



Original article

A case-control study of extracorporeal versus intracorporeal anastomosis in patients subjected to right laparoscopic hemicolectomy[☆]

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Introduction: There is still insufficient scientific evidence on which is the best technique to perform the anastomosis -intracorporeal (IC) or extracorporeal (EC)- in right laparoscopic hemicolectomy. The objective of the present study is to determine whether there are differences to compare in both techniques.

Material and methods: A study was performed on a prospective patient series subjected to right laparoscopic hemicolectomy in our Hospital. The preoperative and the postoperative variables associated with complications recorded depending on the type of anastomosis. **Results:** A total of 60 patients were intervened from June 2004 to June 2010 (35 IC; 25 EC). There were no significant differences between both groups as regards baseline preoperative characteristics or associated comorbidities. The median operation time was 212 minutes (142-305 min), with no significant difference between both techniques. The number of lymph nodes removed was higher in the IC group (21 vs 14; $P=.03$). The beginning of oral tolerance and the first bowel movement were significantly earlier in the IC group. The complications rate was similar for both groups (14% IC; 16% EC; $P=.89$). Three patients in the IC group had anastomosis dehiscence. The mortality rate was 2.8% (one patient in each group).

Conclusion: Intracorporeal versus extracorporeal anastomosis in right laparoscopic hemicolectomy can obtain a higher number of resected lymph nodes and an earlier oral tolerance and intestinal transit.

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Estudio de casos y controles entre anastomosis intra y extracorpórea en pacientes intervenidos de hemicolectomía derecha laparoscópica

R E S U M E N

Palabras clave:

Cirugía colorrectal
Hemicolectomía derecha
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Anastomosis intracorpórea

Introducción: En la actualidad no existe suficiente evidencia científica sobre cuál es la mejor técnica para realizar la anastomosis –intracorpórea (IC) o extracorpórea (EC)– en la hemicolectomía derecha laparoscópica. El objetivo del presente estudio es determinar si existen diferencias al comparar ambas técnicas.

Material y métodos: Se realiza un estudio sobre una serie prospectiva de pacientes intervenidos en nuestro Centro mediante hemicolectomía derecha laparoscópica. Se comparan las variables preoperatorias, intraoperatorias y relacionadas con complicaciones recogidas en función del tipo de anastomosis.

Resultados: Desde junio de 2004 hasta junio de 2010 se intervinieron 60 pacientes (35 IC; 25 EC). No existieron diferencias significativas entre ambos grupos en cuanto a características basales preoperatorias ni comorbilidades asociadas. La mediana de tiempo operatorio fue de 212 minutos (142-305 min), sin diferencias significativas entre ambas técnicas. El número de ganglios extraídos resultó mayor en el grupo IC (21 versus 14; $p = 0,03$). Tanto el inicio de la tolerancia oral como la primera deposición resultaron significativamente más precoces en el grupo IC. La tasa de complicaciones postoperatorias fue similar para ambos grupos (14% IC; 16% EC; $p = 0,89$). Tres pacientes presentaron dehiscencia de anastomosis en las IC. La tasa de mortalidad fue del 2,8% (un paciente en cada grupo).

Conclusión: La anastomosis intracorpórea frente a la extracorpórea en la hemicolectomía derecha laparoscópica permite obtener un mayor número de ganglios resecaados y un inicio más precoz de la tolerancia oral y del tránsito intestinal.

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Introduction

Until recently, only 4%-34% of colon surgeries were performed using laparoscopy.¹⁻⁴ However, in recent years, several different clinical studies have attested to the efficacy and safety of a laparoscopic approach in colon surgeries.⁵⁻¹⁵ Still, one particular case is that of right colectomy, in which the technical difficulty produced by frequent anatomical variations, above all vascular in nature, has led to a more gradual integration of laparoscopic procedures.¹⁶

Transit reconstructions through an ileo-anastomosis can be carried out in one of two ways. In the extracorporeal method, also known as laparoscopic assisted surgery, the suture (manual or mechanical) is placed by externalising the ileum and colon through an incision through which the surgical specimen is also extracted. In intracorporeal anastomosis (normally mechanical suture), which solely uses laparoscopy, a small incision is made in order to extract the surgical specimen. This method presents a greater level of technical difficulty, and its benefits are not clearly established. In this respect, a survey performed among colorectal surgeons indicated that right hemicolectomy with intracorporeal anastomosis was considered as one of the most difficult procedures to perform laparoscopically, and is only surpassed in difficulty by transverse colectomy, low anterior resection of the rectum, and reversal of Hartmann's procedure.¹⁷

The objective of the current study is to determine whether or not short and mid-term differences exist between

intracorporeal and extracorporeal anastomosis in a group of patients that underwent right hemicolectomy using laparoscopy.

