Analysis of risk factors for complications in 262 cases of laparoscopic colectomy

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BACKGROUND: *The aim of the study was to critically review the experience of our unit to identify all the risk factors that can predict the intra-operative and post-operative complications, early and late, that are related to the procedure.*
MATERIALS AND METHODS: *We retrospectively reviewed 293 patients who had undergone laparoscopic colectomy at the General Surgery and Organ Transplantation Unit of the University Hospital of Parma between January 2001 and September 2009. Preoperative tumour staging was performed for all patients by pancolonoscopic examination, performed preferably by the operating surgeon, thoracic-abdominal-pelvic CT, and, for rectal neoplasia, with further input from endoscopic ultrasound and/or pelvic magnetic resonance (MR) imaging. The parameters evaluated for each patient included age, sex, body mass index (BMI), ASA score, preoperative blood tests, associated comorbidities, cancer, others surgical procedures, operative time, laparotomy conversion rate, intra- and post-operative complications, any returns to the operating theatre, length of hospital stay and mortality.*
RESULTS: *A total of 293 laparoscopic colectomy procedures were performed in our unit between January 2001 and September 2009; we analysed 262 of the 293 cases treated, since the data were incomplete and not correctly stored for 31 cases. The overall rate of intra- and post-operative complications was 22.9% (60/262). In 40 cases (40/262, 15.26%), the complications were surgical, and in the other 20 cases (7.63%) they were medical;mortality rate of 0.38% (1/262).*
CONCLUSIONS: *Rectal resection is significantly associated with a greater number of intra- and post-operative complications than the other surgical procedures examined. The laparoscopic approach maintains its benefits even in patients with known preoperative comorbidities and constitutes a feasible procedure even in patients who are obese and/or with ASA status ≥ III.*

KEY WORDS: ASA Score, Colorectal cancer, Hemicolectomy, Laparoscopic colectomy.

Introduction

Several years ago, the laparoscopic treatment of benign and malignant colorectal disease was confined to pilot centres only; nowadays it is used increasingly in General Surgery Units. Laparoscopic approach to colorectal surgery requires an adequate learning curve. The advantages of the laparoscopic approach compared to traditional surgery, in terms of short and long term post-surgical outcomes, are now widely recognized [1-5]. It achieves better post-operative results in terms of pain control, requiring less pain relief, early restoration of intestinal peristalsis, early mobilization of the patient, and less immunosuppression, with a lower incidence of wound infections and fewer respiratory problems with a reduction in the length of hospital stay. Laparoscopy permits

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radical resection that is comparable to the laparotomic technique in terms of medium to long term follow-up[6]. Numerous studies showed the safely of the laparoscopic procedure for advanced stage III colorectal cancer in the absence of metastasis, associating it with a better outcome in terms of recurrence and survival [7,8].

The oncological results and improved quality of life in the postoperative time, with lower hospital stay offset the need for a longer operative time and higher costs of laparoscopic equipment.

We have treated with laparoscopic colorectal procedure, from January 2001 to September 2009, 293 cases.

The aim of the study is to critically review the experience of our Unit in order to identify all the risk factors that can predict the intra-operative and post-operative complications, early and late, that are related to the procedure.

Materials and methods

Study population

We retrospectively reviewed 293 patients who had undergone laparoscopic colectomy at the General Surgery and Organ Transplantation Unit of University hospital of Parma between January 2001 and September 2009. We used the validated technique that uses three trocars and possible placement of the fourth trocar [5]. We proceeded to enter the data in a dedicated database.

The mean age of the study population was 66.4 years (range 36-88 years).

Cholecystectomy, appendectomy, adrenalectomy and nephrectomy procedures were also performed in association with the colonic resection because of loco-regional infiltration events or concomitant surgical disorders.

Preoperative tumour staging was performed for all patients by pancolonoscopic examination, performed preferably by the operating surgeon, thoracic-abdominal-pelvic CT, and, for rectal neoplasia with further input from endoscopic ultrasound and/or pelvic magnetic resonance (MR).

The parameters evaluated for each patient included age, sex, body mass index (BMI), ASA score, preoperative blood tests, associated comorbidities (arterial hypertension, diabetes mellitus, congestive heart disease, chronic renal failure, cirrhosis), cancer, others surgical procedures, operative time, laparotomic conversion rate, intra-and post-operative complications, any returns to operating theatre, length of hospital stay and mortality.

