Research Article

Lower esophageal sphincter pressures in gastroesophageal reflux disease: Where do they stand?

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Abstract

Background: Esophageal manometry is mandatory for localization of lower esophageal sphincter (LES) in patients undergoing ambulatory esophageal pH-metry for proper positioning of the pH-sensing catheter. Manometry not only gives the location of LES but also provides its tone in terms of basal lower esophageal sphincter pressure (BLESP) in mm Hg. **Aims and Objectives:** To study the LES pressures in cases of gastroesophageal reflux disease and to evaluate its significance by determining correlation between LES pressures and DeMeester score. **Materials and Methods:** In the study, 54 subjects with clinical diagnosis of gastroesophageal reflux participated. Manometry was performed using pneumohydraulic water perfused system, followed by a 24-h ambulatory esophageal pH-metry. The data were subjected to statistical analysis using SPSS software, version 22. **Results:** The mean BLESP was 13.68 ± 3.93 mm Hg, and DeMeester score was 16.94 ± 9.57. A significant negative correlation with a Pearson's correlation coefficient (r) of -0.632 ($p < 0.001$) was seen between BLESP and DeMeester score. **Conclusion:** High DeMeester score as in cases of gastroesophageal reflux is found to be significantly negatively correlated with low values of BLESP.

KEY WORDS: Basal Lower Esophageal Sphincter Pressure; Esophageal pH-metry; DeMeester Score; Gastroesophageal Reflux; Correlation

Introduction

According to Montreal international consensus group, gastroesophageal reflux disease (GERD) is defined as "a condition that develops when the reflux of stomach contents causes troublesome reflux-associated symptoms."[1,2] Prevalence of GERD in India is reported to range from 7.6% to 18.7% in adults.[3–5] GERD basically occurs as a consequence of imbalance between the protective factors of esophagus and the aggressive factor from the stomach. The protective factors include anti-reflux barrier, esophageal acid clearance, and tissue resistance.[6] The anti-reflux barrier forms the first line and the main defense against the acid damage. It is formed by lower esophageal sphincter (LES), crura of diaphragm, and the phrenoesophageal ligaments. The LES is a thickened band of circular smooth muscle in the lower 3–4 cm of esophagus. It remains tonically contracted even at rest, thus maintaining a pressure of 10–30 mm Hg.[7] This tonic contraction is due to myogenic tone of clasp and sling fibers, which are regulated by tonic neural activity.

The muscle cells in LES are at a relatively depolarized state (-41 mV) when compared to esophageal body muscle cells (-50 mV) leading to spontaneous generation of spike potentials. This causes influx of Ca^{2+} via voltage-gated calcium channels (I_{CaL}), responsible for tonicity of LES.[8] This tone can also be modulated by excitatory and inhibitory neurohormonal influences. The strongest influence is provided by vagal activity, which has both excitatory (acetylcholine) and inhibitory (nitric oxide) effects in most of species; however, in humans only the inhibitory effect due

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to nitric oxide (produced from nitrergic neurons, previously called nonadrenergic noncholinergic neurons) is present. The tonic contraction prevents gastroesophageal reflux even at times of increased intra-abdominal pressure.[9] Though ambulatory esophageal pH-metry has been established as a gold standard for the diagnostic evaluation of GERD with highest specificity and sensitivity as compared to other tests for the same.[10] pH-metry is time-intensive and patients are required to carry device around their body for minimum 24 h. Placement of catheter-based pH-measuring electrodes is one of the most crucial steps. It is intended to be placed 5 cm proximal to the upper border of LES using pull-through technique. If placed lower, the probe is likely to enter the stomach during esophageal shortening as in swallowing. If probe is placed higher, the sensitivity of pH-metry decreases.

Prior esophageal manometry besides being required for precise localization of LES also is very important in measuring LES pressures. Lower basal LES pressures (hypotensive LES: pressure < 10 mm Hg) do contribute to reflux. Therefore, this study endeavors to correlate the LES tone, measured as basal lower esophageal sphincter pressure (BLESP) in mm Hg by esophageal manometry with reflux status measured as DeMeester score by 24-h esophageal pH-metry.

