Influence of depth of suture bite on integrity of single-layer large-bowel anastomoses: controlled trial¹

M J Greenall FRCS

Mary Evans BA

A V Pollock FRCS

Scarborough Hospital, Scarborough, North Yorkshire

Introduction

Provided technique is faultless, the major determinants of anastomotic dehiscence are old age, malnutrition, disseminated cancer, low anterior resection, the presence of peritoneal sepsis and poor mechanical cleansing of the bowel (Irvin & Goligher 1973).

Good technique is essential. Certain aspects are self-evident: an adequate blood supply to the ends being joined; lack of tension on the anastomosis; and the use of an appropriate suture material.

Some technical refinements, however, are controversial, and we are unaware of any study of the effect on anastomotic integrity of varying the suture distance from the edges of the bowel. Cadaver studies (Leaper *et al.* 1977) showed that the suture-holding capacity of incised abdominal wall depends largely on the distance at which the sutures are inserted from the cut edges, and it seemed logical to extend this concept of the 'deep bite'. We have, therefore, compared colonic anastomoses made by a single layer of interrupted inverting sutures placed at either 5 mm or 10 mm from the cut edges of the bowel.

Patients and methods

First, a spring balance was used to measure the stress required to tear sutures out of the full thickness of transected cadaver colons.

The clinical study, which lasted two years, concerned 100 consecutive patients (excluding one who had an abdomino-anal anastomosis) requiring end-to-end colonic or colorectal anastomoses, who were randomly allocated to have bowel sutures placed either 5 or 10 mm from the cut edges. Table 1 shows that the groups were well-matched.

Ninety-four of the operations were elective, the remaining 6 being emergency right hemicolectomies for obstruction or perforation. Primary anastomoses were not done for obstructing lesions of the left colon. Seventy-three of the operations were for carcinoma.

During the period of the study we were also assessing methods of bowel preparation. With the exception of emergencies, all patients were admitted three days before operation and given a low-residue diet and magnesium sulphate to the point of considerable diarrhoea. The antibacterial regimens are shown in Table 2.

When a colorectal anastomosis lay above the peritoneal reflection the operation was classified as a high, and when below the reflection as a low, anterior resection. In both cases the rectum was mobilized. Colostomy closures were intraperitoneal and sometimes involved resection of the bowel.

Technique of anastomosis

After mobilization, crushing clamps were applied above and below the lesion, and a stainless steel suture inserted into the outer coats around the whole circumference of both ends of the bowel to be joined, at the specified distance from the clamps (Figure 1). These acted as markers

¹ Paper read to Section of Proctology, 22 March 1978. Accepted 2 June 1978

for the depth of suture bite to be taken. The specimen was removed and the anastomosis made without clamps, using a single, full-thickness layer of interrupted, inverting, vertical mattress sutures placed 5 mm apart. The material was braided polyester BPC 4/0 (Mersilene) and the knots were tied on the mucosal surface of the bowel; for the last one or two sutures this was impossible and they were tied on the outside.

All patients having low anterior resections were protected by transverse colostomies, and drains were placed at the site of the anastomosis if it was thought necessary (twice in the 5 mm and three times in the 10 mm group). Faecal content of the bowel and the presence or absence of contamination were recorded.

Clinical anastomotic breakdown was diagnosed either at post-mortem examination or if any of the following complications occurred: general peritonitis, abscess around the anastomosis, passage of pus per rectum, or discharge of faeces through the wound or drain site. About ten days after operation all patients who had had low anterior resections, and all but 3 who had

Table 1. Comparability of the two groups

	5 mm	10 mm
Total number of patients		
Males	20	22
Females	30	28
Age: < 65	7	11
65-74	27	23
75+	16	16
Obese	21	24
Weight loss	11	13
Preoperative anaemia	8	4
Blood transfusion	13	8
Uraemia	1	2
Hypoproteinaemia	11	5
Cardiopulmonary disease	9	11
Indication for resection:		
Carcinoma	36	37
Diverticular disease	8	6
Crohn's disease	6	4
Miscellaneous	0	3
Elective	48	46
Emergency	2	4
Operation performed:		
Right and transverse colectomy	15	16
Left and sigmoid colectomy and high anterior resection	19	16
Colostomy closure	11	12
Low anterior resection	5	6

Table 2. Bowel preparations used in the two groups

	5 mm	10 mm
Nil (emergencies)	2	4
Mechanical preparation alone	7	5
Mechanical preparation + neomycin + phthalylsulphathiazole + tetracycline	23	21
Metronidazole		
Mechanical preparation + metronidazole + tetracycline	9	10

Figure 1. The guide suture inserted at 10 mm from the clamp

had left colon resections, were examined by sodium/meglumine diatrizoate (Gastrografin) enemas to see if subclinical anastomotic leakage had occurred.

The statistical significance of differences between the groups was assessed by the χ^2 test; those in the cadaver study by Student's *t* test.

