Effect of acute stress on anorectal physiology in normal healthy volunteers

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Objective: Visceral hypersensitivity occurs in many patients with irritable bowel syndrome; however, it is more common in those with high anxiety levels, raising the possibility that it is merely a reflection of underlying anxiety. The aim of this study was to assess the effect of acute stress on anorectal motility and sensitivity in normal healthy volunteers.

Design and methods: Anorectal responses to balloon distension were assessed in 14 healthy volunteers (aged from 24–52 years; 11 women) on three separate occasions in random order during exposure to either cold pain, mental stress or control conditions.

Results: Both subjective and objective measures of stress increased significantly during both stress studies [subjective stress level (mean ± SEM): control 23 ± 2.9, cold pain 56 ± 5.4, mental stress 61 ± 6.5, $P < 0.002$; pulse rate: control 71 ± 0.5, cold pain 82 ± 0.9, mental stress 84 ± 1.2, $P < 0.01$]. However, there were no changes in rectal sensitivity [volume to discomfort (ml): control 190 ± 14.5, cold pain 198 ± 16.9, mental stress 180 ± 14.9]; rectal compliance (ml/cmH_2O; control 6.4 ± 0.56, cold pain 7.3 ± 0.86, mental stress 6.3 ± 0.6), or distension-induced motility (control 1405 ± 376, cold pain 1389 ± 387, mental stress 1021 ± 289).

Conclusion: Acute stress does not effect the anorectal response to balloon distension in normal volunteers. Further studies are required to assess whether patients with irritable bowel syndrome respond in a similar or different way to acute stressful stimuli.

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Introduction

It is common experience that psychological stress can influence gut function, and stress is believed to be an important aetiological factor in many patients with functional bowel disorders. Several studies have been published concerning the effects of acute stress on the motor function of both the upper and lower gastrointestinal tract. These have shown that stress can either delay [1] or have no effect [2] on gastric emptying, alter the gastroduodenal response to a meal [3], change the pattern of fasting small bowel activity [4,5], alter small bowel transit [2,6], and increase colonic motility [7,8].

There are, however, no published studies concerning the effect of stress on the sensory function of the gut. Many patients with irritable bowel syndrome (IBS) have increased visceral sensitivity, expressed as decreased tolerance to rectal balloon distension [9,10], or small intestinal gas infusion [11]. It has recently been shown that those patients with abnormal sensitivity often have increased levels of anxiety [10], raising the possibility that the increase in visceral sensitivity noted in these patients relates more to anxiety than to the presence of IBS *per se*.

The purpose of this study was to increase our understanding of the factors influencing visceral sensitivity by studying the effect of acute stress on anorectal responses to distension in healthy volunteers.

Materials and methods

Volunteers

Fourteen healthy volunteers (three men, 11 women; aged from 24–52 years) participated in the study.

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None of the volunteers had experienced any chronic gastrointestinal symptoms nor had a history of anxiety disorders or other psychiatric illnesses. None of the volunteers was on regular medication other than the oral contraceptive. All participants gave informed consent and the study was approved by the local Ethical Committee.

Experimental protocol

Each subject was studied on three occasions and was exposed to cold pain, mental stress, or control in random order. Each stressor was maintained throughout the duration of the study. The studies were performed at the same time of day and were separated by between 1–7 days.

With the volunteer in the left lateral position, a narrow multilumen polyvinyl catheter (4 mm outer diameter; Arndorfer Medical Specialities Inc., Greendale, Wisconsin, USA) was inserted into the rectum and positioned with two side holes in the rectum (4.5 and 15.0 cm from the anal verge) and three side holes in the anal sphincter (0.5, 1.0 and 2.0 cm from the anal verge). Although the catheter was narrow and flexible, it was sufficiently stiff to prevent kinking and acute bending during manual passage through the anus and correct positioning in the rectum. Each side hole was perfused with water at a rate of 0.2 ml/min (Arndorfer Medical Specialities Inc.) and connected via water-filled transducers to a polygraph recorder and visual display unit (Synectics Ltd, Stockholm, Sweden). A 6-cm length of distensible latex tubing was tied to the catheter between 5 and 11 cm from the anal verge and used to distend the rectum. The pressure within the rectal balloon was monitored using a water-filled nonperfused channel situated 8 cm from the anal verge. After a 10-min basal recording period, and 5 min after application of the stressor commenced, the rectal balloon was serially inflated with air at 10, 20, 40, 60, 80, 100 ml, and then in 25 ml increments until the subject experienced discomfort. Each inflation was maintained for 1 min and was separated by 30 s, during which the balloon was totally deflated. During the procedure, the subjects were asked to mark on a standard form the nature of any sensation felt ('sensation', 'wind', 'open bowels', 'urgency' and 'discomfort'). Although the subjects were informed of the nature of the sensations they might experience at the beginning of study, they were not aware of the timing of the balloon distensions or prompted about the sensations during the studies.

