Improvement of Anal Sensation with Preservation of the Anal Transition Zone After Ileoanal Anastomosis for Ulcerative Colitis

Richard Miller, M.S., F.R.C.S.,* David C. C. Bartolo, M.S., F.R.C.S.,* William J. Orrom, M.SC., F.R.C.S.(C),† N.J. McC. Mortensen, M.D., F.R.C.S.,‡ A.M. Roe, M.S., F.R.C.S.,* F. Cervero, Ph.D.*

One of the most important considerations in restorative proctocolectomy for ulcerative colitis is postoperative continence. Preservation of the anal transition zone has been associated with improved results after this procedure in the pediatric age group. This study was carried out to determine the effect of preservation of the anal transition zone in adult patients undergoing restorative proctocolectomy, comparing a group of patients with the anal transition zone preserved with a group of patients with the anal transition zone removed. Physiologic testing demonstrated improved sensation in those patients with a preserved anal transition zone. Functional results were not significantly improved, although there was a trend toward improved continence and discrimination in those with the anal transition zone preserved. Although the results are early and are not conclusive from the clinical standpoint, they are certainly encouraging and may justify continued use of this technique. [Key words: Restorative proctocolectomy; Ileoanal anastomosis; Anal transition zone; Continence; Discrimination; Sensation]

From the Department of Surgery,
Bristol Royal Infirmary,
Bristol, United Kingdom,*
the Division of Colon and Rectal Surgery,
Department of Surgery,
University of Minnesota, Minneapolis, Minnesota,† and the
John Radcliffe Hospital, Oxford, United Kingdom‡

WHILE THE PROCEDURE of total abdominal colectomy and rectal mucosectomy has become an accepted surgical approach in the treatment of ulcerative colitis, there are still problems with high postoperative morbidity and unpredictable functional results. From the patient's standpoint, the most important functional result is that of continence of stool.

The incidence of minor incontinence varies widely in major series but is usually around 20 to 30 percent.[1-4] Major incontinence is seen in about 5 percent of cases.[1,2] Martin et al. reported improved results when the anastomosis between the pouch and the anal canal was performed at the top of the anal columns, preserving the anal transition zone. In this series, less than 6 percent of cases had episodes of minor incontinence and only 2 percent had major incontinence.[5]

In 1960, Duthie and Gairns[6] described a profusion of free nerve endings extending from the anal margin to the proximal anal canal as far as the top of the anal columns. In the rectal mucosa, these free nerve endings cease abruptly. It has been proposed that this part of the anal canal, the anal transition zone, is important

in discriminating between gas, liquid, and solid stool because a sampling reflex allows contact between this sensitive epithelium and rectal contents.[7] It has been demonstrated by Roe et al. that mucosal electrosensitivity is decreased in the anal transition zone in patients with idiopathic fecal incontinence.[8] In a similar group of patients, Miller et al.[9] demonstrated impaired temperature sensation in the anal transition zone.

Because of the functional problems associated with restorative proctocolectomy and the implied importance of the anal transition zone in maintaining continence, the operative technique was modified by one of the authors (D.C.C.B.) to preserve the anal transition zone during restorative proctocolectomy for ulcerative colitis. This study is a comparison of two groups of patients, one without preservation of the anal transition zone, and one with preservation of the anal transition zone.

Patients and Methods

Patients: Two groups of patients with ulcerative colitis were studied, those operated upon before February 1987 in whom restorative proctocolectomy was carried out with anastomosis at the level of the dentate line (anal transition zone removed) and those operated upon after February 1987, in whom the anastomosis was carried out at the level of the top of the anal columns (anal transition zone preserved). In both groups, the distal mucosa was removed endoanally. Eight patients were in the anal transition zone removed group, 2 women and 6 men, and 14 patients were in the anal transition zone preserved group, 5 women and 9 men. The average age in the anal transition zone removed group was 34.5 years and the average age in the anal transition zone preserved group was 41.6 years (not significant). Surgery was performed in most patients because of chronic disease unresponsive to medical management. Exceptions included 2 patients in the anal transition zone removed group, 1 with dysplasia on colonoscopic biopsy and 1 with fulminant colitis, and 3 patients in the anal transition zone preserved group, 1 with dysplasia and 2 with toxic megacolon.

