



## Quality assessment of surgery for colorectal cancer: Where do we stand?

Stefan Morarasu, Cristian Livadaru, Gabriel-Mihail Dimofte

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**Stefan Morarasu, Cristian Livadaru, Gabriel-Mihail Dimofte**, The Second Department of Surgical Oncology, Regional Institute of Oncology, Iasi 707483, Romania

**Corresponding author:** Gabriel-Mihail Dimofte, PhD, Professor, The Second Department of Surgical Oncology, Regional Institute of Oncology, 2-4 General Berthelot St, Iasi 707483, Romania. [gdimofte@gmail.com](mailto:gdimofte@gmail.com)

### Abstract

Quality assurance in surgery has been one of the most important topics of debate among colorectal surgeons in the past decade. It has produced new surgical standards that led in part to the impressive oncological outcomes we see in many units today. Total mesorectal excision, complete mesocolic excision (CME), and the Japanese D3 lymphadenectomy are now benchmark techniques embraced by many surgeons and widely recommended by surgical societies. However, there are still ongoing discrepancies in outcomes largely based on surgeon performance. This is one of the main reasons why many countries have shifted colorectal cancer surgery only to high volume centers. Defining markers of surgical quality is thus a prerequisite to ensure that standards and oncological outcomes are met at an institutional level. With the evolution of CME surgery, various quality markers have been described, mostly based on measurements on the surgical specimen and lymph node yield, while others have proposed radiological markers (*i.e.* arterial stumps) measured on postoperative scans as part of the routine cancer follow-up. There is no ideal marker; however, taken together and assembled into a new score or set of criteria may become a future point of reference for reporting outcomes of colorectal cancer surgery in research studies and defining subspecialization requirements both at an individual and hospital level.

**Key Words:** Colorectal cancer; Colon surgery; Arterial stump; Complete mesocolic excision; Surgical quality

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**Core Tip:** Quality assurance in colorectal cancer surgery has had a major impact on survival, and it is likely the most important factor contributing to the unprecedented decrease in local recurrences. Due to total mesorectal excision and complete mesocolic excision, we have a set of quality markers that can be used as tools to predict outcomes and guide surgical and oncological management in at-risk patients. While there is strong evidence supporting the value of quality markers, we must promote their use at national and institutional levels as a prerequisite of good practice, thus offering our patients the best chances of cure.

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## INTRODUCTION

The importance of defining quality standards in colorectal cancer surgery cannot be overemphasized, and we have Heald's total mesorectal excision (TME) as a benchmark of how proper surgery can radically improve oncological outcomes by adhering to well defined embryological planes and retrieving an intact mesorectum with adequate circumferential and distal margins[1]. The principle of TME was well translated into colon surgery by Hohenberger *et al*[2] who defined the technique of complete mesocolic excision (CME). CME is based on three main principles: (1) Dissection in embryological planes to ensure complete removal of an intact mesocolon; (2) adequate proximal and distal margins of 10 cm; and (3) central vascular ligation (CVL) in order to remove all apical lymph nodes. Through this approach, authors have shown an impressive drop in local recurrence rates. Not only did CME show how surgical technique can significantly change outcomes in colon cancer, but it provided a clear plan and set of values that surgeons should respect in order to provide standardized surgery to their patients. To replicate their results, all the components of CME must be strictly followed. While dissection in embryological planes and longitudinal margins were rapidly embraced, if not already performed by many surgeons, the importance of CVL in all cases is still debated.

CVL is a key component of the CME technique and despite debates against it, it is undoubtedly an essential requirement in locally advanced, N+ colon cancers. While in early colon cancers (*e.g.*, T1-2N0) its oncological benefit might be overturned by a higher risk of nerve and vascular injury[3], in more advanced cancers one must ensure high ligation of the inferior mesenteric artery on the left side and adequate superior mesenteric vein (SMV) exposure and central ileocolic pedicle ligation on the right side. Despite a higher risk of SMV injury, there is solid evidence supporting a more aggressive dissection to ensure removal of apical nodes and less local recurrences[4,5]. In addition, by performing CVL, the surgeon increases the number of excised lymph nodes, and in some cases this will lead to upstaging, thus offering patients the benefit of adjuvant therapy, which will ultimately improve their disease-free survival.