Material and method

We performed a retrospective, open-label analysis on a prospective patient series of consecutive right hemicolectomies performed by the same surgeon at our hospital using laparoscopy, comparing intracorporeal (IC) with extracorporeal (EC) anastomosis.

We analysed preoperative and intraoperative variables, early and late complications, patient evolution, and anatomopathological results for both patient groups. The study was approved by the clinical research ethics committee at our hospital.

Surgical technique

All patients received antibiotic, antithrombotic, and anti-ulcer prophylaxis before the procedure.

With the patient lying down in the Lloyd-Davis position, the pneumoperitoneum was insufflated using a closed technique. Five trocars were used: two 10 mm, one 12 mm, and two 5 mm. After laparoscopy, the ileocolic vessels were identified and cut off (at their origin in the case of malignant neoplasia) after applying haemostatic clips or mechanical

staples. The colon was then mobilised through a systematic medial-to-lateral retroperitoneal dissection. After resection of the ileum and colon using a linear stapler (Endo-GIA), the surgeon proceeded with the anastomosis.

In patients that underwent an extracorporeal anastomosis (EC group), the colon was externalised and sutures applied by widening the incision of one of the trocars along the midline, or by performing a mini-laparotomy at another location (subcostal, suprapubic, etc.). This depended on the possibility of externalising the colon without tension after sufficient mobilisation of the right colon, hepatic flexure, and, if necessary, the proximal transverse colon. The surgeon then proceeded to perform a latero-lateral manual or mechanical anastomosis, and closed the enterotomy by using a stapler with individual sutures. The colon and ileum could be resected before externalising the structures, or extracorporeally just before the anastomosis.

In the case of completely laparoscopic intracorporeal sutures (IC group), the surgeon performed a latero-lateral mechanical anastomosis using a 60 mm Endo-GIA, closing the enterotomy with intracorporeal individual sutures. Before the procedure, the ileum and colon were orientated and fixed using traction. In all cases, the incision was protected by isolating the surgical specimen upon extraction. The resulting mesenteric defect was closed based on its size and the possibility of a tension-free closure. In all cases, the surgeon used a Pfannenstiel incision, except in those patients that had undergone a previous laparotomy.

Postoperative variables

In all patients, oral tolerance commenced 24 hours after the procedure, except when clinically contraindicated. No patients required a nasogastric tube or drainage. There were no changes made to the postoperative management or analgesic treatment with regard to the type of anastomosis performed.

Postoperative complications

Early

Complications were considered early when they occurred within the first 30 days after the procedure. Surgical ileus were defined as intolerance to the start of an oral diet, the need for a nasogastric tube, or when the patient had clinical signs of abdominal distension and paralytic ileus was confirmed by radiological criteria. Surgical wound infections were defined as the presence of fever and exudate with isolation of pathogenic organisms. We have also compiled all cases of general complications, anastomotic dehiscence, re-operations, and death.

Late

The late complications registered were cases of abdominal hernia that were observed in visits at 3 and 6 months after

the operation, or when the patient sought treatment for this problem.

Statistical analysis

We compared the previously mentioned variables between the two groups using statistical analyses based on the type of anastomosis performed. Categorical variables were analysed using contingency tables and chi-square tests. Continuous variables were compared using Student's t-tests, and medians were compared using Mann-Whitney U-tests. P-values less than .05 were considered to be statistically significant. We used SPSS software, version 15.0 (Chicago, IL, USA) for all analyses.

Results

Patient characteristics

Between June 2004 and June 2010, 60 patients underwent right hemicolectomy using laparoscopy. Transit reconstruction was performed using extracorporeal anastomosis until June 2008, when the procedure was switched to the intracorporeal method, based on its theoretical advantages. Two different cohorts were analysed based on the type of anastomosis performed, with 35 cases of intracorporeal anastomoses (58.3%), and 25 of extracorporeal (41.7%). Table 1 displays the demographical characteristics of each group. No statistically significant differences were observed between the two groups with respect to baseline preoperative variables.

