Ambulatory 24-Hour Double-Probe pH Monitoring: The Importance of Manometry

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Objective: Historically, manometry has been used for sphincter localization before ambulatory 24-hour double-probe pH monitoring to ensure accurate placement of the probes. Recently, direct-vision placement (DVP), using transnasal fiberoptic laryngoscopy (TFL), has been offered as an alternative technique. Presumably, DVP might be used to precisely place the proximal (pharyngeal) pH probe; however, using DVP, there appears to be no way to accurately position the distal (esophageal) probe. The purpose of this study was to evaluate the accuracy of DVP for pH probe placement using manometric measurement as the gold standard.

Methods: Thirty patients undergoing pH monitoring participated in this prospective study. Each subject underwent manometric examination of the esophagus to determine the precise location of the upper and lower esophageal sphincters (UES and LES). In addition, external anatomic landmarks were used to estimate interprobe distances. A physician blinded to the manometry results then placed a pH catheter using DVP so that the proximal probe was located just above the UES. The results were recorded and compared with those obtained by manometry.

Results: Accurate DVP of the proximal pH probe was achieved in 70% (23 of 30) of the subjects. The use of external anatomic landmarks to estimate interprobe distance resulted in accurate positioning of the distal probe in only 40% (12 of 30) of the subjects. Using fixed interprobe distances of 15 cm and 20 cm, distal probe position accuracy was 3% (1 of 30) and 40% (12 of 30), respectively. Therefore, using DVP, the distal esophageal probe was in an incorrect position in 60% to 97% of subjects.

Conclusion: For double-probe pH monitoring, the proximal probe can be accurately positioned by DVP; however, there is no precise way to determine the interprobe distance required to correctly position the distal pH probe. Failure to accurately position the distal probe results in grossly inaccurate esophageal acid-exposure times. Thus, manometry is needed to ensure valid double-probe pH monitoring data. Key Words: Manometry, pH monitoring, extraesophageal reflux, pH probes, GERD, reflux, laryngopharyngeal reflux.

INTRODUCTION

The authors' technique of ambulatory 24-hour double-probe (simultaneous esophageal and pharyngeal) pH monitoring was first reported in 1986, and has been well described since. A manometer is inserted through the nasal cavity and advanced through the esophagus into the stomach. It is then slowly withdrawn and the locations of the lower and upper esophageal sphincters (LES and UES) are recorded. Esophageal motility is also assessed by having the patient perform wet and dry swallows with the manometer in the esophageal body. A catheter with pH probes located on its surface is then placed so that the probe is located 5 cm above the LES. The distal probe location above the LES has been standardized, because otherwise esophageal acid exposure data would be unreliable and inconsistent.

Location of the proximal probe has until recently been more controversial. Some gastroenterologists have recommended pH catheters with fixed interprobe distances (commonly 15 cm or 20 cm) that result in the proximal probe being located below the UES in the proximal esophagus. Most otolaryngologists place the proximal probe above the UES by using catheters with variable interprobe distances. The correct interprobe distance is determined by manometry and allows the esophageal probe to be 5 cm above the LES and the pharyngeal probe to be placed behind the laryngeal inlet just proximal to the UES (Fig. 1). It has recently been reported that proximal probes located below the UES will result in a significant number of false-negative pH studies for laryngopharyngeal reflux (LPR). Thus, an accurately placed pharyngeal probe is
essential to evaluate patients for the presence or absence of LPR.

Recently, as an alternative to manometric pH probe placement, direct-vision placement (DVP) using transnasal fiberoptic laryngoscopy (TFL) was reported. This technique involves inserting the pH catheter under direct vision so that the proximal pH probe is encompassed by the mucosa of the UES. The distance between the proximal and distal pH probe is fixed at 15 cm. Using this methodology, the location of the distal pH probe in relationship to the LES is unknown, and thus valid interpretation of the esophageal pH data is impossible.

The present study was performed to verify the accuracy of the DVP technique for pharyngeal pH probe placement. Furthermore, we evaluated the accuracy of using fixed interprobe distances to place the distal esophageal probe 5 cm above the LES. Finally, a method using external measurements of the neck and thorax to calculate the correct interprobe distance was evaluated.

MATERIALS AND METHODS

Thirty patients undergoing ambulatory 24-hour double-probe pH monitoring agreed to participate in this study. The protocol was approved by the investigational review board of the Wake Forest University Baptist Medical Center. All subjects underwent manometry to establish the distance from the nose to both the UES and LES. Following manometry, a pH catheter was inserted through the nose and advanced to its proper position based on the manometric measurements. The technician then withdrew the catheter several centimeters so that the proximal pH probe could be seen in the oropharynx. A physician, blinded to the measurements, used DVP to place the proximal pH probe just above the UES. The position of the pH catheter was then noted and compared with the position determined by manometry. If the two were equal, the catheter was left in that position and secured. If DVP resulted in incorrect positioning of the catheter, it was repositioned according to the manometric data.

External measurements were then taken to estimate the distance from the nose to the UES (N-UES) and LES (N-LES). N-UES was estimated by adding the length from the opening of...
the nostril to the tragus and the tragus to the cricoid cartilage. N-LES was obtained by measuring the distance from the cricoid cartilage to the xiphoid process and adding N-UES to it. The estimated interprobe distance was calculated by subtracting 5 cm from N-LES and then subtracting N-UES. The resulting difference was used as an estimate of the interprobe difference.

