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ORIGINAL ARTICLE

Intraoperative blood pressure changes as a risk factor for anastomotic leakage in colorectal surgery

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Abstract
Purpose Anastomotic leakage is a serious complication after colorectal surgery. Pre- and intraoperative factors may contribute to failure of colorectal anastomosis. In this study we have tried to determine risk factors for anastomotic leakage, with special emphasis on intraoperative blood pressure changes.
Methods During a 24-month period, patients receiving a colorectal anastomosis were prospectively evaluated. For each patient preoperative characteristics, intraoperative adverse events and surgical outcome data were collected. Blood pressure changes were calculated as a relative decrease (>25% and >40%) from preoperative baseline values.
Results During the study period, 285 patients underwent colorectal surgery with an anastomosis. Fifteen patients developed an anastomotic leakage (5.3%). All patients who developed a leakage had a left-sided procedure ($P<0.001$). When blood loss was more than 250 mL ($P=0.003$) or an intraoperative adverse event occurred ($P=0.050$), the risk for developing an anastomotic leakage was significantly increased. A preoperative high diastolic blood pressure of ≥90 mmHg ($P=0.008$) and severe intraoperative hypotension [>40% decrease in diastolic blood pressure ($P=0.049$)] were identified as univariate risk factors for anastomotic leakage.
Conclusions The development of an anastomotic leakage after colorectal surgery is related to surgical, patient and anaesthetic risk factors. A high preoperative diastolic blood pressure and profound intraoperative hypotension combined with complex surgery, marked by a blood loss of ≥250 mL and the occurrence of intraoperative adverse events, is associated with an increased risk of developing anastomotic leakage.

Keywords Anastomotic leakage · Blood pressure · Colorectal surgery

Introduction

Anastomotic leakage is a serious complication occurring in gastrointestinal surgery. Morbidity and mortality increase considerably after the development of an anastomotic leakage. Several factors such as obesity [1], ASA score, emergency surgery [2], lower anastomotic level [3], male gender [4], smoking or alcohol abuse [5, 6] and perioperative fluid management have been identified as independent risk factors for anastomotic failure.

Tissue ischemia at the site of the anastomosis is frequently cited and implicated as a cause for anastomotic breakdown [7, 8]. During anaesthesia, the blood pressure tends to decrease due to a variety of factors, including direct effects of the anaesthetic, inhibition of the sympathetic nervous system and loss of baroreceptor reflex control of arterial pressure. These changes can result in episodes of intraoperative hypotension and microvascular ischemia.

Although hypertension is not considered to be an independent risk factor for the development of cardiovascular complications [9], patients with pre-existing hypertension are

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more likely to experience intraoperative blood pressure variability [10]. This has led to a renewed interest in the association between intraoperative hemodynamic variability and adverse postoperative outcomes such as stroke, slow graft function after organ transplantation [11, 12], anastomotic leakage [13] and even 1-year mortality [14].

The influence of aberrant preoperative and intraoperative hemodynamic status on an adverse outcome following colorectal surgery has not been extensively studied. Our objective was to identify pre- and intraoperative predictive factors contributing to the failure of colorectal anastomoses, with a special emphasis on intraoperative blood pressure changes.

Methods

Patients

This prospective observational study was approved by the hospital ethics committee. During a 24-month period, 285 consecutive patients undergoing elective or emergency colorectal surgery with large bowel anastomoses in our institution were evaluated. The procedures included in this study were open or laparoscopic resections of colon or rectum. The reversal of a stoma was categorised as other. Past medical history and demographic data such as age, gender, body mass index (BMI), American Society of Anesthesiologists (ASA) risk classification, smoking and alcohol consumption were also collected. Physical examination and vital signs such as blood pressure and heart rate were recorded preoperatively in the outpatient clinic.

