

## RELATIONSHIP BETWEEN INTERNAL ANAL SPHINCTER FUNCTION AND LENGTH OF REMAINING RECTUM AFTER RESECTING RECTAL CARCINOMA

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**Objective:** To study the relationship between internal anal sphincter function and length of remaining rectum after resecting rectal carcinoma. **Methods:** Preoperatively, 21 patients were evaluated via patients' clinical data, including anal resting pressure (resting pressure) assay. Six months postoperatively, repeated manometric studies and clinical evaluations were performed to assess the level of continence. The formula use for calculating postoperative resting pressure is as follows:  $\text{postoperative resting pressure} = 0.42 \times \text{preoperative resting pressure} + 1.56 \times \text{length of remaining rectum} + 12.37$  ( $R^2 = 0.58$ ;  $P < 0.01$ ). Degree of continence was graded based on severity of the dysfunction and grade of the continence score. **Results:** It was demonstrated the patients with low postoperative resting pressures ( $< 4.0$  Kpa) had incontinence, and those with high postoperative resting pressures ( $> 4.7$  Kpa) were continent. There were significant correlations between length of the remaining rectum and ratio of the decrease in maximum resting pressure (postoperative/preoperative maximum resting pressure;  $r = 0.62$ ;  $P < 0.01$ ). **Conclusion:** Continence of rectum is influenced by maximum resting pressure of function of the internal anal sphincter, length of remaining rectum is shorter, the more damage to the internal anal sphincter. It is able to foretell stool incontinence by using the postoperative resting pressure formula, and to determine the length of the remaining rectum.

**Key words:** Rectal cancer, Surgery length of remaining rectum, Internal anal sphincter, Maximum resting pressure.

An artificial anus may decrease a patient's quality of life in clinical experiment, therefore, sphincter-preserving operations are now being used.<sup>1,2</sup> Although defecation after surgery is generally good, surgery sometime causes difficulty with defecation, including incontinence, which lead to disturbances in daily activities for the patients.<sup>3</sup> Cause of stool incontinence is said to be dysfunction of the internal anal sphincter, and the shorter remaining rectum is said to cause poorer defecation. We undertook this study to assess the relationship between the function of the internal and sphincter and the length of the remaining rectum. If the continence level can be predicted before performing a low anterior resection, the patient's quality of life may improve.

### PATIENTS AND METHODS

Patients underwent curative surgery for rectal cancer by resection at our hospital from July 1995 to December 1996. No patient was treated by radiation, and patients' characteristics are given in Table 1. After manometric studies were performed preoperatively and postoperatively, the continence score was determined. During surgery, the rectum was resected with a 2 cm distal margin for early-stage cancers and a 4 cm distal margin for advanced cancers. Level of continence was graded according to Kirwan's classification:<sup>4</sup> Grade 1, perfect; Grade 2, incontinent of flatus; Grade 3, occasional minor soiling; Grade 4, frequent major soiling. We graded the continence score (CS). Measure maximum resting pressure

(resting pressure), maximum squeeze pressure (squeeze pressure), minimum threshold volume (threshold volume), and maximum tolerable volume (tolerable volume). Resting and squeeze pressures were measured by a pressure transducer catheter ( $\Phi$ 2 mm microtip transducer, PT-157J), threshold volume and tolerable volume were measured by filling air into a 10 cm latex balloon. Length of the remaining rectum was measured between the site of the anastomosis and where the rectum comes into contact with the pelvic floor. The site of contact between the rectum and the pelvic floor is the terminal of the rectum and can be ascertained by digital examination. Postoperative resting pressures and continence scores were predicted with stepwise multiple regression analyses by using preoperative factors, which included age, height, weight, and preoperative manometric data. Multiple regression analysis was conducted using the statistical analysis program. Two-sided, 5% statistical tests were used.

## RESULTS

### Continence Score (CS)

Eight patients (38%) obtained a decreased level of continence: Two patients with a CS of 2, four with a CS of 3, and two with a CS of 4 (Table 2). Factors that

significantly correlated with CS were length of remaining rectum ( $r=-0.48$ ) and postoperative resting pressure ( $r=-0.7$ ; Table 3).

Eight patients decreased level of continence in six months after resection for rectal carcinoma.

Factors that significantly correlated with CS were length of remaining rectum and postoperative resting pressure (Pearson's test).

