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Endoscopically Assisted Water Perfusion Esophageal Manometry with Minimal Sedation: Technique, Indications and Implication on the Clinical Management

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Abstract

Goals—To demonstrate feasibility and clinical utility of endoscopically-assisted manometry (EAM).

Background—Esophageal manometry performed without sedation is the standard for assessment of esophageal motility. However, some patients can not tolerate the procedure with intranasal intubation. We have accumulated experience performing EAM with minimal sedation on patients that can not tolerate standard esophageal manometry.

Study—We report our single center experience of EAM in adult patients. Patient records were analyzed retrospectively. Procedure protocol: Upper endoscopy is performed with minimal sedation to place a guide wire, over which a water perfusion manometry catheter is introduced and standard manometry protocol performed.

Results—From 2007-2009, 51 patients underwent EAM, 41 (80.4%) for failed transnasal esophageal manometry and 10 (19.6%) for Zencker diverticulum, achalasia, or neurologic disease. Five patients could not tolerate the procedure despite sedation. No early or late complications were recorded and 100% of the completed procedures were diagnostic: 15 (32.6%) patients had a normal study, 13 (28.3%) were diagnosed with achalasia, 12 (26.1%) patients had low LES pressure, 10 (21.7%) patients demonstrated Ineffective Esophageal Motility, 3 (6.5%) patients had hypertensive LES, and one (2.2%) patient had Nutcracker esophagus. Completed procedures resulted in treatment for achalasia (33.3%), medication changes (33.3%), completion of pre-operative assessment for antireflux surgery (27.7%), or no impact clinical management (11.1%). EAM had a direct clinical impact on 89% of patients.

Conclusions—EAM is a safe, reliable, and feasible technique providing objective diagnostic information that directly impacted clinical management in many problematic patients where the standard procedure failed.

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Conflict of Interest

No other conflicts of interest.

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Keywords

esophageal manometry; endoscopy; motility; esophagus; conscious sedation

INTRODUCTION

Esophageal manometry is a standard procedure for the assessment of esophageal motility, and a critical part of the work up of patient with dysphagia, reflux disease, chest pain, or systemic conditions such as neuropathy or scleroderma that may lead to esophageal dysmotility. The procedure is usually performed without sedation in an outpatient setting; however, some patients can not tolerate the standard intranasal intubation of manometric probe for various reasons - poor cooperation during procedure, previous surgery, anatomic variants precluding intranasal intubation, or a hypersensitive gag reflex. In these cases, there is no way to obtain quantified esophageal motility measurements. Nevertheless, information about esophageal motility is vital in certain clinical situations: namely in cases of achalasia, preoperative assessment, or patients with a vague clinical picture, for whom the finding of normal esophageal motility itself represents an important part of the diagnostic workup.

In these scenarios, the need for an alternative technique exists. Barium upper GI series and upper endoscopy may help to evaluate the esophageal motility pattern qualitatively; however, none of these techniques provide the quantitative information needed in making a definitive esophageal motility diagnosis. In 1995, Kwo et al. reported through- the- scope manometry (TTSM) in 12 patients who needed esophageal manometry. The proposed technique used a 250-cm, 3-lumen (0.8-mm internal and 2-mm external diameter) catheter from extruded polyvinyl tube stock, which also has been used before in manometry of the small bowel and colon, and a single, triple-lumen assembly, which passed through the biopsy channel of the Olympus GIF-100 videoendoscope (1). Patients received sedation with midazolam during EGD (mean 5 ± 1 mg) in addition to topical anesthesia to the mouth and oropharynx with benzocaine. The same patients also underwent standard laboratory manometry without sedation. LES pressure and wave amplitude in the lower and upper esophagus by TTSM correlated well with conventional manometry, and the study found no difference in mean LES pressure with and without sedation (1). However, this technique had major limitations - the use of dry swallows while recording the esophageal body motility, limited ability to assess LES relaxations, and the prolonged time period with the endoscope in the esophagus. Assessment of esophageal body peristalsis and LES function with wet swallows are important key measurements for quantitative esophageal manometry. No further attempts to overcome the problem of intranasal intubation have been reported in the literature.

