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REVIEW ARTICLE

Laparoscopic Colorectal Surgery for Cancer: What Is the Role of Complete Mesocolic Excision and Splenic Flexure Mobilization?

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Abstract Laparoscopic colorectal surgery for cancer is nowadays routinely performed worldwide. After the introduction by Heald of total mesorectal excision for rectal cancer, also a complete mesocolic excision has been advocated as an essential surgical step to improve oncologic results in patients with colon cancer. The complete removal of mesocolon with high ligation of the main mesenteric arteries and veins and the mobilization of splenic flexure are well-known but still debated in western surgical society. The authors reviewed the literature and outlined the rationale and the results of splenic flexure mobilization and complete mesocolic excision in laparoscopic surgery for colorectal cancer.

Keywords Splenic flexure mobilization · Complete mesocolic excision · Laparoscopy · Colorectal surgical technique · Colorectal cancer

Introduction

Laparoscopic surgery has gained increasing interest for treatment of colorectal cancer. According to the American Board of colorectal surgery, already in 2005, about 24.3% of laparoscopic colorectal surgery was performed for oncologic indications. In the same year, about 41.1% of surgical operations for colorectal cancer were accomplished laparoscopically [1]. Nowadays, the trend towards laparoscopic technique in colorectal surgery, either for benign or malignant disease, is continuously rising up.

Since Heald, back in 1988, described the "holy plane" of rectal cancer surgery [2], total mesorectal excision (TME) during rectal resection has been broadly adopted and local recurrence rate has successfully been reduced from 40% to less than 10% in mid/low rectal tumours [3, 4].

Thanks to this above-mentioned scientific validated observation that proved great results in survival and recurrence of rectal cancer, a new emphasis has now given to a complete removal of mesocolon of the affected large bowel. This new trend in the surgical treatment of colon cancer has been developed first in the eastern countries and now has become popular among western surgeons. [5].

The complete mesocolic excision (CME) for colon cancer has been introduced in western countries after its publication in 2009 by Hohenberger et al. [6], who performed and standardized this new surgical approach in colon malignancies, consisting in the total removal of the mesocolon with its lymph nodes, in addition to the classical colorectal surgical technique.

This is defined as the approach of "coelomic mesenteric folds", which completely responds to the philosophy of eastern surgeons who have always considered large lymphadenectomies as an important step in surgical oncology. In western countries, on the contrary, lymphadenectomy has been performed only for pathological staging and prognosis rather than for actual survival benefits [7].

Since mesocolic attachments have now a leading role in colon surgery for cancer, splenic flexure mobilization (SFM) has also been reconsidered. Although many surgeons advocate that SFM should be performed as a routine step during anterior resection [8, 9], there is still no universal agreement on the necessity and usefulness of SFM in left colorectal surgery [10, 11]. However, a complete SFM could become

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essential in case of left mesocolic excisions, especially during laparoscopic operations.

In this article, based on these advances, the authors reviewed the literature and discuss on splenic flexure mobilization and complete mesocolic excision. Feasibility, safety and usefulness of these surgical steps during laparoscopic colorectal cancer surgery are debated.

Splenic Flexure Mobilization

The definition of SFM is not homogeneous among different studies. It seems to be essential to differentiate a partial splenic flexure from the complete splenic flexure mobilization. With partial SFM, it should be intended only to the division of spleno-colic and phreno-colic ligaments. Complete SFM includes, otherwise, division of spleno-colic and phreno-colic ligaments (partial mobilization) in addition to division of gastro-colic and pancreatico-mesocolic attachments, and can be technically accomplished either through a lateral-to-medial or a medial-to-lateral fashion [12, 13]. It is in our opinion that only this "complete" SFM matches the criteria for better surgical outcomes.

Routine versus selected SFM during left colorectal laparoscopic surgery is still argued. As a matter of fact, SFM is associated with additional risk of inadvertent splenic injury and subsequent splenectomy. The incidence of splenic injuries resulting in splenectomy during colorectal surgery has been reported in a rate varying from 1.2 to 8% of cases [14]. Patients undergoing colectomy who sustain splenic injury are at increased risk of morbidity and mortality in both short- and long-term postoperative period, regardless of whether or not they have cancer or the spleen was salvaged [15–18].

