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ORIGINAL CONTRIBUTIONS

Nocturnal Reflux Episodes Following the Administration of a Standardized Meal. Does Timing Matter?

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OBJECTIVES: Prospective evidence supporting lifestyle modifications, including avoidance of late evening meals, for gastroesophageal reflux disease (GERD) sufferers is lacking. The aim of this study was to determine the difference of supine esophageal acid exposure in patients consuming an early or late standard meal relative to bedtime.

METHODS: This is a prospective, randomized unblinded crossover trial. Thirty-two patients with typical reflux symptoms were enrolled and randomized to consume a standard meal either at 6 h or 2 h prior to going to bed for 2 consecutive nights. Acid exposure was measured for 48-h using a Bravo wireless pH system. Reflux symptom frequency and severity were recorded.

RESULTS: Thirty patients successfully completed the study (63% male, 70% white, mean age 46 [24–74], mean body mass index [BMI] 28 kg/m^2 [18–40]). EGD revealed esophagitis in 37% and hiatal hernia (HH) in 47% of patients. Following the late evening meal, there was significantly more supine reflux ($P = 0.002$) when compared to the early meal. Significantly more supine reflux was also noted following the late evening meal in patients with HH, in overweight individuals ($25 \leq$ BMI ≤ 29.9), and those reporting heartburn as their chief complaint. Patients with esophagitis had more supine reflux following both the late and early evening meals. There was no significant difference in total symptom score between the 2 days.

CONCLUSIONS: GERD patients consuming a late-evening meal had significantly greater supine acid reflux compared to when they consumed an early meal, especially in overweight patients, and in patients with esophagitis or HH. These findings support the recommendations to our GERD patients to eat dinner early and to lose weight.

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INTRODUCTION

Gastroesophageal reflux disease (GERD) is a common disorder affecting approximately 35–40% of the adult population in the western world (1, 2). Food ingestion and gastric distention have been shown to provoke GERD (3–5). Furthermore, recent evidence suggests that nocturnal reflux (NR) plays an important role in the development of complications from GERD, such as esophagitis, stricture formation, and rarely the development of adenocarcinoma (5–7). In addition to direct mucosal injury, nocturnal acid reflux also has a negative effect on sleep and work productivity (1, 8). Dean *et al*. found that the number of nights with sleep interference was predictive of reduced productivity in patients with nocturnal GERD (7). The management of GERD in these patients includes lifestyle modifications, H_2-receptor antagonists (H_2RA) or proton pump inhibitors (PPIs), and surgical or endoluminal techniques.

Lifestyle modifications are often prescribed to sufferers of GERD as primary therapy or as adjunctive therapy to medical treatments. They include tobacco and alcohol cessation, elevation of the head of bed, and weight loss. Population based studies have shown a clear relationship between excess weight and increase in esophageal acid exposure and reflux symptoms (9–11). Dietary modifications such as avoidance of a late evening meal or spicy food are also commonly advocated. Practice guidelines for the diagnosis and treatment of GERD suggest avoiding recumbence for 3 h following the ingestion of meals (8). A recently published case-control study based on a symptom questionnaire demonstrated that decreased dinner-to-bed time increased the odds ratio (OR) for GERD (12). However, the efficacy of these recommendations has not been clearly demonstrated in prospective studies where standardized meals are administered. The aim of this study was to prospectively evaluate intraesophageal pH parameters, especially in the supine position, and differences in reflux symptoms in patients consuming standardized meals administered early and late relative to bedtime on 2 consecutive days. The term supine reflux is used to refer to esophageal

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acid exposure in the supine position, as defined by increased percentage supine time pH < 4. The secondary objective was to explore the effect of body mass index (BMI), heartburn symptoms, and endoscopic findings of hiatal hernia (HH) and esophagitis on supine esophageal acid exposure.

