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# Role of minimally invasive surgery in colon cancer: A review

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## Abstract

**Background:** Since laparoscopic surgery was first described for gallbladder disease, a widespread application on other surgical fields has been undeniable. Laparoscopic colectomy (LAC) for benign colorectal disease has slowly gain popularity because of the benefits of this procedure in comparison to the conventional colectomy. Nevertheless LAC for malignant disease is still under investigation. This technique should show the same benefits than open surgery with adherence to the same oncologic principles. Whether this is feasible or not is still an unanswered question.

**Objective:** To review the current literature of the practice of laparoscopic colectomy in patients with colon carcinoma.

**Methods:** Selection of the most relevant papers dealing with laparoscopic colectomy for colon cancer was performed on databases such as MEDLINE, PubMed.

**Results:** The current data shows that LAC in patients with colorectal cancer is a secure procedure with no more risks than conventional surgery in survival and recurrence rates, Although the controversy on the advantages of LAC remains, further studies will be design in the future to address this issue.

**Key words:** Laparoscopy, colon cancer, colectomy, recurrence, local.

## BACKGROUND

Colon cancer is the second most frequent malignancy in the United States and the second most common cause of cancer-related deaths in this country,<sup>1,2</sup> in Mexico the na-

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### Abbreviations:

IBD: Inflammatory Bowel Disease

LAC: Laparoscopic colectomy

PSM: Port-site metastasis

SWR: Surgical wound recurrence

## Resumen

**Antecedentes:** Desde que la cirugía laparoscópica fue descrita para el tratamiento de patología vesicular, ha sido innegable la gran variedad de aplicaciones de ésta en los diversos campos quirúrgicos. La colectomía laparoscópica (LAC) en enfermedades colorrectales benignas ha ganado lentamente popularidad debido a los beneficios de este procedimiento en comparación con el abordaje convencional. Sin embargo, su uso en cáncer de colon está aún bajo investigación, ya que esta técnica debería mostrar los mismos beneficios que la cirugía abierta en apego a los mismos principios oncológicos. Aún no se sabe si esto es posible o no.

**Objetivo:** Revisar la literatura actual sobre la práctica de colectomía laparoscópica en pacientes con cáncer de colon.

**Métodos:** Se realizó una búsqueda en las bases de datos MEDLINE y PubMed seleccionando la literatura más relevante acerca de colectomía laparoscópica por cáncer de colon.

**Resultados:** La información actual muestra que la LAC en pacientes con cáncer colorrectal es un procedimiento seguro que no confiere mayores riesgos en términos de sobrevida y recurrencia que los de la cirugía convencional. Aunque la controversia sobre las ventajas de la LAC continúa, otros estudios se diseñarán en el futuro para aclarar este punto.

**Palabras clave:** Laparoscopia, cáncer de colon, recurrencia, local.

tional histopathologic neoplastic registry (RHNN) reported that colon cancer represented 1.8% of all the cancer mortality in the country, and this figure surely underestimates the real number of cases.<sup>3</sup>

Since the advent of laparoscopic surgery, its influence on the surgical field has been highly important. The most clear example is, without any doubt, cholecystectomy. Since Mouret performed the first laparoscopic cholecystectomy in 1987,<sup>4</sup> this procedure has emerged as a standard of care and the benefits over open surgery like less hospital stay, and minimum postoperative pain consequence of less surgical trauma are reported in several studies.<sup>5,6</sup> This has prompted the application of laparoscopic techniques in other procedures like splenectomy and fundoplication.<sup>7,8</sup> Laparoscopic colectomy (LAC) was first reported by Jacobs et al in 1991<sup>9</sup> and since, the procedure has been widely used foremost in benign conditions such as inflammatory bowel disease (IBD)

and diverticular disease<sup>10-14</sup> because of its aesthetic and functional advantages resuming normal activities quickly<sup>15-19</sup> (*Figure 1*). To perform LAC not only requires formal training with experienced surgeons but advanced laparoscopic skills<sup>20</sup> and the steep learning curve can be as high as 70 procedures.<sup>21,22</sup> One of the reasons that LAC had initially a modest acceptance was because of expensive instrumentation and protracted operating times.<sup>23-25</sup> However, once passed the learning curve, the operating time can be reduced up to 50%<sup>26</sup> making LAC a feasible, secure, and cost-effective procedure.<sup>12,27-29</sup> The main debated issue in this area is whether LAC is safe in patients with colon cancer in terms of recurrence rate and long-term survival. When reviewing the data in this area several questions arise: Is LAC the most adequate procedure for patients with curable disease in colon cancer?, Does port-site metastasis (PSM) prohibits the minimally invasive approach?, Is recurrence rate affected by LAC in comparison to the open procedure? Other disadvantages are described like the lack of tactile feedback needed for accurate tumor localization, so an adequate tumor margin can be achieved. The ability of LAC to adhere to several oncologic principles such as adequate lymph node harvesting, length of specimen retrieved, good radial margin are put in doubt because of few large prospective randomized studies. We present a review of the current evidence concerning the application of minimally invasive techniques in patients with colon cancer, outlining certain points of controversy in this issue.

