

The perfect pelvic pouch – what makes the difference?

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Abstract

The aim of this study was to determine what factors are important for the achievement of perfect anal continence after restorative proctocolectomy. One hundred patients underwent paired studies of anorectal physiology before and one year after restorative proctocolectomy with pelvic ileal reservoir (11 S, 25 J, 64 W) with stapled ileoanal anastomosis, without mucosectomy. Fifty seven patients attained perfect anal continence and were able to discriminate flatus from faeces with such confidence that they were able to release flatus safely without fear of faecal soiling. The remaining 43 patients experienced minor problems in this regard. Four factors were found to correlate significantly with a perfect functional result (median, perfect *v* imperfect): maximum resting anal pressure (72 *v* 57 cm H₂O, *p*<0.02), the sensory threshold in the upper and mid-anal canal (7.3 *v* 8.6 and 5.3 *v* 7.0 mA, *p*<0.05 and *p*<0.02), compliance of the ileal reservoir (12.4 *v* 7.6 ml/cm H₂O, *p*<0.01), and the presence of a pouch-anal inhibitory reflex (56 of 57 patients *v* 29 of 43 patients, *p*<0.01). The quality of anal continence depends on several factors: a compliant ileal reservoir, a strong sensitive anal sphincter, and normal reflex coordination of the activities of the reservoir and the sphincter. Excellent pouch-anal coordination is obtainable irrespective of the design of the reservoir, provided that these criteria are satisfied.

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Patients' quality of life after restorative proctocolectomy is clearly dependent on the functional outcome. A good functional result might reasonably be described as the ability of the patient to evacuate the ileal reservoir spontaneously without incontinence of faeces or leakage of mucus, the ability to defer defecation for long periods, if necessary, and a bowel frequency that is not excessive. The ultimate test of coordinated activity between ileal reservoir and anal sphincter, however, is whether or not the patient can discriminate between flatus and faeces, and release flatus safely without fear of faecal soiling with 100 per cent confidence – that is, without having to go to the bathroom. It is surely such

discriminatory ability that transforms a good functional result into one that is close to perfection.

There can be no ideal substitute for normal anorectum with its subtle motor, sensory, and reflex properties. Nevertheless many patients enjoy excellent function after restorative proctocolectomy, and it has been shown previously that good function after restorative proctocolectomy depends on the presence both of a capacious and compliant pelvic ileal reservoir^{1,2} and of an anal sphincter that is strong and sensitive.³⁻⁵ The aim of this study was to determine the optimum functional characteristics of the ileal reservoir, and what combination of motor, sensory, and reflex properties in the anal sphincter complement the reservoir.

Our hypothesis was that a perfect functional result would be provided by a capacious, compliant ileal reservoir acting in concert with an intact anal sphincter with normal motor and sensory properties that responded in a normal reflex manner to activity within the ileal reservoir.

Methods

Patients

A consecutive series of 100 patients (48 male, 52 female) was studied. Ninety eight patients had undergone restorative proctocolectomy for what was thought to be ulcerative colitis, though two were found subsequently to have had Crohn's disease when the resected specimen was examined pathologically. Two patients had familial adenomatous polyposis. The median age was 36 (range 10-66) years. Each patient underwent end to end ileal pouch-anal anastomosis, one to two centimetres above the dentate line, without stripping of the anal mucosa.^{3,5} In 56 patients, the anorectum was everted briefly at the time of operation to facilitate construction of the ileoanal anastomosis at the correct level.⁶ A duplicated (J) reservoir was constructed in 25 patients, a triplicated (S) reservoir in 11 patients, and a quadruplicated (W) reservoir in 64 patients, 30 to 40 cm of distal ileum being utilised for that purpose in each case. Thirty nine patients had a one stage operation, with no defunctioning ileostomy and 61 patients were given a temporary defunctioning ileostomy. The indications for the choice of a one stage or two stage procedure have been discussed elsewhere.⁷ The one stage procedure was reserved for patients who on average were younger, fitter, receiving a lower dose or no

