Impact of laparoscopic right hemicolectomy for colon cancer

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ABSTRACT

INTRODUCTION This study specifically examined right colonic cancer resection, a common operation for colorectal surgeons starting laparoscopic resection, to assess the impact of commencing laparoscopy.

PATIENTS AND METHODS A total of 56 patients undergoing open ($n = 34$) and attempted laparoscopic ($n = 22$) elective right hemicolectomy for colorectal cancer between November 2003 and March 2007 were compared. Postoperative stay was the primary outcome. Secondary outcomes included analgesic requirements, bowel recovery, morbidity and mortality. Frequency of laparoscopic versus open surgery over time was also examined.

RESULTS Resections attempted laparoscopically increased from 9.1% to 75% in the first and last quarters of the study period, respectively ($P = 0.0002$). Uptake of 'enhanced recovery' was mainly in the laparoscopic group. Conversion was required in two of 22 patients. Attempted laparoscopic cases had a shorter median postoperative stay (6 vs 10 days; $P < 0.0001$), duration of parenteral or epidural analgesia (48 vs 72 h; $P < 0.0001$) and time to first bowel action (3 vs 4 days; $P = 0.001$) compared with open cases. Demography, tumour characteristics, morbidity and mortality were comparable between groups. Multivariate analysis identified decreased age, attempted laparoscopic surgery, use of enhanced recovery and absence of complications as independently shortening postoperative stay.

CONCLUSIONS Advantages of laparoscopic surgery and enhanced recovery, even early in a surgeon's experience, suggest this is the preferred mode for elective right colon cancer resection.

KEYWORDS

Colorectal cancer – Laparoscopic colectomy – Right hemicolectomy

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Laparoscopic colorectal cancer resection is safe, oncologically equivalent to open surgery,^{1–4} and an acceptable alternative for routine colorectal cancer resection.⁵ Since its first report,⁶ numerous studies have demonstrated benefits;^{7–11} however, laparoscopic colectomy for cancer is still not uniformly undertaken. Historical reasons for delayed adoption include the long learning curve, expensive instrumentation,^{12,13} and early lack of outcome and survival data.^{11,12}

Whilst an experienced surgeon might attempt 90% of resectable colorectal cancer surgery laparoscopically,¹⁴ the impact of adopting this approach by individual surgeons is still not fully understood and it remains unclear which resections might successfully be undertaken early in a surgeon's laparoscopic experience. Furthermore, the outcome of open surgery has changed with increased use of enhanced recovery protocols necessitating further examination of any added benefit of laparoscopy.

Thus, this study reports the early impact of introducing laparoscopic surgery to a colorectal unit by assessing any

changes in practice and short-term outcomes of patients undergoing right hemicolectomy for colorectal cancer, a typical starting point for colorectal surgeons adopting laparoscopy.

Patients and Methods

Patients

Eighty-nine patients diagnosed with right colon cancer over a 40-month period (November 2003 to March 2007) at one unit were identified through database and case-note analysis. Of these, 13 receiving palliative chemotherapy or care alone were excluded, leaving 76 who underwent surgery. Patients undergoing emergency surgery ($n = 7$), extended right hemicolectomy ($n = 3$), total colectomy ($n = 4$), or an associated surgical procedure such as cholecystectomy ($n = 6$) were also excluded, leaving a study population of 56 patients (median age, 76.5 years; range, 32–95 years) who underwent isolated elective right hemicolectomy.

Table 1 Demography and physiological parameters in 56 patients undergoing right hemicolectomy for colorectal cancer

	Open (<i>n</i> = 34)	Attempted laparoscopic (<i>n</i> = 22)	<i>P</i> -value
Age (years) ^a	76 (47–95)	77.5 (32–88)	0.626 ^d
Sex distribution			
Male	22 (64.7%)	5 (22.7%)	0.002 ^e
Female	12 (35.3%)	17 (77.3%)	
BMI (kg/m ²) ^a	26 (8–30)	26.9 (20–36)	0.741 ^d
Previous abdominal surgery ^c	6 (18.2%)	10 (47.6%)	0.021 ^e
ASA score ^b	3.1 (± 1)	3.3 (± 0.8)	0.457 ^f
P-POSSUM score ^a			
Physiology score	21 (14–35)	23 (14–36)	0.342 ^d
Operative Severity Score	11 (9–17)	11 (10–17)	0.867 ^d
Expected morbidity	42.6% (15–86)	50.5% (17–91)	0.378 ^d
Expected mortality	2.6% (0.6–19)	3.6% (0.7–28)	0.422 ^d

^aValues are median (range). ^bValues are mean (SD). ^cData are missing for one patient in each group.

