

Laparoscopic Treatment of Crohn's Disease

Valeriu Surlin^{1*}, Sidonia Saceanu² and Stefan Patrascu³

¹University of Medicine and Pharmacy of Craiova, Romania

²Gynecology Department, University of Medicine and Pharmacy of Craiova, Romania

³University of Medicine and Pharmacy of Craiova, Romania

***Corresponding author:** Valeriu Surlin, Clinic of Surgery, University of Medicine and Pharmacy of Craiova, Romania. Email: vsurlin@gmail.com

Published Date: October 12, 2016

ABSTRACT

Background: Although the management of Crohn disease rests primarily in the hands of the gastroenterologists, surgery is essential for the management of complications. While before the introduction of modern biologic therapies some studies reported overall operative rates of 90% at 30 years from initial diagnosis, currently it is estimated that up to 80% of patients will require a surgical procedure within the first 10 years from diagnostic. As the laparoscopic approach gains more ground in the armamentarium of modern surgical techniques, it seems that one of the most important changes in the surgical approach to Crohn's disease may be the type of access.

Material and methods: A systematic literature search was performed using the following databases: Pub Med, Embase, the Cochrane Library and Web of Science, and the following terms: Crohn's disease, laparoscopic surgery, laparoscopy, minimal invasive surgery, analyzing all articles published between 1990 and 2015.

Results: The minimal invasive approach to Crohn's disease provides several advantages, such as reduced inflammatory response and faster recovery. All but one studies indicated additional long term benefits such as lower incidence of incisional hernias and postoperative adhesions.

The disadvantages of laparoscopy reside in the high level of expertise required and a relatively higher number of early reinterventions, even though more recent studies indicated no statistically significant difference in terms of complication or reintervention rate. However, most of these studies are non-randomized, thus under powering the significance of any further recommendation. When only taking into consideration the randomized controlled studies no differences are observed in the perioperative complication rate or late postoperative outcomes.

Conclusions: Laparoscopy seems to offer an equal or better alternative to open surgery in terms of postoperative recovery, complication rate, incidence of incisional hernias and adhesions, making it the perfect candidate for the treatment of the complications associated to Crohn's disease.

Keywords: Crohn's disease; Laparoscopy; Minimal invasive surgery

BACKGROUND

Crohn's disease (**CD**) is a chronic inflammatory bowel disease that most often involves the terminal ileum and the colon. Even with the advance of modern medical treatment this condition remains incurable. Although the management of Crohn's disease rests primarily in the hands of the gastroenterologists, surgery is essential for the management of complications. Surgery is indicated in case of stenosis, suppurative complications, premalignant lesions, or in certain cases when the disease does not respond to medical treatment. While way before the introduction of modern biologic therapies the National Cooperative Crohn Disease Study reported operative rates of 90% at 30 years since diagnosis, things did not change much during the last four decades [1]. Nowadays it is estimated that up to 80% of patients will require a surgical procedure within the first 10 years of diagnostic, with additional surgery in more than 25% of these cases during the next 5 years [2]. As laparoscopy and its derivatives (single incision laparoscopy, robotic surgery, minilaparoscopy, NOTES) gain more ground in the armamentarium of modern surgical techniques, it seems that one of the most important changes in the surgical approach to Crohn disease is the type of access. Therefore, an assessment of the current status of minimal invasive surgical techniques for the treatment of Crohn's Disease is necessary. The role of this study was to analyze the role of laparoscopy in the armamentarium of surgical techniques, its benefits, indications and limitations in the more extensive care pathway for CD. Special consideration was taken for specific situations, such as pediatric cases and pregnancy.

MATERIAL AND METHODS

A systematic literature search was performed using the following databases: Pub Med (Medline), Embase, the Cochrane Library and Web of Science. The literature search was conducted by two reviewers, analyzing all articles published between 1990 and 2015. The authors additionally performed a manual search of the reference lists and other related studies. Only the articles included in peer-review journals were taken into consideration. All candidate articles

were evaluated by two independent reviewers (V Surlin and S Patrascu) and the discrepancies were managed by discussion. Case reports and animal experimental studies were excluded. We searched for the following terms: Crohn's disease, laparoscopic surgery, laparoscopy, minimal invasive surgery. The search was limited to English and French articles.

