What Affects Continence After Anterior Resection of the Rectum?

Giacomo Batignani, M.D., Iacopo Monaci, M.D., Ferdinando Ficari, M.D., Francesco Tonelli, M.D.

From the Department of Clinical Physiopathology, Surgical Unit, University of Florence, Florence, Italy

Batignani G, Monaci I, Ficari F, Tonelli F. What affects continence after anterior resection of the rectum? Dis Colon Rectum 1991;34:329–335.

Functional results after anterior rectal resections are commonly considered satisfactory but variable percentages of postoperative incontinence are often reported. Continence was evaluated after 20 low anterior resections (LAR) and 13 high anterior resections (HAR) by means of clinical assessment, anorectal manometry, and evacuation proctography. Whereas all HAR patients had perfect continence, 10 patients (50 percent of the LAR group had occasional episodes of soiling from liquid feces, 5 patients (25 percent had frequent soiling or occasional incontinence for solid feces, and 1 patient (5 percent had frequent solid stool loss requiring surgical treatment. Anal canal resting pressure at 3 and 4 cm from the anal verge was significantly lower in the LAR group ($P < 0.02$ and $P < 0.05$, respectively) than in the HAR group. However, the maximum voluntary contraction did not differ between the two groups. Rectoanal inhibitory reflex was found to be present in 17 of the 20 patients with LAR and in all patients with HAR. The volume at which the anal sphincter is continuously inhibited was significantly reduced in the LAR group ($P < 0.001$). Also, the conscious rectal sensibility volumes were found to be significantly reduced for threshold, constant, and maximum tolerated volume. Threshold volume for internal sphincter relaxation was lower than the threshold volume for rectal sensation in some patients with LAR. This could allow postoperative fecal soiling. Rectal compliance was decreased ($P < 0.001$) in the LAR group. Evacuation proctography, performed in six LAR patients affected by major soiling or solid stool loss, revealed an abnormal obtuse anorectal angle and pathologic lowering of the perineum at rest and during defecation. The concomitance of internal anal sphincter impairment, reduction in rectal compliance, and previous pelvic floor muscle damage are postulated as cause affecting continence in patients who underwent LAR. [Key words: Continence; Anorectal manometry; Rectal compliance; Rectal radiology]

Anterior rectal resection (ARR) is now the most commonly used surgical technique for treatment of both the upper and middle third localization of rectal carcinoma, partly due to the use of stapler devices which allow very low anastomosis. The goal of this operation is continence preservation through conservation of the anal canal with the sphincteric apparatus and some centimeters of the lower rectum. Other operations have the same objective, but they are often more complex, may have higher number of postoperative complications, and may present worse functional results.[1–3] Continence modifications after ARR have been studied since 1951, and it is well established that functional results are worse the closer the anastomosis is to the anal canal.[4,5] More variable percentages of incontinence after ARR have been reported: this depends on the method of evaluation and by the difficulty of determining what actually is the degree of continence present in these patients, because the evaluation of this new situation favorably, depends upon the surgeon's and patient's realization of having avoided a colostomy.[6] The purpose of this study is to assess the functional result of ARR not only through clinical control, but also through investigations such as anorectal manometry and evacuation proctography, in order to establish objectively changes or alterations in those structures which control continence.

METHODS

Thirty-three patients who underwent ARR and left colectomy for rectosigmoid carcinoma were clinically, endoscopically, and manometrically studied.

In 20 patients (13 females and 7 males), the anastomosis was lower than 10 cm from the external anal verge (EAV) (low anterior resections: LAR), whereas in 13 patients (10 females and 3 males) it was over 10 cm (high anterior resections: HAR). The anastomosis was located 6.1 ± 0.2 cm from the EAV in the LAR group, whereas it was 11.3 ± 0.6 in the HAR group.

