

Carcinoma of the Rectum

Profiles of Intraoperative and Early Postoperative Complications

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PURPOSE: The aim of this study was to determine the incidence and risk factors that were significant in contributing the intraoperative and early postoperative complications for operations of carcinoma of the rectum. **METHODS:** Between 1984 and 1986 inclusive, 426 patients underwent surgery for primary adenocarcinoma of the rectum. Cases of local excision were excluded. The relationship between each complication and nominal risk factors were studied. The types of surgery included an abdominoperineal resection, low anterior resection, low anterior resection with coloanal anastomosis, anterior resection, colostomy, and Hartmann's procedure. **RESULTS:** There were two (0.5 percent) deaths. Intraoperative complications occurred in 34 (8 percent) patients. The most common intraoperative complication was presacral bleeding which occurred in 14 patients. Postoperative complications occurred in 214 (50 percent) patients. The two most common complications were urinary retention and urinary tract infection. Abdominoperineal resection had the highest early postoperative complication rate (59 percent). There were 17 clinical anastomotic leaks (7 percent in 221 patients with unprotected anastomoses). The development of complications reached statistical significance with increasing age ($P = 0.003$), male sex ($P = 0.003$), increasing weight ($P = 0.006$), and types of operative procedure ($P = 0.001$). **CONCLUSIONS:** Operations for carcinoma of the rectum can be performed with low mortality. Although the overall early postoperative complications were high, the majority was not life-threatening and usually resolved with time and proper management. [Key words: Rectal carcinoma; Intraoperative complications; Early postoperative complications; Operations for rectal carcinoma]

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Although there has been a dramatic decline in the operative mortality following surgery for rectal adenocarcinoma, morbidity remains surprisingly high. Miles¹ described an operative mortality of 36 percent in his initial series of 61 patients undergoing abdominoperineal resection (APR). A

recent study² reported an operative mortality rate for rectal adenocarcinoma between 1 percent and 7 percent. Morbidity rates, however, were reported between 21 percent and 76 percent.^{3,4} In this retrospective study, the incidence of operative and early postoperative complications were determined. The profiles of the patient, carcinoma, preoperative preparation, and operative procedures were studied as nominal risk factors to determine which were significant in the development of complications. With knowledge of the overall picture of risk factors, the common and uncommon types of complications, the surgeons may be able to minimize their occurrences.

MATERIALS AND METHODS

From 1984 to 1986, 426 patients underwent surgery for primary rectal adenocarcinoma at the Mayo Clinic, Rochester, Minnesota. Cases of local excision of rectal carcinoma were excluded. The data were obtained retrospectively from records of the patients. The study included age, sex, height, weight, and associated diseases in each patient. The distance of the carcinoma from the anal verge and the TNM staging were recorded. Preoperative details including type of bowel preparation, prophylactic antibiotics, and irradiation were recorded. The use of ureteric stents was noted. The surgery was defined as elective or emergency. There were six operative categories: APR, low anterior resection (LAR), anterior resection (AR), low anterior resection with coloanal anastomosis, Hartmann's procedure, and diverting colostomy. Details of concomitant procedures, including protective stomas, were noted.

Operative details included the length of the operation, the use of drains, closure or otherwise of the perineal wound if present, the amount of blood loss, and the number of units of blood replacement. The standard wound classification (I-IV) was

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used. All intraoperative and postoperative complications within the period of hospitalization were recorded.

The relationship of the occurrence of complications to nominal risk factors was investigated with the chi-squared test, or when appropriate, with Fisher's exact test. The relationships of continuous variables with complications were assessed with two sample *t*-tests or, when required, with Wilcoxon's rank sum tests. *P* values less than 0.05 were considered statistically significant.

RESULTS

There were 261 (61.3 percent) males and 165 (38.7 percent) females with a mean age of 64 years. The youngest patient was a 23-year-old female, and there were 14 patients under the age of 40 years. Thirty-one patients were age 80 or older, with the four oldest each being 87. The mean weight was 75 (range, 40-162) kg. Three patients weighed greater than 120 kg.

