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Management of complications in surgery of the colon

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Komplikationsmanagement in der Kolonchirurgie

Zusammenfassung. *Grundlagen:* Allgemeinchirurgen sind in ihrer täglichen Praxis häufig mit kolorektalen Erkrankungen konfrontiert, wobei Kolon- oder Rektumkarzinome in Österreich mit nahezu 5000 Neuerkrankungen pro Jahr zu den häufigsten bösartigen Erkrankungen zählen. Aber auch die Inzidenz gutartiger Kolonerkrankungen, die einer chirurgischen Therapie bedürfen (z. B. Kolonpolypen, Sigmadivertikulitis), ist im Steigen begriffen. Das erste Ziel in der Darmchirurgie sollte es sein Komplikationen zu vermeiden; sind sie aber eingetreten, diese adäquat zu behandeln.

Methodik: Wir unterscheiden allgemeine und spezielle Komplikationen. Bei den allgemeinen Komplikationen sind besonders das Vorbeugen von Mangelernährung und das Stärken der Immunkompetenz zu nennen. Das in den letzten Jahren zunehmend ältere Patientengut zieht neben der Gefahr thrombembolischer Komplikationen mehr kritische Herz- Kreislaufsituationen, Nieren- und Leberfunktionsstörungen nach sich, die besonders zu beachten sind. Spezielle Komplikationen sind entweder vom Operationsverfahren (laparoskopisch assistiert oder offen konventionell) oder von der Operationstechnik (Klammern, händisch) abhängig. Auch der Umgang mit dem Gewebe an sich (z. B. trockene versus feuchte OP-Tücher) ist wichtig.

Ergebnisse: Eine Verkürzung des postoperativen Aufenthalts verringert neben der Spitalskosten auch die Infektionshäufigkeit. Deshalb sind minimal invasive Eingriffe und postoperative ,,Fast Track"-Ernährung zu fördern. Darüber hinaus sollten Notfallsoperationen tunlichst vermieden werden (z. B. durch Bridging mit Stents), da Morbidität und Mortalität deutlich erhöht sind im Vergleich zu Elektiveingriffen. Bei der Operation selbst können neue Geräte und Techniken (z. B. Ultracision®, Ligasure®) sowie ein eingespieltes Operationsteam Komplikationen reduzieren und die Operation beschleunigen.

Schlussfolgerungen: Vermeiden ist besser als Reparieren. Bei eingetretener Komplikation ist es aber wichtig, sofort die nötigen chirurgischen und intensiv-therapeutischen Maßnahmen zu setzen.

Schlüsselwörter: Komplikation, Kolonchirurgie, Stent, Fast Track.

Summary. *Background:* General surgeons are frequently confronted with colorectal diseases in their daily practice, whereby colorectal cancer is the second most common malignant tumour, with almost 5000 new cases every year in Austria. The incidence of benign colon disorders requiring surgery (e.g. colon polyps, sigmoid diverticulitis) is also increasing. The first aim in colon surgery should be to avoid complications and if they occur to treat them properly.

Methods: We basically distinguish between general and special complications. As general complications, prevention of malnutrition and support of the immune system should receive special attention. As the number of elderly patients increases, so does the risk not only of thrombembolic complications but also of critical cardiocirculatory situations, and renal and hepatic failure. Special complications depend either on the type of surgery (laparoscopic assisted, conventional open surgery) or the techniques employed (stapled, hand sutured). Handling of the tissue also plays a major role (e.g. dry versus wet pads).

Results: Shortening of the postoperative stay decreases both hospital costs and the incidence of infections, meaning that minimally invasive surgery and postoperative "fast track nutrition" should be promoted. Emergency operations should be avoided (e.g. bridging through colonic stents), as morbidity and mortality are clearly increased in comparison to (semi-) elective operations. During the operation itself, new equipment and techniques (such as Ultracision®, Ligasure®) as well as a well coordinated team help to reduce complications and duration of surgery.

Conclusions: To avoid is better than to repair. If complications do occur, appropriate surgical and intensive – care measures should be taken immediately.

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Key words: Complications, colon surgery, colonic stents, fast-track.

Introduction

General surgeons are frequently confronted with colorectal diseases in their daily practice, whereby colorectal cancer is the second most common malignant tumour, with almost 5000 new cases every year in Austria [1]. As far as management of complications of colon surgery is concerned, the primary consideration should be their avoidance. This chapter therefore highlights possibilities for preventing complications and, if they occur, offers suggestions for their management.

I. Prevention of complications

A. General complications

1. Pulmonary complications

As pulmonary complications such as pneumonia, pulmonary effusions or ARDS are among the most common causes of morbidity and mortality after abdominal surgery [2], particular emphasis should be placed on identification of risk factors and preventive measures. If there is no history of pulmonary disease, no abnormal breath sounds on auscultation of the lungs and the patient has no problems in climbing at least two flights of stairs, it is likely that the patient has normal pulmonary function. Chronic cough, sputum production, dyspnoea on exertion, wheezing, haemoptysis, or a history of cigarette smoking are indications that the preoperative evaluation should be expanded to include pulmonary function tests, chest radiography, and perhaps determination of arterial gas levels to evaluate the individual risk level. However, it should be pointed out that anorectal surgery alone does not have the same pulmonary risks as abdominal colorectal surgery [3, 4]. From the surgical point of view, pulmonary complications are less likely to occur with incisions made as low in the abdominal wall as possible [5].

2. Cardiac complications

Clinical history and physical examination should focus on careful assessment of any recent history of myocardial infarction or the presence of congestive heart failure (CHF). These are the two most important factors that place patients at risk for perioperative cardiac complications and death [6]. Myocardial infarction occurs in 0.13% of patients undergoing surgery without prior infarction, in 27–38% of patients undergoing surgery within 3 months after infarction, and in 11–16% of patients 3–6 months after infarction [6, 7]. Six months after infarction, the risk for repeat infarction stabilizes at about 5% [7]. Without a prior clinical history of heart disease, men are considered to be at risk from age 35 onward and women from age 40 and many preoperative anaesthesia protocols require an ECG for patients 40 years of age and older [6, 8].

A careful history should also detect any symptoms of a transient ischemic attack (TIA). The carotid bifurcations should be evaluated for the presence of bruits. The presence of either TIA or bruit should prompt further evaluation, because 30–40% of patients with a history of TIA [9] will develop a serious stroke within 3–5 years of initial symptoms. The majority occur in the first year [6, 10–12].

3. Thromboembolic events and disorders of hemostasis

Hypercoagulability is defined as excessive activity of one or more procoagulant substances or a decrease in anticoagulant factors. Occult or known malignancy, obesity, age, infirmity, immobility, pregnancy, hypercoagulative disorders (including inflammatory bowel disease) [13], deficiencies in protein C, protein S and antithrombin III, may all result in hypercoagulability and so predispose to thromboembolic events in patients undergoing major colorectal surgical procedures [14].

A multicenter trial of 2070 patients who underwent elective abdominal surgery found that cancer alone was the strongest single risk factor for major postoperative venous thromboembolic events [15]. Other risk factors in this study included surgical procedures lasting over two hours, a previous history of major orthopaedic surgery, preoperative blood transfusions, and preoperative hospitalization of 6 days or more [16].

Prophylaxis of deep venous thrombosis (DVT) is now an accepted standard for major abdominal surgery. Basically there are 2 options: low molecular weight heparin (LMWH) or unfractionated heparin (UFH). LMWH is preferred to UFH as it has a longer half life, can thus be administered just once per day and is less expensive. However, the combination of compression stockings and LMWH was better than low dose heparin alone in preventing DVT [13].

