Manometry and 24-hour pH monitoring in diagnosis and management of GORD

Gastro-oesophageal reflux disease (GORD) is mainly diagnosed on symptoms and endoscopy findings. At least 50% of patients with GORD will have a normal oesophagus at endosopy. Twenty four-hour ambulatory pH monitoring together with manometry offers an accurate objective diagnosis of GORD and is helpful in directing appropriate treatments including surgery.

Gastro-oesophageal reflux disease (GORD) is the symptomatic reflux of gastric contents into the oesophagus. The condition requires various treatments including lifestyle and dietary modification, acid-neutralizing or inhibitory drugs and in a few cases, either endoscopic or surgical interventions. GORD can severely reduce quality of life and has also been linked to the development of Barrett's oesophagus and carcinoma of the oesophagus.

Prevalence

GORD is very common in western societies and this may be linked with lifestyle and diet. It is also on the increase in developing countries, possibly linked to globalization owing to the changing pattern of eating habits associated with urbanization and affluence, and is one of the commonest cause of referrals to medical practitioners. The widespread use of acid suppression therapy, particularly proton pump inhibitors, is an increasing financial burden on health-care resources worldwide.

Diagnosis

Diagnosis of GORD is mostly based on symptoms and history. Initially, patients self medicate with acid-reducing drugs, many of which are now available without prescription. When symptoms become more troublesome, proton pump inhibitors, increasingly prescribed by GPs, are the mainstay therapy. Few patients ever see a specialist and this is usually limited to those with chronic and relapsing long-term disease. For those patients with reduced or failed response to medication or complications (e.g. oesophagitis, stricture) other management strategies (endoscopic or surgical) may be required.

Symptoms

The classical symptoms of GORD are heartburn, chest pain, regurgitation and occasionally dysphagia. In most cases these are the only diagnostic criteria for GPs and medical treatment is accordingly prescribed, sometimes for many years. If symptoms persist or treatment becomes less effective, specialist referral and further investigation is sought.

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Investigations

In recent decades the first-line objective investigation for GORD has been upper gastrointestinal endoscopy, more increasingly requested by direct GP referral (open access). Where mucosal damage or a mechanical problem (such as a hiatus hernia) is found, the diagnosis can be made. If the gastroscopy is normal (40–50% of cases with GORD) but symptoms persist, objective evidence of oesophageal dysfunction is recommended.

The standard radiological investigation generally performed is a barium swallow. This outlines the oesophageal lumen and mucosa and gives information regarding transit and reflux, as well as highlighting oesophageal mucosal damage such as ulcer or inflammation.

Other tests that can be performed are 24-hour intra-oesophageal pH measurement, sometimes combined with manometry. Manometry cannot detect reflux but it gives accurate and useful information regarding motility and sphincter function. This is useful in exclusion of primary motility disorders such as achalasia but is also helpful in identification of hiatus hernia, an hypotensive lower oesophageal sphincter (LOS) and non-specific dysmotility, each of which may be a factor in reflux disease. Both these investigations have been gaining in popularity, particularly where practitioners may be considering anti-reflux surgery as a treatment option. The pros and cons of pH monitoring and manometry are outlined below.

Twenty four-hour pH monitoring

Twenty four-hour pH monitoring was introduced over 30 years ago (Spencer, 1969; Johnson et al, 1976). The principle of pH measurement relies on detection of gastro-oesophageal reflux (GOR) by an intra-oesophageal pH sensitive electrode mounted on a small catheter introduced via the nares. These catheters are now around 1 mm in diameter and are also available with two or more sensors mounted along the catheter. More recently an endoscopically placed telemetry sensor has been introduced (Pandolfino and Kahrilas, 2005) which obviates the requirement for a nasal connection. In the early 80s ambu-

latory monitoring was advocated (Branicki et al, 1982), initially using a tethered telemetry sensor, as a more sensitive method of detecting pathological reflux in as near a normal setting as possible. This avoided a hospital stay and allowed patients freedom of dietary and normal activities.

