Prognostic factors for survival in colonic perforation

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Abstract. Colonic perforation is an abdominal emergency with high morbidity and mortality. This retrospective study was performed to evaluate the prognostic relevance of several factors and to characterize patients at high risk. One hundred and twelve patients (61 women, 51 men) were treated for colonic perforation from 1979 to 1992. Diverticulitis [65 patients (58%)] and carcinoma [24 patients (21%)] were the commonest pathology. In 62 cases (55%) perforation was found to be covered; 50 (45%) times it was free. 34 (30%) patients had diffuse peritonitis. Resection with primary anastomosis was performed 43 times (7 times with a protective colostomy). Resection without restoration of the intestinal continuity was carried out 53 times (including 49 Hartmann operations). Suture with drainage was performed 16 times mainly after iatrogenic perforation (8 times with a colostomy). The overall mortality was 19.6% (22 patients). The prognostic importance of various factors was investigated by univariate analysis (Wilcoxon and Chi-square test) and stepwise logistic regression including sex, age, underlying disease, localization and type of perforation, degree of peritonitis, pre- or postoperative organ failure, surgical procedure, reoperation, sepsis and the Mannheimer Peritonitis Index (MPI) score. Age over 65 years (relative risk 4.6, $P = 0.0089$), organ failure (relative risk 40, $P = 0.001$) and MPI (relative risk for an increase of 10 points 2.72, $P = 0.001$) proved to be the only risk factors of significance. The patient's course is determined by the septic state, while the underlying pathology and degree of peritonitis did not significantly influence survival.

Résumé. Une perforation colique est une urgence abdominale grevée d'une mortalité et d'une morbidité élevées. Cette étude rétrospective a été entreprise pour évaluer la valeur pronostique d'une série de facteurs et pour caractériser les patients présentant le plus haut risque de complications. Cent-douze patients (61 femmes et 51 hommes) ont été traités pour des perforations coliques entre 1979 et 1992. La diverticulite (65 patients = 58%) et le cancer (24 patients = 21%) sont les pathologies les plus courantes. Dans 62 cas (55%) la perforation était cou-verte, chez 50 malades (45%) elle était en péritoine libre. Trente-quatre (30%) étaient porteurs d'une péritonite diffuse. Une résection avec anastomose première a été réalisée 43 fois (7 fois avec une colostomie de protection). La résection sans rétablissement de la continuité immédiate a été réalisée 53 fois (49 fois selon le procédé de Hartmann). Une suture avec drainage a été réalisée 16 fois, le plus souvent après des perforations iatrogéniques (8 fois avec une colostomie protectrice). La mortalité globale était de 19,6% (22 patients). L'importance pronostique des différents facteurs a été étudiée par une analyse de variables isolées (tests de Wilcoxon et Chi-square) et une analyse des facteurs de régression incluant le sexe, l'âge, la pathologie sous-jacente, la localisation, le type de perforation, le degré de péritonite, les défaillances organiques pré- et post-opératoires, la technique chirurgicale, les réopérations, l'asepsie et l'index de péritonite de Mannheim (MPI). Les seuls facteurs de pronostic qui ont été identifiés sont: l'âge au-delà de 65 ans (un risque relatif de 4,6, $P = 0.0089$), une défaillance organique (risque relatif de 40, $P = 0.001$) et l'index MPI (risque relatif pour une augmentation de 10 points 2,72, $P = 0.001$). L'évolution du patient est déterminée par l'état septique alors que la pathologie sous-jacente et le degré de péritonite n'ont pas d'influence sur la survie.

Perforating lesions of the colon often affect elderly patients and usually present as abdominal emergency with a high morbidity and mortality [1, 2]. Various colonic diseases may result in perforation [2–6]. Whatever the pathology leading to necrosis of the bowel wall, the outcome of perforation is determined by infection. This may result in abscess formation or diffuse peritonitis. Either may cause endotoxinemia and septic shock. Surgical intervention must aim to prevent this occurring by removal of the septic focus [7–9]. As colonic perforation affects a heterogeneous group of patients the outcome is variable. Limited data on the evaluation of prognostic criteria are however available. The aim of this retrospective study

was to assess the prognostic value of several factors and thereby to define patients at high risk.