Anaesthetic procedure

Preoperative beta blockers were continued until surgery. All patients were premedicated with diazepam 10 mg orally 60 min before induction. After arrival in the operating theatre, electrocardiogram tracing from leads II and V5 were displayed continuously. An intravenous drip and radial arterial line were inserted. The urinary bladder was catheterized in all patients. Unless contraindicated, all patients received an epidural catheter, at a level between T6 and T10. Before induction, all patients received an epidurally administered bolus injection of a mixture of levobupivacaine 0.5% and sufentanil 5 μg/mL. Following induction of general anaesthesia with intravenously administered propofol, sufentanil and rocuronium, endotracheal intubation was performed. Controlled ventilation was adjusted to maintain end tidal CO_2 between 35 and 45 mmHg. Anaesthesia was maintained with sevoflurane and 70% nitrous oxide in oxygen, muscle relaxation was preserved with incremental doses of rocuronium. A nasogastric tube was inserted and subsequently removed at the end of surgery. Central venous lines were only inserted on indication. Blood losses were accurately assessed and replaced by blood (packed cells) and fresh frozen plasma when the haemoglobin level fell under 8 g/dL (5.0 mmol/L). Initial blood losses were substituted with intravenous colloids. A base infusion of Ringer's lactate, 2–4 mL/kg/h was administered throughout the operation. Blood and intravenous fluids were warmed before administration. A heated forced air blanket was used to prevent a significant fall in body temperature. In the presence of insufficient analgesia (increased heart rate and blood pressure and/or signs of lacrimation and sweating), a bolus of sufentanil (10 μg) was administered intravenously. Intraoperative blood pressure changes were calculated as a relative decrease (>25% and >40%) in systolic and diastolic blood pressure from preoperative baseline values. If mean blood pressure decreased under 65 mmHg, an intravenous vasopressive agent was administered. Postoperatively an epidural patient controlled analgesia pump was used to provide analgesia.

Surgical procedure

Surgical factors such as previous abdominal surgery, preoperative radiotherapy, the indication for surgery, duration of surgery, complications during surgery and postoperative data were prospectively collected and recorded. All included patients, whether with benign or malignant pathology, entered a multi-modal rehabilitation program. Prior to surgery all patients were informed in detail about the perioperative enhanced recovery protocol, and were given an estimated length of stay. Families were also encouraged to participate, and to motivate the patient during the postoperative recovery.

Patients particularly at risk for respiratory complications received a preoperative consultation by a physiotherapist. Patients received carbohydrate-loaded drinks until 2 h before surgery, and received no bowel preparation. In cases of surgery on the left-sided colon or rectum, patients received an enema on the morning of the day of surgery. Perioperative antibiotics were given as a single intravenous shot of 2 g of cefazolin and 500 mg of metronidazole. The trans-urethral urinary catheter was removed when patients could adequately mobilize. All patients were encouraged to be ambulant on the first postoperative day.

The decision to operate laparoscopically was based on patient characteristics (previous surgery, co-morbidity) and tumour characteristics (size, complexity, involvement of surrounding structures). Drains were only used on indication and in case of surgery in the lower pelvis.

All anastomoses were handsewn, except for colorectal anastomoses, which were achieved using a circular stapler. Gastric tubes were removed postoperatively before leaving the recovery room. Oral fluid intake was commenced on the same day as surgery. Oral food intake was commenced the day after surgery.

Anastomotic leakage

Anastomotic leakage was suspected on clinical indications such as fever, tachycardia, pain, tenderness, peritonitis or purulent/faecal discharge from a drain. All suspected anastomotic leaks were proven by CT scan, ultrasound or after operative evidence was obtained.

Variables and risk factors

Various independent clinical variables were analysed. Patient age and body mass index were evaluated as continuous variables. Gender, smoking, co-morbidity and physical status (ASA ≤2 or ≥3) were evaluated as categorical variables. The use of alcohol was analysed as a categorical variable (≤2 or ≥3 units a day). Indication for operation was categorised as carcinoma, benign or other. The occurrence of an intraoperative complication such as lesion of the spleen, bladder, ureter or ileum, severe bleeding or positive air bubble test was analysed as a categorical variable. Duration of surgery was evaluated as a continuous variable. Blood loss was evaluated as a continuous and categorical variable (<250 and ≥250 mL). Preoperative diastolic (<90 and ≥90 mmHg) and systolic (<150 and ≥150 mmHg) blood pressures were evaluated as continuous and categorical variable. The relative decrease in systolic and diastolic blood pressure from baseline values (preoperative measurements) during the operation were evaluated as continuous (in minutes) and categorical (>25% and >40%) variables.