Table 1. Patients clinical data

Item	Data
Age (Yr)	65.8 $\pm$ 10.2
Gender, m:f	12:9
Height (cm)	166.5 $\pm$ 6.0
Weight (kg)	61.0 $\pm$ 8.0
Length of remaining rectum (cm)	3.2 $\pm$ 3.2
Tumor size (cm)	4.3 $\pm$ 2.8
Duke's stage	
A	12
B	5
C	4
Complication	
Leakage	2
Ileus	2
Abscess	1
Gastric ulcer	1

Table 2. Important factors of each grade of continence score (CS)

CS	No. of cases	Length of remaining rectum (cm)	Preoperative resting pressure (Kpa)	Postoperative resting pressure (Kpa)
1	13	4.4 $\pm$ 3.0	7.2 $\pm$ 3.6	5.8 $\pm$ 1.3
2	2	3.0 $\pm$ 3.0	5.2 $\pm$ 1.6	5.1 $\pm$ 0.5
3	4	0	6.1 $\pm$ 1.2	3.6 $\pm$ 1.4
4	2	1.5 $\pm$ 1.5	4.3 $\pm$ 1.1	3.2 $\pm$ 0.5

### Relation between Postoperative Resting Pressure and Length of Remaining Rectum

Postoperative resting pressure was calculated by preoperative resting pressure and length of the remaining rectum by stepwise multiple regression analysis. The formula used for calculation is as follows: postoperative resting pressure =  $0.42 \times$  preoperative resting pressure +  $1.56 \times$  length of remaining rectum + 12.37 ( $R^2=0.58$ ;  $P<0.01$ ; Table 4). Three was

significant correlation between length of the remaining rectum and the ratio of postoperative to preoperative resting pressure (Figure 1).

Postoperative resting pressure can be calculated by resting pressure and length of remaining rectum.

### Relation between Postoperative Resting Pressure and CS

A postoperative resting pressure greater than 4.7 by

this formula existed in ten patients, of whom nine had a CS of 1 and one had a CS of 3 (this latter patient had minor leakage of the anastomosis after the operation). A postoperative resting pressure of greater than 4.0 and less than 4.7 existed in seven patients, 3 of whom had a CS of 1, 2 of whom had a CS of 2, and 2 of

whom had a CS of 3. A postoperative resting pressure of less than 4.0 existed in four patients, 1 of whom had a CS of 1, 1 who had a CS of 3, and 2 who had a CS of 4. The relation between CS and the three groups data divided by postoperative resting pressure is significant, as demonstrated by  $\chi^2$  test (Table 5).

Table 3. Correlation between continence score (CS) and each parameter

Entry	$\bar{x} \pm s$	Correlation	P value
Length of remaining rectum (cm)	3.2±3.2	-0.481	0.01
Preoperative manometric data			
Resting pressure (Kpa)	6.5±3.2	-0.266	NS
Squeezing pressure (Kpa)	19.6±9.2	-0.314	NS
Threshold volume (ml)	82.0±26.1	0.067	NS
Tolerant volume (ml)	142.9±40.0	-0.157	NS
Postoperative manometric data			
Resting pressure (Kpa)	5.0±1.6	-0.70	<0.01
Squeezing pressure (Kpa)	16.9±6.9	-0.41	NS
Threshold volume (ml)	80.3±28.9	-0.18	NS
Tolerant volume (ml)	135.0±43.2	-0.36	NS

Table 4. Correlation between postoperative resting pressure and continence scores ( $R^2=0.58$ ;  $P<0.01$ )

Entry	Coefficient	SE	t value	P
Constant	12.37	5.59	2.21	0.040
Resting pressure	0.42	0.09	4.94	<0.010
Length of remaining rectum	1.56	0.64	2.44	0.025

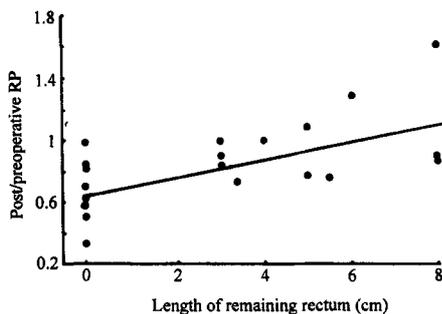


Fig. 1. There is significant correlation between postoperative and preoperative resting pressure and length of remaining rectum. Length of remaining rectum may reflect damage of the internal anal sphincter caused by low anterior resection ( $r=0.62$ ;  $P<0.001$ ; Pearson's test).

