Int J Colorect Dis (1997) 12: 82–87

International Journal of Colorectal Disease

Continence after colorectal reconstruction following resection: impact of level of anastomosis

K. E. Matzel[1], **U. Stadelmaier**[1], **S. Muehldorfer**[2], **W. Hohenberger**[1]

[1] Department of Surgery, University Hospital Erlangen-Nürnberg, Germany
[2] Department of Internal Medicine, University Hospital Erlangen-Nürnberg, Germany

Accepted: 10 February 1997

Abstract. In 48 patients who had undergone anterior resection for rectal cancer with straight colorectal reconstruction, clinical and manometric results were correlated with the level of anastomosis. Patients were divided into four groups by anastomotic level: ≤3, 4–6, 7–9, and ≥10 cm. Functional outcome with regard to frequency of bowel movements, minor leakage, fecal incontinence, ability to defer stool and to differentiate consistency showed increasing impairment the lower the anastomotic level. Frequency, leakage owing to the inability to defer stool, incontinence for solid stool, inability to discriminate flatus from stool, and incomplete emptying were significantly different (P<0.05) between the patients with an anastomotic level between 3–6 cm and between 7–9 cm. Manometric data revealed no trend or significant differences among the groups with regard to anal resting pressure and maximal and median squeeze pressure. Rectoanal inhibitory reflex was abolished in 60% of the patients. Clear changes, with a trend toward reduced function with lower anastomotic levels, were seen in the volume that produced a feeling of urgency, maximal tolerable volume, and neorectal compliance (between anastomotic levels 7–9 and ≥10 cm the differences were significant; P<0.05). Analysis by length of residual rectum (<1.5, 1.5–4.0, 4.1–6.5, >6.5 cm) demonstrated similar findings, suggesting that impaired function after rectal resection is due to reduced function of the neorectum. Thus, as much residual rectum as possible should be preserve without risking cure. If the level of the anastomosis is expected to be below 6 cm, or if the residual rectum is less than 4 cm, the construction of a colon pouch to increase neorectal capacity should be considered.

Résumé. Chez 48 patients qui ont subi une résection antérieure pour cancer du rectum avec rétablissement de la continuité colo-rectale, les résultats cliniques et manométriques ont été corrélés avec le niveau de l'anastomose. Le collectif de patients a été divisé en quatre groupes en fonction du niveau de l'anastomose: ≤3, 4–6, 7–9 et ≤10 cm. Plus le niveau de l'anastomose est bas situé, plus le résultat fonctionnel est altéré en ce qui concerne la fréquence des exonérations, les fuites mineures, l'incontinence fécale, l'aptitude à différer l'exonération et à différencier la consistance des matières. La fréquence, les fuites en raison de l'impossibilité de différer l'exonération, l'incontinence aux selles solides, l'inaptitude à discriminer les gaz des selles et l'exonération in compléte étaient significativement différentes (P<0,05) entre le collectif de patients avec une anastomose entre 3 et 6 cm et ceux porteurs d'une anastomose entre 7–9 cm. Les données manométriques ne montrent aucune tendance ou différence significative entre les différents groupes en ce qui conceme la pression anale de repos et la pression de contraction maximale et médiane. Le réflexe recto-anal inhibiteur était aboli chez 60% des patients, des changement évidents avec une tendance à une diminution de la fonction plus l'anastomose est basse, se traduisent par une diminution du volume nécessaire pour produire un besoin d'exonération d'urgence, un volume tolérable maximum et une compliance du néo-rectum (la différence est statistiquement significative avec P<0,05 lorsque l'on compare des anastomoses situées entre 7–9 cm et celles situées ≥10 cm. Des analyses corrélées à la longueur du rectum résiduel (<1,5, 1,5–4,0, 4,1–6,5 >6,5 cm) montrent des constatations identiques suggérant une altération de la fonction après résection rectale et dues à une diminution de la fonction du néo-rectum. Ainsi, il est nécessaire de conserver le plus de rectum possible sans pour autant compromettre la guérison. Si le niveau de l'anastomose doit se situer à moins de 6 cm ou si le rectum résiduel est de moins de 4 cm, la construction d'une poche colique dans le but d'augmenter la capacité du néo-rectum doit être envisagée.