Statistical analysis

The main object of this study was to identify potential predictors for anastomotic leakage. To identify these potential risk factors, univariate tests were performed using Fisher's exact test (on categorical variables) and the Wilcoxon–Mann–Whitney test (on continuous variables), both with the binary outcome of anastomotic leakage. The analysis was done using the R-project statistical package (R Foundation for Statistical Computing, 2010, Vienna, Austria). *P* values of less than 0.05 were considered to be significant. But at this relatively low number of events, variables with *P* values below 0.3 may still be considered potential predictors and should where possible be included in further studies.

A decision tree was created to identify subgroups with an increased risk of anastomotic leakage. As the statistics are low, the resulting tree should not be used as a predictive model for clinical use. Recursive partitioning using the CHAID algorithm (chi-squared automatic interaction detector) was used to build the decision tree, furthermore the Chordiant Predictive Analytics software (Chordiant Software, 2010, Cupertino, USA) was used.

Results

During the study period of 24 months, 285 ASA I–III patients underwent colorectal surgery with large bowel anastomoses. Of these 285 patients, 263 patients were scheduled for elective and 22 for emergency surgery. The patient characteristics are shown in Table 1 and the surgical history of patients in Table 2. Over 61% (175) of the patients had a malignancy, and in 14% of the patients (40) there was an 'other' indication for surgery such as reversal of a stoma.

In Table 3 the univariate analysis of the risk factors for anastomotic leakage is shown. In 17 cases (6%), an intraoperative adverse event (such as a lesion of the spleen, ureter, bladder or ileum, torsion of the anastomosis, acute massive bleeding or positive air bubble test) occurred. The anastomotic leak rate was 5.3% (15 out of 285).

A left side anastomosis ($P<0.001$) and blood loss as a continuous ($P=0.015$) and as a categorical variable of 250 mL or more ($P=0.003$) were statistically significant risk factors for developing anastomotic leakage. A preoperative high diastolic blood pressure ($P=0.019$) or as categorical

Table 1 Patient characteristics

Variable	Total cohort (*n*=285)	Cases with leakage (*n*=15)	Cases without leakage (*n*=270)	*P* value
Age (mean±SD), years	67±14	64±11	67±14	0.395
Age ≥80 years	50 (17.5%)	1 (6.7%)	49 (18.1%)	0.483
Gender				
Male	149 (52.3%)	9 (60%)	140 (51.9%)	0.603
Female	136 (47.7%)	6 (40%)	130 (48.1%)	
BMI (mean±SD)	25.5±3.8	26.6±3.2	25.4±3.9	0.141
Pts with severe co-morbidity (ASA ≥3)	27 (9.5%)	1 (6.7%)	26 (9.6%)	>0.999
MET ≤4	30 (10.5%)	1 (6.7%)	29 (10.7%)	>0.999

Data expressed as mean±SD or number (percentage)

BMI body mass index. *ASA* physical status classification system according to the American Society of Anesthesiologists. *MET* metabolic equivalent of the task [20]

Table 2 Surgical history

Variable	Total cohort (n=285)	Cases with leakage (n=15)	Cases without leakage (n=270)	P value
Smoking	99 (34.7%)	8 (53.3%)	91 (33.7%)	0.262
Alcohol ≥3 glasses/day	14 (4.9%)	2 (13.3%)	12 (4.4%)	0.114
Indication				
Carcinoma	175 (61.4%)	12 (80%)	163 (60.4%)	0.234
Benign	70 (24.6%)	3 (20%)	67 (24.8%)	
Other	40 (14.0%)	0	40 (14.8%)	
Previous abdominal surgery	126 (44.2%)	3 (20%)	123 (45.6%)	0.642
Preoperative radiotherapy	20 (7.0%)	3 (20%)	17 (6.3%)	0.078

variable of more than 90 mmHg (P=0.008) was also statistically associated with a higher incidence of anastomotic leakage. In 209 cases (73%) the maximum decrease in diastolic blood pressure from baseline was greater than 40%. The median duration of such a decrease in diastolic blood pressure was 13 min. From these procedures, 14 cases of anastomotic leakage resulted (P=0.127 for the categorical test and P=0.049 for the continuous test of the duration of the decrease).