Patients and methods

The hospital records of all patients who were treated for perforation of the colon from 1979 to 1992 were studied. The following factors were investigated for their prognostic value: sex, age (under or over 65 years), cardiopulmonary disease, the primary pathology, localization of perforation and type (covered or free), degree of peritonitis (local or diffuse, involvement of more than one quadrant of the abdomen), pre- or postoperative organ failure, surgical procedure, occurrence of septic shock, reoperation and the Mannheimer Peritonitis Index (MPI).

Organ failure was defined as follows:

- Renal failure; creatinine clearance below 20 ml/min or hemofiltration necessary
- Circulatory failure, systolic arterial pressure less than 90 mmHg with requirement for catecholamines (dobutamine, epinephrine or norepinephrine)
- Respiratory failure requirement for mechanical ventilation

The MPI-score (10) was evaluated during the first operation and used to assess the septic state.

Statistics

The effect of prognostic factors on survival was determined by the logistic regression model. The strength of each prognostic factor was described by estimates of the relative risk and corresponding confidence intervals, relating the risk of the less favourable to the more favourable level of each factor. All P-values refer to two-sided tests. Comparisons of continuous variables between groups were based on Wilcoxon's test for two independent samples. Possible associations between qualitative variables were judged by Chi-square tests for contingency tables.

Results

Between 1979 and 1992, 112 patients (61 women and 51 men) of median age 68 years (range 18 to 80) were operated on for colonic perforation. Twenty-two patients had cardiopulmonary diseases (congestive heart failure, coronary heart disease, chronic obstructive lung disease) on admission. Diverticulitis [65 (58%)] and cancer [24 (21%)] were the most frequent underlying diseases. Iatrogenic and spontaneous perforations occurred in 17 cases. Six patients had inflammatory bowel disease. The left colon was the predominant site of leakage [99 (88%) patients] (Table 1). Perforation was classified as covered if there was no communication of pus or intestinal contents within the abdominal cavity. Peritonitis was regarded as localized if only one quadrant of the abdomen was affected. Involvement of two or more quadrants was defined as diffuse peritonitis. Details are given in Tables 2 and 3.

A pericolic abscess was found at operation in 35 cases. These formed 56% of all patients with a covered perforation. Peritoneal fluid was described as clear in 47 (42%)

Table 1. Localization and underlying disease; ( ) = number of deaths

Underlying disease	Number of patients	Right-sided colon	Left-sided colon
Diverticulitis	65 (10)	2 (1)	63 (9)
Carcinoma	24 (9)	6 (3)	18 (6)
Inflammatory bowel disease	6 (0)	3 (0)	3 (0)
Spontaneous, iatrogenic perforation	17 (3)	2 (0)	15 (3)
Total	112 (22)	13 (4)	99 (18)

Table 2. Type of perforation and underlying disease; ( ) = number of deaths

Underlying disease	Number of patients	Covered	Free
Diverticulitis	65	42 (4)	23 (6)
Carcinoma	24	16 (5)	8 (4)
Inflammatory bowel disease	6	2 (0)	4 (0)
Spontan., iatrogenic perforation	17	2 (0)	15 (3)
Total	112	62 (9)	50 (13)

Table 3. Degree of peritonitis and underlying disease; ( ) = number of deaths

Underlying disease	Number of patients	None	Localized	Diffuse
Diverticulitis	65	17 (0)	31 (4)	17 (6)
Carcinoma	24	6 (0)	10 (4)	8 (5)
Inflammatory bowel disease	6	0	1 (0)	5 (0)
Spontan., iatrogenic perforation	17	9 (3)	4 (0)	4 (0)
Total	112	32 (3)	46 (8)	34 (11)

cases, turbid in 19 (17%), purulent in 24 (21%) and faculent in 22 (20%). Preoperative organ failure was present in 5 patients. Operations on the left colon predominated (99 patients, 88%). They could be divided into four general groups as follows: Resection with primary anastomosis; resection with primary anastomosis and colostomy; resection without restoration of intestinal continuity (Hartmann's operation, subtotal colectomy with ileostomy and right-sided hemicolectomy with ileostomy); suture of the perforation with or without colostomy. Details of complications and mortality are shown in Table 4. Tables 5 and 6 give the outcome of the four treatment groups in relation to the degree of peritonitis and underlying disease.

Primary anastomoses were performed in 16 cases with localized peritonitis. The site of anastomosis had to be away from the site of the abscess for this to be feasible. A primary anastomosis was performed in four patients with diffuse peritonitis. All of these patients had a peritonitis at an early stage with no sign of organ failure.