Physiologic investigations were carried out preoperatively and again postoperatively 3 months after ileostomy closure. Patients were also assessed clinically 3 months after ileostomy closure with particular attention to stool frequency during the day and at night, the necessity for a pad during the day and at night, the ability to pass flatus without soiling, and the ability to discriminate between gas, solid, or liquid stool. Both groups were compared with 20 age- and sex-matched control subjects. Clinical characteristics of the patient groups are shown in Table 1. Statistical analysis of preoperative and postoperative results was made using Wilcoxon rank sum test. Intergroup analysis was

TABLE 1. *Clinical Details of Patients*

	ATZ Preserved	ATZ Removed	Controls
n	14	8	20
Age (S.E.) years	41.6 (4.26)*	34.5 (3.09)	39.1 (3.32)
Follow-up (months)	10.0 (1.27)	29.5 (1.39)	—
Male:Female	9:5	6:2	11:9

*Mean (standard error).

performed with Mann–Whitney U test. Chi-square with Yates' correction was used for comparison of proportions.

Physiologic Investigations: Mean highest resting and mean highest squeeze pressures in the anal canal were measured by the station pull-through technique using a precalibrated water-filled microballoon closed system. This has been previously described in detail.[10,11]

Threshold mucosal electrosensitivity was measured using a constant current pulse generator as described by Roe and colleagues at the lower, middle, and upper anal canal.[8] Temperature sensation was measured with a specially constructed thermode. It consisted of a hollow, bullet-shaped probe, 1 cm in length and diameter, through which water of different temperatures was circulated. It was connected to three thermostatically controlled water baths and two taps allowed the water being pumped through the thermode to be rapidly changed from one bath to another. The temperature of the baths was set such that, with the probe in the anorectum, its temperature could be maintained at 37°C and then either rapidly reduced to 32.5°C or increased to 41.5°C. The temperature changes imposed on the anal mucosa were measured with a small thermocouple embedded in a groove on the thermode surface. As the temperature was shifted, patients were asked to indicate immediately when they sensed a temperature change. Measurements were made at the lower, middle, and upper anal canal, recording the mean minimum detectable temperature change. This technique has been recently described in detail.[9]

Results

Physiologic Investigation: Physiologic investigation (Table 2) showed that maximum resting pressures were significantly decreased postoperatively in both groups of patients compared with preoperative values and with controls (Fig. 1). While maximum voluntary contraction was decreased postoperatively in both groups, in neither group was it significant when compared with controls or with preoperative values.

Preoperative measurement of threshold mucosal electrosensitivity showed no significant difference from

TABLE 2. *Physiologic Investigations*

	ATZ Removed		ATZ Preserved		Controls*
	Preoperative*	Postoperative*	Preoperative*	Postoperative*	
MRP (cm H_2O)	112 (11.2)	66 (14.0)‡	94 (7.6)	60 (3.5)‡	114 (4.6)
MVC (cm H_2O)	338 (45.8)	291 (55.1)	279 (28.4)	257 (30.2)	315 (25.4)
Mucosal electrosensitivity (milliamps)					
Lower	3.4 (0.50)	5.1 (0.77)†	5.3 (0.42)	4.9 (0.25)	4.4 (0.27)
Middle	3.8 (0.47)	7.8 (1.5)‡	4.0 (0.29)	4.5 (0.31)	3.9 (0.38)
Upper	6.7 (1.1)	16.1 (3.0)‡	5.9 (0.93)	7.7 (1.16)	6.11 (0.65)
Minimum detectable temperature change (degrees celsius)					
Lower	—	—	0.94 (0.16)	0.91 (0.14)	1.025 (0.09)
Middle	—	—	0.88 (0.18)	0.77 (0.09)	0.945 (0.09)
Upper	—	—	1.44 (0.22)	1.32 (0.28)	1.34 (0.13)

*Mean (standard error).
†$P < 0.05$ vs. preoperative.
‡$P < 0.05$ vs. preoperative and controls.

controls in either group. Sensitivity was decreased significantly on postoperative testing at all levels of the anal canal in patients having undergone restorative proctocolectomy with removal of the anal transition zone. Compared with controls, significant diminution was seen in the middle and upper anal canal. In those patients with preservation of the anal transition zone, no diminution of anal mucosal electrosensitivity was demonstrated when compared with preoperative values and with controls (Fig. 2).

Temperature sensation showed no significant change between preoperative and postoperative testing in those patients with preservation of the anal transition zone. Again, compared with controls, no defect in temperature sensation was demonstrated at any level of the anal canal in those patients with preservation of the anal transition zone.

