Influence of acute mental stress on the frequency and duration of gastroesophageal reflux in normal volunteers

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ABSTRACT: Six fasted healthy male volunteers (mean age 21.7 years) were studied. A pH probe was inserted with the tip 5 cm proximal to the gastroesophageal junction and recording begun 15 mins after completion of a standard meal. pH was recorded by computerized data logger which sampled every 6 s. Subjects were stressed intermittently by a dichotic listening task in which they attempted to track recorded word lists heard simultaneously in different ears. Mean frequency and duration of reflux episodes was determined from two 30-min stress and control periods. Alterations in heart rate, systolic and diastolic blood pressure confirmed the effectiveness of the stressor. Mean ($\pm$ SEM) duration of reflux per 30-min stress period (1.1 ± 0.53 mins) was not significantly different to mean duration per 30-min control period (1.5 ± 0.53 mins). The mean number of reflux episodes per 30-min stress period (2.3 ± 1.1) did not differ significantly from the mean number of episodes per 30-min control period (2.8 ± 1.1). Therefore, in normal volunteers acute predictable emotional stress does not influence the frequency or duration of postprandial gastroesophageal reflux. *Can J Gastroenterol* 1987;1(1):7-10

Key Words: Esophagus, Gastroesophageal reflux, Lower esophageal sphincter, Stress

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Received for publication May 26, 1987. Accepted June 26, 1987

THE GASTROINTESTINAL TRACT HAS long been recognized as an organ sensitive to emotional expression. The esophagus has been shown to take part in the reaction of the individual to physical as well as psychic stimuli. Emotional stress has long been recognized to precipitate spontaneous, nonpropulsive activity in the body of the esophagus (1-4) and increase the peristaltic amplitude of the distal esophagus (5).

Anecdotally, patient reports of dyspeptic symptoms and heartburn in response to stress are not infrequent. Up to 58% of referrals for esophageal manometric studies have esophageal motility disturbances (6). Furthermore, in patients with the irritable bowel syndrome (IBS) (a condition with a high prevalence of stress related gastrointestinal symptoms), studies

have reported between 37% and 56% to suffer from symptoms of gastroesophageal reflux (7-9). As a group, IBS patients have significantly lower basal lower esophageal sphincter (LES) pressure (9,10) and abnormally frequent gastroesophageal reflux judged by ambulatory pH monitoring (9).

The aim of this study was to determine in asymptomatic individuals, whether acute emotional stress influenced the frequency or duration of postprandial gastroesophageal reflux.

METHODS

Six healthy male volunteers with mean age of 21.7 years (SE = 0.56) and no history of gastrointestinal symptoms were studied. Following an overnight fast, a pH probe (Spectrex, Massachusetts) was passed transnasally without topical anesthesia and the tip positioned 5 cm proximal to the gastroesophageal junction. Subjects were seated in the erect position

and consumed a standard 1000 kcal meal in 15 mins. The meal consisted of 114 g roast beef, two slices whole wheat bread, one pat butter, lettuce, one cup coffee with one creamer, salt and pepper, one milkshake (ice cream and 142 g of 2% milk).

Continuous monitoring of the esophageal pH was achieved with a computerized data logger (Conestogo Medical Electronics Ltd, Kitchener, Ontario). Esophageal pH sampling lasted 6 s. A reflux event was defined as a fall in pH of greater than one unit to a pH below 4, or a further fall from a level below 4 of at least one more pH unit.

The stressor used was a dichotic or dual listening task and has been described in detail elsewhere (11). Briefly, subjects attempted to track one of two different word lists heard simultaneously in different ears through stereo headphones. The task was designed to simulate a stressful work environment in which the individ-

ual is called upon to perform multiple tasks within a limited time while being distracted by noise. During control periods, subjects listened to relaxing music. The effectiveness of the stressor was confirmed by monitoring extraintestinal measures of the stress response including heart rate, systolic and diastolic blood pressure, each of which was measured every 5 mins. Heart rate was measured by means of a 1-min ECG strip taken every 5 mins, and blood pressure was recorded manually using a mercury sphygmomanometer.

Experimental protocol: Each study compromised two 60-min sequences each consisting of a 30-min stress and a 30-min control period. The order of intervention (ie, stress-control or control-stress) was randomized. Subjects were located in a quiet room and no intrusions were permitted during the study. The first stress or control period commenced 15 mins after completion of the meal.

Figure 1) The influence of stressor (dichotic listening task) on extraintestinal measures of stress response. Significant alterations in systolic blood pressure ($P < 0.02$), diastolic blood pressure ($P < 0.01$) and heart rate ($P < 0.001$) were observed in response to the stressor. Note that these measures were higher immediately after the meal and slowly fell with time after the meal

Figure 2) The influence of stressor (dichotic listening task) on frequency and duration of reflux events after a standard meal. No significant stress effect was observed on frequency or duration of reflux events

TABLE 1
Influence of emotional stress on extraintestinal stress measures and post prandial gastroesophageal reflux events

	Sequence 1		Sequence 2		Significance* Stress effect
	Stress	Control	Stress	Control	
Systolic BP (mmHg)	127.2±2.9	122.1±2.5	121.7±3.4	116.5±2.3	P<0.02
Diastolic BP (mmHg)	78.2±2.2	74.2±2.4	77.7±2.2	75.4±2.7	P<0.01
Heart rate (beats/min)	83.8±3.8	77.4±3.0	76.6±3.0	70.1±3.4	P<0.001
Frequency reflux events (per 30 mins)	2.0±0.71	1.8±0.58	2.0±0.82	3.0±1.0	NS
Duration pH<4 (per 30 mins)	1.36±0.72	1.23±0.5	0.83±0.43	0.87±0.27	NS

* Repeated measures ANOVA. Stress effect Overall mean stress effect. No significant effect was observed when all the values of sequence 1 were compared to sequence 2 nor was there a significant difference in stress effect between sequences

Statistical analysis: Mean values for systolic and diastolic blood pressure, heart rate, mean duration of reflux and mean frequency of reflux events were determined for each of the four periods.