The list of associated diseases is presented in Table 1. One hundred twenty-eight (30 percent) patients gave no history of any past or present medical problem. One hundred sixty (37.5 per-

cent) patients described one problem, while 138 (32.4 percent) patients had two or more medical problems. Hypertension was the most common associated disease (34.9 percent). Seventy-two (16.9 percent) patients had undergone pelvic surgery previously. There was only one case of a synchronous colon carcinoma, and one other patient had a previous colon resection for carcinoma.

The mean distance from the anal verge was 8.3 cm. There were 19 patients with carcinomas extending to 2 cm from the anal verge. One hundred seventy-seven (41.6 percent) patients had carcinomas in the lower third of the rectum, up to 7 cm from the anal verge. One hundred fifty-six (36.7 percent) patients had carcinomas in the middle third of the rectum (7-11 cm), and 92 (21.6 percent) in the upper rectum (11-15 cm).

There were 132 (31 percent) patients whose carcinomas were staged as T₁N₀M₀ (Dukes A). One hundred ten (25.8 percent) patients were T₂N₀M₀ (Dukes B). T_xN₁M₀ (Dukes C) and T_xN_xM₁ (Dukes D) comprised 121 (28.4 percent) patients and 63 (14.8 percent) patients, respectively.

A combination of laxatives and enemas was used in 335 (78.6 percent) patients, while 80 (18.7 percent) patients took polyethylene glycol solution. Five patients had no bowel preparation.

A combination of oral and intravenous antibiotics was most frequently used—297 (69.7 percent) patients. Oral antibiotics alone were used preoperatively in 117 (27.5 percent) patients. Intravenous antibiotics were used solely in seven (1.6 percent) patients. Two patients had no antibiotic cover and details were not known for three other patients.

Preoperative radiotherapy was given to 18 (4.2 percent) patients. Ureteric stents were employed in nine (2.1 percent) patients.

Operative Procedures

There were 422 (99.1 percent) elective operations and four (0.9 percent) emergencies. One hundred fifty-eight (37 percent) patients had an APR. One of these patients had a proctocolectomy for a synchronous carcinoma of the splenic flexure. The perineal wound was closed in 151 (95.6 percent) patients and left open in seven (4.4 percent) patients.

A LAR was performed in 137 (32.1 percent) patients. Eight (5.8 percent) of these patients were given a covering stoma. The anastomosis was sta-

Table 1.
Associated Conditions

Disease	No. of Patients (N = 426)	%
Hypertension	149	34.9
Cardiovascular	96	22.5
Previous pelvic surgery	72	16.9
Pulmonary disease	61	14.3
Diabetes	38	8.9
Biliary tract	33	7.7
Cerebrovascular accident	11	2.5
Hypothyroidism	11	2.5
Steroid therapy	8	1.8
Prostatic cancer	8	1.8
Liver disease	5	1.1
Renal failure	4	0.9
Bladder cancer	4	0.9
DVT; AAA; cancer of skin, stomach, breast, ovary, or lung	2 patients for each disease	0.5
BPH; epilepsy; Hodgkin's disease; cancer of thyroid, kidney, larynx or pancreas.	1 patient for each disease	0.2
Synchronous colon cancer, previous colon cancer		

DVT = deep vein thrombosis; BPH = brain prostatic hypertrophy; AAA = abdominal aortic aneurysm.

Table 2.
Operative Procedures

Operation	No. of Patients (N = 426)	%	Drains (%)	Anastomosis Stapled (%)	Anastomosis Handsewn One Layer (%)	Anastomosis Handsewn Two Layers (%)	Protective Stoma (%)
APR	158	37	Not recorded	—	—	—	—
LAR	137	32.1	132 (96.4)	80 (58.4)	4 (2.9)	53 (38.7)	8 (5.8)
AR	71	16.7	63 (88.7)	28 (39.4)	1 (1.4)	42 (59.2)	1 (1.4)
LAR with coloanal anastomosis	25	5.9	Not recorded	—	25 (100)	—	3 (12)
Hartmann's procedure	24	5.6	Not recorded	—	—	—	—
Defunctioning colostomy	11	2.6	—	—	—	—	—

APR = abdominoperineal resection; LAR = low anterior resection; AR = anterior resection.

pled in 80 (58.4 percent) patients, handsewn in one layer in four (2.9 percent) patients, and in two layers in 53 (38.7 percent) patients. Pelvic drains were placed in 132 (96.4 percent) patients.