4. Renal disease

Preexisting renal disease presents a special challenge to the surgeon. Foremost is the prevention of additional injury to the patient. Adequate hydration and monitoring of urine output (0.5–1.0 ml/kg/hr) as an indication of adequate perfusion are critical. Low-dose dopamin therapy (1–2 μg/kg/min) may be beneficial [17].

Patients with uraemia who are receiving dialysis add further challenge and unique risks for complications. Of particular interest to the colorectal surgeon are gastrointestinal manifestations of uraemia: ammonia released by bacterial action on urea in the gut lumen may lead to oedema, ulceration, and haemorrhage [18], postoperative ileus may be prolonged and patients with diverticulosis are at increased risk for acute infection and perforation [19].

Other surgical considerations include anaemia, increased risk for bleeding due to use of heparin during dialysis, platelet dysfunction [20, 21], secondary hyperparathyroidism, and bone demineralization. Compromised leukocyte and immunologic function increases risk for infection and impaired cellular immunity [22]; antibiotic prophylaxis may be beneficial here.

5. Hepatic disease

The liver is the body's physiologic processing centre and performs many functions that have important implica-

tions for the surgical patient. Dysfunction can lead to nutritional wasting, accumulation of toxic waste products, immunocompromise, and bleeding diatheses.

The capacity of hepatic reserve and regeneration is legendary. As a result, the early stages of liver disease may produce only subtle evidence of dysfunction, but a dysfunction that can easily be transformed into fulminating failure by seemingly minor events including the stress of anaesthesia and surgery. Concomitant histories of alcohol abuse, viral hepatitis (especially hepatitis B) as well as metastasis of colorectal cancer are in practice the most common situations, which the surgeon should approach with respect [23].

Disturbance of fluid and electrolyte balance is common in liver disease, including sodium retention, potassium loss, and the development of ascites and oedema. In a patient with marginal hepatic reserve, ascites may become a problem after surgery even if not presented before. Careful attention to exact closure of the abdominal wound may prevent leakage of ascites in the postoperative period. Drains should be omitted [24, 25].

B. Nutrition

Although malnutrition is a frequent pre-existing condition in hospitalized surgical patients, the effect on complications is unclear. Controversy persists as to whether such patients should receive preoperative nutritional supplementation, and whether it is possible to identify those patients who might benefit from both a physiologic and economic point of view [26]. It is estimated that 30–50% of hospitalized patients have a body mass index (BMI) of less than 18.5 and thus can be considered to be malnourished [27]. Clinically, cachexia can be a major problem, leading to a higher infection rate and prolonged recovery after emergency surgery [28, 29].

The Canadian Clinical Practice Guidelines change the paradigm as far as nutritional support strategies for critically ill patients are concerned [3, 4]. The recommendation rather to apply enteral and not parenteral nutrition in patients with a functional gastrointestinal tract has to be considered a key issue of these guidelines. The role of parenteral feeding steps down from a standard to a supplementary procedure for cases of insufficient enteral intake. The early placement of a nasojejunal tube (i.e. within 24–48 h after admission) should become a routine procedure in ICUs of tertiary centres. Low volume jejunal feeding (starting with 10–20 ml/h) should be initiated immediately after admission, provided that there are no contraindications. By ''feeding the gut'' via the enteral route, the feeding strategy aims at maintaining intestinal barrier integrity. The enteral infusion rate should then be raised gradually, but should not provide more than 20–25 kcal per kg of body weight (''feed the patient''). The question when to start supplementary parenteral nutrition remains a matter of debate. The decision whether or not combined enteral and parenteral nutrition strategies will be commenced depends on the degree of gastrointestinal intolerance to enteral feeds, the severity of preexisting malnutrition, and the level of hypermetabolism [29].

Kehlet and Wilmore have recently attempted to employ a multimodal rehabilitation program aimed at reducing both physiologic and iatrogenic factors delaying postoperative recovery after colon resection procedures [30, 31]. The key components of this ''fast track program'' are that the initial meal offered is full liquids followed by advancement to a GI diet as soon as tolerated. Furthermore, routine use of thoracic epidural anaesthesia and analgesia with local anaesthetics and adherence as far as possible to physiological principles (avoidance of long fasts before and after surgery, as well as drains, tubes, and catheters) are the main issues. With this approach, a hospital stay of two days after elective sigmoid colectomy is possible [32–34], but it has been associated with relatively high early readmission rates of 9–11% [35]. In addition, many of the protocols have altered discharge criteria from typically accepted thresholds by allowing discharge on clear liquids without any evidence of return of bowel function [36]. Finally, these pathways are generally reserved for patients undergoing relatively straightforward, uncomplicated colonic resections.

A similar conceptual approach to ''fast-track'' recovery after colectomy for both laparascopic resections and complex re-operative bowel resection and pelvic surgery is described by Zutshi et al. [37]. The key component of success in their experience has been to carefully explain the principles of the ''fast-track'' care to each patient prior to surgery. Furthermore it is important to describe to the patient the daily benchmarks to be expected (including discharge criteria), and to reinforce the same message daily.

The ''fast-track'' approach is applicable to the large majority of cases undergoing colorectal surgery. However, in contrast to the findings of Basse et al. [35, 36, 38], who found that patients do equally well, whatever their status of co-morbidity, Senagore has determined that patients without co-morbidity do even better than those with co-morbidity and achieve hospital stays averaging only 3.5 ± 0.8 days [37, 39]. This is not affected by prior abdominal surgery and confirms that these clinical pathways should be available to all colectomy and pelvic surgery patients.

C. Immunocompromise

A balanced immune system is preferable but not standard. The numerous sources of immunocompromise in potential surgical patients may be primary or acquired. The defects in immunity may be primarily local, as in burns and wounds or loss of mucosal integrity, or systemic. Systemic immunocompromise may include one or any combination of cell mediated (T cell function), humoral (B cell function), phagocytosis (neutophils), or complement defects. Primary immunodeficiencies are relatively rare (1/10,000) and will not be encountered in most surgical practices [40]. Acquired immunodeficiences are common and range from mild defects to complete loss of immune function [41]. Age, malnutrition, obesity, malignancy, burns, sepsis, trauma, surgery, anaesthesia, blood transfusion, diabetes, renal failure, liver disease, splenectomy, radiation, and foreign bodies all modify the body's response to invasion [42–44]. Drugs including chemotherapeutic agents are probably the most frequently encoun-

tered cause of severe immunocompromise manifested by profound neutropenia [45].

The development of disease requiring surgical treatment in an immunocompromised patient presents a unique challenge. For the colorectal surgeon, this may be a perianal inflammation or an intraabdominal catastrophe. Some conditions, such as neutropenic enterocolitis [46], are unique to the compromised state; others may simply be severe manifestations of common disease process. For example, neutropenia has been associated with increasing severity of complications in diverticular disease of the colon [47].

The obvious risks to immunocompromised patients are postoperative sepsis and poor wound healing. In the case of anorectal pain and inflammation, local care and antibiotic therapy should prevail, with open drainage reserved for treatment of a fluctuant mass. If bowel resection becomes necessary, diversion of the faecal stream will most frequently provide the best management, depending on the degree of contamination, preparation of the bowel, presence of peritonitis, and projected duration of the neutropenia [48]. In general, the white blood cell count bottoms out 10–20 days after initiation of chemotherapy [49].