## INDICATIONS AND CONTRAINDICATIONS

Even though the indications in benign disease include IBD, diverticular disease, sigmoid volvulus, rectal prolapse and



**Figure 1.** Postoperative view of a LAR in a patient who had colon cancer. The arrow points out the umbilical scar.

benign polyps the selection criteria in patients with cancer are not well established.<sup>29,30</sup>

There are studies that support the use of laparoscopic surgery in patients with advanced stage colon cancer for palliative procedures such as stoma formation.<sup>7,31</sup> But the controversial indication is in those patients in the early stage.<sup>7</sup>

15 to 20% of the patients with colon cancer will present bowel obstruction.<sup>32,33</sup> In the setting of obstruction, perforation, or any other emergency situation the laparoscopic procedure is not recommended. Also the invasion to adjacent organs and the presence of adhesions that don't allow an adequate colon mobilization is a contraindication.<sup>34</sup>

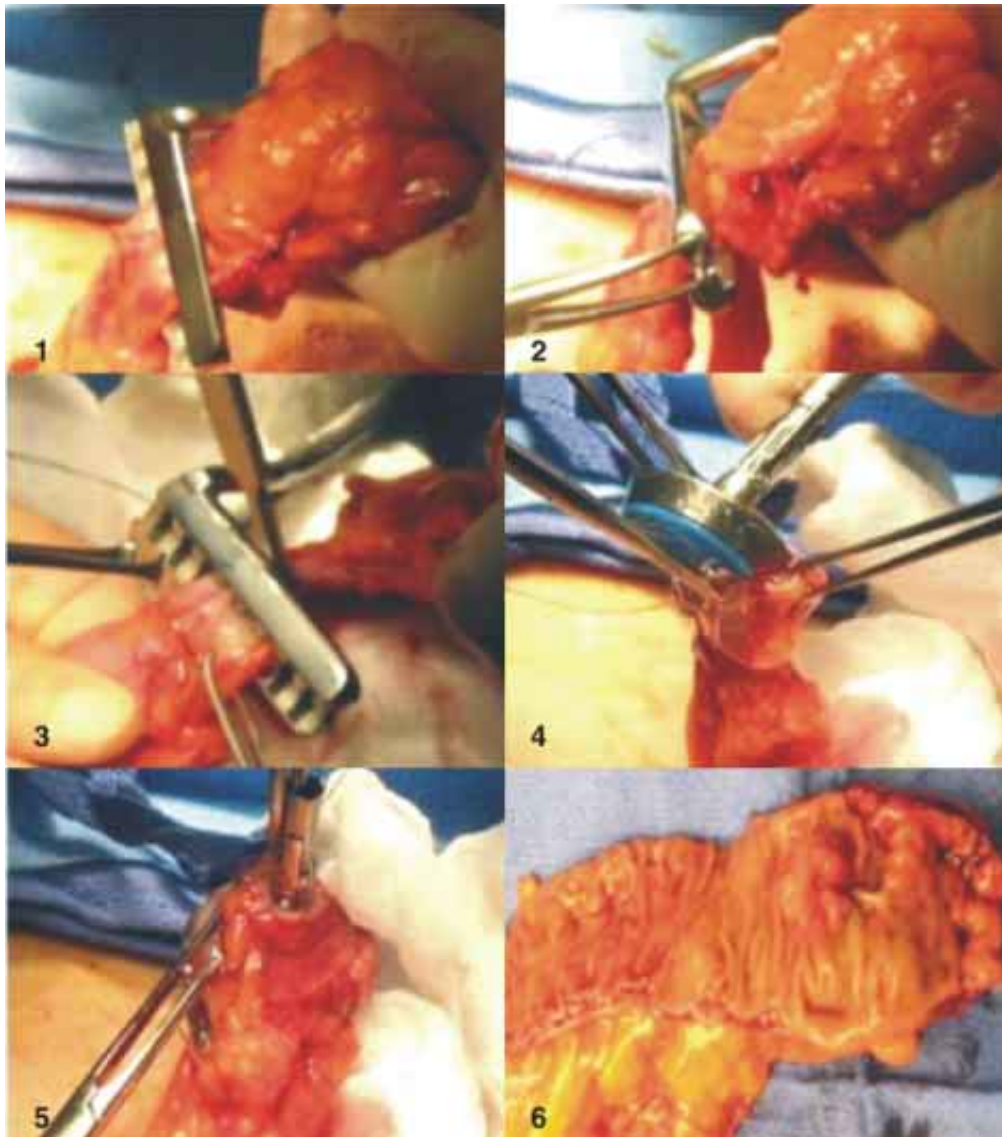
The reported mortality of the open procedure in colon cancer for patients above 70 years old is 4%.<sup>35</sup> This has prompted the performance of comparative studies between these techniques for older patients, and the results show less mortality in the laparoscopic group<sup>36-38</sup> and a similar morbidity between patients younger than 60 and older than 80 when submitted to LAC for colorectal cancer. It is the presence of co morbidity more than age itself what leads to higher mortality, thus age is not a contraindication.

## PREOPERATIVE MANAGEMENT

The preoperative protocol of LAC does not differ that of the open procedure. It is important to perform mechanical bowel preparation and antibiotic prophylaxis with a cephalosporin like cefuroxime given intravenously at the time of the induction. Localization of the tumor by contrast-imaging studies (i.e. CT, barium enema) and a preoperative colonoscopy is mandatory for delimitation of the segment to be resected.<sup>29</sup> Recently a prospective randomized trial compared conventional polyethylene glycol preparation and no preparation, the second group only received one Fleets enema on the day of the surgery and both preoperative oral antibiotics and perioperative intravenous antibiotics, with no differences in infectious complications between the two groups.<sup>39,40</sup>