In our cohort only 20 out of 285 patients (7%) underwent preoperative radiotherapy, with 3 out of 20 patients developing an anastomotic leak (P=0.078). Four other factors may be considered potential predictors (P<0.30), suggesting that they

Table 3 Univariate analysis of the risk factors for anastomotic leakage

Variable	Total cohort (n=285)	Cases with leakage (n=15)	Cases without leakage (n=270)	P value
Surgery				
Elective	263 (92.3%)	14 (93.3%)	249 (92.2%)	>0.999
Acute	22 (7.7%)	1 (6.7%)	21 (7.8%)	>0.999
Laparotomy	182 (63.9%)	10 (66.7%)	172 (63.7%)	>0.999
Laparoscopy	103 (36.1%)	5 (33.3%)	98 (36.3%)	>0.999
Of which conversion	28 (27.2%)	2 (40%)	26 (26.5%)	0.649
Anastomosis, right	84 (29.5%)	0	84 (31.1%)	>0.999
Anastomosis, left	161 (56.5%)	15 (100%)	146 (4.1%)	<0.001
Other	40 (14.0%)	0	40 (14.8%)	>0.999
Duration of surgery (min)	241±82	252±67	240±82	0.306
Intraoperative adverse event[a]	17 (6.0%)	3 (20%)	14 (5.2%)	0.050
Total intraoperative fluid intake (mL)	3513±1315	3523±1040	3513±1331	0.915
Blood loss (mL)	387±437	423±296	384±446	0.015
Blood loss ≥250 mL	87 (30.5%)	10 (66.7%)	77 (28.5%)	0.003
Neuraxial technique	250 (87.7%)	13 (86.7%)	237 (87.8%)	0.390
Preoperative DBP (mmHg)	81±12	87±10	81±13	0.019
DBP ≥90 mmHg	79 (27.7%)	9 (60%)	70 (25.9%)	0.008
Preoperative SBP (mmHg)	141±20	136±17	142±20	0.398
SBP ≥150 mmHg	92 (32.3%)	4 (26.7%)	88 (32.6%)	0.780
DBP: intraoperative ↓ >25% (yes or no)	267 (93.7%)	15 (100%)	252 (93.3%)	>0.999
Duration (min), mean±SD	112±84	137±92	111±84	0.278
Intraoperative ↓ DBP >40% (yes or no)	209 (73.3%)	14 (93.3%)	195 (72.2%)	0.127
Duration (min), mean±SD	38±57	51±57	37±57	0.049
SBP: intraoperative ↓ >25% (yes or no)	263 (92.3%)	15 (100%)	248 (91.9%)	>0.999
Duration (min), mean±SD	93±71	86±58	93±72	0.862
Intraoperative ↓ SBP >40% (yes or no)	205 (71.9%)	13 (86.7%)	192 (71.1%)	0.368
Duration (min), mean±SD	27±43	22±34	28±43	0.923
Intraoperative use of vasoactive drugs	213 (74.7%)	12 (80%)	201 (74.4%)	0.768

[a] Intraoperative adverse events reported: lesion spleen, ureter, bladder or ileum, torsion of the anastomosis, acute massive bleeding, positive air bubble test

might be related to anastomotic failure: BMI (P=0.141), smoking (P=0.262), severe alcohol consumption (≥3 units a day, P=0.114), and the surgical indication being a carcinoma (P=0.234, see Tables 1 and 2).

Recursive partitioning using the CHAID algorithm resulted in the decision tree shown in Fig. 1. Notably, this tree identifies a subgroup of patients with a high incidence of leakage that has a high preoperative diastolic blood pressure combined with a significant decrease in diastolic blood pressure during the operation. The subgroup consists of patients with left-sided resection, blood loss of more than 250 mL, preoperative diastolic blood pressure of more than 90 mmHg and a long (more than 7 min) period of relative decrease in diastolic blood pressure of more than 40% from baseline during the operation. This subgroup consists of 18 patients of which 6 developed an anastomotic leakage.

Most patients received epidural analgesia (253 out of 285). In four patients the epidural failed to provide adequate analgesia and was removed on the day of surgery (day 0). The median duration of continuation of patient controlled epidural analgesia was 2 (1–10) days, with a mean of 2.59 days. The median duration of hospital stay was 6 (1–105) days. Postoperative complications ranging from pneumonia to wound infection occurred in 101 patients (35%). Of the patients with anastomotic leakage, 93% also developed a second complication (14 out of 15). The mortality rate associated with anastomotic leak was 13% (2 out of 15). The overall mortality rate in the group