Administration of broad-spectrum antibiotics, use of prophylactic antifungal therapies such as oral nystatin, and careful respiratory and haemodynamic monitoring are critical [50].

Filgrastim, a granocyte colony-stimulating factor, decreases the duration of neuropenia and the prevalence of infection (compared with that in control groups in patients undergoing chemotherapy for small cell carcinoma of the lung and other nonmyeloid malignancies) [51].

In an HIV positive or AIDS patient, an absolute CD4 count < 200 or a decreasing ratio of CD4 to CD8 (normal 1.8:2.2) is associated with a severe immunocompromise and subsequent risk for viral, fungal, protozoal and bacterial infections and prolonged wound healing.

In immunosuppressed lymphoma or organ-transplant patients, performing an anastomosis after a colectomy should not be forced [50].

D. Bowel preparation

Mechanical bowel preparation has been standard for patients undergoing colon or rectal surgery for the last 40–50 years. The idea was to prevent postoperative septic complications, thereby decreasing morbidity and mortality [52]. This habit is supported by a survey of the American Society of Colon and Rectal Surgeons, which showed that 99% of the colorectal surgeons routinely employ mechanical bowel preparation [52]. One-third of the surgeons prefer a PEG solution.

Few studies have examined the differences in types of bowel preparation performed prior to elective colorectal surgery. In a prospective randomized study, Oliveira et al. compared oral sodium phosphate to polythylene glycol lavage solutions [53]. The sodium phosphate solution was better tolerated and provided better bowel quality. Otherwise, there was no difference in the septic complication rates between the two groups. Valverde et al. randomized 262 patients to receive either senna or PEG solutions [54]. All patients received perioperative antibiotic prophylaxis. The authors found colonic cleanliness to be better in the senna group and found no difference in clinical tolerance. There was also no difference in anastomotic leak rate or postoperative infections [54].

A Cochrane review examined all studies that randomized elective patients undergoing a colon or rectal resection either to bowel preparation or none [55]. The primary outcome used for the review was the rate of anastomotic leakage. This was defined as ''a discharge of faeces from the anastomosis site and the presence of peritonitis or pelvic sepsis confirmed by clinical or radiological investigation.'' Two surgical procedures were considered: low anterior resection (extra-peritoneal anastomosis) and colonic anastomosis (intra-peritoneal anastomosis). Secondary endpoints examined were mortality (within 30 days of surgery), peritonitis, re-operation, wound infection, infectious extra-abdominal complications, non-infectious extra-abdominal complications, overall infections in surgical sites.

Nine randomized controlled studies (out of eleven) with a total of 1592 patients were included in the review. There was a significantly lower anastomotic leak rate in the absence of bowel preparation (Table 1).

Furthermore, there were no other significant differences between the two groups in any of the categories examined, including mortality rates and wound infections. When broken down into colonic anastomosis vs. low anterior resections, a significant difference with respect to anastomotic leak rate (low anterior resection: 9.8 vs. 7.5% (NS); colonic

Table 1. Comparison of outcome following colorectal surgery in presence vs. absence of bowel preparation

Category	Bowel preparation	No bowel preparation	Significance
Total number of patients	595	803	
Leak – low anterior resection	9.8% (11/112)	7.5% (9/119)	NS
Leak – colon anastomosis	2.9%	1.6%	NS
Anastomotic leak overall	6.2%	3.2%	0.003
Wound infection	7.4%	5.4%	NS

Table 2. Randomized studies comparing anastomotic leak rates following colorectal surgery in presence vs. absence of bowel preparation

Study	Year	n	Antibiotic prophylaxis	Leak rates
Brownson	1992	179	+	significantly increased in prep group
Burke	1994	186	+	no difference
Santos	1994	149	+	significantly increased in prep group
Miettinen	2000	267	+	no difference
Fillman	2001	60	+	no difference
Zmora	2003	415	+	no difference
FA-Si-Oen	2003	250	+	no difference

resections: 2.9 vs. 1.6% (NS) could not be demonstrated. A publication bias could be excluded.

Meta-analyses of randomized clinical trials of colorectal surgery with or without mechanical bowel preparation by Slim et al. in 2004 [56] reported on seven out of eleven trials with 1454 patients (Table 2). Patients who underwent bowel preparation had a significantly higher anastomotic leak rate (5.6 vs. 3.2%; $P = 0.032$). Other endpoints examined in the study included wound infection and other septic and nonseptic complications, all of them showed no significant difference between the groups. The authors also performed a subgroup analysis comparing patients who underwent bowel preparation with PEG solution with those who had no prep at all. Their conclusions were that mechanical preparation with PEG solution should be omitted before elective colorectal surgery.

There seems to be no benefit from mechanical bowel cleansing for elective colorectal surgery. Indeed there may be clear-cut disadvantages, with higher anastomotic leak rates in patients undergoing mechanical preparation. Though there does not appear to be a difference in septic complications depending on the type bowel preparation, sodium phosphate does appear to be better tolerated by the patient and to provide better subjective cleaning of the colon [53]. The presence of solid stool in the rectum will make it technically difficult to use an EEA stapler passed through the anus. At present, the literature data do not support the use of mechanical bowel preparation for elective colorectal surgery, thereby obviating the question of which mechanical agent is best for elective surgery [56].

E. Antibiotics

Septic complications are an ever-present danger for patients undergoing elective surgery for diseases of the large bowel. Frequently these infections are limited to the surgical wound, but other potential sites include the abdominal cavity, pelvis and bloodstream. Postoperative wound infections produce serious morbidity and mortality and drive up the cost of health care [57]. Many factors contribute to septic complications and not all of them are controllable. Currently, the use of antibiotics in addition to mechanical cleansing is the North American standard of care before colon surgery.

The antibiotics chosen should be active against both the aerobic and anaerobic colonic bacteria. The question whether an antibiotic agent should be administered intravenously or orally or both has been and is still the topic of some debate. The importance of reducing the number of microorganisms in the colonic lumen before opening the colon is typically emphasized by the advocates of oral administration [58]. In contrast, advocates of parenteral administration emphasize the importance of adequate tissue levels of the antibiotics [59].

Oral non-resorbable antibiotics serve to reduce the concentration of colonic bacteria and have few, if any, systemic effects [60]. Systemic agents protect against the almost inevitable intraperitoneal bacterial contamination that occurs during colon surgery [59].

Improvement in bacteriologic culture techniques and the knowledge of the importance of the anaerobes in the development of postoperative sepsis have guided the evaluation of different prophylactic agents. Older publications have shown that an antibiotic, to be effective, must be present in the tissues in sufficiently high concentrations at the time of contamination. This idea concurs with the now accepted use of parenteral antibiotics for prophylaxis of surgical infections [58, 61]. While there is almost universal agreement that some type of antibiotic should be used, this route of administration has remained a topic for some debate.

Oral antibiotics alone

The classic randomized, prospective study by Clarke et al. showed the effectiveness of oral nonresorbable agents in decreasing the septic complication of colon surgery using the ''Nichols-Condon'' preparation of erythromycin in combination with neomycin to cover both aerobic and anaerobic bacteria [60]. Over a decade later, Lewis could demonstrate that neomycin is unnecessary [62]. However, there is a true need for a broad spectrum anti-anaerobic antibiotic in colorectal surgery [63].

Parenteral antibiotics alone

In 1990, a survey revealed that parenteral antibiotics alone are used for preoperative colon preparation by fewer than 10% of active colon and rectal surgeons [59].