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TABLE I Details of the 100 patients

Discrimination	Perfect	Imperfect
Patients (n)	57	43
Age	36 (28–43)	33 (27–42)†
Sex m:f	27:31	19:24
Diagnosis		
UC	53	39
Indeterminate	2	1
Crohn's disease	1	1
FAP	2	2
Reservoir design		
S	10	1
J	12	13
W	35	29
Eversion	23	33**
One stage RP	17	22*

†Median (interquartile range), * $p < 0.05$, ** $p < 0.01$.
UC=ulcerative colitis, indeterminate=indeterminate colitis, FAP=familial adenomatous polyposis, eversion=eversion of anorectum at operation to facilitate ileo-anal anastomosis, one stage RP=one stage restorative proctocolectomy without a defunctioning ileostomy.

corticosteroids, and whose operation had a lesser degree of urgency.

Laboratory studies

Each patient underwent tests of anal sphincteric function before operation and again 12 months after operation or ileostomy closure. Resting anal sphincter pressure was measured at 1 cm intervals along the anal canal by means of a 5 mm diameter water filled balloon. The pressure at each station was measured for at least one minute, or until the recording became stable. Pressure in the system was transmitted by a transducer and amplifier (3552 Ormed, Welwyn Garden City, England) to a chart recorder (5041 Ormed).³ Threshold electro-sensitivity of the mucosa of the anal canal was measured in the upper mid, and lower anal canal (determined by anal manometry) by means of a bipolar constant current stimulator probe lubricated with a solution of KY Jelly (Johnson and Johnson, Slough, UK) and normal saline in equal quantities.^{4,8}

In addition, measurements of the capacity and compliance of the pouch were made by means of a latex balloon 7.5 cm in length, which was attached to a 14 FG catheter, similar to that used for anal manometry. Pressures within the balloon were transmitted to a Gould Statham P-50 pressure transducer (Spectramed, UK) and

recorded on a Lectromed chart recorder (Multitrace 4; Lectromed, Jersey, UK). The balloon and catheter were inserted into the anal canal with the patient in the left lateral position. The catheter was advanced until the base of the balloon was at least 5 cm from the anal verge. The balloon was then inflated slowly with air at a constant rate of 1 ml per second, to determine the functional capacity (first sensation) and the maximum tolerated volume (unequivocal desire to defecate). The ratio of change in volume to change in pressure was estimated from the baseline curve on the Lectromed chart and was used as an index of compliance.

The recto-anal inhibitory reflex was assessed by measuring the response of the upper anal sphincter to distension with air of a balloon within the rectum or ileal reservoir at a rate of 1 ml per second. A 20 per cent decrease in pressure was taken to denote a positive reflex.⁹

Clinical assessment of outcome

The quality of anal continence was assessed by two clinicians who had not been part of the surgical team, and who were not aware of the anorectal physiology results at the time. They questioned the patients about faecal leakage, anal soreness, their ability to defer defecation, and whether they could not only discriminate between flatus and faeces but actually release flatus safely while standing or sitting without fear of even minor leakage of faeces or mucus. Two groups of patients were thus defined according to whether or not the patient could discriminate with perfect confidence between flatus and faeces (Table I).

Statistical analysis

All grouped data were expressed as median and interquartile range. Groups were compared by means of the Mann-Whitney U test for unpaired data.¹⁰

Results

Anal pressure

Figures 1 and 2 show the pressure profiles of the resting anal sphincter before and after operation. Before operation, the pressure profiles of the two groups of patients were similar. After restorative proctocolectomy, however, resting anal pressures were significantly lower in the patients with imperfect discrimination than in the patients with perfect discrimination. The length of the anal sphincteric high pressure zone was the same before (3.5 (2–4.5) cm) and after operation (3.5 (2–4.5) cm), in both groups of patients ($p = \text{NS}$).

