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ORIGINAL ARTICLE

Use of severity classification systems in the surgical decision-making process in emergency laparotomy for perforated diverticulitis

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Abstract
Purpose Hartman's procedure (HP) or primary anastomosis (PA) are the two surgical techniques used in patients undergoing emergency colectomy for perforated diverticulitis. There are no objective criteria to guide the surgeon's choice of procedure. This study assesses whether classification and scoring systems can be used in the decision-making process.
Methods One hundred eleven patients undergoing emergency laparotomy for perforated diverticulitis were analyzed. Logistic regression and interaction models were used to determine the predictive value in the two settings.
Results Sixty five patients underwent HP and 46 patients underwent PA. Patients with HP had significantly higher scores, median age, and were more often on immunosuppressive medication. Mortality and surgical morbidity did not differ between the groups. The clinical anastomotic leak rate was 28.3% in the PA group. In the univariate logistic regression for in-hospital death, all scores showed a significant influence. The multivariate logistic regression analysis showed that only Charlson comorbidity index (CCI) and American Society of Anesthesiologists score had a significant influence on mortality. Each score was analyzed for its predictive value regarding mortality and morbidity with respect to type of operative procedure. Only CCI revealed a trend towards statistical significance. The risk of death increases with increasing CCI when PA is performed compared to HP.
Conclusion None of the tested scores can be used to help the surgeon decide whether a PA or HP is appropriate in a specific patient. Comorbidity, represented as CCI in this study, might be more important than the locoregional situation.

Keywords Perforated diverticulitis · Severity scoring · Decision-making process · Hartmann's procedure · Primary anastomosis

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Introduction

Diverticulosis of the colon is a common disease with an incidence of up to 60% in the population over 80 years. Up to 30% of affected patients will develop diverticulitis and 20% of the latter will suffer from perforation [1, 2].

Emergency colectomy is usually indicated in cases of contained or uncontained perforation with localized or generalized peritonitis. Traditionally, the Hartmann's procedure (HP), which includes left-sided colectomy with formation of a colostomy and closure of the rectal stump, has been the operative method of choice. Lately, primary anastomosis (PA), with or without diverting ileostomy, has been advocated as a method with similar mortality and

morbidity but with the advantage that no subsequent reversal of colostomy is required [3–6].

The matter as to which of the two methods should be performed in an individual patient is still unresolved. The result is a high variability of treatment strategies employed by different surgeons [7, 8].

In an ideal setting, the surgeon would decide which of the techniques is indicated based on objective, evidence-based criteria. Several classification systems exist to determine severity of disease and are used to help decide which operation to perform on which patient [9–11]. While some are based solely on loco-regional factors, such as the Hinchey score [12], others combine patient- and disease-related factors to determine a score, such as the Mannheim Peritonitis Index [13]. Still others rely on general patient-related data, as in the Charlson Comorbidity Index (CCI) [14]. Most of these scoring and classification systems have been validated and have been shown to correctly predict mortality in patients with diverticulitis.

The primary aim of this study was to determine whether these different scores can be used in the operative decision-making process by analyzing the effects of those different scores on outcome in patients undergoing HP or PA for perforated left-sided diverticulitis.

Patients and methods

All patients undergoing emergency laparotomy for perforated diverticulitis of the left colon between 2001 and 2006 at the Triemli Hospital, a tertiary referral center in Zurich, Switzerland, were included. Approval from the local ethics committee was obtained.

Emergency laparotomy was performed in patients with a clinical diagnosis of generalized peritonitis, evidence of perforation as indicated by free gas on plain X-rays, or localized peritonitis and contained or uncontained perforation on triple contrast CT scan. Peritonitis was defined as generalized or localized abdominal pain with guarding and rebound tenderness upon palpation. Emergency was defined as a procedure performed within 6 h of making the decision to operate.

Surgical technique

All procedures were performed by or under close supervision of a consultant abdominal surgeon. Operative procedures were performed in a standardized way with minor adaptations depending on individual circumstances. Based on severity of peritonitis and grade of abdominal contamination by pus or feces, co-morbidities, and general condition of the patient, the surgeon on-call decided whether to perform a HP or a PA. No colonic lavage was performed.

After a midline laparotomy and verification of the diagnosis, the sigmoid and descending colon was mobilized. The ureter was identified and the sigmoid artery ligated. The proximal resection margin was defined and the colon divided using a linear stapler after transsection of the mesocolon. The upper rectum was mobilized and the distal resection margin defined within the anatomical rectum to ensure removal of the pressure zone. The rectum was divided using a stapler (TA^{TM} or GIA^{TM}, Autosuture^{TM}, Covidien).