## TECHNICAL CONSIDERATIONS

The technique for LAC either the totally laparoscopic (where the restoration of continuity is performed in an intracorporeal fashion) or the laparoscopically assisted (where the anastomosis is performed extracorporeally) has four basic steps: 1) localization of the lesion 2) mobilization of the colon 3) devascularization if the specimen, and 4) specimen retrieval with protection of the wound, and are described in detail elsewhere<sup>41,42</sup> (*Figure 2*). It is important to adhere to the same oncologic principles of conventional surgery, avoid tumor handling and spillage<sup>43</sup> by grasping the bowel by the mesocolon, obtaining adequate resection margin and lymph node



**Figure 2.** Sequence of events in the extracorporeal time of a laparoscopic colon resection (view text) 1, 2. Use of an automatic purse-string device. 3. Incision of the colon to retrieve the specimen. 4. Insertion of the circular stapler's shaft at the proximal end. 5. Closure of the purse-string suture. 6. Specimen with adequate margins.

harvesting by high division of the colonic vascular supply, perform intraoperative assessment of the stage evaluating liver surface, omentum and bowel and adequate exposure an visualization of iliac vessels and ureter to avoid injury. When the anastomosis is performed extracorporeally the extraction site should be long enough so the retrieval of the specimen is done without any tension to the remaining bowel, and the incision protected by a disposable plastic barrier to avoid seeding of viable tumor cells in the surgical wound<sup>42,44,45</sup> (Figures 3 and 4).

The effect of pneumoperitoneum on bowel microperfusion and oxygenation of the colonic mucosa its not well established.<sup>46</sup> But studies in animal models show that high-pres-

sure pneumoperitoneum impairs splanchnic perfusion, the clinical impact of this phenomenon is unknown,<sup>28,47</sup> and the presence of anastomotic leaks relate more with a deficient surgical technique than with the laparoscopic approach.

Preoperative localization of the tumor in LAC is critical and colonoscopy can mark the site of the lesion by way of an endoscopic tattoo, with India ink or indocyanine green, water-soluble dyes are not adequate since they are completely diffused away by 24 h. In some cases the tattoo can not be identified not only because of the localization of the tumor (sometimes the tattoo is oriented towards the retroperitoneum or covered by pericolonc fat) but because of the small amount of ink used and superficial injection.<sup>48,49</sup> There are

several reports of laparoscopic resection of the wrong segment of the colon.<sup>50,51</sup> The paper of Vignati et al reports that 86% of the colonoscopies describe accurately the localization of the tumor.<sup>52</sup> When a transoperatory colonoscopy is done the localization can be marked with an endloop on the serosal surface of the colon.

The conversion rate in LAC for cancer varies from 7 to 28%<sup>18,53-56</sup> this is because of the experience of the surgeon and some studies do not establish the concept of conversion. A conversion should be acknowledged when the extraction site is lengthen to complete mobilization, devascularization or resection or if a separate incision is required to complete the procedure.

The main predictive factors for conversion are the size of the tumor, patient's weight (> 90 kg), and the surgeon's experience (> 50 LAC's), that's why surgery in patients with body mass index (BMI) above > 35 kg/m<sup>2</sup> is not recommended.<sup>34</sup> In the recent large prospective randomized study



**Figure 3.** Plastic barrier surrounding the trocar to protect the extraction site.



**Figure 4.** Right hemicolectomy for colon cancer. A. Note the extraction of the specimen with a segment of the gastrocolic omentum. B. View of the extraction site.

COST the conversion rate was 21% being the most frequent cause advanced disease, since all the surgeons in the study passed rigorous protocol standards, the decrease in conversion rates is therefore a result from a refined process of patient selection rather than from altering oncologic indications from conversions, once the surgeon has passed the learning curve.<sup>57</sup>

## RADICALITY IN LAPAROSCOPY

To review the radicality principles in laparoscopy is indeed controversial since oncologic surgery principles bet on an early aggressive treatment when there's a possibility of cure. This situation is not opposite to laparoscopic surgery, that is, to perform a minimally invasive surgery does not mean a minimally resective surgery. The surgeon must acknowledge that the same principles of conventional surgery prevail. It has been demonstrated that the number of lymph nodes harvested in LAC are the same than in the open procedure, moreover there is no difference in the size of the resected specimen.<sup>26,53,57-60</sup>

The trend of radical resections in oncologic surgery is to include the most amount possible of tumor and surrounding lymphatic tissue, avoiding tumor manipulation. A study by Pezim<sup>61</sup> and Surtees<sup>62</sup> show that the "high ligation" of the inferior mesenteric artery (therefore a wider resection of lymphatic tissue) does not carry any survival advantage over the ligation at the take-off of the left colic artery. However it is a valid conduct that allows to stage the disease accurately and to determine prognosis.<sup>63</sup>

In this sense the goals should be the same for both techniques to be able to perform an adequate comparison.

## COMPLICATIONS

Laparoscopic complications have been classified by Clavien et al<sup>64</sup> divided in four grades (*Table 1*). This classification was used in the prospective randomized multicenter COST

**Table 1.** Classification for laparoscopic complications.

Grade 1	Non-life threatening and temporary
Grade 2	Potentially life-threatening but temporary
Grade 3	Causing permanent disability
Grade 4	Fatal

study (Clinical Outcomes of Surgical Therapy Study group)<sup>57</sup> showing a 20% of complications in the open group and 21% in the laparoscopic group, more than half of the complications were grade 1. Similar results have been reported by other authors.<sup>7,28,53,65</sup>

The effects of laparoscopic surgery on the immune system are still debatable, it seems that a reduced access-related trauma as seen by a decrease in the immune response is observed in laparoscopic approach, but there's controversial data in this issue.<sup>54,66</sup>

Other complications such as postoperative ileus, surgical wound infection, pulmonary complications and urinary tract infection are less frequent in LAC patients.<sup>26,34,67,68</sup> The incidence of anastomotic leaks is similar in both groups.<sup>28</sup> In conventional colectomy the incidence of ureteral injury is 0.7% to 5.7%<sup>69</sup> and 0.2% to 1% in LAC.<sup>70</sup> Port-site herniation can be avoided by suturing the fascia of the 10 mm port sites.