The overall mortality was 19.6% (22 patients). There was no significant difference in mortality between the

Table 4. Surgical procedures and outcome

Surgical procedure	n	Complications	n	Mortality	n
Primary anastomosis	36	Anastomotic leak (2) Bowel obstruction (1) Intraabdominal abscess (1)	4	Septic shock after anastomotic leak (6) Myocardial infarction (2)	8
Primary anastomosis and protective stoma	7		0	Pulmonary embolism (1)	1
Hartmann's reaction	53	Intraabdominal abscess (1) Wound infection (1)	2	Septic shock because of progressive peritonitis (7) pulmonary embolism (2)	9
Suture of the perforation	8	Leakage, reoperation (1)	1	Septic shock (1) Pneumonia (1)	2
Suture of the perforation and protective stoma	8			Septic shock (2)	2
Total	112		7		22

Table 5. Surgical procedures in relation to degree of peritonitis; ( )=number of deaths

Degree of peritonitis	Number of patients	Primary anastomosis	Anastomosis and stoma	Hartmanns	Suture of perforation
No peritonitis	32 (3)	16 (2)	1 (0)	6 (0)	9 (1)
Localized peritonitis	46 (9)	16 (5)	3 (1)	23 (2)	4 (1)
Diffuse peritonitis	34 (10)	4 (1)	3 (0)	24 (7)	3 (2)
Total	112	36 (8)	7 (1)	53 (9)	16 (4)

Table 6. Surgical procedure in relation to underlying disease; ( )=number of deaths

Underlying disease	n	Primary anastomosis	Anastomosis and stoma	Hartmanns	Suture of perforation
Diverticulitis	65	22 (3)	4 (1)	33 (5)	6 (1)
Cancer	24	9 (4)	3 (0)	11 (4)	1 (1)
Inflammatory bowel disease	6	2 (0)	0	4 (0)	0
Spontan., iatrogenic perforation	17	3 (1)	0	5 (0)	9 (2)
Total	112	36 (8)	7 (1)	53 (9)	16 (4)

treatment groups (Chi-square test). Death occurred in nine of 53 patients having resection without restoration of intestinal continuity. This was due to progressive septic shock in 7 cases. Leakage occurred in one case after suture of a perforation and in 8 after primary anastomosis without protective colostomy, six of whom died. Anastomotic leakage did not occur in patients with a protective colostomy. Death due to cardiorespiratory causes occurred in 6 cases (2 times myocardial infarction, 3 times massive pulmonary embolism and pneumonia once).

In 6 patients major complications were successfully treated by reoperation. These included anastomotic leakage (3 cases), intraabdominal abscesses (2 cases), and small bowel obstruction (1 case).

Two patients developed a wound infection. Of 15 patients who required reoperations, 9 (60%) died. Of these, six followed anastomotic leakage and 3 progressive ab-

dominal sepsis after discontinuity-resections. Twenty-seven required intensive care treatment. Of these, five developed preoperative and 13 postoperative organ failure. One or two organs failed in 8 cases; multiple organ failure occurred in 10. Of these 18 cases, 16 died. The MPI score was between 0 and 20 in 80 patients (mortality 10%), between 20 and 30 in 18 cases (mortality 28%) and over 30 in 14 cases (mortality 64%). These differences were significant (Wilcoxon test $P = 0.026$). Forty-seven of 56 patients who survived without anastomosis resection or a procedure with protective stoma underwent subsequent restoration of intestinal continuity. All survived restorative surgery with no anastomotic leakage.

Factors considered to have possible prognostic relevance were studied by univariate analysis (Chi-square and Wilcoxon test). The results are presented in Table 7. Age over 65 years, cardiopulmonary diseases, pre- or postoperative organ failure, complications, development

Table 7. Prognostic factors after univariate analysis ($P<0.05$, Chi-square and Wilcoxon's test)

Prognostic factors	Number of patients	P-value
Age >65 years	62	0.005
Cardiopulmonary disease	22	0.005
Diffuse peritonitis	34	0.05
Septic shock	12	0.04
Reoperation	15	0.003
Organ-failure	18	0.001
MPI>30	13	0.026

Table 8. Prognostic factors after logistic regression analysis

Prognostic factor	Relative risk	95% confidence interval	P
Age >65 years	4.6	1.47–14.9	0.0089
MPI (increase of 10 points)	2.72	1.35–8.21	0.001
Organ-failure	40	4.78–331.2	0.0007

of sepsis, reoperations, and a MPI score of more than 30 resulted in a significant increase in mortality. Multiple logistic regression analysis confirmed independent prognostic influence only for organ failure (relative risk 40, $P=0.0001$), MPI (relative risk for an increase of 10 points 2.72, $P<0.001$) and age over 65 (relative risk 4.6, $P=0.0089$) (Table 8). Type of perforation and the degree of peritonitis did not affect survival.