RESULTS

The initial selection process identified 135 articles from a total of 370, out of which 44 were reviews. Independent evaluation excluded another 15.

Indications for Surgery

Usually, the aim of any treatment used in Crohn's disease is to treat the acute disease, to induce clinical remission and to maintain this clinical response [3]. Before the introduction of anti-TNF (tumor necrosis factor) medication, surgery had the prominent role in the treatment of Crohn's disease, with some studies reporting incidences of surgical procedures in up to 60% of the cases during the first 5 years since diagnosis [4]. Currently, indications for surgery are limited to specific situations, depending on disease severity, location, and disease-associated complications. Still, surgery is acknowledged as a potentially curative method in case of CD limited to the colon, when total colectomy with ileostomy can be advised. Otherwise, the usual indications for surgical procedure are the complications of CD, the medically refractory disease or side effects of medication [5,6].

Perioperative Management

To maximize the postoperative results of surgery and to decrease the postoperative complication rate it is mandatory to have a full diagnosis with exact reference to the presence, extent, and severity of the disease.

In order to have a correct preoperative diagnosis, which takes into account the existence of active disease and complications (fistulas, strictures, or abscesses), and checking for the presence of dysplasia or cancer, it is mandatory to undergo a composite of diagnostic tests, which may include several of the following: upper and lower endoscopy, video capsule endoscopy, small bowel radiography and transabdominal imaging such as CT and MRI [3].

The perioperative use of corticosteroids increases the postoperative complication rate, especially the risk for postoperative infections, contrary to azathioprine, 6-mercaptopurine and infliximab administration which does not seem to influence the postoperative complication rate [3]. Special consideration must be paid to narcotic analgesia, which should only be used in the perioperative setting, due to the high risk of tolerance and abuse [7,8].

Laparoscopy in Crohn's Disease

In its early stages, laparoscopy was used mainly as a diagnostic tool for selected cases of Crohn's disease. However, it is Milson who is credited with the first laparoscopic therapeutic

procedure in 1993, when he published the first study presenting his initial experience with laparoscopically assisted ileocelectomy in Crohn's disease [9]. Nowadays laparoscopic techniques are shown to be more advantageous in certain cases in terms of decreased pain, a faster recovery of normal intestinal motility, reduced hospital stay and better cosmesis [5,10]. Furthermore, the perioperative complication rate in case of laparoscopic access seems to be lower than open surgery. Laparoscopy in Crohn's disease may provide, however, another important advantage - a reduced postoperative inflammatory response -which is normally associated with the minimal invasive approach, and which could be beneficial in an already immune suppressed patient. The association between drug-induced immunosuppression and postoperative alteration of the inflammatory response is probably responsible for the high incidence of wound complications associated to open surgery. Laparoscopy seems to overcome this drawback, showing a significant reduction of this type of complications, especially the surgical site infections, leading to shorter hospitalization and lower treatment costs [11,12]. All but one studies indicated additional long term benefits such as lower incidence of incisional hernias and postoperative adhesions [13].

The disadvantages of laparoscopy reside in the high level of expertise required and a higher number of early reinterventions in some of the series, even though more recent studies show no statistically significant difference in the rate of complications [13,14]. However most of the studies found on this topic are non-randomized, thus underpowering the significance of any further recommendation. Randomization is however difficult to achieve in clinical practice due to the often unpredictable presentations and widespread digestive involvement of this pathology. When taking into consideration only the randomized controlled trials (RCT) no differences are observed in the perioperative complication rate or late postoperative outcomes, but the small number of patients included in these studies seriously limit any conclusive results.