SFM is also a demanding step towards both conventional and laparoscopic procedures and may require patient repositioning, wider incision or additional port insertion [11, 19]. It is considered more difficult in laparoscopic colorectal resection than in open surgery [20]. According to a survey questioning 35 experienced laparoscopic colorectal surgeons, SFM was evaluated as one of the toughest procedures to perform [21]. In the proposed score system, used to evaluate the difficulty of different procedures, SFM was marked as one of the trickiest in colorectal surgery.

Pros and cons of SFM during left colon resections need to be analytically considered. Although some studies have shown that routine SFM confers no advantage with regard to morbidity, oncological results or survival in both laparoscopic and open anterior resections [10, 11], other surgeons perform SFM especially during anterior resection with improved postoperative outcome. Their series demonstrates a lower risk of anastomotic leak and oncological compromise in the groups in which SFM had been undertaken [8, 9].

Besides, SFM is a time-consuming procedure (Table 1, Fig. 1). Analysing four different case-control studies [8, 10, 13, 22], it appears evident that SFM entails a statistically significant extra time, regardless of the type of surgery chosen: open or laparoscopic. In Brennan's experience on open colorectal surgery [10], SFM was associated to a longer operative time with a mean extra time of 47 min ($P = 0.023$). Similar data were reported by Marsden [22] and Akiyoshi [8] in laparoscopic series. The first reported an extra time of 70 min ($P < 0.001$), and the latter an extra time of 52 min ($P < 0.0001$). Kim [13], who prefers to mobilize the splenic flexure through an extended medial-to-lateral approach, showed better results, with only a mean extra time of 16 min, suggesting this approach over the lateral-to-medial one which required 28 min mean ($P < 0.001$). Today, almost all laparoscopic colorectal surgeons, including our team, prefer a medial-to-lateral approach.

Some authors reported that SFM is related to specific intraoperative complications [8], including bleeding near the pancreatic tail and marginal artery injury. Gezen et al. indicated that postoperative complication rates were 22.2 and 36.0% in patients undergoing, respectively, partial and complete SFM [12]. SFM is also significantly associated with greater intraoperative blood loss ($P = 0.0006$) and longer operative time ($P < 0.0001$) because of technical difficulty, which potentially increases risk of complications [8].

On the other hand, in favour of SFM as part of colorectal cancer surgery, there are several anatomical and oncological studies [23–25], which support its usefulness. As a matter of fact, it is plausible to speculate that SFM, extending the colon segment available for colorectal anastomosis, would reduce tension, preserve blood flow to the anastomosis and, subsequently, improve surgical outcomes.

High ligation of the inferior mesenteric artery (HL-IMA) before the origin of the left colic artery, although not universally accepted, is by most considered an essential step for radical oncologic surgery, allowing removal of D3 lymph nodes [26]. HL-IMA, however, is dependent on the arcade

Table 1 Operative time duration for SFM (min, mean)

Author	*Pts N.*	*Surgery*	*SFM*	*No SFM*	*Extra time*	*P value*
Akiyoshi [8]	260	Laparoscopic	194		52	<0.0001
Brennan [10]	100	Open	167	120	47	0.023
Marsden [22]	138	Laparoscopic	255	185	70	<0.001
Kim [13]	237	Laparoscopic	162	140	22	