Intraoperative complications with surgical procedure associated were distributed in the following classes: intestinal, urethral, bladder and vaginal lesions, anastomotic stump lesions Bleeding was classified according to medical or surgical treatment.

Perioperative anaesthesiological problems were classified on the treatment given to resolve them (Intensive care or laparotomic conversion) Two main categories of post-operative complication were identified. The first group named as *Surgical complications*: bleeding, intra-abdominal fluid collection, anastomotic dehiscence, infection of the surgical site or wound dehiscence. The second as *Medical complications:* pneumonia, pulmonary thromboembolism, heart failure, acute myocardial infarction (AMI) and acute kidney failure.

Intra-abdominal fluid collection was diagnosed using ultrasound/CT and treated with broad-spectrum antibiotics, ultrasound/CT guided drain placement or returned to the operating theatre (laparotomy).

Anastomotic dehiscences were diagnosed by abdominal CT with water enema or with enema x-ray (gastrografin), and treated conservatively (total parenteral nutrition, broad spectrum antibiotics and long term maintenance abdominal drainage), conventional surgery debridement, resection/anastomosis, loop colostomy/ileostomy or endoscopic surgery (positioning of endoprosthesis/application of fibrin glue/clips).

Surgical wound infection was diagnosed clinically and treated by local antisepsis and systemic antibiotics.

The population was screened for the following characteristics, considered to be risk factors (associated with a statistically significant increase in the possibility of intra- and post-operative complications): age > 75 years, BMI > 30, BMI < 17, male gender, ASA = 3, diabetes, chronic liver disease (cirrhosis), cerebral and peripheral vasculopathy, cardiopathies (ischaemic cardiopathy, arrhythmia, prior AMI), chronic renal failure, arterial hypertension and lung disease.

We analyzed all the medical and surgical complications that developed in the perioperative period, correlating them with the initial colectomy procedure.

Within the group of patients with complications, two subgroups were identified, based on the presence/absence of presumed risk factors.

We then analysed all the medical and surgical complications, according to the individual disorders observed.

Laparotomic conversion was not considered a complication in itself, since it is more properly a change in technical strategy, necessitated by an intraoperative complication an intrinsic anatomo-surgical situation. The laparotomic conversion rate was calculated in relation to comorbidity, tumour stage (TNM Dukes classification modified by Astler-Coller), intervention type and any intraoperative complications. Finally postoperative morbidity was also assessed in patients who underwent laparotomic conversion. All the data were statistically analysed using students t test and the χ-squared test. Associations were considered statistically significant for values of $p < 0.05$.

Medical Preoperative protocol

The laparoscopic approach requires a specific and targeted preparation of the colon, starting 5 days before,

with a low fibre diet, and continues, 48 hours before the surgical procedure, with administration of 2 litres of polyethylene glycol. The day before the operation a further 2 litres of polyethylene glycol are administered, with 12 tablets of simethicone and parenteral hydration. Antithrombo-embolic prophylaxis with low molecular weight heparin starts the day before the operation and continues until discharge.
Prophylactic antibiotic therapy with clindamycin 600 mg and ampicillin/sulbactam 3g is always performed in the operating theatre 30 minutes before surgical incision, and repeated every eight hours for the first 24 hours. After induction of anaesthesia the bladder catheter and nasogastric tube are applied.

Results

Two hundred and ninety-three laparoscopic colectomy procedures were performed in our unit between January 2001 and September 2009; we analysed 262 of the 293 cases treated, since the data were incomplete and not correctly stored in 31 cases.
The study population was made up of 156 men (59.6%) and 106 women (40.4%), with a mean age of 66.4 years (range: 36-88 years) and a mean BMI of 25.7 (range: 15.6-34.7).
The mean operating time was 214.12 minutes.
The average hospital stay was 8.9 days (range: 6-34 days). Tables 1-3

TABLE 1 - *Casistic*

Age	66.4 (range 37-88 years)
Cases	262
Men/Women	156/106
BMI	25.7 (range 15,6-34,7)
BMI≥ 30 (obeso)	20 (range BMI 30-34,7)
BMI≤17 (malnutrito)	1
Cancer/Benign disease	249(95,03%)/13(4,07%)
Operative time	214,12 min
Hospital stay	8.9 (range 6-34 days)

TABLE II - *Type of surgical procedure and mean operative time*

Surgical procedure	Cases	%	Operative time
Right hemicolectomy	71	27,09	152,26 min.
ransverse resection	3	1,14	216,66 min.
Left hemicolectomy	142	54,19	165,32 min.
Rectal resection	35	13,35	220,51 min.
Abdominal perineal resection	8	3,05	258,33 min.
Other	3	1,14	271,66 min.
Total	262	Mean time	214,12 min.

