

Gastrointestinal Anastomoses

Factors Affecting Early Complications

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A retrospective review of gastric and colonic anastomoses during a recent 12-month period was performed at the Mayo Clinic. One hundred sixty-nine patients had gastroduodenal or gastrojejunal anastomoses (Group I). Five hundred nineteen patients had ileocolonic or ileorectal (222) and colocolonic or colorectal (297) anastomoses (Group II). Major anastomotic complication rates for Group I patients were: leaks, 1%; hemorrhage, 2%; and stenosis or obstruction, 2%. Reoperations and deaths secondary to anastomotic complications during the postoperative period were 2% and 0.6%, respectively. Corresponding rates for Group II were 2%, 1%, and 4%, with reoperative and anastomotic death rates of 1% and 0.2%, respectively. In Group I patients, length of operation had a significant effect ($p < 0.01$) on anastomotic complications. In Group II patients, a significant increase in complications was related to the presence of obstruction ($p < 0.001$), recent weight loss (>10 pounds) ($p < 0.02$), malignancy ($p < 0.04$), and sepsis ($p < 0.05$).

THE REPORTED RATES of major complications involving anastomoses of the gastrointestinal tract have varied widely, and debate has centered around the causes of these complications in regard to anastomotic leaks, in particular. To determine the rates of major complications and to determine the pre- and intraoperative factors that affect these rates, we reviewed our experience with gastrointestinal anastomoses during a recent 12-month period.

Materials and Methods

Between January 1, 1982 and December 31, 1982, 688 patients had abdominal surgery at the Mayo Clinic with performance of an anastomosis involving either the stomach (gastroduodenal, gastrojejunal) or the colon (ileocolonic, ileorectal, colocolonic, or colorectal). The records of these patients were reviewed retrospectively

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for multiple preoperative (Table 1) and intraoperative (Table 2) variables that might affect the rate of anastomotic complications. A "major complication" was defined as leak, hemorrhage, or obstruction (stenosis). Leaks were defined by any evidence of internal or external fistula, abscess, or intra-abdominal sepsis, and they were identified either at reoperation or *via* examinations with contrast medium. Hemorrhage was defined as significant bleeding (>100 mL/h) in the immediate postoperative period that required emergency reoperation or hemodynamic resuscitation. Minor anastomotic bleeding that did not require transfusion was not included. Obstruction or stenosis was defined as narrowing, kinking, or swelling of significant magnitude to delay or halt normal passage of intestinal contents. This obstruction was defined either endoscopically or radiographically with contrast material. Gastric atony was not included in this group. The rates of minor complications (*e.g.*, wound infection, urinary tract infection, and pneumonia), reoperations, and operative mortality were also analyzed. Results were analyzed by using Fisher's exact test (two tailed), the Wilcoxon test, or Student's *t*-test where appropriate.

Results

Group I

One hundred sixty-nine patients (88 men and 81 women; mean age: 60 years) had either gastroduodenal or gastrojejunal anastomosis. The rates of major anastomotic complications are listed in Table 3. There were no significant differences in these rates among the various

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types of gastric anastomoses, with overall rates for leaks of 1%; hemorrhage, 2%; and stenosis/obstruction, 2%. Reoperations were required in six patients within 3 months of the initial procedure; however, only three patients had re-exploration because of anastomotic complications (2%). The operative mortality rate was 9% overall, with one death (0.6%) secondary to anastomotic complication. Tables 1 and 2 show the rates of anastomotic complications and the various preoperative and intraoperative factors. None of the preoperative factors were significant predictors of complications; however, the presence of malignancy and recent or intraoperative radiation therapy approached significance ($p = 0.07$; $p = 0.09$, respectively). No significant differences were noted when comparing age or sex of patients with or without complications.

Length of surgery was the only intraoperative variable that was significant: 247 minutes for those with anastomotic complications compared with 174 minutes for those without complications ($p < 0.02$). Patients with malignancy had an 8% rate of major complication compared with 1% for patients without malignancy ($p = 0.07$).

Group II

Five hundred nineteen patients (264 men and 255 women; mean age: 63 years) had anastomosis involving

TABLE 1. Preoperative Variables and Risk of Major Complications

	Patients, %	
	Gastric (Group I)	Colonic (Group II)
Steroids		
Yes	8	11
No	4	6
Diabetes mellitus		
Yes	7	8
No	5	6
Obstruction		
Yes	5	37*
No	5	3
Weight loss (malnutrition)		
Yes	12	15†
No	4	5
Malignancy		
Yes	8	7‡
No	1	3
Sepsis		
Yes	0	9§
No	5	5
Hypotension		
Yes	0	15
No	5	5
Radiation therapy		
Yes	18	10
No	4	5

* $p < 0.0001$, † $p < 0.02$, ‡ $p < 0.04$, § $p < 0.05$.