^dMann–Whitney U-test. ^eChi-squared test. ^fUnrelated *t*-test.

BMI, body mass index; ASA, American Society of Anesthesiologists;

P-POSSUM, Portsmouth Physiological and Operative Severity Score for the enumeration of mortality and morbidity.

Surgical technique

Operations were performed under the care of four consultant surgeons, all of whom were core members of the colorectal multidisciplinary team and regularly performed colorectal cancer resection. Two surgeons performed both open and laparoscopic-assisted techniques whilst the other two solely performed open surgery. Right hemicolectomy was defined as a radical cancer operation involving high ligation of the ileocolic, right colic (where present) and up to or including the right branch of the middle colic vascular pedicles, mobilisation and resection of the terminal ileum, caecum, ascending colon and up to mid transverse colon with anastomosis undertaken either in hand-sewn or stapled fashion.

Surgery involving total middle colic vessel ligation was considered extended right hemicolectomy and thus excluded, as this usually necessitated splenic flexure mobilisation. Open surgery was undertaken either through a vertical mid-line or transverse incision. Laparoscopic surgery has previously been described.¹⁵ This involves medial-to-lateral dissection with intracorporeal vessel ligation and division prior to bowel extraction via a transverse or vertical extraction site with extracorporeal resection and anastomosis. Principles of Enhanced Recovery Programmes (ERP) adopted in this unit¹⁶ included omission of bowel preparation, pre-operative maintenance of hydration, early cessation of postoperative intravenous fluid and recommencing oral intake as soon as practically possible postoperatively, together with oral analgesia and active early mobilisation.

This programme was in place for all to use, although there was no specific protocol-driven practice at the time.

Outcome

Short-term and in-hospital outcomes within 30 days of surgery and up to discharge from hospital were assessed.

Statistical analysis

Data were analysed according to the intention-to-treat principle (converted cases were included in the laparoscopic group). Laparoscopic (LRH) and open right hemicolectomy (ORH) groups were compared with respect to patient demographics, physiological (pre-operative Portsmouth Physiological and Operative Severity Score for the enumeration of Mortality and morbidity [P-POSSUM] and American Society of Anesthesiologists [ASA] scores) and operative (operating time, blood loss) parameters, recovery criteria (postoperative analgesia, time to first bowel action), clinical outcomes (postoperative hospital stay, 30-day re-operation or re-admission rate, in-hospital and 30-day mortality), morbidity and histopathology (lymph node harvest, TNM). Proportion of cases attempted by laparoscopic surgery was analysed over quarters of the study period. Categorical variables were analysed using chi-squared test and continuous variables using Mann–Whitney U- or unpaired *t*-tests. *P*-values less than 0.05 were considered statistically significant. Uni- and multivariate linear regression analysis examined factors influencing length of postoperative stay. As values

were skewed to shorter stays, this variable was log transformed, with analysis undertaken on this transformed scale. As the outcome was given a log transformation, the size of effect that each variable has upon outcome was given by a ratio (together with the corresponding 95% confidence interval [CI]), which indicates the ratio of length of stay in one situation relative to another.

Results

Thirty-four patients underwent open surgery leaving 22 of 56 patients undergoing attempted laparoscopic elective right hemicolectomy, with conversion to open surgery required in two (9% conversion rate).

Patterns of surgical resection

Of right hemicolectomy resections, 9.1%, 22%, 35% and 75% were attempted laparoscopically during the first, second,

third and fourth 10-month cohorts of the study period, respectively ($P = 0.002$).

Demographics, physiological parameters and tumour characteristics

Patients in the two groups were comparable in age, body mass index (BMI) and ASA scores. However, there were more females and patients who underwent previous abdominal surgery in the laparoscopic group (Table 1). P-POSSUM scores were also comparable in the two groups. The median physiology score was 21 in the open group and 23 in the laparoscopic group ($P = 0.342$). The median operative severity score was 11 in the two groups (Table 1).