**PORT SITE METASTASIS (PSM)**

Since the first report of PSM by Dobronte et al in 1978,<sup>71</sup> the most alarming study, that created great concern was the one of Berends et al<sup>72</sup> where he reports 3 PSM in 14 patients studied with a PSM rate of 21%. This data provided a compelling rationale for a controlled evaluation, since the PSM rates of LAC for colon cancer in early studies were practically prohibitive.

The first report of PSM in colon cancer was in 1993,<sup>73</sup> after which there was growing concern for this phenomenon, putting in doubt the profits of LAC in colon cancer.<sup>74,75</sup>

There are several postulated theories on the pathogenesis of PSM<sup>4</sup> (Table 2), and are based on the fact that they have occurred in different clinical scenarios, even in early stages of colorectal cancer,<sup>76,77</sup> or in lateral assistant trocar positions far from the site of tumor extraction, even in cases when no direct tumor handling occurs.<sup>78-80</sup>

Ziprin et al made a review of 27 studies with at least 50 cases of LAC each and found a 0.71% PSM rate. Currently prospective studies performed by experienced laparoscopic surgeons shows that the rate of recurrence in the surgical wound (SWR) is practically the same as the open procedure.<sup>4,76,81</sup> The COST study reported a 0.5% in LAC and 0.2% in open surgery.<sup>57</sup> Although the SWR rate of less of 1% in the conventional procedure<sup>4,82</sup> is probably underestimated as

**Table 2.** Potential mechanisms for the development of port-site metastases.

Hematogenous spread
Direct wound implantation
Extraction of specimen
Instrument contamination
“Chimney effect”
Aerosolization of tumor cells
Surgical technique
Excessive tumor manipulation
Surgical experience
Effect of the pneumoperitoneum
Pressure
Effect of CO <sub>2</sub>
Impairment of the host local immune response

the *post mortem* studies shows a slight increased rate of SWR,<sup>83</sup> the most recent review on this issue by Curet concludes that the incidence of PSM in LAC is close to the open procedure but its exact rate remains unknown.<sup>75</sup> The truth is that the concern has decreased importantly and special attention should be placed in technical aspects of LAC since this is the most important factor for PSM. The measures taken to decrease the PSM rate are controversial and merely experimental (Table 3) their effectiveness should be proven in a prospective randomized setting.

**RESULTS OF COMPARATIVE CLINICAL STUDIES FOR LAC AND OPEN SURGERY IN COLORECTAL CANCER**

The main critic towards LAC in colon cancer is its indication in patients with potentially curable disease, because security in terms of long-term survival rate and recurrence rate has not been proved.<sup>84</sup> It is estimated that to show a 10% difference in five-year survival, the sample size in each study arm of a trial would need to be 600 (80% power, 5% significance).<sup>85</sup> Several studies have tried to answer this issue but don't have enough statistical power because of the design (non-randomized, selection bias) or the number of patients.<sup>26,28,34,53,86,87</sup> Because of this, prospective multicenter randomized trials were design to answer this questions,<sup>88</sup> like the COST study promoted by the National Cancer Institute in the US.<sup>57</sup>

In the COST study 872 patients with colorectal cancer underwent randomization assigning 437 to the open colectomy group and 435 to the LAC group. This study shows that there is no difference in time to recurrence, overall survival rate and disease-free survival rate between the two groups, and concludes that LAC provides no additional risk of cancer, being an acceptable and safe alternative to open surgery.<sup>57</sup>

**Table 3.** Suggested techniques for prevention of port site metastases.**Before resection**

Minimize tissue trauma by proper placement of trocars (perpendicularly to peritoneum)  
 Perform trocar fixation  
 Prevent carbon dioxide leakage around trocars  
 Minimize handling of tumor  
 Carry out colonoscopy and intraluminal irrigation with Betadine  
 Clean instruments with Betadine after each use  
**Resection**  
 Do not cut through or handle the tumor  
 Perform high-vascular ligature  
 Control colon lumen, especially of resected specimen

**After resection**

Irrigate trocars with 5% Betadine before removal  
 Bag the specimen  
 Protect extraction site  
 Drain the peritoneal cavity before deflating, thus preventing the "slosh" phenomenon  
 Perform trocar site closure  
 Deflate the abdomen with the trocars in place  
 Avoid liquid spillage when closing the trocar sites  
 Use closed suction drain  
 Irrigate trocar and extraction sites with Betadine and water  
**Other factors**  
 Adequate training  
 Adequate technique  
 Proper patient selection  
 Surgical Team training  
 Adequate laparoscopic equipment for colon resection

Another prospective randomized study was conducted in Europe, the COLOR trial (Colon carcinoma Laparoscopic or Open resection Trial) was started in 1997 participating 27 hospitals of Sweden, Germany, the Netherlands, France, Italy, Spain and the UK, the data of this study is still to be reported.<sup>89</sup> Other studies have reported not only advantages in a decreased hospital stay and morbidity but a longer disease-free survival rate.<sup>90</sup> Initial results small of randomized con-

trolled studies are strengthened by the results of the COST trial.<sup>16,17,54,55,91-93</sup>

