Lessons learned from one thousand consecutive colonic resections in a teaching hospital

Buchs, Nicolas; Gervaz, Pascal; Bucher, Pascal Alain Robert; Huber, Olivier; Mentha, Gilles; Morel, Philippe

Peer reviewed article

Lessons learned from one thousand consecutive colonic resections in a teaching hospital

Nicolas C. Buchs, Pascal Gervaz, Pascal Bucher, Olivier Huber, Gilles Mentha, Philippe Morel

Department of Surgery, University Hospital Geneva

Summary

Background: The aim of this study was to assess the risk factors associated with mortality and morbidity following colorectal surgery.

Methods: All data regarding patients who underwent colonic resection in our institution between November 2002 and February 2006 were prospectively entered into a computerised database.

Results: Over a 40-month period 1,016 colonic resections were performed (43 ileocecal; 225 right; 11 transverse; 98 left; 287 sigmoid; 52 subtotal; 108 low anterior; 29 abdominoperineal resections; 103 Hartmann; 46 reversal of Hartmann; and 14 proctocolectomy). The most common indications for surgery were: adenocarcinoma (44%); diverticulosis (19%); complicated diverticulitis (12%); adenoma (4%); and inflammatory bowel disease (4%). There were 719 (71%) elective and 297 (29%) emergency procedures. Overall mortality and morbidity rates were 5.4% and 20.7% respectively. The anastomotic leak rate was 3.8% (31 leaks out of 809 anastomoses). In univariate analysis, patients who underwent elective surgery had lower mortality (0.7% vs. 17%, p <0.001) and morbidity rates (17% vs. 30%, p <0.001), as well as a shorter hospital stay (12.4 days vs. 19.9 days, p <0.001). In multivariate analysis ASA score ≥3 and emergency surgery were both associated with increased mortality (p <0.001) and morbidity (p <0.001) following colonic resection.

Conclusion: Elective colectomies are standard procedures carrying below 1% mortality; by contrast, emergency colonic resections remain surgical challenges in compromised and/or elderly patients and are associated with high complication rates.

Key words: colorectal surgery; outcome; training; specialisation; prospective; emergency

Introduction

In 2004, according to the Swiss Federal Statistical Office, more than 6,300 colorectal resections were performed in Switzerland with a mean hospital stay of over 15 days [1]. These procedures, usually of intermediate complexity, are routinely performed in most institutions: however, complications of this type of surgery are severe and easily recognisable, resulting in significant morbidity and prolongation of hospital stay [2]. Thus for teaching institutions colorectal resections provide a good surrogate for assessment of surgical quality [3]. However, very few data have so far been published in this country which would help to identify the risk factors associated with morbidity and mortality following colorectal surgery.

Large series from the United States and Europe have reported the experience of highly specialised centres, but only 6 prospective multicentric studies [4–9] including more than 1000 patients have focused on mortality/morbidity rates

No financial support declared.

Table 1

Clinical outcome after colonic resection in prospective series >1,000 patients.

Reference	Year(s)	N	Mortality overall (%)	Morbidity overall (%)	Emergency surgery (%)	Mortality elective (%)	Mortality emergency (%)	Comments
Khuri [4]	1991-3	13,310	6.9	N/A	18.6	N/A	N/A	Multicentric
Alves [5]	2002	1,421	3.4	35	19	1.5	11.1	Multicentric
Tekkis [6]	1999-2001	8,077	7.5	N/A	19.8	5.6	14.9	Multicentric
Mella [7]	1994-5	3,221	7.6	N/A	17.1	5.5	21.7	Cancer
Köckerling [8]	1995-8	1,143	1.57	22.3	0	1.57	N/A	Laparoscopic
Longo [9]	1991-5	5,853	5.7	28	15	N/A	N/A	Cancer
Buchs	2002-6	1,016	5.4	20.7	29	0.7	16.8	

after colorectal surgery. The results in these six series, which are summarised in Table 1, indicate that colorectal surgery is still associated with a 5–6% mortality rate and a 20–40% morbidity rate [10–12]. Numerous risk factors have been identified, including ASA grade, advanced age and operative urgency.

