Bile Reflux Measurement and its Contribution to the Severity of Reflux Esophagitis

Nabil A. GadEl-Hak, Mohamed El-Hemaly, Emad Hamdy, Ahmed AbdEl-Raouf, Mohamed Mostafa, Magdy Haleem

Gastroenterology Surgical Center, Mansoura University, Mansoura, Egypt
Address: Prof. Nabil A GadEl-Hak, Gastroenterology Surgical Center, Mansoura University, Mansoura, Egypt. E-mail: gadelhak_n_eg@hotmail.com

ABSTRACT

Background/Aims: Gastroesophageal reflux disease (GERD) may occur with acid, bile or in a mixed form. Endoscopic injury and mucosal metaplasia are a known sequela to pathological GERD. The aim of the study was to determine the contribution of acid and duodenogastroesophageal reflux to endoscopic severity in patients with GERD and Barrett’s esophagus (BE). Materials and Methods: Ninety-one patients complaining of reflux symptoms were studied with upper gastrointestinal endoscopy and graded to nonerosive reflux disease (NERD), erosive reflux disease (ERD) and BE. Esophageal manometry and simultaneous ambulatory 24-h esophageal pH and bilirubin monitoring (Bilitec 2000) were performed in all patients. Results: Seventy-one patients (78.0%) had ERD (Savary-Miller (grade I-III), 11 patients (12.1%) had NERD and 9 patients (9.9%) had BE, which were suspected endoscopically and diagnosed by histological esophageal biopsy. Combined 24-h esophageal bilirubin and pH monitoring revealed the following: 39 patients (42.9%) had mixed acid and bile reflux; 16 (17.6%) had pathological acid reflux alone, 18 (19.8%) had bile reflux alone and 18 patients (19.8%) showed no evidences of abnormal reflux. The percentage of the total time of the bilirubin absorbance > 0.14 in 71 patients with ERD was (8.18 ± 11.28%) and in 9 patients with BE was (15.48 ± 30.48%), which was significantly greater than that in 11 patients with NERD (4.48 ± 8.99%), P < 0.05 and P = 0.01 respectively. All the BE patients had abnormal esophageal bile reflux (bile alone (3 patients)); and mixed bile and acid (6 patients)); 44 of 71 patients (61.97%) with ERD had abnormal esophageal bile reflux (alone (13 patients) and mixed bile and acid (31 patients)); meanwhile, 15 of them (21.2%) had abnormal acid exposure alone. Despite 11 patients having NERD, four patients (36.4%) had abnormal esophageal bile reflux and two of them had mixed reflux of bile with acid. Conclusion: We believe that the Bilitec method reliably identifies the presence of bilirubin and quantitatively detects the duodenogastroesophageal reflux of bile. Mixed reflux (acid and bile) is the chief pattern of reflux in our GERD patients. Bile reflux either alone or along with acid reflux contributes to the severity of erosive and nonerosive reflux diseases as well as in BE.

Key Words: Duodenogastroesophageal reflux, reflux esophagitis

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The composition of the reflux material, sensitivity or resistance of the esophageal mucosa to the reflux material, motility of the esophageal body and function of the gastroesophageal sphincter and stomach are all important pathophysiologic factors in the development of gastroesophageal reflux disease (GERD). Hydrochloric acid leads to the development of GERD; however, only around half of the patients with pathologic acid reflux develop esophagitis[1] and approximately 10% of the patients with esophagitis develop esophageal stricture or Barrett’s esophagus (BE); further, not all the patients with complications have underlying pathologic acid reflexes.[2]

Duodenal contents are often held to be the cause of the symptoms not only because of increased duodenogastric reflux (DGR)[3] but also because of a reduced amount of acid available for reflux. Very few studies have been performed to indicate whether the esophageal refluxate is acid, mixed acid and duodenal content or pure duodenal content, and in particular, whether there is any correlation between the nature of the refluxate and the symptoms.[4]

The pH studies are difficult to evaluate because the factors other than duodenal reflux may be responsible for esophageal alkalization; for example, saliva and secretion from the submucosal esophageal glands.[5-7]

Barrett’s esophagus is widely considered to be a consequence of long-standing acid-induced injury commencing as an
To evaluate the importance of bile reflux episodes in the pathogenesis of GERD, it is necessary to use an in situ method for prolonged recording in the esophagus. Bilitec 2000 is a new spectrophotometric system that can measure the bilirubin concentration within the esophagus.\[11,12\] Bilitec 2000 has been used in a few studies previously\[13-17\] and has shown that patients with severe esophagitis and patients with BE have more bilirubin reflux episodes than normal subjects and that these reflux episodes coincide with acid-reflux episodes. However, there is a substantial overlap between the results in the normal subjects and the patients. Results of several studies have confirmed that the Bilitec system can detect bilirubin in artificially composed samples in the laboratory, however, the condition in the esophagus is somewhat different and other factors such as food and mucosal folds may interfere with the measurements.\[11,14,18\]

The aim of the present study was to determine the contribution of acid and duodenogastroesophageal reflux (DGER) to endoscopic severity in patients with GERD and BE.