Table 5. Relation between postoperation resting pressure and continence scores

Postoperative resting pressure (kpa)	<4.0 n=4	4.0-4.7 n=7	>4.7 n=10
Continence score			
1	1	3	9
2	0	2	0
3	1	2	1
4	2	0	0

$\chi^2$  test,  $P=0.014$

## DISCUSSION

Fecal continence is maintained by the interaction of several factors, which include fecal consistency,

colonic motility, rectal distensibility, anorectal angle, and internal and external anal sphincter activity. Dysfunction of more than one of these factors causes stool incontinence. The causes of stool incontinence after low anterior resection include dysfunction of the internal anal sphincter, the reservoir, and the pelvic floor.<sup>5</sup> Dysfunction of the reservoir is caused by rectal compliance, minimum threshold volume, or maximum tolerable volume. In our study, the minimum threshold and maximum tolerable volumes were measured as the factors of reservoir function, there was no significance between these factors and continence scores. This may be because we performed a straight anastomosis, we did not make a pouch, and preoperative reservoir function may be a reflection of the existence of a tumor. However, there was no significance between length of remaining rectum and the two reservoir factors. The length of remaining rectum may not reflect reservoir function in straight anal anastomosis. We have no critical data regarding the pelvic floor. If the pelvic floor influenced continence and squeeze pressure, which influences the external anal sphincter, would become a significant factor, because both the external anal sphincter and the pelvic floor were composed of the same muscle.

Some authors have reported that the chief cause of soiling after low anterior resection is dysfunction of the internal anal sphincter.<sup>4-6</sup> In our study, patients with a low maximum resting pressure following surgery had a decrease in continence. The maximum resting pressure is maintained primarily by the internal anal sphincter, therefore, a decrease in maximum resting pressure indicates dysfunction of the internal anal sphincter. Results of our study are consistent with previous reports.<sup>4-6</sup> We believe that continence after low anterior resection depends on internal anal sphincter function, and if the internal anal sphincter is damaged during surgery, incontinence will occur. In a contrasting report, Lewis et al.<sup>7</sup> reported that an appropriate response of the anal sphincter to distention of the neorectum was the more important factor for continence than resting pressure. The authors indicated that resting pressure did not differ significantly in patients with poor function compared with those who had good function. They divided patients into two groups using many different symptoms of the patients, not only incontinence. Also, they did not use manometric testing and patients' symptoms simultaneously, they used only surgical results. This may be the reason for different results regarding

maximum resting pressure after surgery.

In this study, short length of the remaining rectum decreased rectum functioning and decreased maximum resting pressure after surgery. The short rectum may result in damage to the internal anal sphincter and may lead to dysfunction. Length of the remaining rectum is shorter, and more damage to the internal anal sphincter by mobilization and stretching may occur. In a contrasting report, Jehle et al.<sup>8</sup> reported that the level of anastomosis did not influence functional outcome after anterior resection for rectal cancer. They measured the manometric data and incontinence at three months after surgery. At this time, patients' anal function and symptoms are unstable because of disorder bowel movements, however, these are stable after six months postsurgery. There was significant correlation between postoperative and preoperative resting anal pressures in our study, a shorter remaining rectum may cause a decrease in resting anal pressure. Therefore, we believe that the length of the remaining rectum may influence functioning of the internal anal sphincter after surgery.

In explaining the mechanisms of clinical outcome, one of the best methods is to be able to predict the results of a procedure. Ho et al.<sup>9</sup> reported the prediction of frequent defecation following anterior resection, in this study, the frequency was predicted by multiple regression analysis. Postoperative resting pressure was well calculated by a formula that was able to predict the continence level after an operation. However, we could not predict stool incontinence critically because continence scores were graded according to Kirwan's classification. Therefore, further evaluation is necessary. Use of this formula offers the possibility of predicting continence postoperative and allows for improving medical treatment of incontinence after surgery and an improved ability to determine the indications for a low anterior resection of rectal carcinoma. To sum up, continence of rectum is influenced by maximum resting pressure of function of the internal anal sphincter, length of remaining rectum is shorter, the more damage to the internal anal sphincter.

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