Short term results

In a prospective non-randomized study by Fichera et al on ileocolonic Crohn's disease, the authors observed a lower narcotic requirement, lower blood loss, shorter hospital stay, fewer late small bowel obstructions, and similar postoperative complications including one anastomotic leak that required reoperation for each group [15]. A systematic review by Polle et al, assessing the short-term advantages of laparoscopic resection over open surgery for ileocolic CD, showed no difference in term of postoperative complications, but shorter overall hospital stays and acceptable conversion rates varying between 0 and 16.7%. Yet again, only 2 of the 14 studies included in this analysis were RCT and another 2 were case-matched studies [16].

Long term results

Laparoscopy offers similar or better results compared to open surgery in terms of late complications such as incisional hernias and adhesences. There is also a decrease in radiologic and endoscopic recurrence rate in case of laparoscopic access [17,18]. Functional outcome and quality of life are similar but cosmetic results, especially for women are better also after laparoscopic interventions [18].

Risk factors

There is a growing number of risk factors that are being incriminated in the postoperative results of the surgical procedures for CD, varying from socio-demographics to metabolism or pharmacologic agents, many of which have not yet been statistically proven to have any role as a surgical risk factor. Moreover, laparoscopy by itself could be a protective factor for the postoperative course and local recurrences, when compared to open access, as previously discussed. Ethnicity does not seem to influence the outcomes of surgery when open and laparoscopic approach was compared [19]. However, malnutrition and recurrent clinical episodes are known risk factors for anastomotic-associated complications and intra-abdominal sepsis, for both open and laparoscopic procedures [20-22]. It seems that preoperative intra-abdominal sepsis alone can significantly affect the outcomes of surgery, especially in terms of anastomotic-associated complications [21]. Long term steroid usage, such as ≥ 20 mg prednisolone for more than 6 weeks, could be a risk factor for surgical complications, for both laparoscopy and open surgery, making significant difference for any of the approaches [21,23].

Intracorporeal anastomosis

In a prospective study on 80 patients, Bergamaschi observed better outcome for laparoscopic ileocolic resection with intracorporeal vascular division and anastomosis in selected patients with refractory Crohn's disease. Patients with perforated Crohn's disease, frozen abdomen and recurrences in Crohn's disease following resection were excluded from this study [24]. However, it is certain that there are more factors involved in the final outcome of the anastomosis, as indicated by a meta-analysis on 661 patients by Simillis et al [25]. It seems that in patients with CD the end-to-end anastomosis performed in ileocolonic resection had a higher anastomotic leak rate and post-operative complications compared to side-to-side anastomosis [25]. To this date, side to side anastomosis is the preferred type of anastomosis in laparoscopic surgery.

Laparoscopy in fistulas

The penetrating Crohn's disease, as it is described in the Montreal classification, better known as fistulizing Crohn's disease, accounts for a variety of pathological entities defined as abnormal connection between 2 epithelialized surfaces, one of which usually involving the gut. Two types of fistulas have been described: the "simple" ileo-ileal fistulas and the "complex", ileo-vesical, ileo-colonic, ileo-salpingeal or colo-colic fistulas, the resection of which is more technically demanding and is associated with a higher morbidity [26]. Although laparoscopy is a feasible and safe alternative to open surgery in case of simple, entero-enteral fistulas, the choice for the laparoscopic approach for the surgical management of complex entero-visceral fistulas has been a matter of debate. Most often, the existence of an abscess, complex fistula or an inflammatory mass has been regarded as potential risk factors for conversion [27,28]. Ileo-vesical fistula is a relatively uncommon complication of Crohn's disease. Despite the low number of studies on this topic, it seems that there is no statistical significance in incidence of complications between

laparoscopic and open surgery. Nevertheless, early intervention is advisable in ileo-vesical fistulas due to a lower incidence of recurrence and morbidity [29]. The most frequent type of complex fistula is the ileo-sigmoid variety, which requires, whenever possible, the closure of the fistula with the preservation of the bowel [30].