Clinical Results: The median follow-up in the anal transition zone removed group was 28.9 months (range, 24.0 to 35.6 months) while in the anal transition zone

preserved group, the median follow-up was 9.4 months (range, 4.5 to 16.0 months). This difference was statistically significant with $P < 0.0001$. The average stool frequency during the day and night was 3.9 and 0, respectively, in the anal transition zone removed group and 5.5 and 0.43, respectively, in the anal transition zone preserved group. The daytime stool frequency was significantly higher in the anal transition zone preserved group ($P < 0.05$). No patient in the anal transition zone preserved group had to wear a pad during the day and they all denied any soiling. Only one patient (7 percent) wore a pad at night. In the anal transition zone removed group, one patient wore a pad during the day (13 percent), while a second patient complained of daytime soiling, and two patients wore pads at night (25 percent). Thirteen of 14 patients (93 percent) in the anal transition zone preserved group could pass flatus without soiling,
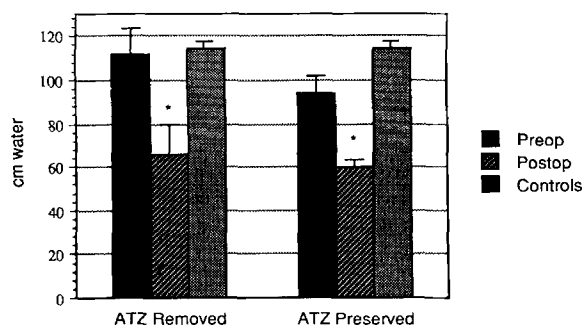

FIG. 1. Maximum resting pressure measured preoperatively and postoperatively. Vertical bars show standard error. *$P < 0.05$ preoperative vs. postoperative and controls.
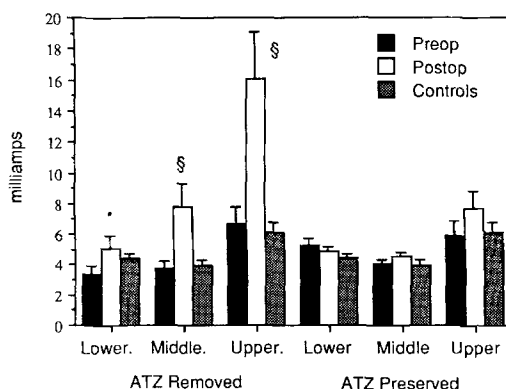

FIG. 2. Mean mucosal electrosensitivity measured preoperatively and postoperatively. Vertical bars represent standard error. Significant increases are seen in threshold mucosal sensitivity postoperatively in those with the anal transition zone removed. *Significant difference postoperative vs. preoperative. §Significant postoperative vs. preoperative and controls.

TABLE 3. *Functional Results*

	ATZ Preserved	ATZ Removed
Stool Frequency (mean)		
Day	5.5	3.9*
Night	0.43	0
Pad/Soiling		
Day	0/14	2/8 (25 percent)
Night	1.14 (7 percent)	2/8 (25 percent)
Flatus without soiling	13/14 (93 percent)	5/8 (63 percent)
Discrimination	13/14 (93 percent)	5/8 (63 percent)

*$P < 0.05$ ATZ preserved *vs.* ATZ retained.

FIG. 3. Functional results. A trend to improved continence is seen in those with the anal transition zone preserved. *Significant ATZ preserved *vs.* ATZ removed.

while 5 of 8 patients (63 percent) could do so with the anal transition zone removed. The ability to distinguish between flatus, solid, and liquid stool was seen in 13 of 14 patients with the anal transition zone preserved and in 5 of 8 patients with the anal transition zone removed (Fig. 3). In neither group of patients has there been a recurrence of disease.

Discussion

The continence mechanism is a complicated, multifactorial process. Sensation in the anal canal has been implicated as one of the factors in maintaining continence.[6,8,9] While it has been demonstrated that the application of local anesthetics to the anal canal does not result in any measurable impairment of the continence mechanism,[12] in the borderline case where other factors have been interfered with (such as internal sphincter function with decreased resting pressure in the anal canal), sensory mechanisms may assume a more important role in maintaining continence.

In this study, anal sensation was maintained with preservation of the anal transition zone when measured physiologically. Although this did not translate into significantly improved functional results, there was a trend toward improved continence in the anal transition zone preserved group. Over 90 percent of patients had perfect continence, while only 75 percent of cases with the anal transition zone removed had such a result. An increased stool frequency was seen in the anal transition zone preserved patients, but the period of follow-up in this group is less than 1 year in most patients. Stool frequency has been shown to decrease over the first 12 to 18 months[1] after ileostomy closure and the expectation is that stool frequency will decrease with longer follow-up.

