Feasibility and accuracy in performing complete mesocolic excision during laparoscopic left colectomy

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Laparoscopic colorectal surgery for cancer is nowadays performed in several referral centers and has been gaining increasing interest for treatment of colo-rectal cancer.
After the introduction of complete mesorectal excision for rectal cancer, complete mesocolic excision has been advocated as an essential surgical step to improve oncologic results for patients with colon cancer. Complete mesocolic excision is a crucial step of hemicolectomy, and consists in the total removal of the mesocolon and its lymph nodes with high ligation of main mesenteric arteries and veins.
In laparoscopic surgery, magnification of the images and gas dissection might probably improve the precision and safety of this surgical step.
In this paper, the Authors reviewed the Literature and discussed on the feasibility and accuracy of complete mesocolic excision performed during laparoscopic left colectomy for cancer in a preliminary series.

KEY WORDS: Colic lymph nodes, Laparoscopic left hemicolectomy, Mesocolon excision

Introduction

The complete mesocolic excision (CME) for colon cancer has been introduced in western countries after its publication in 2009 by Hohenberger et al [1], who performed and standardized this new surgical approach in colon malignancies. CME consists in the total removal of the mesocolonwith its lymph nodes, in association to the classic technique of colo-rectal surgery. Dissection must ensure complete removal of the lymphatic, vascular, and neural tissues coming from the colon cancer area, according to the underlying principle of CME.
Laparoscopic surgery might be crucial in the general acceptance of mesocolic excision, since the magnification of the images and the help of gas dissection could improve the precision and safety of this surgical step [2-5].
In this paper, we reviewed the Literature and discussed on the feasibility and accuracy of CME performed during laparoscopic left colectomy for cancer in a preliminary series.

Patients and Methods

Twelve consecutive patients who underwent colorectal resection at our surgical unitwere analyzed in this study. Seven patients were operated on for a descending-sigmoid cancer, whereas the remaining five were surgically treated for a rectal cancer. A laparoscopic left colectomy

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with complete mesocolic excision was performed in all the cases, associated with total mesorectal excision in rectal cancer patients.

The technique started with the patients positioned in a semilateral position with the left flank elevated about 20° from the operating table, and introduction of four trocars. The inferior mesenteric vein was identified, suspended and later ligated at the lower border of the pancreas. We then dissected the mesocolon from the Toldt's fascia with sharp bloodless maneuvers, until the splenic hilum was seen (Fig. 1). Attention was paid not to damage the marginal artery, a risk that is higher in obese patients. Then, the attachment between the transverse colon and omentumwas divided using the harmonic scalpel. The lesser sac was entered, and dissection proceeded over the anterior surface of the pancreas to the splenic hilum. The splenic flexure of the colon was mobilized in all cases. If tumoral invasion of the spleen was present, splenectomy was performed.Complete splenic flexure mobilization was accomplished through division of spleno-colic, phreno-colic, gastro-colic ligaments and pancreatico-mesocolic attachments (Figs. 2, 3). The pancreatico-mesocolic ligaments was divided up to the level of the left branch of the middle colic artery, bringing to thecompleteseparation of the distal transverse mesocolon from its retroperitoneal attachments to the tail of the pancreas.

In order to find the inferior mesenteric artery (IMA), the landmark we use is the superior margin of the promontory medial to the right iliac artery.

Then we opened the posterior parietal peritoneum keeping close to the left edge of aorta. Generally, this maneuver facilitates the isolation of inferior mesenteric artery (IMA), which was divided by vascular linear endo-stapler. We usually divide the IMA at 1.5-2 cm from its aortic origin, pushing down the aorta with surrounding sympathetic plexus in order not to injure it.

Dissection of the mesocolon along the plan of Toldt's fascia was then progressed until complete mobilization of descending colon was achieved.

We then performed the dissection of recto-sigmoid junction by changing the table into Trendelenburg position. At this point, we proceeded to preparation of mesorectal dissection. The left ureter should be identified in order to avoid accidental injury, particularly when there is inflammation around this area. The plan of dissection started posteriorly at perisacral region, paying attention to keep away from the middle sacral vein, which, if damaged, can be a source of very serious bleeding.

The dissection of the mesorectum continued toward the right side of the rectum then toward the left, with identification of sympathetic sacral plexus. Saving these nerves is important to avoid erectile dysfunction in males.