Method

The pH sensor is positioned, usually via the nares, 5 cm above the proximal border of the lower oesophageal sphincter (ideally defined by manometry) and pH is continuously monitored for up to 24 hours by a portable body-borne recorder. The patient is allowed normal meals and the monitoring continues at night to detect any nocturnal reflux that may occur during sleep. In most cases the recording is performed as an outpatient procedure and the patient returns home for the duration of the recording. One or more symptom markers are provided which allows patients to record episodic symptoms so that GOR can be correlated with symptoms on analysis of the recording. Patients usually have to stop acid-reducing medication for up to 5 or 7 days before the test to avoid masking GOR that may be reduced by medication. Occasionally, patients are studied while taking medication to test for efficacy of acid suppression.

The results of the pH recording are analysed by computer software according to standardized criteria previously derived by international agreement (Emde et al, 1987). Reflux is classified in terms of the percentage acid exposure to the distal oesophagus, the number and length of reflux episodes and its relation to symptoms. Where a proximal oesophageal or laryngopharyngeal electrode is used, acid exposure to these areas is important in relation to extra-oesophageal symptoms (Kaufman et al, 2002).

Figures 1 and *2* illustrate normal and pathological reflux showing a 24-hour pH profile recorded from the distal oesophagus, 5 cm above the proximal border of the LOS. They show the severity and patterns of reflux in relation to meals, activities and sleep, and also the correlation between symptoms as indicated by the patient and reflux recorded by the sensor.

Figures 3a and *3b* are twin channel probe studies performed on a patient on two occasions. The first is a baseline study without any medication, the second during therapy with a proton pump inhibitor taken in the morning and evening. The two sensors are positioned in the distal oesophagus and the gastric body. These two studies are designed to assess the efficacy of acid suppression in patients who may be achieving only sub-optimal symptom relief from this type of medication. While the twice daily dosage is effective in reducing reflux, in this case the nocturnal dose allows breakthrough of reflux during the night as a result of incomplete acid suppression as shown by the low pH value.

pH monitoring is widely available in specialist hospitals and is generally required when decisions on non-medical management are being considered or where complications of GORD are found. *Table 1* highlights the clinical indications of GORD that may require the use of pH monitoring.

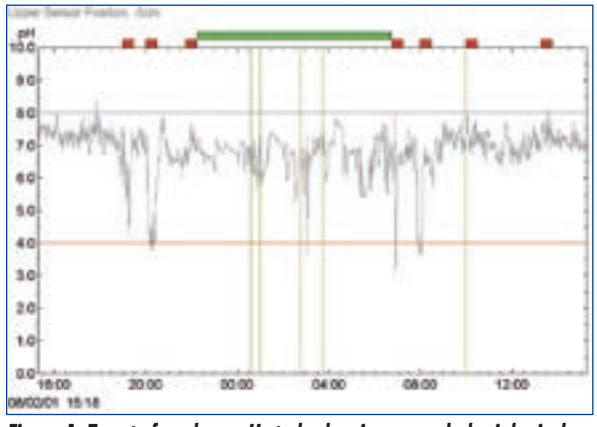


Figure 1. Twenty four-hour pH study showing normal physiological gastro-oesophageal reflux by day and by night.