In 18 patients the colorectal anastomosis was handsewn in a single layer, whereas in 15 patients (who all belonged to the LAR group), a circular stapler device EEA 31 was used. The average age

Read at the Congress on Colo-Rectal Disease Milan, Italy, June 29–30, 1989.

Address reprint requests to Professor Tonelli: Dipartimento di Fisiopatologia Clinica, Unitá di Chirurgia, Universitá di Firenze, Viale Morgagni, 85. 50134 Firenze, Italy.

of those patients who underwent LAR was 63 ± 2.3 years, no different from that of the HAR group (64.5 ± 2.3 years). Follow-up averaged 12.2 ± 1.9 months from surgery (range, 3–42 months).

Clinical Assessment

The following parameters were clinically evaluated: number of defecations/24 hours, number of defecations during the night. The presence of incontinence to solid or liquid feces classified, respectively, as frequent or occasional was noted.

Accordingly to McDonald and Heald,[5] we divided these patients in six classes, indicating as class 0 those patients who had no changes in bowel habits and continence; class I those who had an increase in number of defecations but that did not alter their normal lifestyle; class II were those who had an increase in defecations that changed their daily habits; class III were those who reported an occasional soiling from liquid feces; class IV were those who reported frequent soiling or occasional solid feces loss; and class V were those who frequently reported incontinence to solid feces.

Anorectal Manometry

Anorectal manometry was carried out by means of a polyethylene catheter (80 cm long and with external diameter of 2.7 mm) opened at the tip with four side holes of 0.7 mm diameter. This catheter was connected to a pressure transducer MK5-04 DTMVF (Sorenson Research Co., Salt Lake City, UT) perfused at a constant flow (3 ml/hour), with a saline solution using an "Intraflow" perfusion system (Abbott Labs, North Chicago, IL) that was connected to a polygraph recorder "Honeywell RM 300" (Honeywell Medical Division, The Netherlands). The pressure rise-rate of the system was 50 mm Hg/second. Anal canal resting pressure was measured at 4, 3, 2 and 1 cm from EAV, performing a station pull-through. With the catheter tip at 2 cm from EAV, we measured the maximum voluntary contraction expressed as the pressure increase (mm Hg) in respect to resting pressure.

We then positioned a 5 × 6 cm latex balloon immediately above the anorectal ring, in order to verify the presence of rectoanal inhibitory reflex and its volumetric threshold (ml of air). Then, by connecting this balloon to another pressure transducer of the same type and inflating it with progressively increasing volumes (20 ml of air every 30 seconds), the inner air pressure was measured and through the simultaneous anal canal pressure recording, the continuous relaxation of the internal sphincter (volume at which the internal sphincter becames constantly inhibited and is unable to recover) was measured. Also the volume and pressure at which the patient feels a transient sensation of rectal distention (threshold sensation), the volume and pressure at which the sensibility is no longer transitory but lasts more than 30 seconds (constant sensation), and the maximum tolerable volume and pressure (volume and pressure at which the patient feels the urge to defecate and is forced to do so) were recorded. Compliance was expressed as the reciprocal of the slope of the straight-line (1/b) resulting from pressure/volume points thus obtained (ml air inflated/mm Hg measured; dV/dP).

Anorectal Radiology

Evacuation proctography was performed in six patients who presented class IV and V continence by injecting transanally 60 ml of baritate solution through a Foley catheter. Patients were then invited to sit on a radiolucent commode and were examined by means of well-penetrated lateral radiographs at rest and during straining in order to evaluate: the anorectal angle, the angle existing between the posterior rectal wall and the anal canal expressed in degrees, and the perineum descent measured in cm and represented by the distance between anorectal angle and pubococcygeal line. We expressed as negative those values for the angle above the line. Data were compared with those obtained from six healthy voluntary controls (four females and two males mean age 52.3 ± 2.9, range 30–74).

Statistical Analysis

The results were expressed as means of the values ± standard error, significance calculated using Student's *t*-test for paired and unpaired samples, and the correlation coefficient determined using linear regression analysis (Pearson's test). We accepted $P < 0.05$ as significant.