Fig. 1

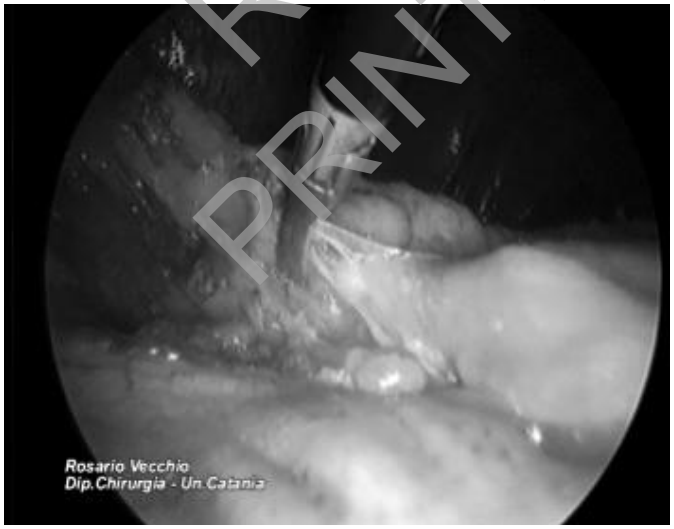

Fig. 2

Fig. 3

Finally, we proceeded anteriorly to the dissection of the anterior side of the rectum through a virtual space situated behind the fascia of Denonvillier. In male, attention should be paid to the seminal vesicles and the prostate. In females we dissect the rectovaginal junction, which can be better exposed by suspending the uterus with a transfixed suture.
Below the seminal vesicles, the Denonvillier's fascia was divided close to the rectum until reaching the plane of the levator ani muscle. For rectal transection, a linear staple was utilized.
Descending colon with sigma and proximal rectum then were exteriorized through a lower transverse incision (Pfannestiel), lower midline or left paramedian incision, and the specimen was resected. Attention should be paid to blood supply of the anastomosis.
The anvil of circular stapler ILS28 or 29 mm was introduced into the proximal stump and fixed with a polypropylene purse-string suture. The choice of stapler's diameter depends on the size of large bowel.
The bowel was then returned to the abdominal cavity, the incision was closed by suture and pneumoperitoneum was re-established.
Finally, after gentle dilation of the anus, the handle of the stapler was inserted into the rectum and was properly connected to the anvil, previously positioned in the descending colon. The first assistant fired from below the circular stapler after insuring correct orientation of the proximal bowel, fashioning an end-to-end anastomosis.
We checked the hemostasis and the integrity of anastomosis using a hydro-aerial test. At the end, the abdomen was desuflated and the trocars were taken out after irrigation of the abdominal cavity with saline solution, and positioning of a 19 French drainage in the Douglas space. Trocar sites were closed by deep-sited fascia closure.

Results

Among 12 patients, 7 were males whereas 5 were female with a male/female ratio of 1.1. Age ranged from 57 to 86 years with a mean age of 71.8 years. With regard to history and physical examination, constipation was referred by 7 patients (58%), weight loss by 6 (50%), anemia was evident in 4 cases (33%), and 2 patients (17%) complained rectal bleeding. Preoperative diagnosis was achieved by means of colonoscopy with biopsy. All the patients were studied by a preoperative CT scan to assess the stage of the disease.
Operative time ranged between 3.5 and 6 hours with a mean of 4 hours. Conversion to open surgery was required in only one case for uncontrolled bleeding. According to the classicc classification [6], the macroscopic examination of the surgical specimen revealed a complete mesocolic excision (grade A) in 10 patients (83%), with an intact mesocolic surface and only peritoneal or fascial defects no deeper than 5 mm. In two cases (17%) a grade B with a significant irregularity and defects of peritoneal or fascial surface deeper than 5 mm, was observed.
Postoperative complication, consisting only in anastomotic leakage, was observed in 2 patients (17%), one of them requiring re-intervention with Hartmann procedure.
Mean hospital stay ranged from 4 to 9 days (mean 6 days).
Postoperative cancer staging revealed a T4N1 in 1 colon cancer patient, a T3N2 in 1 colon cancer patient, a T3N1 in 1 colon cancer patient and in 1 rectal cancer patient, a T3N0 in 2 rectal cancer patients, a T2N1 in 1 colon cancer patient, a T2N0 in 2 colon cancer patient and in 2 rectal cancer patients, and a T1N0 in 1 colon cancer patient.
Mean number of lymph nodes harvested in descending-sigmoid colon cancer by laparoscopic technique was 16.5 (range 10-26), and 14.5 (range 12-19) in rectal cancer cases.