In patients undergoing HP, the rectal stump was oversewn using absorbable monofilament sutures (Biosyn^{TM}, Syneture^{TM}, Covidien). The splenic flexure was mobilized whenever tension-free stoma formation was not possible. Stoma location was in the left abdomen. After preparing the colonic passage through the abdominal wall, washout of the peritoneal cavity with saline was performed. A 15-mm silicone drain was routinely left at the rectal stump. After closure of the abdomen, the bowel lumen was opened and the stoma fashioned with resorbable vertical mattress sutures (4-0 Vicryl^{TM} Rapide, Ethicon).

In patients undergoing PA, the splenic flexure was always mobilized for tension-free anastomosis. Intraoperative colonic lavage was only performed in cases where protective loop ileostomy was considered. The rectal stump was irrigated with dilute betadine solution. For the anastomosis, a circular stapler was used (Premium Plus CEEA^{TM} 31 mm, Autosuture^{TM}, Covidien). The surgeon decided whether a protective ileostomy was necessary, depending on the quality of the anastomosis. Before closure of the abdomen, the integrity of the anastomosis was tested with air and betadine. A silicone drain was left at the anastomotic site.

Data collection

Data was obtained retrospectively (2001-2004) and prospectively (2005-2006) from case notes, intensive care, and anesthetic protocols and surgery reports. Data was complete.

Demographic data assessed were age, gender, and body mass index (BMI). The following classifications and scores were evaluated: Hinchey staging system (Hinchey score) [12], Mannheim peritonitis index (MPI) [13], Charlson comorbidity index [14], American Society of Anesthesiologists score (ASA) [15], colorectal physiological and operative severity score for the enumeration of mortality and morbidity (CR-POSSUM) [16], and Cleveland Clinic diverticular disease propensity score (CDS) [17]. Details of the different scores are shown in Table 1.

Definition of outcome measures

The primary aim was to assess whether the risk of the nominated outcome was dependent upon the different

Table 1 The different scoring systems

Score	Description	Published
Hinchey score [12]	Defines four stages in complicated diverticular disease based on degree of spillage. Stage I and II representing contained abscesses, stage III and IV representing purulent or fecal peritonitis	1978
Mannheim peritonitis index [13]	Predicts the individual risk of death from peritonitis by combining demographic data (age, sex), physiological state (organ failure, malignancy), symptoms related history (duration of symptoms) and loco-regional situation (nature, origin and spread of exudates) to a score	1987
Charlson comorbidity index [14]	Combines comorbidities (e.g., chronic heart failure, diabetes, dementia, malignant diseases) to a score. Does not include physiological state at time of presentation or loco-regional situation	1987
American Society of Anesthesiologists score (ASA) [15]	Assesses physical state of patient before surgery according to five (later six) categories. ASA score I represents a normal healthy patient, ASA scores II and III represent patients with mild to severe systemic disease, ASA scores IV and V represent patients in life-threatening physical conditions. (ASA score VI was developed solely for declared brain-dead persons qualifying for organ donation.)	1963
CR-POSSUM [16]	The dedicated colorectal physiological and operative severity score for the enumeration of mortality and morbidity (CR-POSSUM) equation for predicting operative mortality combines a physiological score (e.g. age, blood pressure and pulse, hemoglobin and urea level) and an operative severity score (e.g., operative urgency, peritoneal soiling).	2004
Cleveland Clinic diverticular disease propensity score (CDS) [17]	Developed for selection of patients for non-restorative procedures in diverticular disease. Combines patient status represented by the Mannheim peritonitis index plus Body mass index and intraabdominal contamination represented by the Hinchey classification. Additionally, it takes operative urgency into consideration	2006

scores in the alternate procedures. The nominated outcomes were in-hospital mortality and morbidity. Mortality was defined as in-hospital death. Morbidity was divided into intraoperative and postoperative. Intraoperative morbidity was defined as any kind of unintended injury to bowel, spleen, or ureter. Postoperative morbidity was further divided into surgical or medical. Surgical morbidity was defined as complications directly related to the operation, e.g., anastomotic leak, wound infection, and hemorrhage. Medical morbidity included all complications not directly related to surgery, e.g., cardiac, respiratory, or renal disorders. Anastomotic integrity was assessed using clinical indicators (e.g., drainage of fecal fluid). Clinical suspicion of a leak was confirmed by CT scan with rectal contrast instillation. Stoma complications such as necrosis or parastomal abscess were also recorded.