Seventy-one (16.7 percent) patients had an AR. Only one patient (1.4 percent) had a protective stoma. The anastomosis was stapled in 28 (39.4 percent) patients, handsewn in one layer in one (1.4 percent) patient, and in two layers in 42 (59.2 percent) patients. Pelvic drains were used in 63 (88.7 percent) patients.

Twenty-five (5.9 percent) patients had a LAR with a coloanal anastomosis. Three (12 percent) of these patients were given a covering colostomy. Hartmann's procedure was performed in 24 (5.6 percent) patients and 11 (2.6 percent) patients had a defunctioning colostomy only (Table 2).

Concomitant Procedures

There were 172 concomitant procedures performed in 135 (31.7 percent) patients. One hundred eight (25.3 percent) patients had one concomitant procedure performed, while 27 (6.3 percent) patients had two or more procedures performed (Table 3). The most common procedure was a liver biopsy performed in 43 (10 percent) patients. Oophorectomies were performed in 33 (7.7 percent) patients. Eleven (2.6 percent) patients were given intraoperative radiotherapy.

Wounds were classified into the standard four types: Type I, clean; Type II, clean contaminated; Type III, contaminated; and Type IV, existing infection. There were no wounds classified as Type I. Four hundred eighteen (98.1 percent) wounds were classified as Type II, six (1.4 percent) as Type III, and two (0.5 percent) as Type IV.

The abdominal wound was closed in all cases. A suction catheter was placed in the subcutaneous

abdominal wound in 352 (82.6 percent) patients. The mean operating time was 158 (range, 55–405) minutes.

In 72 (16.9 percent) patients, blood loss was described as minimal and the amount was not recorded. In the other 354 (83.1 percent) patients, the mean blood loss was 650 (range, 50–6,500) ml. Six (1.4 percent) patients had a recorded blood loss of 3 or more liters.

Table 3.
Concomitant Procedures

Procedure	No. of Patients	%
Liver biopsy	43	10
Oophorectomy	33	7.7
Hysterectomy	11	2.6
Intraoperative radiation	11	2.6
Vaginal wall excision	10	2.3
Bladder resection	9	2.1
Cholecystectomy	7	1.6
Appendectomy	7	1.6
Small bowel resection	7	1.6
Colonoscopic polypectomy	6	1.4
Inguinal herniorrhaphy	4	0.9
Meckel's diverticulectomy	3	0.7
Colotomy-polypectomy	3	0.7
Colectomy (polyp), umbilical herniorrhaphy, ureteroneocystostomy	2 patients for each procedure	0.5
Small bowel enterotomy, wedge resection liver, pelvic exenteration, coccygectomy, suprapubic cystostomy, exploration pharyngocutaneous fistula, pelvic lymphadenectomy, ileal conduit, orchiectomy, thyroidectomy, mastectomy, lumbar sympathectomy	1 patient for each procedure	0.2

Two hundred eighty-five (66.9 percent) patients were not transfused. The mean intraoperative blood transfusion was 0.7 of a unit. Two (0.5 percent) patients required 9 units each and one (0.2 percent) patient needed 13 units.

Mean hospital stay was 16 (range, 7–58) days. Eight (1.9 percent) patients had prolonged hospitalization in excess of 30 days because of anastomotic leakage.

Intraoperative Complications

These are listed in Table 4. Intraoperative complications occurred in 34 (7.9 percent) patients. Presacral bleeding was the most common complication, occurring in 14 (3.3 percent) patients. There were two splenic injuries, neither requiring splenectomy. There was no ureteric or urethral injury. Three patients each had two intraoperative complications. All three had presacral bleeding. One developed shock as a result, the other two patients had a bladder injury and a small bowel enterotomy, respectively. No statistically significant relationship was found between the type of operation and the occurrence of an intraoperative complication.