Discussion

The magnification of the images obtained with laparoscopic surgery has recently allowed re-introducing concepts of surgical anatomy such as 'mesocolon' and 'Toldt's fascia'. Contemporary appraisals have confirmed that the mesenteric organ is a continuous structure from the duodeno-jejunal flexure to the mesorectum [7,8]. In a recent study of Culligan et al. [7], several new anatomical findings emerged. In their cohort of 109 patients, the mesocolon was continuous from ileocaecal to rectosigmoid level. A mesenteric confluence can be found at the ileocaecal and recto-sigmoid junction, as well as at the hepatic and splenic flexures. Each flexure and theileo-caecal junction were a complex of peritoneal and omental attachments to the colon centered on a mesenteric confluence. Moreover, the proximal rectum originated at the confluence of the mesorectum and mesosigmoid tract. A plane occupied by Toldt's fascia separated the entire mesocolon from the retroperitoneum.
Based on the rationale of total mesorectal excision (TME) in colon malignancies, in 2009 Hohenberger et al. proposed a new technique for colon cancer [1], emphasizing the concept of "complete mesocolic excision" (CME), which consists of total removal of the mesocolon and its lymph nodes, in association to the classic technique of colo-rectal surgery. He performed and standardized this new surgical approach for colon cancer, which contemplates large lymphadenectomies as an important step in oncologic surgical treatment.
There are three crucial points in the surgical technique of CME. The main component involves a dissection between the mesenteric plane and the parietal fascia, and removal of the mesentery within a complete envelope of

mesenteric fascia and visceral peritoneum that contains all lymph nodes draining from the tumor area [1,9]. This envelope contains potentially involved lymph nodes and, by keeping it intact, the risk of spillage of neoplastic cells into the peritoneal cavity will be minimized.

The second point is a central (high) vascular ligation of the main vessels to completely remove all lymph nodes in the central (vertical) direction [1,10]. Even though a high vascular tie has always been recommended, there has never been clear guidelines about how high the vascular tie should be.

High ligation of the inferior mesenteric artery before the origin of the left colic artery, although not universally accepted, is by most considered an essential step for radically oncologic surgery, allowing removal of D3 lymph nodes [11].

The third point is the resection of an adequate length of bowel to remove involved pericolic lymph nodes in the longitudinal direction. The length of the remaining left colon after bowel resection, which must ensure negative resection margins, should be sufficient to build a tension-free anastomosis. In order to perform a tension-free anastomosis, splenic flexure mobilization is often needed. Besides, splenic flexure mobilization, extending the remaining colonic segment for colorectal anastomosis, preserves the blood flow to the anastomosis and, subsequently, improves the surgical outcomes.

If a partial mobilization is sufficient to assure an adequate length of the remaining left colon, division of spleno-colic and phreno-colic ligaments carries out the complete splenic flexure mobilization. Otherwise, division of the gastro-colic and pancreatico-mesocolic attachments is also required.

The medial limit of complete splenic flexure mobilization should be the left aortic wall. The full separation of the distal transverse mesocolon from its retroperitoneal attachments at the anterior pancreatic border should be accomplished medially up to the left branch of the middle colic artery. In our opinion, only the complete splenic flexure mobilization, which can be accomplished either through a lateral-to-medial or through a medial-to-lateral fashion, matches the criteria for a best surgical oncologic approach [11].

Splenic flexure mobilization is associated with an additional risk of inadvertent splenic injury and subsequent splenectomy, whose incidence ranges from 1.2% to 8% of cases [12]. It is a risky and demanding step and may require a longer laparotomy, if performed in open surgery, or an additional trocar insertion, if in laparoscopy [13,14]. Splenic flexure mobilization is considered more difficult in laparoscopic colorectal resection than in open surgery [15,16].

Complete mesocolic excision might improve oncologic outcome since it allow a complete removal of lymphatic drainage from the original tumor site. As already known, the area of lymphatic spread is divided into the pericolic nodes along the marginal artery (D1), the mesenteric or intermediate nodes (D2), and the central or main (D3) nodes along the main vessels. In colon cancer it has been shown that lymph node metastases may not occur in a stepwise fashion (i.e., from paracolic to intermediate to apical nodes) in up to 18% of patients [17].