Basic tumour characteristics in the two groups were similar (Table 2). Mean primary tumour size in the two groups was around 5.5 cm. Both groups were comparable with regard to Dukes' and TNM staging. Metastases were present in 6 (17.6%) ORH versus 3 (13.6%) LRH cases ($P =$

Table 2 Tumour and pathological characteristics in 56 patients undergoing right hemicolectomy for colorectal cancer

	Open (<i>n</i> = 34)	Attempted laparoscopic (<i>n</i> = 22)	<i>P</i> -value
Primary tumour site			
Caecum	16 (47.1%)	5 (22.7%)	0.162 ^e
Ascending colon	15 (44.1%)	13 (59.1%)	
Hepatic flexure	3 (8.8%)	4 (18.2%)	
Tumour size ^b	5.5 (± 2.7)	5.6 (± 2.3)	0.890 ^f
Dukes' staging			
Dukes' A	4 (11.8%)	3 (13.6%)	0.373 ^e
Dukes' B	14 (41.2%)	9 (40.9%)	
Dukes' C	14 (41.2%)	10 (45.5%)	
Tis (carcinoma <i>in situ</i>) & non-adenocarcinoma	2 (5.9%)	0 (0%)	
TNM classification ^c			
pT			0.433 ^e
Tis (carcinoma <i>in situ</i>)	1 (3%)	0 (0%)	
T1	3 (9.1%)	1 (4.5%)	
T2	1 (3%)	3 (13.6%)	
T3	19 (57.6%)	10 (45.5%)	
T4	9 (27.3%)	8 (36.4%)	0.150 ^e
N			
N0	19 (57.6%)	12 (54.5%)	
N1	11 (33.3%)	4 (18.2%)	
N2	3 (9.1%)	6 (27.3%)	0.690 ^e
M (metastases)	6 (17.6%)	3 (13.6%)	
Length of resected specimen (cm) ^b	27.1 (± 7.5)	29.4 (± 7.7)	0.274 ^f
Distance to nearest resection margin (cm) ^a	7.25 (0–14)	9.5 (5–12)	0.070 ^d
Lymph node harvest ^b	21.2 (± 8.8)	23.8 (± 10.7)	0.181 ^f

^a Values are median (range). ^b Values are mean (SD). ^c One patient in the open group had an endocrine tumour which does not have a TNM classification.

^d Mann-Whitney U-test. ^e Chi-squared test. ^f Unrelated *t*-test.

Table 3 Postoperative recovery parameters and clinical outcomes in 56 patients undergoing right hemicolectomy for colorectal cancer

	Open (<i>n</i> = 34)	Attempted laparoscopic (<i>n</i> = 22)	<i>P</i> -value
Recovery parameters			
Postoperative HDU stay (days) ^a	0 (0–13)	1 (0–6)	0.520 ^d
Initial analgesia method ^b			
Oral medications	0 (0%)	5 (25%)	0.013 ^e
PRN parenteral morphine	1 (3.2%)	0 (0%)	
Narcotic PCA	28 (90.3%)	12 (60%)	
Epidural	2 (6.5%)	3 (15%)	0.090 ^d
Morphine in first 24 h (mg)	47 (12–82)	32 (0–72)	
Parenteral/epidural narcotic use (h) ^a	72 (24–216)	48 (0–117)	< 0.0001 ^d
Day of first bowel action ^a	4 (2–8)	3 (2–4)	0.001 ^d
Clinical outcomes			
Total postoperative stay (days) ^a	10 (6–42)	6 (3–32)	< 0.0001 ^d
Complicated patients ^c	9 (29%)	4 (19%)	0.415 ^e
Details of complications	14	7	
Chest infection	3	2	
DVT	1	0	
PE	2	0	
ACS	2	0	
Haemorrhage	0	1	
Anastomotic leak	2	2	
Wound infection	4	2	
30-day re-operation ^c	1 (3.2%)	3 (14.3%)	0.142 ^e
30-day re-admission	1 (3.3%)	0 (0%)	0.398 ^e
Combined in-hospital and 30-day mortality	2 (5.9%)	1 (4.5%)	0.828 ^e

^aValues are median (range). ^bData missing for three patients in the open group and two patients in the laparoscopic group.