We are all aware of the benefits of quality colorectal surgery, but are we all practicing it? Any surgeon would answer yes, and some would say they were performing quality surgery even before the introduction of CME, which might be true. But 'might' is not enough. We must ensure that quality surgery is universally standardized in order to improve outcomes at a global level and to reduce confounding biases related to surgical techniques when international or local audits are performed on colorectal cancer patients. This is the main reason why markers of surgical quality need to be implemented universally by governing bodies in order to define proper techniques and improve oncological outcomes of colon surgery.

Quality markers are measurable, quantitative, evidence-based indicators that can objectively predict extent of surgery. While most quality markers indirectly predict prognosis by quantifying surgery, it is not a prerequisite as disease-free survival is dependent on other factors, apart from quality of surgery. In breaking down CME we can define quality markers for each main component, namely dissection plane, distal and circumferential margins, and CVL.

## QUALITY MARKERS OF DISSECTION

When it comes to TME, quality markers of dissection are well known and based on defining which plane of dissection the surgeon adhered to. It is up to the pathologist to define it as mesorectal plane (good quality, mesorectal fascia preserved), intramesorectal plane (moderate quality, plane of dissection largely violated the mesorectal fascia), and muscularis propria plane (poor quality, defects in the mesorectum down to the muscular wall of the rectum) (Table 1). These have been transferred to colon surgery, and such a mesocolic dissection plane should be graded as mesocolic (mesocolic fascia intact with minor defects), intramesocolic (significant defects in the mesocolic fascia), and muscularis propria (large defects in the mesocolon extending down to the muscular tube) (Table 2).

In addition to the TME quality assessment, mesocolonic specimens should also define the area of mesentery excised because some specimens may have intact mesocolic fascia but with only a small, pericolic fragment of mesocolon excised, which is not a CME standard. The area of mesentery is also one of the significant differences between CME and D3 resection practiced by Japanese surgeons, where more focus is placed on CVL rather than wide mesenteric resection, as long as the mesocolic fascia is kept intact and a 10 cm distal and proximal margin is achieved[6]. However, even in CME

**Table 1 Quality markers in rectal surgery for rectal cancer**

Dissection	Margins	CVL
Mesorectal plane	Proximal margin	Tumor to tie length
Intramesorectal plane	Distal margin	IMA stump
Muscularis propria plane	CRM	
Mesenteric area	Extramesorectal CRM	

CRM: Circumferential resection margin; CVL: Central vascular ligation; IMA: Inferior mesenteric artery.

**Table 2 Quality markers in colon surgery for colon cancer**

Dissection	Margins	CVL
Mesocolic plane	Proximal margin	Tumor to tie length
Intramesocolic plane	Distal margin	IMA stump
Muscularis propria plane	Posterior CRM	ICA stump
Mesenteric area	Extramesocolic CRM	Middle colic stump

CRM: Circumferential resection margin; CVL: Central vascular ligation; ICA: Ileocolic artery; IMA: Inferior mesenteric artery.

specimens the area of excised mesentery varies a lot depending on the patient's anatomy, as some patients have short pedicles and short mesentery. This is why it is difficult to establish an objective normal range for measurement of the mesenteric area.

## QUALITY MARKERS OF RESECTION MARGINS

Resection margins are another key factor in standardized colorectal surgery both in CME and D3 resections. There are two sets of indicators that need to be addressed. First are longitudinal margins, which by consensus need to be 10 cm both distally and proximally. However, in low rectal cancer, a distal margin of 1 cm is universally considered safe and adequate in order to perform sphincter-preserving procedures. Some studies showed that even a tumor-free distal margin of less than 1 cm is sufficient with comparable oncological outcomes[7-10].

Negative circumferential resection margin (CRM) is a must in rectal cancer and widely proven to impact local recurrence rates (Tables 1 and 2). Once a mesorectal dissection is performed adequately, CRM should not be an issue if the tumor and worrying lymph nodes are not violating the mesorectal fascia. This is now commonly achieved with the advent of neoadjuvant therapy but not always. One must be careful and should spot tumors that threaten the CRM on preoperative magnetic resonance imaging (MRI) because an extramesorectal approach should be considered to ensure negative CRM. This should be signaled by the pathologist on the specimen as a quality indicator.