The lymphatic metastatic spread is not always predictable in colon cancer [17.] In some studies, skip metastatic nodes were detected in up to 5.1% of patients who had no other nodal disease close to the tumor [17-19]. Micro-metastases, defined as nodal tumor spread<2 mm [20,21], may also occur along the lymphatic ways of spread of colon cancer. It has been hypothesized that surgical removal of micro-metastases may contribute to the benefits of CME in TNM stage II patients [18,20]. In a recent study [19], moreover, longitudinal spread was observed to the N1 zone (within 5 cm) and N2 (within 10 cm) pericolic stations. Bidirectional spread along the colon arcade to any of the two nearest feeding vessels is also possible if these are at an equal distance from the tumor. This suggests an appropriate removal of bowel length above and below the tumor site.This oncologic evidence suggests the importance of CME, either for treatment and for staging.

With standard surgery, patients with skip node metastasis may not receive appropriate adjuvant therapy. The removal of lymph nodes including the D3 area should be recommended as part of the CME with central vascular ligation strategy. D3 lymphadenectomy resection for colon cancer has been described by the Japanese, Chinese, Korean and Taiwanese Authors [22-25]. In Japan, a D3 lymphadenectomy has remained the standard of care for II and III stage of colorectal cancer [26,27]. D3 lymphadenectomy should be considered equivalent to CME with central vascular ligation [9].

The most commonly used grading system with regard to CME is the one devised for the CLASICC trial by the Medical research council [6,9,28] and is based on the grading system used for TME. According to this grading system, a colon resection is defined as to be performed in a mesocolic plane (grade A) if on the surgical specimen an intact mesocolic surface with only peritoneal or fascial defects no deeper than 5 mm occurs during surgery. It is defined as to be performed in an intramesocolic plane (grade B) if in the surgical specimen a significant irregularity and defects of peritoneal or fascial surface in at least one area that is deeper than 5 mm (with an intact colon muscularis propria) is observed. Finally, a colectomy is defined as to performed in a muscularis propria plane (grade C) if in the surgical specimen a defect extending down to the colic muscularis propria has been produced during surgery. In our series of laparoscopic left colectomy, a grade A mesocolic dissection (which has to be considered good/excellent mesocolic dissection) has been observed in10 patients (83%) and a grade B in 2 patients (17%). These data, when compared to similar data of open surgery, confirm

that the laparoscopic approach is accurate in this step of the left colectomy.
Although until now there are no randomized prospective studies comparing the difference in outcomes between CME and traditional colon cancer surgery, or systematic prospective studies analyzing the application of CME for colonic tumors at different locations, stages, pathological grades and patterns of lymph node metastasis, the benefits in terms of local recurrence or 5-year survival rate are demonstrated and reported in some retrospective not randomized studies [1,18-42]. The execution of CME through laparoscopy, according to our reported experience, is feasible, accurate and reproducible. The laparoscopic approach, when CME is planned, should be recommended since the magnification of the images and the help of gas dissection could improve the precision and safety of this surgical step.

Conclusions

Laparoscopic surgery for colorectal cancer represents the gold standard in referral centers for surgical bowel conditions. As it has been reported in our study, postoperative results and complications are on the average, when compared to results after traditional surgery. Minimally invasive surgery has offered in our series, differently than the open approach, several benefits in terms of short hospital stay, lesser cost and better cosmetic results. Moreover, a lesser postoperative immunologic weakness, which results in a better defense against cancer in the postoperative time, is expected after the laparoscopic colon surgery. Consequently, time between surgery and chemotherapy might be reduced with oncologic advantages.
CME in the era of laparoscopic colorectal surgery should be recommended along with splenic flexure mobilization. Randomized studies are required to confirm the value of these steps in laparoscopic colorectal surgery, both to demonstrate the reduction of postoperative leaking complications and to validate the improvement with regard to oncologic outcome and survival.