Postoperative Complications

Postoperative complications occurred in 214 (50.2 percent) patients. The most frequent postoperative complications are shown in Table 5. Urinary retention after catheter removal occurred in 96 (22.5 percent) patients. There was a statistically significant relationship between postoperative urinary retention and the male sex ($P = 0.001$) and also with previous pelvic surgery ($P = 0.004$). Perineal wound infection occurred in 25 (15.8 percent of the APR group) patients. An anastomotic

Table 4.
Intraoperative Complications

Complications	No. of Patients (N = 34, 8%)	%
Presacral bleeding	14	3.3
Rectal perforation	11	2.6
Bladder injury	4*	0.9
Small bowel enterotomy	3*	0.7
Splenic injury	2	0.5
Hemorrhagic shock	2*	0.5
Anaphylactic shock	1	0.2

* One of each occurred in conjunction with presacral bleeding.

Table 5.
Most Frequent Postoperative Complications

Complications	No. of Patients (N = 426)	%
Urinary retention	96	22.5
Urinary tract infection	68	16.0
Atelectasis	33	7.7
Perineal wound infection	25	15.8 of APR group
Anastomotic leaks	17	7.3
Pneumonia	16	3.8
Ileus	15	3.5
Septicemia	15	3.5
Abdominal wound infection	14	3.3
Small bowel obstruction*	13	3
Perineal wound dehiscence	10	6.6 of closed APR group
Myocardial infarction	8	1.9
Cardiac arrhythmias	7	1.6
Colostomy complications	4	0.9
Respiratory failure	4	0.9

* Four patients required lysis of adhesions.

leak developed in 17 (7.3 percent) patients. Thirteen (3 percent) patients developed a small bowel obstruction, and four of these needed lysis of adhesions. Complications occurring less frequently are listed in Table 6.

The development of postoperative atelectasis (33 patients) obtained statistical significance with respect to age ($P = 0.003$), weight ($P = 0.0012$), pre-existing cardiovascular disease ($P = 0.001$), hypertension ($P = 0.005$), and existing pulmonary disease ($P = 0.027$). The mean age of the patients developing postoperative atelectasis was 70 years compared with a mean age of 63 years for those without postoperative atelectasis. The mean weight of the patients with atelectasis was 85 kg compared with 74 kg for the patients who did not develop postoperative atelectasis. Sixty percent of the patients who developed postoperative atelectasis weighed more than 30 percent of their ideal body weight. The body mass index was significantly greater in those patients who developed atelectasis ($P = 0.0001$).

Further significant relationships were found between postoperative pneumonia (16 patients, 3.8 percent) and pre-existing pulmonary disease ($P = 0.019$); postoperative stroke (2 patients) and age ($P = 0.0186$), cardiovascular disease ($P = 0.014$), and liver disease ($P = 0.012$); postoperative cardiac failure (two patients), postoperative respiratory failure (four patients), and diabetes ($P = 0.004$). Patients with the body weight greater than 30 per-

Table 6.
Less Frequent Postoperative Complications

Three Patients with Each Complication	Two Patients	One Patient
Abdominal wound dehiscence	Death	Epididymorchitis
Deep vein thrombosis	Cerebrovascular accident	Bladder fistula
Pulmonary embolism	Peroneal nerve neuropraxia	Hematemesis
Intra-abdominal abscess	Renal failure	Jaundice
Cholecystitis (cholecystectomy)	Epileptic convulsion	Ureteric obstruction (edema)
	Congestive heart failure	Transient ischemic episode
	Hemorrhagic shock	Perianastomotic abscess
	Myocardial shock	

cent above their ideal body weight had a greater risk of developing cardiac and respiratory failure.

The relationship between the development of postoperative complications and the type of operation obtained statistical significance ($P = 0.037$). Of the 158 patients who had an APR, 94 (59.5 percent) developed at least one postoperative complication. This group had the highest percentage of postoperative complications (Tables 7 and 8). Males developed more postoperative complications than females did ($P = 0.002$). A history of previous pelvic surgery also had a significant association with postoperative complications ($P = 0.018$). The risk of postoperative complications also increased with increasing age and weight. The mean age of those with one or more postoperative complications was 66 years compared with 63 years ($P = 0.006$). The mean weight was 77 kg for those with postoperative complications compared with 74 kg for those without postoperative complications ($P = 0.04$). Of the 214 (50.2 percent) patients with postoperative complications, 132 (30.9 percent) had one postoperative complication. Eighty-two (19.2 percent) patients had two or more postoperative complications. Those patients with four or more complications were all associated with anastomotic leaks.

