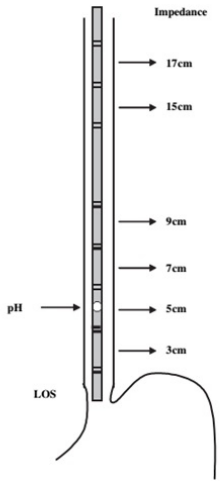

Figure 1. Schematic representation of a combined impedance-pH catheter. There is one antimony electrode placed 5cm above the LOS and six pairs of impedance electrodes set at 2cm intervals .

Manometry

Manometry quantifies intraluminal oesophageal and LOS pressure during swallowing to detect abnormalities of peristalsis and sphincter relaxation. Stationary oesophageal manometry is performed by water-perfused catheters with volume displacement transducers or strain gauge transducers with solid-state circuitry. Water-perfused catheters are in wider use due to their lower cost, reusability and versatility, but require skilled personnel for maintenance. A perfused sleeve assembly is commonly used to hold the catheter in place during oesophageal shortening with swallowing. High resolution manometry (HRM) is a relatively recent advancement, which is characterized by the use of catheters which have a large number of sensors (21-36 sensors) which are very closely spaced (1-2cm). Data from HRM is usually illustrated as an oesophageal pressure topography (OPT) plot. OPT plots utilize colours to illustrate different pressure domains, and can be used to clearly demonstrate the gastro-oesophageal junction (GOJ) and the functional anatomy of the oesophagus [10].

Use in gastro-oesophageal reflux

pH/impedance-pH monitoring

pH monitoring in patients with endoscopy proven erosive oesophagitis has been shown to have excellent sensitivity (77–100%) and specificity (85–100%); however, the sensitivity is lower in those with endoscopy-negative reflux symptoms (<71%) [11]. The differentiation between physiological and pathological reflux is thought to be best achieved by recording the percentage of time the pH is < 4 [12].

The temporal relationship between the symptoms and reflux episodes is expressed using the symptom index (SI) or symptom association probability (SAP). A positive SI and/or SAP indicates a high probability that the relationship between reflux and symptoms did not occur due to chance and thus suggests causality [13]. Both these indices have been used in patients off PPI therapy who are experiencing heartburn. For patient management, a strongly positive SI or SAP may suggest the need for a therapeutic intervention and a negative result supports the notion that the patients symptoms are unlikely to be due to reflux [14]. However, a major shortcoming is that these depend on the patient

identifying and reporting all symptoms completely. Additionally reflux episodes that occur as prolonged rather than transitory events may not be reported correctly [11].

According to current guidelines, indications for ambulatory pH monitoring in GORD are [14.15]:

1. In the evaluation of patients refractory to PPI therapy.
2. Before consideration of endoscopic or surgical therapy in patients with non-erosive disease.
3. Where the diagnosis of GORD is in question.

On patients refractory to PPI therapy, cessation of treatment prior to pH monitoring (7-14 days) is commonly done [15]. However, it is difficult to make recommendations on the "off vs on PPI" approaches according to the available evidence in centers where impedance-pH testing is available [14]. If reflux monitoring off medication is negative, the probability of GORD is very low, while a positive reflux test offers objective evidence to support the diagnosis. However, it does not provide information on the reason for the poor response to therapy. If pH monitoring alone is used in refractory patients while on PPI therapy, up to 96% may show normal acid exposure levels [16]. The use of combined pH-impedance monitoring is useful in these cases to detect non-acid reflux, which may increase the sensitivity up to 90% in endoscopy negative patients [5].

In patients with extra-oesophageal manifestations of GORD (mainly laryngeal and respiratory), a negative reflux monitoring test will point towards non-GORD aetiologies for the symptoms. The presence of abnormal pH monitoring results in patients with extra-oesophageal symptoms vary widely in reports [17].

24-hour pH monitoring also provides important prognostic information on patient selection for anti-reflux surgery [15]. It has been shown to be the strongest outcome predictor of laparoscopic Nissen fundoplication, although this is probably based more on the correct identification of the disease than on its severity [18].

Manometry

During oesophageal manometry, gastro-oesophageal reflux is signified by the occurrence of absent LOS pressure with a common cavity phenomenon which is ended by primary and secondary peristalsis [19]. A common cavity phenomenon is identified by the rapid increase of intra-oesophageal pressure to match the intra gastric pressure, which signifies the relaxation of both the LOS and the crural diaphragm [20]. However, this phenomenon is technically difficult to detect with a low volume refluxate and is a relatively insensitive and non-specific method of measuring reflux [5]. Due to these reasons, manometry is not considered important in establishing the diagnosis of GORD.

However, manometry is recommended prior to antireflux surgical procedures to exclude other dysmotility disorders. GORD may co-exist with undiagnosed conditions such as achalasia, scleroderma oesophagus or non-reflux induced oesophageal spasm, which are best diagnosed by manometry [21]. The association between post-surgical dysphagia and preoperative peristaltic dysfunction detected by manometry has been a controversial issue, although current data do not support it [22].

Conclusion

Gastro-oesophageal reflux disease remains one of the commonest conditions seen in our practice and should be diagnosed based on its common symptoms. While oesophageal manometry and pH studies help in the diagnosis and management of GORD they should not be routinely done for all patients. If used selectively and in the proper setting, they will help alleviate some of the most troublesome symptoms seen in the population.

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