^cComplications data missing for three patients in the open group and one patient in the laparoscopic group.

^dMann–Whitney U-test. ^eChi-squared test.

PRN, *pro re nata* 'as needed'; PCA, patient controlled analgesia; DVT, deep vein thrombosis; PE, pulmonary embolism; ACS, acute coronary syndrome.

0.690). The oncological clearance of the tumour was the same in both groups (Table 2).

Operative parameters

Attempted laparoscopic surgery took on average 60 min longer than ORH (median 187 min; range, 105–310 min vs 130 min; range 60–190 min, respectively; $P < 0.0001$), however, was associated with less blood loss (median 150 ml; range 50–350 ml vs 300 ml, range 50–1690 ml, respectively; $P = 0.016$).

Enhanced recovery uptake

During the study period, an Enhanced Recovery Programme was available for all cases; however, uptake varied significantly between the groups. In the LRH group, 17 out of 20 patients (85%) followed ERP (data missing in two) versus 1 of 31 (3.2%) in the open group (data missing in 3) ($P < 0.0001$).

Postoperative recovery and clinical outcomes

The duration of high dependency unit (HDU) stay was similar between groups. LRH patients were more likely to use oral medications only as the initial method of analgesia than the ORH group (5 [25%] vs 0 [0%]; $P = 0.007$), and similarly had a trend to use less parenteral morphine in the first 24 h postoperatively (32 mg vs 47 mg; $P = 0.090$). Average duration of use of parenteral narcotics postoperatively was a day shorter in the laparoscopic group (72 h vs 48 h; $P < 0.0001$). This was associated with a quicker return of bowel function in LRH patients (3rd versus 4th day; $P = 0.001$; Table 3).

Patients in the LRH group were discharged a median of 4 days earlier than those in the open group (6 days vs 10 days; $P < 0.0001$). None of the LRH patients were re-admitted following discharge, whilst one ORH patient was re-admitted with sepsis and managed with intravenous antibiotics. Whilst morbidity data were missing for three patients in the open group and one in the laparoscopic group, 30-day

complications rates were similar. Nine (29%) ORH and four (19%) LRH developed short-term complications ($P = 0.415$), as detailed in Table 3.

One ORH patient developed an enterocutaneous fistula from the anastomotic site, initially managed conservatively with uneventful surgical closure after 1 year. Three other anastomotic leaks (two LRH, one ORH) were diagnosed with a combination of clinical assessment and CT scanning. None were managed laparoscopically, all necessitating laparotomy and anastomotic take down with end ileostomy.

Another re-operation in the LRH group involved an elderly male with chronic leukaemia and Parkinson's disease. Whilst initially stable intra- and postoperatively, he developed hypovolaemia within 24 h and, despite laparotomy where intraperitoneal clots but secure vascular pedicles were found, coupled with aggressive resuscitation, the patient died shortly afterwards (likely reactive mesenteric haemorrhage).

Combined in-hospital and 30-day mortality were similar in the two groups. Two patients (5.9%) died in the open (comorbidity, cardiorespiratory) and one (4.5%) in the laparoscopic group (reactive haemorrhage as above).

Multivariate analysis examining factors influencing post-operative length of stay

Univariate analysis indicated a significant effect of operative approach, age, distant metastases, Enhanced Recovery programme implementation and presence of complications upon length of stay (Table 4). The results for 'operative approach' indicated that LRH patients stayed in hospital only half as long as ORH patients. The results for 'age' were only of borderline signif-

icance ($P = 0.05$), but indicated that older subjects stayed in hospital longer. A 10-year increase in age was associated with an increase in length of stay of 19%. Patients with distant metastases stayed in hospital 70% longer than those without. In addition, those who were in an enhanced recovery programme stayed in hospital only half the time as those not in the programme; patients with complications stayed in hospital 2.6 times longer than those without.

Subsequently, a multivariate analysis with backwards selection was performed (Table 5). Age, enhanced recovery programme and occurrence of complications had a significant effect upon length of stay. After adjusting for these variables, this analysis indicated no significant effect of operative approach upon length of stay. However, further data examination indicated a close relationship between operative approach and the enhanced recovery programme (*i.e.* laparoscopic approach and enhanced recovery vs open and no enhanced recovery), with agreement for 47 of 51 valid observations (92%); thus, the two variables could be used interchangeably. Therefore, an alternative final model could include 'operative approach' rather than 'enhanced recovery programme' (Table 6).