Sedation represents another challenge, as the effect of sedation on esophageal motility is controversial. Majority of studies demonstrated no difference in LES pressure or motility patterns, measured with and without sedation with benzodiazepines and local anesthetics (1-7).

We report our single center experience of endoscopically-assisted esophageal manometry (EAM) with minimal sedation in adult patients to demonstrate the feasibility and clinical utility of this technique.

MATERIALS AND METHODS

Medical records of patients underwent the EAM were analyzed retrospectively. This study was approved by the Massachusetts General Hospital Institutional Review Board (protocol 2010 P000376).

Sedation

All patients arrived after fasting for at least 6 hours. First, all patients were given two oral puffs of lidocaine spray 1% in upright position and asked to swallow the local anesthetic. After 2-3 min the patient was asked to lie down on the procedure table. A standardized IV sedation protocol was applied, with the goal of minimal conscious sedation to allow the passage of the scope into the stomach without major discomfort.

The standardized sedation protocol included the combination of midazolam and fentanyl. Midazolam is an efficient anesthetic widely used for conscious sedation and is also helpful in reducing the patient's anxiety level. Midazolam has been shown not to have a major influence on esophageal motility (3). Fentanyl is a synthetic morphine with the advantage of being relatively short acting; it is also widely used for conscious sedation. The sedation protocol starts with 1 mg midazolam, and then the dose is escalated gradually depending on the patient's degree of sedation in 3-minute intervals. If 1 mg of midazolam is not enough, another 1 mg is given. If the patient is still not sufficiently sedated, fentanyl is added starting at a dose of 25 mcg. The doses were increased gradually by 1 mg of midazolam and 25 mcg of fentanyl alternately until the appropriate sedation level is achieved to tolerate oral intubation of endoscope. A fixed low dose of sedation was not used because it might not provide adequate sedation for this procedure in all patients. In selected patients, other medications or medication combinations have been used, including as midazolam alone, fentanyl alone, or combinations of midazolam, meperidine, diphenhydramine, and fentanyl based on individual allergy history, efficacy, and tolerability (Table 2).

EAM technique

The water perfusion manometric system included an electrical pump (8-Channel: # PIP-4-8SS, water infusion rate 0.6 ml/min; water chamber pressure 15(103) pound/square inch (kPa); Mui Scientific) and an 8-channel esophageal water perfused catheter (4.7 mm O.D. Mui Scientific).

Patients were kept in the left lateral decubitus position during the procedure. First, they underwent a regular upper endoscopy with an Olympus GIF H180 endoscope. While the scope was in the stomach, the guide wire (Jag wire, straight tip 0.0035 inx450 cm, Boston Scientific) was inserted via the working channel of the endoscope. The scope was pulled out, leaving the wire in the stomach, and the water perfusion manometry catheter was introduced over the guide wire (through the central lumen of the catheter) into the stomach until the pressure sensors were positioned in the stomach and gastric baseline pressure was

recorded. When the probe was located at the right position, we waited several minutes before recording the measurements to allow patient adjustment to the catheter.

While the patient was breathing quietly, a slow, station pull-through is performed for evaluation of LES pressure. LES pressure was measured at the mid respiratory level in the area of maximal pressure (compared with gastric baseline pressure). With the pressure sensor positioned in the LES, the patient was asked to perform several separate wet swallows (5 ml of water) to assess the completeness of swallow-induced LES relaxation. Next, peristalsis was evaluated by positioning at least three pressure sensors separated by intervals of 5 cm in the body of the esophagus. The distal sensor was positioned at a level 3 cm above the LES, and a series of 10 wet swallows is performed. The swallows were separated by an interval of at least 20 seconds and pressure wave amplitude, duration, and velocity were measured.

Upon the completion of 10 swallows, the manometric probe was pulled through until the UES was located. UES pressure was measured and the probe together with the wire was pulled out (8, 9).

Medtronic Polygram Net software was used for analyzing the tracings.

RESULTS

From 2007-2009, 51 (M/F 14/37, mean age 60.1 (range 24-88)) patients underwent endoscopically-assisted manometry. Forty-one (80.4%) patients were referred after failed transnasal esophageal manometry and an additional 10 (19.6%) patients were primarily referred for EAM due to Zencker diverticulum, severe achalasia, or neurological disease. Only 5 patients could not tolerate the procedure despite sedation. No early or late complications were recorded as a result of EAM (Table 1).