Statistics

Subjects' characteristics were compared according to the type of procedure performed using independent *t* tests or Mann–Whitney U tests where appropriate. Univariate logistic regression was used to assess the effects of independent variables on each of the six outcomes (death, intra-operative morbidity, surgical morbidity, stoma morbidity, overall morbidity, and medical morbidity). Variables were transformed for normality where necessary. Any variables with a p value<0.20 in univariate analysis were considered for inclusion in multivariate logistic regression. Age and gender were included in the final models a priori. In order to assess whether the effects on outcome of each score variable was dependent on the type of procedure used, separate models with procedure, the score variable, and an interaction term between procedure and the score variable were assessed. Model terms were considered significant for p values<0.05. All analysis was performed using Stata version 10.2 (StataCorp, Texas, USA).

Results

A total of 111 consecutive patients underwent emergency laparotomy for complicated diverticulitis in the time period observed (January 2001 until December 2006). Of these, 65 patients had HP (58.6%) and 46 patients had PA (41.4%). Protective loop ileostomy was performed in eleven of the PA patients (23.9%).

Basic demographics are shown in Table 2. HP patients were significantly older and more often taking immunosuppressive medication. BMI was also significantly higher in the HP group. The preoperative comorbidity and the severity of the perforated diverticulitis are shown in Table 3. Mean white cell count at time of hospital admission was not different between groups (HP mean 14.2×10^9/l versus 15.2×10^9/l, $p=0.483$). Mean C-reactive protein count at

Table 2 Basic demographic data

	HP group N=65	PA group N=46	p value
Median age in years (range)	78 (46–92)	71.5 (40–89)	0.003
Gender			
Male (%)	25 (38.5)	21 (45.7)	0.449
Female (%)	40 (61.5)	25 (54.3)	
Immunosuppression			<0.01
No (%)	43 (66.2)	44 (95.7)	
Yes (%)	22 (33.8)	2 (4.3)	
Mean BMI (SD)	25.9 (±4.1)	24.2 (±3.4)	0.02
Mean duration of surgery in minutes (SD)	165 (±48.7)	160 (±56.9)	0.679
Median duration of hospitalization in days (range)	18 (1–303)	18.5 (1–79)	0.862

HP Hartmann's procedure, *PA* primary anastomosis, *BMI* body mass index, *SD* standard deviation

time of hospital admission was higher in the HP group, without reaching statistical significance (HP mean 172 mg/l versus 129 mg/l, p=0.095). Mortality and morbidity did not differ significantly between the groups except that postoperative medical morbidity was higher in the HP group (Table 4). In the HP group, one patient (1.5%) with a splenic laceration required a splenectomy and one patient (1.5%) with a small bowel injury an additional bowel resection. In the PA group, all intraoperative complications were due to bowel injuries, with five patients (10.9%) requiring a resection. The clinical anastomotic leak rate was 28.3% (13 patients) in the PA group. Of these, 12 patients (26.1%) underwent reoperation. In eight patients (17.4%), a HP was secondarily performed; in the remaining four patients (8.7%), the anastomosis was oversewn and a protective ileostomy fashioned. One patient was treated conservatively by leaving the intraoperative drain in place and with antibiotic therapy. None of the patients with a leak had a defunctioning stoma. Four out of 13 patients with anastomotic leakage died in the hospital. The reason for death of all four patients was abdominal sepsis with consecutive multi-organ failure.

Overall, 18 (27.7%) patients in the HP underwent relaparotomy compared to 15 (32.6%) patients in the PA group (p=0.728).

All scores were significantly higher in the HP group (Table 5).

In the univariate logistic regression for in-hospital death, all scores and age showed a significant influence whereas gender and duration of surgery had no significant effect. The multivariate logistic regression analysis showed that only CCI and ASA had a significant influence on mortality (Table 6). In the logistic regression for overall morbidity, none of the scores showed any significant predictive value.

In the analysis of the predictive value regarding mortality and morbidity with respect to type of operative procedure, only CCI revealed a trend towards statistical significance (Table 7). The risk of death increases with increasing CCI when PA is performed compared to HP (Fig. 1). However, none of the scores showed any predictive value regarding morbidity in the analysis.

