



## Original article

# Training periods with experts improve results in colorectal laparoscopic surgery<sup>☆</sup>

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### ABSTRACT

**Objective:** To analyse the effects of training in elective colorectal laparoscopic surgery with a minimum 6 months follow up to assess early and delayed complications, and comparing the first 40 cases in the 1st Period (P-1: 1996-2002) with the 100 cases in the 2nd Period (P-2: 2003-2008). One of the surgeons had 2 training courses between P-1 and P-2.

**Material and methods:** A total of 66 colorectal resections due to cancer were performed and 74 operations for benign disease. The cases of malignant diseases increased between P-1 and P-2 ( $P < .001$ ). (odds ratio = 0.16).

**Results:** There number of complex cases increased between P-1 and P-2 (anterior resection-amputation, left hemicolectomy, total colectomy, rectopexy) versus others (sigmoidectomy, right resections) ( $P < .05$ ), but the mean duration of the operations was reduced by 29 minutes ( $P < .01$ ). There were 24% conversions, with no change in P-2 ( $P = .85$ ). Surgical mortality at 3 months (1.4%) showed no differences ( $P = .49$ ). The total complications rate (31%) was significantly lower in P-2 ( $P = .001$ ), because medical complications ( $P = .05$ ), the more serious surgical complications (with reintervention) ( $P = .05$ ) and wound infections ( $P = .0001$ ) were lower. There was no change in the other surgical complications ( $P = .61$ ).

The overall mean stay was 7.8 days (3-36) (median = 6 days), with no differences between P-1 and P-2 ( $P = .165$ ). Conversion significantly lengthened the mean hospital stay ( $P = .015$ ) (from 7.2 [5] days to 10.1 [7] days), but there was no increase in complications ( $P = .31$ ).

**Conclusion:** Training in colorectal laparoscopy and training periods with experts improve results (duration, complications, more complex surgery). Conversions did not decrease with experience and the hospital stays lengthened, but they were not associated with more complications.

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## Las estancias de formación con expertos mejoran los resultados en cirugía laparoscópica colorrectal

### R E S U M E N

#### Palabras clave:

Laparoscopia  
Cirugía colorrectal  
Adiestramiento  
Curva de aprendizaje  
Morbilidad  
Conversiones

**Objetivo:** Analizar el efecto del aprendizaje en cirugía electiva laparoscópica colorrectal con seguimiento mínimo de 6 meses para contabilizar complicaciones precoces y tardías mediante la comparación de los primeros 40 casos del primer período (P1) (1996 a 2002) con los 100 casos del segundo período (P2) (2003 a 2008). Entre P1 y P2, uno de los cirujanos realizó 2 estancias formativas.

**Material y métodos:** Se realizaron 66 resecciones colorrectales por cáncer y 74 intervenciones por enfermedad benigna. Entre P1 y P2 se incrementaron los casos de enfermedad maligna ( $p < 0,001$ ) (odds ratio = 0,16).

**Resultados:** Entre P1 y P2 se incrementaron los casos de intervenciones complejas (resección anterior-amputación, hemicolectomía izquierda, colectomía total, rectopexia) frente a otras (sigmoidectomía, resecciones derechas) ( $p < 0,05$ ), pero se redujo la duración media de las intervenciones en 29 min ( $p < 0,01$ ). Las conversiones alcanzaron el 24%, sin cambiar en P2 ( $p = 0,85$ ). La mortalidad operatoria a 3 meses (1,4%) no mostró diferencias ( $p = 0,49$ ). La tasa total de complicaciones (31%) se redujo significativamente en P2 ( $p = 0,001$ ) a costa de las complicaciones médicas ( $p < 0,05$ ), las quirúrgicas más graves (con reintervención) ( $p < 0,05$ ) y la infección de herida ( $p < 0,0001$ ). Las demás complicaciones quirúrgicas no cambiaron ( $p = 0,61$ ).