TABLE III - *Surgical procedure associated*

Surgical procedure	Associated procedures
Right hemicolectomy	2 cholecystectomies
Left hemicolectomy	3 cholecystectomies 1 oophorectomy 1 splenectomy 1 appendicectomy
Rectal resection	1 nephrectomy

In 71 patients, we performed a right hemicolectomy for adenocarcinoma of the caecum and/or ascending colon with 2 associated cholecystectomy procedures, 3 patients underwent segmental resection of the transverse colon, again for cancer.
Left hemicolectomy procedure were performed in 142 patients (15 segmental resections of the sigmoid), with 6 associated consensual procedures (3 cholecystectomies, 1 splenectomy, 1 left oophorectomy, and 1 appendectomy): 123 for malignant disease, 18 for diverticular disease and 1 for ischaemic sigmoiditis.
Thirty-five patients underwent rectal resection.
Of a total of 6 ultralow resections, protective lateral ileostomies were created in three cases, and in one patient we opted for a ghost-ileostomy In one case intestinal continuity could not be restored, due to lesions of the distal rectal stump during introduction of the stapler. We were therefore forced to perform a terminal colostomy in 29 patients undergoing anterior rectal section for adenocarcinoma of the upper and middle rectum, 5 protective lateral ileostomies and 2 ghost ileostomies were created. In one case a consensual nephrectomy procedure had to be performed, due to double neoplasia (left kidney and rectum) and Meckel's diverticulum was removed (intraoperative finding).
There were 8 abdominoperineal amputations using the Miles procedure, for adenocarcinoma less than 2 cm from the anus. We also report a total proctocolectomy with J pouch and protective ileostomy for ulcerative rectocolitis with microfoci of adenocarcinoma, an Hartmann resection of the sigmoid-rectum for occlusive phase proximal rectal cancer infiltrating the neighbouring organs, and finally a left hemicolectomy associated to cecal resection for double neoplasia.

Intra-operative complications

The only medical incident found was ventricular fibrillation, which required intraoperative defibrillation with restoration of sinus rhythm and subsequent continuation of the procedure.
During **right hemicolectomy**, an accidental sero-muscular wound to the second duodenal portion was treated with laparotomic raffia. Tangential damage to the ileo-caeco-colic vein required laparotomic conversion to bleeding control. Bleeding of the right mesocolon required laparotomic haemostasis.

During **left hemicolectomy**, iatrogenic perforation of the transverse colon, associated with a lesion of the splenic capsule, was treated by laparotomic raffia and the application of haemostatic sponges.
Two spleen wounds required laparotomic haemostatis, by splenectomy and local application of fibrin glue.
Two iatrogenic perforations of the bladder were rectified with intracorporeal sutures.
A case of left uretheral transection in the first year of our experience, was treated in open surgery, with end to end anastomosis after endoluminal stent placement.
During rectal **resection** iatrogenic perforation of the upper rectum, the tumor site, resulted in further isolation of the bowel.
Accidental section of the lower mesenteric artery necessitated emergency laparotomic conversion.
A terminal colostomy had to be made after laceration of the distal rectal stump when the circular stapler was introduced, after ultra-low resection.
Two bladder injuries, unrecognized during the laparoscopic procedure, that only became evident after the Pfannenstiel laparotomy and sutured without others incisions. A concomitant colporrafia was associated in one of the two cases mentioned, due to perforation of the posterior wall of the vagina, in post-actinic phlogistic outcomes