Symptoms on referral

Twenty four (47%) patients had solid dysphagia, 18(35.3%) liquid dysphagia, 11(21.6%) chest pain, 3(5.8%) sore throat/hoarseness, 3(5.8%) cough, 30(58.8%) heartburn, and 8(15.7%) other symptoms (some had >1 symptom) (Table 1).

Sedation

All patients received lidocaine spray as a local anesthetic prior to procedure. Mean dose amounts of IV medication were as following: 30 patients (65.2%) received a combination of midazolam 2.45 mg (1-3.5 mg) and fentanyl 55.17 mcg (25-100mcg); 4 patients (8.7%) received only midazolam 2.75 mg (1-6 mg); 8 patients (17.4%) received combination of midazolam 3.2 mg (2-4 mg) and meperidine 51.25 mg (25-60 mg), other combinations- 4 patients (8.7%). Five patients could not tolerate the procedure despite the sedation and were excluded from the analysis (Table 2).

Procedure duration

The mean time from the beginning of sedation until the withdrawal of the manometry catheter was 42 minutes, while the procedure itself from the beginning of endoscopy until

the catheter withdrawal lasted - on average - 31 minutes. Mean time between the beginning of sedation and the beginning of endoscopy was 11 minutes.

Diagnosis

In all cases we were able to locate LES, UES, and induce esophageal body contractions with wet swallows. 5 patients who could not tolerate the procedure despite sedation were excluded from the analysis. Forty six patients tolerated the procedure. Of those, 100% had a diagnostic study: 15 (32.6%) patients had a normal study, 13 (28.3%) were diagnosed with achalasia, 3 (6.5%) patients had hypertensive LES, 1 (2.2%) patient had Nutcracker esophagus, 10 (21.7%) patients demonstrated Ineffective Esophageal Motility, and 12 (26.1%) patients had low LES pressure (Figure 1).

Clinical implications

Of the 46 patients who completed EAM, 10 did not have follow-up at our institution. For the remaining 36 patients post- procedure management was analyzed. Ten (27.7%) patients underwent EAM as a part of pre-op work up for antireflux surgery; of those 7 (70%) underwent surgery. Twelve (33.3%) patients underwent specific treatment for achalasia (4 Botox injection, 3 dilatation, 5 myotomy). In one (2.7%) patient, achalasia was ruled out, thus preventing an invasive intervention. In twelve (33.3%) patients, medications were changed following EAM including the addition of a promotility agent or modification of acid suppression regimen (half of the patients had Bravo pH monitoring performed at the same session. For these cases, drug change was based on the results of both studies). In four (11.1%) patients, there were no identified implications on clinical management. Overall, EAM had a direct impact on clinical management in 89.1% of patients (Table 3).

DISCUSSION

We report our experience performing endoscopically-assisted water perfusion esophageal manometry with minimal sedation and its implication on clinical management. The procedure is geared toward an especially challenging patient population, in whom no other way to assess esophageal motility is feasible yet quantified manometric information for clinical management is required.

EAM was usually performed with the major goals of identifying achalasia, pre-operative assessment, or documentation of normal motility. All patients referred for the procedure could not undergo intranasal manometry for different reasons, and EAM with minimal sedation was the only feasible way to obtain required information. Our experience demonstrated that the endoscopically-assisted procedure is feasible, safe, and guides clinical management.

The proposed technique has several benefits. The endoscopic guidance helps to overcome technical issues including large hernias, tortuous esophagus, tight LES sphincters, or past cranial surgeries; it also ensures proper location of the manometric probe. The water perfusion catheter has a central lumen, through which a guide wire can be passed, ensuring accurate location and maintaining catheter placement during the procedure. These catheters are also less expensive, sturdier, and more durable than the solid state high resolution

probes. Given these technical advantages, we found the use of the water perfusion catheter convenient and sufficient for obtaining the necessary diagnostic information.

Mild sedation makes the first part of EAM – the endoscopic intubation - more comfortable and helps to overcome a hypersensitive gag reflex. Local anesthesia with 1% lidocaine spray was used, which was shown in previous studies to not affect the esophageal manometric measurements and improve the tolerance of procedure (10, 11).