Combination of oral and parenteral antibiotics

Presently, most surgeons use both oral and parenteral antibiotic agents in addition to mechanical cleansing as preparation for elective colorectal surgery [64].

F. Timing of operation

Concerning timing, we distinguish between three types of surgery: emergency operations (immediate), urgent (within 24–48 hours) and elective surgery (more than

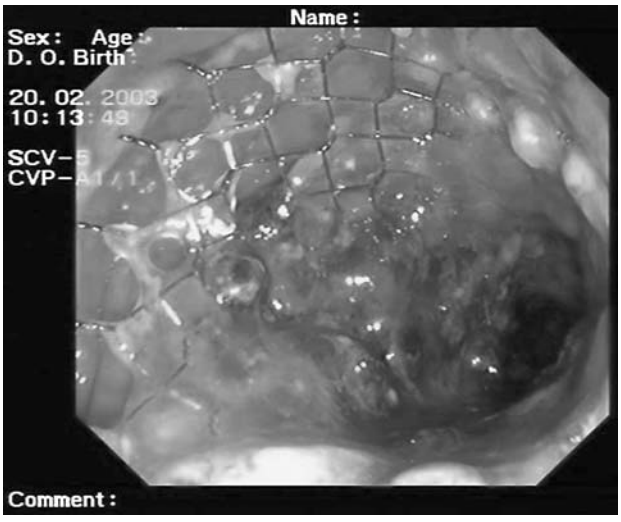

Fig. 1. Endoscopic image of colonic stent for acute management of tumor induced bowel obstruction, as described in the text

Table 3. Outcome following stenting of colonic obstruction

Author	Ref.	Year	Patients n	Techn. success n (%)	Stent migration n (%)	Re-obstruction (%)	Perforation (%)
Rey	[68]	1995	12	11 (92)	3 (25)	0 (0)	0 (0)
Mainar	[69]	1996	12	10 (83)	0 (0)	0 (0)	0 (0)
Saida	[70]	1996	15	12 (80)	1 (7)	0 (0)	2 (13)
Baron	[71]	1998	27	23 (85)	5 (19)	2 (7)	4 (15)
Binkert	[72]	1998	13	12 (92)	0 (0)	2 (15)	0 (0)
de Gregorio	[73]	1998	24	23 (96)	2 (8)	1 (4)	0 (0)
Wholey	[74]	1998	10	9 (90)	4 (40)	0 (0)	0 (0)
Wallis	[75]	1998	7	7 (100)	1 (14)	0 (0)	0 (0)
Arnell	[76]	1998	7	7 (100)	0 (0)	0 (0)	0 (0)
Mainar	[67]	1999	71	66 (93)	0 (0)	0 (0)	1 (1)
Repici	[77]	2000	16	15 (94)	2 (13)	0 (0)	1 (6)
Tamim	[78]	2000	10	9 (90)	1 (11)	0 (0)	0 (0)
Camunez	[79]	2000	80	70 (88)	1 (1.5)	13 (19)	2 (3)
Seymour	[80]	2002	21	20 (95)	0 (0)	2 (10)	0 (0)
Dauphine	[81]	2002	26	23 (88)	1 (4)	4 (17)	2 (9)
Kang	[82]	2002	26	25 (96)	5 (20)	2 (8)	0 (0)
Clark	[83]	2003	16	13 (81)	0 (0)	1 (8)	0 (0)
Maetani	[84]	2004	12	11 (92)	2 (18)	1 (9)	0 (0)
Carne	[85]	2004	25	22 (88)	0 (0)	0 (0)	0 (0)
Syn	[86]	2005	17	13 (76)	0 (0)	0 (0)	0 (0)
Watson	[87]	2005	119*	112 (94)	4 (3)	3 (2.5)	2 (1.7)
Davies	[88]	2005	21	16 (76)	1 (5)	1 (5)	1 (5)
Total			587	529 (90.1)	33 (5.6)	32 (5.4)	15 (2.5)

* In this study 12 individuals underwent double stenting; "Ref." indicates number in references.

5–7 days after an acute attack). As emergency operations are often a challenge for the surgical team because of the high risk of morbidity and mortality [65], the main interest must be to try to convert an emergency situation into an urgent one [66]. One of these possibilities in left-sided large bowel obstruction is placement of an expandable stent similar to stents used for esophageal malignancies (Fig. 1). The metallic, expandable stent is passed through an obstructing tumour under endoscopic and fluoroscopic guidance [67]. Stent expansion will increase the luminal diameter and thus allow relief of the acute bowel obstruction (Table 3). Colonic stent placement has an excellent chance of providing a bridge to surgery so that emergency surgery with an unprepped patient can be avoided, allowing an elective operation. Bowel prep can be performed and the decompressed bowel will more often allow resection and primary anastomosis [89].

Furthermore, in a palliative setting, long-term palliation can be achieved in 92% of patients suffering from recurrent cancer or metastatic cancer without requiring a laparotomy or stoma [85].

G. Intraoperative complications: general remarks

1. Team

Surgery is teamwork. A good outcome depends on a highly motivated and specialized team. This is especially true for laparoscopic operations [90]. In special situations (e.g. large bowel obstruction and a young resident or surgical nurse on duty), it might be wise to postpone an operation until the next morning, when an experienced, relaxed and motivated team will be available. In such a case of bowel obstruction, a decompression nasal tube might be helpful in the meantime [91]. It should be stressed that laparoscopy is not useful in emergency situations [92]. An exception might be an abdominal knife wound in a haemostable patient, where the goal is to exclude injury of the peritoneum with a diagnostic laparoscopy [92, 93].

2. Position

In emergency situations, we recommend placing the patient in supine position with the legs apart (''Lloyd Davies'' position). A long midline incision allows access to all quadrants of the abdomen and the smaller pelvis as well as the anus.

H. Operative steps

1. Dissection

Adequate bowel mobilisations, appropriate illumination, correct positioning of assistants and retractors and good and careful handling of the tissue is the key to a successful operation. The small bowel especially should be treated carefully, using wet instead of dry pads in order to reduce damage to the bowel's serosa, which may lead to postoperative formation of adhesions [94]. Moreover, during lengthy colorectal surgery the bowel should be covered with warm, moist pads, which should be changed frequently to avoid hypothermia and evaporation.

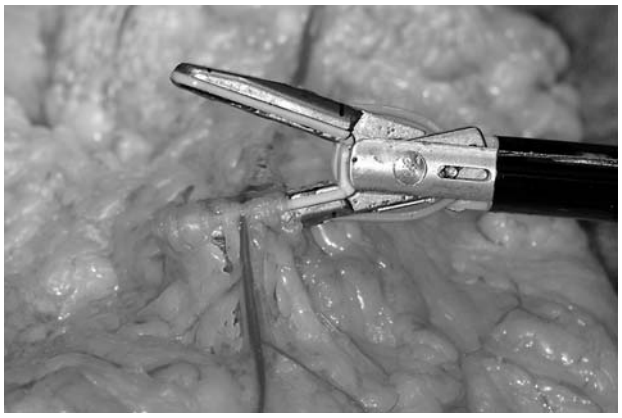

Fig. 2. Image of Ligasure® technology for vessel sealing. Image shows vessel of greater omentum before closing the branches of Ligasure® for sealing and dissection, as described in the text

Generally, sharp dissection with blunt-tipped scissors (to avoid inadvertent bowel damage) under direct vision is preferred. Newer technologies including harmonic scalpel (Ultracision®) or a vessel-sealing system (Ligasure®) (Fig. 2) help to reduce blood loss [95].