TABLE 2. Intraoperative Variables and Risk of Major Complications

	Patients, %	
	Gastric (Group I)	Colonic (Group II)
Emergency		
Yes	0	12
No	5	6
Technique		
1 layer	0	15
2 layer	5	5
Stapled	6	11
Suture (2 layer)		
Chromic/silk	2	7
Silk/silk	14	0
Vicryl/silk	6	5
Other	6	8
Surgeon		
Resident	5	6
Staff	4	6
Procedure		
Gastrojejunostomy (loop)	5	
Gastroduodenostomy (Billroth I)	0	
Gastrojejunostomy (Billroth II)	2	
Gastrojejunostomy (Roux-en-Y)	12	
Ileocolostomy		4
Colocolostomy		5
Ileorectostomy		10
Colorectostomy		11
Pathology		
Cancer	8	7
Inflammatory	0	4
Ulcer	0	
Other	6	5

the colon or rectum (ileocolonic, ileorectal, colocolonic, colorectal). The rates of major complications were leaks, 2%; hemorrhage, 1%; and stenosis/obstruction, 4%. The reoperation rate was 2% overall (1% secondary to anastomotic complications) and the mortality rate was 3% (0.2% secondary to anastomotic complications).

There were no statistically significant differences in the rates of leak (1% and 5%) or hemorrhage (1% and 0%) for anastomoses performed above or below the peritoneal reflection. However, there was a significant difference in the rates of stenosis/obstruction for intraperitoneal and extraperitoneal anastomoses (3% and 9%, $p < 0.02$). Minor complications were noted with increased frequency ($p < 0.0001$) in anastomoses involving the ileum, whereas an increased rate of reoperations ($p = 0.02$) was noted in colocolonic or colorectal anastomoses. No differences were noted when comparing age or sex of patients with or without anastomotic complications.

Several preoperative variables were associated with an increased risk of anastomotic complication (Table 1). Obstruction of the colon (37% and 3%, $p < 0.0001$), recent weight loss of greater than 10 pounds (malnutri-

TABLE 3. *Anastomotic Complications and Type of Anastomosis*

	Patients					
	Anastomotic Leak	Anastomotic Hemorrhage	Anastomotic Stenosis/Obstruction	Minor Complications	Reoperation*	Mortality†
	% (N)	% (N)	% (N)	% (N)	% (N)	% (N)
Gastric (Group I)						
Gastrojejunostomy (73) (palliative)	0	3 (2)	3 (2)	18 (13)	3 (2)	11 (8)
Gastroduodenostomy (18) (Billroth I)	0	0	0	11 (2)	0	6 (1)
Gastrojejunostomy (53) (Billroth II)	0	0	2 (1)	19 (10)	4 (2)	6 (3)
Gastrojejunostomy (25) (Roux-en-Y)	4 (1)	8 (2)	0	28 (7)	8 (2)	16 (4)
Total	1	2	2	19	4	9
Colonic (Group II)						
Colocolostomy (190)	1 (2)	1 (2)	3 (6)	4 (7)	3 (6)	1 (2)
Ileocolostomy (212)	1 (3)	1 (3)	2 (4)	13‡ (28)	0§	4 (9)
Colorectostomy (107)	5 (5)	0	8¶ (9)	2 (2)	3 (3)	2 (2)
Ileorectostomy (10)	0	0	10¶ (1)	30# (3)	0	0
Total	2	1	4	8	2	3

* Reoperation for all causes (secondary to anastomotic complications, 2% in Group I and 1% in Group II).

† Deaths due to any cause (deaths secondary to anastomotic complications, 0.6% in Group I and 0.2% in Group II).

‡ Ileocolostomy higher than colocolostomy ($p < 0.001$) and colorectostomy ($p < 0.001$).

§ Ileocolostomy lower than colocolostomy ($p < 0.02$) and colorec-

tostomy ($p < 0.04$).

¶ Colorectostomy higher than ileocolostomy ($p < 0.02$) and colocolostomy ($p < 0.05$).

¶¶ Colorectostomy and ileorectostomy higher than colocolostomy and ileocolostomy combined ($p < 0.02$).

Ileorectostomy higher than colocolostomy ($p < 0.01$) and colorectostomy ($p < 0.01$).

tion) (15% and 5%, $p < 0.02$), malignancy (7% and 3%, $p < 0.04$), and sepsis (9% and 6%, $p < 0.05$) were all significant. None of the intraoperative variables (Table 2) significantly affected the rate of major anastomotic complications.