Riassunto

La chirurgia colorettale laparoscopica per cancro è al giorno d'oggi eseguita in numerosi centri di riferimento e sta guadagnando crescente interesse per il trattamento del cancro del colon-retto.
Dopo l'introduzione del concetto dell'escissione completa del mesoretto per cancro del retto, l'escissione completa mesocolica è stata proposta come un passo chirurgico essenziale per migliorare i risultati oncologici nei pazienti affetti da tumore del colon. L'escissione completa del mesocolon è un passo cruciale dell'emicolectomia, e consiste nella rimozione totale del mesocolon e dei suoi linfonodi con legatura alta delle principali arterie e vene mesenteriche.
In chirurgia laparoscopica, l'ingrandimento delle immagini e la dissezione facilitata dallo pneumoperitoneo potrebbero probabilmente migliorare la precisione e la sicurezza di questa fase chirurgica.
In questo lavoro, gli Autori hanno esaminato la Letteratura e hanno discusso sulla fattibilità e l'accuratezza dell'escissione mesocolica completa eseguita durante la colectomia sinistra laparoscopica per cancro in una serie preliminare.

References

1. Hohenberger W, Weber K, Matzel K, Papadopoulos T, Merkel S: *Standardized surgery for colonic cancer: complete mesocolic excision and central ligation. Technical notes and outcome.* Colorectal Dis, 2009; 11(4):354-64; discussion 364-65.

2. Vecchio R, MacFayden BV, Palazzo F: *History of laparoscopic surgery*. Panminerva Med, 2000; 42(1):87-90.

3. Vecchio R, Marchese S, Swehli E, Intagliata E: *Splenic hilum management during laparoscopic splenectomy*. J Laparoendosc Adv Surg Tech A, 2011; 21(8):717-20. Epub 2011 Jul 21. doi: 10.1089/lap.2011.0165.

4. Vecchio R, Marchese S, Leanza V, Leanza A, Intagliata E: *Totally laparoscopic repair of an ileal and uterine iatrogenic perforation secondary to endometrial curettage*. Int Surg, 2015; 100(2):244-8. doi: 10.9738/INTSURG-D-13-00267.1. PMID: 25692425

5. Vecchio R, MacFadyen BV: *Laparoscopic common bile duct exploration*. Langenbecks Arch Surg, 2002; 387(1):45-54. Epub 2002 Apr 10. Review. DOI 10.1007/s00423-002-0289-7. PMID: 11981684 [PubMed - indexed for MEDLINE]

6. Parfitt JR, Driman DK: *The total mesorectal excision specimen for rectal cancer: A review of its pathological assessment*. J Clin Pathol, 2007; 60:849-55.

7. Culligan K, Coffey JC, Kiran RP, Kalady M, Lavery IC, Remzi FH: *The mesocolon: A prospective observational study*. Colorectal Dis, 2012; 14(4):421-28; discussion 428-30.

8. Culligan K, Walsh S, Dunne C, Walsh M, Ryan S, Quondamatteo F, Dockery P, Coffey JC: *The mesocolon: A histological and electron microscopic characterization of the mesenteric attachment of the colon prior to and after surgical mobilization.* Ann Surg, 2014; 260(6):1048-56.

9. West NP, Hohenberger W, Weber K, Perrakis A, Finan PJ, Quirke P: *Complete mesocolic excision with central vascular ligation produces an oncologically superior specimen compared with standard surgery for carcinoma of the colon*. J Clin Oncol, 2010; 28(2):272-78.

10. Hohenberger W, Merkel S, Weber K: *Lymphadenektomiebei Tumoren des unteren Gastrointestinaltraktes.* Chirug, 2007; 78:217-25.

11. West NP, Kobayashi H, Takahashi K, Perrakis A, Weber K, Hohenberger W, Sugihara K, Quirke P: *Understanding optimal colonic cancer surgery: Comparison of Japanese D3 resection and European complete mesocolic excision with central vascular ligation*. J ClinOnco, 2012; 30(15):1763-769.

12. Langevin JM, Rothenberger DA, Goldberg SM: *Accidental splenic injury during surgical treatment of the colon and rectum*. Surg Gynecol Obstet, 1984; 159(2):139-44.

13. Katory M, Tang CL, Koh WL, Fook-Chong SM, Loi TT, Ooi BS, Ho KS, Eu KW*: A 6-year review of surgical morbidity and oncological outcome after high anterior resection for colorectal malignancy with and without splenic flexure mobilization.* Colorectal Dis, 2008; 10(2):165-69. Epub 2007 May 16.