Characteristics of the surgery

Table 2 displays the comparison of intraoperative variables between the two study groups. 67% of patients (n=40) underwent surgery for cancer, and the other patients for benign pathologies, with no difference between the two groups. The most frequent location of the lesion was the caecum, 45% (n=27), followed by the ascending colon, 33% (n=20). On 10 occasions, the patient underwent an extended right hemicolectomy, in which the resection was extended to the proximal half of the transverse colon (7 intracorporeal anastomoses and 3 extracorporeal). The global median duration of the procedure was 212 minutes (range: 142-305), this being slightly greater in intracorporeal procedures, although not statistically significantly (226 minutes compared to 208 minutes, $P=.06$). The conversion rate from laparoscopic to open surgery, which was defined as unplanned incisions greater than 8 cm, was 2.8% (both cases occurred with extracorporeal anastomosis).

Anatomopathological characteristics

The mean size of the tumour and distance from the resection edge were similar in both groups (Table 3). The mean length of the surgical specimen extracted was slightly greater in the IC group (29.5 cm vs 25 cm), with a tendency towards statistical

Table 1 – Patient demographic characteristics

Variable	Intracorporeal No.=35 (%)	Extracorporeal No.=25 (%)	P value
Age ^a	62.6 (13.4)	58.9 (12.9)	.29
Sex			.89
Male	19 (54)	14 (56)	
Female	16 (46)	11 (44)	
BMI ^a	25.9 (3.1)	26.7 (3.9)	.41
ASA			.38
I-II	17 (48.6)	15 (60)	
III/IV	18 (51.4)	10 (40)	
Comorbidity			.96
Yes	18 (51.4)	13 (52)	
No	17 (48.6)	12 (48)	
Previous abdominal surgery			.18
Yes	6 (17.1)	8 (32)	
No	29 (82.9)	17 (68)	

^aMean (standard deviation). BMI, body mass index.**Table 2 – Intraoperative characteristics**

Variable	Intracorporeal No.=35 (58.3%)	Extracorporeal No.=25 (47.1%)	P value
Indication			.46
Benign	13 (37.1)	7 (28)	
Malignant	22 (62.9)	18 (72)	
Location			.12
Caecum/ascending	25 (71.4)	22 (88)	
Hepatic flexure/transverse	10 (28.6)	3 (12)	
Type of resection			.41
Standard	28 (80)	22 (88)	
Extended	7 (20)	3 (12)	
Conversion	0 (0)	2 (8)	.09
Duration of surgery ^a	226 (160-305)	208 (142-288)	.055

^aMedian (range).**Table 3 – Anatomopathological results**

Variable	Intracorporeal No.=35 (%)	Extracorporeal No.=25 (%)	P value
Size (width) ^a	3.55 (1.92)	3.88 (2.33)	.56
Size (length) ^a	2.71 (1.39)	3.28 (2.14)	.23
Resection margin ^a	8.45 (5.47)	7.75 (3.41)	.57
Length surgical specimen ^a	29.54 (11.09)	25.03 (4.32)	.06
Lymph nodes resected ^a	20.66 (11.53)	14.28 (9.93)	.03
TNM no.=41			0.65
0/Tis	3 (12.5)	1 (5.9)	
I-II	17 (70.8)	11 (58.8)	
III/IV	4 (16.6)	5 (29.4)	

^aMean (standard deviation). TNM, oncological staging.

significance ($P=.006$). Furthermore, a greater number of lymph nodes were extracted when the anastomosis was performed intracorporeally (20.6 vs 14.3), and in this case, the difference observed was statistically significant ($P=.03$).

Postoperative evolution (Table 4)

The criteria for hospital discharge were a good general state of health, good oral tolerance, recovered intestinal function,

Table 4 – Postoperative characteristics

Variable	Intracorporeal No.=35 (%)	Extracorporeal No.=25 (%)	P value
Hospitalisation stay ^a	6 (4-36)	8 (5-32)	.09
Oral tolerance ^a	1 (1-9)	2 (1-10)	.002
First bowel movement ^a	3 (2-8)	4 (2-8)	.004
Paralytic ileus	4 (11.4)	3 (12)	.94
Complications			
Early	5 (14.3)	4 (16)	.89
Late	2 (5.7)	1 (4)	.76
Dehiscence	3	0	.13
Mortality	1 (2.9)	1 (4)	.67

^aMedian (range).

and the absence of fever and pain. The median duration of hospital stay was less in the IC group (6 days vs 8 days), although this difference was not statistically significant, $P=.09$ (Table 4).