Postoperative medical complications

After **right hemicolectomy**, we recorded medical complications in eleven cases. Two cases of atrial fibrillation with a high ventricular response were resolved by antiarrhythmic treatment on the surgical ward. The same condition, however, led to another patient being transferred to the Cardiology Unit.
Six cases of significant anaemia were resolved by blood transfusions.
In two patients, prolonged postoperative paretic ileus caused a channelling delay that continued until the sixth day after the operation.
After **left hemicolectomy**, we recorded medical complications in two cases. One patient already displayed hypoaesthesia and hypostenia of the upper right arm in the immediate post-operative period, attributed, after electromyographic investigation, to injury to the homolateral brachial plexus, probably caused by the fixing device resting there during the operation. Remission of the clinical symptoms was obtained by physiokinesitherapy for more than two months. In a case of atrial fibrillation treatment with intravenous amiodarone restored the sinus rhythm
After **rectal resection** we recorded medical complications in three cases. An acute coronary syndrome that developed on the day after surgery required an emergency transfer to the Cardiac Intensive Care Unit, where the clinical symptoms were gradually resolved and the patient was discharged 16 days after the operation.
A significant anaemia was treated by blood transfusions. One patient already displayed hypoaesthesia and hypostenia of the upper leftt arm in the immediate post-operative period, attributed, after electromyographic investigation, to injury to the homolateral femoral nerve, probably caused by the fixing device resting there during the operation. Remission of the clinical symptoms was obtained by physiokinesitherapy for more than three months.
After **abdominoperineal amputation**, we recorded medical complications in two cases. One patient, after the onset of delirious psychosis on the fourth day after surgery, was transferred to a psychiatric unit. In the second case the clinical picture was characterized by a prolonged ileus that resolved on the fifth day after surgery.
The patient who underwent the **Hartmann procedure** developed acute kidney failure that did not respond to medical treatment and died in the Acute Kidney Disease Unit 10 days after surgery.

Postoperative surgical complications

There were two cases of surgical complications after **right hemicolectomy** (Table IV). A fistula of the ileo-colic anastomosis was noted on the 5th day after surgery, confirmed by CT scan with gastrografin enema. Laparotomic surgery was required to resect the ileo-colic anastomosis, with the creation of a protective lateral ileostomy.
A perforation of the ileal loop, secondary to probable iatrogenic trauma (microlaceration by forceps) was noted on the sixth day after surgery, confirmed by direct abdominal X-ray, and required a further intestinal raffia procedure.
We report a case of an adherence-based intestinal subocclusion that was treated conservatively (hydration, cathartic and pro kinetic medication) after a resection of transverse colon.
There were thirteen cases of **surgical complications** associated with the left hemicolectomy procedure.
Leakage of the colo-rectal anastomosis occurred in five patients.
In all cases the diagnosis was confirmed within the first 9 days of hospitalisation by enema CT with gastrografin. Three patients needed a further surgical procedure to create a protective lateral ileostomy. In the first case, the resolution of the clinical picture allowed discharge 17 days after the operation, but the patient returned to our attention (second admission) with hyperpyrexia associated with abdominal pain, with an ultrasound finding of perianastomotic fluid collection. Combined medical (broad-spectrum antibiotics) and surgical (ultrasound-guided drainage of the collected fluid) treatment meant that the patient could be discharged after 5 days in hospital. In the second case, a third procedure was required because of a non-anastomotic ileal perforation that had

TABLE IV - *Postoperative complications and surgical procedure*

Procedure	Complications
Right hemicolectomy	1 anastomotic leakage: relaparotomy
	1 ileal loop perforation; suture
Left hemicolectomy	5 anastomotic leakages: 3 ileostomies; 1 endoscopic treatment and 1 conservative treatment;
	3 endoabdominal collected fluid: ecoguided drainages;
	2 occlusion/1 reoperations; 1 endoscopic treatment with pneumatic dilatation (anastomotic stenosis);
	1 wound infection;
	1 left haemotorax: toracotomy (clipped of diaphragmatic artery);
	1 broken drainage: removed
Rectal resection	4 anastomotic leakages: 2 ileostomies, 1 conservative treatment; 1 endoscopic treatment with fibrin glue;
	1 bladder leakage: suture
	1 wound infection;
Transverse resection	1 subocclusion: conservative treatment
Miles	1 bladder leakage; clips in cystoscopy
	1 colostomy necrosis reoperation and new colostomy

occurred above the ileostomy: after resection of the ileal segment affected, and immediate ileo-ileal anastomosis, a totally excluding ileostomy (terminal ileostomy) was made. The patient was discharged after 22 days of hospitalisation The third case requiring derivative surgery did not need further surgery (discharged 17 days after surgery).