Results

Cadaver studies

The mean stress required to tear out sutures inserted at 5 mm from the cut edges of the transected colons was 1.10 kg ($n=64$, s.d. 0.38). When inserted at 10 mm the mean stress was 1.95 kg ($n=46$, s.d. 0.66), $t=8.42$, $P<0.001$.

Clinical trial

Deaths: Five patients died (one in the 5 mm and 4 in the 10 mm group – this difference is not statistically significant) and necropsies were done in 4. In only one was there evidence of anastomotic leak (Table 3), but the patient on whom permission for post-mortem examination was refused may also have burst his anastomosis.

Non-fatal anastomotic leakage: Gastrografin enemas were performed in 46 patients. Four X-ray leaks were found in the 5 mm and 6 in the 10 mm group. In addition, one patient in the

Table 3. Analysis of the deaths

Age (years)	Disease	Operation	Depth of bite	Necropsy	Cause of death	Day
70	Obstructing carcinoma of right colon	Right hemicolectomy	10 mm	Yes	Anastomotic leak	5
76	Obstructing carcinoma of right colon	Right hemicolectomy	10 mm	No	?Pulmonary embolus ?Anastomotic leak	9
74	Obstructing carcinoma of right colon	Right hemicolectomy	10 mm	Yes	Respiratory failure	15
70	Carcinomatosis	Colostomy closure	10 mm	Yes	Carcinomatosis	16
66	Perforated Crohn's disease of terminal ileum	Right hemicolectomy	5 mm	Yes	Meningitis	48

former passed pus per rectum, and one in each group developed a temporary faecal fistula (Table 4). There is no significant difference between the groups.

An analysis of other factors which influence anastomotic integrity was made (Table 5). The effects of carcinomatosis, weight loss, low anterior resection, emergency operation, poor bowel preparation and fixity of the lesion stand out.

Anastomotic stenosis: Slight narrowing at the site of resection was found in nearly all patients submitted to contrast enema examination within two weeks of operation, but in no case did this progress to permanent stenosis.

Table 4. Incidence of leaks in the two groups

	5 mm	10 mm
X-ray	4 out of 25	6 out of 21
Clinical (recovered)	2	1
Clinical (died)	0	2
Total	6	9

Table 5. Results

	No. of patients	Patients with anastomotic leak No. (%)
Total	100	15 (15)
Male	42	6 (14)
Female	58	9 (16)
Age: <65	18	3 (17)
65-74	50	8 (16)
75+	32	4 (12)
Operation:		
Right hemicolectomy	31	3 (10)
Closure of colostomy	23	1 (4)
Left colon resection	35	8 (23)
Low anterior resection	11	3 (27)
Emergency	6	3 (50)
Elective	94	12 (13)
Disease:		
Carcinoma - curative operation	62	5 (8)
- palliative operation	11	4 (36)
Diverticulitis	14	3 (21)
Crohn's	9	1 (11)
Miscellaneous	4	2 (50)
Local fixity of lesion	35	8 (23)
Obesity	45	4 (9)
Weight loss	24	6 (25)
Anaemia	12	2 (17)
Hypoproteinaemia	16	1 (6)
Uraemia	3	0 (0)
Blood transfusion	21	4 (19)
Loaded colon at operation	10	3 (30)
No bowel preparation	6	2 (33)
Faecal contamination at operation	5	3 (60)
Surgeon operating:		
Consultant	57	8 (14)
Registrar	43	7 (16)

Discussion

Clinically-significant leaks are found after 5–14% of colonic anastomoses (Schrock *et al.* 1973, Irvin & Goligher 1973), but subclinical extravasation of X-ray contrast medium at the site of two-layer anastomoses was found in 40% of high, and 69% of low, anterior resections (Goligher, Graham & de Dombal 1970).

Many causes of leakage have nothing to do with the technique of anastomosis. Chemotherapy, radiotherapy, blood transfusions and prolonged operations have all been shown to increase the incidence of breakdown (Schrock *et al.* 1973). Rosenberg *et al.* (1971) found that efficient mechanical and antibacterial preparation of the bowel reduced the incidence of failure. Hawley (1973) showed that faecal soiling and peritoneal sepsis significantly impaired the healing of colonic anastomoses, and Crowson & Wilson (1973) incriminated drainage to the site of anastomosis as a cause of breakdown. Bell (1970) noted an increased incidence of leakage when neostigmine had been given at the end of the operation and suggested that it induced contraction of the gut causing excessive tension on the suture line.

Opinion is divided on the question of the safest way to do an anastomosis. Most surgeons invert the ends of the bowel by using two layers of sutures (Goligher 1975). Halsted (1887), on the other hand, advocated a one-layer technique and was the first surgeon to stress the importance of including the strong submucosa in the anastomosis. Other advocates of a single-layer method have included Gambee *et al.* (1956), Matheson & Irving (1975) and Sharma (1977). Controlled trials by Irvin *et al.* (1973) and Goligher *et al.* (1977) revealed little difference between one- and two-layer techniques, but Everett (1975) had only one breakdown in 11 low anterior resections sutured in one layer, compared with 7 out of 14 when two layers were used.