The current data shows that LAC in patients with colorectal cancer is a secure procedure with no more risks than conventional surgery in survival and recurrence rates, nevertheless the controversy on the advantages of LAC remains, since the modest benefits in several reports<sup>94</sup> (some show no benefits at all),<sup>92</sup> makes obligatory to design future studies that asses this benefits, because of the controversial data.<sup>91,93,95</sup>

**CONCLUSIONS**

Some authors suggest that LAC in colon cancer should not be performed outside a prospective randomized study.<sup>96,97</sup> Those surgeons with laparoscopic once passed the learning curve to develop enough advanced laparoscopic skills to adhere to the oncologic principles of conventional surgery are the ideal candidates to perform this procedure. If LAC should be offered to colon cancer patients in a general basis is still an training unanswered question. Future studies will give more insight.

We have come a long way since the Swedish surgeon Hans Christian Jacobaeus in 1900 performed a laparoscopy on humans using a rudimentary monocular instrument, the advent of new instruments like the fiberoptic materials, and the high resolution monitors with digitalization of images, allows a wider application of this resource in different medical fields. 13 years ago was impossible to talk about laparoscopic cholecystectomy as an alternative procedure, nowadays is the gold standard for surgical treatment of gallbladder disease.

More changes are to come in minimally invasive surgery and a greater challenge will follow. New applications will stop being experimental to become the standard of care. The german philosopher Arthur Schopenhauer once said: Change alone is eternal, perpetual, immortal. This is certainly the case of laparoscopic surgery in oncologic disease, there will be changes in the future since the ever-evolving nature of medicine carries out new studies.

**REFERENCES**

- Franklin ME, Kazantsev GB, Abrego D, Diaz-E JA, Balli J, Glass JL. Laparoscopic surgery for stage III colon cancer. Long term follow up. *Surg Endosc* 2000; 14: 612-616.
- Loren DE, Lewis J, Kochman ML. Colon cancer: Detection and prevention. *Gastroenterol Clin North Am* 2002; 31: 565-586.
- Garcia GJG, Cuéllar HM. En: *Cáncer de colon. Manual de oncología quirúrgica*. Instituto Nacional de Cancerología. Ed McGraw-Hill. México 2000: 275.
- Ziprin P, Ridgway PF, Peck DH, Darzi AW. The theories and realities of port-site metastases: A critical appraisal. Collective review. *J Am Coll Surg* 2002; 195: 395-408.
- Hendolin HI, Paakonen ME, Alhava EM, Tarvainen R, Kemppinen T, Lahtinen P. Laparoscopic or open cholecystectomy: A prospective randomized trial to compare postoperative pain, pulmonary function, and stress response. *Eur J Surg* 2000; 166: 394-399.
- Sanabria JR, Clavien PA, Cywes R, Strasberg SM. Laparoscopy versus open cholecystectomy: a matched study. *Can J Surg* 1993; 36: 330-336.
- Hartley JE, Monson JRT. The role of laparoscopy in the multimodality treatment of colorectal cancer. *Surg Clin of North Am* 2002; 82: 1019-33.