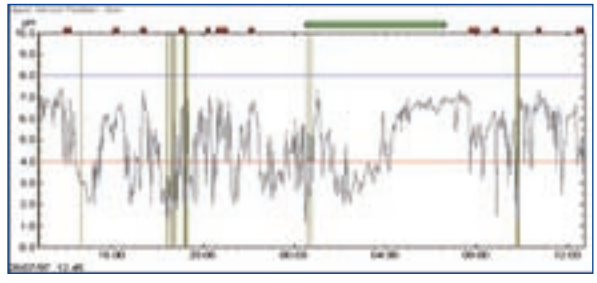
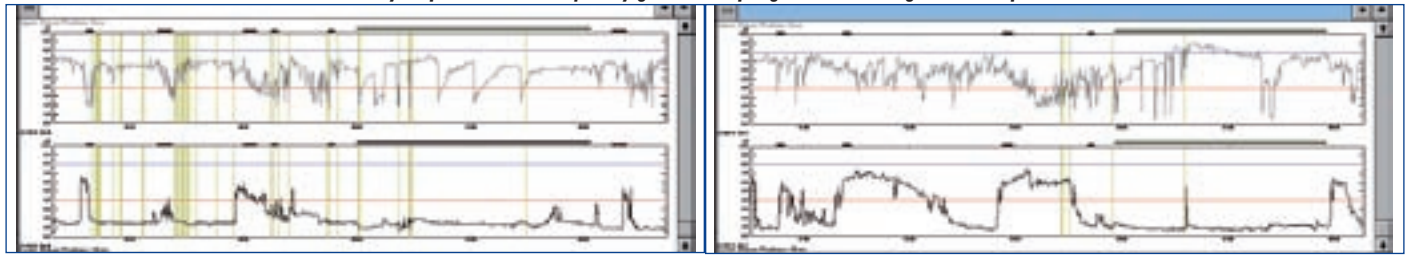


Figure 2. Pathological gastro-oesophageal reflux by day and night with good symptom correlation. Green bar signifies sleep, red bars signify meals. Yellow vertical lines are symptoms indicated by patient. Gastro-oesophageal reflux is said to occur when pH falls below 4. Note the number of reflux episodes not experienced as pain – this is classified as 'silent' reflux.

Figure 3. Twin pH studies showing the effect of omeprazole 20 mg twice daily on oesophageal reflux and gastric pH. a. Baseline study without acid suppression and (b) after steady state with omeprazole 20 mg twice daily. Gastro-oesophageal reflux is reduced by acid inhibition and there is also a reduction in symptoms. The nocte dose does not afford the same inhibitory response and consequently gastro-oesophageal reflux at night remains problematic.



Oesophageal manometry

Oesophageal manometry was developed in its present form over 50 years ago and is a sensitive investigation in describing the pathophysiology of motor function in symptomatic patients (Richter et al, 1987). It is a measurement of dynamic function of the upper and lower sphincters and propulsion within the oesophageal body. It is primarily used to investigate abnormalities of motility but is also useful in GORD to give detailed information relating to impairment of sphincter function at the gastro-oesophageal junction which may relate to reflux. It is particularly helpful where symptoms are not entirely limited to heartburn (i.e. regurgitation, dysphagia and pain on ingestion of food and drink) and in reflux disease when anti-reflux surgery is being considered.

Manometry does not measure reflux but it can be useful to give a fuller picture of functional abnormalities that may contribute to, or even be causative of GORD.

Method

Two methods of measurement are currently available: the traditional pull-through technique or a more prolonged ambulatory measurement performed usually as an outpatient procedure.

Station-pull through

The patient is intubated, usually through the nasal route, with a multi-sensor (3–8 channel) catheter. This is either a water perfused, disposable polyvinyl catheter (2.5–4 mm diameter) or a re-usable solid state device. Both catheters detect luminal pressure changes within the sphincters and the body of the oesophagus. Pressures are converted to a continuous, recordable display with dedicated computer software and a standardized protocol is used to calculate recorded parameters of sphincter and body function.

Figure 4 illustrates a normal examination showing a normal dynamically relaxing LOS and good peristalsis and contractility in the body.

Figure 5 shows a patient with achalasia, the commonest primary motor disorder found within the oesophagus. In this case, the LOS is hypertensive and without any relaxation on swallowing and there is total loss of peristalsis in the body. By comparison, *Figure 6* shows a patient with reflux symptoms who demonstrated non-specific dysmotility. This is relatively common in GORD and may be an important finding in some cases where there is no other obvious cause for the reflux.