La estancia media global fue de 7,8 días (3 a 36) (mediana de 6 días), sin diferencias entre P1 y P2 ( $p = 0,165$ ). La conversión alargó significativamente la estancia media ( $p = 0,015$ ) (de  $7,2 \pm 5$  días a  $10,1 \pm 7$  días), pero no incrementó las complicaciones ( $p = 0,31$ ).

**Conclusión:** El adiestramiento en laparoscopia colorrectal y las estancias de formación con expertos mejoran los resultados (duración, complicaciones, cirugía más compleja). Con la experiencia, las conversiones no disminuyen y alargan la estancia hospitalaria, pero no se asocian a más complicaciones.

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## Introduction

Training on a minimum number of colorectal laparoscopic surgeries is necessary in order to perform these operations with good results and few complications.<sup>1</sup> Experience gained in the 1990s enabled expert surgeons pioneering the field of colorectal laparoscopy to determine that the learning curve for guaranteeing safe procedures could be reached at about 30 cases.<sup>2</sup> Furthermore, surgeons who participated in some of these randomised studies on safety in the laparoscopic approach to colon cancer, such as the COST study, were asked to have a minimum experience of 20 cases, and to present a video recording of a procedure for review.<sup>1,3</sup>

In order to analyse the experience and effect of training in elective colorectal surgery, the authors of this article will present a study of the first 140 cases.

## Material and methods

For this retrospective clinical study, we used a database to prospectively record the authors' experiences with colorectal laparoscopy in the first 140 consecutive elective procedures (excluding creating and closing stomas, with a 6-month minimum follow-up period in order to analyse early- and

late-onset complications). The main aim of the study is to compare the first 40 cases (first period [P1]: 1996-2002) with the following 100 cases (second period [P2]: 2003-2008), and meet the minimum requirement of the COST study<sup>3</sup> (given that the first cases used a team of 2 surgeons, 40 cases =  $20 \times 2$ ). P1 was a period of technical skill acquisition after attending a brief course with live surgeries in 1995. In addition, 2 stays (E.B.) were carried out in centres with ample experience in colorectal laparoscopy (a total of four months between 2000 and 2002). During the study period, scheduled colon resection procedures were performed on 1273 patients (89% by laparotomy) (Table 1).

The surgeon was free to indicate the laparoscopic approach, and the tendency for the first experience was to choose it only in the case of a benign condition: colon polyps that could not be excised by colonoscopy, with edges affected by polypectomy or with early-stage carcinoma; colonic diverticular disease complicated by chronic symptoms or at least 2 episodes of diverticulitis leading to hospital admission; Crohn's disease; and patients who had experienced severe lower digestive haemorrhage due to angiodysplasia or colon diverticulas. Following this experience, the indications were broadened to include more advanced colorectal cancer, and then to include the rectum and transverse colon, particularly since the 2004 publication of the COST study's medium-term results.<sup>4</sup>

**Table 1 – Number of colorectal resections in different periods in the study, and percentage using a laparoscopic approach**

Period in study	Total colorectal resections	Open resections	Laparoscopic resections	% Laparoscopy
1996–2008 (12 years)	1273	1133	140	11
2005–2008 (3 years)	348	278	70	20
2007–2008 (12 months)	139	107	32	23

**Table 2 – Surgical procedures completed**

Surgical procedure	No.	Conversion	Duration, min	Surgical complications	Medical complications
Sigmoidectomy	45	11 (24%)	185 (120–300)	9 (20%)	7 (16%)
Right colectomy	38	6 (16%)	163 (120–210)	12 (32%)	3 (8%)
Rectal resection	32	8 (25%)	201 (130–360)	7 (22%)	3 (9%)
Left colectomy	11	3 (27%)	217 (150–300)	2 (18%)	0
Total colectomy	4	1 (25%)	290 (280–300)	1 (25%)	0
Ileocolic resection	6	1 (17%)	139 (65–240)	1 (17%)	0
Rectopexy	2	0	120 (90–150)	0	0
Amputation	2	2 (100%)	230 (160–300)	1 (50%)	0
Associated procedures	7	Inguinal hernioplasty			
	4	Cholecystectomy			
	3	Ileostomy			
	2	Anexectomy			
	1	Myomectomy			
	1	Ventral hernioplasty			
	1	Hepatic ultrasound			
	1	Partial cystectomy			