Provision of accurate, clinically valid and prospectively collected information is a prerequisite for the evaluation of healthcare quality in Swiss teaching hospitals. The aim of this study was therefore to assess the risk factors associated with mortality and morbidity in a large cohort of consecutive patients undergoing colorectal surgery in a single institution.

Methods

From November 2002 to February 2006, all consecutive patients undergoing elective or emergency resection of the colon or rectum in our institution were prospectively included in this study. Colorectal procedures which did not result in a formal bowel resection (i.e. rectopexy, transanal excision of rectal tumors, isolated creation or closure of colostomy/ileostomy) were excluded from this analysis.

The structured data collection sheet included the following items:

1) Patient characteristics: gender; age; ASA score; body mass index; comorbidity (cardiopulmonary, neurological, hepatic, renal).

2) Disease features: cancer, polyp, diverticulosis, diverticulitis, inflammatory bowel disease and its mode of presentation (pain, alteration of bowel habits, constipation, diarrhoea, bleeding).

3) Surgical procedure: urgent or elective; open or laparoscopic; type of anaesthesia; type of incision; duration of the procedure; blood loss; amount of homologous blood transfused; type of resection (right, transverse, left, sigmoid, low anterior, abdomino-perineal); type and location of anastomosis (manual or stapled, ileocolic, colocolic, colorectal, coloanal, ileorectal, ileoanal).

4) Postoperative events: mortality and its cause; morbidity (wound infection; prolonged ileus; fever >38.5° C; intraabdominal abscess; clinical anastomotic leak; pneumonia; cardiopulmonary failure; arrhythmia; renal failure; bleeding; pulmonary embolism; deep vein thrombosis; sepsis); and the need for reintervention.

In this study, postoperative mortality was defined as a death during the hospital stay. The surgeon himself was responsible for completing the data sheet at the end of the operation, and a dedicated clinical nurse (BK) was in charge of prospectively collecting the information regarding postoperative course and the date of discharge. The University Hospital in Geneva is the only public medical institution in a mainly urban area with a population of approximately 500,000 inhabitants. Annually, more than 300 colonic resections (5% of all colectomies done in Switzerland) are performed in our Department.

Statistical analysis

Statistical analyses were undertaken by means of the software package STATGRAPH 3.0 software for Windows (Statgraph Software Inc., San Diego, CA). Quantitative data were expressed as median (range). Group comparisons were made using two-sided Fisher's exact test for categorical variables, and two-sided Student t-test for continuous variables. Multivariate analysis was performed using the software GB-STAT (Dynamic Microsystems Inc, Silver Spring, MD, USA). Multiple strait regression models were used to test identified independent factors in relation to the dependent variables, mortality or morbidity. P values less than or equal to 0.05 were considered statistically significant.

Results

Patients and procedures

Over a 40-month period one thousand and sixteen colectomies were performed in our institution. The patients were 534 women (52.5%) and 482 men (47.5%) with a median age of 68 (range 17–98) years. The median duration of hospital stay was 11 (range 2–205) days. The procedures and indications for surgery in this series are summarised in Table 2. Roughly half of the operations were performed for tumours and one third for diverticular disease. The median duration of the procedure was 180 (range 50–640) minutes

There were 719 (71%) elective and 297 (29%) emergency procedures. In emergency surgery, 61% of patients were ASA $\geq$3, and 71% of patients with an ASA score of 4 were emergency cases. In elective procedures 72% of patients were ASA $\leq$2. 194 (27% of elective procedures) patients were initially scheduled for laparoscopic resection, which was successfully completed in 165 patients (15% conversion rate).

Mortality and morbidity

Overall mortality and morbidity rates were 5.4% and 20.7% respectively. Table 3 summarises surgical and medical complications in this series. 366 complications were observed in 211 patients. Anastomotic leak, wound infection, multiple organ failure, arrhythmia, respiratory failure, pneumonia, intraabdominal abscess and prolonged ileus were the the complications reported most frequently. The anastomotic leak rate was 3.8% (31 leaks out of 809 anastomoses). The clinical leak rate was highest for ileorectal (12.5%), followed by coloanal (8%) anastomoses; the detailed analysis of risk factors associated with anastomotic dehiscence is summarised in Table 4. In addition, 36 patients (3.5%) required reoperation, mainly due to anastomotic dehiscence.