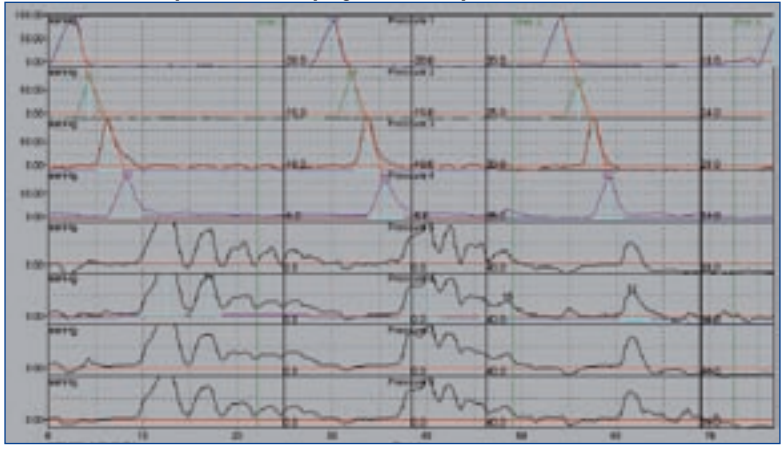
Table 2 summarizes the range of normal parameters that are measured during a standard procedure. These data can be used to compare values derived from symptomatic patients.

Table 3 summarizes the major differences seen in the most common oesophageal motor disorders. The results of manometry are useful in directing appropriate treatments and also assessing the efficacy of treatment where patients remain symptomatic.

Table 1. Indications for pH monitoring

When acid suppression therapy is sub-optimal or fails to abolish symptoms
When patients symptoms recur after long-term acid suppression is withdrawn
When patients are concerned about long-term side effects of drugs
When surgery for reflux is being considered

Figure 4. Normal manometry showing peristaltic function and coordinated lower oesophageal sphincter (LOS) relaxation during standardized wet swallows. Channels 1–4 are sited in the oesophageal body at 5 cm intervals. Channels 5–8 are radial channels sited across the LOS. Respiratory excursions are superimposed over LOS resting pressure. This relaxes to zero as a peristaltic wave progresses distally.

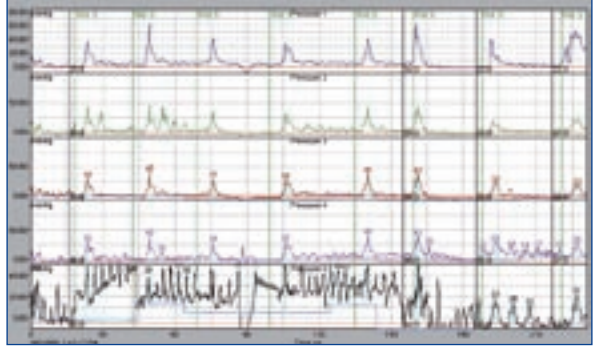


Ambulatory

Ambulatory oesophageal manometry is occasionally used in patients with either reflux or transit symptoms when both standard manometry and pH are inconclusive.

Ambulatory manometry uses a solid state, multisensor pressure catheter connected to a portable recorder with symptom markers, capable of storing up to eight channels of recorded pressures for at least 24 hours. This enables detection of intermittent contractile abnormalities and correlation with symptoms. It is most useful in the detection of oesophageal spasm in association with non-cardiac chest pain (Barham et al, 1997). The recorders are also able to monitor pH and this is useful where reflux-induced spasm is found to be the cause of symptoms.

Figure 5. Manometric pattern of achalasia showing loss of peristalsis in the oesophageal body and hypertension and non-relaxation in the lower oesophageal sphincter.



Multiple intraluminal impedance

Multiple intraluminal impedance (MII) measurements in the oesophagus have been developed (Fass et al, 1994) as an alternative to pH monitoring and manometry. The principle of detection uses alterations of oesophageal luminal impedance in relation to bolus transit and reflux within the lumen.