Anal sensation

Figures 3 and 4 show sensory thresholds before and after operation. Before operation, the thresholds for sensation were significantly lower in patients who subsequently achieved a perfect result than in patients with an imperfect

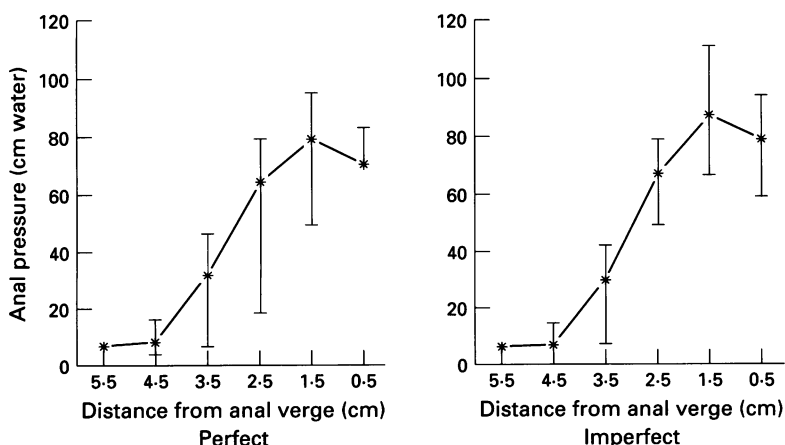


Figure 1: Resting anal sphincter pressure profiles before restorative proctocolectomy in 57 patients who achieved perfect results after operation and in 43 patients who did not. The pressure profiles of the sphincter did not differ significantly before operation.

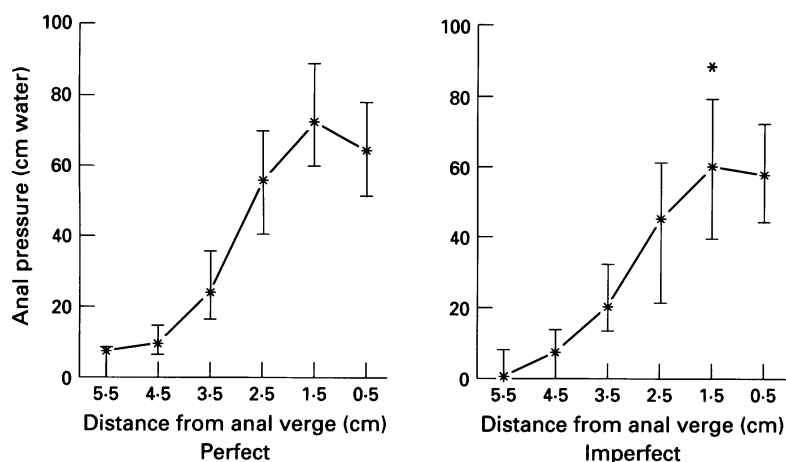


Figure 2: The resting anal pressure profile after restorative proctocolectomy. Patients with imperfect functional results had significantly lower resting anal pressure (* $p < 0.02$).

result, at each level of the anal canal. After operation, the thresholds for sensation were again significantly lower at each level of the anal canal in patients with a perfect result.

Inhibitory reflex (recto-anal and pouch-anal)

The recto-anal inhibitory reflex was present in all patients before operation. One year after restorative proctocolectomy, a pouch-anal inhibitory reflex was present in 56 of 57 patients with perfect discrimination, but in only 29 of 43 patients with imperfect discrimination ($p < 0.01$). The volume of air in the neo-rectum that was required to elicit the reflex was the same in the two groups of patients (150 (100–160) v 150 (110–220) ml of air) ($p = \text{NS}$). The pressure within the compliance balloon that was required to elicit the reflex was lower, however, in the patients with perfect discrimination than in those with imperfect discrimination (15 (12.4–19.5) v 20 (15.5–23.0) cm H₂O) ($p = 0.08$).