Discussion

Much discussion has appeared in the literature concerning anastomotic complications, primarily, anastomotic leaks after colorectal surgery. Rates as high as 50% have been reported when routine postoperative visualization with contrast material has been performed, with corresponding clinical leak rates of 10–30% reported after low anterior resections.¹ Leak rates have been lower for intraperitoneal colonic and gastric anastomoses (8% and 5%, respectively).^{2,3} In this study, leak rates were 1% for gastric and 2% for colonic anastomoses. For colonic anastomoses, there was an increased rate of anastomotic leak in patients with colorectal anastomoses (5% compared with 1%), but this was not statistically significant.

Several studies have reported various factors to be related to an increased rate of anastomotic complications: advanced age, diabetes mellitus, weight loss, emergency surgery, infection, hypotension, prolonged surgery, inexperienced surgeon, and performance of extraperitoneal anastomosis.^{4–6} Our review identified pre-

operative bowel obstruction as the strongest predictor of anastomotic complications (37% compared with 3%, $p < 0.0001$) in colonic surgery; other predictors were significant weight loss ($p < 0.02$), presence of malignancy ($p < 0.04$), and sepsis ($p < 0.05$). No factors in gastric surgery except length of operation ($p = 0.02$) were significant.

The reports concerning the technical aspects of anastomoses have yielded conflicting data concerning anastomotic complications when comparisons were made between sewn and stapled anastomoses,^{7–11} single- and double-layered sewn anastomoses,¹² and everted and inverted sewn anastomoses.¹³ However, the consensus of these studies is that inverted anastomoses are superior to everted anastomoses and that no significant differences exist between single or double and sewn or stapled anastomoses, although the rate of stenosis is increased with stapled or double-layered anastomoses compared with single-layered anastomoses. In our study, the majority of anastomoses were constructed in a double layer, inverting fashion and there was no statistically significant difference when comparing stapled and sewn anastomoses. We did, however, note an increased rate of obstruction/stenosis in anastomoses performed to the rectum ($p = 0.02$).

Our study highlights that the level of anastomotic complications, particularly leaks, can be held to an ac-

ceptable level with attention to technical details regardless of whether the anastomosis is constructed with the stapler or hand-sewn, performed by a resident or a staff surgeon, or performed above or below the peritoneal reflection. The technical principles involving all anastomoses warrant repetition: (1) good blood supply, (2) no tension, (3) adequate lumen, (4) water-tight anastomosis, and (5) no distal obstruction. There is no significant effect of diabetes mellitus, steroid use, age, or sex on rates of complications, but radiation therapy and hypotension may play a role. Colonic obstruction, malignancy, weight loss/malnutrition, and sepsis all had a significant role in anastomotic complications in patients who had colonic anastomoses, and particular care should be taken when these factors are present.

References

- Sharefkin J, Joffe N, Silen W, Fromm D. Anastomotic dehiscence after low anterior resection of the rectum. *Am J Surg* 1978; 135:519-523.
- Debas HT, Thomson FB. A critical review of colectomy with anastomosis. *Surg Gynecol Obstet* 1972; 135:747-752.
- Jansson O, Lundell L, Thulin A. Infectious complications of the abdomen following gastric operations. *Surg Gynecol Obstet* 1983; 156:171-176.
- Fielding LP, Stewart-Brown S, Blesovsky L, Kearney G. Anastomotic integrity after operations for large-bowel cancer: a multicentre study. *Br Med J* 1980; 281:411-414.
- Schrock TR, Deveney CW, Dunphy JE. Factors contributing to leakage of colonic anastomoses. *Ann Surg* 1973; 177:513-518.
- Morgenstern L, Yamakawa T, Ben-Shoshan M, Lippman H. Anastomotic leakage after low colonic anastomosis: clinical and experimental aspects. *Am J Surg* 1972; 123:104-108.
- Nance FC. New techniques of gastrointestinal anastomoses with the EEA stapler. *Ann Surg* 1979; 189:587-598.
- Weil PH, Scherz H. Comparison of stapled and hand-sutured gastrectomies. *Arch Surg* 1981; 116:14-16.
- Chassin JL, Rifkind KM, Sussman B, et al. The stapled gastrointestinal tract anastomosis: incidence of postoperative complications compared with the sutured anastomosis. *Ann Surg* 1978; 188:689-696.
- Scher KS, Scott-Conner C, Jones CW, Leach M. A comparison of stapled and sutured anastomoses in colonic operations. *Surg Gynecol Obstet* 1982; 155:489-493.
- Beart RW Jr, Kelly KA. Randomized prospective evaluation of the EEA stapler for colorectal anastomoses. *Am J Surg* 1981; 141:143-146.
- Goligher JC, Lee PWG, Simpkins KC, Lintott DJ. A controlled comparison of one- and two-layer techniques of suture for high and low colorectal anastomoses. *Br J Surg* 1977; 64:609-614.
- Goligher JC, Morris C, McAdam WAF, et al. A controlled trial of inverting versus everting intestinal suture in clinical large-bowel surgery. *Br J Surg* 1970; 57:817-822.