Repeated measures analysis of variance (ANOVA) and covariance was used to determine statistical significance between the outcome measure means during stress versus control periods. This analysis yielded three values: overall significance of the stress effect; significance of the sequence effect, referring to differences in means between first and second sequence; and significance of the treatment sequence interaction, referring to differences in mean stress effect in sequence 1 (stress-control) with that in sequence 2 (control-stress). All values are expressed as mean ± SEM.

RESULTS

Effectiveness of the stressor: Under the influence of the dichotic listening task, heart rate increased significantly ($P<0.001$) by a mean of 6.12 ± 0.85 beats/min. Significant elevation of systolic blood pressure ($P<0.02$) and diastolic blood pressure ($P<0.01$) were also observed in response to the stressor. Systolic blood pressure rose by a mean of 4.7 ± 1.4 mmHg and diastolic blood pressure rose by 3.2 ± 0.6 mmHg (Table 1, Figure 1). Neither sequence effect nor stress sequence interaction effects were significant, indicating no apparent adaptation to the stressor on second exposure.

The mean number of reflux events per 30 mins during stress (2.33 ± 1.12) did not differ significantly from the mean

number of reflux events during control conditions (2.83 ± 1.13). Mean duration of reflux events per 30 mins under stress conditions (1.08 ± 0.53) did not differ significantly from that of control conditions (1.48 ± 1.53) (Table 1, Figure 2).

DISCUSSION

On the basis of alterations in several different measures of the autonomic response it was demonstrated that the study population was stressed by the dichotic listening task. However, a significant influence of stress on the frequency or duration of gastroesophageal reflux events could not be demonstrated.

The lack of correlation between stress and reflux in asymptomatic volunteers may be explained by one or more theories. Symptoms attributed to the esophagus in response to stress are not related to gastroesophageal reflux. The potency of the stressor was insufficient to provoke reflux or the asymptomatic subjects studied were insufficiently susceptible to the degree of stress that might be expected to produce a response in predisposed individuals. Multiple factors are operational in susceptible individuals before a particular stimulus can "trigger" reflux events.

In addressing these issues, one must consider that, while esophageal motility disturbances (rather than reflux events) might account for stress related "heartburn", there has been no clear and consistent demonstration of manometric abnormalities concurrent with esophageal symptoms attributed to those abnormalities (12). With regard to the adequacy of

the dichotic listening task in this situation, comparable autonomic cardiovascular changes have previously been demonstrated together with pharyngoesophageal sphincter hypertonicity in normal subjects (13), and others have induced esophageal peristaltic abnormalities using a comparable stressor (5). However, the task used is an acute and predictable stress and the present study may not be as readily extrapolated to the more chronic or unpredictable stress events of daily life.

The most feasible explanation for these findings is based on the heterogeneity of factors implicated in gastroesophageal reflux. Gastroesophageal reflux in normal subjects occurs nearly exclusively by the mechanism of transient complete relaxation of the LES (14). In reflux patients, transient LES relaxation or a persistently low basal LES pressure are determinants of reflux (15, 16). However, a low or absent LES pressure does not guarantee the occurrence of gastroesophageal reflux. Other factors such as intragastric volume (17), intra-abdominal pressure (18), relaxation of the diaphragmatic hiatus (19) and possibly longitudinal esophageal shortening (20) appear to be important. It is possible that stress contributes to gastroesophageal reflux but that several of the above criteria need to be operative before stress can trigger a reflux event.

Transient complete relaxations of the LES do not occur in asymptomatic subjects during sleep but are observed during arousal from sleep or during full wakefulness (14). Cervical vagotomy in dogs eliminates transient LES relaxation in response to gastric distension (21). Labyrinthine stimulation in human volunteers significantly lowers basal LES pressure (11). These data strongly suggest that central nervous system arousal, through brain stem and vagal pathways, may be an important determinant of LES relaxation and hence gastroesophageal reflux. Furthermore, the repeated demonstration of a high prevalence of heartburn (4, 7, 8), abnormal 24 h esophageal pH profiles (9) and low basal LES pressure (9, 10) in IBS patients suggests that susceptibility to stress might be a factor in the expression of their esophageal as well as intestinal symptoms.

Our inability to demonstrate stress related reflux in asymptomatic volunteers

does not preclude the prospect of stress playing a potential role in causing reflux in predisposed individuals. As outlined, the interplay of factors resulting in gastroesophageal reflux is complex. For example, it is not known whether stress will precipitate reflux in individuals with low basal LES pressure (such as IBS or reflux patients). Furthermore, it is suspected but not known whether certain psychological

profiles might render an individual more susceptible to the effects of stress.

Factors operative in the perception of esophageal pain are equally poorly understood and almost certainly depend on local as well as psychic factors (22, 23). For example, stress and psychological profile may influence esophageal sensitivity or threshold to stimuli such as low pH or distension (23). The stress prone individ-

ual might not reflux more frequently than normal, but might perceive each event more readily.

In spite of the apparent lack of correlation between stress and reflux in asymptomatic volunteers, the available evidence would suggest the investigation of the hypothesis in patient populations intuitively predisposed to stress and/or reflux, is warranted.

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