Both the start of oral tolerance and the first bowel movement occurred significantly earlier in the IC group. Prokinetic agents were prescribed to 21.5% of patients during the immediate postoperative period, being more frequently administered in the IC group (11 patients vs 2 in the EC group; $P=.03$). The same comparative analysis was repeated between the two groups while excluding those patients that received this medication, and the same differences were observed with regard to the start of oral tolerance and first bowel movement ($P<.01$) in favour of the IC group. Twelve percent of patients ($n=7$) had postoperative ileus and 6 cases required a nasogastric tube, with no differences between the two study groups.

Early and late complications

Early

In general, 13% of patients had some type of complication in the immediate postoperative period, 5 in the IC group and 4 in the EC group, with no significant differences between them ($P=.89$). Three patients in the IC group had dehiscence of the anastomosis ($P=.13$), which was complicated by infection of the surgical wound in one patient, postoperative rectorrhagia requiring haemodynamic support in another, and death in the third. One patient in the EC group developed pneumonia and died, and another patient required re-operation for an obstruction. Additionally, two patients in this group developed infections of the surgical wound. We documented no cases of readmission to the hospital.

The global mortality rate was 2.8% (one patient in each group).

Late

Three patients (5%) developed hernias, two from the IC group, both of which were treated using a midline incision instead of a Pfannenstiel incision.

Discussion

In this study, we have observed that using the method of intracorporeal anastomosis for transit reconstruction following a right hemicolectomy was associated with a greater number of lymph nodes extracted, as well as a significant improvement in the time to oral tolerance and the recovery of intestinal transit. The fact that food ingestion was achieved earlier in this group may be due to the greater tendency for surgeons to incorporate fast-track techniques in the postoperative period. There was no increase in perioperative morbidity or mortality or the duration of the procedure when compared with extracorporeal anastomosis.

Several studies have been published in the medical literature comparing these two different techniques. Some authors claim that no significant differences exist and that the intracorporeal method offers no advantages over the extracorporeal method,¹⁸ or that the only benefit would be a smaller incision.¹⁹ Other studies maintain that intracorporeal sutures are safe and feasible, with a similar rate of complications.^{20,21} Due to its greater simplicity and speed, the majority of authors continue to support extracorporeal anastomosis. However, in patients with shortened and thickened mesentery, externalisation of the colon can become complicated, hindering exposure of the surgical site and compromising the surgical technique for the anastomosis, as well as limiting the extension of the resection.^{7,22} Furthermore, a greater risk of mesenteric and portal vein thrombosis has been associated with excessive mesenteric traction during these types of externalising manoeuvres.²³

Controversy exists with regard to the duration of the procedure, as some authors have reported that the intracorporeal method^{20,24} takes longer than the extracorporeal.^{25,26} In our study, we found no significant difference between the duration of the operation. Fabozzi et al¹⁶ recently demonstrated that the intracorporeal approach requires less time and lower analgesic treatment, and leads to an earlier recovery of the intestinal transit, shorter hospital stay, and fewer complications. Casciola et al also observed differences in favour of the intracorporeal method.²⁴

Both techniques allow for applying oncologic principles of open surgery, such as not manipulating the tumour, proximal

ligation of the surrounding vessels, lymphadenectomy, and adequate margins of the resection. However, in our study, we observed a greater size of the surgical specimen and a greater number of lymph nodes when the anastomosis was intracorporeal. We believe that this could be due to the fact that, in this technique, preserving a certain length of the transverse colon is not required in order to externalise and suture the structure, and so the extent of the resection is not limited by this factor. The differences observed in the number of lymph nodes resected between groups could be due to the greater number of extended right hemicolectomies in the IC group.

Hernias are produced in 7%-24% of laparoscopic colon surgeries.^{27,28} Only 5% of patients in our study developed this complication, always along the midline, which proves that a Pfannenstiel-type incision is a protective factor against this complication, as has been reported by other authors.²⁹ An added advantage of intracorporeal anastomosis is that the surgeon no longer depends on the length of the colon and meso-colon in order to externalise them and suture the structure. The incision can be made in an ideal location for removing the surgical specimen, thus improving the aesthetic aspect of the surgery and reducing the risk for developing this complication by performing a Pfannenstiel-type incision.