Discussion

Diverticulitis represents the most common cause of large bowel perforation [1, 11, 12]. Nevertheless, this occurs only in a minority of patients with the condition [2]. Perforation usually is covered and leads to abscess formation. Free perforation with diffuse peritonitis occurs rarely. According to a review by Krukowski [2] the average number of patients with diffuse peritonitis after diverticular perforation was 5 per year (range 1 to 7) in 34 hospitals. Our findings of 17 patients in 12 years (26% of all cases with diverticular perforation) confirm these results. Despite the substantial mortality of 9–13% according to Krukowski, and 15% in the present series, patients with diverticular perforation compare favourable to those with perforating cancer [1, 3]. Perforation occurs in 3 to 8 percent of all cancer patients [13, 14] and is associated with an advanced tumour stage [3]. In our patients with cancer 62% have had T4 and 31% T3-tumours. Lymph node metastases have been found in 62% of all patients and distant metastases had developed in 50%. Mortality usually is high (30%) and most often a result of sepsis [3]. Long-term survival in cancer patients is significantly decreased compared to those without perforation [3].

Ulcerative colitis complicated by perforation usually affects patients with advanced disease as in toxic megacolon. Reported mortality rates as high as 50 percent

[4, 15]. Crohn's disease most often leads to covered perforation and abscess formation, but may also produce diffuse peritonitis [16, 17]. In our study one patient with Crohn's disease developed diffuse peritonitis after multiple perforations of the terminal ileum, the ascending and transverse colon.

Perforation after colonoscopy respresent a special situation. Owing to the bowel preparation, faecal contamination is low. Conservative treatment has been applied successfully [5]. Simple suturing of the lesions is often an appropriate treatment. Nevertheless, 10 percent of all patients die after this complication according to Hall [5]. In our series the mortality rate was 11%.

Most perforations occur in the sigmoid colon and rectum. Only right sided perforation occurs most frequently in Crohn's disease and obstructed carcinoma complicated by rupture of the cecum [18, 3]. It has been regarded to be less dangerous perhaps owing to the greater safety of an ileocolic anastomosis even in the presence of peritonitis [19] but Runkel [3] has reported a mortality of 20%. This high mortality has been confirmed by others [20, 21]. In the present series, right-sided perforations resulted in a higher mortality of 31%, higher than left-sided ones (18%) although this difference was not statistically significant.

There has been debate on the appropriate surgical procedure to be used. Simple suture of the perforation should only be performed after iatrogenic injury e.g. during colonoscopy, or in patients who are not fit for any other procedure (7 in our series). In all other situations primary resection of the septic focus is regarded as the safest approach. The question then arises as to whether a primary anastomosis should be done with our without a protective stoma or whether a Hartmann type procedure should be carried out. The latter is a fast and safe operation, especially in severely ill patients and most surgeons use it in cases with diffuse peritonitis [2].

Subtotal colectomy with ileostomy and mucous fistula formation if possible is the treatment of choice in perforated toxic megacolon [18]. Subsequent reconstructive surgery is often difficult and the morbidity and mortality of reanastomosis have to be added to those of the first operation when comparing the results to one-staged procedures [21]. Many elderly and weak patients cannot or do not wish to undergo a second operation and therefore have to live with a colostomy [1]. We were however able to perform second stage restorative surgery in 84% of all patients without any major complications.

Primary anastomosis takes more time than a Hartmann type procedure and there is a risk of anastomotic leakage [23]. Primary anastomosis in peritonitis was first recommended by Madden in 1966 [11]. In a recently published study Mealy demonstrated good results after one-stage emergency surgery with a mortality of 5.2% and a leak rate of 7.2% [1].

In the present series there was a high rate of anastomotic leakage (22%, 8/36) and mortality (22%) after primary anastomosis. Complications occurred equally often in patients with localized and diffuse peritonitis. Patients with perforated cancers had the greatest risk of anastomotic insufficiency (33%).

Ultimately the decision on which procedure to perform has to be made by the surgeon at the time of the operation. We feel it is justified to perform a primary anastomosis in peritonitis in a small group of patients in good general condition and where the bowel can be joined without tension. In all other situations especially in critically ill patients and patients with perforating cancers a Hartmann procedure should be used.