RESULTS

Clinical Data

Defecations. Number of defecations/24 hours were 4.1 ± 0.7 for the LAR group and 1.4 ± 0.2 for

the HAR group ($P < 0.005$). Defecations during the night were 0.7 ± 0.4 and 0.0 ± 0.0 respectively for LAR and HAR (P = n.s.).

Continence. All the patients with HAR and 20 percent of those with LAR belong to classes 0, I, and II; 50 percent of the LAR group reported occasional soiling with liquid feces, and in 25 percent there was occasional incontinence to solid feces or a frequent soiling with liquid feces. Frequent solid stool loss was present in one patient of the LAR group (Table 1).

Manometric Studies

Pressure profile. Pressure values recorded at 4 and 3 cm from EAV were significantly decreased in patients who underwent a LAR in respect to those who underwent HAR (18.9 ± 2.5 *vs.* 30.5 ± 5.9; $P < 0.05$ and 29.2 ± 3.4 *vs.* 49.5 ± 8.6; $P < 0.02$). Even pressure values measured at 2 and 1 cm from EAV were decreased but not significantly (42.1 ± 4.2 *vs.* 57.0 ± 7.0 and 30.7 ± 4.3 *vs.* 41.4 ± 2.7, respectively). The maximum voluntary contraction did not differ significantly among the two groups (Table 2).

Rectoanal inhibitory reflex (RAIR). In 3 of 20 LAR patients it was not possible to evoke the RAIR even at a distance from surgery. The threshold volume for RAIR was, however, found to be less in patients who underwent LAR in respect to those who underwent HAR, but this decrease did not reach significance (27.9 ± 4.0 *vs.* 40.0 ± 7.9; P = n.s.). The volume at which the internal sphincter was continuously inhibited was significantly reduced in patients with LAR (30.8 ± 4.3 *vs.* 168.0 ± 22.4 ml of air; $P < 0.001$) (Fig. 1).

Rectal sensation and compliance. Conscious rectal sensation volumes and rectal compliance showed a significant reduction in respect to those measured in LAR patients: $P < 0.01$ for threshold volume; $P < 0.001$ for constant volume; $P < 0.01$ for maximum tolerance; and $P < 0.001$ for compliance, whereas intrarectal pressures measured at the given volumes were not significantly different (P = n.s.) (Table 3). A statistical correlation exists between compliance after ARR and number of defecations per day: this correlation is significantly inverse: $r = -0.43$ ($P < 0.02$) (Fig. 2).

Radiologic Data

At rest and during straining, the mean anorectal angle was more obtuse in patients than in controls. This difference was significant. Also the perianal lowering was significantly higher in patients than in controls at rest and during straining. Evacuation proctography showed the presence of a pathologic lowering of the perineal plate and relaxation of anorectal angle at rest and during defecation. (Table 4; Fig. 3, A and B). Moreover, a rectocele was found to be present in four of six patients.

DISCUSSION

Fecal continence is normally guaranteed by the interaction of several factors such as fecal consistency, colonic motility, rectal distensibility, anorectal angle, and internal and external sphincter activity. The lack of alteration of one of the previous factors rarely determines incontinence, which instead may develop when more than one factor is affected.

Continence must be considered as the capacity to voluntarily delay defecation in order that it may

Table 1.
Continence Degree

Class	HAR		LAR	
	n	%	n	%
0	10	77	1	5
I	2	15	1	5
II	1	8	2	10
III	0	0	10	50
IV	0	0	5	25
V	0	0	1	5

Table 2.
Pressure Profile and Maximum Voluntary Contraction

	4 cm*	3 cm*	2 cm*	1 cm*	MVC†
LAR (20 pts)	18.9 ± 2.5	29.2 ± 3.4	42.1 ± 4.2	30.7 ± 4.3	43.5 ± 5.4
HAR (13 pts)	30.5 ± 5.9	49.5 ± 8.6	57.0 ± 7.0	41.4 ± 2.7	58.7 ± 8.1
	$P < 0.05$	$P < 0.02$	P = n.s.	P = n.s.	P = n.s.