In the other 2 cases, resolution of the anastomotic fistula was achieved without resorting to surgery: by endoscopy in one patient (positioning an endoprothesis and fibrin glue), and by conservative treatment in the other (total parenteral nutrition, prolonged maintenance of perianastomotic drainage and broad spectrum antibiotics).

The symptomatic incidences of endoabdominal fluid collected, documented by abdominal ultrasound/CT, were treated by ultrasound-guided drainage and broad spectrum antibiotics in the surgical unit (5 days in hospital).

In the context of the study population, the case of a patient who had undergone left hemicolectomy for diverticular disease was brought to our attention as an emergency: after a surgical procedure that was straightforward in all phases, and a post-operative stay that was ordinary in all medical and surgical respects, haemorrhagic shock developed when the patient was being discharged in the seventh day after surgery, and was returned to theatre immediately. After ultrasound showing a perisplenic liquid layer, an explorative laparotomy was performed that excluded active endoabdominal bleeding, but showed a marked lowering of the left hemidiaphragm. Transesophageal ultrasound raised a suspicion of left haemothorax, while excluding aortic dissection. A thoracotomy was therefore performed at the sixth left intercostal space, and this confirmed the massive loss of blood, from a damaged branch of the intercostal artery. Haemostasis was achieved clipping the vessel.

A case of obstruction secondary to ileal volvulus, required surgical adhesiolysis and medio-ileal resection-anastomosis.

In another patient, stenosis of the colo-rectal anastomosis caused a subocclusion that was resolved after endoscopic pneumatic dilation.

A single case of wound infection was treated with .daily application of topical antiseptics.

In one patient, the para-anastomotic drainage was not completely removed, and the distal end of the device remained in the abdominal cavity. The foreign body was extracted later in the operating theatre through the previous laparotomy incision under radioscopic guidance.

Post-operative surgical complications developed in six patients after **rectal resection**.

We found 4 cases of anastomotic leakage. In two patients, further surgery was necessary: the creation of a protective lateral ileostomy in one, and the opening of an existing ghost ileostomy in the other.

The third case was treated conservatively because the patient already presented with a protective ileostomy.

The fourth patient was treated endoscopically with the application of fibrin glue.

We report a case of adherence-related intestinal obstruction with concomitant bladder fistula (previous intraoperative iatrogenic perforation treated with raffia).

Adhesiolysis was carried out and the bladder suture was repaired.

A single case of wound infection was treated with daily application of topical antiseptics.

In abdominoperineal amputations we found two cases with post-operative surgical complications.

In one patient necrosis of the colostomy required further surgery for colonic resection and recreation of the colostomy.

A case of bladder leakage was treated by the cystoscopic application of clip and the subsequent placement of a permanent bladder catheter, which was removed after three months.