** MATERIALS AND METHODS**

**Study populations**

Ninety-one patients (60 males, 31 females; mean age 36.12±12.65 years) were included in the study. All the patients had suffered at least three episodes of reflux symptoms such as heartburn, acid regurgitation or noncardiogenic chest pain every week in the preceding three months. All the patients underwent upper gastrointestinal endoscopy and graded to nonerosive reflux disease (NERD)\[8\] (free esophagitis) and erosive reflux disease (ERD), which includes GI, GII and GIII, according to Savary-Miller classification.\[19\] Barrett’s esophagus was suspected endoscopically while a definitive diagnosis was established by histological esophageal biopsy. Simultaneous ambulatory 24-h esophageal pH and bilirubin monitoring (Bilitec 2000) were performed in all patients.

Until recently, the relative contribution of duodenogastroesophageal reflux to the development of reflux-related lesions and symptoms has been controversial and difficult to study.\[20\] The new ambulatory system, Bilitec 2000, quantifies duodenogastroduodenal and duodenogastroesophageal reflux by the estimation of the bilirubin concentration.\[11\]

**Simultaneous ambulatory 24-h esophageal pH and bilirubin monitoring**

All subjects discontinued any medications affecting gastrointestinal motility and secretion for at least 3 days before the study. Proton pump inhibitor (PPI) treatment was discontinued seven days before the study. All subjects first underwent esophageal manometry after 6h fasting to determine the lower esophageal sphincter (LES) position and pressure and the characteristics of esophageal body peristalsis. Subsequently, an antimony esophageal pH electrode and fiber optic probe for detecting acid and bilirubin were introduced nasally and positioned 5cm above the upper border of the LES and were connected, respectively, to an ambulatory pH recorder (Digtrapper MKIII) and an ambulatory duodenogastric reflux monitoring system, Bilitec 2000 (Synectics M edical, Sweden).

Bilitec 2000 is a portable spectrophotometric system composed of a fiber optic probe and an optoelectric unit acting as a light signal generator, data was downloaded and data storage device. Bilitec 2000 measures the bilirubin concentration on the basis of its spectrophotometric properties (peak absorbance at 470 nm). Two light-emitting diodes (at 470 and 565 nm) are used for measurements: one for bilirubin and the other for reference. The light is converted into electric signals and the difference between the absorbance at 470 nm and 565 nm is calculated. This value is directly proportional to the bilirubin concentration. A bilirubin reflux episode is observed when the absorbance value is greater than 0.14. Data are stored every 8s in the portable data storage device.

The bile probe was calibrated in water and the pH probe was calibrated in buffer solutions at pH = 7 and pH = 1, respectively. After the investigation, data are downloaded and analyzed with the computer program Esophgram (ver. 5.70).

The day after the synchronous 24-h pH and bilirubin monitoring the probes were removed and the data were collected for analysis. During the monitoring, all the subjects maintained their daily living rhythm; however, they were asked to avoid all such activities that might increase the intraabdominal pressure significantly. They were advised to eat a semiliquid diet (PH > 4 and < 8) and drink 100 ml water after meals to clean the esophageal lumen. Patients were also forbidden to eat foods that absorbed light of the same wavelengths as bilirubin, for example tomatoes, carrots and bananas. The optical fiber was not bent excessively so that it did not interfere with the conduction of light.
Table 1: Results of 24-h esophageal bilirubin monitoring in 20 healthy subjects and 96 patients with reflux symptoms

<table>
<thead>
<tr>
<th></th>
<th>Normal values</th>
<th>Healthy subjects n=20</th>
<th>Patients with reflux symptoms n=91</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Total reflux with bilirubin absorbance ≥ 0.14</td>
<td>≤1.9</td>
<td>0.47±0.71</td>
<td>8.46±14.05*</td>
</tr>
<tr>
<td>% Reflux time in upright</td>
<td>≤3.1</td>
<td>0.72±1.14</td>
<td>8.7±10.7*</td>
</tr>
<tr>
<td>% Reflux time in supine</td>
<td>≤1.2</td>
<td>0.2±0.46</td>
<td>4.2±10.68</td>
</tr>
</tbody>
</table>

