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ORIGINAL ARTICLE

Predictive factors for conversion in laparoscopic colorectal surgery

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Abstract Background Although laparoscopic colon and rectal surgery can be safely performed in the hands of well-trained surgeons, criteria for patient selection should be further developed in order to decrease the conversion rate. The main objective of this study was to identify predictive factors for conversion of laparoscopic colorectal surgery to an open procedure based on statistical analysis. **Methods** A retrospective survey was performed using data collected from 400 patients who underwent laparoscopic colorectal surgery between March 2000 and December 2006. As potential predictive factors for conversion, we considered demographic characteristics, surgery-related variables and disease-related variables. Univariable analysis was performed to identify individual predictive risk factors for conversion. Factors with *p* values below 0.05 were included in a regression model. **Results** Conversion to open surgery was required in 51 patients (12.7%). Age (>65 years) was the only independent predictive demographic factor (OR=2.3; 95% CI, 1.25–4.46). Low anterior resection (OR=3.9; 95% CI, 1.64–9–18) and complicated diverticulitis (OR=3.9; 95% CI, 1.64–9.18) were also predictive factors. The only predictive factor evidenced in the multivariate analysis was complicated diverticulitis (OR=159.99; 95% CI, 41.02–624.02). Indications for conversion were: adhesions in 53% of the patients, technical problems in 18%, bleeding in 1%, and other indications for the remaining 28%. **Conclusion** Complicated diverticulitis or cancer of the rectum treated by low anterior resection have higher probabilities of conversion.

Key words Conversion · Laparoscopy · Colorectal surgery

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Introduction

The safety of laparoscopic colorectal surgery has been repeatedly reported since the first laparoscopic colectomy performed in 1991 by Jacobs et al. [1]. During the last 15 years, laparoscopic colorectal surgery has rapidly expanded with successful reports for a wide variety of pathologies, including benign and malignant diseases [2–4]. The requirements for operating in many quadrants, controlling large blood vessels, and very often restoring intestinal continuity with anastomosis make colorectal resection one of the most challenging laparoscopic procedures currently performed [2, 3, 5, 6]. However, this type of surgery is accompanied by many benefits, such as less postoperative pain, shortened hospital stay, improved short-term quality of life, faster return to routine activities and improved cosmesis [2, 4, 7, 8].

The overall reported rate of conversion to open surgery in laparoscopic colorectal resections ranges from 7% to 25% in large studies [2, 8–10] and from 2% to 41% in smaller series [1, 5, 6]. Previous descriptive studies have identified several risk factors associated with conversion to open surgery, such as body mass index, excessive tumor bulk, adhesions, diverticular phlegmon, inflammatory mass associated with Crohn's disease and operative experience [6, 7, 11, 12]. Although conversion itself is not considered a complication, patients undergoing conversion do not experience the same benefits of those subjected to a complete laparoscopic procedure [13]. Experienced laparoscopic surgeons may have the ability to preoperatively identify patients with an elevated risk of conversion. However, surgeons that are still acquiring laparoscopic skills are probably likely to select cases based on preoperative assessment in order to identify patients who would benefit more from an open colectomy in view of their increased risk of conversion [2, 9, 14]. Thus, the aim of the current study was to identify risk factors associated with the conversion of laparoscopic to open colorectal surgery, based on statistical analysis.

Materials and methods

We reviewed all data of patients subjected to planned or emergency laparascopic colorectal procedures between March 2000 and December 2006. In particular, we considered demographic characteristics, including age, sex, previous abdominal surgery, ASA (American Society of Anesthesiologists) score and body mass index (BMI), factors related to the procedure (type of surgery, surgeon's experience) and disease-specific factors (benign disease, polyps, rectal and colon cancer, diverticulitis, complicated diverticulitis, Crohn's disease, ulcerative colitis).

Conversion was defined as the need for a midline laparotomy larger than 10 cm, either for complications of the operative procedure or for specimen extraction. All patients received standard preoperative bowel preparation and antibiotic prophylaxis. Informed consent for the planned laparoscopic procedure was obtained from all patients. The laparoscopic procedure involved the use of 4–5 trocars. During right colectomy, the bowel was anastomosed extracorporeally through a small midline incision after laparoscopic mobilization. For left-sided laparoscopic resection, a transverse incision was made in the left lower quadrant, bowel resection was performed extracorporeally and then the bowel was returned to the peritoneal cavity to perform the anastomosis under laparoscopic vision. For total colectomy, the entire procedure was performed intracorporeally and the specimen was retrieved through the right lower quadrant incision.

Univariate statistical analysis was performed using a chi-square test to identify individual risk factors. Risk factors with a univariate p value below 0.05 were included in a multiple regression analysis.