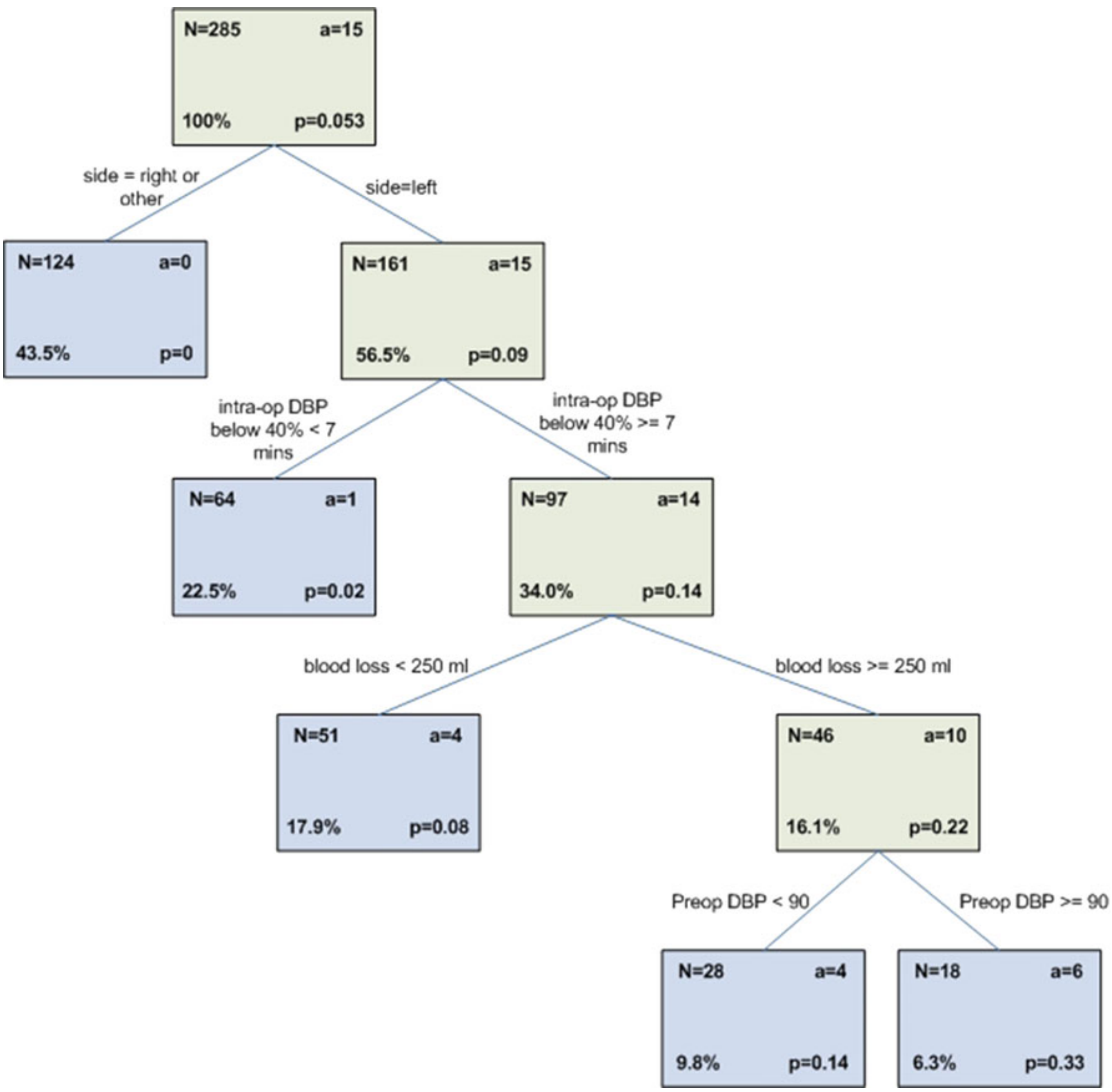

Fig. 1 Decision tree: The overall risk of developing an anastomotic leak is 5.3% in our population. The subgroup of patients after left-sided resection had an increased risk of 9%. The patients who had a relative decrease in DBP of more than 40% during the operation had an increased risk of 14%, and their risk further increased to 22% if intra-operative blood loss was ≥250 mL. Patients in this subgroup who had a preoperative DBP of ≥90 mmHg had a 33% increased risk of developing an anastomotic leak

of patients without anastomotic failure was 0.7% (2 out of 270, see Table 4).