14. Veldkamp R, Kuhry E, Hop WC, Jeekel J, Kazemier G, Bonjer HJ, Haglind E, Påhlman L, Cuesta MA, Msika S, Morino M, Lacy AM: *Colon cancer Laparoscopic or Open Resection Study Group (COLOR). Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial*. Lancet Oncol, 2005; 6(7):477-84.

15. Benseler V, Hornung M, Iesalnieks I, von Breitenbuch P, Glockzin G, Schlitt HJ, Agha A: *Different approaches for complete mobilization of the splenic flexure during laparoscopic rectal cancer resection*. Int J Colorectal Dis, 2012; 27(11):1521-529.

16. Jamali FR, Soweid AM, Dimassi H, Bailey C, Leroy J, Marescaux: *Evaluating the degree of difficulty of laparoscopic colorectal surgery*. Arch Surg, 2008; 143(8):762-76; discussion 768. doi: 10.1001/archsurg.143.8.762.

17. Liang JT, Huang KC, Lai HS, Lee PH, Sun CT: *Oncologic results of laparoscopic D3 lymphadenectomy for male sigmoid and upper rectal cancer with clinically positive lymph nodes.* Ann Surg Oncol, 2007; 14(7):1980-90. Epub 2007 Apr 26.

18. Merrie AE, Phillips LV, Yun K, McCall JL: *Skip metastases in colon cancer: Assessment by lymph node mapping using molecular detection*. Surgery, 2001; 129(6):684-91.

19. Tan KY, Kawamura YJ, Mizokami K, Sasaki J, Tsujinaka S, Maeda T, Nobuki M, Konishi F: *Distribution of the first metastatic lymph node in colon cancer and its clinical significance.* Colorectal Dis, 2010; 12(1):44-7.

20. Faerden AE, Sjo OH, Bukholm IR, Andersen SN, Svindland A, Nesbakken A, Bakka A: *Lymph node micrometastases and isolated tumor cells influence survival in stage I and II colon cancer*. Dis Colon Rectum, 2011; 54(2):200-06.

21. Sobin LGM, Wittekind C (eds): *International Union Against Cancer TNM Classification of Malignant Tumours,* 7th edn., Hoboken: Wiley-Blackwell, 2009.

22. Park JS, Choi GS, Lim KH, Jang YS, Kim HJ, Park SY, Jun SH: *Clinical outcome of laparoscopic right hemicolectomy with transvaginal resection, anastomosis, and retrieval of specimen*. Dis Colon Rectum, 2010; 53(11):1473-479.

23. Uematsu D, Akiyama G, Magishi A: *Multimedia article. Radical lymphadenectomy for advanced colon cancer via separation of the mesocolon into two layers as in filleting fish*. Surg Endosc, 2011; 25(5):1659-660.

24. Feng B, Sun J, Ling TL, Lu AG, Wang ML, Chen XY, Ma JJ, Li JW, Zang L, Han DP, Zheng MH: *Laparoscopic complete mesocolic excision (CME) with medial access for right-hemi colon cancer: feasibility and technical strategies*. Surg Endosc, 2012; 26(12):3669-765.

25. Wang JP: *Chinese standard for the diagnosis and treatment of colorectal cancer (2010).* Zhonghua Wei Chang WaiKeZaZhi, 2011; 14(1):1-4.

26. Watanabe T, Itabashi M, Shimada Y, Tanaka S, Ito Y, Ajioka Y, Hamaguchi T, Hyodo I, Igarashi M, Ishida H, Ishiguro M, Kanemitsu Y, Kokudo N, Muro K, Ochiai A, Oguchi M, Ohkura Y, Saito Y, Sakai Y, Ueno H, Yoshino T, Fujimori T, Koinuma N, Morita T. Nishimura G, Sakata Y, Takahashi K, Takiuchi H, Tsuruta O, Yamaguchi T, Yoshida M, Yamaguchi N, Kotake K, Sugihara K: Japanese Society for Cancer of the Colon and Rectum. *Japanese Society for Cancer of the Colon and Rectum (JSCCR) guidelines 2010 for the treatment of colorectal cancer*. Int J Clin Oncol, 2012; 17(1):1-29.

27. *General rules for clinical and pathological studies on cancer of the colon, rectum and anus. Part I. Clinical classification. Japanese Research Society for Cancer of the Colon and Rectum*. Jpn J Surg, 1983; 13(6):557-73.