Correspondence to: K. E. Matzel, Chirurgische Universitätsklinik, Erlangen, Maximiliansplatz, D-91054 Erlangen, Germany

The vast majority of patients with rectal carcinoma can now be treated with sphincter-saving procedures [1, 2].

Intestinal continuity can be reestablished by coloanal or colorectal anastomosis at various levels. This has been made possible by a variety of technical and oncologic advances: stapling devices allow safe low anastomoses [3, 4]; rates of operative mortality, local recurrence, and tumor-free survival are comparable after anterior resection and abdomino-perineal excision [5, 6], and a distal radical clearance of 2 cm and complete mesorectal excision are sufficient [7, 8].

The quality of life of patients with sphincter-saving procedures is better than after abdomino-perineal excision [9, 10]. However, anal sphincteric function is challenged by such operative procedures: up to 50% of patients experience impaired anorectal function after low anterior resection, in particular fecal leakage and urgency of defecation [11–13]. A variety of physiological causes has been suggested. Functional outcome has frequently been related to the level of anastomosis or length of the residual rectum, but published results are mixed [11, 13–17]. The aim of the present study was to investigate functional outcome and anorectal physiologic function after low anterior rectal resection with straight colorectal reconstruction at different levels of anastomosis.

Patients and methods

A total of 48 patients (mean age 64.3 years; 26 men, 22 women) were studied. All had undergone low anterior resection for rectal cancer in 1993 and 1994. None had experienced anorectal dysfunction before manifestation of the tumor. Resection was potentially curative in all; no anastomotic leakage occurred; none had pre- or postoperative radio-chemotherapy or radiation therapy. In 46 patients intestinal continuity was restored by straight colorectal anastomosis performed with a transanally inserted stapling device (EEA™, outer diameter 28 or 31 mm), in the remaining two patients by handsewn coloanal anastomosis.

Clinical assessment

The clinical and manometric assessment was performed at a mean of 18 months (8–28 months) after rectal resection. In 8 patients a diverting ileostomy was placed and removed after 3 months. At the time of laboratory investigation, the level of anastomosis above the anal verge was determined by rigid sigmoidoscopy; in 46 cases the anastomosis was located above the anal canal, in the two patients with handsewn coloanal anastomosis the anastomotic level was above the dentate line.

Patients were divided by level of anastomosis into four groups: A 1, anastomosis equal or below 3 cm; A 2, anastomosis between 4 and 6 cm; A 3, anastomosis between 7 and 9 cm; A 4, anastomosis equal or above 10 cm. The groups were similar in age, gender, median follow-up time, and tumor stage (Table 1). Functional outcome was assessed clinically with a standardized questionnaire that the patients completed on their own. It was then reviewed with the patient by two doctors who had not been part of the surgical team. Each patient was questioned about daily bowel frequency, minor leakage and incontinence for flatus, liquid and solid stool, type of incontinence, ability to discriminate stool and to defer defecation, use of sanitary pads, anal soreness, and rectal emptying.

Leakage was defined as involuntary loss of gas or involuntary loss of stool less frequently than once a week, fecal incontinence as involuntary loss of liquid or solid stool at least once a week.

Anorectal manometry

Anorectal manometry was recorded with a water-perfused, 8-channel balloon catheter system (Synectics Medical, Frankfurt/Main, Germany) with a stationary pull-through technique for anal pressure recording. The following parameters were evaluated: length of high-pressure zone, maximal resting pressure (highest pressure recorded with the patient relaxed), maximal squeeze pressure (highest pressure recorded during voluntary contraction of the anal sphincter), and mean squeeze pressure (maximal squeeze pressure over 30 seconds). Squeeze pressure values represent increments over maximal resting pressure.

The length of the residual rectum was calculated by subtracting the length of the high-pressure zone from the level of the anastomosis.

The perception of rectal filling and capacity of the neorectum was measured by placement of a balloon with its lower edge 5 cm from the anal verge and subsequent stepwise inflation with air in 10-cc increments. The thresholds of the patient's first perception of rectal filling (when the patient first detected any sensation or difference), urge to defecate (when the patient felt a definite urge to defecate), and maximal tolerable volume (when the patient could not tolerate further rectal distension) were assessed. Rectal compliance was determined, as proposed by Sørensen et al. [18], at the maximum tolerable volume.