Twenty-nine (6.8 percent) patients had life-threatening cardiovascular or respiratory complications in the absence of anastomotic leaks (pneumonia, septicemia, myocardial infarction, pulmonary embolus, and respiratory failure). All of these patients survived.

There were two postoperative deaths (0.5 percent), both in patients with Stage $T_xN_xM_1$ carcinomas. One was an 87-year-old man with pre-existing

Table 7.
Operative Procedure and Postoperative Complication Rate

Operation	No. of Patients	No. with Complications	%
APR	158	94	59.5
LAR	137	55	40.1
AR	71	34	47.9
LAR with coloanal anastomosis	25	14	56.0
Hartmann's procedure	24	11	45.8
Colostomy only	11	6	54.5

APR = abdominoperineal resection; LAR = low anterior resection; AR = anterior resection.

cardiovascular and hepatic disease, who died of hepatic failure and a cerebrovascular accident eight days after a diverting colostomy. The other was a 77-year-old female with pre-existing cardiovascular disease. Her APR was complicated by hemorrhage from the presacral veins. She died on the seventh postoperative day from pulmonary edema. Statistical significance was revealed for the presence of cardiovascular disease ($P = 0.01$), liver disease ($P = 0.01$), and age ($P = 0.03$).

Anastomotic leaks occurred in 17 (7.3 percent) patients. Resection with coloanal anastomosis had the highest percentage of leaks (16 percent) (Table 9). Thirteen patients required a celiotomy and a colostomy. One patient had a celiotomy alone and three were treated only with antibiotics. Details of these 17 patients are listed in Table 10. Although resection with coloanal anastomosis had the highest percentage of anastomotic leaks, the relationship between the operative procedure (LAR, AR, and resection with coloanal anastomosis) and anas-

Table 8.
Operative Procedure and Most Frequent Postoperative Complications

Complications	APR (N = 158) (%)	LAR (N = 137) (%)	AR (N = 71) (%)	Coloanal (N = 25) (%)	Hartmann's Procedure (N = 24) (%)	Colostomy Only (N = 11) (%)
Urinary retention	50 (31.5)	25 (18.2)	12 (16.9)	5 (20)	1 (4.2)	1 (9.1)
Urinary tract infection	31 (19.6)	19 (13.9)	8 (11.3)	3 (12)	4 (16.7)	1 (9.1)
Perineal wound infection	25 (15.8)	—	—	—	—	—
Atelectasis	16 (10.1)	4 (2.9)	6 (8.4)	2 (8)	2 (8.3)	2 (18.2)
Perineal wound breakdown	10 (6.3)	—	—	—	—	—
Anastomotic leak	—	10 (7.3)	3 (4.2)	4 (16)	—	—
Septicemia	8 (5.1)	3 (2.2)	2 (2.8)	1 (4)	1 (4.2)	—
Small bowel obstruction	7 (4.4)	2 (1.5)	1 (1.4)	1 (4)	1 (4.2)	1 (9.1)
Abdominal wound infection	7 (4.4)	3 (2.2)	1 (1.4)	—	3 (12.5)	1 (9.1)

Table 9.
Anastomotic Leaks

Operation	No. of Patients	No. of Patients with Anastomotic Leaks	%
LAR	137	10	7.3*
AR	71	3	4.2*
Coloanal	25	4	16.0*
Total	233	17	7.3

LAR = low anterior resection; AR = anterior resection.
* $P = 0.15$.

tomatic leaks did not reach statistical significance ($P = 0.15$). Of the 17 anastomotic leaks, eight were stapled, three were handsewn in two layers, and six were handsewn in one layer.