Local anesthetics have been widely used for oropharyngeal anesthesia in different types of procedures, including esophageal manometry. Resting LES and UES pressure were found to be unaffected by oropharyngeal topical anesthesia in the study which compared those parameters with and without local anesthetic (lidocaine spray 1%). Frequency of swallows also did not change following the use of Lidocaine spray in this study (10). No significant differences in LES pressure and amplitude of esophageal body contractions were found in another study comparing esophageal motility measured with and without local pharyngeal anesthesia with 20% benzocaine spray, but tolerance of the procedure was improved (11).

Because the esophageal manometry protocol includes ten swallows of 5 cc of water, there is some concern that local anesthesia may increase the risk of aspiration. Several studies investigated this question, finding that only high-dose local oropharyngeal anesthesia with complete absence of sensation could increase the risk of aspiration. In one study, subjects were anesthetized to the point of absence of oropharyngeal touch sensation with up to 22–24 puffs of 10% benzocaine. Aspirations were clinically observed in subjects in whom sudden successive coughs occurred during swallowing of water. This was observed at the beginning of topical anesthesia administration, but the anesthesia became less effective as time passed. The effect of anesthesia lasted 3–6 min, confirmed by electrophysiological findings (2). Another study, using 20 puffs of 2% Lidocaine spray, demonstrated that a decrease in oropharyngeal sensory input impedes the cortical control of swallowing (12). Thus, low dose local anesthesia—which reduces—but not completely eliminates oropharyngeal sensation, appears to be safe. Clinical judgment, though, is warranted.

On average, the time period from the beginning of sedation until the start of endoscopy was 11 minutes. After passing the scope into the esophagus, no more sedative drugs were administered. The time spent performing endoscopy and positioning of the catheter allows from some diminishing of the sedation effect. When the manometric catheter is located at the right position, we allow an additional time period of several minutes for probe adjustment and further recovery from sedation. Mean duration of the procedure was 42 minutes. By the time the patient begins the wet swallow phase of the protocol, the lingering effect of local anesthetics is minimal (2), further reducing risk of aspiration, associated with low dose local anesthesia. Because we use the minimal possible amount of IV sedation in each individual, the patients were universally awake and cooperative during the manometric measurements. All 5 patients who were unable to tolerate the procedure failed in the initial phase of endoscopic intubation; they subsequently required deeper sedation, making quick recovery and cooperation for manometry impossible.

To be diagnostic, esophageal manometry must provide an evaluation of the LES and the peristaltic function of the esophageal body. In our series of cases, we were able to locate LES, assess the LES pressure and relaxations and induce esophageal body contractions using wet swallows in all patients.

The influence of sedation on esophageal motility remains a controversial issue, mainly in terms of potential to reduce the mean LES pressure and induce ineffective contractions. Nevertheless, manometric pressure measurement of the sphincter of Oddi is routinely performed in patients sedated with benzodiazepines (13). Fung *et al.* reported that midazolam did not change LES pressure or motility patterns, but Marsh *et al.* reported that midazolam produced nonspecific esophageal motility changes (3, 4). Diazepam has been reported in three separate studies to increase, decrease, and not change LES pressure (5-7). Notably, Kwo *et al.* demonstrated no difference in manometric measurements performed, in patients who needed esophageal manometry with and without sedation (1). Several studies have investigated the influence of fentanyl on gastric and duodenal motility in animals (14, 15) and humans (16). However, the results of studies can not be applied directly to esophageal motility due to distinctive differences in motility patterns between these parts of the GI tract. The effects of fentanyl on esophageal motility have not been studied, but its short duration of action makes this drug attractive to use during this type of procedure. Propofol, a rapidly metabolized anesthetic, could be considered but the effects of the drug upon GI muscle are unknown and there are increased logistical issues with its use.

The potential limitation of EAM is the impact of sedation upon the measurement of low LES pressure, because of sedation's potential to alter the physiology of the lower esophageal sphincter. Similarly, sedation may alter the amplitude of esophageal peristalsis. Indeed the finding of ineffective esophageal motility on EAM should be interpreted cautiously with correlation to other clinical data.