Keighley *et al.*[13] have studied a smaller group of patients in whom the anal transition zone was preserved, and again noted improved postoperative sensory function in the anal canal. No functional improvement was noted in comparison to those patients without an anal transition zone, but the groups were very small.
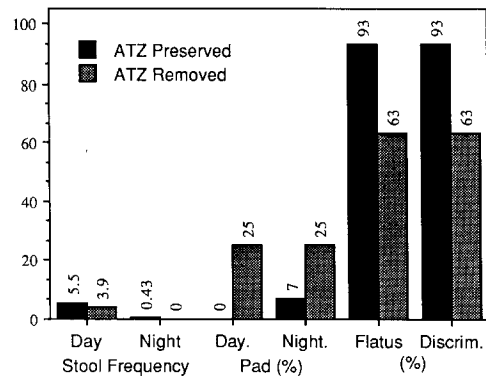
Johnston *et al.*[14] have reported on a similar operative approach that preserves the transition zone, but have completed the rectal excision without an endoanal mucosectomy using a double-stapling EEA technique. This surgical approach maintained maximum resting pressures postoperatively when compared with patients undergoing restorative proctocolectomy with endoanal mucosectomy without preservation of the anal transition zone. Eleven of 12 patients with preservation of the anal transition zone had perfect continence while 58 percent of patients had minor fecal leakage when treated with a more conventional anastomosis just above the dentate line.

The decrease in resting anal pressure after restorative proctocolectomy has been attributed to stretching of the internal sphincter during endoanal mucosectomy.[2,15] Johnston and colleagues believe this decrease is more likely to occur secondary to division of the intramural nerve plexus in the proximal anal canal, interfering with internal sphincter reflex function.[14] However, Keighley has shown that excision of the entire anal canal from above, eliminating any traction on the sphincter musculature, results in preservation of maximum resting pressures.[16] In this study, preservation of these neural pathways did not preserve internal sphincter function implicating stretching of the sphincter as the more likely etiologic factor. Internal sphincter dysfunction has been shown to continue up to 13 months postoperatively and may be permanent.[17] Whether preservation of the proximal anal canal will improve internal sphincter recovery will require longer follow-up.

Although, to date, all results are speculative regarding whether preservation of the anal transition zone is beneficial, we believe the results are encouraging enough to justify a continuation of this surgical technique. In the usual case, such an approach may be of minimal benefit, but in the borderline case where continence may

be a problem, preservation of the proximal anal canal may contribute to a more satisfactory outcome. Long-term follow-up from the Mayo Clinic has shown a slight increase in daytime and nighttime soiling at 5 years, mainly in female patients.[1] This may reflect the known propensity of idiopathic fecal incontinence to affect women more than men.[18] Since anal sensation has been shown to be impaired in idiopathic fecal incontinence, preservation of the anal transition zone may help maintain continence as patients age and develop similar degenerative changes in the continence mechanism, which may occur in the general population regardless of previous anorectal disease or surgery.

Criticism of this surgical approach lies in the possibility of residual rectal mucosa with recurrence of disease and the threat of malignant change in such mucosa. Deasy et al.[19] have examined the anal transition zone in 31 cases of ulcerative colitis and 20 control proctocolectomy specimens of rectal carcinoma. None of the controls showed any islands of columnar epithelium and only 5 percent of ulcerative colitis specimens demonstrated such islands. No histologic evidence of ulcerative colitis was seen in the anal transition zone in 61 percent of cases and the remainder showed only mild inflammatory change at the upper border. Residual columnar epithelium is a problem with all types of restorative proctocolectomy, regardless of the level of the anastomosis. O'Connell et al.[20] have demonstrated residual rectal mucosa in 6 of 29 patients (21 percent) after restorative proctocolectomy with anastomosis at the dentate line. The only method of ensuring complete removal of rectal mucosa is in total proctocolectomy with permanent ileostomy. In this respect, both approaches to restorative proctocolectomy are a compromise of function over complete ablation of the diseased mucosa. In this series, there has been no clinical recurrence of disease. The incidence of malignant transformation of colorectal mucosa in ulcerative colitis is directly related to the extent of disease and is not increased over the general population in cases confined to the rectum.[21] The risk of malignancy in a few small areas of rectal mucosa would therefore be extremely small. In addition, the anastomosis can be inspected easily and biopsied in future follow-up examinations.

