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RELATIVE BOWEL REST AND HEALING OF COLONIC ANASTOMOSES

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SUMMARY – The effect of relative bowel rest on the strength of surgical anastomoses in the left colon in the early phase of healing, and correlation between mechanical strength of anastomosis and collagen content in the colonic wall were investigated. The breaking strength of surgical stitches in the left colon after end-to-end anastomosis and collagen content in the colonic wall around the anastomosis were measured and evaluated in rats fed low residue or standard diet. The anastomosis strength decreased by approximately 30% of the immediate postoperative value in the first two days in both groups. After day 2, there was an increase in the anastomosis strength, reaching day 0 strength after 7 days. The strength increase was mainly due to collagen deposition in the anastomosis. From day 0 till day 2, the increase in collagen content was greater in the standard laboratory diet group than in the low residue diet group. Results on anastomotic adhesions and condition of anastomosis sutures in animals on the standard laboratory diet group and low residue diet group are also presented. Low residue diet did not impair the suture holding capacity or anastomosis strength. Instead, there was evidence for a more uncomplicated healing when the bowel content was diminished.

Key words: *colon-surgery; gastriontestinal motility; wound healing*

Introduction

Bowel preparation is generally accepted to be necessary before performing an anastomosis, although this surgical dogma has recently been questioned in prospective series of colon resections[1]. Convincing evidence that reducing fecal load and thus bacterial load reduces both wound and anastomotic problems is yet to be confirmed.

Enteral nutrition with chemically defined diets low in residues has been introduced to provide nutritional support during colonic preparation for operative site as well as for standard laboratory diet. Diminished colonic content obtained by feeding rats a low residue diet results in marked depression of collagen turnover in the colonic wall[2]. On the other hand, greater collagen deposition occurred in animals on standard laboratory diet. This may influence anastomosis strength, since collagen formation is one of the central factors for the strength development[3,4].

The aim of the study was to investigate the effect of relative bowel rest on the breaking strength of anastomoses in the left colon in the early phase of healing, and to evaluate the possible correlation between the mechanical strength of anastomosis and collagen content in the colonic wall.

Material and Methods

Eighty male Wistar rats weighing about 200 g were randomly allocated to either standard laboratory diet or low residue diet group. Low residue diet group had free access to water and low residue diet (Biosorbin MCTÒ, Abbott, Abbott Park, IL, USA; 100 g/100 g water) for four days before and seven days after the operation. The control group had free access to water and standard laboratory diet (Biorat ACT®, Abbott, Abbott Park, IL, USA; 100 g/100 g

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water) for four days before and seven days after the operation.

Low median abdominal incision was performed. General anesthesia was induced by intraperitoneal injection of chlorhydrate 25-30 mg/100 g body weight (b.w.), and one centimeter of the left colon 2.5 cm above the peritoneal reflection was resected. Standard end-to-end anastomosis was made using a single layer of continuous suture with 5-0 Vicryl® (Ethicon, Inc., Somerville, NJ, USA). Animals were sacrificed by an overdose of ether immediately after the anastomosis had been made (day 0), or on days 1, 2, 3, 4 and 7 postoperatively (Table 1).

Table 1. Number of sacrificed animals according to postoperative days

Postoperative day	Standard diet (n)	Low residue diet (n)	N
0	6	6	12
1	6	6	12
2	6	6	12
3	6	6	12
4	7	8	15
7	7	8	15
Total	38	40	78

Gross complications such as perianastomotic abscesses were observed and recorded at autopsy. The diameter of the colon proximally and distally to the anastomosis was determined by a caliper (accuracy to 0.1 mm). The left colon was dissected free along the mesenteric border and adhesions were carefully removed from the anastomosis in order to create comparable conditions before strength testing. The suture material was removed in all animals on day 7. The anastomotic strength was tested by use of a specially constructed tensiometer[5,6], which provided constantly increasing force of 0.22 newton (N)/second. The force at rupture was recorded.

After the mechanical strength tests, 5-mm segments were taken on each side of the anastomosis for collagen content analysis according to the method described by Stegemann and Stadler[7].

On statistical analysis of the results, mean, standard deviation (SD) and standard error of mean (SE) were calculated. Means ± SD are presented in tables, and means ± SE in figures. Comparisons between the groups were done by ANOVA statistical.

Results

Anastomotic adhesions were present in all animals from the standard laboratory diet group, but were absent in 36 out of 40 animals from the low residue diet group. On days 0 to 4, the sutures were left in place. On postoperative day 7, the sutures had disappeared or hanged loose in the colonic lumen in 34 out of 38 animals from the standard laboratory diet group, but in only 5 animals from the low residue diet group. Caliper determination of colonic diameter showed the bowel to be wider on both sides of the anastomosis in the standard laboratory diet group than in the low residue diet group (Figs. 1 and 2). Also, diameter was wider on the proximal than on the distal side in both groups.