MATERIALS AND METHODS

Study Subjects

This is a prospective, randomized unblinded crossover trial of patients referred to the Walter Reed Gastroenterology Service with symptomatic GERD between January 2004 and January 2005. For this study, we included patients with symptoms of heartburn, regurgitation, and belching; however, all patients had to have heartburn as a component of their symptoms. Patients were screened for symptoms at their initial consultative appointment with a gastroenterologist. Study patients who met inclusion criteria, and had no contraindication to ambulatory esophageal pH monitoring or endoscopy, were prospectively enrolled. The Walter Reed Army Medical Center Institutional Review Board and Human Use Committee approved the protocol for this study, and written informed consent was obtained from all participants.

Patients were excluded if they had a history of upper gastrointestinal surgery. Other exclusion criteria were history of bleeding diathesis or coagulopathy, stroke or transient ischemic attack within the past 6 months, significant medical comorbidities (*i.e.*, congestive heart failure), esophageal varices, uncontrolled diabetes mellitus, and symptoms or signs of gastroparesis.

All participants underwent a thorough history and physical examination and were randomly assigned by a computer generated randomization scheme to consume either an early or late evening meal on the first 24-h pH monitoring period followed by the opposite schedule on the second 24-h period. Patients were instructed to consume the early meal at 1700 and the late meal at 2100. Patients were instructed to go to bed at 2300 and to get up at 0600 on both days of the study. All study participants were taken off their antisecretory medications, such as PPIs and H_2RAs for at least 10 days prior to undergoing the Bravo^{TM} pH placement. The study period included the morning of the endoscopy and Bravo^{TM} capsule placement on the first day of the study and ended when the patients returned the pH-monitoring device. Total duration for pH recording was approximately 48 h.

All participants filled out an intake symptom quality and severity questionnaire prior to undergoing the pH study and a standardized symptom questionnaire each morning following the test meal. This postmeal questionnaire included information regarding the severity and frequency of heartburn, regurgitation, chest pain, and belching.

Severity and frequency of symptoms were each graded on a scale of 0–3. Severity was graded as grade 0 = no symptoms, grade 1 = mild symptoms with spontaneous remission with no interference of normal activity, grade 2 = moderate symptoms with interference of normal activity, grade 3 = severe symptoms without spontaneous remission or marked interference of normal activity. Frequency of symptoms was graded as grade 0 = absent, grade 1 = present less than 2 days per week, grade 2 = present 2–4 days per week, and grade 3 = present more than 4 days per week. A score for each symptom was calculated by multiplying the severity and frequency score. A total composite symptom score was then calculated as the sum of each individual symptom score for each 24-h period. Details of this symptom index have been previously reported (13, 14).

The meals consisted of a McDonalds^{TM} Big Mac^{TM} (560 kcal), medium french fries (350 kcal), and a medium carbonated beverage such as Sprite^{TM} or 7 UP^{TM} (approximately 600 mL). The calorie content of the meal was approximately 900 kcal. The fat content was 45% and the total volume of the meal was approximately 850 mL. Because carbonated caffeinated products such as Coca-Cola^{TM} have a very low pH and since caffeine can affect the LES, these beverages were prohibited (15). The meal was provided to the participants on both nights through a McDonalds^{TM} gift voucher worth the total amount of the specified meal. The breakfast and lunchtime meals were not standardized. We encouraged subjects to consume their usual lunchtime meal, as this most closely resembled their usual pattern of food consumption. Snacks between the standardized meal and bedtime were discouraged. All subjects were required to record the amount of the meal that they consumed and the time it took them to finish the meals. All subjects were encouraged to eat similar amount of meal on both evenings.

Endoscopy

All subjects underwent an overnight fast before arrival at the endoscopy laboratory. Upper endoscopy with a GIF-140 Olympus endoscope (Olympus Corporation, Tokyo, Japan) was performed in the left lateral decubitus position to localize the squamocolumnar junction (SCJ), as well as to evaluate for esophagitis and hiatus hernia. Conscious sedation included midazolam 1–5 mg and meperidine 50–100 mg. Three gastroenterologists performed endoscopies on study patients.

Placement of the pH Capsule

After completion of the diagnostic upper endoscopy, the Bravo^{TM} (Medtronic, Inc., Shoreview, MN) delivery system was passed orally into the esophagus. The delivery system was introduced with the patient remaining in the same left lateral decubitus position assumed during endoscopy. The Bravo^{TM} capsule was placed 6 cm proximal to the SCJ with other details of the procedure previously described (16).