Conversion to open surgery

It seems that fistulas and intra-abdominal abscesses, as well as recurrent disease are the most common risk factors for conversion to open surgery. Complex cases of CD can justify a high conversion rate in order to ensure patient safety. Thus it is advisable that complex cases should be managed by laparoscopic approach only in experienced, high volume centers, within clinical studies [31].

Costs of the procedure

For Duepre et al. direct costs per case were higher for laparoscopic group [13]. However Young-Fadok et al reported lower direct and indirect costs for laparoscopic surgery compared to open procedures. The overall cost for laparoscopic cases was significantly lower than those for the open access (\$9895 for laparoscopy compared to \$13,268 for conventional surgery) [32].

Special Situations

Surgery in pregnant women

Although there is only a limited number of a study evaluating this particular aspect in the management of CD, the indications for surgery in pregnant women, such as hemorrhage, obstruction, perforation or abscess, do not differ from those for non-pregnant women [33-36]. However it appears that continued disease for severely ill patients poses a potentially higher risk to the fetus than the surgical intervention in itself [33,24]. A wide ranges of procedures have been successfully described: segmental resections, right and left hemicolectomies, proctocolectomy, and ileostomy. Whenever an anastomosis is performed a temporary ileostomy is usually advisable in order to reduce the risk or severity of post-operative complications, such as leak and local abscess [36].

Surgery for pediatric patients

Although almost one third of patients are diagnosed before the age of 21, there is still limited data on minimal invasive surgery for children with Crohn's disease, as most recommendations and clinical experience is based on extrapolation from studies on adult patients. For the pediatric population, reducing the surgical stress, the postoperative pain, the hospital stays and scar formation may be of even greater importance than in other population subgroups.

Furthermore, laparoscopy seems to be particularly beneficial in these patients as it provides similar or decreased requirement for intravenous narcotics, shorter postoperative stay, minimal postoperative complications and superior cosmetic results [37,38].

Post-operative Recurrence of Crohn's Disease

Recurrences after laparoscopy

Currently, except for total proctocolectomy for Crohn's disease of the colon, no surgical technique has been proven to be superior to each other in decreasing the postoperative recurrence risk of CD. It seems that the presence of histologic disease at the surgical resection margins is no predictor for a higher risk of recurrence [39].

Surgery, both open and laparoscopic, is not curative as the postoperative recurrence rate remains high. The incidence varies according to a number of factors such as smoking, previous intestinal surgery, the extension of small bowel resection and the disease behavior [40-43]. One of the most important aspect in the incidence of postoperative recurrence is the definition of recurrence in itself. In absence of medical treatment, a high rate of recurrences of 80-100% at 3 years is reported when colonoscopy is used as the main diagnostic parameter, in contrast to the low incidence reported when resection rate is taken into account. In a prospective, randomized trial comparing laparoscopic to conventional surgery for refractory ileocolic Crohn's disease, Milsom et al. found no clinical recurrence at a median follow-up of 20 months (range 12-45 months) [44].

Laparoscopy in recurrent CD

In case of recurrent Crohn's disease, the results of laparoscopic resection appear to be comparable to those for primary resection [45]. As recurrent disease is often synonymous to complex Crohn's disease, posing additional technical challenges even to the experienced surgeon, it is not surprising that recurrent disease is one of the most serious risk factors for conversion to open surgery.

Perspectives

The technical advances in the field of laparoscopic surgery, the introduction of new instruments, as well as the accumulation of critical experience in laparoscopy have led to the introduction of new minimal invasive techniques, such as single incision laparoscopic surgery (SILS), minilaparoscopy, robotic-assisted surgery and other derivatives of laparoscopy.

SILS can be performed entirely through the umbilicus, thus providing better cosmesis than multiport laparoscopy. This new approach has been successfully applied to the most common abdominal procedures, including cholecystectomy, appendectomy, gynecological and urological procedures. Some reports start to emerge regarding the feasibility of SILS in colon cancer and Crohn's disease [46]. This approach is supposed to have certain advantages, including reduced pain, improved cosmetic results, and reduced port-site complications, which should be put in balance with a number of possible drawbacks such as increased operative time, compromised visualization, difficult triangulation and problems with ergonomics, which lead to high perioperative complications and costs.