*P<0.05 compared with healthy subjects

Table 2: Number of patients with or without pathological acid and/or bilirubin reflux

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated acid reflux</td>
<td>16</td>
<td>17.6</td>
</tr>
<tr>
<td>Isolated bilirubin reflux</td>
<td>18</td>
<td>19.8</td>
</tr>
<tr>
<td>Mixed acid and bilirubin reflux</td>
<td>39</td>
<td>42.9</td>
</tr>
<tr>
<td>No reflux</td>
<td>18</td>
<td>19.8</td>
</tr>
</tbody>
</table>

No significant difference in LESP between 18 patients with no reflux (14.4±9.01) mm Hg and 73 patients with acid and/or bilirubin reflux (12.7±8.1) mm Hg.

Data analysis
Gastroesophageal acid reflux was defined as a fall in esophageal pH below 4. Acid reflux was considered pathological if the DeMeester score exceeded 14.7. Gastroesophageal bilirubin reflux was defined as an absorbance greater than 0.14.\[18\]

An acid or bilirubin reflux episode was defined using pH < 4 or bilirubin absorbance greater than 0.14 lasting for 20 s or more. Reflux was considered the cause of a symptom, if the symptom occurred in a 2-min interval at the either side of a reflux episode for reasons detailed elsewhere;\[21\] the data were compared to 20 healthy subjects based on the studies of Lin et al.\[22\] the data were compared to 20 healthy subjects based on the studies of Lin et al.\[22\]

Statistical analysis
Data were analyzed using SPSS (ver. 10). Qualitative data was presented in the form of numbers and percentages. Quantitative variables were compared with unpaired Student t test. The parametric data followed normal distribution. P < 0.05 was considered to be statistically significant.

RESULTS

24-h esophageal pH monitoring
The mean percentage of the total times esophageal pH < 4 was significantly greater in 91 patients with reflux symptoms than the 20 healthy subjects (7.8±9.29 vs 0.65±0.61%, P < 0.05). The mean acid reflux score was significantly greater in patients than the healthy subjects (4.18±3.08 vs 29.58±33.44; P < 0.05). Pathological esophageal acid reflux was detected in 55 patients (60.4%). Meanwhile, esophageal manometry revealed significant reduction in LESP between the patients with physiological reflux as compared to those with pathological esophageal acid reflux (14.04±5.6 and 11.08±5.1; P = 0.005).

24-h esophageal bilirubin monitoring
The results of the 24-h esophageal bilirubin monitoring for 20 healthy subjects and 91 patients with reflux symptoms are shown in Table 1. All the variables were significantly greater in patients with reflux symptoms than in healthy subjects (P < 0.05), except for the percentage of total reflux time with bile reflux when the patients were in supine position. When the normal value for the percentage of total time for bilirubin absorbance above 0.14 was taken to be ≤1.9, the majority of patients with GERD 39 out of 91 patients (42.9%) had abnormal bilirubin (mixed acid and bile reflux), 16 of 91 patients (17.6%) had only pathological acid reflux, 18 of 91 patients (19.8%) had only bilirubin reflux and the remaining 18 patients (19.8%) had no signs of reflux, as shown in Table 2. The association between esophageal motility with reflux of acid and bile showed no significant difference in the LESP between 18 patients with no reflux and 73 patients with acid and/or bilirubin reflux (14.4±6.56 and 12.7±8.1 mm Hg).

Endoscopic results
These results revealed that 71 patients (78.0%) had ERD (grade I-III), 11 patients (12.1%) had NERD and 9 patients (9.9%) had BE suspected endoscopically and diagnosed by histological esophageal biopsy.

The percentage of the total time for which bilirubin absorbance was above 0.14 in 71 patients with ERD was (8.18±11.28%) and in 9 patients with BE was (15.48±30.48%), which were greater than that in 11 patients with NERD (4.48±8.99%), (P < 0.05 and P = 0.01, respectively). The acid score of patients with ERD was (33.4±36.25) and in 9 patients with BE was (17.79±5.17), which was greater than that in patients with NERD (14.55±14.6), (P = 0.004 and P = 0.028, respectively) [Table 3].