Bravo^{TM} Capsule pH Monitoring

Prior to placement, the Bravo^{TM} pH capsule was activated by a magnetic switch and calibrated according to the manufacturer's protocol. The capsule was first submerged in buffer solution of pH 7.01 at room temperature (about 22°C) until the 100% calibrated prompt was reached on the receiver. The

capsule was rinsed and then submerged in a second buffer solution of pH 1.07 at room temperature until the 100% calibration prompt was reached. In the process, the capsule and receiver were also checked to confirm proper functioning of data transmission and receiving hardware.

After recording was completed and the receivers were returned, the pH data were uploaded to a computer via Datal (Medtronic, Inc., Shoreview, MN), which is compatible with Windows 95/98/2000 NT (Microsoft, Redmond, WA). Temporal food intake, symptom, and supine period data extracted from the subject diaries were manually merged with the pH recording data. Esophageal acid reflux was defined as decrease in intraesophageal pH to <4 (4). Based on those values, abnormal supine reflux was defined as >1.2% time pH < 4 during the supine position and an abnormal 24-h pH score was defined as a Johnson-Demeester score >22 (4).

Data Analysis

Sample size was based on results of a previous study by Orr and Harnish (17). A sample size of 20 patients was estimated to have 80% power to detect a change of two nocturnal episodes between study nights, while controlling the probability of a type I error at alpha = 0.05. Continuous data are expressed as mean ± standard error of the mean (SEM), unless otherwise specified. Categorical data are expressed as ratio and percentage and analyzed with Fisher's exact test. Paired categorical data were analyzed using McNemar's test. Within patient changes in reflux parameters, pH score, and symptom scores while consuming an early *versus* late meal were compared with nonparametric Wilcoxon signed ranks test. Between-group comparisons of continuous variables were analyzed with the Mann-Whitney U test.

Analysis was performed on the entire study population as well as several subgroups including BMI, heartburn as primary symptom, endoscopic findings of HH or esophagitis, and GERD defined as an abnormal pH score on the day the early evening meal was consumed. Three BMI categories were constructed for subanalysis: <25, 25–29.9, and ≥30. Johnson-Demeester (JD) 24-h pH score and percentage supine reflux were dichotomized into normal and abnormal to calculate the OR for having an abnormal value. ORs are expressed as value with 95% confidence interval. A probability value of <0.05 was considered statistically significant.

RESULTS

A total of 32 patients were enrolled into our study. Two patients were excluded due to failed Bravo^{TM} capsule attachment. Thirty patients successfully completed the study and were included in the analysis. The remaining two patients declined to undergo a repeat attempt at capsule attachment. Demographic, prestudy symptoms, endoscopic findings, and mean time to a meal are noted in Table 1. Majority of the subjects were white men. In the prestudy symptom questionnaire, all patients reported heartburn as one of their complaints, with heartburn as the primary complaint in 70% (21/30) of patients while regurgitation (16.7%), belching (6.7%), and chest pain (6.7%) comprised the other primary complaints. Nocturnal heartburn was reported by 60% (18/30) of our patients with the majority (76%, 16/21) of them identifying heartburn as their chief complaint. In this study cohort, 63% (19/30) of patients had an abnormal 24-h pH score (GERD+) and 36.6% (11/30) had a normal 24-h pH score (GERD) on the day when consuming the early evening meal. The mean time from dinner to bedtime was 93 min (± 11 min) for the late meal and 330 min (± 13 min) for the early meal.

Table 1. Baseline Patient Profile

Male/female	19 (63%)/11 (37%)
Age, yr	46 ± 11
White, no. (%)	21 (70%)
Primary GI symptom, no. (%)	
HB	21 (70%)
Regurgitation	5 (17%)
Belching	2 (6.7%)
Chest pain	2 (6.7%)
Nocturnal reflux	18 (60%)
Body mass index (kg/m^2)	28 ± 5
Hiatal hernia (no. of patients)	14 (47%)
Small (<3 cm)	5 (36%)
Medium (3–4 cm)	7 (50%)
Large (>4 cm)	2 (14%)
Esophagitis (no. of patients)	11 (37%)
Late meal to bedtime (min)	93 ± 11
Early meal to bedtime (min)	330 ± 13

Continuous data expressed as mean ± standard deviation. Nominal data expressed as no. of patients (%).