Capacity of the ileal reservoir

The median maximum tolerated volume of the pelvic reservoir was greater in patients

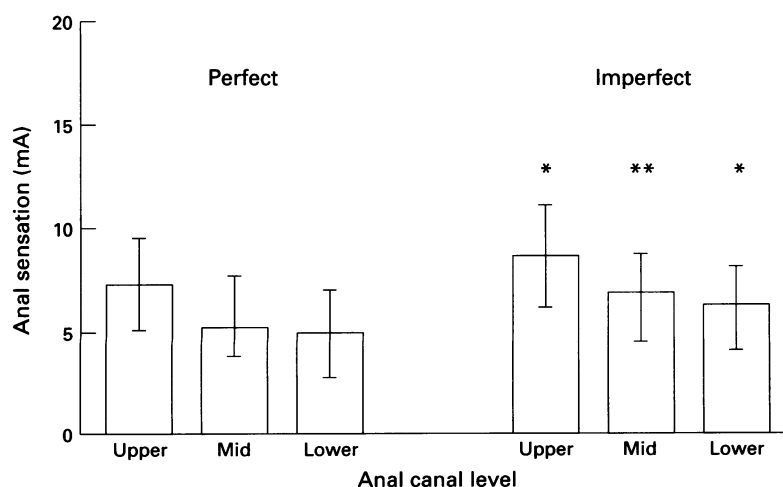


Figure 3: Sensation in the anal canal before restorative proctocolectomy in 57 patients who achieved perfect results after operation and in 43 patients who did not. The threshold for sensation was significantly higher in patients with an imperfect result compared with a perfect result (* $p < 0.05$, ** $p < 0.01$).

with perfect discrimination than in patients with imperfect discrimination (318 (230–390) v 288 (195–420) ml air) ($p = \text{NS}$).

Compliance of the ileal reservoir

Patients with perfect discrimination had reservoirs that were significantly more compliant than those of patients with imperfect discrimination (12.4 (7.7–15.6) v 7.6 (6.2–10.4) ml/cm H₂O) ($p < 0.01$).

Clinical results

Table II summarises the clinical results.

Discussion

The principal findings were that the quality of anal continence after restorative proctocolectomy depends on several factors working in combination. It was interesting that the patient's age and sex mattered little in terms of perfect function after operation. We found, however, that it was not enough to construct a pelvic ileal reservoir that was capacious, supple, and compliant. Without an anal sphincter that is fully functional in all three physiological dimensions, motor, sensory and reflex, a perfect functional result cannot be achieved.

The importance of the motor function of the anal sphincter, has been highlighted yet again by the results of this study.^{4,10} Patients with perfect discrimination had significantly higher resting anal pressure than patients with imperfect discrimination. Why some patients in this study had low resting anal pressure after restorative proctocolectomy is unclear. Certainly not one of them was found to have a weak anal sphincter before restorative proctocolectomy, and none underwent mucosectomy with endo-anal ileoanal anastomosis, a manoeuvre that is known to reduce resting anal pressure significantly after restorative proctocolectomy.^{3,5,11,12} It is of note that 33 of 43 patients (77 per cent) with a less than perfect functional result had undergone eversion of the anorectum in the course of restorative proctocolectomy to facilitate construction of the ileoanal anastomosis at the correct level, whereas significantly fewer of the patients (23 of 57, 40 per cent, $p < 0.01$) with a perfect result had undergone eversion. We showed previously that eversion of the anorectum was associated with significant reduction in resting anal pressure, one year after operation,⁶ whereas after stapled anastomosis without eversion no reduction in resting anal pressure was found in the long term.¹³

Sensation within the anal canal both before and after operation was also found to correlate significantly with the quality of anal continence. Indeed, the only preoperative factor we were able to identify that correlated significantly with perfect function after restorative proctocolectomy was the threshold for sensation of the anal mucosa. The diminished sensory thresholds of the patients with less than perfect discrimination may also be associated with eversion of the anorectum, which could in