In univariate analysis (Table 5), the parameters associated with increased postoperative mortality were ASA score III-IV; emergency surgery; and age >70 years. Interestingly, the mortality rate after

Table 2
Clinicopathological characteristics of patients.

Characteristic	Emergency	Elective	Overall
Gender, n (%)			
Female	166 (56)	368 (51)	534 (52)
Male	131 (44)	351 (49)	482 (48)
Body mass index, mean			
	24.5	25.1	25
ASA score, n (%)			
1	8 (2.7)	86 (12)	94 (9.2)
2	90 (30)	394 (55)	484 (48)
3	98 (33)	167 (23)	265 (26)
4	50 (17)	20 (2.8)	70 (6.9)
5	3 (1)	0	3 (0.3)
Undetermined	48 (16)	52 (7.2)	100 (9.8)
Primary pathology, n (%)			
Adenocarcinoma	97 (33)	346 (48)	443 (44)
Diverticulosis	9 (3)	185 (26)	194 (19)
Diverticulitis	76 (26)	51 (7.1)	127 (12)
Other tumours	9 (3)	50 (7)	59 (5.8)
Adenoma	1 (0.3)	29 (4)	30 (3)
Ischaemia	26 (8.7)	2 (0.3)	28 (2.8)
Crohn's disease	7 (2.4)	13 (1.9)	20 (2)
Ulcerative colitis	4 (1.3)	10 (1.4)	14 (1.4)
Volvulus	12 (4)	1 (0.1)	13 (1.3)
Others	56 (19)	32 (4.4)	88 (8.7)
Operations, n (%)			
Sigmoidectomy	32 (11)	255 (36)	287 (28)
Right colectomy	78 (26)	147 (20)	225 (22)
Low anterior resection	9 (3)	99 (14)	108 (11)
Hartmann procedure	95 (32)	8 (1.1)	103 (10)
Left colectomy	24 (8)	74 (10)	98 (9.6)
Subtotal colectomy	29 (9.8)	23 (3.2)	52 (5.1)
Reversal of Hartmann	0 (0)	46 (6.4)	46 (4.5)
Ileocaecal resection	27 (9.1)	16 (2.2)	43 (4.2)
Abdominoperineal amputation	0 (0)	29 (4)	29 (2.9)
Proctocolectomy	1(0.3)	13 (1.8)	14 (1.4)
Transverse colectomy	2 (0.7)	9 (1.2)	11 (1.1)

right colectomy (8%) was not only higher than expected, but also significantly higher than those for left sided resections (sigmoid [2.1%]; low anterior [0.9%]). Similarly, in univariate analysis the parameters associated with increased risk of postoperative morbidity were ASA score III–IV; emergency surgery; age >70 years; and the type of resection, a low anterior resection being associated with a higher complication rate (30%) than sigmoid (13%) or right colon resection (17%) (Table 6).

In multivariate analysis the parameters associated with increased risk of postoperative death were ASA score III–IV; emergency surgery; and surgical/medical complications (Table 7). In multivariate analysis the parameters associated with increased risk of postoperative morbidity were ASA score III–IV; emergency surgery; prolonged duration of the procedure; need for peroperative blood transfusion; and stoma creation (Table 8).

Discussion

To the best of our knowledge this is the first prospective study of more than a thousand consecutive patients undergoing colorectal resection in a single institution. Our data show that, in a non-selected cohort of patients, elective colectomy has become a standard procedure of intermediate complexity, associated with a mortality rate below 1%. However, 29% of patients are operated on as

Table 3
Complications of surgery.