Materials and Methods

Subjects: A total of 54 subjects aged 18–60 years were selected for the study from patients visiting gastroenterology OPD who were clinically diagnosed with gastroesophageal reflux. Medical records were evaluated to exclude conditions that were likely to interfere with the study such as known structural and motility disorders of esophagus, history of esophageal surgery, patients on drugs that are likely to interfere with LES function (e.g., calcium channel blockers), and chronic systemic illnesses such as diabetes mellitus and hypertension.

Study Protocol: The study protocol was approved by the institutional ethical committee. The subjects were explained the detailed protocol including its benefit and also the discomfort they are likely to experience once the catheter is inserted or due to carrying the pH-metry device for 24 h. A written informed consent was taken. The subjects were asked to stop any proton pump inhibitors 7 days before the study, H_2 antagonists 3 days before test, and antacids for 24 h. They were asked to stay nil per oral overnight.

High-resolution manometry: It was performed using 16-channel pneumohydraulic water perfused catheter system with electronic pressure transducers manufactured by Royal Melbourne Hospital, Australia. The catheter was introduced into the esophagus through nasogastric route. A real-time esophageal pressure topography was displayed in monitor using Trace software, version 1.2. Location of LES was assessed. Six readings of pressure at LES were measured in right lateral position at the end of expiration and averaged to get the BLESP.

24-h ambulatory pH-metry: The subjects then underwent 24-h ambulatory pH-metry using Gastrograph Mark IV equipment manufactured by Medical Instruments Corporation, Switzerland.[11] Antimony crystal–based pH catheter manufactured by Mediplus, UK, was inserted through nasogastric route till 5 cm proximal to the upper border of LES as determined by the prior manometry. The subjects were explained about the event marking buttons to be pressed in the data logger (erect, supine, pain, food, and medication) and were asked to follow-up after 24 h. On the next day, the catheter was removed and data were transferred to computer using Winreflux, version 2.20b to obtain the DeMeester score.[10]

Statistical Analysis: The data were subjected to statistical analysis using SPSS software, version 22. A Pearson's correlation analysis was done between the BLESP and DeMeester score to study the relationship between LES tone and gastroesophageal reflux status. A p-value of <0.05 was taken as statistically significant.

Results

A total of 54 subjects (48 men and 6 women) were included in the study. The mean age of the subjects was 44.17 ± 7.77 years, weight was 69.54 ± 10.07 kg, and height was 168.13 ± 3.41 cm. The frequency distribution of BLESP in the subjects is given in Table 1. The mean BLESP was 13.68 ± 3.93 mm Hg; 63% of the subjects had their BLESP either below normal value or near lower range of normal.

The frequency distribution of DeMeester score is given in Table 2. The mean DeMeester score was 16.94 ± 9.57. Of total 54 subjects examined, 29 had a score of <14.7 whereas 25 had the score of >14.7 suggestive of pathological acid reflux.

The Pearson's correlation analysis is shown in Figure 1. It shows a highly significant negative correlation between BLESP and

Table 1: Frequency distribution showing BLESP

BLESP (mm Hg)	No. of subjects (n = 54)
0–5	0
5–10	13
10–15	21
15–20	15
20–25	5
Total	54
Mean BLESP ± SD	13.68 ± 3.93

BLESP, basal lower esophageal sphincter pressure.

Table 2: Results of 24-h ambulatory esophageal pH-metry

DeMeester score	No. of subjects (n = 54)
0–5	3
5–10	6
10–15	20
15–20	11
20–25	4
25–30	5
>30	5
Total	54
Mean score ± SD	16.94 ± 9.57