When the normal value for the percentage of total time bilirubin absorbance above 0.14 is taken as ≤1.9, then 80
Table 3: Relation between endoscopic results and percentage of total reflux with bilirubin absorbance ≥ 0.14

<table>
<thead>
<tr>
<th>Number of patients (%)</th>
<th>% Total reflux with bilirubin absorbance ≥ 0.14</th>
<th>% Total reflux with bilirubin absorbance ≥ 0.14 that had % bilirubin ≥ 1.9</th>
<th>Acid score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-erosive esophagitis</td>
<td>4.48 ± 8.99</td>
<td>15.56 ± 12.26</td>
<td>14.55 ± 14.6</td>
</tr>
<tr>
<td>Esophagitis</td>
<td>8.18 ± 11.28</td>
<td>12.67 ± 11.9</td>
<td>33.4 ± 36.25</td>
</tr>
<tr>
<td>Barrett’s esophagus</td>
<td>15.48 ± 30.48</td>
<td>15.48 ± 30.48</td>
<td>17.79 ± 5.17</td>
</tr>
</tbody>
</table>

P = 0.01 when patients with nonerosive esophagitis were compared with patients with Barrett’s esophagus. P < 0.05 when patients with esophagitis were compared with patients with nonerosive esophagitis. P = 0.004 when the acid score of patients with esophagitis were compared with patients with nonerosive esophagitis and P = 0.028 when the acid score is compared with patients with Barrett’s esophagus.

out of 91 symptomatic patients were found with GERD (71 patients with esophagitis and 9 patients with BE), all the BE patients had abnormal esophageal bile reflux (bile alone (3 patients) and mixed bile and acid (6 patients)); 44 of 71 patients (61.97%) with ERD had abnormal esophageal bile reflux (bile alone (13 patients) and mixed bile and acid (31 patients)); meanwhile, 15 of them (21.1%) had abnormal acid exposure alone. Despite having NERD, 4 patients (36.4%) had abnormal esophageal bile reflux, two of them had mixed acid and bile reflux. There were 13 patients with esophagitis out of the 18 patients (72.2%) with bile reflux only. 15 patients out of 16 patients (93.7%) with acid only and 31 patients out of 39 patients (79.8%) with mixed reflux [Table 4, Figure 1].

Thirty-one patients out of 39 patients (79.5%) with mixed acid and bile reflux had esophagitis, 15 patients with esophagitis out of 16 (93.75%) patients with acid reflux alone and 13 (72.2%) patients with esophagitis out of 18 patients with bilirubin alone [Table 4].

The LES pressure decreased nonsignificantly with esophagitis although, the esophageal body peristalsis was impaired significantly in patients with BE when compared with patients with esophagitis, P = 0.032 [Table 5].

**DISCUSSION**

In most cases, symptoms of GERD occur due to excessive acid reflux. When duodenal motility is disturbed and pylorus opens abnormally, duodenal contents containing bile can regurgitate into stomach and then together with gastric contents move to the esophagus, resulting in DGER. Duodenogastroesophageal reflux can occur when there are functional or structural abnormalities of pylorus and duodenum and at the same time, the lower esophageal sphincter cannot carry out its barrier function. Gastroesophageal reflux disease is commonly accompanied by DGER. The correlation between the total bilirubin content and the concentrations of bile acids contained in the esophageal refluxate suggests that bilirubin is a good tracer for nonacid, duodenal or intestinal reflux in the esophagus.

We found that the main variables describing the extent of acid reflux and bile reflux in our patients were greater than those measured in healthy subjects and this was the same observation by Lin et al. In the present study (73/91, 80.2%), patients had pathological GERD (either acid and/or bile reflux), which was less than that found in the study of Li et al. (47/52, 90.4%).

In fact, most of the patients with typical symptoms of GERD have normal esophageal mucosa on upper endoscopy. Indeed, more than two-third of all the patients...

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with reflux symptoms never develop esophageal erosions, ulcer or stricture. Cuomo et al. [20] showed that in 84 patients with suspected GERD, 54% of patients had NERD and 46% had endoscopic esophagitis. While, in the present study, out of 91 symptomatic patients with GERD, 80 (87.9%) patients had ERD (71 patients with esophagitis and 9 patients with BE) and 11 (12.1%) patients had NERD. The percentage of ERD patients is completely different from them, and this can be explained by the fact that most of these patients were referred to our Gastroenterology Surgical Center, Mansoura University, Egypt, to be evaluated for the possibility of antireflux intervention. Therefore, these patients were chronic patients with recurrent symptoms and frequent treatment.