While sedation may theoretically contribute to the diagnosis of low LES pressure and IEM, other diagnoses are unlikely to be influenced by sedation. In our report, one third of patients had a normal study, another third had been diagnosed with achalasia, and others had Nutcracker esophagus or hypertensive LES- incorporating more than half of the patients. Moreover, upon review of the clinical records of patients in whom IEM and low LES have been observed, we found that in many cases these manometric findings were consistent with the clinical picture.

Our study is limited by the lack of a control group, which would allow us to compare esophageal manometry with and without sedation in the same patients. Unfortunately, all patients who underwent EAM failed conventional manometry, thus precluding traditional paired comparison. In all of our study population, endoscopic assistance and sedation was required to obtain any quantitative manometric data. While controlled manometric measurements with and without sedation are a feasible option in healthy volunteers, such data may not necessarily be good reference for the challenging patients group, which require different amount of sedation and duration of procedure, and have concomitant comorbidities and medications, affecting motility, as compare to healthy subjects. For these patients esophageal manometry is difficult and highly uncomfortable procedure, thus making

performing both procedures (with and without sedation) not only impossible, but also not ethical in this selected group.

Establishing a diagnosis as well as documentation of normal esophageal motility by EAM has important clinical implications in this patient population. As an example, preoperative assessment became possible for some of the patients. Potential surgeries were avoided based on the manometry results. Confirmation or exclusion of achalasia is also extremely important, as it leads directly to therapeutic intervention. In challenging clinical situations, the information garnered from esophageal manometry is critical for the management of the patient and may be worth the drawbacks of sedation's affecting motility measurements. Judgment in assessing the entire clinical picture is important to place into context the results from such a study.

EAM can be also combined with another diagnostic or treatment intervention in the same endoscopic session, potentially decreasing the risks from additional procedures. In appropriate cases, esophageal dilatation or botulinum toxin injection might be performed following the manometric assessment. When a patient can not tolerate both the regular intranasal manometry and pH test, Bravo wireless pH monitoring may be considered at the same endoscopic session with EAM. In our practice, 54% of the patients had a Bravo capsule placed at the same session.

EAM with minimal sedation is a safe, reliable, and feasible technique for objective assessment of esophageal motility. The procedure can provide a needed solution in cases of problematic catheter placement, where evaluation of esophageal motility is a necessity. Preoperative assessment of patients, confirming the diagnosis of achalasia, as well as establishing of normal esophageal motility all have important implications on clinical management. In our study, EAM with minimal sedation was able to establish a diagnosis in many problematic situations, where intranasal intubation could not be performed, directly impacting patient care.

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*IEM: Ineffective Esophageal Motility

Figure 1.
Diagnosis of patients by percentage.

Table 1

Demographics of subjects under analysis.

M/F	14/37
Age, years	60.1 (24-88)
Referral:	
After failed standard manometry	41 (80.4%)
Primary referral	10 (19.6%)
Symptoms:	
Dysphagia for solids	24 (47.06%)
Dysphagia for liquids	18 (35.3%)
Chest pain	11 (21.6%)
Sore throat, hoarseness	3 (5.8%)
Cough	3 (5.8%)
Heartburn/GERD	30 (58.8%)
Other	8 (15.7%)

Table 2

Table displaying conscious sedation IV drugs combinations. Lidocaine spray was given to all patients before starting IV sedation.

Number of patients (%)	Midazolam (mg)	Fentanyl (mcg)	Meperidine (mg)	Other
	Mean amount of drug (range)			
30 (65.2)	2.45 (1-3.5)	55.17 (25-100)	-	-
8 (17.4)	3.19 (2-4)	-	51.25 (25-60)	-
4 (8.7)	2.75 (1-6)	-	-	-
1 (2.2)	4	-	75	Diphenhydramine 50 mg
1 (2.2)	2.5	25	60	-
2 (4.3)	-	37.5 (25-50)	-	-

Table 3

Clinical implications of the endoscopically-assisted esophageal manometry.

Number of patients (%)	
Anti reflux surgery pre-op work up	10 (27.7)
Underwent surgery	7
No surgery	3
Achalasia diagnosis and treatment	12 (33.3)
Botulinium toxin injection	4
Endoscopic Dilatation	3
Surgical Myotomy	5
Medication change	12 (33.3)
Ruled out achalasia	1 (2.7)
None	4 (11.1)