The rectoanal inhibitory reflex was elicited by inflation of the balloon in increments of 10 cc and identified by a decrease in the resting anal pressure. Rectal distension was terminated when the maximal tolerable volume was reached.

Statistical methods

Postoperative qualitative results obtained by the questionnaire and manometric data for the different patient groups were compared with the Mann-Whitney U-test with Yates correction and the chi-square test. Significance was assumed when $P<0.05$.

Table 1. Patient details

Level of anastomosis	A 1 ≤3 cm	A 2 4–6 cm	A 3 7–9 cm	A 4 ≥10 cm
No. of patients	3	12	20	13
Median age [years (range)]	67 (61–73)	63.5 (52–75)	62.5 (41–84)	64 (49–79)
Sex ration [M : F]	2 : 1	7 : 5	10 : 10	7 : 6
Median follow-up [months]	16	18	19	21
Residual rectum [mean, cm (range)]	0.5 (0–1.0)	2.3 (1–3.5)	5.1 (3–6.5)	8.9 (6.5–11.5)
Tumour stage:				
pT 1/pT 2/pT 3/pT 4 [n]	0/1/2/0	1/3/8/0	6/5/8/1	3/2/7/2
UICC I/II/III/IV [n]	1/2/0/0	3/9/3/1	10/4/4/2	4/4/5/0

Results

Questionnaire

Median stool frequency was elevated in all groups (Table 2), but was significantly less in A 3 than in A 2 (2.8 vs. 5.2; $P<0.05$). In 54% of the patients, continence was impaired. Minor leakage was caused mainly by urge (A 2 and A 3: 58.3% and 20.0%; respectively; $P<0.05$). Fecal incontinence occurred in 33%: rates ranged from 100% to 23% in the four groups. The reduced ability to defer the call for stool, frequently resulting in urge incontinence, was predominant.

Further analyses of the extent of the involuntary loss of stool revealed a trend towards aggravation of the symptoms in the groups with lower-level anastomoses: complete incontinence for liquid and solid stool occurred in the A 1 group in 100%, whereas it was 41.7% in A 2, 20% in A 3, and 23.1% in A 4 (Table 2). Incontinence for solid stool only was less frequent in all groups, also demonstrating a trend towards deteriorating function with lower anastomotic levels.

Stool discrimination was reduced in all groups: 31% of all patients were unable to discriminate flatus from stool. Deterioration was greater with lower anastomoses (58% and 20% in A 2 and A 3, respectively; $P<0.05$). The regular use of sanitary pads was increased in patients with lower-level anastomoses, and anal soreness occurred more frequently (50% and 10% in A 2 and A 3, respectively; $P<0.05$). Emptying of the neorectum was more frequently impaired in patients with anastomoses below 6 cm (75.0% and 15.0% in A 2 and A 3, respectively; $P<0.05$).

Anorectal manometry

Sphincteric function. Anorectal manometry revealed no significant differences among the four groups with regard to maximal resting pressure, maximal squeeze pressure, and median squeeze pressure (Table 3). Comparison with

Table 2. Results of questionnaire: clinical outcome

Level of anastomosis [cm]	A 1 ≤3	A 2 3–6	A 3 7–9	A 4 ≥10
Median stool frequency/d (range)	5.17 (3.5–8.5)	5.17 (2–14)	2.78 * (1–6.5)	2.08 (1–3.5)
Leakage overall [%]	100	75.0	45.0	38.5
Urge leakage [%]	100	58.3	20.0 *	30.8
IC overall [%]	100	41.7	25.0	23.1
IC liquid [%]	100	41.7	20.0	23.1
IC solid [%]	33.3	0.0	5.0 *	15.4
Urge IC [%]	100	41.8	5.0 *	7.7
Reduced ability to defer stool [%]	100	50.0	30.0	15.2
Inability to discriminate stool [%]	66.7	58.33	20.0 *	16.4
Regular use of pads [%]	100	50.0	30.0	0.0
Anal soreness [%]	100	50.0	10.0 *	7.7
Incomplete emptying [%]	66.7	75.0	15.0 *	15.4