Results

A total of 400 patients underwent planned or emergency laparoscopic colorectal procedures during the period of review. There were 221 (55.2%) male and 179 (44.8%) female patients, with a mean age of 58.8 years (range, 16–92) and a mean BMI of 25.2 (12–38). Surgery was performed for both benign (226 cases, 56%) and malignant (174 cases, 44%) diseases. The main indications for surgery were diverticular disease in 165 cases (41%), colon cancer and polyps in 112 cases (28%), inflammatory bowel disease in 54 cases (13%), rectal cancer in 32 (8%) and other pathologies in 37 cases (9%). Most procedures were segmental resections. Table 1 shows the surgeries performed. The mean operating time was 214 minutes.

Intraoperative complications occurred in 15 patients (3.8%), 10 of which required conversion. Overall, conversion was required in 51 cases (12.8%), including 11 patients with rectal cancer and 11 with complicated diverticulitis. Table 2 shows the reasons for conversion.

Converted patients had an increased requirement for intensive care: 28 of 51 converted patients (54.9%) vs. 44 of 349 not converted patients (12.6%) ($p<0.05$). However, there were no significant differences in the frequency of postoperative complications (43.1% vs. 31.0% of patients, p=NS) or hospital stay (mean, 4.6 days vs. 6.4 days, p=0.43).

No significant association was found between conversion to an open procedure and gender, previous

Table 1 Laparoscopic colorectal surgeries performed in 400 patients

Procedure	Patients, n (%)
Segmental colectomies	288 (72.0)
Left	212
Right	63
Ileocecal resection	9
Transverse	4
Anterior resection	34 (8.5)
Proctocolectomy	20 (5.0)
Subtotal colectomy	19 (4.8)
Proctectomy	15 (3.8)
Reversal Hartmann's operation	13 (3.3)
Hartmann's procedure	5 (1.3)
Other	6 (1.5)

abdominal surgery, high ASA score or BMI (Table 3). However, there was a statistically significant increased risk of conversion in patients over 65 years (p=0.007). Regarding the type of surgical procedure and the surgeon's experience, only low anterior resection (p=0.001) was identified as a risk factor for conversion. A trend towards a higher rate of conversion was found when the surgeon's experience was under 50 cases, although this difference was not statistically significant (p=0.06). Finally, regarding disease-specific variables, rectal cancer (p=0.001) and complicated diverticulitis (p=0.001) had a significant influence on the frequency of conversion.

Table 2 Reasons for conversion in 51 of 400 treated patients

Cause	Patients, n (%)
Adhesions	14 (27.4)
Inflammatory process or abscess	13 (25.9)
Narrow pelvis	5 (9.8)
Technical difficulties	4 (7.8)
Intraoperative bleeding	3 (5.8)
Anastomotic failure	3 (5.8)
Difficulty to obtain oncological margin	3 (5.8)
Uretheral lesion	2 (3.9)
Other	4 (7.8)

Multiple logistic regression analysis showed that only complicated diverticulitis was predictive of conversion to open surgery (OR=159.99; 95% CI, 41.02 to 624.02;) (Table 4). Considering the significant associations between conversion and both a diagnosis of complicated diverticulitis and the need for a low anterior resection and in order to evaluate whether the experience of the surgeons was a variable predicting conversion, the population of patients was divided according to the surgeon's experience, defined as the patient's chronological order in the case series (Table 5). During the first 100 cases, a statistically significant conversion rate was evidenced for complicated diverticulitis, while no low anterior resections were performed. During cases 100 to 200 of the series, there was a high likelihood of conversion in patients undergoing low anterior resection. After this, an increased rate of conversion was no longer observed.

Table 4 Multiple logistic regression analysis for factors related to conversion

Characteristic	OR (95% CI)
Age >65	1.74 (0.52–5.85)
Low anterior resection	1.24 (0.23–6.58)
Complicated diverticulitis	159.99 (41.02–624.02)
BMI > 30	3.29 (0.4–27.18)
Previous surgery	5.54 (1.15–26.69)

Table 3 Rate of conversion of laparoscopic colorectal procedures to open procedures in 400 patients, according to demographic, surgical and clinical characteristics