Esophageal motility study in patients with NERD and ERD showed nonsignificant decrease in the LES pressure, on the other hand there is a significant increase in the acid and bile reflux parameters in patients with ERD than patients with NERD, which was also found by Nicholas. [26]

In the present study, 91 patients with reflux symptoms underwent simultaneous 24-h esophageal pH and bilirubin monitoring; we found that (43.7%) of patients with esophagitis were found to have mixed acid and bile reflux, which was almost similar to the findings by Vaezi et al. [17] and less than 63.3%, as found in the study from China. [21] Lin et al. found that, among the 47 GERD patients, there were 32 (68.1%) patients with acid reflux alone and 15 (32%) with mixed acid and bile reflux and no patients had bile reflux alone. [22] In our study, 73 from 91 patients (80.2%) had pathological GERD acid and/or bile reflux; there were 16 patients (21.9%) with acid reflux alone, 18 (24.7%) patients with bilirubin reflux alone and 39 (53.4%) patients with mixed acid and bilirubin reflux.

Cuomo et al. found that the mixed reflux of both acid and duodenal reflux was often present in each group of patients complaining of reflux symptoms and exposure to mixed reflux increased with the severity of esophagitis. [20]

Table 4: Distribution of patients with or without pathological acid and/or bilirubin reflux in patients with esophagitis

<table>
<thead>
<tr>
<th></th>
<th>Total patients (91)</th>
<th>Patients with nonerosive (11)</th>
<th>Patients with esophagitis (71)</th>
<th>Patients with BE (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated acid reflux</td>
<td>16 (17.6)</td>
<td>1 (9.1)</td>
<td>15 (21.1)</td>
<td>3 (33.3)</td>
</tr>
<tr>
<td>Isolated bilirubin reflux</td>
<td>18 (19.8)</td>
<td>2 (18.2)</td>
<td>13 (18.3)</td>
<td>6 (66.7)</td>
</tr>
<tr>
<td>Mixed acid and bilirubin reflux</td>
<td>39 (42.9)</td>
<td>2 (18.2)</td>
<td>31 (43.7)</td>
<td>9 (100)</td>
</tr>
<tr>
<td>No reflux</td>
<td>18 (19.8)</td>
<td>6 (54.5)</td>
<td>12 (16.9)</td>
<td></td>
</tr>
</tbody>
</table>

P=0.032 when the distal esophagus of patients with esophagitis was compared with patients with Barrett’s esophagus. P=0.004 when the acid score of patients with esophagitis was compared with that of patients with nonerosive esophagitis and P=0.028 with Barrett’s esophagus. LES pressure and esophageal body contractions decreased nonsignificantly with esophagitis. Percentage of the patients with total reflux with bilirubin absorbance ≥0.14 increased with the degree of esophagitis.

Table 5: Comparison between patients with erosive esophagitis, nonerosive esophagitis and Barrett’s esophagus

<table>
<thead>
<tr>
<th></th>
<th>Non-erosive esophagitis (11)</th>
<th>Patients with esophagitis (71)</th>
<th>Patients with BE (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophageal motility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LESP</td>
<td>14.06 ± 6.59</td>
<td>12.4 ± 5.5</td>
<td>10.5 ± 4.06</td>
</tr>
<tr>
<td>Mid body</td>
<td>44.0 ± 15.09</td>
<td>50.1 ± 29.2</td>
<td>33.2 ± 40.07</td>
</tr>
<tr>
<td>Distal body</td>
<td>60.0 ± 16.7</td>
<td>71.4 ± 35.7</td>
<td>22.6 ± 19.8</td>
</tr>
<tr>
<td>24-h pH monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Time reflux upright</td>
<td>1.3 ± 1.7</td>
<td>8.95 ± 9.8</td>
<td>4.15 ± 4.3</td>
</tr>
<tr>
<td>% Time reflux supine</td>
<td>4.51 ± 6.9</td>
<td>7.16 ± 12.6</td>
<td>2.63 ± 2.57</td>
</tr>
<tr>
<td>% Time reflux total</td>
<td>2.69 ± 2.38</td>
<td>9.06 ± 10.7</td>
<td>4.5 ± 4.0</td>
</tr>
<tr>
<td>Acid score</td>
<td>14.56 ± 14.6</td>
<td>33.4 ± 36.3</td>
<td>17.79 ± 15.17</td>
</tr>
<tr>
<td>24-h bilirubin monitoring</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Time reflux upright</td>
<td>6.82 ± 13.06</td>
<td>9.02 ± 11.01</td>
<td>8.75 ± 4.6</td>
</tr>
<tr>
<td>% Time reflux supine</td>
<td>1.63 ± 4.32</td>
<td>4.91 ± 11.12</td>
<td>1.57 ± 3.7</td>
</tr>
<tr>
<td>% Total reflux bilirubin Absorbance &gt; 0.14</td>
<td>4.48 ± 8.9</td>
<td>8.18 ± 11.2</td>
<td>15.48 ± 30.48</td>
</tr>
<tr>
<td>% Total reflux with bilirubin absorbance ≥ 0.14 that had % bile ≥ 1.9</td>
<td>15.56 ± 12.26</td>
<td>12.67 ± 11.9</td>
<td>15.48 ± 30.48</td>
</tr>
<tr>
<td>No. (%)</td>
<td>3/11 (27.3)</td>
<td>44/71 (61.97)</td>
<td>9/9 (100)</td>
</tr>
</tbody>
</table>