Mechanical strength test showed a significant decrease in breaking strength on the first two postoperative days in both groups. From that time on, a significant strength gain was recorded until postoperative day 7, when the breaking strength reached preoperative values (Fig. 3). There was no statistically significant between-group difference in the breaking strength decrease on the first two postop-

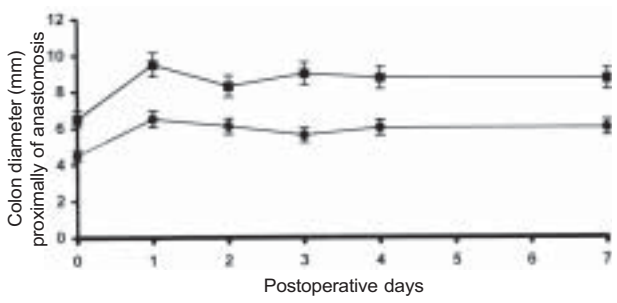

Fig. 1. Colonic diameter proximally (closed symbols) to the anastomosis on days 0-4 and 7 postoperatively in rats on low residue diet (circles) and standard laboratory diet (squares).

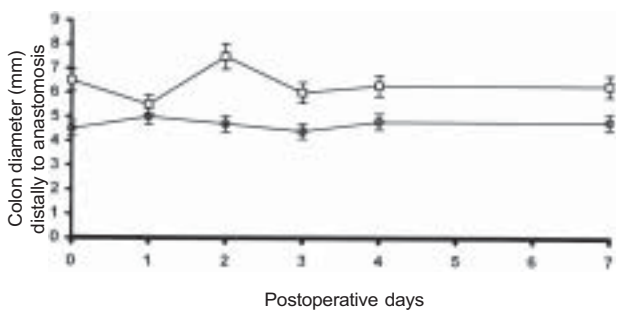

Fig. 2. Colonic diameter distally (open symbols) to the anastomosis on days 0-4 and 7 postoperatively in rats on low residue diet (circles) and standard laboratory diet (squares).

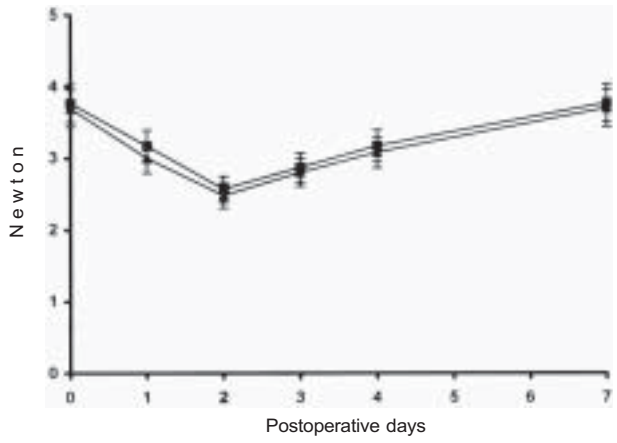

Fig. 3. Breaking strength development in the early healing after colon anastomosis in rats fed low residue diet (squares) and standard laboratory diet (triangles).

erative days or strength gain recorded from day 2 until postoperative day 7.

Collagen determination was performed in 78 animals. Two animals from the standard laboratory diet group were lost and excluded from the experiment because they developed perianastomotic abscesses and expulsion of bowel content into the abdominal cavity due to the failure of stitches.

Collagen content in the anastomotic segment in the two groups of animals is shown as a proportion of the value measured on day 0 (preoperative). There was no statistically significant difference in the collagen content between the proximal and distal anastomotic segments. Pooled results on the two segments are presented (Fig. 4). From day 0 to day 2, an increase in collagen content was recorded in both groups. In the low residue diet group, the collagen content increased slightly but not significantly, reaching 1.4-fold day 0 value on day 2. In the control group, the collagen content increased about 2.5 times from day 0 up to day 2, which differed significantly ($p<0.01$) from the change observed in the low residue diet group (Table 2).

Discussion

The present study showed the anastomoses to have a comparable development in the two groups despite greater collagen deposition in the animals fed standard laboratory diet than in those on low residue diet. This indicated that either the quality of the collagen formed differed between the two groups, or an increased amount of collagen was mainly located outside the anastomotic line[8].

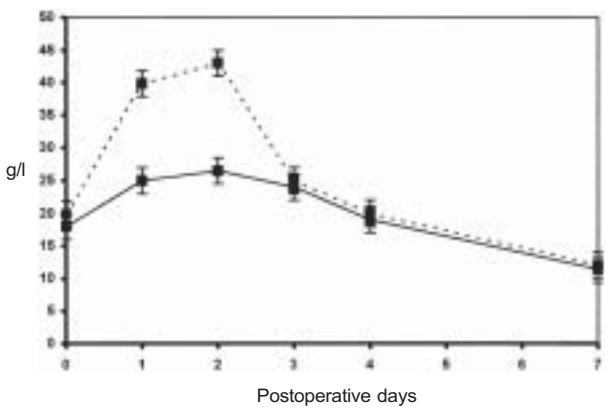

Fig. 4. Collagen content (g/L) in the anastomotic segments of the colon on postoperative days 0-4 and 7 in rats fed low residue diet (full line) and standard laboratory diet (dashed line).