As with all new surgical techniques, laparoscopic intracorporeal anastomosis requires a learning curve.³⁰ Conversion to a laparotomy was required in 2 (2.8%) of patients: one case was due to technical difficulties secondary to obesity (BMI>30), and the other was due to previously unknown diaphragmatic metastasis. The global rate of dehiscence was 4.2%. Three patients from the IC group developed this complication. The first of these was produced in the first anastomosis that was performed intracorporeally. Another was produced in a cirrhotic patient with renal failure and receiving peritoneal dialysis, in the context of a generalised intestinal ischaemia. The third patient did not have a purely anastomotic leak, but it was from a traction point between the ileum and the colon that was used for fixing and orientating the structure for suturing. Even so, we observed no differences with regard to the number and type of other postoperative complications. In 11.6% of cases the patient suffered from postoperative ileus, which is a comparable rate to those from other published studies, and no differences were found between our two study groups.

With regard to the mortality rate (2.8%), one death was recorded in each study group. In the case of the EC group, death was secondary to hospital-acquired pneumonia in a patient with advanced cirrhosis. The death in the IC group was the previously mentioned case of anastomotic dehiscence in a patient with cirrhosis, advanced chronic renal failure, intestinal ischaemia, and receiving peritoneal dialysis.

Conclusions

According to our experience, intracorporeal anastomosis for laparoscopic right hemicolectomy allows for a greater number of lymph nodes to be resected, as well as an earlier

start of oral tolerance and intestinal transit when compared with the extracorporeal technique. Although we did observe a greater rate of anastomotic dehiscence in the intracorporeal group, only one case was due to the surgical technique used, and no significant differences were observed in terms of other perioperative complications. For this reason, we believe that intestinal transit reconstruction using intracorporeal anastomosis for laparoscopic right hemicolectomy is a feasible and safe option, and provides new advantages to those already provided by laparoscopy compared to the traditional technique. In any case, further randomised studies must be carried out in order to confirm these results.

Conflict of interest

The authors affirm that they have no conflict of interest.

REFERENCES

1. Grams J, Tong W, Greenstein AJ, Salky B. Comparison of intracorporeal versus extracorporeal anastomosis in laparoscopic-assisted hemicolectomy. *Surg Endosc*. 2010;24:1886-91.
2. Kemp JA, Finlayson SR. Outcomes of laparoscopic and open colectomy: a national population-based comparison. *Surg Innov*. 2008;15:277-83.
3. Delaney CP, Chang E, Senagore AJ, Broder M. Clinical outcomes and resource utilization associated with laparoscopic and open colectomy using a large national database. *Ann Surg*. 2008;247:819-24.
4. Bilimoria KY, Bentrem DJ, Nelson H, Stryker SJ, Stewart AK, Soper NJ, et al. Use and outcomes of laparoscopic-assisted colectomy for cancer in the United States. *Arch Surg*. 2008;143:832-9.
5. Kennedy GD, Heise C, Rajamanickam V, Harms B, Foley EF. Laparoscopy decreases postoperative complication rates after abdominal colectomy: results from the national surgical quality improvement program. *Ann Surg*. 2009;249:596-601.
6. 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.
7. Nelson H, et al. The Clinical Outcomes of Surgical Therapy Study Group. A comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med*. 2004 May 13;350:2050-9.
8. Guillou PJ, Quirke P, Thorpe H, Walker J, Jayne DG, Smith AM, et al. Short-term endpoints of conventional versus laparoscopic-assisted surgery in patients with colorectal cancer (MRC CLASICC trial): multicentre, randomised controlled trial. *Lancet*. 2005;365:1718-26.
9. Tong DK, Fan JK, Law WL. Outcome of laparoscopic colorectal resection. *Surgeon*. 2008;6:357-60.
10. Buunen M, Veldkamp R, Hop WC, Kuhry E, Jeekel J, Haglind E, et al. Survival after laparoscopic surgery versus open surgery for colon cancer: long-term outcome of a randomised clinical trial. *Lancet Oncol*. 2009;10:44-52.
11. Bonjer HJ, Hop WC, Nelson H, Sargent DJ, Lacy AM, Castells A, et al. Laparoscopically assisted vs open colectomy for colon cancer: a meta-analysis. *Arch Surg*. 2007;142:298-303.