* From external anal verge.
† MVC = Maximum Voluntary Contraction.
All values are expressed as Mean ± SEM of mm Hg.

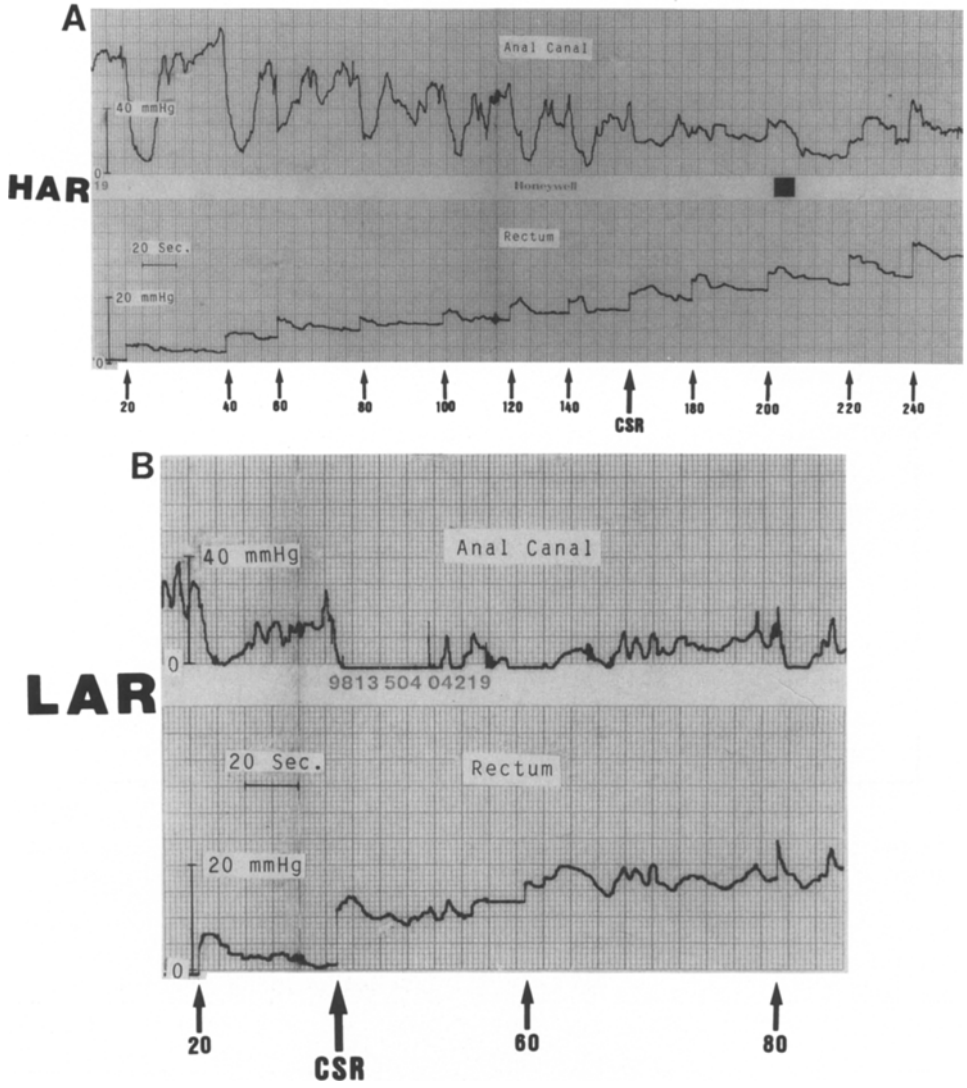

Figure 1. Pressures recorded in the anal canal (upper graph) and in the rectum (lower graph) of HAR and LAR patients during the administration of 20 ml of air each time (arrows) in a rectal balloon until maximum tolerated sensation. Continuous sphincter relaxation (CRS) happened earlier (40 ml) in LAR patients than in HAR patients (160 ml).