Tumours larger than 8 cm in diameter, those with radiological proof of infiltrating neighbouring organs, or those located at the splenic flexure of the colon were contraindicated for laparoscopy.

Four trocar ports were used (measuring 5, 10, or 12 mm; for cancer cases, an expanding balloon is used to prevent the “chimney effect” due to an efflux of gas), except in rectopexies (3) and if the splenic flexure of the colon had to be dissected (5).<sup>5</sup> We used 10 mm, 0° lenses except for right or left hemicolectomy in obese patients (30°). Early polyps and carcinomas were marked with Indian ink during a previous colonoscopy. Despite this measure, we recurred to intraoperative colonoscopy to locate a small polyp or tumour in 2 cases. Except for ileocolic resection due to Crohn’s disease, vascular dissection was always performed laparoscopically, and almost always with a medial approach (before displacing the colon). The intestinal dissections were performed with EndoGIA Universal endocutters, 60–3.5 or 45–3.5 mm (Tyco, Norwalk, USA). In right resections, anastomosis was performed extracorporeally and manually, almost always by means of expanding the umbilical port. Left colorectal resections were always associated with a suprapubic midline, left McBurney or Pfannenstiel incision for extracting the specimen, and anastomosis was nearly always laparoscopic and intracorporeal using circular staplers (Proximate ILS

CDH 29, Ethicon-EndoSurgery, Puerto Rico, USA, or Premium Plus CEEA 31, Tyco, Norwalk, USA). The access incisions, or laparotomy incisions in the event of conversion, are always protected with bandages or plastic barriers. In some cases of rectal cancer, we performed what some authors call a mixed or laparoscopically-assisted surgery (displacement of the colon with laparoscopic resection of vascular pedicles, and completing all or part of the pelvic dissection through an access incision): compared with others, these cases are considered conversions to open surgery, since they had been planned as completely laparoscopic.

The final diagnosis was benign growth in 74 cases (40 cases of diverticulitis, 22 cases of polyps, 7 of Crohn’s disease, 3 of rectal prolapses, 1 of rectal endometriosis, and 1 of colon angiodysplasia) and cancer in 66 cases (8 early-stage pT1 adenocarcinomas of a polyp; 3 patients in stage IV TNM [in P2] with inoperable metastatic cancer that could only be treated with chemotherapy). The surgical techniques are listed in Table 2 along with their duration, percentage of conversion and complications and associated procedures. Two patients were treated with a self-expanding endoprosthesis prior to laparoscopic resection due to being diagnosed with an acute obstruction.

“Complex” colorectal techniques are considered to be all techniques except for sigmoidectomy, right hemicolectomy

or ileocolic resection. This is because other techniques are associated with more complications<sup>6</sup> because they require performing surgery deep within the pelvis, or liberating the splenic flexure or the colon or the entire transverse colon in total colectomy. Complex techniques were influenced not only by cumulative experience, but also by the technological improvements ushered in by the hospital: for example, the 5mm thermoelectric bipolar vessel sealer LigaSure V (LigaSure<sup>®</sup>, Valleylab-Tyco, Boulder, USA)<sup>7</sup> was used systematically after case 67 (November 2005), while during the 10 previous years, vascular resection was always done using EndoGIA vascular endocutters measuring 30-2.5 or 45-2.5 mm (Tyco, Norwalk, USA).