The late evening meal was associated with significantly increased supine reflux (mean change 5.2 ± 1.6, $P = 0.002$) while no significant increase in upright reflux was noted following the late evening meal (mean change 0.7 ± 1.1, $P = 0.713$, Fig. 1). Based on these results and the study design, we believe the finding of significant difference in total JD score between the 2 days is solely related to the difference in the supine period. There was a significant increase in the number of nocturnal episodes after the late evening meal compared to the early evening meal (mean change 4.8 ± 2.3, $P = 0.021$). Overall reflux parameters data for our study group are listed in Table 2.

Although not statistically significant, patients who had supine reflux following the early meal were more likely to have the similar finding following the late evening meal. In our cohort, 33% (10/30) of patients had abnormal supine reflux following the early evening meal, with 80% (8/10) of these patients also having abnormal supine reflux following the late evening meal. In contrast, of the 20 patients who did not experience abnormal supine reflux following the early evening meal, only 35% (7/20) had abnormal supine reflux following the late evening meal. The OR for having abnormal supine reflux following the late evening meal in supine

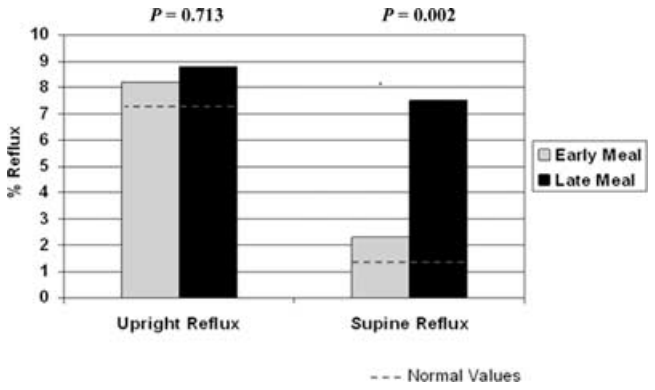

Figure 1. Differences in the percentage upright time pH <4 (upright reflux) and percentage supine time pH <4 (supine reflux) in patients consuming either an early or late evening meal. There was a significantly higher percentage supine reflux when patients consumed a late evening meal compared to when they consumed an early evening meal.

refluxers *versus* nonsupine refluxers was 7.43 (95% CI 1.23–45.0, $P = 0.180$).

All patients completed the postmeal symptom questionnaires following each study day detailing the frequency and severity of their symptoms. There was no significant difference in individual symptoms and total composite symptom score between the 2 study days. As a secondary objective, we assessed possible factors that could be associated with an increase in supine reflux following a late evening meal as compared to an early evening meal. Factors considered were presence of esophagitis, having a chief complaint of heartburn in the prestudy questionnaire, presence of HH, and BMI.

Endoscopy revealed the presence of esophagitis in 37% (11/30) of patients. Following the late evening meal, there was significantly greater supine reflux in patients with esophagitis (mean increase 9.6 ± 3.0, $P = 0.014$, Table 3). In the 19 patients who did not have esophagitis, a late evening meal also increased degree of supine reflux, but this did not reach statistical significance (mean increase 2.7 ± 1.7, $P = 0.060$, Table 3). In general, patients with esophagitis (E+) had significantly more supine reflux than patients without esophagitis (E−) following both early (E+ 4.4 ± 1.7 *vs* E− 1.1 ± 0.64, $P = 0.010$) and late (E+ 13.9 ± 3.7 *vs* E− 3.8 ± 1.5, $P = 0.018$) evening meals.