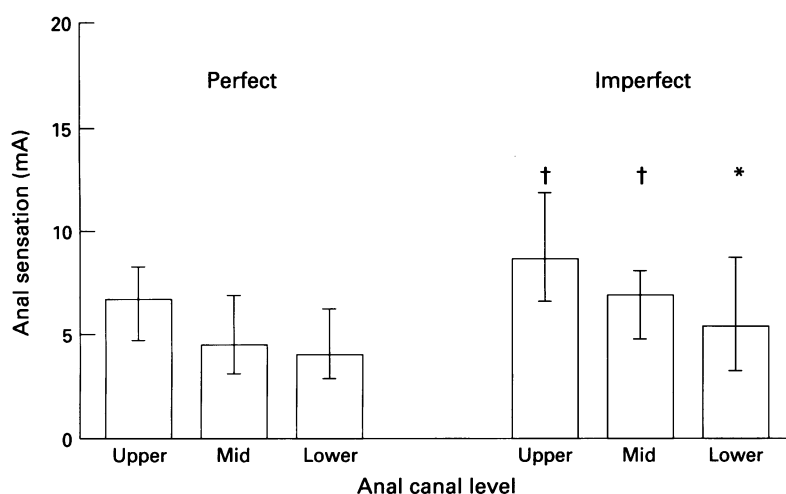


Figure 4: Sensation in the anal canal after restorative proctocolectomy. Patients with imperfect functional results had significantly higher sensory thresholds (* $p < 0.05$, † $p < 0.02$).

theory produce a traction neuropathy of the pudendal nerve.

The third component of the physiological function of the anal sphincter, namely reflex function, is probably the most important one when the patient's ability to discriminate flatus from faeces is being considered. The reflex coordination of rectal and anal function is intimately related both to motor and sensory function, because it is the patient's ability to modulate pressure automatically by means of the recto-anal or pouch-anal inhibitory reflex that is crucial for sampling of the contents of rectum or ileal reservoir by the sensitive mucosa of the upper anal canal.¹⁴ Although the presence of the inhibitory reflex correlated well with perfect discriminatory ability, the mere presence of the reflex did not guarantee perfect discrimination, nor did its absence imply that discrimination would necessarily be imperfect. Hence we believe that the inhibitory reflex merits further examination by means of ambulatory manometry to permit more precise delineation and quantification. We showed previously, for example, that after low anterior resection for rectal cancer, quantitative changes in reflex inhibition may correlate with the functional outcome.¹⁵

We used all the standard types of pelvic ileal reservoir; duplicated (J), triplicated (S), and quadruplicated (W), but found that the type of reservoir used had no significant influence on the patient's ability to discriminate. That is not surprising, because patients with perfect function did not have ileal reservoirs that were significantly more capacious than the reservoirs of patients who had imperfect discrimination. Nevertheless, the compliance of the reservoirs was significantly greater in

patients with perfect discrimination than in patients who did not have perfect discrimination. Moreover, patients who could discriminate with confidence between flatus and faeces were more likely to be able to defer defecation for long periods, and were less likely to experience leakage of mucus or faeces, than patients with imperfect discrimination.

In conclusion, the quality of anal continence after restorative proctocolectomy depends on several inter-related factors. The past decade has seen great advances in the preservation of continence in patients who undergo rectal excision for benign and malignant disease. All forms of sphincter saving enteroanal surgery achieve gross anal continence,^{16 17} but as we look to the future with a view to improving both operative technique and patients' functional outcome, we should now consider modalities such as the patient's ability to discriminate between solid, liquid, and gaseous rectal content, so that flatus may be released and faeces retained without the patient having to visit the bathroom. Judging by the results of this study the role of the upper anal sphincter would seem to be crucial for the attainment of this objective. Certainly an ileal pouch-anal anastomosis constructed 1 to 1.5 cm above the dentate line to preserve this area of the sphincter should not be denigrated as merely a pouch-distal rectal anastomosis.¹⁸ The 'holy grail' of a perfect substitute for normal anus and rectum is unattainable if viewed from the standpoints of anatomy and histopathology, but from the physiological point of view, if we aim to preserve the areas of physiological function highlighted in this study, by providing patients with a compliant neorectal reservoir and complement this by preserving a strong and sensitive anal sphincter with normal reflex properties, then at least patients can enjoy good quality anal continence and an excellent quality of life.