8. Walsh RM, Henriford BT, Brody F, Ponsky J. The ascendance of laparoscopic splenectomy. *Am Surg* 2001; 67: 48-53.
9. Jacobs M, Verdeja JC, Goldstein HS. Minimally invasive colon resection (laparoscopic colectomy). *Surg Laparosc Endosc* 1991; 1: 114-50.
10. Wu JS, Birnbaum EH, Kodner IJ, Fry RD, Fleshman JW. Laparoscopic-assisted ileocolic resections in patients with Crohn's disease: Are abscess, phlegmons, or recurrent disease contraindications? *Surgery* 1997; 122: 682-9.
11. Reissman P, Salky BA, Edye M, Wexner SD. Laparoscopic surgery in Crohn's disease: Indications and results. *Surg Endosc* 1996; 10: 1201-3.
12. Guller U, Jain N, Hervey S, Purves H, Pietrobon R. Laparoscopic vs open colectomy. Outcomes comparison based on large nationwide databases. *Arch Surg* 2003; 138: 1179-1186.
13. Franklin ME Jr, Dorman JP, Jacobs M, Plasencia G. Is laparoscopic surgery applicable to complicated colonic diverticular disease? *Surg Endosc* 1997; 11: 1021-1025.
14. Smadja C, Sbai Idrissi M, Tahrat M, Vons C, Bobocescu E, Baillet P, Franco D. Elective laparoscopy sigmoid colectomy for diverticulitis: Results of a prospective study. *Surg Endosc* 1999; 13: 645-648.
15. Schwenck W, Bohm B, Muller JM. Postoperative pain and fatigue after laparoscopic or conventional colorectal resection for colorectal cancer. *Surg Endosc* 1998; 12: 1131-1136.
16. Leung KL, Lai PBS, Ho RLK et al Systemic cytokine response after laparoscopic-assisted resection of rectosigmoid carcinoma: a prospective randomized trial. *Ann Surg* 2000; 231: 506-511.
17. Psaila J, Bulley SH, Ewings P, Sheffield JP, Kennedy RH. Outcome following laparoscopic resection for colorectal cancer. *Br J Surg* 1998; 85: 662-664.
18. Lacy AM, Garcia-Valdecasas JC, Pique JM, Delgado S, Campo E, Bordas JM, Taura P, Grande L, Fuster J, Pacheco JL et al. Short term outcome analysis of a randomized study comparing laparoscopic versus open colectomy for colon cancer. *Surg Endosc* 1995; 9: 1101-5.
19. 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.
20. Geis WP, Coletta AV, Verdeja JC, Plasencia G, Ojogho O, Jacobs M. Sequential psychomotor skills development in laparoscopic colon surgery. *Arch Surg* 1994; 129: 206-12.
21. Bennett CL, Stryker SJ, Ferreira MR, Adams J, Beart RW Jr. The learning curve for laparoscopic colorectal surgery. Preliminary results from a prospective analysis of 1,194 of laparoscopic-assisted colectomies. *Arch Surg* 1997; 132: 41-4.
22. Simons AJ, Anthonie GJ, Ortega AE, Franklin M, Fleshman J, Geis WP, Beart RW Jr. Laparoscopic-assisted colectomy learning curve. *Dis Colon Rectum* 1995; 38: 600-603.
23. Hoffman GC, Baker JW, Fitchett CW, Vansant JH. Laparoscopic-assisted colectomy: Initial experience. *Ann Surg* 1994; 219: 732-40.
24. Philipson BM, Bokey EL, Moore JW, Chapuis PH, Bagge E. Cost of open versus laparoscopically-assisted right hemicolectomy for cancer. *World J Surg* 1997; 21: 214-217.
25. Ramos JM, Beart RW Jr, Goes R, Ortega AE, Schlinkert RT. Role of laparoscopy in colorectal surgery: A prospective evaluation of 200 cases. *Dis Colon Rectum* 1995; 38: 494-501.
26. Franklin ME, Rosenthal D, Abrego-Medina D, Dorman JP, Glass JL, Norem R, Diaz A. Prospective comparison of open vs laparoscopic colon surgery for carcinoma: five year results. *Dis Colon Rectum* 1996; 39: Suppl. S35-S46.
27. Huscher C, Silecchia G, Croce E, Farello GA, Lezoche E, Morino M, Azzola M, Feliciotti F, Rosato P, Tarantini M, Basso N. Laparoscopic colorectal resection: A multicenter italian study. *Surg Endosc* 1996; 10: 875-879.
28. Braga M, Vignali A, Gianotti L, Zuliani W, Radaelli G, Gruarin P, Dellabona P, Di Carlo V. laparoscopic versus open colorectal surgery a randomized trial on Short term outcome *Ann Surg* 2002; 236: 759-766. discussion 767.
29. Metcalf AM. Laparoscopic colectomy. *Surg Clin North Am* 2000; 80: 1321-6.
30. Pandya S, Murray JJ, Coller JA, Rusin LC. Laparoscopic colectomy. Indications for conversions to laparotomy. *Arch Surg* 1999; 134: 471-475.
31. Koea JB, Guillem JG, Conlon KC, Minsky B, Saltz L, Cohen A. The role of laparoscopy in the initial multimodality management of patients with near-obstructing rectal cancer. *J Gastrointest Surg* 2000; 4: 105-108.
32. Phillips RK, Hittinger R, Fry JS, Fielding LP. Malignant large bowel obstruction. *Br J Surg* 1985; 72: 296-302.
33. Serpell JW, McDermontt FT, Katrivessis H et al. Obstructing carcinomas of the colon. *Br J Surg* 1989; 76: 965-969.
34. Champault GG, Barrat C, Raselli R, Elizalde A, Catheline JM. Laparoscopic versus open surgery for colorectal carcinoma. A prospective trial involving 157 cases with a mean follow-up of 5 years. *Surg Laparosc Endosc Percutan Tech* 2002; 12: 88-95.
35. Greenburg AG, Salk RP, Pridham D. Influence of age on mortality of colon surgery. *Am J Surg* 1985; 150: 65-70.
36. Delgado S, Lacy AM, Garcia Valdecasas JC, Balague C, Pera M, Salvador L, Momblan D, Visa J. Could age be an indication for laparoscopic colectomy in colorectal cancer? *Surg Endosc* 2000; 14: 22-26.
37. Senagore AJ, Madbouly KM, Fazio VW, Duepre HJ, Brady KM, Delaney CP. Advantages of laparoscopic colectomy in older patients. *Arch Surg* 2003; 138: 252-256.
38. Yamamoto S, Watanabe M, Hasegawa H, Baba H, Kitajima M. Short-Term surgical outcomes of laparoscopic colonic surgery in octogenarians. *Surg Laparosc Endosc Percutan Tech* 2003; 13: 95-100.
39. Wexner SD, Sands DR. What's new in colon and rectal surgery? *J Am Coll Surg* 2003; 196: 95-103.
40. Zmora O, Mahijna B, Bar-Zakai D et al. Left sided anastomosis without mechanical bowel prep, a randomized prospective trial. *Dis Colon Rectum* 2002; 45: A7-8.
41. Milsom JW, Bohm B. *Laparoscopic colorectal surgery*. New York, NY: Springer Verlag NY Inc: 1996.
42. Ing R, Jacobs M, Plasencia G. Laparoscopic colectomy for colon cancer. In: Zucker KA, ed. *Surgical laparoscopy*. 2nd ed Baltimore: Lippincott Williams & Wilkins, 1996.
43. Jacobi CA, Bonjer HJ, Puttick MI, O'Sullivan R, Lee SW, Schwalbach P, Tomita H et al. Oncologic implications of