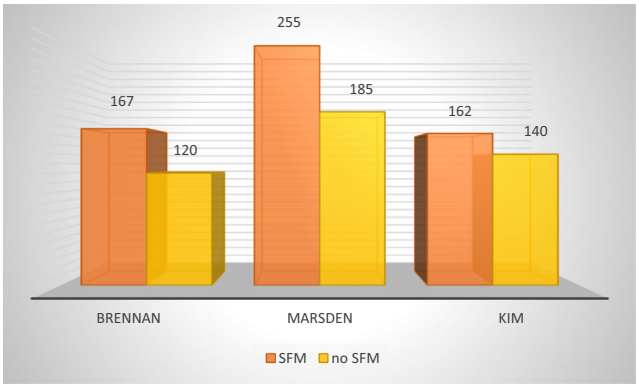

Fig. 1 Operative time duration for SFM (min, mean)

of Riolan as well as the vascularization of any distal anastomosis. But the arcade of Riolan is an inconstant artery. Therefore, in cases it was not present, but HL-IMA was accomplished for oncologic reasons, the redundancy of colon after SFM should allow to resect the colon more proximally and still to achieve a tension-free anastomosis. This more proximal resection would also assure a better blood supply to the anastomosis ensuring its vitality.

In Aranjo's study [23], anatomical dissections for left colectomy and colorectal anastomosis were conducted in 20 fresh bodies by the same team of surgeons. The effect of partial and complete splenic flexure mobilization on the extent of the mobilized left colon segment was determined. The length of the resected left colon, enabling a tension-free colorectal anastomosis at the level of sacral promontory, achieved without mobilizing the splenic flexure, was 46.3 cm (range 35–81 cm). After partial mobilization of the splenic flexure, the length of the achieved mobilized left colon segment reached 57 cm (range 48.3–76.3 cm). Eventually, after full mobilization of the distal transverse colon, it measured 85.3 cm mean (range 67–122 cm).

Thum-umnuaysuk, in his article [24], measured the colon length gained after three different surgical procedures of colon mobilization for low rectal anastomosis. The maximum colon elongation was achieved only when high ligation of inferior mesenteric artery (HL-IMA) and SFM had been associated with high ligation of the inferior mesenteric vein (HL–IMV), demonstrating a high statistical significance when compared with the other two techniques ($P < 0.0001$).

In Kye's work [25], the author defines ligation of the IMV after the left colic vein converged to the IMV as a high ligation, and ligation of the IMV before the left colic vein converged to the IMV as a low ligation. The obtained redundancy of the colon after SFM in the HL-IMV group (29.54 ± 7.17 cm) was higher than in the low ligation group (24.94 ± 6.07 cm; $P < 0.0001$).

For sure, SFM is an additional and complex surgical step also in experienced teams and the controversy over the utility of SFM will not reach a clear conclusion until evidence from randomized trials will be available.

Complete Mesocolic Excision

In 2009, based on similar theories introduced for total mesorectal excision (TME), Hohenberger et al. proposed a new technique for colon cancer [6], termed "complete mesocolic excision" (CME). Dissection, according to the concept of CME, ensures complete removal of the lymphatic, vascular and neural tissues in the drainage area of the colon cancer. Hohemberg's principle matched eastern philosophy where lymphadenectomies are performed for oncological purposes to increase survival rate. On the contrary, in Europe and North America lymphadenectomy has been performed only for staging and prognosis [7]. 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 [27].

There are three essential components of CME. The main one 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 tumour area [6, 28]. This envelope contains potentially involved lymph nodes, and, by keeping it intact, the risk of spillage of neoplastic cells into the peritoneal cavity is minimized. The second component is a central (or high) vascular ligation of the relevant blood supply feeding vessel so as to completely remove all lymph nodes in the central (or vertical) direction [6, 29]. For right-sided resections, there might be quite radical differences. Even though a high vascular tie has always been recommended, there have never been clear guidelines on exactly how high the vascular tie should be. The third component is the resection of an adequate length of bowel to remove involved pericolic lymph nodes in the longitudinal direction.

The most commonly used grading system with regard to CME is the one designed for the CLASICC trial by the Medical Research Council [28, 30], and it is based on the grading system used for TME. Surgery is classified as being in the muscularis propria ("poor" plane) if the layer of dissection gives little bulk to the mesocolon and contains disruptions extending down into the muscularis propria. The intramesocolic plane ("moderate" plane of surgery) occurs if the layer of dissection gives moderate bulk to the mesocolon, and it breaches through the mesocolon fascia but without reaching the muscularis propria. The mesocolic ("good") plane occurs when there is an intact mesocolon with a smooth, peritoneal lined surface. Following the mesocolic plane, and then performing a CME, also allows a better staging for the following adjuvant chemotherapy, even in cases of skip lymph node metastasis.