	Emergency	Elective	Overall
Complications, n (%)	205	161	366
Postoperative death	50 (24)	5 (3.1)	55 (15)
Reoperation	15 (7.3)	21 (13)	36 (10)
Anastomotic leak	8 (4)	23 (14)	31 (8.5)
Wound abscess	13 (6.3)	9 (5.6)	22 (6)
Multiple organ failure	19 (9.3)	2 (1.2)	21 (5.7)
Sepsis	17 (8.3)	3 (1.9)	20 (5.5)
Arrhythmia	11 (5.4)	8 (5)	19 (5.2)
Respiratory insufficiency	10 (4.9)	6 (3.7)	16 (4.4)
Pneumonia	6 (2.9)	10 (6.2)	16 (4.4)
Intraabdominal abscess	4 (2)	11 (6.8)	15 (4.1)
Prolonged (>5 days) ileus	8 (3.9)	6 (3.7)	14 (3.8)
Myocardial infarct	3 (1.5)	4 (2.5)	7 (1.9)
Renal failure	4 (1.9)	2 (1.2)	6 (1.6)
Thromboembolic disease	2 (1)	4 (2.5)	6 (1.6)
Others	35 (17)	47 (29)	82 (22)

Table 4
Univariate analysis of factors associated with anastomotic leak.

Variable	Anastomotic leak rate (%)	p
Age		0.85
<70	3.7	
>70	4.0	
ASA		0.40
I–II	2.6	
III–IV	3.8	
Gender		0.46
Male	4.7	
Female	3.4	
BMI		0.17
<25	2.5	
>25	4.8	
Condition		0.19
Cancer	5.0	
Other	2.9	
Anastomosis		0.23
Ileocolic	2.6	
Colorectal	4.6	
Coloanal	8.0	
Ileorectal	12.5	
Ileoanal	0	

emergencies, and in this setting colorectal surgery remains a surgical challenge associated with significant mortality and morbidity rates.

Our results are in accordance with other series reporting postoperative morbidity ranging from 18% to 37% [13, 14]. The overall mortality rate (5.4%) in our series also compares favourably with results reported by others [4–7]. Our mortality rate in elective procedures (<1%) is significantly lower than previous studies [15–17]. By contrast, in our institution the mortality rate after emergency colorectal resection (17%) was higher than in others [5, 6, 18]. Coco et al. [19] also reported a much higher morbidity rate (44% vs. 12%) in the group of patients undergoing emergency surgery.

Three parameters may have an impact on the results of colorectal surgery; (i) the patient's general condition; (ii) the degree of faecal contamina-

Table 5
Univariate analysis of risk factors associated with mortality.

Variable	Mortality rate (%)	p
Age		<0.001
<70	2.8	
>70	8.4	
ASA		<0.001
I–II	0.3	
III–IV	13	
Timing of surgery		<0.001
Elective	0.7	
Emergency	16.8	
BMI		0.2
<25	2.4	
>25	4.1	
Condition		0.01
Cancer	3.5	
Other	7.3	
Type of resection		<0.001
Right colectomy	8.0	
Sigmoidectomy	2.1	
Low anterior	0.9	
AAP	0	
Hartmann	15	
Subtotal	17	

Table 6
Univariate analysis of risk factors associated with morbidity.

Variable	Morbidity rate (%)	p
Age		0.001
<70	17	
>70	25	
ASA		<0.0001
I–II	14	
III–IV	30	
Timing of surgery		<0.0001
Elective	17	
Emergency	30	
BMI		0.35
<25	19	
>25	22	
Condition		0.87
Cancer	21	
Other	20	
Type of resection		<0.001 *
Right colectomy	17	
Sigmoidectomy	13	
Low anterior	30	
AAP	24	
Hartmann	35	

* Low anterior vs. right colectomy

Table 7
Multivariate analysis of risk factors associated with mortality.

Variable	Relative risk (95% CI)	p
ASA ≥3	39.33 (9.6–161)	0.009
Emergency	3.29 (1.33–8.18)	0.006
Complication	7.73 (4.77–12.53)	0.002

Table 8
Multivariate analysis of risk factors associated with morbidity.