The method relies on detection of luminal impedance changes in association with pH recordings within the oesophagus and stomach using a catheter with multiple impedance electrodes and two pH sensors. Recorded data can be analysed for a number of parameters relating to the patterns of swallows, acid and non-acid reflux, oesophageal bolus transit, oesophageal clearance, and gas, liquid and solid regurgitation.

Recently, the equipment has been commercialized and an ambulatory system enables 24-hour recordings to detect acid and non-acid reflux, bolus transit and oesophageal clearance. Sophisticated analytical software enables rapid analysis of recordings and detection of abnormalities and correlation with symptoms (Tutian and Castell, 2005). This allows accurate assessment of data and may increase the diagnostic yield in patients where symptoms are atypical and intermittent, and pathology uncertain.

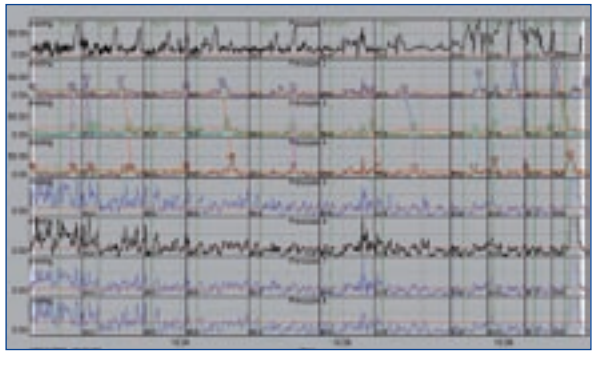
Diagnostic value of tests

24-hour pH monitoring

Twenty four-hour pH monitoring is a useful investigation in patients with oesophageal symptoms thought to be caused by GOR for a number of reasons.

1. It detects and monitors acid reflux, identifying patterns of reflux in relation to food and drink, daily activities and when supine and asleep
2. Symptom markers allow for positive correlation of reflux to experienced symptoms
3. Using a two-channel catheter with the second channel sited in the stomach, it can monitor the efficacy of acid-reducing drugs in raising pH and reducing reflux
4. Using a two-channel catheter with the second channel sited in the proximal oesophagus or in the pharyngo-laryngeal space, it can identify the proximal migration of reflux and laryngo-pharyngeal reflux in patients with extra-oesophageal symptoms (*Table 4*)
5. It is essential in patients with poorly treated long-standing symptoms being considered for anti-reflux surgery to confirm that GOR is causal and severe

Figure 6. Non-specific motor disorder (also known as inefficient oesophageal motility). Peristalsis is partially lost in the body and associated with sporadic weak contractions on swallows. The lower oesophageal sphincter is also often hypotensive. This pattern is common in reflux.



Oesophageal manometry

Static and prolonged oesophageal manometry is also a useful investigation in GORD.

Table 2. Manometric parameters with normal values

Area of measurement		Median value	Normal range
Lower oesophageal sphincter	Resting pressure	15 mmHg	8–25 mmHg
	Total length	3 cm	2–4 cm
	Intra-abdominal length	1.5 cm	1–3 cm
	Relaxation on swallows	◘ 5 mmHg	0–5 mmHg
Upper oesophageal sphincter	Resting pressure	50 mmHg	30–100 mmHg
	Relaxation	to 5 mmHg above baseline	0–5 mmHg
Oesophageal body motility	Contractions	Mono or biphasic	Repetitive or absent
	Amplitudes	30–160 mmHg	<30 or>160 mmHg
	Coordination	100% peristalsis	>20% non-peristalsis
	Peristaltic velocity	3 cm/sec	1.8–5 cm/sec
	Wave duration	4 secs	2–6 secs