The knowledge of embryology and anatomy of the peritoneal layer is essential to understanding the role of mesocolic dissection in colon cancer. The embryologic development, however, can help to understand the anatomy of coelomic mesenteric folds in the adult. At the end of the embryologic rotations, the mesentery of the colon is attached posteriorly to the retroperitoneum, medially to the colon sections. This is in accordance with the hypothesis of Toldt, who in 1873 identified a distinct fascial plane between the mesocolon and the underlying retroperitoneum, formed by the fusion of the visceral peritoneum of the mesocolon with the parietal peritoneum of the retroperitoneum (Toldt's fascia).

Interestingly, laparoscopic surgery, with its high magnification and resolution, sustained the terminology such as "mesocolon" and "Toldt's fascia", and led to a resurgence of interest in surgical anatomy in general. Contemporary appraisals have confirmed that the mesenteric organ is, as a matter of fact, a continuous structure from the duodenojejunal flexure to the mesorectum [31, 32].

Beside the embryologic and anatomic considerations above reported, the rationale for CME has been remarked, by several oncologic studies. As known, central lymphatic spread occurs along the feeding vessels. The area of lymphatic spread is divided into the pericolic nodes along the marginal artery (D1), mesenteric or intermediate nodes (D2) and central or main nodes (D3). In colon cancer, it has been shown that lymph node metastases may not occur in a stepwise fashion (i.e. from pericolic to intermediate to apical nodes) in up to 18% of patients [33]. In some studies, apical skip metastatic nodes were detected in up to 5.1% of patients who had no other nodal disease close to the tumour [33–35].

This above-mentioned oncologic evidence suggests the importance of CME, both for treatment and staging. When standard surgery is performed, patients with skip node metastasis may not receive appropriate adjuvant therapy. The removal of lymph nodes up to and including the D3 area should thereby be currently recommended as part of the CME with central vascular ligation (CVL) strategy. D3 lymphadenectomy should be considered equivalent to CME with CVL [26]. D3 lymphadenectomy resections for colon cancer have now been widely published by the Japanese, Chinese, Korean and Taiwanese [36–39]. In Japan, a D3 lymphadenectomy has remained the standard of care for clinical stage II and III for colorectal cancer surgery through all editions of their general rules [40, 41].

Micro-metastases, defined as tumour deposits (<2 mm) identified within lymph nodes with special staining methods [42, 43], may also occur along the lymphatic ways of spread of colon cancer. It has been hypothesised that surgical removal of micro-metastases may offer an explanation for, at least, part of the benefits of CME in TNM stage II patients [34, 42].

In a recent study [35], moreover, longitudinal spread was only 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 tumour. This suggests an appropriate removal of bowel length above and below the tumour site.

Until now, there has been neither randomized prospective study comparing the difference of outcomes between CME and traditional colon cancer surgery, nor a systematic prospective study analysing the application of CME for colonic tumours at different locations, stages, pathological grades and patterns of lymph node metastasis. However, the benefits, in terms of local recurrence or survival rate, are demonstrated and reported in some case-control studies (Table 2, Fig. 2) [6, 30, 44–46]. In these large series, 3- and 5-year survival rate ranged between 61.5 and 90.5% in the study group where CME was performed and from 46.0 to 82.1% in the standard colectomy group. Statistical significance confirmed the superiority of CME in four out of five analyses. Local 5-year recurrence rate also increased considerably. Hohemberg showed a reduction from 6.5% in the classic colectomy subgroup to 3.6% in the CME group [6], whereas in Galizia's article it passed from 20.7 to 0% where significance has been statistically proved ($P = 0.03$) [46].