Therefore, the main objective of the study was to compare complications, mortality, conversions, hospital stay, and duration among the 40 initial cases in the series (P1) and the 100 next consecutive cases (P2) to confirm the effect of training. We studied postoperative complications during the first 60 days, and classified them as medical or surgical (wound infection and other). Severe surgical complications were considered to be those that required surgical reoperation. We also recorded other late-onset complications occurring more than 2 months after surgery.

#### Statistical method

In order to compare proportions and qualitative variables (mortality, complications, conversion to open surgery, and more complex techniques), we used contingency tables ( $\chi^2$  test using a continuity correction for independent samples, or else Fisher's exact test when more than 20% of the anticipated frequencies were below 5). Student t-test was used (with Levene's test for equality of variances) in order to compare quantitative variables (length of the procedure and the hospital stay). Calculations for the comparative statistical study were done using the statistical software SPSS version 14.0 (Chicago, USA).

## Results

The indications for laparoscopic colorectal surgery for a malignant condition increased from 15% in P1 to 52% in P2 ( $P<.001$ ). The overall conversion rate was 24%, but this did not change significantly in P2 with respect to the P1 learning period, despite a significant increase in the technical complexity of the case material ( $P<.05$ ) (Table 3). The mean duration of the procedures was 185 min, and decreased significantly from P1 to P2 ( $P<.01$ ) (Table 3). The comparative results from both the P1 and P2 group, as well as the list of complications and causes for conversion, are listed in Table 3.

Procedure mortality (up to 3 months) showed no difference (Table 3) between the 2 periods; overall, it was 1.4% (1 case per group) and consisted of one suture dehiscence of the rectum with acute adrenal failure following reintervention with a Hartmann's procedure, and a superinfected pancreatic fistula with sepsis and endocarditis due to *Staphylococcus aureus*.

The overall complications rate (Table 3) was 31%, but it decreased significantly in P2 compared to P1 ( $P=.001$ ). The

medical complications decreased significantly ( $P=.011$ ) and wound infection decreased by a highly significant rate ( $P<.0001$ ) with respect to the learning curve period. Excluding wound infection, the rest of the surgical complications did not change overall, but the most severe (those requiring reintervention) decreased significantly ( $P=.02$ ) (Table 3). In the set of 140 patients, 39% of those patients converted to open surgery experienced complications, compared with 28% who did not require conversion ( $P=.31$ ).

The overall mean hospital stay for the 140 patients was 7.8 days (range, 3-36) with a median of 6 days. Although the mean stay was 9 days in P1 and 7.5 days in P2, the difference is not significant (Table 3). If we analyse the 33 converted patients and 107 non-converted patients separately, we observed that although P2 hospital stays were shorter than in P1 for both the converted (9.6 vs 11.3) ( $P=.56$ ) and the non-converted patients (6.7 vs 8.3 days) ( $P=.17$ ), the differences are not significant. However, in the total of 140 patients, the mean stay was significantly longer ( $P=.015$ ) in the converted group (10.1 days [7]) than in the non-converted group (7.2 days [5]), despite there not being a difference between P1 and P2.

Late-onset complications are recorded in detail in Table 3, and its most fundamental data shows 9% ventral hernia, 3% intestinal occlusion, and 3% anastomotic stenosis (3 colonoscopic dilations and a reintervention by laparotomy). With a mean follow-up period of 29 months (7-102 months) and a median of 25 months, excluding the 2 patients who died in the postoperative period and the cases of polyp carcinoma, we found 4.5% cancer relapse rate: three percent was locoregional at 16 and 22 months (one with an implant at the extraction incision) and 1.5% was distant at 15 months: single hepatic metastasis extracted laparoscopically. None of these relapses occurred in stage IV patients who underwent a procedure.