There were 30 patients with a one-layer handsewn anastomosis, resulting in a failure rate of 20 percent. The relationship between an anastomotic leak and the technique of the anastomosis, therefore, reached statistical significance ($P = 0.008$). Statistical significance was also reached with the method of bowel preparation ($P = 0.05$). All of the anastomotic leaks occurred in patients whose bowel preparation was a combination of laxatives and enemas, instead of using polyethylene glycol. The addition of oophorectomy increased the risk of anastomotic leakage ($P < 0.02$). The reasons were unclear. In the group of patients undergoing a LAR, 25 percent of the anastomotic leaks were staged as $T_xN_xM_1$ ($P < 0.02$). There was no signifi-

cant relationship between any intraoperative complications and an anastomotic leak.

DISCUSSION

This retrospective study confirms that surgery for adenocarcinoma of the rectum continues to carry a high morbidity. The morbidity was essentially early postoperatively (214 patients, 50.2 percent). Intraoperative complications occurred in 34 (8 percent) patients and were not related to any particular operative procedure. Presacral hemorrhage was the most common, occurring in 14 (3.3 percent) patients, two of whom developed hemorrhagic shock. Other authors^{5, 6} report rates were between 4 percent and 7 percent. Splenic injury occurred in two (0.5 percent) patients, neither of whom required a splenectomy. Langevin *et al.*⁷ reported a 0.8 percent incidence of splenic injury in 993 colorectal operations. There was no ureteral injury during this period of study.

The overall postoperative complication rate was 50.2 percent, a high figure, but not at variance with other reports. The most common complications were urologic. Urinary retention occurred in 96 (22.5 percent) patients and urinary tract infection in 68 (15.9 percent) patients. APR had the highest rate at 59.4 percent. Rosen *et al.*'s⁸ study from the Lahey Clinic reported a morbidity rate of 61 percent. Halpern *et al.*⁴ recorded a complication rate of 76 percent following APR with urologic complications comprising 49 percent.

Patients with obstructive airway disease had a significantly greater chance of developing postop-

Table 10.
Details of Anastomotic Leaks

No.	Age (yr)	Sex	Associated Diseases	Operation	Intraoperative Complications	Treatment of Anastomotic Leaks	Other Postoperative Complications	Days in Hospital
1	83	Male	Biliary, diabetes, HT, hypothyroid, DVT	AR 2-layer Handsewn	Presacral hemorrhage	Laparotomy, colostomy	—	55
2	63	Male	Cardiovascular disease	AR 1-layer Handsewn	—	Laparotomy, colostomy	—	21
3	71	Male	Cardiovascular disease, HT, previous pelvic surgery	AR Stapled	Splenic tear	Antibiotics	Urinary retention, septicemia	32
4	43	Female	—	LAR Stapled	Presacral hemorrhage	Antibiotics	—	24
5	77	Female	Hypothyroid	LAR Stapled	—	Laparotomy, colostomy	—	24
6	87	Female	Cardiovascular disease	LAR Stapled	—	Laparotomy, colostomy	Rectovaginal fistula	30
7	61	Male	Diabetes	LAR Stapled	—	Laparotomy only	—	32
8	68	Male	Biliary HT	LAR Stapled	—	Laparotomy, colostomy	Urinary retention	26
9	65	Female	HT steroids	LAR 1-layer Handsewn	—	Laparotomy, colostomy	Abdominal wound infection, UTI, septicemia	32
10	62	Male	—	LAR 2-layer Handsewn	—	Antibiotics	Urinary retention, UTI	28
11	68	Male	HT	LAR 2-layer Handsewn	—	Laparotomy, colostomy	Urinary retention, septicemia	29
12	50	Male	HT	Coloanal	—	Laparotomy, colostomy, proctectomy	—	34
13	56	Male	—	Coloanal	—	Laparotomy, colostomy	Urinary retention, pneumonia	47
14	65	Male	Pulmonary disease, steroids	Coloanal	—	Laparotomy, colostomy	Pneumonia, septicemia	25
15	74	Female	Cardiovascular, CVA, diabetes	Hysterectomy Oophorectomy	—	Antibiotics	Atelectasis UTI, CCF, respiratory failure	33
16	73	Female	Cardiovascular	LAR Stapled	—	Laparotomy, colostomy	—	20
17	77	Male	HT	Oophorectomy LAR Stapled	Operative blood loss 1.5 liters	Laparotomy, colostomy	Atelectasis, pneumonia, respiratory failure, MI, abdominal wound infection, UTI, septicemia, renal failure	58