Inversion of the mucosa has been standard practice since the early nineteenth century. Hertzler & Tuttle (1952) challenged this concept, finding that an everting technique was satisfactory in dogs, but Goligher, Morris *et al.* (1970) showed, in a controlled clinical trial, a significantly higher incidence of breakdown after single-layer everting than two-layer inverting anastomoses.

The present trial was undertaken to examine the possibility that deep (10 mm) suture bites might result in more secure anastomoses than shallow (5 mm). The incidence of anastomotic complications was not significantly different between the two groups (which were well-matched in respect of high-risk factors) indicating that sutures placed 5 mm from the cut edges of colon or rectum offer adequate security against tearing out. This is the distance at which staples are inserted by the Russian SPTU gun with which Goligher (1979) has achieved a low incidence of breakdown in rectal anastomoses.

We conclude, therefore, that it is unnecessary to insert sutures for colorectal anastomoses any further than 5 mm from the cut edges.

Summary

One hundred consecutive colonic or colorectal anastomoses were performed with a single layer of interrupted sutures, inserted at 5 or 10 mm from the cut edges of the bowel. Two patients died as a result of anastomotic breakdown, and 3 others suffered non-lethal but clinically apparent leakage. X-ray contrast enemas were performed in 46 patients and revealed asymptomatic leakage in 10. There were no significant differences between the groups in any of these results. Sutures placed 10 mm from the cut edges of the bowel offer no advantages over those placed at 5 mm.

References

- Bell C M A (1970) *Proceedings of the Royal Society of Medicine* **63**, 752
- Crowson W N & Wilson C S (1973) *American Surgeon* **39**, 597–601
- Everett W G (1975) *British Journal of Surgery* **62**, 135–140
- Gambee L P, Garnjobst W & Hardwick C E (1956) *American Journal of Surgery* **92**, 222–227
- Goligher J C (1975) *Surgery of the Anus, Rectum and Colon*. 3rd edn. Baillière Tindall, London

- Goligher J C (1979) *Surgery, Gynecology and Obstetrics* (in press)
- Goligher J C, Graham N G & de Dombal F T (1970) *British Journal of Surgery* **57**, 109–118
- Goligher J C, Lee P W G, Simpkins K C & Lintott D J (1977) *British Journal of Surgery* **64**, 609–614
- Goligher J C, Morris C, McAdam W A F, de Dombal F T & Johnston D (1970) *British Journal of Surgery* **57**, 817–822
- Halsted W S (1887) *American Journal of the Medical Sciences* **94**, 436–461
- Hawley P R (1973) *Diseases of the Colon and Rectum* **16**, 272–277
- Hertzler J H & Tuttle W M (1952) *Archives of Surgery* **65**, 398–405
- Irvin T T & Goligher J C (1973) *British Journal of Surgery* **60**, 461–464
- Irvin T T, Goligher J C & Johnston D (1973) *British Journal of Surgery* **60**, 457–460
- Leaper D J, Pollock A V & Evans M (1977) *British Journal of Surgery* **64**, 603–606
- Matheson N A & Irving A D (1975) *British Journal of Surgery* **62**, 239–242
- Rosenberg I L, Graham N G, de Dombal F T & Goligher J C (1971) *British Journal of Surgery* **58**, 266–269
- Sharma C M P (1977) *Journal of the Royal College of Surgeons of Edinburgh* **22**, 214–217
- Schrock T R, Deveney C W & Dunphy J E (1973) *Annals of Surgery* **177**, 513–518

Conferences

4–7 July 1979

Human placenta: proteins and hormones

in Siena, Italy

Information from: Serono Symposia

International, Bessemer Road,

Welwyn Garden City, Herts AL7 1HH, UK

11–13 July 1979

Polypeptide hormones

in Baltimore, Maryland, USA

Information from: Edward G Bassett, PhD,

Miles Laboratories, Inc, PO Box 40,

Elkhart, Indiana 46515, USA

11–12 October 1979

International symposium on pathophysiology of puberty

in Bologna, Italy

Information from: Serono Symposia,

Via Casilina 125, Rome, Italy 00176

23–26 October 1979

First international colloquy of angiology

in Florence, Italy

Information from: Serono Symposia

International, Bessemer Road,

Welwyn Garden City, Herts AL7 1HH, UK

4–8 December 1979

IV Asian cancer conference

in Bombay, India

Information from: Indian Cancer Society,

E Borges Road, Parel, Bombay 400 012, India

2–5 September 1980

IV International symposium on facial nerve surgery

in Los Angeles, California, USA

Information from: Ear Research

Institute, 256 South Lake Street,

Los Angeles, California 90057, USA