28. West NP, Morris EJ, Rotimi O, Cairns A, Finan PJ, Quirke P: *Pathology grading of colon cancer surgical resection and its association with survival: A retrospective observational study.* Lancet Oncol, 2008; 9(9):857-65.

29. Bokey EL, Chapuis PH, Dent OF, Mander BJ, Bissett IP, Newland RC: *Surgical technique and survival in patients having a curative resection for colon cancer.* Dis Colon Rectum, 2003; 46(7):860-66.

30. PicardiN(1), Vene M, Visini R: *Critical update on the no-touch technique in colonic cancer using the grasping tie.* Ann Ital Chir, 2003; 74(4):469-76.

31. Storli KE, Søndenaa K, Furnes B, Nesvik I, Gudlaugsson E, Bukholm I, Eide GE: *Short term results of complete (D3) vs. standard (D2) mesenteric excision in colon cancer shows improved outcome of complete mesenteric excision in patients with TNM stages I-II*. Tech, 2014; 18(6):557-64.

32. Galizia G, Lieto E, De Vita F, Ferraraccio F, Zamboli A, Mabilia A, Auricchio A, Castellano P, Napolitano V, Orditura M: *Is complete mesocolic excision with central vascular ligation safe and effective in the surgical treatment of right-sided colon cancers? A prospective study.* Int J Colorectal Dis, 2014; 29(1):89-97.

33. Bokey L, Chapuis PH, Chan C, Stewart P, Rickard MJ, Keshava A: *Dent OF. Long-term results following an anatomically-based surgical technique for resection of colon cancer: A comparison with results from complete mesocolic excision.* Colorectal Dis, 2015.

34. Siani LM(1), Pulica C: *Stage I-IIIC right colonic cancer treated with complete mesocolic excision andcentral vascular ligation: Quality of surgical specimen and long term oncologic outcome according to the plane of surgery.* Minerva Chir, 2014; 69(4):199-208.

35. Shin JW, Amar AH, Kim SH, Kwak JM, Baek SJ, Cho JS, Kim J: *Complete mesocolic excision with D3 lymph node dissection in laparoscopic colectomy for stages II and III colon cancer: long-term oncologic outcomes in 168 patients.* Tech Coloproctol, 2014; 18(9):795-803. doi: 10.1007/s10151-014-1134-z. Epub 2014 Mar 15.

36. Dedavid e Silva TL, Damin DC: *Lymph node ratio predicts tumor recurrence in stage III colon cancer*. Rev Col Bras Ci, 2013; 40(6):463-70.

37. Willaert W, Mareel M, Van De Putte D, Van Nieuwenhove Y, Pattyn P, Ceelen W: L*ymphatic spread, nodal count and the extent of lymphadenectomy in cancer of the colon.* Cancer Treat Re, 2014; 40(3):405-13.

38. Chandrasinghe PC, Ediriweera DS, Hewavisenthi J, Kumarage S, Deen KI: *Total number of lymph nodes harvested is associated with better survival in stages II and III colorectal cancer.* Indian J Gastroenterol. 2014; 33(3):249-53.

39. Gleisner AL, Mogal H, Dodson R, Efron J, Gearhart S, Wick E, Lidor A, Herman JM, Pawlik TM: *Nodal status, number of lymph nodes examined, and lymph node ratio: What defines prognosis after resection of colon adenocarcinoma?* J Am Coll Surg, 2013; 217(6):1090-100.

40. Lu YJ, Lin PC, Lin CC, Wang HS, Yang SH, Jiang JK, Lan YT, Lin TC, Liang WY, Chen WS, Lin JK, Chang SC: *The impact of the lymph node ratio is greater than traditional lymph node status in stage III colorectal cancer patients.* World J Surg, 2013; 37(8):1927-933.

41. Nedrebø BS, Søreide K, Nesbakken A, Eriksen MT, Søreide JA, Kørner H; Norwegian Colorectal Cancer Group: *Risk factors associated with poor lymph node harvest after colon cancer surgery in a national cohort.* Colorectal Dis, 2013; 15(6):e301-8.

42. Allaix ME, Arezzo A, Cassoni P, Mistrangelo M, Giraudo G, Morino M: *Metastaticlymphnode ratio as a prognostic factor after laparoscopic total mesorectalexcision for extraperitoneal, rectalcancer.* Surg Endosc, 2013; 27(6):19579-67.