Robotic surgery should, at least in theory, overcome these disadvantages. Recently, Tou et al reported encouraging results in case of robotic-assisted stricturoplasty [47]. Except for incidental cases, there are very few studies specifically evaluating the impact of this new type of surgery in Crohn's disease [48].

Limitations of the Study

There are several aspects that limit this analysis, most notably the paucity of high quality data, with most of the articles published so far being under-powered, retrospective studies. Another issue that may alter the quality of this research is the heterogeneity of these studies.

CONCLUSIONS

Laparoscopy seems to offer an equal or better alternative to open surgery in terms of postoperative recovery, complication rate, incidence of incisional hernias and adhesions, making it the perfect candidate for the treatment of the complications associated to Crohn's disease. However, a good expertise is a prerequisite, especially for complicated disease.

References

1. Mekhjian HS, Switz DM, Melnyk CS, Rankin GB, Brooks RK. Clinical features and natural history of Crohn's disease. *Gastroenterology*. 1979; 77: 898-906.
2. Bernell O, Lapidus A, Hellers G. Risk factors for surgery and recurrence in 907 patients with primary ileocaecal Crohn's disease. *Br J Surg*. 2000; 87: 1697-1701.
3. Lichtenstein GR, Hanauer SB, Sandborn WJ. Practice Parameters Committee of American College of Gastroenterology. Management of Crohn's disease in adults. *Am J Gastroenterol*. 2009; 104: 465-483
4. Bouguen G, Peyrin-Biroulet L. Surgery for adult Crohn's disease: what is the actual risk? *Gut*. 2011; 60: 1178-1181.
5. Gardiner KR, Dasari BV. Operative management of small bowel Crohn's disease. *Surg Clin North Am*. 2007; 87: 587-610.
6. Steele SR. Operative management of Crohn's disease of the colon including anorectal disease. *Surg Clin North Am*. 2007; 87: 611-631.
7. Cross RK, Wilson KT, Binion DG. Narcotic use in patients with Crohn's disease. *Am J Gastroenterol*. 2005; 100: 2225-2229.
8. Edwards JT, Radford-Smith GL, Florin TH. Chronic narcotic use in inflammatory bowel disease patients: prevalence and clinical characteristics. *J GastroenterolHepatol*. 2001; 16: 1235-1238;
9. Milsom JW, Lavery IC, Böhm B, Fazio VW. Laparoscopically assisted ileocectomy in Crohn's disease. *Surg Laparosc Endosc*. 1993; 3: 77-80.
10. Tilney HS, Constantinides VA, Heriot AG, Nicolaou M, Athanasiou T. Comparison of laparoscopic and open ileocecal resection for Crohn's disease: a metaanalysis. *Surg Endosc*. 2006; 20: 1036-1044.
11. Indar AA, Young-Fadok TM, Heppell J, Efron JE. Effect of perioperative immunosuppressive medication on early outcome in Crohn's disease patients. *World J Surg*. 2009; 33:1049-1052.
12. Seifarth C, Ritz JP, Kroesen A, Buhr HJ, Groene J. Effects of minimizing access trauma in laparoscopic colectomy in patients with IBD. *Surg Endosc*. 2015; 29: 1413-1418.
13. Duepre HJ, Senagore AJ, Delaney CP, Brady KM, Fazio VW. Advantages of laparoscopic resection for ileocecal Crohn's disease. *Dis Colon Rectum*. 2002; 45: 605-610.
14. Patel SV, Patel SV, Ramagopalan SV, Ott MC. Laparoscopic surgery for Crohn's disease: a meta-analysis of perioperative complications and long term outcomes compared with open surgery. *BMC Surg*. 2013; 13: 14.
15. Fichera A, Peng SL, Elisseou NM, Rubin MA, Hurst RD. Laparoscopy or conventional open surgery for patients with ileocolonic Crohn's disease? A prospective study. *Surgery*. 2007; 142: 566-571.