Another topic for debate is the importance of positive lateral pelvic lymph nodes that should be considered as part of an extramesorectal approach and signaled as a quality indicator of resection in cases where they are found to be invaded on MRI before and after neoadjuvant radiochemotherapy[11-13]. During radiation therapy, they are considered as part of the extramesorectal group and if invaded benefit from boost therapy. Also, if positive on initial imaging, they benefit from chemotherapy as part of a total neoadjuvant approach[14]. Persistence of lateral lymph nodes larger than 5 mm on postneoadjuvant MRI should be an indication for lateral lymph node dissection. Although this topic is not clear cut, some clinicians advocate lateral lymph node dissection, regardless of response, if positive on initial imaging[15,16].

In colon cancer, the importance of CRM is more ambiguous. In the anterior plane the CRM is defined by the serosa, and if invaded CRM cannot be extended surgically. However, the posterior plane is where surgical quality can be quantified. As in rectal cancers, the posterior plane respecting the mesocolic dissection is sufficient for early tumors. However, in cancers that invade beyond the mesocolic fascia, one should perform extramesocolic resection to achieve a negative CRM and that means partial resection or full resection of the abdominal wall, perirenal fat, ureter, or gonadal vessels. An extramesocolic approach and negative/positive CRM should be reported by the pathologist to predict risk of local recurrence.

## QUALITY MARKERS OF CVL

In our opinion, CVL is the most important and underexamined quality indicator of CME or D3 resection (Tables 1 and 2).

All the above quality markers should be assessed together as a checklist or score with a quantified CVL because one might have a poor-quality specimen with an intact mesocolic plane and good resection margins but inadequate CVL, which will translate to poor survival. Other specimens might have a smaller mesenteric area, but with adequate CVL they can be classified as good quality, as seen in the Japanese specimens.

The CME group uses the distance from tie to tumor measured on fresh specimens as an indicator of CVL, and this is by any means adequate if reported by pathologists, which in real world practice is not the case. But there is a way of quantifying the CVL retrospectively without using the specimen and that is by measuring the central vessel stumps on postoperative computed tomography scans, which are performed as part of a routine cancer follow-up[17-20]. The inferior mesenteric artery stump on the left and ileocolic artery (even middle colic artery in transverse colon cancers) stumps on the right can be measured with replicability both by radiologists and clinicians with minimal training. This is important as it can be measured at any time when looking back on past cohorts to assess quality of CVL on an individual or institutional level.

Especially on the right side, CVL is the most difficult component of CME/D3 and usually the key and significant difference between non-CME and CME surgery in right colon cancer. CVL is in real practice the reason why some surgeons do not adhere to CME because it is associated with an increased risk of major vascular injury without a widely proven oncological benefit in early colon cancers. A few past reports[21,22] and a meta-analysis[23], published at the early stages of CME implementation, concluded that CME was associated with more intraoperative blood loss and higher overall morbidity and mortality. These results have been counterargued by updated meta-analyses[24-26]. This shift might be explained by the experience many surgeons have gained over time in the proper technique of CME through published technical notes, books, video-vignettes, and courses. Even if CME is associated with more complications, if one does not perform CVL in early cancers to gain confidence, they will likely have difficulty performing CVL in more advanced cancers with positive apical lymph nodes where oncological quality surpasses risks of complications. This is why using CVL as a quality indicator may help in selecting patients who would benefit if operated in a center capable of performing CVL safely.

## WHERE DO WE STAND?

TME, CME, D3 resections, and all the research behind them have had an unprecedented impact on colorectal cancer surgery. We are now able to aim for 0% local recurrence in colorectal cancer by offering our patients quality surgery. However, the type of surgery and recurrence rates still vary among surgeons, institutions, and countries. Once we have defined what and how proper surgery can impact colorectal cancer treatment, we must aim for universal adoption of quality indicators and regular audits of these indicators. Including all markers in a user-friendly score for measuring quality in colorectal cancer surgery might help to streamline reporting from surgeons or institutions and make research more reproducible and predictable by uniformizing cohorts of patients internationally.