- laparoscopic and open surgery. *Surg Endosc* 2002; 16: 441-445.
44. Lujan HJ, Plasencia G, Jacobs M, Viamonte M 3rd, Hartmann RF. Long-term survival after laparoscopic colon resection for cancer: Complete five-year follow-up. *Dis Colon Rectum* 2002; 45: 491-501.
  45. Lezoche E, Feliciotti F, Paganini AM, Guerrieri M, De Sanctis A, Minervini S, Campagnacci R. Laparoscopic vs open hemicolectomy for colon cancer. Long term outcome. *Surg Endosc* 2002; 16: 596-602.
  46. Schafer M, Krabenbuhl L. Effect of laparoscopy on intra-abdominal blood-flow. *Surgery* 2001; 129: 385-389.
  47. Schilling MK, Redaelli C, Krahenbuhl L, Signer C, Buchler MW. Splanchnic microcirculation changes during CO<sub>2</sub> laparoscopy. *J Am Coll Surg* 1997; 184: 378-382.
  48. Botoman VA, Pietro M, Thirlby RC. Localization of colonic lesions with endoscopic tattoo. *Dis Colon Rectum* 1994; 37: 775-776.
  49. Kim SH, Milsom JW, Church JM, Ludwig KA, Garcia-Ruiz A, Okuda J, Fazio VW. Perioperative tumor localization for laparoscopic colorectal surgery. *Surg Endosc* 1997; 11: 1013-1016.
  50. Larach SW, Salomon MC, Williamson PR, Goldstein E. Laparoscopic assisted colectomy: Experience during the learning curve. *Coloproctology* 1993; 1: 38-41.
  51. Wexner SD, Cohen SM, Ulrich A. Reissman P. Laparoscopic colorectal surgery-are we being honest with our patients? *Dis Colon Rectum* 1995; 38: 723-727.
  52. Vignati P, Welch JP, Cohen JL. Endoscopic localization for colon cancers. *Surg Endosc* 1994; 8: 1085-1087.
  53. Curet MJ, Putrakul K, Pitcher DE, Josloff RK, Zucker KA. Laparoscopically assisted colon resection for colon carcinoma. Perioperative results an long-term outcome. *Surg Endosc* 2000; 14: 1062-1066.
  54. Hewitt PM, Ip SM, Kwok SP, Somers SS, Li K, Leung KL, Lau WY, Li AK. Laparoscopic-assisted vs open surgery for colorectal cancer: comparative study of immune effects. *Dis Colon Rectum* 1998; 41: 901-9.
  55. Stage JG, Schulze S, Moller P, Overgaard H, Andersen M, Rebsdorf-Pedersen VB, Nielsen HJ. Prospective randomized study of laparoscopic versus open resection for adenocarcinoma. *Br J Surg* 1997; 84: 391-6.
  56. Tekkis PP, Senagore AJ, Delaney CP. Conversion rates in laparoscopic colorectal surgery: A predictive model with 1,253 patients. *Surg Endosc* 2004; Epub ahead of print.
  57. The Clinical Outcomes of Surgical Therapy Study Group. A Comparison of laparoscopically assisted and open colectomy for colon cancer. *N Engl J Med* 2004; 350: 2050-2059.
  58. Gray D, Lee H, Schlinkert R, Beart RW. Adequacy of lymphadenectomy in laparoscopic-assisted colectomy for colorectal cancer: a preliminary report. *J Surg Oncol* 1994; 57: 8-10.
  59. Khalili TM, Fleshner PR, Hiatt JR, Sokol TP, Manookian C, Tsushima G, Phillips EH. Colorectal cancer: comparison of laparoscopic with open approaches. *Dis Colon Rectum* 1998; 41: 832-838.
  60. Moore JWE, Bokey EL, Newland RC, Chapuis PH. Lymphovascular clearance in laparoscopically assisted right hemicolectomy is similar to open surgery. *Aust N Z J Surg* 1996; 66: 605-607.
  61. Pezim ME, Nicholls RJ. Survival after high or low ligation of the inferior mesenteric artery during curative resection for rectal cancer. *Ann Surg* 1984; 200: 729-33.
  62. Surtees P, Ritchie JK, Phillips RKS. High versus low ligation of the inferior mesenteric artery in rectal-cancer. *Br J Surg* 1990; 77: 618-21.
  63. Bruch HB, Schwandner O, Schiedeck THK, Roblick C. Actual standards and controversies on operative technique and lymph node dissection in colorectal cancer. *Langenbeck's Arch Surg* 1999; 384: 167-175.
  64. Clavien PA, Sanabria JR, Strasberg SM. Proposed classification of complications of surgery with examples of utility in cholecystectomy. *Surgery* 1992; 111: 518-526.
  65. Wexner SD, Reissman P, Pfeifer J, Bernstein M, Geron N. Laparoscopic colorectal surgery. Analysis of 140 cases. *Surg Endosc* 1996; 10: 133-136.
  66. Gupta A, Watson DI. Effect of laparoscopy on immune function. *Br J Surg* 2001; 88: 1296-1306.
  67. Senagore AJ, Luchtefeld MA, Mackelgan JM, Mazier PW. Open colectomy versus laparoscopic colectomy: are there differences? *Am Surg* 1993; 59: 549-553.
  68. Schwenk W, Bohm B, Witt C, Junghans T, Grundel K, Muller J. Pulmonary function following laparoscopic or conventional colorectal resection. A randomized controlled evaluation. *Arch Surg* 1999; 134: 6-12.
  69. Anderson A, Bergdahl L. Urologic complications following abdominoperineal resection of the rectum. *Arch Surg* 1976; 111: 969-971.
  70. Holzman MD, Eubanks. Laparoscopic colectomy. Prospects and problems. *Gastrointest Endosc Clin N Am* 1997; 7: 525-539.
  71. Dobronte Z, Wittmann T, Karacsony G. Rapid development of malignant metastases in the abdominal wall after laparoscopy. *Endoscopy* 1978; 10: 127-30.
  72. Berends FJ, Kazemier G, Bonjer HJ, Lange JF. Subcutaneous metastases after laparoscopic colectomy. *Lancet* 1994; 344: 58.
  73. Alexander RF, Jaques BC, Mitchell KG. Laparoscopically assisted colectomy and wound recurrence. *Lancet* 1993; 341: 249-50.
  74. Wexner SD, Cohen SM. Port metastases after laparoscopic colorectal surgery for cure of malignancy. *Br J Surg* 1995; 82: 295-8.
  75. Curet MJ. Port site metastasis. *Am J Surg* 2004; 187: 705-12.
  76. Prasad A, Avery C, Foley RJ. Abdominal wall metastases following laparoscopy. *Br J Surg* 1994; 81: 1697.
  77. Champault G, Lauroy J, Rizk N, Boutelier P. Neoplastic colonization of trocar paths. Should laparoscopic surgery be stopped for digestive cancers? *Presse Med* 1994; 23: 1313.
  78. Nieveen van Dijkum EJ, de Wit LT, Obertop H, Gouma DJ. Port-site metastases following diagnostic laparoscopy. *Br J Surg* 1996; 83: 1793-4.
  79. Neuhaus S, Hewett P, Disney A. An unusual case of port site seeding. *Surg Endosc* 2001; 7: 7.
  80. Zmora O, Gervaz P, Wexner SD. Trocar site recurrence in laparoscopic surgery for colorectal cancer myth or real concern? *Surg Endosc* 2001; 15: 788-93.