Discussion

This study presents right hemicolectomy cases performed in a 40-month period representing early laparoscopic experience, and compares equivalent open and laparoscopic segmental cancer resections. Previously, most authors have compared open and laparoscopic colonic surgery, often grouping both right- and left-sided resections together, sometimes benign and malignant.

Table 4 Univariate analysis of factors influencing the length of postoperative hospital stay in 56 patients undergoing right hemicolectomy for colorectal cancer

Variable	Group	Ratio (95% CI)	P-value
Operative approach	Open	1	< 0.001
	Attempted laparoscopic	0.50 (0.36–0.77)	
Age ^a	–	1.19 (1.00–1.41)	0.05
ASA score	–	1.07 (0.84–1.38)	0.57
Distant metastases	No	1	0.04
	Yes	1.69 (1.04–2.76)	
Dukes' stage	A	1	0.23
	B	1.74 (0.91–3.34)	
	C1 or C2	1.61 (0.85–3.06)	
Abdominal wall incision	Vertical	1	0.43
	Transverse	0.85 (0.56–1.29)	
Enhanced Recovery Programme	No	1	< 0.001
	Yes	0.48 (0.34–0.68)	
Complications	No	1	< 0.001
	Yes	2.58 (1.72–3.87)	

^aRatios are given for a 10-unit increase in the explanatory variable.

Table 5 Multivariate analysis of factors influencing the length of postoperative hospital stay in 56 patients undergoing right hemicolectomy for colorectal cancer

Variable	Group	Ratio (95% CI)	P-value
Age ^a	–	1.12 (0.99–1.27)	0.07
Enhanced Recovery Programme	No	1	
	Yes	0.55 (0.41–0.74)	< 0.001
Complications	No	1	
	Yes	2.16 (1.53–3.06)	< 0.001

^aRatios are given for a 10-unit increase in the explanatory variable.

However, laparoscopic right hemicolectomy for cancer was specifically selected for analysis on the premise that it is a technically simpler laparoscopic resection¹⁷ and is often the starting point for surgeons commencing laparoscopic colorectal resection. Further, benign resections, which often have a marked inflammatory component, may be technically more of a challenge in the early phase of a surgeon's experience. Few published studies have compared laparoscopic and open right hemicolectomy.^{18–25} Zheng *et al.*²⁰ reported a long hospital stay (13.9 ± 6.5 days) in the laparoscopic group which was even longer (18.3 ± 5.7 days) in the open group. Baker *et al.*²¹ found a high conversion rate in their laparoscopic patients with a long hospital stay (9.9 ± 7.5 days) which did not differ from open cases,

Table 6 Results of final model of multivariate analysis of factors influencing length of postoperative hospital stay (considering 'operative approach' instead of 'enhanced recovery protocol') in 56 patients undergoing right hemicolectomy for colorectal cancer

Variable Group	Ratio (95% CI)	P-value
Age ^a	1.13 (1.00–1.29)	0.05
Operative approach		
Open	1	
Attempted laparoscopic	0.55 (0.41–0.74)	< 0.001
Complications		
No	1	
Yes	2.31 (1.64–3.25)	< 0.001

^aRatios are given for a 10-unit increase in the explanatory variable.

but noted an analgesic benefit with laparoscopy. Lezoche *et al.*²² reported no conversions but, despite a shorter hospital stay with laparoscopy, this length of stay was still long (9.2 days). Bokey *et al.*²³ had a high conversion rate and reported a long hospital stay (12 days); however, this study is now dated.

To date, two studies have demonstrated a relatively short hospital stay after laparoscopic right colectomy^{18,19} in comparison with open surgery; however, these are matched only according to basic demography, ASA scores and tumour staging. A weakness of the present study is its retrospective nature; nevertheless, patient demographics, physiological parameters and tumour characteristics are matched. It is unlikely that the higher proportion of females in the laparoscopic group affected the outcome of colonic resection.