Variable	Relative risk (95% CI)	p
ASA ≥3	3.19 (2.54–4)	<0.001
Duration of surgery	1.89 (1.23–2.16)	0.003
Blood transfusion	2.5 (1.98–3.15)	0.01
Emergency	2.72 (2.21–3.33)	0.01
Stoma creation	2.57 (2.11–3.14)	<0.001

tion; and (iii) the surgeon's degree of expertise. Regarding the first parameter, it is obvious that patients who underwent emergency surgery in our institution were often in poor health. In other series an ASA score >3 was an independent risk factor for increased postoperative morbidity [9]. In addition, Alves et al. have shown that four risk factors are related to the patient's characteristics: age over 70, neurological comorbidity, cardiorespiratory comorbidity, and hypoalbuminaemia [5]. Therefore, it is logical to assume that the poor general condition of patients is a major contributing factor to high mortality rates observed after emergency colorectal surgery.

However, the patient's compromised health status is insufficient in itself to explain the much higher risk of dying after emergency surgery; the role of the surgeon is certainly important, although more difficult to assess. In our institution, as in most European countries, emergency colorectal surgery is often performed at night by chief residents: whether this may have an impact on patient outcome remains hypothetical, but there is growing evidence that the results of colorectal surgery are correlated with the surgeon's specialised training: Bates et al. [20] reported that the overall mortality rate in colorectal procedures performed by colorectal surgeons was 1.4%, in contrast to the 7.3% mortality among other surgeons. Other series have clearly demonstrated that patient outcome improved with the surgeon's certification and experience [21–23]. In teaching institutions, where by definition the level of surgical expertise is highly variable, it is therefore important to provide a training programme not only for elective, but also for emergency procedures: in this context it appeared in two series from Australia and UK that outcomes after surgery for colorectal cancer did not differ between the consultant and trainees [24, 25].

We conclude that in Swiss teaching institutions colorectal resections are associated with an overall mortality rate of 5.4%. Elective colectomies are standard procedures carrying mortality of less than 1%, whereas emergency colonic resection remains a surgical challenge in compromised and/or elderly patients, resulting in high mortality and morbidity rates (17% and 30% respectively). One of the vocations of university-based hospitals is the training of young surgeons, and it would be tempting to speculate that the high mortality rate of emergency colorectal procedures is related to the lack of expertise of surgical residents who perform these operations at night. We support a more balanced opinion, and believe that in fact a combination of many factors (high-risk patients in poor condition; faecal contamination; difficult procedures) is responsible for this high mortality rate. However, these data highlight the important role of a closely supervised training programme if the results of emergency colorectal resections are to be improved.

Correspondence:
Pascal Gervaz, P.D.
Service de Chirurgie Viscérale
Hôpital Universitaire de Genève
24 rue Micheli-du-Crest
CH-1211 Genève
E-Mail: pascal.gervaz@hcuge.ch