CCF = congestive cardiac failure; CVA = cerebrovascular accident; HT = hypertension; MI = myocardial infarction; UTI = urinary tract infection.

erative atelectasis and pneumonia ($P = 0.03$ and $P = 0.02$, respectively). This correlated with other reports.^{9,10} Of the 33 patients with postoperative atelectasis, 90 percent of them were above ideal body weight. Sixty percent of patients had a body mass index measurement greater than 30, in the morbidly obese range.¹¹

In the APR group, the perineal wound was closed primarily in 151 (95.6 percent) patients and left open in seven patients. Perineal infection occurred in 25 (16 percent) patients and perineal wound breakdown occurred in 10 (6.6 percent of the closed group) patients. This resulted in a primary healing rate of 76.8 percent. Reported primary healing rates range between 45 percent and 95 percent.^{2,12}

Anastomotic leaks occurred in 17 (7.3 percent) patients. Resection with coloanal anastomosis had the highest percentage of anastomotic leaks (Table 9), but the relationship between the type of operation and the occurrence of anastomotic leakage was not statistically significant ($P = 0.15$). For the patients undergoing LAR and AR, there was no statistical significance when stapled anastomoses were compared with the total group of handsewn anastomoses ($P = 0.06$). However, if the anastomotic techniques for LAR and AR were considered separately, the single-layer anastomosis had a higher leakage rate than the double layers. This could be attributed to the more difficult patients in the group of the single-layer anastomosis. Several studies report an overall leakage rate between 0 percent and 16 percent.^{2,13-16}

The anastomotic leakage rate in patients with a coloanal anastomosis following resection was high at 16 percent. There was a wide range reported in the literature. Parks,¹⁷ reporting on 76 patients undergoing this procedure, recorded leaks in two patients and in an additional eight patients with pelvic sepsis without an obvious leak. Sweeney *et al.*¹⁸ reported an anastomotic dehiscence rate of 47.6 percent in 84 patients. In an earlier study at the Mayo Clinic, Drake *et al.*¹⁹ reported a leakage rate of only 3.4 percent for coloanal anastomosis. Fifty-five percent of that group of patients had a diverting colostomy compared with only 12 percent in this study. Although a complimentary diversion of fecal stream may not prevent an anastomotic leak, its presence may make the leak less serious. An exploratory celiotomy may be avoided in many patients. It should be seriously considered for the very low anastomosis. Combining results

with coloanal anastomosis from the Mayo Clinic and Cleveland Clinic, Cavaliere *et al.*²⁰ reported a major complication rate (stricture, leaks, failure) of 39 percent, with 23 percent of patients having minor complications. The method of bowel preparation also appeared to be significant ($P = 0.02$) in this study, inasmuch as all of the leaks occurred in patients whose preparation consisted of a combination of laxatives and enemas, as compared with patients who were prepared with polyethylene glycol solution. Keighley²¹ noted that this method of bowel preparation resulted in a "perfect preparation" in only 23 percent of his patients.

An anastomotic leak has serious consequences. Three of four patients with anastomotic leaks required reoperation and a colostomy. Although there were no deaths, all patients required a prolonged hospitalization, from 20 to 55 days (Table 10).

Excluding anastomotic leaks, the other potentially life-threatening complications were infective (pneumonia, septicemia) and cardiovascular (myocardial infarction, pulmonary embolus, pulmonary edema). There were 29 (6.8 percent) patients who developed serious infective or cardiovascular complications and survived. The study of Lindmark *et al.*²² showed a 6 percent incidence of cardiovascular complications following surgery for rectal cancer.

The postoperative mortality in this study was 0.5 percent. Both of the patients who died had liver metastasis. One patient had an APR and the other a diverting colostomy only. There was no mortality for the groups undergoing LAR, AR, or resection with coloanal anastomosis. If potentially curative cases alone are considered, then a zero mortality was obtained. Operative mortality rates of 1.9 percent to 9.6 percent were reported in recent studies.²²⁻²⁸

CONCLUSIONS

Surgery for rectal carcinoma could be accomplished with a low mortality. Postoperative morbidity remained high, but most complications were not potentially life-threatening and usually resolved with time and proper management.

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