Table 2. Reflux Parameters and Patient Total Symptom Score Following the Early Meal and Mean Change in Reflux Parameters Following the Late Meal

	Early Meal	Mean Change	*P* Value
JD 24-h pH score	27.2 ± 3.7	16.7 ± 4.6	0.001*
% Total time pH <4	6.5 ± 0.8	1.9 ± 0.8	0.057
% Upright time pH <4	8.2 ± 1.1	0.7 ± 1.1	0.713
% Supine time pH <4	2.3 ± 0.8	5.2 ± 1.6	0.002*
No. episodes >5 min	3.5 ± 0.6	1.1 ± 0.7	0.121
Total no. nocturnal episodes	5.2 ± 1.4	4.8 ± 2.3	0.021*
Longest episode	15.6 ± 3.4	7.7 ± 3.4	0.019*
Total symptom score	7.7 ± 1.2	0.8 ± 0.9	0.275

Numerical values expressed as mean ± standard error of the mean.
*Indicates $P < 0.05$, Wilcoxon signed ranks test. JD = Johnson-Demeester.

Table 3. Percentage Supine Reflux Scores for Subgroups of Patients Following the Early Meal and Mean Change in Percentage Supine Reflux Following the Late Meal

	N	Early Meal	Mean Change	*P* Value
GERD+	19	3.5 ± 1.1	6.8 ± 2.3	0.18*
GERD−	11	0.14 ± 0.1	2.3 ± 1.9	0.031*
HB+	21	2.5 ± 1.0	5.5 ± 2.0	0.008*
HB−	9	1.8 ± 1.0	4.6 ± 3.0	0.141
Hiatal hernia+	14	1.8 ± 0.9	9.0 ± 2.5	0.002*
Hiatal hernia−	16	2.7 ± 1.3	2.0 ± 1.7	0.391
Esophagitis+	11	4.4 ± 1.7	9.6 ± 3.0	0.014*
Esophagitis–	19	1.1 ±0.6	2.7 ± 1.7	0.060
BMI				
≤24.9	7	0.0 ± 0.0	3.0 ± 3.0	0.500
25–29.9	14	3.0 ± 1.4	7.4 ± 2.3	0.001*
≥30	9	3.1 ± 1.4	3.5 ± 3.4	0.641

Numerical values expressed as mean ± standard error of the mean.
*Indicates $P < 0.05$, Wilcoxon signed ranks test. JD = Johnson-Demeester; GERD+ = abnormal acid reflux; GERD− = normal acid reflux.

HH was present in 47% (14/30) of patients, in whom there was significantly greater supine reflux following consumption of a late evening meal compared to the early meal (mean change 9.0 ± 2.5, $P = 0.002$, Table 3). Patients without HH also had greater supine reflux following the late evening meal, although these differences did not reach statistical significance when compared to the early meal (Table 3).

In patients with heartburn as their chief complaint, 70% (21/30) had significantly greater supine reflux (mean change 5.5 ± 2.0, $P = 0.008$) following the late evening meal compared to the early evening meal (Table 3). Additionally, if patients complained of nocturnal heartburn, they had significantly more supine reflux following the late evening meal (mean change 6.8 ± 2.2, $P = 0.004$) compared to patients without nocturnal heartburn in whom no significant difference was noted between the early *versus* late meal (mean change 2.9 ± 2.1, $P = 0.516$), (Fig. 2).

In our cohort, 47% (14/30) of patients were considered overweight as defined by BMI 25–29.9 while 30% (9/30) of our patients were obese as defined by a BMI > 30. Patients who were overweight had significantly higher supine reflux following the late evening meal compared to the early evening meal (mean change 7.4 ± 2.3, $P \leq 0.001$). Although not statistically significant, obese patients and normal weight individuals had a similar increase in supine reflux following the late meal compared to the early meal suggesting that a late evening meal had the greatest effect on overweight rather than obese patients (Table 3). However, given the small number of patients in each BMI subgroup, the lack of statistical significance may be related to low power.