References

1 www.bfs.admin.ch/bfs/portal/fr/index/themen/gesundheit/gesundheitsversorgung.Supplément CHOP/2004.
2 Cook A, Hyman N. Quality assessment and improvement in colon and rectal surgery. Dis Colon Rectum. 2005;47:2195–201.
3 Vrancken Peeters MP, Vrancken Peeters MJ, Corion LU, Breslau PJ. Quality control of colorectal surgery with an extensive complication registration system. Dig Surg. 2005;22:168–73.
4 Khuri SF, Daley J, Henderson W, Hur K, Hossain M, Soybel D, et al. Relation of surgical volume to outcome in eight common operations. Results from the VA national surgical quality improvement program. Ann Surg. 1999;230:414–32.
5 Alves A, Panis Y, Mathieu P, Mantion G, Kwiatkowski F, Slim K; Association Francaise de Chirurgie. Postoperative mortality and morbidity in French patients undergoing colorectal surgery: results of a prospective multicenter study. Arch Surg. 2005;140:278–83.
6 Tekkis PP, Poloniecki JD, Thompson MR, Stamatakis JD. Operative mortality in colorectal cancer: prospective national study. BMJ. 2003;327:1196–201.
7 Mella J, Biffin A, Radcliffe AG, Stamatakis JD, Steele RJ. Population-based audit of colorectal cancer management in two UK health regions. Colorectal Cancer Working Group, Royal College of Surgeons of England Clinical Epidemiology and Audit Unit. Br J Surg. 1997;84:1731–6.
8 Kockerling F, Rose J, Schneider C, Scheidbach H, Scheuerlein H, Reymond MA, et al. Laparoscopic colorectal anastomosis: risk of postoperative leakage. Results of a multicenter study. Laparoscopic Colorectal Surgery Study Group (LCSSG). Surg Endosc. 1999;13:639–44.
9 Longo WE, Virgo KS, Johnson FE, Oprian CA, Vernava AM, Wade TP, et al. Risk factors for morbidity and mortality after colectomy for colon cancer. Dis Colon Rectum. 2000;43:83–91.
10 Killingback M, Barron P, Dent O. Elective resection and anastomosis for colorectal cancer: a prospective audit of mortality and morbidity 1976–1998. ANZ J Surg. 2002;72:689–98.
11 Tekkis PP, Prytherch DR, Kocher HM, Senapati A, Poloniecki JD, Stamatakis JD, et al. Development of a dedicated risk-adjustment scoring system for colorectal surgery (colorectal POSSUM). Br J Surg. 2004;91:1174–82.
12 Goodney PP, Siewers AE, Stukel TA, Lucas FL, Wennberg DE, Birkmeyer JD. Is surgery getting safer? National trends in operative mortality. J Am Coll Surg. 2002;195:219–27.
13 Ko CY, Chang JT, Chaudhry S, Kominski G. Are high-volume surgeons and hospitals the most important predictors of in-hospital outcome for colon cancer resection? Surgery. 2002;132:268–73.
14 Hyman NH, Ko CY, Cataldo PA, Cohen JL, Roberts PL. The New England colorectal cancer quality project: a prospective multi-institutional feasibility study. J Am Coll Surg. 2006;202:36–44.
15 Anderson JH, Hole D, McArdle CS. Elective versus emergency surgery for patients with colorectal cancer. Br J Surg. 1992;79:706–9.
16 Ondrula DP, Nelson RL, Prasad ML, Coyle BW, Abcarian H. Multifactorial index of preoperative risk factors in colon resections. Dis Colon Rectum. 1992;35:117–22.
17 Oomen JL, Engel AF, Cuesta MA. Mortality after acute surgery for complications of diverticular disease of the sigmoid colon is almost exclusively due to patient related factors. Colorectal Dis. 2006;8:112–9.
18 Slim K, Panis Y, Alves A, Kwiatkowski F, Mathieu P, Mantion G. Predicting postoperative mortality in patients undergoing colorectal surgery. World J Surg. 2006;49:330–5.
19 Coco C, Verbo A, Manno A, Mattana C, Covino M, Pedretti G, et al. Impact of emergency surgery in the outcome of rectal and left colon carcinoma. World J Surg. 2005;29:1458–64.
20 Bates EW, Berki SE, Homan RK, Lindenauer SM. The challenge of benchmarking: surgical volume and operative mortality in Veterans Administration Medical Centers. Best Pract Benchmarking Healthc. 1996;1:34–42.
21 Prystowsky JB, Bordage G, Feinglass JM. Patient outcomes for segmental colon resection according to surgeon's training, certification, and experience. Surgery. 2002;132:663–70.
22 Harmon JW, Tang DG, Gordon TA, et al. Hospital volume can serve as a surrogate for surgeon volume for achieving excellent outcomes in colorectal resection. Ann Surg. 1999;230:404–11.
23 Zorcolo L, Covotta L, Carlomagno N, Bartolo DC. Toward lowering morbidity, mortality, and stoma formation in emergency colorectal surgery: the role of specialization. Dis Colon Rectum. 2003;46:1461–7.
24 Renwick AA, Bokey EL, Chapuis PH, Zelas P, Stewart PJ, Rickard MJ, Dent OF. Effect of supervised surgical training on outcomes after resection of colorectal cancer. Br J Surg. 2005;92:631–6.
25 Aitken RJ, Thompson MR, Smith JA, Radcliffe AG, Stamatakis JD, Steele RJ. Training in large bowel cancer surgery: observations from three prospective regional United Kingdom audits. BMJ. 1999;318:702–3.