This study has demonstrated that patients in the laparoscopic group had a significantly shorter postoperative hospital stay, decreased blood loss, decreased analgesic requirements and quicker bowel recovery in comparison with open right hemicolectomy with comparable histopathological criteria, confirming oncological safety of the laparoscopic approach. The longer operating times in the laparoscopic group are consistent with other reports,^{18–20,22–26} in which operating times range from 85–261 min. This time is likely to reduce with more experience. Tekkis *et al.*¹⁷ reported single-centre results of 900 laparoscopic procedures over a 12-year period. Their risk-adjusted cumulative sum model showed a learning curve of 55 cases for right colonic resections with significant reductions in operating times with experience.¹⁷

Although representing early experience, conversion in this study is lower, at 9%, than in most studies where conversion ranges from 4.2–18.2%, despite the fact that the present laparoscopic patients had undergone a higher frequency of previous abdominal surgery than the open group. Whilst Senagore *et al.*²⁵ reported shorter lengths of stay for laparoscopic completed cases, their 30-day re-admission rate was high at 7%. The incidence of postoperative complications in this study is comparable to that reported in the literature which ranged from 1.9% to 25.2%. The slightly higher re-operation rate in laparoscopic patients in our study may reflect heightened anxiety to re-explore surgically, early in a surgeon's experience; despite this, laparoscopic patients were discharged significantly earlier than their open counterparts. The significant increase in the use of laparoscopic right hemicolectomy over the study period in this centre shows the applicability of this approach. Other work has demonstrated that laparoscopic resection was achievable in around 90% of elective colorectal cancer resections by an experienced surgeon in one study;¹⁴ whether other surgeons or indeed units may approach these figures with time is as yet unclear.

One potential confounding variable in the present study is that the enhanced recovery programme was almost exclusively adopted for laparoscopic patients, despite the fact it was available for all. It is thus hard to tease out the specific benefit for laparoscopy versus enhanced recovery in this subset. Obviously,

this is important particularly when outcomes of open colorectal surgery are changing with 'enhanced recovery' protocols.^{16,27} Reasons behind this different uptake are unclear, but most likely relate to the higher incidence of nausea, ileus or pain-related events in open surgery especially in the initial absence of a protocol-driven practice. Binderow *et al.*²⁸ showed that length of stay is shortened in open cases on adoption of early postoperative feeding. Further results in this area are eagerly awaited.

Conclusions

This study has shown that laparoscopic right hemicolectomy coupled with enhanced recovery offers significant recovery advantages in comparison with the traditional open approach, even during surgeons' early laparoscopic colorectal experience. This approach, coupled with low complications results in a good oncological outcome and a short hospital stay.