Table 3 Clinical morbidity and severity of the diverticulitis

	HP group N=65	PA group N=46
Clinical morbidity		
Cardiac (%)	36 (55.4)	28 (60.9)
Pulmonary (%)	13 (20.0)	7 (15.2)
Diabetes (%)	6 (9.2)	4 (8.7)
Hepatic (%)	3 (4.6)	5 (10.9)
Vascular (%)	13 (20.0)	8 (17.4)
Hinchey classification		
I (%)	3 (4.6)	9 (19.6)
II (%)	14 (21.5)	25 (54.3)
III (%)	33 (50.8)	12 (26.1)
IV (%)	15 (23.1)	0

HP Hartmann's procedure, *PA* primary anastomosis

Discussion

The main aim of this study was to evaluate whether the different scores and classification systems can be used in the decision-making process in perforated diverticulitis, and not the direct comparison of the two techniques. However, it is important to acknowledge the differences between the groups and the different outcomes.

The groups differed significantly in age, number of patients on immunosuppressive medication, and BMI, thus demonstrating selection by the treating medical staff. All

Table 4 Outcome measures

	HP group N=65	PA group N=46	p value
Intraoperative morbidity			0.292
No (%)	58 (89.2)	37 (82.2)	
Yes (%)	7 (10.8)	8 (17.8)	
Injury of spleen (%)	4 (6.2)	0	
Injury of small bowel (%)	3 (4.6)	8 (17.8)	
Postoperative overall morbidity			0.449
No (%)	32 (49.2)	26 (56.5)	
Yes (%)	33 (50.8)	20 (43.5)	
Postoperative surgical morbidity			0.112
No (%)	50 (76.9)	29 (63)	
Yes (%)	15 (23.1)	17 (37)	
Anastomotic leak (%)	0	13 (28.3)	
Rectal stump leak (%)	2 (3.1)	0	
Intra-abdominal abscess (%)	5 (7.7)	7 (15.2)	
Intra-abdominal hematoma (%)	0	4 (8.7)	
Dehiscence of fascia (%)	8 (12.3)	3 (6.5)	
Postoperative medical morbidity			0.012
No (%)	41 (63.1)	39 (84.8)	
Yes (%)	24 (36.9)	7 (15.2)	
ARDS (%)	9 (13.9)	4 (8.7)	
Pneumonia (%)	16 (24.6)	4 (8.7)	
Myocardial infarction (%)	5 (7.7)	0	
Renal failure (%)	10 (15.4)	5 (10.9)	
Stoma morbidity			0.014
No (%)	57 (87.7)	46 (100)	
Yes (%)	8 (12.3)	0	
Death			0.152
No (%)	46 (70.8)	38 (82.6)	
Yes (%)	19 (29.2)	8 (17.4)	

HP Hartmann's procedure, *PA* primary anastomosis, *ARDS* adult respiratory distress syndrome

scores were significantly higher in the HP group, reflecting the fact that direct comparison of the two techniques is difficult as they are often applied to two different groups of patients. To our knowledge, no randomized trials comparing the two procedures have been published. Several studies compare PA favorably to HP [4, 5, 18, 19], but systematic reviews of the literature reach no definitive conclusion on the matter [2, 7, 8] and the revised practice parameters of the American Society of Colon and Rectal Surgeons published in 2006 describe both approaches for emergency laparotomy in complicated diverticulitis and do not recommend PA be performed routinely [3].

Table 5 Results of the different scoring systems

	HP group N=65	PA group N=46	P value
Median ASA (range)	4 (3–5)	4 (3–5)	<0.001
Median CCI (range)	3 (0–13)	2 (0–9)	0.03
Mean CR-POSSUM (standard deviation)	27.2 (±3.5)	24.2 (±4.7)	<0.001
Mean MPI (standard deviation)	21.2 (±7.6)	13.9 (±7.1)	<0.001
Median Hinchey score (range)	3 (0–4)	2 (0–3)	<0.001
Median CDS (range)	8 (1.6–8.8)	4.4 (3.5–8)	<0.001

HP Hartmann's procedure, *PA* primary anastomosis, *ASA* American Society of Anesthesiologists score, *CCI* Charlson comorbidity index, *CR-POSSUM* colorectal physiological and operative severity score for the enumeration of mortality and morbidity, *MPI* Mannheim peritonitis index, *CDS* Cleveland Clinic diverticular disease propensity score

Table 6 Logistic regression analysis for nominated outcome 'death'