IC, incontinence
* $P<0.05$ Mann-Whitney U-Test

Table 3. Manometric data

Level of anastomosis [cm]	A 1 ≤3	A 2 3–6	A 3 7–9	A 4 ≥10	Norm
Sphincteric function:					
Length of high Pressure zone [cm]	2.17 (0.29)	2.83 (0.44)	2.98 (0.55)	3.38 (0.68)	2–4
Resting P [mmHg]	32.33 (11.59)	32.33 (11.76)	37.75 (11.37)	41.92 (11.16)	>40
Max. squeeze P [mmHg]	131.00 (51.16)	140.58 (60.53)	134.0 (60.03)	128.38 (50.67)	>80
Med. squeeze P [mmHg]	89.00 (38.30)	77.25 (41.46)	75.55 (44.45)	63.69 (25.70)	>60
RAIR positive [%]	0	25	75 ***	85	100
Neorectal function:					
First sensation [ml]	33.33 (25.17)	24.17 (13.11)	32.50 (7.16)	33.85 (6.5)	<30
Feeling of urgency [ml]	40.00 (45.83)	48.33 (25.88)	51.50 (16.31)	63.08 (10.32) **	50–70
Max. tolerable vol. [ml]	50.00 (0)	50.83 (52.65)	77.00 (54.40)	171.46 (67.4) *	>200
Compliance [ml/mmHg]	2.65 (0.78)	3.08 (1.46)	3.65 (1.96)	6.53 (3.06) *	6–8

Standard deviation in parentheses
* $P<0.002$; ** $P<0.01$; *** $P<0.05$ Mann-Whitney U Test

Table 4. Length of residual rectum – clinical and manometric results

	S 1	S 2	S 3	S 4
Length of residual rectum	<1.5 cm	1.5–4.0 cm	4.1–6.5 cm	>6.5 cm
Number of patients:	6	14	17	11
Clinical outcome:				
Median stool frequency/d (range)	5.58 (3.5–8.5)	4.5 (1–14)	2.26** (1–4.5)	2.05 (1–3.5)
IC overall [%]	100	28.6**	23.6	18.2
IC for liquid [%]	100	28.6**	17.6	18.2
IC for solid [%]	16.7	0	11.7	9.1
IC urge [%]	83.3	28.6**	0	9.1
Manometrical results: neorectal function:				
Perception [ml] [a]	33.33 (20.65)	27.14 (12.04)	32.35 (7.52)	34.54 (6.87)
Call for stool [ml] [a]	46.67 (32.66)	50.00 (23.20)	50.59 (17.84)	64.54 (8.20)*
Max. tolerable vol. [ml] [a]	53.33 (28.53)	60.71 (51.66)	93.53 (68.37)	166.27 (72.52)*
Compliance [ml/mmHg] [a]	2.28 (1.09)	3.35 (1.63)	4.10 (2.07)	6.58 (331)*
RAIR positive [%]	0	43%**	71%	91%

IC, incontinence
[a] Standard deviation in parentheses
* $P<0.025$; ** $P<0.05$ Mann-Whitney U Test

normal control data showed reduced resting pressures in patients with anastomotic levels below 9 cm. A trend towards reduced length of the anal canal high-pressure zone was noticed, but the differences between groups were not significant.

(Neo)rectoanal inhibitory reflex (RAIR). The rectoanal relaxation reflex could be elicited in 60% of patients. It was more frequently absent in patients with lower-level anastomoses (present in 75% in A 3 and 25% in A 2; $P<0.05$), and was consistently absent in group A 1.

Neorectum. During balloon distension of the rectum, no trend was seen regarding threshold for first sensation. The threshold volumes to elicit urgency and to reach the maximal tolerable were diminished in all groups and were significant between A 3 and A 4 (feeling of urgency: 51.50 and 63.08 ml for A 3 and A 4, respectively, $P<0.01$; maximal tolerable volume: 77.00 and 171.46 ml for A 3 and A 4, respectively, $P<0.002$). The compliance of the neorectum was decreased in all groups, significantly so between A 3 and A 4 (3.65 vs. 6.53 ml/mmHg; $P<0.002$). Thus, in comparison with healthy volunteers, the thresholds to elicit first sensation, urge and the maximal tolerable volumes were clearly reduced, as was compliance, in the groups with anastomoses <9 cm.

Because the results of anorectal manometry, which reflect the function of the neorectum (feeling of urgency, maximal tolerable volume, and compliance), showed differences with a clear trend or significance among the four groups, we focused on the function of the neorectum.