If inflammatory masses are present in the abdomen, it might be advisable to dissect bowel loops and intra-abdominal abscesses mainly by blunt finger dissection [96]. High energy water jet dissection might also be helpful on special occasions [97].

In the case of a patient with very severe multiple injuries, as from gunshot, with lacerations not just of the small and large bowel but also of other organs like the liver, pancreas and kidney, the concept of damage control should be used [93]. The idea is to do only as much as necessary to stop bleeding and further spillage of bowel content into the abdominal cavity, e.g. ligation of major vessels, closure of the bowel wall with staples, etc. Then the abdominal wall is temporarily closed and after medical resuscitation in the ICU (with stabilization of metabolic functions, temperature, electrolytes, etc.), usually after 6–12 hours a final operation with extensive resections can be performed with the patient in better general condition, and a better outcome achieved [98].

2. Technical aspects

Complications can often be prevented by adequate exposure of the surgical field. Traction and counter-traction comprise the key for precise dissection. However, excessive traction in the area of the left colonic flexure may inadvertently injure the spleen. In slender patients, correct dissection lines of the bowel mesentery are best determined by transillumination. In very obese patients, digital palpation of the vessels can help avoid damage. Avoiding tension on the anastomosis or stoma site can be prevented by good mobilization of the bowel (Figs. 3a and b). If a stoma is required, obese patients in particular may present problems with the blood supply to the ostomy limb, which can easily lead to retraction and/or necrosis of the stoma [99, 100].

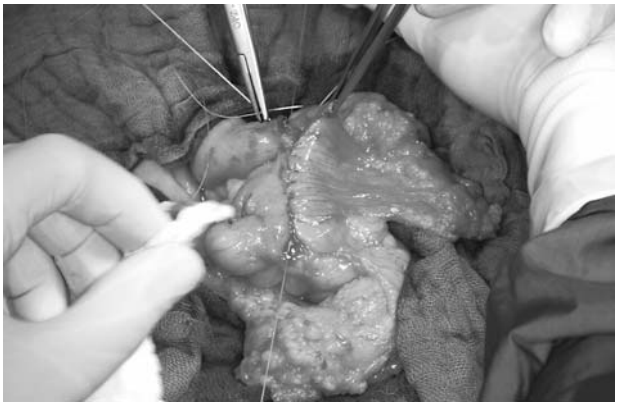

Fig. 3a. Image of hand-sewn anastomosis. Absence of tension and presence of good blood supply is mandatory

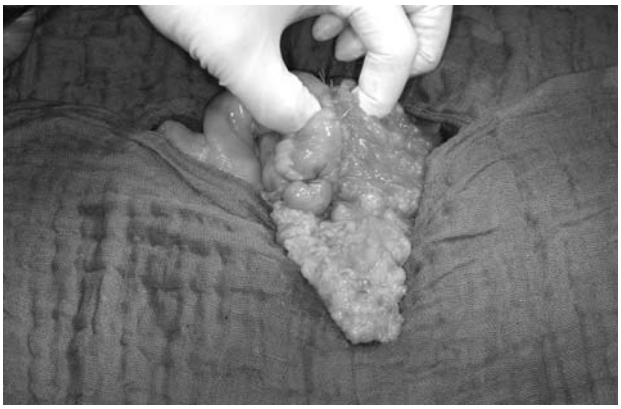

Fig. 3b. Digital examination of anastomosis for proof of absence of stenosis

3. Bleeding

Every surgeon aims to operate as bloodlessly as possible as it is well known that blood units administered decrease the immunocompetence of the patient [101]. This is especially true in cancer patients; the outcome will be worse in the long run when blood units must be given during or after surgery [102]. In open colorectal surgery, there are some critical steps during dissection that should be highlighted.

The mobilization of the left colonic flexure, which is situated high up in the left upper quadrant of the abdomen, is often technically challenging, especially when fatty omental attachments are present. The view can be obstructed and bleeding may occur from manipulation alone. Usually, the surface of the lower pole of the spleen is damaged. The first steps are to tamponade the bleeding site and proceed with the operation. If necessary, the splenic laceration may be glued when dissection is completed [103]. With severe bleeding, we recommend a full mobilization of the spleen, inserting two large pads in the direction of the diaphragm and behind the organ to elevate it. The site of damage may be inspected more carefully and selective treatment applied (gluing, partial resection or splenorrhaphy). Splenectomy is rarely necessary except

when the general situation demands a quick solution to finish surgery as soon as possible [104].

Transsection and ligation of the major vessels (ileocolic artery, right colic and inferior mesenteric artery) are usually not too difficult. However, dissection of the middle colic artery and vein may sometimes present a problem, especially in the presence of multiple enlarged and cancerous lymph nodes at the transsection line. Small dissection steps with frequent stitches are required.

In the presence of an inflammatory mass or extensive cancer in the sigmoid colon, the left iliac vein may be at risk. Careful dissection under direct vision and soft manipulation will help to avoid more serious problems. If bleeding occurs, a 5-0 monofilament thread should be used to repair the defect.

Another problematic region is the presacral space. Massive life-threatening intraoperative pelvic bleeding from basivertebral veins may require a thumbtack occlusion [100].

4. Anastomosis

The principles of a good and reliable colo-colonic or colorectal anastomosis are as follows:

1. good exposure and access to large bowel (sufficiently long incision),
2. adequate blood supply to anastomosed stumps,
3. prevention of sepsis or gross faecal contamination,
4. sutures or staplers should be properly placed, assuring good approximation of all layers of bowel wall (most important is the submucosa) [105],
5. no tension on the anastomosis (always release the splenic flexure in left colorectal surgery),
6. prevention of distal obstruction,
7. the patient should be well nourished and the large bowel should be well prepared mechanically (no faecal contamination) [29].

Reality, however, is different. If an anastomotic leakage occurs, the causes are usually multifactorial and may include faulty technique with ischemia or excessive tension at the suture line. Other factors might be an anaemic and/or malnourished patient with several comorbidities or who is on high dose steroids or immunosuppressant drugs [106]. Anastomotic leakage after colorectal surgery is the major cause of postoperative morbidity and mortality [107]. It occurs more often after anterior resection than after colo-colonic anastomosis [108]. If there is rectal anastomotic insufficiency, in 60% of the cases leakage will cease with conservative treatment [108]. Colonic anastomoses are less prone to leak [55, 100], but surgical correction is almost always necessary [100]. If re-laparotomy is necessary, morbidity and mortality increase due to peritonitis, fistula formation or abscess. A few practical tips for the operation are as follows: Always mobilize the bowel ends. To have an adequate blood supply, the cut ends of bowel should bleed before the anastomosis is created. Use non-crushing bowel clamps if necessary and close them lightly without including the mesentery. There are numerous variations in anastomosis technique. Most common are: end-to-end anastomosis (double layer, single layer full thickness, single layer extramucosal) and end-to-side anastomosis. It is generally accepted that the inversion techniques (running suture or interrupted stitches) should be employed for colorectal anastomosis [109]. It does not seem to matter whether a single or two layer technique is used for a colorectal anastomosis; it is a matter of the surgeon's preference. In the presence of local sepsis (e.g. perforated diverticulitis or colorectal cancer, colorectal trauma, gross faecal contamination during colorectal surgery), one should still try to re-anastomose as often as possible. Elderly patients especially will have problems learning to care for a stoma [110]. Only with severe faecal peritonitis or in patients with very fragile tissue (elderly patients, chronic use of corticosteroids, immunosuppressants, etc.) a primary anastomosis may not be a wise decision [111]. During creation of an anastomosis, the surgeon should avoid traction during manipulation and prevent infections by covering the neighbouring area with wet pads to stop spillage. Gloves should be changed after the anastomosis has been established. Though more costly, stapling devices will allow colonic or rectal closure and anastomosis to be performed more quickly than manually [112]. Furthermore, it is easier to perform a clean operation as spillage can be reduced by opening the bowel lumen just when the anastomosis is to be made, and not when the bowel is transsected. The Contour® (Johnson and Johnson) is especially useful in rectal surgery [113]. If a stapled anastomosis is performed, the largest calibre of stapler that can accommodate the bowel lumen should be used.