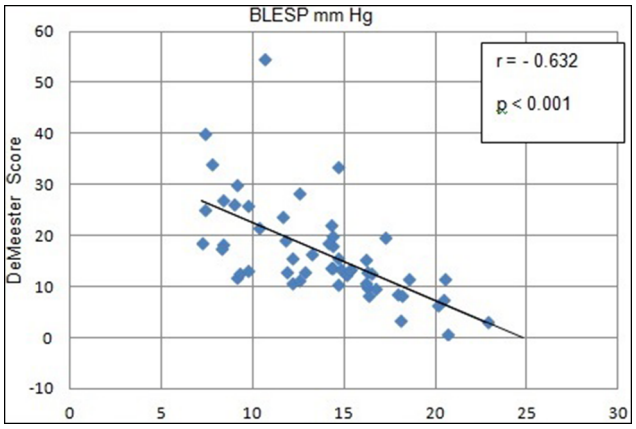

Figure 1: Correlation between basal lower esophageal sphincter pressure (BLESP; in mm Hg) and DeMeester score

Table 3: Results of mean DeMeester score for various BLESPs recorded in subjects

BLESP (mm Hg)	Mean DeMeester score
0–5	-
5–10	23.26
10–15	19.52
15–20	11.49
20–25	6.04

BLESP, basal lower esophageal sphincter pressure.

Table 4: Mean BLESP at various DeMeester scores recorded in subjects

DeMeester score	Mean BLESP (mm Hg)
0–5	20.47
5–10	18.25
10–15	14.23
15–20	12.45
20–25	12.6
25–30	9.34
>30	9.86

BLESP, basal lower esophageal sphincter pressure.

DeMeester score with a coefficient of r = -0.632, $p < 0.001$. Table 3 shows mean values of DeMeester score for values of BLESPs obtained in our subjects. Similarly, Table 4 shows mean values of BLESPs for various DeMeester scores obtained in our subjects.

Discussion

The significant negative correlation found in the study between DeMeester score a measure of acid reflux and BLESP reinforces the importance of basal tone and pressures at the lower end of esophagus, hence, the relevance of measuring and studying BLESP as an additional marker for gastroesophageal reflux. The Chicago classification for esophageal motility disorders defined hypotensive LES as pressure <10 mm Hg and hypertensive LES as pressures >30 mm Hg.[12,13]

Nind et al.[14] found that in critically ill mechanicallly ventilated patients, GERD is a major problem and found this problem to be coexisting with BLESP as low as 2.2 ± 0.4 mm Hg. In their subjects, 55% reflux events were associated with low BLESP. In this study, in the cases where BLESP was between 20 and 25 mm Hg, mean DeMeester score was as low as 6.04 vis-à-vis a score of 23.26 where BLESP was as low as 5–10 mm Hg. Iovino et al.[15] in their study on twins though found no significant difference in preprandial BLESP in symptomatic versus asymptomatic subjects but found significantly lower postprandial BLESP in symptomatic versus asymptomatic twins with no difference in peristaltic amplitude, LES length, or transient lower esophageal sphincter relaxation (tLESR). GERD is caused by reflux of gastric acidic contents, and protective factors such as LES tone as indicated by BLESP, and esophageal acid clearance is important to prevent it.[13] LES tone is also affected by other factors including diurnal variations, presence of food in stomach, hormones like progesterone and cholecystokinin, drugs like theophylline calcium channel blockers etc .[12] Hence, patients with acid reflux should be advised accordingly to avoid all those situations that tend to decrease LES pressures. Besanko et al.[16] in a comparative study found lower BLESP in healthy older adults in contrast to patients with dysphagia who besides having decreased duration of tLESR also had higher BLESP further emphasizing the contribution of LES pressures in regulating the functionality of LES. Tsuboi et al.[17] in a retrospective analysis of well-maintained database of 2000 cases of GERD found a significantly higher DeMeester score in patients with incompetent LES as compared to patients with normal or hypertensive LES. Hence, besides surgical interventions, nonsurgical as well as nonpharmacological measures that can increase BLESP including respiratory physiotherapy are also being explored to decrease reflux events.[18] Despite the growing trend of recording integrated relaxation pressures in esophageal motility disorders, LES pressures are still very important in cases of GERD.

Conclusion

The study has found a significant negative correlation between BLESP and DeMeester's score with a coefficient of r = - 0.632, p < 0.001. This study reinforces that LES pressures (LES Competence) should be taken into account while reporting manometric findings in cases of GERD.

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