To exclude the individual length of the anal high-pressure zone, the length of the residual rectum was measured by subtracting the length of the high-pressure zone from the level of anastomosis. The patients were then grouped by the length of the rectal stump: S 1, <1.5 cm; S 2, 1.5–4.0 cm; S 3, 4.1–6.5 cm; S 4, >6.5 cm.

Median stool frequency was elevated in all groups (Table 4), but was significantly less in S 3 than in S 2 (2.3 vs, 4.5; $P<0.05$). Continence was reduced in patients with a short residual rectum (Table 4). Overall incontinence and incontinence for liquids revealed significant differences between the groups with a residual rectum ≤1.4 cm and 1.5–4.0 cm (overall incontinence, 100% and 28.6% for S 1 and S 2, respectively, $P<0.05$; incontinence for liquid, 100% and 28.6% for S 1 and S 2, respectively, $P<0.05$). Incontinence mainly resulted from an inability to defer the call for stool, leading to urge incontinence. The differences between the groups were significant (S 1 vs. S 2: 83.3% vs. 28.6%, $P<0.05$; S 2 vs. S 3: 28.6% vs. 0%, $P<0.05$).

The thresholds for urge and maximal tolerable volume and compliance demonstrated a clear tendency towards reduced function with decreased length of the rectal stump (Table 4). The differences between S 3 and S 4 were significant (urge volume: 50.1 vs. 64.5 ml, $P<0.025$; maximal tolerable volume. 93.53 vs. 166.3 ml, $P<0.025$; compliance, 4.1 vs. 6.6 ml/mmHg, $P<0.025$).

The rectoanal inhibitory reflex showed significant differences between Groups S 1 and S 2.

Discussion

The various anatomical structures of the anorectal continence organ can function independently, but synergistically they provide control of continence. The rectum acts primarily as a reservoir, whereas the anal sphincter functions as an outlet obstruction. Integration of rectal and anal function results in control of defecation.

With surgery for rectal cancer, the anorectum as such is removed or a functional part of the continence organ is excised and replaced. The increasing use of sphincter-saving surgical procedures has meant that total removal of the

continence organ can be avoided, providing rates of local recurrence, 5-year survival [6], and postoperative mortality and morbidity [5, 19] comparable to those after abdomino-perineal excision while avoiding a permanent stoma [9, 10, 20, 21]. However, after low anterior resection of the rectum and coloanal or colorectal anastomosis, the anal continence organ is confronted with major changes in its anatomy and function and does not always withstand this challenge. The incidence of fecal leakage and urgency of defecation in patients after low anterior resection varies from 25% to 50% and is more common after very low colorectal or coloanal anastomoses [11–13]. Although these clinical problems may resolve with time [16, 23], unfortunately this is not always the case [11, 22].

This impairment in fecal continence has been shown to be caused by a variety of factors reflecting both anorectal sphincteric function [14, 17, 23–25] and reservoir function [14, 16, 17, 23, 25]. After resection of the rectum for carcinoma, the size of the residual rectum will vary, depending on anastomotic level. The extent of the resection is defined by the site and stage of the tumor: in carcinoma of the upper rectum, usually the distal rectum can be partially preserved, as it is the case in some tumours of the mid rectum; in carcinoma of the lower rectum, complete removal of the rectum and mesorectum is unavoidable.

A variety of studies has focused on the effect of level of anastomosis on anorectal function after low anterior resection [1, 13, 15, 25]. The studies are inconsistent with regard to study design and patient population. In particular, the variations in patient grouping by anastomotic level make comparison difficult. The findings are partially contradictory: in one study the level of anastomosis had a deteriorating effect on the ability to defer defecation but not on stool frequency and discrimination ability [13]; in another, stool frequency and fecal incontinence were increased in patients with anastomoses lower than 6 cm, and the correlation between low anastomotic and decreased neorectal capacity was significant [17]; in a third study, fecal and stool frequency were increased with lower anastomotic level and shorter rectal stump, but sphincteric pressure was not affected significantly although sphincteric pressure profile revealed major differences [11]; lastly, no correlation between level of anastomosis and stool frequency and manometric values was found [15].