Table 3. Oesophageal motor disorders and their specific features

Disorder	Symptoms	Lower oesophageal sphincter	Oesophageal body
Achalasia	Dysphagia Regurgitation Chest pain	Hypertensive Total or partial loss of relaxation	Total loss of peristalsis Common cavity
Pseudo-achalasia	Dysphagia Regurgitation Chest pain	Hypertensive long rigid segment at gastro-oesophageal junction	Common cavity Occasional peristalsis in proximal third
Diffuse/distal oesophageal spasm	Chest pain	Normal Occasional mild hypertension Occasional partial relaxation	Hypertensive, multi-peaked long duration mixed simultaneous (>20%) and peristaltic
Nutcracker oesophagus	Chest pain GOR	Normal or occasional partial relaxation	Grossly hypertensive no peristaltic loss
Scleroderma	GOR Regurgitation	Hypotensive or absent	Hypotensive or absent
Non-specific dysmotility (ineffective oesophageal motility)	GOR Regurgitation Mild dysphagia	Normal or hypotensive	>20% loss of peristalsis incomplete peristalsis variable amplitude

GOR = gastro-oesophageal reflux

1. It eliminates patients with GORD symptoms who have a primary or secondary motor abnormality (achalasia, oesophageal spasm, nutcracker oesophagus, scleroderma)
2. It documents abnormal LOS pressures and dynamics, and hiatal characteristics. This is helpful when surgical repairs to the sphincter are being considered
3. It documents non-specific dysmotility in the body of the oesophagus (common in GORD), leading to sensible prescribing of prokinetic drugs and surgery
4. It may be useful in determining the type of surgery for effective reflux control without complications (dysphagia, gas bloat syndrome, early reflux recurrence)
5. Prolonged manometry helps in identification of motor abnormalities in patients with atypical or intermittent symptoms.

Table 4. Extra-oesophageal symptoms

Oro-pharyngeal	Halitosis
Laryngo-pharyngeal	Laryngitis, laryngeal lesions
Dental	Erosive toothwear
	Oral lesions
	Peridontitis
	Sore throats
Respiratory	Unexplained cough
	Recurrent chest infections
	Pneumonia
Gastric	Generalized dyspepsia
	Nausea and vomiting
	Post *Helicobacter pylori* eradication
	Excessive eructation
	Waterbrash

KEY POINTS

- Gastro-oesophageal reflux disease (GORD) is the symptomatic reflux of gastric content into the oesophagus.
- Complications of GORD included recurrent oesophagitis, peptic stricture, Barrett's oesophagus and adenocarcinoma.
- Objective diagnosis of GORD is important in determination of pathological reflux and motility disorders.
- Twenty four-hour pH monitoring allows objective diagnosis of gastro-oesophageal reflux – its frequency, duration, symptom correlation and diurnal patterns.
- Oesophageal station-pull through manometry allows evaluation of oesophageal sphincters (upper and lower) and motility patterns, which is important in exclusion of motor pathology mimicking reflux.
- Laparoscopic fundoplication for GORD is the less invasive surgical correction of reflux with hiatus hernia repair and augmentation of lower oesophageal sphincter.

MII

The introduction of ambulatory MII increases diagnostic fidelity. In conjunction with pH monitoring:

1. It detects non-acid gastric and oesophageal reflux
2. It can measure oesophageal transit and clearance time
3. It also gives useful information relating to gas liquid and solid transit and regurgitation.

Conclusions

The addition of manometry and 24-hour pH and impedance monitoring in the clinical investigation of GORD and other oesophageal motility disorders has increased the diagnostic yield in otherwise poorly managed or undiagnosed patients. This has lead to improved management by identifying specific abnormalities in individual patients. Neither of these investigations have 100% specificity or sensitivity (Jones and Galmiche, 2005) but the use of these investigations helps to direct medication more effectively to the individual and highlights those who may benefit from invasive non-pharmacological treatments such as endoscopic or laparoscopic surgery. More efficient use of drugs also gives greater symptom relief and can lead to savings in health-care costs by reducing the overusage of expensive acid-reducing or prokinetic compounds.

Clinical GI physiology units are gradually being introduced in many hospitals in the UK and Europe. This means that more patients can benefit from the availability of such services and treatments can be directed more efficiently with the corresponding benefits of reduction in symptoms and increased quality of life. BJHM

Conflict of interest: none.

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