No serious adverse events occurred during this study. One patient reported nonexertional chest discomfort following the placement of the Bravo^{TM} pH capsule. This quickly resolved

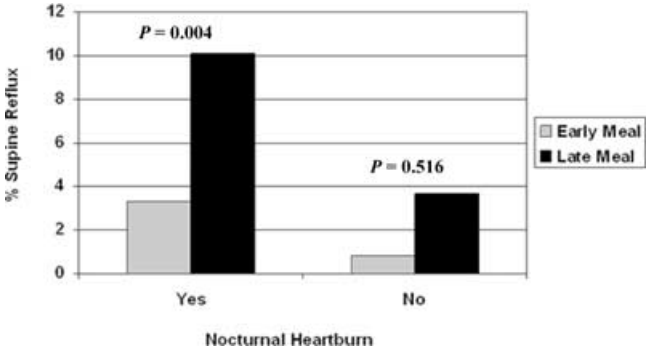

Figure 2. Percentage supine reflux (% supine time pH <4) in patients with and without nocturnal heartburn symptoms following the early and late evening meals. There was a significant increase in percentage supine reflux following a late evening meal in patients who had nocturnal heartburn.

with oral low-dose acetaminophen and this patient was completely asymptomatic on the second day of the study. There were no retained capsules and no patients complained of dysphagia.

DISCUSSION

Lifestyle modifications for patients with typical GERD symptoms often include dietary restrictions consisting of avoidance of spicy food and not eating the evening meal close to bedtime. Because there is no strong evidence for these recommendations, these measures may not be as strongly reinforced to patients by physicians and health care workers, possibly leading to decreased quality of life and worsening of GERD pathophysiology. The findings of the current study indicate that for patients with typical GERD symptoms, consuming a late-evening meal resulted in significantly greater supine reflux compared to when the meal was consumed earlier in the evening. For this analysis, the term supine reflux was used to refer to esophageal acid exposure in the supine position as demonstrated by increased percentage supine time pH <4. Interestingly, while patients complain of more heartburn when eating late, this is the first prospective study using a standardized meal to validate the advice that we give to patients in advising them to avoid late meals before going to bed.

Factors associated with a significant increase in supine reflux following a late meal compared to an early meal included the following: heartburn as a chief complaint, HH, endoscopic esophagitis, and being overweight. This study also provides information concerning how long patients should wait following the dinner meal before lying down and going to sleep. If the gastroesophageal junction is incompetent as noted in some patients with large HHs and severe esophagitis, eating an early meal, in this case 5.5 h prior to sleeping, was still associated with GERD, albeit less than when consumed 1.5 h prior to sleeping. As noted in previous reports, significant supine acid reflux is the most important factor in developing endoscopic erosive esophagitis (18). Patients in this study with erosive esophagitis had supine reflux following both the early and late evening meals compared to patients without esophagitis. Although these findings are intriguing, this study was not powered for the small number of patients in each subanalysis and these findings need to be validated in larger numbers of patients.

Interestingly, the symptom scores did not differ between the early evening and the late evening meals. Although this may be due to the subjective nature of symptom recording, these findings are consistent with other studies that show a poor correlation with symptoms and the degree of reflux (19, 20). A recent Gallup poll study indicated that over 79% of GERD patients complain of nighttime heartburn but only 60% of patients in our study had nighttime reflux (1). The difference may relate to the fact that in the Gallop poll study, nighttime heartburn was considered to be any heartburn subsequent to laying down to sleep while in our study nighttime heartburn was included only if patients woke up from sleep.

Previously, Fujiwara *et al*. demonstrated in a case-controlled study a relationship between shorter dinner-to-bedtime and an increased odds ratio for GERD (12). This finding was observed when the dinner-to-bedtime was less than 3 h. However, their analysis was based on a patient questionnaire and the meals were not standardized in individual patients.

Orr and Harnish attempted to answer the question of whether a late evening meal would stimulate sleep-related gastroesophageal reflux (17). This study involved giving a late evening meal to 20 symptomatic volunteers several hours prior to them going to sleep, and measuring esophageal acid exposure with a standard pH probe. They found no statistically significant difference in either the reflux events or the total time of esophageal pH below 4.0 between days when an earlier meal was ingested or the day when the late evening standardized meal was consumed. They concluded that food ingestion does not exacerbate gastroesophageal reflux during sleep. However, in this study the early and late meals in some patients were administered within 2 h of each other, and the earlier meal was not standardized. Furthermore, in some instances, data were collected on separate days over 2–3 wk intervals, allowing for great variability in the results.