## Discussion

In this centre, 15 years after the first laparoscopic cholecystectomy, we have seen that implementation of the laparoscopic approach in colorectal surgery was a slow process (Table 1). We attribute this fact to the lack of training methods and not having a pre-established plan for our objectives, which was shown to be very effective in other Spanish hospitals.<sup>8,9</sup> With regard to the progressive broadening of the indication for the laparoscopic approach in colorectal surgery, experiences similar to our own have already been published<sup>10</sup> and they have been particularly informative dating back to the first COST results.<sup>11</sup> At the same time as we gained skill, we implemented improved instruments and laparoscopy towers. For this reason, this study cannot possess the value of a randomised study; technological advances in the equipment coincide with an obvious technical improvement on the part of surgeons and assistants in all laparoscopic procedures. It is useful for observing how the technique and results have improved through practicing more advance laparoscopic operations for handling a frequent and common process such as colorectal resection, with the aim of improving care for patients undergoing colorectal surgery. According to the authors of

**Table 3 – Variables compared between P1 and P2**

Variable	Period P1 (n=40)	Period P2 (n= 00)	P-value
Duration, min (Range)	207 (130–360)	178 (65–300)	.002
Malignant condition (%)	6 (15%)	52 (52%)	<.001
Complex surgery	10 (25%)	43 (43%)	.047
Anterior resection	3	29	
Left hemicolectomy	5	7	
Total colectomy	1	3	
Rectopexy	1	2	
Amputation	0	2	
Non-complex surgery	30 (75%)	57 (57%)	
Right	12	32	
Sigmoidectomy	18	25	
Conversions	9 (22%)	24 (24%)	.85
Improper exposure	1	8	
Uncontrollable haemorrhage	0	4	
Tumour/polyp not located	2	2	
Intestinal perforation	2	2	
Left ureter not located	1	0	
Adhesions	1	0	
Indian ink not located	0	2	
Invasion of neighbouring organ	0	2	
Bubbling anastomosis	1	0	
Does not admit CEEA 31 (circular stapler)	1	0	
Inflammation (prosthesis)	0	1	
Anaesthesia factors	0	1	
Complications	21 (52%)	22 (22%)	.001
Compl. medical units	9 (22%)	6 (6%)	.011
Urinary infection	2	3	
Fever	2	2	
Catheter infection	1	1	
High digestive haemorrhage	1	0	
Arrhythmia	1	0	
Pneumonia	1	0	
Heart failure	1	0	
Surgical complications			
• Infected wound	13 (32%)	4 (4%)	<.001
• Other surgical complications	9 (22%)	17 (17%)	.61
Paralytic ileus	1	8	
Haemorrhage	2	4	
Digestive fistula	1	2	
Urethral fistula	0	1	
Severe surgical complications	5 (12.5%)	2 (2%)	.02
Dehiscence	3	2	
Ventral hernia	1	0	
Perforated colon	1	0	
Mortality	1 (2.5%)	1 (1%)	.49
Hospital stay (range in days)	9 (4–24)	7.5 (3–36)	.165
• Median	7	5	
Late-onset complications	7 (17%)	14 (14%)	.79
Ventral hernia	3 (7%)	10 (10%)	
Anastomotic stenosis <sup>a</sup>	1 (2%) reoperation	3 (3%)	
Occlusion due to adhesion	2 (5%) (one death)	2 (2%)	
Relapse	1 (local)	2 (local and hepatic)	
Abdominal pain	1	0	
Rectal haemorrhage	1	0	

<sup>a</sup>With a need for endoscopic dilation or reintervention.

this article, the presence of surgeons with ample experience in colorectal laparoscopy in the operating theatre enables us to get around difficulties that are hard to explain in a written text (patient positioning and restraint, medial approach to the colon, exposure in obese patients, and those with previous laparotomy, etc) From a vascular control viewpoint, it seems that using LigaSure® has become a necessity for increasing haemostatic safety and speed, since a single instrument is able to cut, dissect and fuse the vascular pedicle.