As minimally invasive surgery is evolving and becomes more accessible, we will surely witness a wide adoption of robotic surgery over laparoscopy as it has clear benefits. It may also increase the confidence of surgeons to adopt CME [27] when operating with a more comfortable and precise platform. Robotic surgery seems to have better lymph node yields, and this can be explained by the more stable and precise dissection maintained over the SMV when performing CVL compared to standard laparoscopy[28].

Another major advantage of robotic surgery is the ease of artificial intelligence (AI) integration within its software. AI will naturally make its way into colorectal surgery, and a main contribution would be to encompass quality markers into an AI-guided robotic surgery module. Defining embryological planes through color-coding is already proven to aid in CME dissection[29].

Indocyanine green is becoming a standard approach for assessing microperfusion[30] and has been used with plausible results for guiding extended lymphadenectomy in CME colectomies in the GREENLIGHT trial[31]. Preoperative anatomical mapping of the superior mesenteric artery and SMV branches on computed tomography scans is a strong recommendation for improving operative time and reducing the risk of intraoperative vascular injuries[4,32]. It would be advantageous to have all these tools mixed in a state-of-the-art AI software that could provide real-time integrated mapping of dissection planes, vasculature, and lymph node distribution, thus boosting surgeons' performance in terms of surgical quality. It is too early to say when this will become reality but is realistic indeed.

## FOOTNOTES

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**Country/Territory of origin:** Romania

**ORCID number:** Stefan Morarasu 0000-0001-7767-0975; Cristian Livadaru 0000-0002-5872-4058; Gabriel-Mihail Dimofte 0000-0002-7839-9512.