There are some important findings in the literature. According to Kusunoki, there are no significant differences in anastomotic dehiscence (5–7%) or recurrence of Crohn's disease between the stapling and hand-sewn procedures [114]. Furthermore, in 1998 Miettinen et al. demonstrated that preoperative bowel preparation seems to offer no benefit in elective open colorectal surgery with regard to mortality, wound infections and anastomotic leakage rate [115]. Defunctioning stoma does not reduce the incidence of major leakage; however, the risk of peritonitis and its consequences can be minimized [116]. It has been considered prudent to defunction the low rectal anastomosis below 6 cm from the anal verge, particularly after total mesorectal excision [117]. The presence of drains is associated with an increased incidence of anastomotic leakage. Thus drains may adversely affect anastomotic healing in colon surgery [118].

5. Injury to other organs

a) **Splenic injury:** The bleeding complication most often experienced in colorectal surgery is laceration of the spleen [119] but the inadvertently injured organ can usually be rescued (see above).
b) **Ureteric injuries:** In contrast to a right-sided colectomy, a left-sided colectomy always requires identification of the ureter. The latter can easily be found running medial from the gonadal vessels where they cross the iliac artery. In addition, the ureter can be identified by its peristaltic response to light touch. A non-identified ureter might be an indication for conversion in laparoscopic-assisted colon surgery [120]. Ureteric injury is the most common intra-operative

urologic complication. Typical lacerations would be at the crossing of the uterine vessels with the pelvic brim or next to the lateral ligaments of the rectum. Types of injuries include devascularization, crushing or transsection. If an injury has been identified intraoperatively, a primary re-anastomosis can often be done by an urologist without any further problems.

c) **Bladder injury:** If the bladder is injured, the defect must be closed with a monofilic thread, usually in two rows. With a larger injury, a suprapubic catheter should be applied for a fortnight after prior consultation with an urologist. In case of a cancer with macroscopically unclear delimitation towards the bladder, the resection margin should comprise a primary multivisceral resection including partial bladder resection. The final outcome is then better than if inadvertent tumour spillage has occurred (5-year survival rate 71 vs. 25%) [121].

I. Minimal invasive surgery

Minimal invasive surgery was pioneered in the late 1980s and was very quickly adopted by surgeons for a variety of indications. Laparoscopic cholecystectomy was the breakthrough for minimally invasive techniques in general surgery. This technique has replaced the open cholecystectomy as the operation of choice for gallbladder disease and is now being practiced worldwide [122]. In contrast, laparoscopic colorectal surgery has been slower to evolve. The postoperative benefits demonstrated in laparoscopic cholecystectomy were not as obvious in colorectal surgery. In addition, reports on port-site metastasis in colorectal cancer patients have raised concern regarding the suitability of this approach in oncological cases [123]. Finally, the more complex nature of these procedures has contributed to their lower acceptance. Laparoscopic colorectal surgery is a technically challenging procedure because it involves difficult laparoscopic manoeuvres such as operating in different quadrants of the abdomen with a frequent need to reposition the patient and the instruments, controlling major blood vessels, extracting large specimens, identifying extraperitoneal structures (such as the ureters) and re-establishing bowel continuity [124].

Nevertheless, laparoscopic colorectal surgery is growing in popularity as a procedure for the treatment of both benign and neoplastic intestinal diseases. Ever more large published series demonstrate that patients undergoing laparoscopic colorectal procedures have less discomfort and more rapid postoperative recovery [125–127]. Laparoscopic colorectal surgery for benign diseases has been proved to be as safe as open surgery with comparable mortality and morbidity rates [124, 125]. Oncologic standards of curative surgery for colorectal cancer include en-bloc resection, no-touch isolation technique with primary ligation of the corresponding vessels, and systematic lymph node dissection. These principles are mandatory for both open and laparoscopic surgery.

It is important to realize that in laparoscopic surgery, everything is enlarged due to the zoom effect of the camera, and that even minor bleeding sites may look dangerous. Blood in the abdomen may reduce illumination, rendering dissection more difficult, and even small amounts of blood on the lens of the camera can obstruct the view. Particular prudence is essential, especially as small bleeding sites can be compressed by the pressure of the insufflated gas in the abdomen, but then bleeds postoperatively when the pneumoperitoneum is released. Cold insufflated gas may predispose the patient to bleeding [124].

For practical reasons, a few issues must be discussed more extensively:

a) **Team:** The factor that appears to have the most crucial effect on the complication rate is the cumulative experience of the surgeon and the team [128]. The surgeon's experience may be reflected in better technical skills, better patient selection and sometimes better technology. The best way to deal with complications is to avoid them by careful patient selection and adequate training with laparoscopic instrumentation and stapling devices. Especially in critical bleeding situations, everybody on the team should know what his/her job is, as a false camera position can be as dangerous as wrong assistance, and both can lead to emergency laparotomy [129].

b) **Position and instruments:** In laparoscopic (assisted) colon surgery an electronically operated table is useful as frequent changes in position are needed for laparoscopic colectomy. Good fixation of the patient on the OR table is crucial so that the table can be titled when necessary to use gravity to retract the intestines from the site of dissection. Because there is a limited access to the surgical site during laparoscopic surgery, instruments are a key to successful surgery. Essential equipment includes a high resolution video system with a good light source, monitoring and recording devices, as well as high-flow insufflators delivering at least 10 l of gas/min. Surgical instruments should be long enough, should be easy to manipulate and capable of 360° rotation with the surgeon's single hand. It is wise to position the patient and the team so that endoscopic access to the colorectum is possible if needed.

The transanal endoscopic microsurgery (TEM) technique also requires special patient positioning, i.e. so that the lesion to be removed is always "on the bottom" (at 6 O'clock) of the operating scope.

c) **Trocar-related complications:** Although relatively safe, the placement and use of trocars and pneumoperitoneum needles can cause complications. Injuries to the bladder, to solid organs and to major vessels have all been described [124]. Most trocar-related injuries result from technical problems such as inappropriate placement and/or inadequate skin incision, necessitating increased insertion force [130]. We recommend that the first trocar should always be inserted with an open technique (Hasson technique); an adequate pneumoperitoneum is then established which moves the abdominal wall away from the intraperitoneal organs and lessens the chances of organ injury. Further trocars are then positioned under direct camera vision. Good clinical practice teaches that trocars should not be located too close to each other as this could make it difficult to operate. The best position is when the camera and the working instrument have a common focal point, forming a triangle. If there is bleeding from the

trocar site, it should be attended to and stopped immediately; otherwise, it can create problems throughout the whole operation. Abdominal wall bleeding from trocar sites used to be common early in the laparoscopic era. With increasing experience, this typical laparoscopic complication is now encountered less often. Port site bleeding can be avoided by placing the trocars preferably in the midline or lateral to the rectus muscle in order to reduce the risk of injuring the inferior epigastric vessels. If this nonetheless happens, the best thing is to enlarge the trocar opening, look for the stumps of the vessels and to sew or ligate them selectively. Injuries to larger intraabdominal vessels require immediate conversion to open surgery [124]. Laparoscopic dissection of the colonic mesentery may be difficult, especially when it is diseased and thickened. To avoid bleeding from large vessels, the vascular pedicle should be completely dissected and visualized before the vessels are clipped or stapled; this reduces the tissue bulk in the staples and so achieves more secure hemostasis. The use of newer vessel sealing systems like the Ultracision® or Ligasure® have also contributed to a decrease in bleeding complications [131, 132].