In the present study, we evaluated clinical and manometric sphincteric function after rectal resection with different anastomotic levels. Factors that may affect bowel function (pre- or postoperative radiation therapy, anastomotic irregularities such as strictures or leaks, inflammation or recurrence) were excluded. The levels of anastomosis were measured in 1-cm steps and grouped by ascending order in 3-cm increments. We chose not to compare pre- and postoperative manometric findings because the preoperative presence of a tumor in the lower rectum would of itself give abnormal results. The manometric anorectal findings were compared with laboratory reference data obtained from healthy volunteers.

Clinical data showed that anorectal function was clearly impaired a mean of 18 months after rectal resection with regard to frequency, minor leakage (54%), incontinence for liquid and solid (33%), the ability to defer stool (37%), and the ability to discriminate the consistency of stool (31%). Perianal skin soreness – in 25% of our patients – lends clinical support to these findings. The lower the anastomosis, the more these symptoms were aggravated. A noticeably increased risk of impaired function was observed when the level of anastomosis was below 6 cm and differences were significant for frequency, leakage and incontinence owing to the inability to defer stool, the inability to discriminate stool, associated anal soreness, and incomplete emptying. This is in accord with findings in the recent literature [11, 13, 16, 17].

Maximal resting pressure was slightly reduced, but no significant difference was observed between the different levels of anastomosis or between patient data and normal values. In other studies, transanal introduction of a stapling device [24] and intraoperative damage of autonomic sphincteric innervation [26] were found to be potential causes for postoperative reduction of internal sphincter function. In all our four groups, the length of the high-pressure zone was not significantly affected. Maximal and median squeeze pressure was normal in all patients. Hence, in contrast to other studies [23–25], no convincing evidence for internal or external anal sphincteric damage was found.

Neorectal perception was reduced in our patients: the threshold volumes to elicit first sensation was not affected. The feeling of urgency was reduced in all groups, with a distinct trend towards a decrease with lower anastomostic level, but rectal sensibility was not abolished. Reduced volumes [14] as well as increased intrarectal pressures to elicit rectal sensation [23] (not necessarily contradictory [17]) have been reported to be observed after low anterior resection.

Maximal tolerable volume and compliance showed a clear impairment in all groups – to a major extent in patients with low anastomoses. Less impairment was seen in patients with an anastomotic level above 6 cm. This confirms previous reports [14, 16, 17, 23, 25].

Our findings suggest that impairment after rectal resection results mainly from reduced capacity of the neorectum, less from sphincteric damage. Thus, we feel that the length of the residual rectum would be a more appropriate parameter to relate to impaired sphincteric function than anastomotic level: the level of anastomosis is a summation of the length of the anal canal and residual rectum; to obtain the length of the residual rectum, we subtracted the length of the anal high-pressure zone (reflecting the anal canal) from the level of the anastomosis. Residual rectum can also easily be estimated intraoperatively by an intra-abdominal approach.

Clinical outcome and neorectal capacity are related to the length of residual rectum. The risks of frequency, leakage and incontinence were less when the residual rectum was ≥1.5 cm. The maximal tolerable volume and compliance were noticeably improved if the rectal stump was ≥4 cm. The longer the residual rectum, the greater the neorectal capacity and the better the clinical outcome.

The rectoanal inhibitory reflex was absent in 39.6% of our patients. If the anastomosis was below 3 cm or the residual rectum was shorter than 1.5 cm, the reflex was negative; with higher levels of anastomosis and a longer

rectal stump, the reflex was frequently positive. Because rectoanal inhibitory relaxation recovers up to 24 months postoperatively [27], the differences in median follow-up among the groups may explain this finding. A comparison of clinical function with regard to negative and positive rectoanal inhibitory relaxation revealed no significant differences between patients with good and bad clinical outcome.

Given the mixed results of studies focusing on continence function after low anterior rectal resection, impairment of continence is multifactorial. Our findings clearly indicate that neorectal capacity is of major importance. The capacity in patients with straight colorectal reconstruction after rectal resection is decreased the lower the anastomotic level and the shorter the residual distal rectum. A residual rectum ≥4 cm markedly improves functional outcome. The practical implication is two-fold: If residual rectum can be preserved without jeopardizing distal tumor clearance and mesorectal excision, it should be attempted; if complete removal is unavoidable owing to the site and size of the tumor, the construction of a colon pouch should be considered to increase neorectal capacity.

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