Peritonitis and septic state

Peritoneal contamination with intestinal bacteria rapidly leads to endotoxinemia and septic shock [24]. The course of sepsis, once perforation of the colon has occurred, develops independently of the underlying disease. The septic state of the patients cannot be related to the degree of peritonitis. For example, a small pericolic abscess may result in septic shock. Intensive care and surgical treatment are the main stay in preventing progression to organ failure. This included stabilization of the patient's state preoperatively and eradication of the septic focus by operation as soon as possible. Despite modern intensive care septic shock is associated with a high mortality. According to our analysis organ failure and an MPI score of over 30 are the most powerful prognostic factors in colonic perforation.

The prognosis of patients with large bowel perforation is determined by the development of septic shock. The underlying disease does not influence survival. Surgical therapy must eliminate the septic focus in order to interrupt the infective process.

References

1. Mealy K, Salman A, Arthur G (1988) Definitive one-stage emergency large bowel surgery. Br J Surg 75:1216–1219
2. Krukowski Z, Matheson N (1984) Emergency surgery for diverticular disease complicated by generalized and fecal peritonitis: a review. Br J Surg 71:921–927
3. Runkel N, Schlag P, Schwarz V, Herfarth C (1991) Outcome after emergency surgery for cancer of the large intestine. Br J Surg 78:183–188
4. Greenstein A, Barth J, Sacher D, Aufses A (1986) Free colonic perforation without dilatation in ulcerative colitis. Am J Surg 152:272–275
5. Hall C, Dorricott N, Donovan I, Neoptolemos J (1991) Colon perforation during colonoscopy: surgical versus conservative management. Br J Surg 78:542–544
6. Serpell J, Nicholls RJ (1990) Stercoral perforation of the colon. Br J Surg 77:1325–1329
7. Botsford T, Zollinger R, Hicks R (1971) Mortality of the surgical treatment of diverticulitis. Am J Surg 121:702–705
8. Eng K, Ranson J, Localio A (1977) Resection of the performed segment. Am J Surg 133:67–72
9. Rodkey G, Welch C (1984) Changing patterns in the surgical treatment of diverticular diseases. Am Surg 200:466–478
10. Linder M, Wacha H, Feldmann U, Wesch G, Gundlach E, Streifensand R (1987) Der Mannheimer Peritonitis-Index. Chirurg 58:84–92
11. Madden J (1966) Treatment of perforated lesions of the colon by primary resection and anastomosis. Dis Colon Rectum 9:413–416
12. Thow G (1980) Emergency left colon resection with primary anastomosis. Dis Colon Rectum 23:17–24
13. Kelley W, Brown P, Lawrence W, Terz J (1981) Penetrating, obstructing and perforating carcinomas of the colon and rectum. Arch Surg 116:381–384
14. Kyllonen L (1987) Obstruction and perforation complicating colorectal carcinoma. Acta Chir Scand 153:607–614
15. Albrechtsen D, Bergon A, Nygaard K, Gjone E, Flatmark A (1981) Urgent surgery for ulcerative colitis: early colectomy in 132 patients. World J 5:607
16. Bundred N, Dixon J, Lumsden A (1985) Free perforation in Crohn's colitis: a ten-year review. Dis Colon Rectum 28:35
17. Steinberg D, Cook W, Alexander-Williams J (1973) Free perforation in Crohn's disease. Gut 14:187
18. Jones P (1987) Emergency abdominal surgery, Blackwell, Oxford London, pp 261–268
19. Goligher J (1975) Surgery of the anus, rectum and colon, 3rd edn. Bailliere Tindall, London
20. Waldron R, Donovan I (1986) Mortality in patients with obstructing colorectal cancer. Ann R Coll Surg Engl 68:219–221
21. Dutton J, Hreno A, Hampson L (1976) Mortality and prognosis of obstructing carcinoma of the large bowel. Am J Surg 131:36–41
22. Nagorney D, Adson M, Pemberton J (1985) Sigmoid diverticulitis with perforation and generalized peritonitis. Dis Colon Rectum 28:71–75
23. Gregg R (1987) An ideal operation for diverticulitis of the colon. Am J Surg 153:285–290
24. Bone R, Fisher C, Clemmer T, Slotman G, Metz C, Balk R (1989) Sepsis syndrome: A valid clinical entity. Crit Care Med 17:389–393

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