During the early phase of anastomotic healing, the mechanical strength of anastomosis depends almost entirely on the suture strength and ability of the bowel wall to hold the sutures. As the new tissue bridges the defect, the role of sutures gradually decreases. Thus, evaluation

Table 2. Comparison of standard laboratory diet group and low residue diet group

	Standard diet (mean±SD)	Low residue diet (mean±SD)	F	*p*
Proximal diameter (mm)	8.46±0.96	5.81±0.67	201.21	0.00
Distal diameter (mm)	6.35±0.64	4.71±0.27	219.69	0.00
Breaking strength (N)	3.21±0.57	3.13±0.55	0.34	0.557
Collagen content (g/L)	26.06±11.33	20.12±5.41	686.81	0.004

of the importance of suture support is of interest during the first critical days of healing, when anastomotic dehiscence is most common[9]. In our study, the mechanical strength of anastomosis was tested during the first postoperative week.

During the first two days, the anastomotic strength decreased by approximately one third as compared with the strength of the newly made anastomosis. During these days, the suture holding capacity of the intestinal wall decreased. There was no correlation between changes in the anastomotic strength and changes in the collagen content. Since the suture holding capacity of the bowel wall is mainly due to collagen[8], not only the content but also the quality of collagen in the tissue around the sutures must be of importance. In our study, there was a gradual increase in the anastomotic strength from day 2 on, reaching day 0 strength after 7 days. Some of the anastomotic strength regain may be due to changes in the suture holding capacity of the colonic wall[3], however, formation of the new tissue with collagen deposition in the anastomosis is probably a major factor[4]. As in these experiments the sutures were removed before day 7 test, all strength recorded at that time was attributable to the new tissue.

The sutures were regularly found to have loosened from the proximal side of the anastomosis on days 2-4 in the standard laboratory diet group. This could imply that the tearing forces were greater on the proximal side, or that the structure of collagen suffered more profound changes on that side of the anastomosis.

The passage of fecal pellets exerts a strain on the anastomosis[10], which probably explains why the sutures hung loose or had disappeared in the animals on standard laboratory diet but remained intact in the animals on low residue diet. Gross complications did not differ significantly between the two groups of animals. Anastomotic adhesions, however, were common in the animals on standard laboratory diet but were absent in those on low residue diet. This suggests that the diminished bowel content might be associated with a lower rate of complications during the process of normal healing. This further supports the assumption of a less uncomplicated wound healing after feeding animals a low residue diet.

The calculated strength of a newly made anastomosis would be only 30% of the intact bowel wall strength, and would be lowest on day 2 postoperatively, approximately 20% of the intact intestinal wall strength. The values of anastomosis strength for small intestine found by Jonsson *et al.*[11,12] were also lowest on day 2, however, reporting on different time schedule of changes in the small intestine anastomotic strength.

In conclusion, the findings recorded in the present study indicated only minor differences in the anastomotic strength during the early phase of colonic healing between the animals on low residue diet and those on standard laboratory diet. The reduced collagen turnover rate as a consequence of low residue diet does not impair the suture holding capacity or anastomotic strength in the early phase of healing. Instead, we found some evidence for a more uncomplicated anastomotic healing when the bowel content was diminished.

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Sažetak

RELATIVNO MIROVANJE CRIJEVA I ZARAŠTANJE ANASTOMOZA KOLONA

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Istraživan je utjecaj crijevnog sadržaja na snagu anastomoze lijevog kolona u ranoj fazi cijeljenja, te odnos između mehaničke snage anastomoze i sadržaja kolagena u crijevnoj stijenci. Mjerena je i procijenjena snaga pucanja kirurških šavova na lijevom kolonu nakon termino-terminalne anastomoze, te sadržaj kolagena u crijevnoj stijenci oko anastomoza kod štakora kojima je davana hrana s minimalnim ostatkom i štakora hranjenih standardnom hranom. Snaga anastomoze se smanjila za oko 30% u odnosu na neposrednu poslijeoperacijsku vrijednost u prva dva dana kod obje skupine životinja. Nakon drugog dana snaga anastomoze postupno je rasla, da bi sedmoga dana dosegla poslijeoperacijske vrijednosti. Ovaj porast snage uglavnom je bio uvjetovan odlaganjem kolagena u crijevnu stijenku oko anastomoze. Od nultog do drugog dana porast sadržaja kolagena bio je veći u skupini životinja na standardnoj prehrani. Prikazane su i pojave priraslica oko anastomoza, te stanje kirurških šavova kod životinja koje su dobivale hranu s minimalnim ostatkom i onih na standardnoj prehrani. Prehrana s minimlnim ostatkom ne utječe na snagu anastomoze i stanje kirurških šavova anastomoze. Ipak, očito je da smanjenje crijevnog sadržaja doprinosi boljem cijeljenju anastomoza.

Ključne riječi: xxx