CME can be safely performed laparoscopically for proximal right- and left-sided tumours with good oncological results. The evidence for hepatic flexure and transverse colon tumours, however, remains lacking. In open-access surgery, the lateral-to-medial approach to the retro-mesenteric plane (Toldt's) is relatively easy. It has been questioned if the medial-to-lateral approach most often used in laparoscopic surgery can achieve the same clearance [47, 48]. Specimen inspection by laparoscopic specialist surgeons and specialist pathologists has confirmed the adequacy of this approach. The place of laparoscopy for tumours in the transverse colon or bulkier or T4 tumours, or in patients with a high BMI, is still debated by some [49]. Nevertheless, these limitations are not absolute [49, 50]. Therefore, the range of bowel resection should be determined, based on three considerations—standardized paracolic dissection, bowel viability after D3 lymph node dissection and restoration of near-normal consistency after anastomosis—rather than ensuring negative resection margins alone.

Table 2 Survival rate (%) with CME versus classic colectomy

Author	*Pts N.*	*Stage*	*Years*	*CME*	*Classic*	*P value*
Hohenberg [6]	1329	I–III	5	89.1	82.1	0.039
West [30]	399	I–IV	5	61.5	46.0	0.02
Bokey [44]	867	A–C	5	63.7	48.1	<0.0001
Storli [45]	189	I–II	3	88.1	79.0	0.003
Galizia [46]	103	I–IVa	5	90.5	74.4	0.13

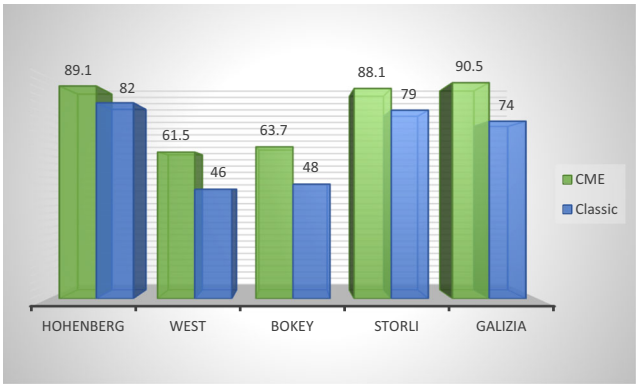

Fig. 2 Survival rate (%) with CME versus classic colectomy

Conclusion

CME in the era of laparoscopic colorectal surgery should be recommended, along with SFM. Randomized studies are required to confirm the value of these steps in laparoscopic colorectal surgery, both to demonstrate the reduction of postoperative complications and to validate the improvement towards oncologic long-term survival. The laparoscopic approach might be of great help in the teaching and standardization of the surgical technique including CME and SFM.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