12. 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.
13. Leung KL, Kwok SP, Lam SC, Lee JF, Yiu RY, Ng SS, et al. Laparoscopic resection of rectosigmoid carcinoma: prospective randomised trial. *Lancet.* 2004;363:1187-92.
14. Reza MM, Blasco JA, Andradas E, Cantero R, Mayol J. Systematic review of laparoscopic versus open surgery for colorectal cancer. *Br J Surg.* 2006;93:921-8.
15. Kuhry E, Schwenk WF, Gaupset R, Romild U, Bonjer HJ. Long-term results of laparoscopic colorectal cancer resection. *Cochrane Database Syst Rev.* 2008;CD003432.
16. Fabozzi M, Allietta R, Contul RB, Grivon M, Millo P, Lale-Murix E, et al. Comparison of short- and medium-term results between laparoscopically assisted and totally laparoscopic right hemicolectomy: a case-control study. *Surg Endosc.* 2010;24:2085-91.
17. Jamali FR, Soweid AM, Dimassi H, Bailey C, Leroy J, Marescaux J. Evaluating the degree of difficulty of laparoscopic colorectal surgery. *Arch Surg.* 2008;143:762-7.
18. Bernstein MA, Dawson JW, Reissman P, Weiss EG, Nogueras JJ, Wexner SD. Is complete laparoscopic colectomy superior to laparoscopic assisted colectomy? *Am Surg.* 1996;62:507-11.
19. Hellan M, Anderson C, Pigazzi A. Extracorporeal versus intracorporeal anastomosis for laparoscopic right hemicolectomy. *JSLs.* 2009;13:312-7.
20. Franklin ME, Gonzalez JJ, Miter DB, Mansur JH, Trevino JM, Glass JL, et al. Laparoscopic right hemicolectomy for cancer: 11-year experience. *Rev Gastroenterol Mex.* 2004;69(Suppl 1):65-72.
21. Bergamaschi R, Schochet E, Haughn C, Burke M, Reed 3rd JF, Arnaud JP. Standardized laparoscopic intracorporeal right colectomy for cancer: short-term outcome in 111 unselected patients. *Dis Colon Rectum.* 2008;51:1350-5.
22. Senagore AJ, Delaney CP. A critical analysis of laparoscopic colectomy at a single institution: lessons learned after 1000 cases. *Am J Surg.* 2006;191:377-80.
23. Baixauli J, Delaney CP, Senagore AJ, Remzi FH, Fazio VW. Portal vein thrombosis after laparoscopic sigmoid colectomy for diverticulitis: report of a case. *Dis Colon Rectum.* 2003;46:550-3.
24. Casciola L, Ceccarelli G, Di Zitti L, Valeri R, Bellochi R, Bartoli A, et al. Laparoscopic right hemicolectomy with intracorporeal anastomosis. Technical aspects and personal experience. *Minerva Chir.* 2003;58:621-7.
25. Baca I, Perko Z, Bokan I, Mimica Z, Petricevic A, Druzijanic N, et al. Technique and survival after laparoscopically assisted right hemicolectomy. *Surg Endosc.* 2005;19:650-5.
26. Kaiser AM, Kang JC, Chan LS, Vukasin P, Beart RW. Laparoscopic-assisted vs. open colectomy for colon cancer: a prospective randomized trial. *J Laparoendosc Adv Surg Tech A.* 2004;14:329-34.
27. Winslow ER, Fleshman JW, Birnbaum EH, Brunt LM. Wound complications of laparoscopic vs open colectomy. *Surg Endosc.* 2002;16:1420-5.
28. Singh R, Omiccioli A, Hegge S, McKinley C. Does the extraction-site location in laparoscopic colorectal surgery have an impact on incisional hernia rates? *Surg Endosc.* 2008;22:2596-600.
29. Kisielinski K, Conze J, Murken AH, Lenzen NN, Klinge U, Schumpelick V. The Pfannenstiel or so called "bikini cut": still effective more than 100 years after first description. *Hernia.* 2004;8:177-81.
30. Li JC, Hon SS, Ng SS, Lee JF, Yiu RY, Leung KL. The learning curve for laparoscopic colectomy: experience of a surgical fellow in an university colorectal unit. *Surg Endosc.* 2009;23:1603-8.