81. Lacy AM, Delgado S, Garcia-Valdecasas JC, Castells A, Pique JM, Grande L, Fuster J, Targarona EM, Pera M, Visa J. Port site metastases and recurrence after laparoscopic colectomy a randomized trial. *Surg Endosc* 1998; 12: 1039-42.
82. Hughes ES, McDermott FT, Polglase AL, Johnson WR. Tumor recurrence in the abdominal wall scar tissue after large-bowel cancer surgery. *Dis Colon Rectum* 1983; 26: 571-2.
83. Welch JP, Donaldson GA. The clinical correlation of an autopsy study of recurrent colorectal cancer. *Ann Surg* 1979; 189: 496-502.
84. Chapman AE, Levitt MD, Hewett P, Woods R, Sheiner H, Maddern GJ. Laparoscopic assisted resection of colorectal malignancies: a systematic review. *Ann Surg* 2001; 234: 590-606.
85. McCall JL, Parry BR. Prospective randomized study of laparoscopic vs open colonic resection for adenocarcinoma (Letter). *Br J Surg* 1997; 84: 1174.
86. Patankar SK, Larach SW, Ferrara A, Williamson PR, Gallagher JT, De Jesus S, Narayanan S. Prospective comparison of laparoscopic vs open resections for colorectal adenocarcinoma over a ten-year period. *Dis Colon Rectum* 2003; 46: 601-611.
87. Wu WX, Sun YM, Hua YB, Shen CZ. Laparoscopic versus conventional open resection of rectal carcinoma a clinical comparative study. *World J Gastroenterol* 2004; 10: 1167-1170.
88. Pikarsky AJ. Updated on prospective randomized trials of laparoscopic surgery for colorectal cancer. *Surg Oncol Clin N Am* 2001; 10: 639-53.
89. COLOR: a randomized clinical trial comparing laparoscopic and open resection for colon cancer. *Dig Surg* 2000; 17: 617-622.
90. Lacy AM, Garcia-Valdecasas JC, Delgado S et al. Laparoscopy assisted colectomy versus open colectomy for treatment of non metastatic colon cancer a randomized trial. *Lancet* 2002; 359: 2224-9.
91. Wexner SD, Johansen OB, Noguerras JJ, Jagelman DG. Laparoscopic total abdominal colectomy: a prospective trial. *Dis Colon Rectum* 1992; 35: 651-655.
92. Weeks JC, Nelson H, Gelber S, Sargent D, Schroeder G. Short-term quality of life outcomes following laparoscopic-assisted colectomy vs open colectomy for colon cancer: a randomized trial. *JAMA* 2002; 287: 321-328.
93. McLeod RS, Stern H. Laparoscopic-assisted colectomy versus open colectomy for treatment of non-metastatic colon cancer: A randomized trial. *Can J Surg* 2004; 47: 209-211.
94. Liang JT, Shieh MJ, Chen CN, Cheng YM, Chang KJ, Wang SM. Prospective evaluation of laparoscopic-assisted colectomy versus laparotomy with resection for management of complex polyps of the sigmoid colon. *World J Surg* 2002; 26: 377-383.
95. Janson M, Bjorholt I, Carlson P, Haglind E, Henrickson M, Lindholm E, Andeberg B. Randomized clinical trial of the costs of open and laparoscopic surgery for colonic cancer. *Br J Surg* 2004; 91: 409-17.
96. Nelson H, Petrelli N, Carlin A, Couture J, Fleshman J, Guillem J, Miedema B, Ota D, Sargent D. National Cancer Institute Expert Panel. Guidelines 2000 for colon and rectal surgery. *J Am Coll Surg* 2002; 195: 545-8.
97. American Society of Colon and Rectal Surgeons approved statement on laparoscopic colectomy. *Dis Colon Rectum* 1994; 37: 8-12.

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