	Odds ratio	Standard error	95% Confidence interval		*p* value
Univariate					
Sex	0.85	0.38	0.354	2.039	0.716
Age	1.05	0.02	1.0	1.1	0.032
Duration of Surgery	0.99	0.004	0.99	1.01	0.992
Immunosuppression	2.3	1.14	0.87	6.1	0.094
ASA	6.01	3.94	1.66	21.7	0.006
CCI	1.43	0.13	1.19	1.71	<0.001
CR-POSSUM	1.21	0.08	1.06	1.38	0.004
MPI	1.08	0.03	1.02	1.14	0.011
Hinchey score	2.15	0.62	1.22	3.78	0.008
CDS	1.33	1.17	1.04	1.69	0.023
Multivariate					
Sex	0.62	0.4	0.17	2.21	0.460
Age	0.99	0.03	0.95	1.05	0.940
ASA	6.45	5.59	1.18	35.3	0.031
CCI	1.44	0.16	1.16	1.79	<0.001
MPI	1.02	0.067	0.90	1.16	0.703
Hinchey score	2.2	1.17	0.78	6.24	0.138
CDS	0.99	0.27	0.59	1.69	0.968

HP Hartmann's procedure, *PA* primary anastomosis, *ASA* American Society of Anesthesiologists score, *CCI* Charlson comorbidity index, *CR-POSSUM* colorectal physiological and operative severity score for the enumeration of mortality and morbidity, *MPI* Mannheim peritonitis index, *CDS* Cleveland Clinic diverticular disease propensity score

In this study, only postoperative medical morbidity was higher in the HP group, whereas intraoperative and postoperative surgical morbidity did not differ. Mortality was also higher, though non-significant, reflecting the greater age and comorbidities of this group.

A concern regarding morbidity was the high number of patients with a clinical anastomotic leak in the PA group. A 28% leak rate is not acceptable and might reflect that a PA was performed too often in this emergency setting and that the true clinical status of these patients was not appreciated. The leak rate for elective sigmoid or high anterior resections in our institution during this time period was 3%. The median age of 70 years in the PA group was higher than in most reported series [20]. None of the patients with an anastomotic leak had a loop ileostomy. Obviously, a PA without performing a defunctioning stoma was the wrong decision for approximately a third of the patients in the PA group. This reflects again the problem in assessing which technique is most appropriate for an individual patient. One limitation of this study is the fact that we did not assess personal experience of the surgeons. This might have had an influence in the choice of procedure and therefore needs to be mentioned as a limitation of this study.

The main difficulty in the setting of emergency laparotomy for complicated diverticulitis is to decide whether it is safe to perform a PA. Severe abdominal soiling, degree of inflammation at the surgical resection site, and adverse physiological state of the patient are reasons not to perform a primary anastomosis.

Table 7 Interaction analysis for in hospital death

	Odds ratio	Standard error	95% Confidence interval		*p* value
ASA	2.50	3.50	0.16	39.19	0.514
CCI	1.76	0.54	0.97	3.21	0.062
CR-POSSUM	1.02	0.14	0.78	1.35	0.873
MPI	0.99	0.07	0.87	1.13	0.896
Hinchey score	0.43	0.30	0.11	1.69	0.227
CDS	1.00	0.29	0.56	1.78	0.997

Each score was analyzed for its predictive value regarding mortality with respect to type of operative procedure (PA versus HP)

HP Hartmann's procedure, *PA* primary anastomosis, *ASA* American Society of Anesthesiologists score, *CCI* Charlson comorbidity index, *CR-POSSUM* colorectal physiological and operative severity score for the enumeration of mortality and morbidity, *MPI* Mannheim peritonitis index, *CDS* Cleveland Clinic diverticular disease propensity score

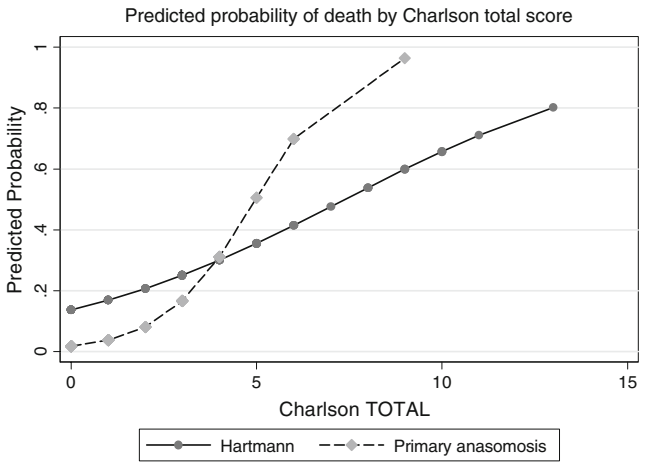

Fig. 1 Predicted probability of death in patients undergoing Hartmann's procedure or primary anastomosis

In an ideal setting, the surgeon could rely on evidenced-based data, in form of a score, for help with that decision. A number of scores and classification systems have been developed to determine severity of the disease and to predict mortality. These scores are used to help the surgeon decide whether one procedure or the other is safe. For example, most surgeons would not consider a primary anastomosis to be safe in patients with a Hinchey IV perforation (fecal peritonitis). But is the classification according to Hinchey truly a good predictor as to whether or not a PA is safe? Until now, no generally accepted scoring system has been developed that guides this decision.