Characteristic	Total, n	Conversion, n (%)	95% CI	p[a]
Demographic factors				
Age >65 years	126	25 (19,8)	1.25–4.47	0.007
Age <35 years	39	3 (7.7)	0.13–1–94	0.45
Gender (men)	221	31 (14.0)	0.68–2.47	0.48
Previous abdominal surgery	154	26 (16.8)	0.96–3.38	0.07
ASA score 3 or 4	19	2 (10.5)	0.28–10.9	0.72
BMI <22	55	3 (5.4)	0.08–1.25	0.12
BMI >30	76	9 (11.8)	0.38–2.04	0.94
Surgery-related variables				
Reversal of Hartmann's procedure	13	3 (23.1)	0.44–8.76	0.47
Low anterior resection	34	11 (32.3)	1.64–9.14	0.001
Segmental colectomy	288	32 (11.1)	0.31–1.18	0.160
Proctocolectomy	20	5 (25.0)	0.73–7.60	0.18
Abdominoperineal resection	5	1 (20.0)	0.01–16.9	1
First 50 procedures of the series	50	6 (12.0)	0.33–2.42	1
Surgeon with <50 procedures	50	11 (22.0)	0.97–4.86	0.06
Disease-specific variables				
Benign disease	226	27 (11.9)	0.45–1.59	0.69
Colonic polyp	35	7 (20.0)	0.68–4.71	0.28
Rectal polyp	2	1 (50.0)	0.18–257.77	0.6
Colon cancer	77	12 (15.6)	0.63–2.84	0.52
Rectal cancer	32	11 (34.4)	1.79–10.2	0.001
Diverticular disease	165	20 (12.1)	0.47–1.72	0.87
Complicated diverticulitis	34	11 (32.4)	1.64–9.15	0.001
Crohn's disease	9	2 (22.2)	0.28–10.91	0.72
Ulcerative colitis	54	8 (14.8)	0.49–2.92	0.78

BMI, body mass index; [a] Chi-square test

Table 5 Risk of conversion to open procedure, for 68 patients who underwent low anterior resection or who were treated for complicated diverticulitis, according to their chronological position within the case series (surgeon's learning curve)

Case number	Diverticulitis		Low anterior resection	
	p	OR (95% CI)	*p*	OR (95% CI)
1–50	0.007	21.71 (1.76–592.46)	-	-
51–100	0.017	13.66 (1.36–166.85)	-	-
101–200	0.2	4.22 (0.61–29.36)	0.046	3.2 (1.01–10.14)
201–300	0.31	4.2 (0.46–32.75)	0.13	3.21 (0.761–13.4)
301–400	1	0 (0.93–260.38)	0.86	1.78 (0.21–11.88)

Discussion

One of the most important principles of laparoscopic surgery is that conversion should not be considered a complication. Instead, it should be viewed as a wise decision when the technical limitations of a laparoscopic procedure have been exceeded [2, 15, 16]. No compromise in established surgical principles should be allowed for the purpose of completing a procedure laparoscopically. Belizon et al. [2] showed that surgical conversions performed within the first 30 minutes of operation have better clinical outcomes than conversions carried out later on in the procedure. The rate of conversion should not be considered as a measurement of surgery quality. However, when a laparoscopic approach is proposed to a patient, the rate of conversion should also be communicated.

Many reasons for variable conversion rates have been described in the literature; however, there is no standarized definition of conversion, the surgeon's experience differs among the studies, and patient selection criteria are different [13]. For example, patients undergoing resection for cancer, unexpected tumor fixation, poor visualization, or inability to obtain adequate margins led to higher conversion rates in some studies [14, 17] but not in others [5, 18].

In this study, the only demographic factor related to conversion was age >65 years. Schwandner et al. [7] considered that age between 55 and 64 years was a statistically significant factor for conversion, but a case-control study by Reissman et al. [19] found no association between age and conversion rate. In obese patients, it is clear that laparoscopy is more technically demanding, but in our study body mass index was not associated with an increased conversion rate. In agreement with Sarli et al. [9], as well as many other authors [2, 7, 10, 12, 19–24], we failed to demonstrate a correlation between previous abdominal surgery and requirement for conversion to open surgery.

Consistent with previous reports, one of the most important determinants of conversion to open surgery was the type of procedure performed. Low anterior resection was the only procedure that increased the rate of conversion in this series, in accordance with the study by Pandya et al. [18]. Tekkis et al. reported a conversion rate of 18.4% in low rectal resection, whereas the average conversion rate was 10% [8].

Multiple reports have conflicting results as to which factors may significantly influence the risk of conversion to open surgery, but is important to note that they are interrelated and difficult to separate. On the contrary, in our series low anterior resection and rectal cancer were considered separately and both were found to be predictive factors of conversion. Schwandner et al. [7] reported that most conversions were directly related to inflammatory conditions, and Sher et al. [6] reported conversion rates as high as 50% for sigmoid diverticulitis. Hoffman et al. [11] reported a conversion rate of 22.5%, in which 70% of the conversions were due to severe inflammatory processes. Multiple logistic regression analysis identifies independent risk factors by allowing one predictor to vary while controlling the effects of other confounders. In the present study, complicated diverticulitis was the only significant predictive factor of conversion evidenced by multiple logistic regression analysis.

In conclusion, patients over 65 years of age or with a diagnosis of complicated diverticulitis or rectal cancer treated by low anterior resection have higher probabilities of conversion. The only factor identified in the logistic regression model was complicated diverticulitis. These factors should be taken into consideration, especially by groups of surgeons with limited surgical experience.

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