References

1. Schoetz DJ Jr (2006) Evolving practice patterns in colon and rectal surgery. J Am Coll Surg 203(3):322–327
2. Heald RJ (1988) The 'Holy Plane' of rectal surgery. J R Soc Med 81(9):503–508
3. Sauer R, Becker H, Hohenberger W, Rödel C, Wittekind C, Fietkau R, Martus P, Tschmelitsch J, Hager E, Hess CF, Karstens JH, Liersch T, Schmidberger H, Raab R, German Rectal Cancer Study Group (2004) Preoperative versus postoperative chemoradiotherapy for rectal cancer. N Engl J Med 351(17):1731–1740
4. Bosset JF, Collette L, Calais G, Mineur L, Maingon P, Radosevic-Jelic L, Daban A, Bardet E, Beny A, Ollier JC, EORTC Radiotherapy Group Trial 22921 (2006) Chemotherapy with preoperative radiotherapy in rectal cancer. N Engl J Med 355(11):1114–1123
5. Chow CF, Kim SH (2014) Laparoscopic complete mesocolic excision: West meets East. World J Gastroenterol 20(39):14301–14307. doi:10.3748/wjg.v20.i39.14301
6. 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. Color Dis 2009;11(4):354–364; **discussion 364-5**. doi: 10.1111/j.1463-1318.2008.01735.x.
7. Nelson H, Petrelli N, Carlin A, Couture J, Fleshman J, Guillem J, Miedema B, Ota D, Sargent D, National Cancer Institute Expert Panel (2001) Guidelines 2000 for colon and rectal cancer surgery. J Natl Cancer Inst 93(8):583–596
8. Akiyoshi T, Kuroyanagi H, Oya M, Ueno M, Fujimoto Y, Konishi T, Yamaguchi T (2010) Factors affecting difficulty of laparoscopic surgery for left-sided colon cancer. Surg Endosc 24(11):2749–2754. doi:10.1007/s00464-010-1039-5
9. Farke S, Bouchard R, Blumberg C, Keller R, Roblick UJ, Bruch HP, Fischer F (2010) Mobilization of the splenic flexure: a standard in laparoscopic left colon and rectum resections! Surg J 5:31–35. doi:10.3923/sjour.2010.31.35
10. Brennan DJ, Moynagh M, Brannigan AE, Gleeson F, Rowland M, O'Connell PR (2007) Routine mobilization of the splenic flexure is not necessary during anterior resection for rectal cancer. Dis *Colon rectum* 50(3):302–307 **discussion 307**
11. Katory M, Tang CL, Koh WL, Fook-Chong SM, Loi TT, Ooi BS, Ho KS, Eu KW (2008) A 6-year review of surgical morbidity and oncological outcome after high anterior resection for colorectal malignancy with and without splenic flexure mobilization. Color Dis 10(2):165–169
12. Gezen C, Altuntas YE, Kement M, Vural S, Civil O, Okkabaz N, Aksakal N, Oncel M (2012) Complete versus partial mobilization of splenic flexure during laparoscopic low anterior resection for rectal tumors: a comparative study. J Laparoendosc Adv Surg Tech A. 22(4):392–396. doi:10.1089/lap.2011.0409
13. Kim HJ, Kim CH, Lim SW, Huh JW, Kim YJ, Kim HR (2013) An extended medial to lateral approach to mobilize the splenic flexure during laparoscopic low anterior resection. Color Dis 15(2):e93–e98. doi:10.1111/codi.12056
14. Langevin JM, Rothenberger DA, Goldberg SM (1984) Accidental splenic injury during surgical treatment of the colon and rectum. Surg Gynecol Obstet 159(2):139–144
15. Holubar SD, Wang JK, Wolff BG, Nagorney DM, Dozois EJ, Cima RR, O'Byrne MM, Qin R, Larson DW (2009) Splenic salvage after intraoperative splenic injury during colectomy. Arch Surg 144(11):1040–1045. doi:10.1001/archsurg.2009.188
16. Vecchio R, Marchese S, Swehli E, Intagliata E (2011) Splenic hilum management during laparoscopic splenectomy. J Laparoendosc Adv Surg Tech A 21(8):717–720. doi:10.1089/lap.2011.0165
17. Vecchio R, Intagliata E, Marchese S, La Corte F, Cacciola RR, Cacciola E (2014) Laparoscopic splenectomy coupled with laparoscopic cholecystectomy. JSLS 18(2):252–257. doi:10.4293/108680813X13693422518434
18. Vecchio R, Cacciola E, Martino M, Cacciola RR, MacFadyen BV (2003) Modifications of coagulation and fibrinolytic parameters in laparoscopic cholecystectomy. Surg Endosc 17(3):428–433
19. 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) (2005) Laparoscopic surgery versus open surgery for colon cancer: short-term outcomes of a randomised trial. Lancet Oncol. 6(7):477–484
20. Benseler V, Hornung M, Iesalnieks I, von Breitenbuch P, Glockzin G, Schlitt HJ, Agha A (2012) Different approaches for complete mobilization of the splenic flexure during laparoscopic rectal cancer resection. Int J Color Dis 27(11):1521–1529. doi:10.1007/s00384-012-1495-6
21. Jamali FR, Soweid AM, Dimassi H, Bailey C, Leroy J, Marescaux J Evaluating the degree of difficulty of laparoscopic colorectal surgery. Arch Surg 2008;143(8):762–767; **discussion 768**. doi: 10.1001/archsurg.143.8.762.
22. Marsden MR, Conti JA, Zeidan S, Flashman KG, Khan JS, O'Leary DP, Parvaiz A (2012) The selective use of splenic flexure mobilization is safe in both laparoscopic and open anterior resections. Color Dis 14(10):1255–1261. doi:10.1111/j.1463-1318.2011.02927.x
23. Araujo SE, Seid VE, Kim NJ, Bertoncini AB, Nahas SC, Cecconello I (2012) Assessing the extent of colon lengthening