Discussion

There are numerous reports over the association between surgical procedures and surgical outcome such as anastomotic leakage. However, aberrant preoperative and intraoperative hemodynamic status and their influence on adverse outcome after colorectal surgery have not been analysed in detail. Our current study investigates associations between adverse surgical outcome, in particular anastomotic leakage, and intraoperative hemodynamic aberrations. The occurrence of preoperative diastolic hypertension, defined as DBP ≥90 mmHg was independently associated with the occurrence of anastomotic leakage, possibly indicating a higher susceptibility for microvascular ischemia due to hypotension at the site of anastomosis. Also severe intraoperative relative hypotension (a relative decrease in diastolic blood pressure of more than 40%) was associated with an increased incidence of anastomotic leakage. Although the decrease in diastolic blood pressure was accompanied by a decrease in systolic blood pressure, this drop was less severe and was not of statistical significance. This is probably due to the relatively small population size in our study. The identification of high diastolic blood pressure as a risk factor in our small cohort could be a stimulation to find confirmation in a larger study and in other hospital populations. This outcome may have important consequences when deciding which patient deserves a covering ileostomy and which patient has such a limited risk for anastomotic failure that defunctioning of the anastomotic site is not necessary. Furthermore, an increased awareness of the importance of intraoperative blood pressure control may be necessary.

Besides the vital signs used in the current study, biochemical indicators such as systemic arterial hyperlactatemia may also be important to correctly interpret microcirculation. The systemic concentrations of lactate, however, may vary widely due to overall hemodynamic state and liver function. It has been demonstrated by Deeba et al. [15] that rapid intraluminal sampling microdialysis of glucose and lactate were important parameters for detection of bowel ischemia. Therefore, in a future prospective trial it might be interesting to add intraluminal glucose and lactate measurements.

Various articles describe an increased chance of anastomotic leakage in males because of the smaller pelvis; however, no significant difference was found in our study group. In our cohort colonic surgery and rectal surgery was combined which may be the reason for the lack of difference. Furthermore, in this study, the use of steroids is not evaluated.

All anastomoses were handsewn, except for colorectal anastomoses, which were achieved using a circular stapler. Stapled anastomosis with a circular device is a well-established technique for anastomosis after sigmoid resection or low anterior resection. Results of stapled anastomoses are not inferior to handsewn methods, and therefore, the rate of left-sided anastomotic leak is probably not a result of the use of stapling devices [16, 17].

In our study population, most patients (88%) received (patient controlled) epidural analgesia. We did not control for possible severe sympathicolysis caused by the neuraxial blockade, but by using patient controlled analgesia and avoiding motor blockade, it was our intention to minimize the influence on postoperative blood pressure. With patients undergoing laparoscopic resections, a neuraxial technique might not be necessary and with regards to blood pressure control has to be used with caution.

In contrast to findings in previous studies, we did not find long operation duration as a risk factor for anastomotic leakage. But, the occurrence of intraoperative adverse events (P=0.050) was an indicator for the development of anastomotic leakage. Intraoperative adverse events could be an indication of more complex surgery. Acute massive bleeding was not specifically mentioned as a complication in the leakage group (see Table 5 and 6), but blood loss of 250 mL or more proved to be a significant independent risk factor for anastomotic failure. The cutoff point of 250 mL for this continuous variable of blood loss was arbitrary. A recent study from Telem et al. [18] pointed out that blood loss of more than 200 mL is an independent risk factor. Arbitrarily chosen or not, there are indications that subsequent blood loss during operation is a strong predictor for the development of anastomotic leakage. In our study only 12 out of 285 patients (4.2%) needed a blood transfusion of which 1 patient developed an anastomotic leak. Despite the

Table 4 Outcome

	Total cohort (n=285)	Cases with leakage (n=15)	Cases without leakage (n=270)	P value
Development complications[a]	101 (35.4%)	14 (93.3%)	87 (32.2%)	<0.001
Hospital stay (days)	10±11	29±24	9±9	<0.001
Mortality	4 (1.4%)	2 (13.3%)	2 (0.7%)	0.015

[a] Other than anastomotic leak: pneumonia, anaphylactic or septic shock, bleeding, wound infection, abscesses, oedema, bladder dysfunction, gastric perforation