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References

1. Lacy AM, Garcia-Valdecasas JC, Delgado S, Castells A, Taura P, Pique JM *et al.* Laparoscopy-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: a randomised trial. *Lancet* 2002; **359**: 2224–9.
2. Cost Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004; **350**: 2050–9.
3. Veldkamp R, Kuhry E, Hop WC, Jeekel J, Kazemier G, Bonjer HJ *et al.* Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. *Lancet Oncol* 2005; **6**: 477–84.
4. Guillaou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM *et al.* Short-term end-points of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet* 2005; **365**: 1718–26.
5. National Institute for Health and Clinical Excellence. NICE technology appraisal guidance 105. *Laparoscopic surgery for colorectal cancer* (review of NICE technology appraisal 17). London: NICE, 2006. Reviewed at <<http://guidance.nice.org.uk/TA105/Guidance/pdf/English>>.
6. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surg Laparosc Endosc* 1991; **1**: 144–50.
7. Franklin Jr ME, Rosenthal D, Abrego-Medina D, Dorman JP, Glass JL, Norem R *et al.* Prospective comparison of open vs. laparoscopic colon surgery for carcinoma. Five-year results. *Dis Colon Rectum* 1996; **39** (Suppl): S35–46.
8. Zucker KA, Pitcher DE, Martin DT, Ford RS. Laparoscopic-assisted colon resection. *Surg Endosc* 1994; **8**: 12–7, discussion 18.
9. Lacy AM, Garcia-Valdecasas JC, Pique JM, Delgado S, Campo E, Bordas JM *et al.* Short-term outcome analysis of a randomized study comparing laparoscopic vs. open colectomy for colon cancer. *Surg Endosc* 1995; **9**: 1101–5.
10. Stage JG, Schulze S, Moller P, Overgaard H, Andersen M, Rebsdorf-Pedersen VB *et al.* Prospective randomized study of laparoscopic versus open colonic resection for adenocarcinoma. *Br J Surg* 1997; **84**: 391–6.
11. Milsom JW, Bohm B, Hammerhofer KA, Fazio V, Steiger E, Elson P. A prospective, randomized trial comparing laparoscopic versus conventional techniques in colorectal cancer surgery: a preliminary report. *J Am Coll Surg* 1998; **187**: 46–54, discussion 54–5.
12. Hartley JE, Monson JR. The role of laparoscopy in the multimodality treatment of colorectal cancer. *Surg Clin North Am* 2002; **82**: 1019–33.
13. Bittner R. Laparoscopic surgery – 15 years after clinical introduction. *World J Surg* 2006; **30**: 1190–203.
14. Buchanan GN, Malik A, Parvaiz A, Sheffield JP, Kennedy RH. Laparoscopic resection for colorectal cancer. *Br J Surg* 2008; **95**: 893–902.
15. Psaila J, Bulley SH, Ewings P, Sheffield JP, Kennedy RH. Outcome following laparoscopic resection for colorectal cancer. *Br J Surg* 1998; **85**: 662–4.
16. King PM, Blazeby JM, Ewings P, Longman RJ, Kipling RM, Franks PJ *et al.* The influence of an Enhanced Recovery Programme on clinical outcomes, costs and quality of life after surgery for colorectal cancer. *Colorectal Dis* 2006; **8**: 506–13.
17. Tekkis PP, Senagore AJ, Delaney CP, Fazio VW. Evaluation of the learning curve in laparoscopic colorectal surgery. Comparison of right sided and left sided resections. *Ann Surg* 2005; **242**: 83–91.
18. Leung KL, Meng WC, Lee JF, Thung KH, Lai PB, Lau WY. Laparoscopic-assisted resection of right-sided colonic carcinoma: a case-control study. *J Surg Oncol* 1999; **71**: 97–100.
19. Del Rio P, Dell'Abate P, Soliani P, Tacci S, Arcuri MF, Sianesi M. Standardized laparoscopic right hemicolectomy technique for colon cancer. *Minerva Chir* 2006; **61**: 293–7.
20. Zheng MH, Feng B, Lu AG, Li JW, Wang ML, Mao ZH *et al.* Laparoscopic versus open right hemicolectomy with curative intent for colon carcinoma. *World J Gastroenterol* 2005; **11**: 323–6.
21. Baker RP, Titu LV, Hartley JE, Lee PW, Monson JR. A case-control study of laparoscopic right hemicolectomy vs. open right hemicolectomy. *Dis Colon Rectum* 2004; **47**: 1675–9.
22. Lezoche E, Felicetti F, Paganini AM, Guerrieri M, De Sanctis A, Minervini S *et al.* Laparoscopic vs. open hemicolectomy for colon cancer. *Surg Endosc* 2002; **16**: 596–602.
23. Bokey EL, Moore JW, Chapuis PH, Newland RC. Morbidity and mortality following laparoscopic-assisted right hemicolectomy for cancer. *Dis Colon Rectum* 1996; **39** (Suppl): S24–8.
24. Baca I, Perko Z, Bokan I, Mimica Z, Petricevic A, Druzjanic N *et al.* Technique and survival after laparoscopically assisted right hemicolectomy. *Surg Endosc* 2005; **19**: 650–5.
25. Senagore AJ, Delaney CP, Brady KM, Fazio VW. Standardized approach to laparoscopic right colectomy: outcomes in 70 consecutive cases. *J Am Coll Surg* 2004; **199**: 675–9.
26. Franklin Jr ME, Gonzalez Jr JJ, Miter DB, Mansur JH, Trevino JM, Glass JL *et al.* Laparoscopic right hemicolectomy for cancer: 11-year experience [Abstract only]. *Rev Gastroenterol Mex* 2004; **69** (Suppl 1): 65–72.
27. Basse L, Jakobsen DH, Billesbolle P, Werner M, Kehlet H. A clinical pathway to accelerate recovery after colonic resection. *Ann Surg* 2000; **232**: 51–7.
28. Binderow SR, Cohen SM, Wexner SD, Nogueras JJ. Must early postoperative oral intake be limited to laparoscopy? *Dis Colon Rectum* 1994; **37**: 584–9.