Table 3.
Rectal Sensation Volumes and Pressure and Rectal Compliance

	Threshold Volume (ml air)	Threshold Pressure (mm Hg)	Constant Volume (ml air)	Constant Pressure (mm Hg)	Maximum Tolerable Volume (ml air)	Maximum Tolerable Pressure (mm Hg)	Rectal Compliance (ml air/mm Hg)
LAR (20 pts)	34.5 ± 3.2	14.3 ± 1.4	60.0 ± 5.0	23.7 ± 2.0	133.5 ± 15.0	46.7 ± 2.3	3.4 ± 0.6
HAR (13 pts)	56.9 ± 8.2	15.7 ± 2.0	126.1 ± 14.3	25.6 ± 2.0	225.7 ± 21.0	43.4 ± 2.8	7.6 ± 0.5
	$P < 0.01$	P = n.s.	$P < 0.001$	P = n.s.	$P < 0.001$	P = n.s.	$P < 0.001$

Values are expressed as mean ± SEM.

take place at a chosen time and place, discriminate between fecal contents for the safety release of air, and maintain nightly control. The increase in defecations per day is not commonly considered as affecting continence. This change in bowel habits, however, is the most frequently observed phenomenon after high and low ARR.

The left colon (systematically removed in our

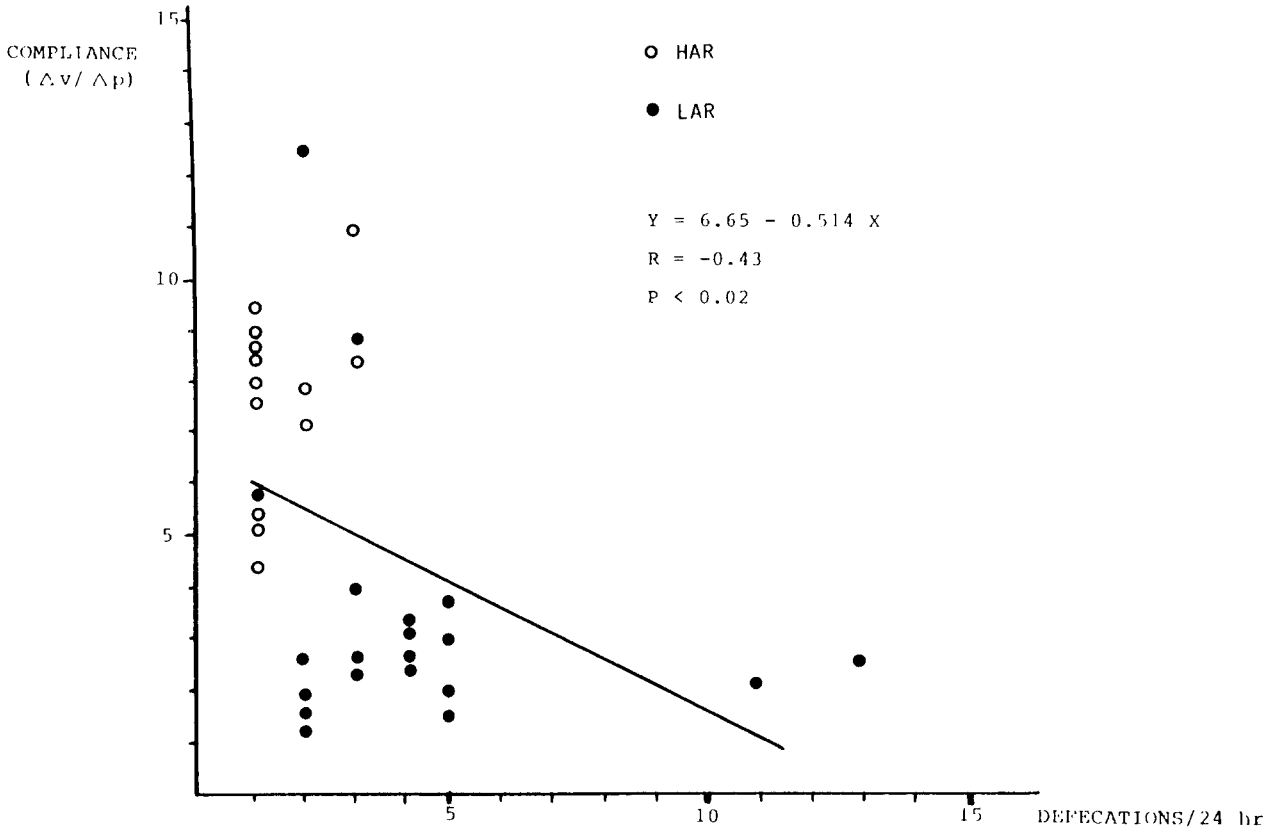

Figure 2. Inverse correlation between rectal compliance and number of defecations per day in both HAR and LAR patients. LAR patients show lower compliance and higher number of defecations than HAR patients.

Table 4.
Anorectal Angle and Perineal Lowering at Rest and During Straining

	ARA at Rest* (degree)	ARA at Straining* (degree)	PL at Rest† (cm)	PL at Straining† (cm)
LAR (6 pts)	118.5 ± 3.8	138.3 ± 3.5	2.8 ± 0.4	4.6 ± 0.8
Controls (n = 6)	98.5 ± 2.6	112.2 ± 6.3	−0.3 ± 0.6	1.5 ± 0.4
	$P < 0.02$	$P < 0.02$	$P < 0.04$	$P < 0.01$

All values are expressed as mean ± SEM.
* ARA = anorectal angle.
† PL = perineal lowering.

patients) plays a role in fecal continence due to colonic segmental activity (major motor activity in this colonic segment). The lack of the left colon and the denervation of the transverse colon pulled-down allow an increase in number of defecations through a reduction of motor activity and therefore faster colonic transit time.[7] In fact, even in patients who underwent HAR, defecations were, on average, higher than one per day.

In our study we observed a significant difference between defecations per day in the LAR group and the HAR group. This difference remains significant even if we exclude those patients with a follow-up of less than 1 year and is due to the different compliance of the colorectal anastomotic "complex," considering the lower distensibility of the colon in respect to the rectum.[1,8] We have found a decrease in the reservoir capacity demonstrated by the decrease of conscious rectal sensitivity volumes and compliance in patients who underwent LAR. This reduction in rectal reservoir capacity can explain, at least in part, the inverse correlation existing between compliance and number of defecations in patients with high and low anterior resections.