Table 5 Characteristics of patients with anastomotic leakage

ID	Procedure	Indication	M/F	Age	BMI	ASA	MET	Alcohol	RT
1	Low anterior resection	Malignancy	F	74	23	3	≤4	<3	Yes
2	High anterior resection	Malignancy	M	73	29	1	5 to 8	None	No
3	Hemicolectomy	Malignancy	F	85	27	2	5 to 8	<3	No
4	High anterior resection (conversion)	Diverticulitis	M	68	25	1	5 to 8	<3	No
5	Low anterior resection	Malignancy	M	50	28	2	≥9	>6	No
6	High anterior resection	Diverticulitis	F	77	29	2	5 to 8	None	No
7	High anterior resection	Stenosis	M	73	24	1	5 to 8	<3	No
8	Low anterior resection	Malignancy	M	54	24	1	5 to 8	<3	Yes
9	Colectomy (conversion)	Malignancy	M	63	26	1	5 to 8	<3	Yes
10	Low anterior resection	Malignancy	M	67	25	1	5 to 8	3 to 6	No
11	High anterior resection	Malignancy	F	66	28	2	5 to 8	None	No
12	High anterior resection	Malignancy	F	57	32	1	5 to 8	<3	No
13	Low anterior resection	Malignancy	M	44	21	2	5 to 8	<3	No
14	Low anterior resection	Malignancy	F	76	30	2	≥9	<3	No
15	Low anterior resection	Malignancy	M	55	30	2	≥9	<3	No

difference in blood loss between the groups who developed anastomotic leakage, blood transfusion-associated immunosuppression is presumably not an obvious explanation.

Patients were evaluated up until 14 days post-discharge. Since anastomotic leakages are detected anywhere from 3 to 40 days postoperatively [19], it is possible that some of the anastomotic leakages were not evaluated. Clinically significant leaks would however almost certainly have been identified, since all patients received follow-up in our surgical outpatient clinic.

The sample size of 285 procedures with 15 anastomotic leakages does not allow the use of multivariate logistic regression. Therefore, this study has focused on a univariate identification of potential risk factors. The risk factors appointed in this study need further evaluation in a large prospective trial. We should be cautious with the interpretation of the results of this small study, but we can point out the potential importance of intraoperative blood pressure control.

Table 6 Intraoperative and postoperative complications of patients with anastomotic leakage

ID	Blood pressure (mmHg)	Time ↓ SBP >40% (min)	Time ↓ DBP > 40% (min)	Intraoperative adverse events	Duration of surgery (min)	Blood loss (mL)	Postoperative complication	Hospital stay (days)
1	128/85	11	42		211	300	Wound infection	25
2	151/90	126	109		317	600	Pneumonia, wound infection	34
3	158/61	47	7		297	250	Stomach perforation	9
4	130/95	5	8		306	300		5
5	122/75	0	0		298	<150	Multiple abcesses	60
6	110/90	3	128	Lesion bladder	393	1,180	Septic shock	27
7	165/95	1	26	Lesion ureter	181	400	Double J catheter ureter	15
8	140/80	0	15	Torsion anastomosis	158	250	Pneumonia	6
9	144/99	55	89		305	300	Abdominal compartment syndrome, pneumonia	4
10	105/80	5	49		215	200	Wound infection	49
11	136/92	29	42		299	200	Wound infection	28
12	120/90	6	20		234	<150	Wound infection	30
13	130/95	2	204		366	800	Wound infection	33
14	154/87	37	7		315	300	Wound dehiscence	94
15	145/95	10	25		329	<150	Cardiac arrythmias	19

Patients 3 and 9 died during the study, see also Table 4 (Outcome)

Conclusion

In our study several preoperative and intraoperative factors were demonstrated to be associated with the postoperative development of an anastomotic leak. In particular, high preoperative diastolic blood pressure and longer episodes of severe intraoperative hypotension, combined with complex surgery (marked by blood loss of ≥250 mL) and the occurrence of intraoperative adverse events, resulted in a significant increase in the development of anastomotic leakage. This could be an indication that hypotension should be avoided, particularly in patients with high preoperative blood pressures.

Proximal diversion does not prevent anastomotic leakage and leads in its own right to morbidity. In patients with multiple risk factors for the development of an anastomotic leak, however, one can imagine that a proximal diversion could lessen the dreaded sequelae should a leak occur.

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