Statistical study

The overall rate of intra-and post-operative complications was 22.9% (60/262) In 40 cases (40/262:15.26%) the complications were surgical, and in the other 20 (7.63%) they were medical.
A single patient died within thirty days, resulting in a mortality rate of 0.38% (1/262).
The overall mean operating time was 214.12 min; however, if we analyse only the patients with intra-operative complications, the mean duration of surgery is 220.42 min.
Regarding the 16 intraoperative surgical complications, bleeding was the most frequent adverse event, accounting for 50% of the complications; bladder injuries, injuries accounted for 25%, intestinal injuries for 18.75%, uretheral lesions for 6.25%, and lesions to the anastomotic stump and vaginal lesions accounted for 6.25%.
The only medical complication during surgery (0.38%) was ventricular fibrillation.
Of the 24 post-operative surgical complications, the most frequent was the anastomotic fistula, representing 45.83%; followed, in decreasing frequency, by intestinal obstruction with 12.5%, intra-abdominal fluid collection with 12.5%, bladder fistulas with 8.33%, and wound infection with 4.16%.
Of the 19 postoperative medical complications, the most frequent was anaemia with 31.57%, then, in order of decreasing frequency, cardiological complications with 21.05%, neurological injuries (hypostenia, hypoaesthesia, paraesthesia, etc.) with 10:52% and lung disorders with 5.26%. The incidence of all minor medical complications was 21.05%.
The 60 intra-operative complications developed in 52 patients (19.84% of the study population).
Fifteen patients did not present comorbidities, identified as presumed risk factors predictive of complications (age = 75, BMI >30, BMI =<17; arterial hypertension, diabetes, heart disease, peripheral and cerebral vascular disease, liver disease, lung disease, chronic kidney failure). The frequency of the individual complications is reported in table V.
Age ≥ 75 years was found in 59.45% of patients with complications, compared to 16.41% of the general population (p <0.001), 62.16% were men(p <0.001); arterial hypertension occurred in 51.35% v 20.22% (p <0.001), heart disease in 16:21% v. 3.43% (p <0.001), and diabetes in 16:21% v 5.72% (p <0.01).
Although BMI ≥ 30, cirrhosis of the liver, IRC, bronchopulmonary diseases, and vasculopathies, occurred in a higher percentage of the study population, there were no statistically significant differences. ASA status = 3 (p = 0.735) is actually less frequent than in the general population (13.51% v. 16.79%).
The 60 surgical complications recorded were stratified: 25% in the group of patients without comorbidities (15/60) and 75% in the group of patients with comorbidities (45/60): the generic presence of associated disease was found to be statistically correlated with the onset of intra-operative complications (p <0.001).
Regarding intraoperative complications (17/262: 6.48%), rectal resection was found to be a higher risk than left hemicolectomy (p = 0.034), while comparison with right hemicolectomy showed no statistically significant differences between the two procedures (p = 0061%) (Table VIII). If we analyse the postoperative complications (43/262:16.41%), rectal resection is burdened with a significantly larger number of complications than right hemicolectomy (p = 0.025) but not left hemicolectomy (p = 0.228).
The overall conversion rate in our population was 11.45% (30 of 262 cases), with the following stratification for surgery: right hemicolectomy, 2.67% [7]; left hemicolectomy, 6.10% [16]; resection of the rectum, 1.90% [5]; the remaining resection procedures, 0.76% [2]. The incidence of conversion involved, in order of decreasing frequency, rectal resection with 14.28% (5/35), left hemi-

TABLE V - *Rate of risk factors*

Risk factors	Cases (262) N (%)	Complicated cases with comorbility (37) N (%)	P value
Age > 75	43 (16,41%)	22 (59,45%)	<0.001
BMI ≥ 30	20 (7,63%)	5 (13,51%)	0.263
BMI ≤ 17	1 (0,38%)	1 (2,70%)	
Sex male/female	156/106 (59,54%/40,45%)	23/14 (62,16%/37,83%)	<0.001
ASA ≥ 3	44 (16,79%)	5 (13,51%)	0.735
Diabetes	15 (5,72%)	6 (16,21%)	<0.01
Cyrrosis	6 (2,29%)	2 (5,40%)	0.439
vascular Disease	8 (3,05%)	3 (8,10%)	0.158
cardiac disease	9 (3,43%)	6 (16,21%)	<0.001
Chronic kidney failure	1 (0,38%)	1 (2,70%)	0.932
Arterial hypertension	53 (20,22%)	19 (51,35%)	<0.001
Lung disease	7 (2,67%)	2 (5,40%)	0.574

TABLE VI - *Laparotomic conversion and comorbility*

Risk factors	Cases (262) N(%)	Converted cases (30) N(%)	P
Age > 75	43 (16,41%)	11 (36,6%)	<0.003
BMI ≥ 30	20 (7,63%)	2 (6,66%)	0.878
BMI ≤ 17	1 (0,38%)	0	
Sex male/female	156/106 (59,54%/40,45%)	24/6 (80%/20%)	<0.001
ASA ≥ 3	44 (16,79%)	9 (30%)	0.07
Diabetes	15 (5,72%)	5 (16,66%)	<0.02
Cyrrosis	6 (2,29%)	2 (6,66%)	0.292
Vascular disease	8 (3,05%)	1 (3,33%)	0.639
Cardiac disease	9 (3,43%)	2 (6,66%)	0.617
Insufficienza renale cronica	1 (0,38%)	1 (3,33%)	0.225
Arterial hypertension	53 (20,22%)	15 (50%)	<0.001
Lung disease	7 (2,67%)	2 (6,66%)	0.401

colectomies, with 11.26% (16/142), and finally right hemicolectomies, with 9.85% (7/71).
The causes related to conversion were: bleeding for 26.6% [8], iatrogenic (intestinal) lesions for 10% [3], phlogistic, tumoral or chemotherapy-induced adhesions, for 20% [6], tumors beyond the sierosa with loco-regional lymphadenopathy (stage > Astler-Coller C1) for 36.6% [11], distension of intestinal loops for 6.66% [2].
In our population, the higher number of laparotomic conversions - 36.6% (11/30) - is, therefore, to be attributed to the advanced stage of the cancer (T3/T4), which also a statistically significant risk factor ($p < 0.0003$), as are advanced age ($p < 0.003$), diabetes ($p < 0.02$) and hypertension ($p < 0.001$)(Table VI).