In summary, preservation of the anal transition zone results in improved sensation on physiologic testing. While this has not translated into improved functional results at the present time, there is an indication of improved continence. With longer follow-up and a larger number of cases, these differences may become more significant. In cases where continence may be a problem, this technique may be of considerable value in maintaining an adequate continence mechanism.

References

1. Pemberton JH, Kelly KA, Beart RW, Dozois RR, Wolff BG, Ilstrup DM. Ileal pouch-anal anastomosis for chronic ulcerative colitis: long-term results. Ann Surg 1987;206:504–11.
2. Pescatori M, Mattana C, Castagneto M. Clinical and functional results after restorative proctocolectomy. Br J Surg 1988;75:321–4.
3. Nicholls RJ, Pescatori M, Motson RW, Pezim ME. Restorative proctocolectomy with three loop ileal reservoir for ulcerative colitis and familial adenomatous polyposis. Ann Surg 1984;199:383–8.
4. Wong WD, Rothenberger DA, Goldberg SM. Ileoanal pouch procedures. Curr Probl Surg 1985;22:1–78.
5. Martin LW, Fischer JE, Sayers HJ, Alexander F, Torres MA. Anal continence following Soave procedure: analysis of results in 100 patients. Ann Surg 1986;203:525–30.
6. Duthie HL, Gairns FW. Sensory nerve-endings and sensation in the anal region of man. Br J Surg 1960;47:585–95.
7. Duthie HL, Gairns FW. The relation of sensation in the anal canal to the functional anal sphincter: a possible factor in anal continence. Gut 1963;4:179–82.
8. Roe AM, Bartolo DC, Mortensen NC. New method for assessment of anal sensation in various anorectal disorders. Br J Surg 1986;73:310–12.
9. Miller R, Bartolo DC, Cervero F, Mortensen NJ. Anorectal temperature sensation: a comparison of normal and incontinent patients. Br J Surg 1987;74:511–15.
10. Bartolo DC, Roe AM, Virjee J, Mortensen NJ, Locke-Edmunds JC. An analysis of rectal morphology in obstructed defecation. Int J Color Dis 1988;3:17–22.
11. Roe AM, Bartolo DC, Mortensen NJ. Diagnosis and surgical management of intractable constipation. Br J Surg 1986;73:854–61.
12. Read MG, Read NW. Role of anorectal sensation in preserving continence. Gut 1982;23:345–7.
13. Keighley MR, Winslet MC, Yoshioka K, Lightwood R. Discrimination is not impaired by excision of the anal transition zone after restorative proctocolectomy. Br J Surg 1987;74:1118–21.
14. Johnston D, Holdsworth PJ, Nasmyth DG, et al. Preservation of the entire anal canal in conservative proctocolectomy for ulcerative colitis: a pilot study comparing end-to-end ileo-anal anastomosis without mucosal resection with mucosal proctectomy and endo-anal anastomosis. Br J Surg 1987;74:940–4.
15. Pescatori M, Parks AG. The sphincteric and sensory components of preserved continence after ileoanal reservoir. Surg Gynecol Obstet 1984;158:517–21.
16. Keighley MR. Abdominal mucosectomy reduces the incidence of soiling and sphincter damage after restorative proctocolectomy and J-pouch. Dis Colon Rectum 1987;30:386–90.
17. Neal DE, Williams NS, Johnston D. Rectal, bladder, and sexual function after mucosal proctectomy with and without a pelvic ileal reservoir for colitis and polyposis. Br J Surg 1982;69:599–604.
18. Mendelstam DA. Fecal incontinence: social and economic factors. In: Henry MM, Swash M. Coloproctology and the pelvic floor: pathophysiology and management. London: Butterworths, 1985:217–22.
19. Deasy JM, Quirke P, Dixon M, Lagopoulos M, Johnston D. The surgical importance of the anal transition zone in ulcerative colitis. Br J Surg 1987;74:533.
20. O'Connell PR, Pemberton JH, Weiland LH, et al. Does rectal mucosa regenerate after ileoanal anastomosis? Dis Colon Rectum 1987;30:1–5.
21. Devroede G. Risk of cancer in inflammatory bowel disease. In: Winawer SJ, Schottenfeld D, Sherlock P. Colorectal cancer: prevention, epidemiology, and screening. New York: Raven Press, 1980:325–34.