Continence alterations observed by us only after

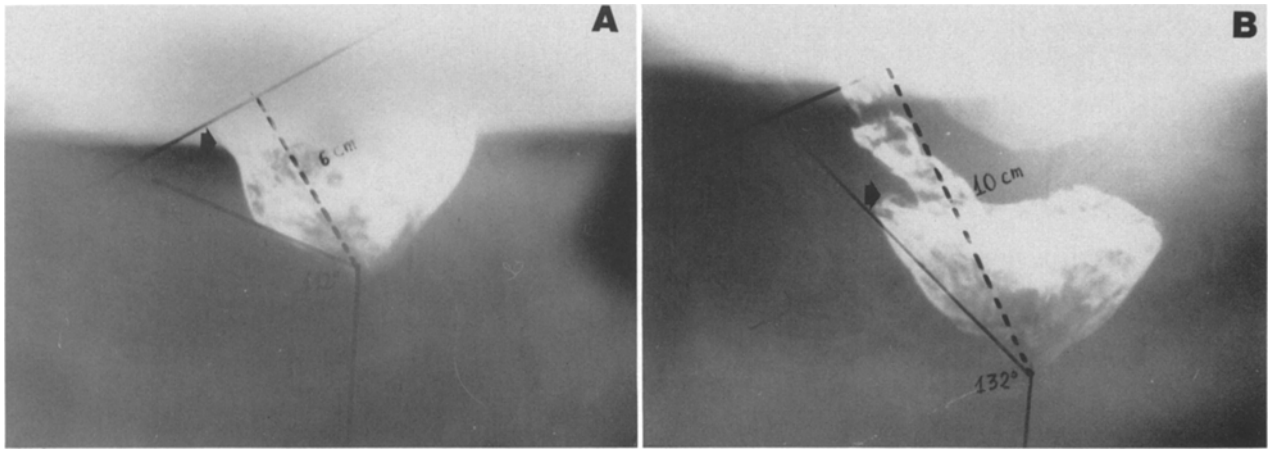

Figure 3. Evacuation proctography at rest (A) and during attempt to defecate (B) in a 62-year-old woman in the LAR group. Note the perineal descent with an obtuse anorectal angle at rest and during straining and the presence of rectocele. The arrow shows the anastomosis.

LAR are represented by the occasional or frequent presence of fecal soiling with loss of liquid feces and by occasional or frequent incontinence to solid feces. The incidence of continence alteration after ARR reported depends on anastomosis level and generally becomes worse the lower the anastomosis is: McDonald and Heald[5] reported that there is a rate 6 percent in incontinence to solid feces and 25 percent to liquid feces in cases of anastomoses placed between 10 and 5 cm; meanwhile, they reported 57 percent incontinence for liquid feces when the anastomosis is placed lower than 5 cm from EAV.

In our cases we observed no continence alterations in patients with anastomosis above 10 cm; an occasional soiling of liquid feces was present in patients with anastomosis placed lower than 10 cm; 25 percent of our patients reported occasional solid feces loss, and in one patient (5 percent) this type of incontinence was so frequent as to require a second operation of the pelvic floor muscles plasty (post-anal repair).

The presence of fecal soiling after LAR could be correlated mainly to an alteration of the anal sphincter apparatus; in fact, we observed a significant decrease in anal canal resting pressure. This is due to decreased activity of the internal sphincter, inasmuch as we did not observe a significant reduction in maximum voluntary contraction. This type of reduction has already been reported by other authors.[3,9,10] This alteration could be due to autonomic nerve damage (sympathetic or parasympathetic) that controls smooth sphincter innervation occurring at surgery due to a cut inferior mesenteric artery, full rectal mobilization, or to rectal transection. On the contrary, one recent study shows that, rather than autonomic nerve damage, the direct injury to the internal sphincter, such as stretching, is postulated as the cause of anal hypotonia in patients who have had a stapled LAR.[10]

Data that support an alteration in internal sphincter activity are the permanent absence of RAIR in some patients,[9-11] and the reduction in basic rhythmic pressure waves.[12,13] These alterations could be transitory; in fact authors report, after some months, an increase in anal resting pressure and reappearance of RAIR postoperatively.[3] This may represent the main aspect along with increased compliance[9,11] allowing continence improvement with time. Some patients, however, do not improve with time and show incontinence at distance from surgery. In patients with hypotonic anal sphincter, inhibitory reflex of internal sphincter can develop earlier, sometimes much ahead of the conscious rectal sensivity level, due to an increase in endorectal pressure even in presence of a little volume of feces, because neorectum compliance is very low. This sphincter relaxation can be marked or total and continues for several seconds allowing the loss of feces, especially if these are liquid. If the voluntary contraction is decreased or the external sphincter reflex is absent, the continence is more severely affected.