d) **Anatomy:** Sometimes anatomical orientation is difficult and the operation proceeds only slowly or approaches a standstill. Conversion to open surgery can be a very important tool in avoiding complications. In cases of unclear anatomy such as dense adhesions, obesity and severe inflammation the surgeon should not hesitate to convert to open surgery. Timely abandonment of a laparoscopic approach should be regarded as good surgical judgement rather than failure. If in laparoscopic surgery there is no progress within 30 minutes, conversion to open surgery is indicated.

e) **Organ injuries:** Intraoperative identification of an injury can greatly help to minimize associated morbidity [133]. The two most typical intra-operative surgical complications are bleeding (intraabdominal and port-site) and bowel injury. The rate of intraoperative complications reported in some published series of laparoscopic colorectal surgery is about 5–7% [120, 128, 134, 135]. It is important to state that bleeding can be minimized with good and careful dissection with suitable instruments. Another important factor is the use of soft and non-crushing laparoscopic instruments to avoid tearing the bowel wall. In practice, we try to avoid touching the bowel wall itself, holding instead the mesentery of the bowel segment. If other organs like liver, gallbladder or ureters are injured, conversion is almost always a must [124].

f) **Anastomosis:** As it is usually very difficult to create an anastomosis intra-abdominally, the better and faster option seems to be an extracorporal anastomosis through the bowel extraction site. This can be done in the conventional way with suture or staplers if preferred.

g) **Malignant tumour:** With the introduction of laparoscopic curative surgery in colorectal cancer, some concern was voiced regarding the ability to maintain the oncologic principles of open cancer surgery. It has been proven recently that laparoscopic oncological resections are possible with at least the same outcome as open conventional surgery [134, 136].

h) **Other complications:** Less frequent surgical complications are instrument failure (stapling device failure), cutaneous emphysema due to trocar dislocation, rotated anastomosis and missed colonic lesions due to the lack of palpation [120, 135]. If small colonic lesions like polyps are to be removed, preoperative ink-marking of the diseased area seems to be helpful [136]. As in other laparoscopic procedures, nonsurgical complications may result from the intra abdominal pressure and the CO_2 insufflation during the procedure.

J. Infection

To avoid infection, pre-, intra- and postoperative antibiotics with focus on gram-positive and gram-negative colonic bacteria should be given [137]. However, the most important issue is to avoid spillage of bowel content during dissection and creation of the anastomosis. We therefore recommend a ''closed resection'' where both bowel ends are closed after transsection. Coverage of the neighbouring organs during anastomosis creation is important in open surgery, while plastic bags for extraction of the diseased bowel segment are useful in laparoscopic surgery [120].

II. Postoperative complications

A. Early complications

1. Anastomotic leak

As an anastomotic leak is one of the most dreaded postoperative complications, it is obvious that meticulous postoperative clinical and laboratory observation is necessary after colectomy. The most important clinical signs are fever, sweating, bloating and nausea, and laboratory findings of increasing leucocytes and/or CRP may be the first indication of an anastomotic leak. Determination of lysozyme content in the wound or in the effluent from pelvic drains can be useful in the early diagnosis of anastomotic dehiscence. Lysozyme is a component of local defence and is produced in macrophages. In patients with impending anastomotic leak, lysozyme activity is significantly increased as early as the first postoperative day in contrast to patients without any anastomotic complications [138]. Several systemic and local factors play a significant role in the aetiology of an anastomotic leak.

Local factors include bowel preparation, surgical anastomosis technique, intraabdominal sepsis and drains [139, 140, 141]. The following systemic factors have all been described in the literature: shock, sepsis, advanced age of patient (above 75 years), coagulopathy, steroids, anaesthetic drugs, advanced malignant disease, radio- and chemotherapy, diabetes, uraemia, anaemia, iron, zinc, cystein, vitamin C depletion, malnutrition with hypoalbuminemia, congestive heart failure and chronic obstructive pulmonary disease [107, 111, 142, 143].

The prompt diagnosis of anastomosis leak is of paramount importance for the patient. Contrast enema with either uropolin or gastrographine enables early diagnosis of anastomotic leak if the situation is clinically unclear

[144]. Conservative treatment options are total parenteral nutrition, broad spectrum antibiotics and treatment of the septic shock [145]. However, in most cases prompt surgery (depending on patient status, drainage and diameter of fistula) is essential [111, 139, 144, 146]. Surgical possibilities are either a re-do of the anastomosis (often with a segmental resection) or a disconnection procedure with creation of a stoma and a blind closure of the distal bowel lumen (Hartmann procedure) [147, 148].

2. Sepsis

Sepsis may be defined as a proliferation of bacteria in the bloodstream. It may be accompanied by fever, chills, leukocytosis, tachycardia, and in some cases, circulatory collapse and shock [57, 146]. Septicemia may be a direct complication of surgical procedure, resulting from an anastomotic leak or wound infection, or it may result from invasive studies or monitors such as an infected central line [149]. Elderly patients, poor nutrition, immunocompromised individuals, and co-morbidities may also affect the incidence and degree of sepsis [150]. The increasing occurrence of sepsis may be related to advances in critical care medicine as more patients now survive antibiotic resistant organisms [151]. Studies attempting to identify preoperative risk factors for patients undergoing elective colorectal surgery have identified only three: patient gender, physical status, and seniority of the surgeon. Female patients in poor physical health with a relatively inexperienced surgeon had a worse outcome and higher morbidity [44].

The best method of treating sepsis is to prevent it in the first place. This may be accomplished by adherence to meticulous surgical technique [57]. Care should be undertaken to prevent bowel spillage upon resection and anastomosing. A bowel anastomosis must always be done without tension and with good blood supply. The bowel ends should be free of faecal matter. A low-lying bowel anastomosis should always be considered for a proximal diversion due to the higher leak rate associated with the former [144]. Radiated bowel as well as high risk patients, particularly immunocompromised individuals, should always be considered for proximal diversions [152]. Although proximal diversion will not prevent a distal leak, it will, however, prevent the devastating consequences of leak such as pelvic sepsis, or pelvic inflammation with subsequent fibrosis ultimately causing an anastomotic stricture, and possibly death [117].

A study from Spain revealed that the five-year survival of patients with major septic complications (anastomotic leak or peritoneal abscess) was significantly lower than in non-complicated cases [57].

Most importantly, however, the source of sepsis must be aggressively sought and corrected. Anastomotic leaks and intra-abdominal infections will never be adequately treated by fluids and antibiotics alone. Surgical intervention, whether by percutaneous or invasive open procedures, must be undertaken in order to remedy the situation and potentially salvage the patient [144, 153]. Percutaneous catheter drainage of intra-abdominal or pelvic infections, often done under ultrasonic or CT guidance, has largely replaced open drainage procedures [153].