TABLE II Clinical functional results

Discrimination	Perfect	Imperfect
Patients (n)	57	43
Bowel frequency		
Per 24 h	4 (3-5)	5 (4-6)*
Nocturnal	0 (0-2)	1 (0-3)*
Defer defecation >30 min	57	37†
Leakage of mucus or faeces (pad)	1 (0)	7 (3)†

*Median (interquartile range), † $p < 0.01$.

- Neal DE, Williams NS, Johnston D. Rectal, bladder and sexual function after mucosal proctectomy with an without a pelvic reservoir for colitis and polyposis. *Br J Surg* 1982; **69**: 599-604.
- Nasmyth DG, Johnston D, Godwin PGR, Dixon MF, Smith A, Williams NS. Factors influencing bowel function after ileal pouch-anal anastomosis. *Br J Surg* 1986; **73**: 469-73.
- Johnston D, Holdsworth PJ, Nasmyth DG, Neal DE, Primrose JN, Womack N, 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 mucosa; resection with mucosal proctectomy and endo-anal anastomosis. *Br J Surg* 1987; **74**: 940-4.
- Holdsworth PJ, Johnston D. Anal sensation after restorative proctocolectomy for ulcerative colitis. *Br J Surg* 1988; **75**: 993-6.
- Martin LW, Torres AM, Fischer JE, Alexander F. The critical level for preservation of continence in the ileo-anal anastomosis. *J Pediatr Surg* 1985; **20**: 664-7.
- Lewis WG, Holdsworth PJ, Sagar PM, Holmfild JHM, Johnston D. Effect of anorectal eversion during restorative proctocolectomy on anal sphincter function. *Br J Surg* 1993; **80**: 121-3.
- Sagar PM, Lewis WG, Holdsworth PJ, Johnston D. One stage restorative proctocolectomy without temporary defunctioning ileostomy. *Dis Colon Rectum* 1992; **35**: 582-8.
- Roe AM, Bartolo DCC, Mortensen NJMcM. A new method for assessment of anal sensation in various anorectal disorders. *Br J Surg* 1986; **73**: 310-2.
- Keighley MRB, Henry MM, Bartolo DCC, Mortensen NJM. Anorectal physiology measurement: report of a working party. *Br J Surg* 1989; **75**: 356-7.
- Altman DG. *Practical statistics for medical research*. London: Chapman and Hall, 1991.
- Nicholls RJ, Belliveau P, Neill M, Wilks M, Tabaqchali S. Restorative proctocolectomy with ileal reservoir: a pathophysiological assessment. *Gut* 1981; **22**: 462-8.

- 12 Seouw-Choen, Tsunoda A, Nicholls RJ. Prospective randomised trial comparing anal function after handsewn ileo-anal anastomosis with mucosectomy versus stapled ileo-anal anastomosis in restorative proctocolectomy. *Br J Surg* 1991; **78**: 430-4.
- 13 Sagar PM, Holdsworth PJ, Johnston D. Correlation between laboratory findings and clinical outcome after restorative proctocolectomy: serial studies in 20 patients with end-to-end pouch-anal anastomosis. *Br J Surg* 1991; **78**: 67-70.
- 14 Bennett RC, Duthie HL. The functional importance of the internal anal sphincter. *Br J Surg* 1964; **51**: 355-7.
- 15 Lewis WG, Holdsworth PJ, Stephenson BM, Finan PJ, Johnston D. Role of the rectum in the physiological and clinical results of coloanal and colorectal anastomosis after anterior resection for rectal carcinoma. *Br J Surg* 1992; **79**: 1082-6.
- 16 Pezim ME, Pemberton JH, Dozois RR. Enteric continence and the ileal pouch-anal procedure. *Semin Surg Oncol* 1987; **3**: 92-8.
- 17 Beart RWJr, Dozois RR, Wolff BG, Pemberton JH. Mechanisms of continence. Lessons from the ileoanal procedure. *Am J Surg* 1985; **149**: 31-4.
- 18 Kelly KA. Anal sphincter-saving operations for chronic ulcerative colitis. *Am J Surg* 1992; **163**: 5-11.