Sensibility of the rectum to distension and the anorectal distension reflex in ulcerative colitis

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SUMMARY The maximum volume of air tolerated within a rectal balloon was less in colitic patients than in normal subjects (p < 0.001). Smaller volumes were tolerated by patients with a spontaneously bleeding mucosa than by those with less severe inflammation (p < 0.001). Severe urgency of defaecation with incontinence was experienced by about half those with spontaneous mucosal haemorrhage but was infrequent among other colitics. Those patients with inactive colitis and a reduced maximum tolerable volume tended to have a smaller rectal size than those who could tolerate a normal volume within the rectum. Reflex relaxation of the internal anal sphincter on distension of the rectum appeared normal in patients with colitis.

Urgency of defaecation, sometimes leading to incontinence, is one of the most disabling symptoms experienced by a patient with colitis. The studies of rectal distension reported here show that many patients with colitis are unable to tolerate normal volumes within the rectum. The reflex relaxation of the internal sphincter on distension of the rectum, is apparently unaffacted by the altered sensory responses and does not contribute to the tendency to incontinence.

METHODS

PATIENTS STUDIED
Thirty-four patients with established colitis, 15 female (mean age 44·3 years) and 19 male (mean age 46·1 years), were compared with 15 control subjects, seven female (mean age 55·4 years) and eight males (mean age 49·8 years). The colitis extended to the hepatic flexure in nine patients, was confined to the distal colon in 14, and was intermediate in 11. Fourteen of the patients with colitis were studied serially, four on three occasions and 10 on two occasions. The control subjects had a normal rectum; five had a polyp or carcinoma elsewhere in the large bowel and 10 had no colonic disorder.

TECHNIQUE

Rectal distension
A Latex balloon 40 × 60 mm was attached with its longest diameter over a 2 mm external diameter polyethylene tube so that on introduction into the rectum its centre lay 10-12 cm from the anal verge. The balloon was inflated with air at intervals of 30 seconds, initially using increments of 10 ml until constant sensation (see below) was experienced by the subject and then with increments of 50 ml. Care was taken to introduce air at a constant rate and with a constant force to avoid any bias due to the observer's knowledge of the patient's symptoms and the sigmoidoscopic appearance. No corrections of volume in the balloon because of pressure or temperature were made. Lateral radiographs of the pelvis (Fig. 1) showed that the balloon took up an ovoid configuration with its lower end just above the anus.

As the balloon was progressively inflated, the subject was asked to say when a sense of rectal distension was first experienced. This volume of air was recorded as the 'sensation threshold'. As the volume in the balloon increased this sensation persisted throughout the 30 second interval between increments of air. This volume was recorded as corresponding to 'constant sensation'. The largest volume of air which the subject could tolerate, usually limited by difficulty in resisting an urge to defaecate with some discomfort, was recorded as the 'maximal tolerable volume'.

Anorectal distension reflex
An open-ended polyethylene tube (external diameter 2 mm, internal diameter 1 mm) perfused with water at a rate of 2 ml per hour was placed within the anal canal. Relaxation of the sphincter was shown by a

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Fig 1. Radiograph showing the position and shape of the balloon distended with air and coated with barium at the maximum tolerated volume (110 ml) in a patient with colitis.

Fig 2. Method of measuring rectal size from a tracing of a lateral barium enema radiograph.

Sigmoidoscopic appearance of mucosa in colitis
The rectum was examined on the day before the observations on rectal distension. The inflammation of the mucosa was graded as 'active' if there was spontaneous bleeding, 'moderately active' if there was contact bleeding, and 'inactive' if there was no bleeding on contact (Baron et al., 1964).

Results

Anorectal distension reflex
Reflex relaxation of the internal anal sphincter on distension of the rectum appeared to be normal in the patients with colitis. Normal transient relaxation of the sphincter was observed in all patients as small volumes of air were introduced into the balloon. In two-thirds of the patients with active colitis distension of the balloon to the volume necessary to cause prolonged relaxation of the sphincter was prevented by discomfort. As it is in these patients that incontinence occurs, it is evident that prolonged relaxation of the sphincter with small volumes in the rectum is not a factor in incontinence.