In patients with frequent major soiling, solid feces incontinence was reported exclusively in female patients and, in all cases, evacuation proctography showed a pathologic lowering of the perineum with an abnormal obtuse anorectal angle

which can explain, at least in part,[14] incontinence. Also in the cases reported by McDonald and Heald,[5] Nakahara *et al.*,[9] Horgan *et al.*,[10] and Kirwan *et al.*,[15] failures of this type are described in female patients.

Our study confirms and underlines the precision of data already reported after ARR, such as increased defecations per day, decreased anal resting pressure, decreased volume necessary to determine continuous relaxation of internal sphincter, and decrease in conscious rectal sensitivity volumes and compliance. Moreover, in patients without satisfactory functional results, we have found pelvic floor muscle defect, like that encountered mainly in female patients.

Surgery in fact always affects one or more factors that contribute to maintain continence. Incontinence may thus develop and become clinically evident when other factors are altered preoperatively. In these patients a modification in technique such as the construction of a colonic pouch or plication of the levator ani muscles may be indicated to improve functional results.

ACKNOWLEDGMENTS

The authors wish to thank Mr. Francesco Venneri and Miss Mary Forrest for their assistance in the preparation of this manuscript.

REFERENCES

1. Keighley MR, Matheson D. Functional results of rectal excision and endo-anal anastomosis. Br J Surg 1980;67:757–61.
2. Rosen L, Khubchandani IT, Sheets JA, Stasik JJ, Riether RD. Clinical and manometric evaluation of continence after the Bacon two-stage pull-through procedure. Dis Colon Rectum 1985;28:232–4.
3. Iwai N, Hashimoto K, Yamane T, *et al.* Physiologic status of the anorectum following sphincter-saving resection for carcinoma of the rectum. Dis Colon Rectum 1982;25:652–9.
4. Goligher JC. The functional results after sphincter saving resection of the rectum. Hunterian Lecture, R. Coll. Surg. Engl. 13 March 1951.
5. McDonald PJ, Heald RJ. A survey of postoperative function after rectal anastomosis with circular stapling devices. Br J Surg 1983;70:727–9.
6. Duthie HL. The rectum and the anal canal. Clin Gastroenterol 1979;8:443–54.
7. Catchpole BM. Motor pattern of the left colon before and after surgery for rectal cancer: possible implications in other disorders. Gut 1988;29:624–30.
8. Williams NS, Price R, Johnston D. The long-term effect of sphincter preserving operations for rectal carcinoma on function of the anal sphincter in man. Br J Surg 1980;67:203–8.
9. Nakahara S, Itoh H, Mibu R, *et al.* Clinical and manometric evaluation of anorectal function following low anterior resection with low anastomotic line using an EEA™ stapler for rectal cancer. Dis Colon Rectum 1988;31:762–6.
10. Horgan PG, O'Connell PR, Shinkwin CA, Kirwan WO. Effect of anterior resection on anal sphincter function. Br J Surg 1989;76:783–6.
11. Pedersen D, Hint K, Olsen J, Christiansen J, Jensen P, Mortensen P. Anorectal function after low anterior resection for carcinoma. Ann Surg 1986;204:133–5.
12. Tonelli F, Indinnimeo M, Felli F. La funzione anorettale dopo interventi di resezione del retto: valutazione clinica e manometrica. Il Policlinico 1979;86:1–19.
13. Suzuki H, Matsumoto K, Amano S, Fujioka M, Honzumi M. Anorectal pressure and compliance after low anterior resection. Br J Surg 1980;67:655–7.
14. Bartolo DC, Read NW, Tarrah JA, Read MG, Donnelly TC, Johnson AG. Differences in anal sphincter function and clinical presentation in patients with pelvic floor descent. Gastroenterology 1983;85:68–75.
15. Kirwan WO, O'Riordain MG, Waldron R. Declining indications for abdominoperineal resection. Br J Surg 1989;76:1061–3.