Discussion

The first laparoscopic cholecystectomy (1987) changed the assumptions of traditional abdominal surgery: the gold standard for many surgical procedures (cholecistectomy, Nissen fundoplicatio, gastric bypass, adrenalectomy, splenectomy) are now laparoscopic approaches [9].
Since 1991, the year of the first laparoscopic colectomy, a number of comparative studies have agreed that laparoscopic surgery is associated with well-defined short-term benefits, [1,2] lower tissue trauma, with less insult to systemic immunity and consequent containment of the inflammatory response, which justifies the significant gain in terms of postoperative morbidity with a better quality of life [3-5].
The use of laparoscopic techniques in the surgical resection of the colon and rectum has not received the immediate consensus as videolaparocholecystectomy.
The first case studies obtained general consensus in terms of the safety, practicality, efficacy and post-surgical outcome of laparoscopic colectomy in the treatment of benign conditions (diverticular disease, ulcerative rectocolitis, Crohn's disease and familial adenomatosis), but the application of the technique in oncology remains an open question [3,10-14].
Recent multicentre studies show that laparoscopy is as effective as open surgery in the treatment of neoplastic disease of the colon and rectum. On this basis it is rational to believe that the long-term results will also be superimposible [6].
Subsequent studies have shown that a laparoscopic approach to colon-rectal cancer, even in stage III and advanced stage M0, allows an operation to be performed that is superimposible on the traditional one, in terms of lymph node excision and resection margins, and in terms of follow-up in the short to medium term (22 months), defined as overall survival and disease-free survival [7,8].
Laparoscopic colectomy is associated with a better outcome in terms of relapse and survival [15], in coherence with the role of surgical stress in the life expectancy of the patient. The trauma that is characteristic of the laparoscopic approach represents lower insult for cell-mediated immunity [16-18].
The biochemical response to surgical trauma is proportional to the entity of the trauma. Interleukine-6, an important mediator of the acute inflammatory response, is a sensitive marker of tissue damage. The literature indicates a level of IL-6 that is significantly higher 24 hours after abdominal colectomy, and a PCR value after 72 hours that is significantly lower in laparoscopy [17].
One study, in particular, shows that O2 pressure during the pneumoperitoneum induced during laparoscopy plays an important role in the resumption of gastrointestinal motility and healing of the surgical wound [4].
Recent meta-analyses of clinical trials confirm the oncological results of the laparoscopic approach, but also show the lower postoperative morbidity (intestinal adhesions, hernia) that is associated with it [9].
However, laparoscopic surgery does have some limits, in the form of its technical complexity, which requires adequate training, increased operating times and higher costs [19].
The literature shows that the number of intra-operative complications, the conversion rate, and the incidence of

morbidity and mortality are reduced as the experience of the operator increases [20-23].

The experience of the operator is assessed in improvement studies (improvement of one's own capacity to operate laparoscopically). Most authors recommend a training programme of at least 30/70 consecutive cases, depending on whether the right or left colon [23].

One of the major criticisms of laparoscopy in oncology is the suspicion that the cancer may recur at the site's trocar were introduced [18]. Some case studies show that as 21% more cases than the previous year [24]. It has been thought that the cause of recurrence was the induction of pneumoperitoneum, combined with a possible role of CO_2 as a factor in tumour growth [25]. These theories are not supposed by the later studies [26,27] which indicate that only a few tumour cells are present in an environment with high concentration of CO_2, even in case of massive peritoneal contamination. An analysis of data collected at the Mayo Clinic shows that recurrence at the port locations is between 0.6% and 1.3 [28], and there is no statistically significant difference with neoplastic seeding at the parietal peritoneum during laparotomic surgery (1%).