Sensory responses to rectal distension with increasing volumes of air

Overall results
The mean results found in the control subjects and in colitics grouped according to the severity of the mucosal inflammation are shown in the Table. There

fall in the yield pressure measured with an SE Laboratories 4-8 transducer, SE 4910 amplifier, and SE 2005 U-V recorder. The volumes of air in the balloon at which transient relaxation of the internal sphincter first occurred and the volumes at which relaxation persisted throughout the 30 seconds between increments of air were noted.

Estimation of rectal size
This was estimated from the current true lateral pelvic radiograph of a double-contrast barium enema examination by measuring with a 10 mm grid the area below a perpendicular line to a tangent at the 2nd sacral vertebra (Fig. 2). A standard radiological technique was used in which, after coating the bowel wall with barium, air was introduced into the rectum using a Higgison's syringe until satisfactory distension of the colon was obtained on screening or the patient complained of discomfort. The pressure of air distending the rectum was not measured. It was not considered ethical to perform replicate radiographs for the purpose of this study.

Overall results
The mean results found in the control subjects and in colitics grouped according to the severity of the mucosal inflammation are shown in the Table. There

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were significant differences for the sensation threshold, the volume at which constant sensation was experienced, and the maximal tolerable volume between the control group and patients with colitis of all grades of severity. There was almost complete separation between the control group and patients with active colitis using the criterion of maximal tolerable volume, as shown in Fig. 3; all the patients tolerated 150 ml or less and all the normal subjects tolerated 150 ml or more. There was considerable overlap between patients with moderately active or inactive colitis and the normal range.

Serial observations
Results for maximal tolerable volume in patients whose colitis improved, deteriorated, or remained unchanged, as judged by the sigmoidoscopic findings, are shown in Fig. 4. It will be seen that the maximal volume that was tolerated tended to increase as inflammation improved and decrease with time in patients whose colitis appeared to be more severe. In five patients the mucosal appearance was unchanged but the maximal tolerable volume decreased in four and was unchanged in the fifth.

Correlations between maximal tolerable volume, sigmoidoscopic appearance, and rectal size
The rectal size in seven of the control subjects for whom a barium enema was available lay between 44 and 65 cm². The corresponding MTV for these subjects is shown in Fig. 5 in which the lower limits of normal are shown so that all normal results lie in the upper right hand quadrant. Corresponding values for patients with active and inactive colitis are shown in the other two sections of the Figure. All patients with active colitis had a low MTV, some had a normal rectal size, and others a contracted rectum. Those patients with inactive colitis and a low MTV tended to have a smaller rectal size than those with a normal MTV suggesting that contraction of the rectum is a factor determining the low MTV in some of these patients.

Correlations between maximal tolerable volume, sigmoidoscopic appearance, extent of colitis, and symptoms
Although there was some correlation between urgency of defaecation and incontinence with maximal tolerable volume, there was a more obvious correlation with the mucosal appearance. Of the 22 patients with a spontaneously bleeding mucosa, 11 could resist the urge to defaecate for one minute or less. Conversely, none of the 15 patients with a non-haemorrhagic mucosa, and only one of the patients with contact bleeding experienced this degree of urgency. Of the 23 patients with less urgency, there was no obvious correlation with the mucosal appearance but 19 had a maximal tolerable volume below 150 ml. Of the 14 patients who experienced episodes of
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SIGMOIDOSCOPIC APPEARANCE

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Fig 4. Results of serial observations on maximal tolerable volume correlated with changes in sigmoidoscopic appearance of the rectal mucosal in colitis.

incontinence. 12 had a spontaneously bleeding mucosa and all but one had a low maximal tolerable volume on distension of the rectum.

No correlation was found between the extent of the colitis and the symptoms of urgency or incontinence.