16. Polle SW, Wind J, Ubbink DT, Hommes DW, Gouma DJ. Short-term outcomes after laparoscopic ileocolic resection for Crohn's disease. A systematic review. *Dig Surg*. 2006; 23: 346-357.
17. Stocchi L, Milsom JW, Fazio VW. Long-term outcomes of laparoscopic versus open ileocolic resection for Crohn's disease: follow-up of a prospective randomized trial. *Surgery*. 2008 Oct; 144: 622-627.
18. Eshuis EJ, Polle SW, Slors JF, Hommes DW, Sprangers MA. Long-term surgical recurrence, morbidity, quality of life, and body image of laparoscopic-assisted vs. open ileocolic resection for Crohn's disease: a comparative study. *Dis Colon Rectum*. 2008; 51: 858-867.
19. Griglione N, Yarandi S, Srinivasan J, Ahearn T, Dhere T. A comparison of abdominal surgical outcomes between African-American and Caucasian Crohn's patients. *Int J Colorectal Dis*. 2014; 29: 917-922.
20. Alves A, Panis Y, Bouhnik Y, Pocard M, Vicaut E. Risk factors for intra-abdominal septic complications after a first ileocecal resection for Crohn's disease: a multivariate analysis in 161 consecutive patients. *Dis Colon Rectum*. 2007; 50: 331-336.
21. Tzivanakis A, Singh JC, Guy RJ, Travis SP, Mortensen NJ. Influence of risk factors on the safety of ileocolic anastomosis in Crohn's disease surgery. *Dis Colon Rectum*. 2012; 55: 558-562.
22. Yamamoto T, Allan RN, Keighley MR. Risk factors for intra-abdominal sepsis after surgery in Crohn's disease. *Dis Colon Rectum*. 2000; 43: 1141-1145.
23. Aberra FN, Lewis JD, Hass D, Rombeau JL, Osborne B. Corticosteroids and immunomodulators: postoperative infectious complication risk in inflammatory bowel disease patients. *Gastroenterology*. 2003; 125: 320-326.
24. Bergamaschi R, Haughn C, Reed JF, Arnaud JP. Laparoscopic intracorporeal ileocolic resection for Crohn's disease: is it safe? *Dis Colon Rectum*. 2009; 52: 651-656.
25. Simillis C, Purkayastha S, Yamamoto T, Strong SA, Darzi AW. A meta-analysis comparing conventional end-to-end anastomosis vs. other anastomotic configurations after resection in Crohn's disease. *Dis Colon Rectum*. 2007;50: 1674-1687.
26. Beyer-Berjot L, Mancini J, Bege T, Moutardier V, Brunet C. Laparoscopic approach is feasible in Crohn's complex enterovisceral fistulas: a case-match review. *Dis Colon Rectum*. 2013; 56: 191-197.
27. Goyer P, Alves A, Bretagnol F, Bouhnik Y, Valleur P. Impact of complex Crohn's disease on the outcome of laparoscopic ileocecal resection: a comparative clinical study in 124 patients. *Dis Colon Rectum*. 2009; 52: 205-210.
28. Tan JJ, Tjandra JJ. Laparoscopic surgery for Crohn's disease: a meta-analysis. *Dis Colon Rectum*. 2007; 50: 576-585.
29. Hastings JW, Garg M, Lynn ET, Divino CM. Surgical repair of ileovesical fistulas: long-term complications, quality of life, and patient satisfaction. *Am Surg*. 2014; 80: 1207-1211.
30. Melton GB, Stocchi L, Wick EC, Appau KA, Fazio VW. Contemporary surgical management for ileosigmoid fistulas in Crohn's disease. *J Gastrointest Surg*. 2009; 13: 839-845.
31. Alves A, Panis Y, Bouhnik Y, Marceau C, Rouach Y, et al. Factors that predict conversion in 69 consecutive patients undergoing laparoscopic ileocecal resection for Crohn's disease: a prospective study. *Dis Colon Rectum* 2005; 48: 2302-2308.
32. Young-Fadok TM, HallLong K, McConnell EJ, Gomez Rey G. Advantages of laparoscopic resection for ileocolic Crohn's disease. Improved outcomes and reduced costs. *SurgEndosc*. 2001; 15: 450-454.
33. Subhani JM, Hamilton MI. Review article: The management of inflammatory bowel disease during pregnancy. *Aliment Pharmacol Ther*. 1998; 12: 1039-1053.
34. Nielsen OH, Andreasson B, Bondesen S, Jacobsen O, Jarnum S. Pregnancy in Crohn's disease. *Scand J Gastroenterol*. 1984; 19: 724-732.
35. Hill J, Clark A, Scott NA. Surgical treatment of acute manifestations of Crohn's disease during pregnancy. *J R Soc Med*. 1997; 90: 64-66.
36. Kane S. Inflammatory bowel disease in pregnancy. *Gastroenterol Clin North Am*. 2003; 32: 323-340.
37. Diamond IR, Langer JC. Laparoscopic-assisted versus open ileocolic resection for adolescent Crohn disease. *J Pediatr Gastroenterol Nutr*. 2001; 33: 543-547.
38. Von Allmen D, Markowitz JE, York A, Mamula P, Shepanski M. Laparoscopic-assisted bowel resection offers advantages over open surgery for treatment of segmental Crohn's disease in children. *J Pediatr Surg*. 2003; 38: 963-965.
39. Fazio VW, Marchetti F, Church M, Goldblum JR, Lavery C. Effect of resection margins on the recurrence of Crohn's disease in the small bowel. A randomized controlled trial. *Ann Surg*. 1996; 224: 563-571.
40. Ryan WR, Allan RN, Yamamoto T, Keighley MR. Crohn's disease patients who quit smoking have a reduced risk of reoperation for recurrence. *Am J Surg*. 2004; 187: 219-225.