3. Bleeding

Postoperative haemorrhage is a dangerous complication that, if overlooked, can result in significant patient morbidity and mortality [154]. As the abdomen and pelvis represent large potential spaces for fluid accumulation and exsanguination can easily occur, postoperative clinical and laboratory control of bleeding is necessary. Furthermore, intra-abdominal haematomas may contribute to abscess formation [155].

4. Ileus

Traditionally, postoperative hospitalization following major gastrointestinal surgery has been between five and ten days. A variety of factors contribute to the length of stay including inadequate analgesia, nausea and vomiting, delay in ileus resolution, and stress-induced organ dysfunction [156]. In addition, iatrogenic factors including nasogastric tubes, transabdominal drains, and enforced malnutrition affect patient recovery after colectomy [8]. Recent years have seen a trend toward earlier feeding [8, 157, 158]. It is now well known that the fast track approach to feeding is applicable to the large majority of cases involving colorectal surgery [35, 36]. Another reason why the length of stay after colectomy could be reduced is the greater use of minimally invasive surgical techniques, with earlier return of bowel function than with conventional open technique [31, 33, 35, 36, 157]. Furthermore, epidural analgesia with local anaesthesia appears to reduce time to recovery from postoperative ileus [159]. The advent of new therapeutic drugs such as Ì-opioid receptor antagonists may provide further improvement in the outcome after major abdominal surgery [160].

However, despite careful surgical technique, a postoperative mechanical ileus cannot be predicted or prevented in about 15% of cases [161]; these require an early re-operation.

B. Late complications

1. Stricture/stenosis

Several etiologies for postoperative stricture formation are discussed. Among them, injury, ischemia, inflammation, infection and neoplasm are most common [162]. If a stenosis in a Crohn's patient evolves according to the stricture site, operative treatment is indicated. In small bowel stenosis, strictureplasty is a good option, especially if multiple stricture sites are visible. In ileocolic or colonic strictures, either a bypass or a segmental resection should be done [163, 164].

Ischemic strictures which are very low in the rectum may be treated with frequent dilatation and/or additional laser cutting [165]. Recently, strictures, mainly in the rectosigmoid, have been stented with great success (Table 3). If conservative or semi-conservative treatment options fail, surgical resection is necessary.

2. Adhesions

Postoperative adhesions remain a significant source of morbidity and their prevention would significantly aid

medical care. All abdominal surgical procedures have the potential for creating adhesions [166]. In the absence of surgery, abdominal and pelvic infections and therapy, such as peritoneal dialysis, may incite the inflammatory cascade. Clearly, the optimal solution is prevention. Diminishing the deposition of fibrin and enhancing fibrinolysis without interfering with wound healing are the goals. This may theoretically be achieved primarily by four means: 1) mechanical bowel fixation (e.g. long tubes, suture-pexy) to promote ''friendly'' or ''benign'' adhesions which will not lead to obstruction, 2) systemic pharmacologic therapy (e.g. anti-inflammatory medications), 3) intraperitoneal therapy or barriers (e.g. carboxymethylcellulose, sodium hyaluronate, irrigants), and 4) local factors (e.g. surgical technique, foreign bodies). While none of these will completely prevent adhesions, several have been found to be promising in retrospective and prospective studies [167, 168].

The benefit of pexing or stenting is minimal, so, because of the potentially associated complications, they are generally not recommended for uncomplicated adhesive bowel obstructions. Some caution may be given for patients suffering from multiple episodes. Systemic therapy in an attempt to modify the inflammatory response has been investigated. Associated side effects include bleeding and poor wound healing with resultant anastomotic disruption and incisional dehiscence, and so the routine use of such therapy is not currently recommended [167, 169, 170]. Common practices such as suturing the peritoneum, using surgical gloves with talc and using non-absorbable suture should be eliminated entirely. There is clear evidence that these techniques are unnecessary and promote adhesions [171]. There are many simple techniques all surgeons should be aware of which may reduce the severity of adhesions. Primarily, these involve minimizing the presence of minimal adhesions by using wet pads during the operation, thereby reducing the amount of raw surfaces, and judicious use of prosthetic material, including suture [172]. When it is necessary to use prosthetic material, such as mesh, there are simple manoeuvres that may reduce the inflammatory reaction and the subsequent formation of adhesions. Modifications in the mesh, which reduce tissue in-growth, include lack of matrix in the material (Gore-Tex), use of absorbable mesh (polyglactin lined polypropylene) and interposition of a barrier between the mesh and viscera (omentum). Recently, a mesh with an adhesion material bonded to it (SepraMesh R, Genzyme, Cambridge, MA) has become available. First results are promising [173].

3. Port-site incisional hernia/incisional hernias

Port-site incisional hernia may develop after laparascopy as a result of infection, premature suture disruption, or failure to adequately re-approximate the fascial wound edges [174]. A study found the incidence of port site hernias to be 6.3% in obese patients with BMI >30 [175].

The practice of using prosthetic material to obtain tension-free repair of incisional hernias is well established in open surgery. Applying the same principle, surgeons have utilized mesh in laparoscopic repair of various types of hernias; the use of an intraperitoneal onlay mesh (IPOM) was originally practiced for the repair of inguinal hernias, but was abandoned in favour of the transabdominal and totally extraperitoneal approaches [176, 177]. An IPOM repair remains the standard technique used in the laparoscopic repair of incisional hernias. Most authors advocate the use of expanded polyterafluoroethylene (PTFE) or a composite polyester mesh (Parietex, Sofradim, Villefranche-sur-Saone, France), as these have a low propensity for inducing intraperitoneal adhesions [176–178]. Chowbey et al. have recently reported a series of 34 patients in whom incisional hernias were repaired laparoscopically utilizing polypropylene mesh in a preperitoneal location [178]. This repair not only confers the benefits to the patient of a minimal assess procedure but also avoids the risk of bowel adhesions present with intraperitoneal placement of the mesh [176–178].

4. Stoma complications

Some surgeons advise creating a defunctioning stoma in order to prevent faecal contamination of an anastomosis and when anastomotic leakage appears [148, 149, 179].

The decision whether to create a protective colostomy or ileostomy is often not rational but emotional, based on feelings that ''the operation was technically difficult to perform'', ''there was considerable blood loss'', ''the tumour was stuck in the pelvis'', the patient had many medical problems'', ''the anastomosis looked tenuous'', ''there was some tension across the anastomosis'', ''I didn't feel good about it,'' ''I'll sleep better tonight.'' All those are reasons for protecting the anastomosis with a proximal stoma. Probably the most common reason for a subsequent anastomotic complication is tension in the suture line (distraction, vascular insufficiency). If the above precautions are taken, a protective colostomy is usually unnecessary [139]. There are relative indications for protecting the anastomosis: pelvic sepsis, excessive blood loss and arterial hypotension, poor nutritional status and ultralow anastomosis (below 6 cm from the anal verge). It is generally believed that a temporary defunctioning colostomy is avoided more often if a stapled anastomosis is performed than if a hand-sewn technique is used [179, 180]. There is no evidence that protective stoma prevents anastomotic leak [153].

When a stoma is created, it should be considered that the following late complications may occur: parastomal hernia in 5–14%, stoma prolapse in 2–13%, stoma stenosis in 3–9%, stoma retraction in 1% and peristomal dermatitis in 12–15% [110, 181]. The latter are usually the most troublesome as far as the patient's life quality is concerned [110, 181].

Discussing treatment options for these complications, however, is beyond the scope of this manuscript.

Conclusion

The best ''treatment'' for colonic complications is their avoidance. If colonic complications do occur, it is important to manage them properly on the basis of clinical decision-making.

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