Both the COST<sup>4</sup> and the COLOR<sup>12</sup> studies, which met the conditions for randomised controlled studies, showed that laparoscopic procedures are as safe as laparotomic ones for colon cancer, and not just for relapses, but also for complications. The main advantage is that laparoscopy offers better quality of life in the first month of follow-up.<sup>13</sup> Based on experience with cancer, and with a mean follow-up period of less than two and a half years, relapse was low. According to COST<sup>3</sup> and other studies,<sup>14,15</sup> laparoscopic surgery for colon cancer is also oncologically safe in the long term. Although these randomised studies excluded transverse colon and rectal cancer, other publications demonstrate that the laparoscopic approach to tumours in these locations is safe from a complications viewpoint.<sup>10,16-19</sup>

In the present comparison, the postoperative complications rate went down significantly from P1 to P2, which demonstrates the importance of gaining technical skill. It decreased for patients who did and did not convert to open surgery alike, which suggests that experience is the primary factor that affects results. It has been shown that conversion to open surgery lengthens the hospital stay, although it is not associated with more complications. This is probably because we have also learned to choose the proper moment and method for conversion.

The percentage of conversions was much higher than in many published series, but it is similar to multi-centre studies such as COST<sup>4</sup> with 21% (only oncological segmental resections of the left and right colon). This rate is acceptable, considering that it includes rectal surgery and there was no selection of cases for which laparoscopy was contraindicated due to obesity, previous abdominal surgery or cardiorespiratory diseases. Upon analysing Table 3, we observe that there was only 1 case of conversion due to intolerance of the anaesthetic used in the procedure, and that in 10 cases (30%), conversion was due to intraoperative complications (mainly intestinal or rectal perforation and uncontrolled haemorrhaging). On the other hand, the most frequent causes of conversion are the same as are found in other series: nine cases (27%) because of exposure difficulty (nearly always due to abdominal obesity) and 6 cases (18%) due to failure to locate the tumour, polyp or Indian ink mark. Other authors with more experience have had few conversions, despite not excluding higher-risk cases.<sup>20</sup> We must note that the increase in technical complexity of the case material during P2 did not lead to a significant increase in the number of conversion, although it did tend to increase in 2007 and 2008. This is probably due to including more cases of rectal cancer,<sup>10</sup> which increases the conversion rate substantially according to the CLASICC study.<sup>21</sup>

Experience reduced procedure time significantly, by nearly 30 minutes (from 207 to 178 minutes), despite the increase in

complexity during P2. Experience also favours a decrease in the mean hospital stay, but not by a statistically significant amount.

The combined results (mortality, complications) of the present experience are quite comparable to those from extensive series (1.8% mortality, 22% complications),<sup>6</sup> multi-centre studies (0.5% mortality, 21% complications) and an American register of 11 000 laparoscopic colorectal procedures<sup>22</sup> compared with 22 000 colectomies by laparotomy: twenty-six percent complications. There is no literature based on scientific tests to indicate if the laparoscopic approach is also a long-term advantage for late-onset complications, such as ventral hernias, chronic pain, colon function, or adhesions and cases of intestinal occlusion.<sup>23</sup> However, many recent comparative studies show a lower incidence rate for hernias<sup>24</sup> and adhesion<sup>25</sup> with a laparoscopic approach. The patients in this series have been observed through exhaustive follow-up, and the results for long-term effects and late-onset complications are shown in Table 3.

With the present study, we can confirm that training in increasingly complex laparoscopic colorectal procedures improves results in the affected patients. The training was never systematically programmed, but training seminars have had an effect. These results may be reproduced in accredited, highly experienced centres,<sup>4,6</sup> and in any location.<sup>22,26</sup> Given that approximately 50% of the conversions we have seen were due to exposure difficulties and not being able to locate the polyp or tumour, we feel that progress toward resolving such cases laparoscopically could involve manually-assisted surgery and a better use of intraoperative colonoscopy. These measures may prevent extended hospital stays (estimated at 3 days per case) due to conversion to laparotomy.

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