41. Onali S, Petruzzello C, Calabrese E, Condino G, Zorzi F. Frequency, pattern, and risk factors of postoperative recurrence of Crohn's disease after resection different from ileo-colonic. *J Gastrointest Surg.* 2009; 13: 246-252.
42. Sachar DB, Lemmer E, Ibrahim C, Edden Y, Ullman T. Recurrence patterns after first resection for stricturing or penetrating Crohn's disease. *Inflamm Bowel Dis.* 2009; 15: 1071-1075.
43. Hofer B, Bottger T, Hernandez-Richter T, Seifert JK, Junginger T. The impact of clinical types of disease manifestation on the risk of early postoperative recurrence in Crohn's disease. *Hepatogastroenterology* 2001; 48: 152–155.
44. Milsom JW, Hammerhofer KA, Böhm B, Marcello P, Elson P. Prospective, randomized trial comparing laparoscopic vs. conventional surgery for refractory ileocolic Crohn's disease. *Dis Colon Rectum.* 2001; 44: 1-8.
45. Pinto RA, Shawki S, Narita K, Weiss EG, Wexner SD. Laparoscopy for recurrent Crohn's disease: how do the results compare with the results for primary Crohn's disease? *Colorectal Dis.* 2011; 13: 302-307.
46. Maeda K, Noda E, Nagahara H, Inoue T, Takii M, et al. A comparative study of single-incision versus conventional multiport laparoscopic ileocecal resection for Crohn's disease with strictures. *Asian J Endosc Surg.* 2012; 5: 118-122.
47. Tou S, Pavesi E, Nasser A, Mazirka P, Bergamaschi R. Robotic-assisted strictuoplasty for Crohn's disease. *Tech Coloproctol.* 2015; 19: 253-254.
48. Lujan HJ, Molano A, Burgos A, Rivera B, Plasencia G. Robotic right colectomy with intracorporeal anastomosis: experience with 52 consecutive cases. *J Laparoendosc Adv Surg Tech A.* 2015; 25: 117-122.