due to splenic flexure mobilization techniques: a cadaver study. Arq Gastroenterol 49(3):219–222
24. Thum-umnuaysuk S, Boonyapibal A, Geng YY, Pattana-Arun J (2013) Lengthening of the colon for low rectal anastomosis in a cadaveric study: how much can we gain? Tech Coloproctol. 17(4): 377–381. doi:10.1007/s10151-012-0930-6
25. Kye BH, Kim HJ, Kim HS, Kim JG, Cho HM (2014) How much colonic redundancy could be obtained by splenic flexure mobilization in laparoscopic anterior or low anterior resection? Int J Med Sci 11(9):857–862. doi:10.7150/ijms.8874 **eCollection 2014**
26. West NP, Kobayashi H, Takahashi K, Perrakis A, Weber K, Hohenberger W, Sugihara K, Quirke P (2012) Understanding optimal colonic cancer surgery: comparison of Japanese D3 resection and European complete mesocolic excision with central vascular ligation. J Clin Oncol 30(15):1763–1769. doi:10.1200/JCO.2011.38.3992
27. Vecchio R, MacFayden BV, Palazzo F (2000) History of laparoscopic surgery. Panminerva Med 42(1):87–90
28. West NP, Hohenberger W, Weber K, Perrakis A, Finan PJ, Quirke P (2010) Complete mesocolic excision with central vascular ligation produces an oncologically superior specimen compared with standard surgery for carcinoma of the colon. J Clin Oncol 28(2):272–278. doi:10.1200/JCO.2009.24.1448
29. Hohenberger W, Merkel S, Weber K (2007) Lymphadenektomie bei Tumoren des unteren Gastrointestinaltraktes. Chirug 78:217–225. doi:10.1007/s00104-007-1311-y
30. West NP, Morris EJ, Rotimi O, Cairns A, Finan PJ, Quirke P (2008) Pathology grading of colon cancer surgical resection and its association with survival: a retrospective observational study. Lancet Oncol 9(9):857–865. doi:10.1016/S1470-2045(08)70181-5
31. Culligan K, Coffey JC, Kiran RP, Kalady M, Lavery IC, Remzi FH The mesocolon: a prospective observational study. Color Dis 2012;14(4):421–428; **discussion 428-30**. doi: 10.1111/j.1463-1318.2012.02935.x.
32. Culligan K, Walsh S, Dunne C, Walsh M, Ryan S, Quondamatteo F, Dockery P, Coffey JC (2014) The mesocolon: a histological and electron microscopic characterization of the mesenteric attachment of the colon prior to and after surgical mobilization. Ann Surg 260(6):1048–1056. doi:10.1097/SLA.0000000000000323
33. Liang JT, Huang KC, Lai HS, Lee PH, Sun CT (2007) Oncologic results of laparoscopic D3 lymphadenectomy for male sigmoid and upper rectal cancer with clinically positive lymph nodes. Ann Surg Oncol 14(7):1980–1990
34. Merrie AE, Phillips LV, Yun K, McCall JL (2001) Skip metastases in colon cancer: assessment by lymph node mapping using molecular detection. Surgery 129(6):684–691
35. Tan KY, Kawamura YJ, Mizokami K, Sasaki J, Tsujinaka S, Maeda T, Nobuki M, Konishi F (2010) Distribution of the first metastatic lymph node in colon cancer and its clinical significance. Color Dis 12(1):44–47. doi:10.1111/j.1463-1318.2009.01924.x
36. Park JS, Choi GS, Lim KH, Jang YS, Kim HJ, Park SY, Jun SH (2010) Clinical outcome of laparoscopic right hemicolectomy with transvaginal resection, anastomosis, and retrieval of specimen. Dis *Colon rectum* 53(11):1473–1479. doi:10.1007/DCR.0b013e3181f1cc17