Our study is not limited to the description of complications in laparoscopic colorectal surgery, but seeks to identify the risk factors that are predictive of adverse events, since, as pointed out by Kirchhoff, the peri-operative period can only be managed optimally if we know those aspects that have a significant influence on its progression [29,30].

The critical review of our series showed a global morbidity of 22.9%, entirely consistent with the findings of a number of experiences reported in the literature, which report morbidity rates between 6% and 31% [31,32].

Postoperative mortality involved a single patient (0.38%)

We found 60 medical and surgical intra-operative complications, in 52 patients, of which 37 presented comorbidities. The statistical significant risk factors that were correlated with the development of intra-operative complications were: age > 75 years, male gender, hypertension, diabetes and heart disease. Moreover, these aspects have already been highlighted as factors connected to a worsened prognosis in the literature. In our study, they proved to have poor correlation with both types of correlation (medical and surgical) so they are not intrinsic to the laparoscopic approach, but may be associated with surgery for colorectal resection irrespective of the technique used. Contrary to what seems an acquired datum in the literature, BMI>30 and ASA status $\geq$ III did not influence incidence of complications [33,34].

Rectal resection is significantly associated with a greater number of intra-and post-operative complications than the other surgical procedures examined

Conversions in the first 30 minutes of the procedure had better repercussions on postoperative outcome than later ones [33,35-38]. In our population the rate of conversion was 11.45%: in 36.6% of cases, the tumour was at an advanced stage (Astler-Coller stage C1), with anatomical and pathological condition related to disease ($p < 0.0003$). However, whatever the underlying cause, we have not considered the conversion rate as a measure of quality of surgery [33-39]. We have rather preferred to contribute to the knowledge of those factors that adversely affect the outcome for the patient undergoing laparoscopic colorectal resection, verifying that in any case, despite an "inevitable" rate of complications, the laparoscopic approach maintains its benefits even in patients with known preoperative comorbidities, and constitutes a feasible procedure even in patients who are obese and/or with ASA status $\geq$ III, without an additional risk correlated with the method used.

Riassunto

Lo scopo del presente studio è quello di effettuare una revisione critica dell'esperienza della nostra unità di chirurgia per identificare tutti i fattori di rischio correlati con gli interventi di colectomia videolaparoscopica in grado di fornire una previsione delle possibili complicazioni sia intra- che postoperatorie, sia precoci che tardive.

Lo studio è stato condotto procedendo ad una revisione retrospettiva di 293 pazienti già sottoposti ad una colectomia per via laparoscopica presso l'Unità di Chirurgia Generale e dei Trapianti di Organo dell'Ospedale Universitario di Parma tra il gennaio 2001 ed il settembre 2009.

La stadiazione preoperatoria della neoplasia era stata effettuata per tutti i pazienti mediante la pancolonscopia, effettuata preferibilmenta dal chirurgo operatore, la CT toracica, addominale e pelvica, e limitatamente alle localizzazioni neoplastiche rettali con l'ecografia endorettale e/o con la risonanza magnetica nucleare pelvica.

Per ogni paziente sono stati considerati i seguenti parametri: età, sesso, indice di massa corporea, condizione ASA, studio ematologico preoperatorio, presenza di comorbilità associate tra cui eventuali altri tumori, pregresse procedure chirurgiche subite, durata dell'intervento, tasso di riconversione alla laparotomia, complicazioni intra- e postoperatorie, ogni reintervento, durata della degenza ospedaliera e mortalità.

I pazienti analizzati sono 262 degli originari 293 sottoposti alla tecnica laparoscopica, per l'incompletezza o la non corretta raccolta dei dati in 31 casi. L'incidenza globale delle complicazioni intra- e postoperatorie è stata del 22.9% (60/262). In 40 casi (40/262, 15.26%), si trattava di complicazioni chirurgiche, e negli altri 20 casi (7.63%) si trattava di complicazioni mediche; il tasso di mortalità è risultato essere dello 0.38% (1/262).

In conclusione la resezione rettale è risultata significativamente più esposta a complicazioni intra- e postoperatorie rispetto alle altre procedure chirurgiche analizzate. Inoltre dai risultati è evidente che l'approccio laparosco-

pico mantiene i suoi benefici anche in presenza di comorbilità e rappresenta una procedura eseguibile anche in pazienti obesi e con uno stato ASA ≥ III.

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