Stressful stimuli

Two stressors were used in the study: cold pain was induced by immersing the non-dominant hand into water at 4°C for 1 min, the hand being removed for 15 s between each immersion. This cycle was continued until the end of the anorectal physiology study. Mental stress comprised a series of mathematical problems, each of which had to be completed within a time limit. A monetary reward was given for all correct answers and the subjects were told that a small electric shock would be applied to the dorsum of the foot after five incorrect answers. Mental stress was continued until the end of the anorectal physiological study.

During the control study, subjects listened to relaxing music; their pulse rates were monitored at 5 min intervals, and subjective levels of stress were assessed at the end of each study by the subjects marking a cross on a visual analogue scale of 0–100 (100 being maximum) as to how stressed they had felt during the study.

Data analysis

The following measurements were derived from the rectal distension study: the lowest balloon volumes required for initial perception and to induce the sensations of gas, desire to defecate, urgency of defecation and discomfort; the steady state pressure in the rectal balloon at each distending volume and the rectal compliance (calculated from the volume : pressure relationship at 100 ml distension); the lowest balloon volume required to induce repetitive rectal contractions, defined as a sequence of more than four consecutive contractions; the rectal motility index during distension was calculated by summing the area under the rectal pressure profiles at 4.5 and 15 cm from the anal verge. A mean motility index for each subject was then calculated from which an overall group mean was calculated. The basal anal pressure, and the lowest distending volume required to initiate internal anal sphincter relaxation and cause relaxation sustained throughout distension were also determined.

Statistical analysis of the effect of stress on anorectal physiology was performed using the Wilcoxon signed rank test for paired data.

Results

The results of the study are summarized in Table 1. The anxiety levels of the subjects were significantly increased during both the cold pain and mental stress studies ($P < 0.002$) and were accompanied by a significant increase in pulse rate ($P < 0.01$). However, no changes in rectal sensitivity, rectal compliance, distension-induced motility, or any of the anal parameters were observed with either stressor. In addition, no correlation could be found between individual changes in subjective stress levels and changes in any of the anorectal physiological measurements.

Table 1. Effect of stressors on anorectal function.

Variable	Control	Cold pain	Mental stress
Stress level	23±2.9	56±5.4**	61±6.5**
Pulse rate/min	71±0.5	82±0.9*	84±1.2*
Rectal sensation (ml)			
perception	18±3.3	16±2.3	18±3.5
gas	35±5.7	30±5.2	30±5.7
desire to defecate	74±9.3	73±11.9	72±6.8
urgency	132±12.1	129±15.1	119±15.4
discomfort	190±14.5	198±16.9	180±14.9
Rectal compliance (ml/cmH_2O)	6.4±0.56	7.3±0.86	6.3±0.69
Rectal motility			
volume for repetitive contractions (ml)	109±23.4	96±22.7	105±23.1
motility index per distension	1405±376	1389±387	1021±289
Anal parameters			
basal pressure (cmH_2O)	101±6.6	97±6.2	113±7.4
threshold IAS relaxation (ml)	16±1.4	22±4.5	19±3.9
threshold sustained relaxation (ml)	103±9.5	95±8.0	114±9.3

Results expressed as mean±SEM. IAS, internal anal sphincter; *$P<0.01$, **$P<0.002$ cold pain and mental stress versus control.

Discussion

This study has shown that acute mental or physical stress does not effect rectal sensitivity to balloon distension in normal healthy volunteers. However, two important factors have to be taken into consideration. Firstly, it is possible that only chronic, long-term stress may be important in inducing changes and, secondly, different stressors may not produce the same physiological effects. Some support for the former possibility comes from the observation that patients with IBS and rectal hypersensitivity tend to be more anxious than IBS patients who do not exhibit rectal hypersensitivity [10]. In addition, a more recent study using sleep deprivation as a chronic stressor has shown an increase in rectal sensitivity [12]. With respect to the second possibility, there are no data on whether rectal responses differ according to the type of stressor, but studies on the stomach would suggest that this may be the case [1,2].

It was surprising that no changes in rectal compliance or distension-induced motor activity were observed in response to stress in this study, in contrast to previous observations [7,8]. This was not due to lack of effectiveness of the stressors used, as both pulse rate and the subjective level of stress increased in response to these stressors. However, it is important to note that our technique was different from previous studies in that a balloon for sensitivity testing was also present within the lumen as well as the pressure recording channels. An inflated balloon would extend the rectal wall thus introducing a space between side holes and the wall, so reducing their effectiveness at recording pressure changes. It is possible, therefore, that these technical differences may have accounted for the recorded discrepancies in motor activity. Support for this hypothesis comes from the work of Bergin and Read [12] who also did not observe significant changes in motility in response to stress using a similar technique to that used in this study.

In conclusion, these studies suggest that acute, as opposed to chronic, stress does not alter the anorectal response to balloon distension in normal healthy volunteers. These results cannot necessarily be extrapolated to other conditions such as IBS, where different responses to acute or chronic stress may occur. However, this study provides a baseline from which other work can proceed.

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