37. Uematsu D, Akiyama G, Magishi A (2011) Multimedia article. Radical lymphadenectomy for advanced colon cancer via separation of the mesocolon into two layers as in filleting fish. Surg Endosc 25(5):1659–1660. doi:10.1007/s00464-010-1439-6
38. Feng B, Sun J, Ling TL, Lu AG, Wang ML, Chen XY, Ma JJ, Li JW, Zang L, Han DP, Zheng MH (2012) Laparoscopic complete mesocolic excision (CME) with medial access for right-hemi colon cancer: feasibility and technical strategies. Surg Endosc 26(12): 3669–3675. doi:10.1007/s00464-012-2435-9
39. Wang JP (2011) Chinese standard for the diagnosis and treatment of colorectal cancer (2010). Zhonghua Wei Chang Wai Ke Za Zhi 14(1):1–4
40. 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 (2012) Japanese Society for Cancer of the Colon and Rectum (JSCCR) guidelines 2010 for the treatment of colorectal cancer. Int J Clin Oncol 17(1):1–29. doi:10.1007/s10147-011-0315-2
41. (1983) 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 13(6):557–73
42. Faerden AE, Sjo OH, Bukholm IR, Andersen SN, Svindland A, Nesbakken A, Bakka A (2011) Lymph node micrometastases and isolated tumor cells influence survival in stage I and II colon cancer. Dis *Colon rectum* 54(2):200–206. doi:10.1007/DCR.0b013e3181fd4c7c
43. (2009) Sobin LGM, Wittekind C (eds). International Union Against Cancer TNM Classification of Malignant Tumours, 7th edn. Wiley, Hoboken
44. Bokey EL, Chapuis PH, Dent OF, Mander BJ, Bissett IP, Newland RC (2003) Surgical technique and survival in patients having a curative resection for colon cancer. Dis *Colon rectum* 46(7):860–866
45. Storli KE, Søndenaa K, Furnes B, Nesvik I, Gudlaugsson E, Bukholm I, Eide GE (2014) 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 Coloproctol 18(6):557–564. doi:10.1007/s10151-013-1100-1
46. Galizia G, Lieto E, De Vita F, Ferraraccio F, Zamboli A, Mabilia A, Auricchio A, Castellano P, Napolitano V, Orditura M (2014) 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 Color Dis 29(1):89–97. doi:10.1007/s00384-013-1766-x
47. Ding J, Liao GQ, Xia Y, Zhang ZM, Pan Y, Liu S, Zhang Y, Yan ZS (2013) Medial versus lateral approach in laparoscopic colorectal resection: a systematic review and meta-analysis. World J Surg 37(4):863–872. doi:10.1007/s00268-012-1888-2 **Review**
48. Gouvas N, Pechlivanides G, Zervakis N, Kafousi M, Xynos E (2012) Complete mesocolic excision in colon cancer surgery: a comparison between open and laparoscopic approach. Color Dis 14(11):1357–1364. doi:10.1111/j.1463-1318.2012.03019.x
49. Bagshaw PF, Allardyce RA, Frampton CM, Frizelle FA, Hewett PJ, McMurrick PJ, Rieger NA, Smith JS, Solomon MJ, Stevenson AR, Australasian Laparoscopic Colon Cancer Study Group (2012) Long-term outcomes of the australasian randomized clinical trial comparing laparoscopic and conventional open surgical treatments for colon cancer: the Australasian Laparoscopic Colon Cancer Study trial. Ann Surg 256(6):915–919. doi:10.1097/SLA.0b013e3182765ff8
50. Storli KE, Søndenaa K, Furnes B, Eide GE (2013) Outcome after introduction of complete mesocolic excision for colon cancer is similar for open and laparoscopic surgical treatments. Dig Surg 30(4–6):317–327. doi:10.1159/000354580 **Erratum in: Dig Surg. 2013;30(4-6):327**