Discussion

Distension of the rectum with an air-filled balloon has been used by investigators for study of sensation in normal subjects and in patients with incontinence or megarectum (Goligher and Hughes, 1951; Porter, 1961; Callaghan and Nixon, 1964; Ihre, 1974) but it does not appear to have been applied previously to a study of the rectal symptoms in colitis. The technical problems of using air within a distensible balloon have been well studied by Ihre (1974) who concluded that air was preferable to water for studies of the sensory responses to distension because subjects are conscious of the weight and temperature of water. We have not followed his example of correcting the volume of air in the balloon for the pressure exerted on it by the balloon and rectal wall because it was hoped that the present technique might provide a simple clinical test of rectal sensation in colitis without the need for pressure measurements.

It could be that the anorectal distension reflex would be altered in colitis so that the internal anal sphincter relaxes, transiently or for prolonged periods, when the rectum is distended with smaller volumes than would cause these responses in normal subjects. No evidence of such an alteration in the anorectal distension reflex was found. In many patients who suffered severely from incontinence it was impossible to produce prolonged relaxation of the anal sphincter by rectal distension because an adequate volume could not be tolerated within the rectum.

A striking feature of the present study was the correlation between activity of the mucosal inflammation, as judged by sigmoidoscopy, the severity of symptoms, and the experimental findings. Every patient who experienced an episode of incontinence daily or weekly, and all but one of the patients who
could resist an urge to defaecate for one minute or less, had a spontaneously bleeding mucosa. About half the patients with this severity of mucosal inflammation experienced incontinence. These patients were also unable to tolerate distension of a balloon in the rectum to the volume tolerable by normal subjects.

The effect of decreased capacity of the rectum on its sensibility to distension is difficult to establish. The barium enema technique in which introduction of air may be limited by discomfort makes it likely that the observed size of the rectum on radiography will correlate with the sensibility to distension measured by the balloon technique. However, in patients whose colitis was inactive there was a tendency for the rectum to be small in those who could tolerate only a small volume in the rectum and to be normal in those who could tolerate a normal volume, suggesting that, in such patients, contraction of the rectum does influence the maximum volume tolerable within the rectum.

Serial studies have shown that the maximal volume tolerable within the rectum tends to increase as inflammation subsides but decrease if inflammation becomes more severe or remains apparently unchanged over a period. The importance of treating rectal inflammation, which determines some of the distressing symptoms in colitis, is apparent.

The rectum is normally sensitive only to pressure or distension, although if this is extreme it may produce pain in some subjects. Anatomical and physiological studies (Duthie and Gairns, 1960) show that, unlike the anal canal, which is richly supplied with nerve endings allowing appreciation of pain, light touch, and temperature, the normal rectum has only nerves and nerve plexuses without demonstrable nerve endings and is insensitive to these modes of sensation. It has been suggested that sensory receptors in the rectal wall (Parks et al., 1962) or in the levator ani muscle and perirectal tissues (Goligher and Hughes, 1951; Scharli and Kieswetter, 1970) contribute to the rectal sensation of distension. The present results show that mucosal inflammation affects the sensory response of the rectum to distension. However, the sensitivity to distension demonstrated in this study may be only one of the factors involved in the urgency and incontinence of colitis. In addition, there may be the effects of liquid stimulating the sensory receptors of the upper anal canal, alterations in muscular tone and movement within the colon and rectum, and anatomical factors such as narrowing of the rectum and straightening of the anorectal angle. Furthermore, in the stomach it has been shown that when the mucosa is inflamed, minor stimuli of many different types can cause pain, whereas when the

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**Fig 5. Correlations between maximal tolerable volume, sigmoidoscopic appearance, and rectal size.**

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mucosa is normal painful sensations cannot be elicited (Wolf, 1965). It seems possible that the inflamed rectal mucosa also becomes sensitive to tactile, thermal, or chemical stimuli to which it is normally insensitive and this possibility deserves investigation.

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