Data collected included the location of the UES and LES (based both on manometry and external measurements), the location of the proximal probe after DVP, and the location of the distal esophageal probe based on fixed and estimated interprobe distances. All probes placed by DVP within 1 cm of the UES as determined by manometry were considered successful/accurate placements. Failure of the distal esophageal probe to be placed 5 cm above the manometrically defined LES was considered a failure.

RESULTS

Thirty subjects (16 women and 14 men) participated in the study. The mean age of the subjects was 47 years. When compared with manometry, DVP of pH catheters resulted in correct placement of the proximal probe in 70% (23 of 30) of subjects; Figure 2 shows the distribution of DVP errors in centimeters. The average placement error of the proximal probe was $0.75 \pm 0.7$ cm (see Table I).

Using estimated interprobe distances, DVP accurately placed the distal esophageal probe in 40% (12 of 30) of subjects (see Fig. 3). Using fixed (15 cm and 20 cm) interprobe distances, DVP accurately placed the distal esophageal probe in 3% (1 of 30) and 40% (12 of 30) of subjects, respectively (Figs. 4 and 5). A summary of the DVP probe placement errors is shown in Table I.

### RESULTS

<table>
<thead>
<tr>
<th>Probe Location</th>
<th>Interprobe Distance</th>
<th>Correct Position</th>
<th>Mean Error ($\pm$ SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pharyngeal</td>
<td>N/A</td>
<td>70% (23/30)</td>
<td>$0.75 \pm 0.7$ cm</td>
</tr>
<tr>
<td>Esophageal</td>
<td>Fixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 cm</td>
<td>3% (1/30)</td>
<td>$4.73 \pm 1.95$ cm</td>
</tr>
<tr>
<td></td>
<td>20 cm</td>
<td>40% (12/30)</td>
<td>$1.60 \pm 1.14$ cm</td>
</tr>
<tr>
<td></td>
<td>Estimated</td>
<td>40% (12/30)</td>
<td>$2.27 \pm 1.77$ cm</td>
</tr>
</tbody>
</table>

SD = standard deviation; N/A = not applicable.

DISCUSSION

The results of this study demonstrate that DVP placement of the proximal pH probe, as described by Smit et al., is reasonably accurate. Seventy percent of subjects undergoing DVP had the proximal probe positioned within 1 cm of the UES. It is likely that the success rate is higher than we have reported because of a learning curve inherent to the technique of DVP. When we reviewed the data from the last 20 subjects, the percentage of accurate placements increased to 95%. Using DVP to place the proximal probe was simple. The probe itself is readily visible and the catheter is easily advanced until the probe just disappears behind the larynx (see Fig. 6).

Unfortunately, estimated and fixed interprobe distances did not consistently position the distal esophageal probe in the proper location (Table I). Estimated interprobe distances successfully placed the distal esophageal probe in only 40% (12 of 30) of patients, whereas fixed interprobe distances (15 and 20 cm)
placed the probe correctly in 3% (1 of 30) and 40% (12 of 30) patients.

The importance of this finding cannot be underestimated. The parameters that define abnormal esophageal reflux were established in studies in which the distal esophageal probe was positioned 5 cm above the UES. As one moves proximally from the LES, the degree of reflux and number of reflux events decreases significantly. Weusten et al. demonstrated that the mean acid exposure 6 cm from the LES was only 77% of
that found at 3 cm. Therefore, the validity of data obtained from the esophageal probe is dependent on its accurate placement. Even small variations from the 5-cm location may result in significantly altered data. Probes placed too low may result in false-positive studies, and probes placed too high may result in false-negative studies. Depending on the interprobe distance used, 60% to 97% of subjects in the current study would have had the distal esophageal probe located in the wrong position with respect to the LES. Most laryngologists would agree that the indications for double-probe pH monitoring include failure of empiric LPR therapy and pre- and postoperative evaluation of Nissen fundoplication candidates. At our center, we test most patients with moderate to severe manifestations of LPR. Such conditions include laryngotracheal stenosis, carcinoma, chronic cough, recurrent granulomas, diffuse laryngeal edema, and moderate to severe paradoxical vocal fold motion. In such patients, the evaluation of the esophagus for gastroesophageal reflux disease (GERD) is as important as the evaluation for LPR.

In addition, the value of manometry is not limited to the selection of the correct interprobe distance, but also includes useful information about UES and LES function, i.e., resting pressure, relaxation, coordination of swallowing, and esophageal motility. This information is often invaluable in the care of patients with swallowing and voice disorders. Sometimes these results alter either the surgical or medical management of GERD and LPR. For instance, many surgeons will base the specific type of fundoplication performed on the results of manometry.

Our study suggests that the DVP technique is inappropriate for use in patients with LPR undergoing double-probe pH monitoring. Its inability to reliably position the esophageal probe makes data from the distal probe invalid. DVP should be used only if documentation of pharyngeal reflux is the sole reason for pH testing.

CONCLUSION
For double-probe (simultaneous esophageal and pharyngeal) pH monitoring, DVP of the proximal pH probe was accurate in 70% (23 of 30) of subjects. However, in 60% to 97%, the distal probe position was sufficiently inaccurate so that the esophageal pH data were deemed useless.

BIBLIOGRAPHY