With reflux symptoms never develop esophageal erosions, ulcer or stricture. [24,25]
Lin et al. found that the bile reflux plays an important role in damaging the esophageal mucosa of patients with GERD; hence, more attention should be paid to the diagnosis of DGER when dealing with GERD. Some studies have demonstrated that bile and gastric acid have a synergistic action in causing damage to the esophageal mucosa membrane. This was comparable with our finding: 31 of 71 patients (43.7%) with ERD had abnormal mixed bile and acid reflux while 15 of them (21.2%) had abnormal acid exposure alone.

The percentage of total reflux time with bile reflux was greater in patients with esophagitis than in those without esophagitis. There were 8 patients out of the 15 (53.3%) patients with acid bile reflux who had esophagitis; however, only 4 patients out of the 32 (12.5%) patients with acid reflux alone had esophagitis. In the present study, 31 patients out of 39 patients (79.5%) with mixed acid and bile reflux had esophagitis, 15 patients out of 16 (93.75%) patients with acid reflux alone had esophagitis and 13 (72.2%) patients out of 18 patients with bilirubin alone had esophagitis [Table 4].

Dixon et al., showed that bile as a part of DGER could have a role in producing intestinal metaplasia in the esophagus, while Champion et al., concluded that both acid reflux and DGER significantly increased in patients with BE. In our study, we found that in patients with BE, bile reflux alone was present in 3 (33.3%) patients and mixed reflux with acid in 6 (66.7%) patients. We also found that bile reflux in patients with BE is more severe than that in the GERD patients with or without esophagitis; the percentage of total reflux time with bile reflux was greater in patients with esophagitis than those without esophagitis. Our results agree with those of other studies; they had found that bile reflux in patients with BE was more severe than that in the GERD patients with or without esophagitis (absence of Barrett’s mucosa).

By functional assessment, Champion et al., and other authors found that patients with BE as compared with patients with GERD without columnar mucosa have more end-stage esophageal disease, which characterized by lower LES pressure, more impaired peristalsis and more frequent and prolonged episodes of acid reflux by pH monitoring. The present study confirmed the severity of esophageal impairment in patients with BE, which is characterized by lower LES pressure and more impaired peristalsis in comparison to patients with or without esophagitis.

Pisegna et al. and Buttar et al., reported that patients with BE have a higher degree of esophageal acid exposure than patients with erosive and nonerosive GERD. Contrary to the studies of Pisegna et al. and Buttar et al., the present study showed a higher esophageal acid exposure in patients with erosive esophagitis than patients with BE (P = 0.028). On the other hand, patients with BE showed higher esophageal acid exposure than patients with nonerosive esophagitis (P = 0.004).

**CONCLUSION**

We believe that the Bilitec method reliably identifies the presence of bilirubin and quantitatively detects the duodenogastroesophageal reflux of bile. Mixed reflux (acid and bile) is the chief pattern of reflux in our GERD patients. Bile reflux either alone or along with acid reflux contributes to the severity of erosive and nonerosive reflux diseases as well as in Barrett’s esophagus.

**REFERENCES**

13. Champion G, Richter JE, Vaezi MF, Singh S, Alexander R. The present study confirmed the severity of esophageal impairment in patients with BE, which is characterized by lower LES pressure and more impaired peristalsis in comparison to patients with or without esophagitis.


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