The FDA approved Esophageal function testing using the technique of combined MII-EM in July 2002. The technology combines measurement of intraesophageal pressure using solid-state transducers with evaluation of intraesophageal bolus movement using multichannel intraluminal impedance. Combined videoimpedance measurements have validated the changes observed during bolus presence in the impedance-measuring segment (1,2).

One currently available combined MII-EM system (shown in Figure 1) uses a 9-channel MII-EM catheter (Konigsberg Instruments Inc., Pasadena, CA). This catheter has 5 solid state pressure transducers located at 5, 10, 15, 20 and 25 cm from the tip of the catheter and 4 pairs of metal rings 2-cm apart (impedance measuring segments) centered at 10, 15, 20 and 25 cm from the tip of the catheter; thus straddling the 4 proximal pressure transducers. During esophageal testing the distal pressure transducer is placed in the lower esophageal sphincter (LES) high-pressure zone with the combined impedance and pressure transducers at 5, 10, 15 and 20 cm above the LES. Both pressure and MII data area analyzed through a computer-based semi-automated program (Bioview, Sandhill Scientific Inc., Highlands Ranch, CO).

The combination of MII and manometry provides the opportunity to describe and quantify the functional aspects of esophageal contractions. Traditional manometry classifies swallows (3) into (1) normal peristaltic (defined as contraction amplitude in the distal part of the esophagus of at least 30 mmHg and onset velocity in the distal esophagus not greater than 8 cm/sec), (2) simultaneous contractions (defined as contraction amplitude in the distal part of the esophagus of at least 30 mmHg and distal onset velocity greater than 8 cm/sec) and (3) ineffective contractions (defined as contraction amplitude in the distal part of the esophagus less than 30 mmHg). Examples are shown in Figure 2. Multichannel intraluminal impedance (MII) complements this information and defines swallows as having either (1) complete bolus transit (defined as detection of bolus exit in all three of the distal MII channels) or (2) incomplete bolus transit (defined as absence of bolus exit in any of the three distal MII channels). Combining the information from
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Figure 1. 9-channel EFT probe positioned with distal transducer in the lower esophageal sphincter (LES). The catheter contains 4 impedance measuring segments (Z-1 through Z-4) each 5 cm apart and 5 pressure transducers each 5 cm apart. P1, P2 and P3 are unidirectional solid state transducers, P4 and P5 are circumferential solid-state transducers.

MII and manometry allows assessing bolus transit produced by a manometric normal peristaltic, simultaneous or ineffective swallow.

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Figure 2. Manometric classification of swallows: (a) normal peristaltic (defined as contraction amplitude in the distal part of the esophagus of at least 30 mmHg and onset velocity in the distal esophagus of not more than 8 cm/sec), (b) simultaneous contractions (defined as contraction amplitude in the distal part of the esophagus of at least 30 mmHg and distal onset velocity of more than 8 cm/sec) and (c) ineffective contractions (defined as contraction amplitude in the distal part of the esophagus less than 30 mmHg).
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Figure 3. Information obtained from combined MII-EM studies in patients. MII channels are in the upper part and manometry channels in the lower part of the tracings. Swallows shown are manometric normal (swallow 1) with complete bolus transit (a), manometric ineffective (swallow 2) with complete (b) or incomplete (c) bolus transit and simultaneous (swallow 3) with complete (d) or incomplete (e) bolus transit.

In a recent multicenter study (4) in 43 healthy volunteers normal values for esophageal function testing using combined MII-EM were established. In healthy volunteers almost all manometric normal peristaltic liquid (99.5%) and viscous (97.7%) swallows had complete bolus transit. For the occasional “abnormal” contractions occurring in these healthy subjects all (100%) liquid and more than half (54.5%) viscous simultaneous contractions had complete bolus transit and almost two thirds (61.9%) liquid and more than one third (39.1%) of viscous ineffective swallows had complete bolus transit (examples are shown in Figure 3). These studies also established criteria for normal or abnormal bolus transit during standard MII-EM testing
with 10 swallows. Normal transit for a series of ten 5 mL liquid swallows is defined by 8 or more (80%) showing complete bolus transit. The corresponding value for ten 5 mL viscous swallows is 7 out of 10 (70%) complete transit. These results underscore the functional effectiveness of a normal peristaltic progression and raise the possibility that combined MII-EM may identify which manometrically abnormal studies are functionally defective.

Preliminary data in patients evaluated for esophageal symptoms in our laboratory appear to show similar results (Figure 3). Based on the manometric more than 90% of patients with normal esophageal manometry have complete bolus transit, over 90% of patients with nutcracker esophagus have complete bolus transit, 50%–68% of patients with distal esophageal spasm (DES) or ineffective esophageal motility (IEM) have complete bolus transit. As expected all patients with achalasia and scleroderma have incomplete bolus transit by MII. To date, studies in patients with isolated LES abnormalities (hypertensive or hypotensive LES and poor relaxing LES) have revealed overall complete bolus transit by MII.

The above observations suggest that routine esophageal function testing with combined MII-EM may result in a new paradigm in our thinking regarding esophageal motility abnormalities; distinguishing those associated with abnormal bolus transit from those showing only abnormal pressure (Figure 4). Overall these results suggest that the bolus transit information obtained by combined MII-EM will clarify which patients with “abnormal” manometry actually have an esophageal function defect (Figure 4).

Outcome based studies are needed to establish the prognostic values of combined MII-EM and establish the clinical utility of the additional information obtained with this form of testing. Will MII-EM be superior to traditional manometry in the esophageal function testing armamentarium, particularly in patients with non-obstructive dysphagia and in preoperative testing for antireflux surgery?

References