The mechanisms of postprandial reflux are multifactorial. Wildi *et al*. demonstrated that the consumption of a standardized daytime meal in normal subjects within 5 min was associated with more reflux than a meal consumed over a 30 min period (21). The mechanism of reflux in this study was postulated to result from an increased rate of transient lower esophageal sphincter relaxations (TLESRs). This is not unexpected as TLESRs are associated with more daytime, upright reflux in normal subjects *versus* nighttime, supine acid reflux, which is usually associated with a low lower esophageal sphincter pressure (LES_p) (22, 23). Another reason for more reflux in patients who consume their meal rapidly could be related to acute gastric distention, which may result in increased TLESRs. In our study, patients were advised to finish the

meal over 30 min so that some of the meal may have emptied before the meal was completely consumed. Although the LESp was not continuously monitored, nor was high-resolution manometry performed to identify separation of the LES from the diaphragmatic sphincter, most supine reflux episodes are related to low LESp with retrograde flow of gastric contents into the esophagus. This pathophysiology was seen in the majority of our patients with supine reflux as patients with esophagitis and HH were a significant part of this group. Once acid reflux occurs in the supine position of sleeping patients, extensive acid exposure occurs as clearance mechanisms such as swallowing, secondary peristalsis, and arousals are severely impaired (24).

The composition of food may have influenced our results, and therefore meals of different composition may not apply to the findings of our study. Evidence exists that fat increases postprandial reflux, increases the frequency of TLESRs, and decreases LES resting pressure (25). We intentionally selected a refluxogenic meal to maximize the effect. However, given the crossover design and the same patients acting as their own controls, the difference would have been similar on both nights of the study.

Additionally, we found significantly greater supine reflux following the later evening meal in overweight individuals, a finding consistent with previous reports (9, 26). In fact, a specific dose–response relationship has been demonstrated between increasing BMI and GERD prevalence (10, 26, 27). Some of the mechanisms thought to be responsible for increased reflux include the increased stress posed on the lower esophagogastric junction (EGJ) and anatomic disruption of the EGJ in overweight and obese individuals (28). In our analysis, obese and normal weight patients had similar degree of reflux between the two nights. We can attribute this finding to the low power of the analysis due to the small number of subjects in each BMI subgroup. Larger number of patients would be needed to better interpret the clinical significance of this finding.

Our study has some potential limitations. The patient's lunchtime meal, although theoretically sufficiently early to avoid interaction with the evening meal, may have interfered with the standardized meal, and may have caused greater gastric distention and therefore acid reflux. We tried to control for this by excluding patients with symptoms or signs of delayed gastric emptying. Recall bias might exist relating to erroneous entry on their symptoms questionnaire, and this may be why the symptoms were not different between the early and late meals. Additionally, because the current study only enrolled patients with typical GERD symptoms, we have limited ability to extrapolate these findings to a subset of GERD patients with noncardiac chest pain or other atypical presentations.

In conclusion, results of this study suggest that eating meals closer to bedtime significantly increases supine reflux, regardless of whether patients are able to differentiate this by reporting symptoms. The patients at greatest risk for supine reflux following a late meal are those who complain of NR symptoms, have either HH or esophagitis on endoscopy, or those who are overweight. These findings support our current recommendations to our GERD patients to eat their dinner early and to lose weight.

STUDY HIGHLIGHTS

What Is Current Knowledge

- Gastroesophageal reflux disease is common in the general population.
- Nocturnal acid reflux has been associated with significant morbidity and loss of work productivity.
- Lifestyle modifications, including avoidance of a late evening meal, are often prescribed first to patients suffering from acid reflux. However, prospective evidence for such recommendation is lacking.

What Is New Here

- This is the first prospective study to show that patients with typical reflux symptoms have significantly greater supine acid reflux following a late evening standardized meal compared to when the same meal is consumed earlier in the evening.

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CONFLICT OF INTEREST

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