All scores evaluated in this study showed good predictive value for mortality in the univariate analysis. In the multivariate analysis, only CCI and ASA had a significant predictive value. None of the scores predicted morbidity as they were not developed for this purpose. CCI performed best at predicting mortality. It does not take the actual physiological state or local conditions into consideration but concentrated on comorbidity. This coincides with a study presented by Biondo et al. who assessed the predictive value of a number of factors in patients presenting with left colonic perforation. In their multivariate analysis, only ASA score and organ failure on admission showed a significant correlation with mortality whereas loco-regional factors did not influence mortality [21].

A recently published study found that the Acute Physiology and Chronic Health Evaluation II (APACHE II) [22] score has the highest predictive value regarding mortality [10]. The APACHE II was not included in this study because the arterial blood gas results were not obtainable in retrospect. The major disadvantage of the APACHE II is its complexity and the fact that it may not be easily applicable in an emergency situation. The authors also evaluated the predictive power of the MPI and came to the same conclusion as us. Namely that the MPI shows no significant difference between the groups and has a comparatively low predictive value concerning morbidity and mortality. A reason for its limited applicability is that it relies on several factors that are difficult to determine, especially in the elderly, such as time between onset of peritonitis symptoms and operation [10].

The scores which primarily take locoregional conditions into account showed no predictive value in the interaction analysis for death. This finding is consistent to Mulier et al, who showed that local situation, cause of peritonitis and its nature (fecal or purulent), and operative technique are not independent factors predicting mortality [23]. The loco-regional situation might not be useful to guide the decision as to whether PA or HP is indicated.

The interaction model in this study showed that none of the scores reliably predicted outcome dependent on the type of operation performed. However, the CCI performed best. The higher the CCI, and thus the more comorbidities present, the higher the risk of death if a PA is performed. PA with defunctioning stoma has been shown to be a good strategy for a subset of patients, but only when the risk for postoperative complications is estimated to be lower than 44% [24]. However, it may be very difficult to estimate the postoperative complication rate in advance. The authors of this study used data retrieved from databases as well as from the literature. Furthermore, it is a probability estimate model and difference in patients' perceptions may have influenced the results.

Loco-regional conditions and soiling seem not to influence mortality whether a PA or a HP is performed. In a patient with multiple comorbidities but moderate soiling, the latter should not guide the surgeon towards a PA. Assessment of the patients' comorbidities is possible prior to surgery and should be performed with great detail by the responsible surgeon, as it may already define the choice of technique. Patients with comorbidities have fewer reserves and are therefore more prone for complications. Indeed, it might be advisable to decide early what procedure should be performed. The results of our study show that the loco-regional condition is less important and should not guide the decision.

To our knowledge, no study so far has addressed the problem of validity of the different scoring and classification systems in providing support for the decision-making process in emergency left-sided colectomy. A recently published review addressed the problem of whether to operate at all on a sick elderly person with an intra-abdominal emergency [25]. The authors concluded that no test had a sufficient predictive value to be used without the input of clinical experience. This is consistent with a number of other studies that have shown that clinical

judgment by an experienced surgeon is better than any scoring system [26–29]. The results of this study support this conclusion. The only score that had an influence to some extent was the CCI, which concentrates on comorbidities and not on loco-regional conditions. However, it is apparent that the surgeon's selection of technique is reflected by the differences between the two groups. HP patients were older and had higher scores than PA patients. Underestimation of a patient's illness and relying on scoring systems might guide toward performing an anastomosis. Although PA with or without defunctioning stoma seems desirable, this choice must be made very carefully in patients with comorbidities and the HP might be the safer option.

Conclusion

None of the tested scores can be used to help the surgeon decide whether a PA or HP is appropriate in a specific patient. Comorbidity, represented as Charlson comorbidity index in this study, might be more important than the loco-regional situation. In patients with multiple comorbidities, HP might be the safer operation.

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