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## REFERENCES

- 1 Heald RJ. The 'Holy Plane' of rectal surgery. *J R Soc Med* 1988; **81**: 503-508 [PMID: 3184105 DOI: 10.1177/014107688808100904]
- 2 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**: 354-64; discussion 364 [PMID: 19016817 DOI: 10.1111/j.1463-1318.2008.01735.x]
- 3 Prevost GA, Odermatt M, Furrer M, Villiger P. Postoperative morbidity of complete mesocolic excision and central vascular ligation in right colectomy: a retrospective comparative cohort study. *World J Surg Oncol* 2018; **16**: 214 [PMID: 30376849 DOI: 10.1186/s12957-018-1514-3]
- 4 Tejedor P, Francis N, Jayne D, Hohenberger W, Khan J; on behalf the CME Project Working Group. Consensus statements on complete mesocolic excision for right-sided colon cancer-technical steps and training implications. *Surg Endosc* 2022; **36**: 5595-5601 [PMID: 35790593 DOI: 10.1007/s00464-021-08395-0]
- 5 Seow-En I, Chen WT. Complete mesocolic excision with central venous ligation/D3 lymphadenectomy for colon cancer - A comprehensive review of the evidence. *Surg Oncol* 2022; **42**: 101755 [PMID: 35405620 DOI: 10.1016/j.suronc.2022.101755]
- 6 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 Clin Oncol* 2012; **30**: 1763-1769 [PMID: 22473170 DOI: 10.1200/JCO.2011.38.3992]
- 7 Yan H, Wang PY, Wu YC, Liu YC. Is a Distal Resection Margin of  $\leq 1$  cm Safe in Patients with Intermediate- to Low-Lying Rectal Cancer? A Systematic Review and Meta-Analysis. *J Gastrointest Surg* 2022; **26**: 1791-1803 [PMID: 35501549 DOI: 10.1007/s11605-022-05342-9]
- 8 Kang DW, Kwak HD, Sung NS, Yang IS, Baek SJ, Kwak JM, Kim J, Kim SH. Oncologic outcomes in rectal cancer patients with a  $\leq 1$ -cm distal resection margin. *Int J Colorectal Dis* 2017; **32**: 325-332 [PMID: 27900522 DOI: 10.1007/s00384-016-2708-1]
- 9 Keranmu A, Liu HN, Wu YC, Liu TT, Li C, Guo TA, Liu FQ, Zheng HT, Xu Y. A negative-doughnut distal resection margin less than 5 mm does not affect prognosis in rectal cancer. *J Surg Oncol* 2018; **118**: 536-543 [PMID: 30259516 DOI: 10.1002/jso.25161]
- 10 Manegold P, Taukert J, Neeff H, Fichtner-Feigl S, Thomusch O. The minimum distal resection margin in rectal cancer surgery and its impact on local recurrence - A retrospective cohort analysis. *Int J Surg* 2019; **69**: 77-83 [PMID: 31362126 DOI: 10.1016/j.ijsu.2019.07.029]
- 11 Hazen SJA, Sluckin TC, Konishi T, Kusters M. Lateral lymph node dissection in rectal cancer: State of the art review. *Eur J Surg Oncol* 2022; **48**: 2315-2322 [PMID: 34802862 DOI: 10.1016/j.ejso.2021.11.003]
- 12 Kroon HM, Malakorn S, Dudi-Venkata NN, Bedrikovetski S, Liu J, Kenyon-Smith T, Bednarski BK, Ogura A, van de Velde CJH, Rutten HJT, Beets GL, Thomas ML, Kusters M, Chang GJ, Sammour T. Local recurrences in western low rectal cancer patients treated with or without lateral lymph node dissection after neoadjuvant (chemo)radiotherapy: An international multi-centre comparative study. *Eur J Surg Oncol* 2021; **47**: 2441-2449 [PMID: 34120810 DOI: 10.1016/j.ejso.2021.06.004]
- 13 Chen JN, Liu Z, Wang ZJ, Mei SW, Shen HY, Li J, Pei W, Wang Z, Wang XS, Yu J, Liu Q. Selective lateral lymph node dissection after neoadjuvant chemoradiotherapy in rectal cancer. *World J Gastroenterol* 2020; **26**: 2877-2888 [PMID: 32550762 DOI: 10.3748/wjg.v26.i21.2877]
- 14 Peacock O, Manisundaram N, Dibrito SR, Kim Y, Hu CY, Bednarski BK, Konishi T, Stanietzky N, Vikram R, Kaur H, Taggart MW, Dasari A, Holliday EB, You YN, Chang GJ. Magnetic Resonance Imaging Directed Surgical Decision Making for Lateral Pelvic Lymph Node Dissection in Rectal Cancer After Total Neoadjuvant Therapy (TNT). *Ann Surg* 2022; **276**: 654-664 [PMID: 35837891 DOI: 10.1097/SLA.0000000000005589]
- 15 Özdemir Ü, Gündoğdu E, Yakar M, Canaz F, Ulaş M, Özer İ. Lateral lymph node involvement presents another challenge in rectum cancer in the age of neoadjuvant chemoradiotherapy + total mesorectal excision: an evaluation of survival outcomes. *Langenbecks Arch Surg* 2023; **408**: 356 [PMID: 37702958 DOI: 10.1007/s00423-023-03101-1]
- 16 Zhou S, Jiang Y, Pei W, Liang J, Zhou Z. Prognostic significance of lateral pelvic lymph node dissection for middle-low rectal cancer patients with lateral pelvic lymph node metastasis: a propensity score matching study. *BMC Cancer* 2022; **22**: 136 [PMID: 35109810 DOI: 10.1186/s12885-022-09254-4]
- 17 Livadaru C, Morarasu S, Frunza TC, Ghitun FA, Paiu-Spiridon EF, Sava F, Terinte C, Ferariu D, Lunca S, Dimofte GM. Post-operative computed tomography scan - reliable tool for quality assessment of complete mesocolic excision. *World J Gastrointest Oncol* 2019; **11**: 208-226 [PMID: 30918594 DOI: 10.4251/wjgo.v11.i3.208]
- 18 Livadaru C, Moscalu M, Ghitun FA, Huluta AR, Terinte C, Ferariu D, Lunca S, Dimofte GM. Postoperative Quality Assessment Score Can Select Patients with High Risk for Locoregional Recurrence in Colon Cancer. *Diagnostics (Basel)* 2022; **12** [PMID: 35204454 DOI: 10.3390/diagnostics12020363]
- 19 Livadaru C, Morarasu S, Bargaoanu R, Iacob S, Frunza T, Musina AM, Velenciuc N, Roata CE, Zugun-Eloae F, Ferariu D, Lunca S, Dimofte MG. The mesocolic apical fragment in complete mesocolic excision colectomies: Should it be analysed separately? A proof-of-concept study. *Colorectal Dis* 2023; **25**: 234-242 [PMID: 36227063 DOI: 10.1111/codi.16362]
- 20 Vogelsang RP, Gögenur M, Dencker D, Bjørn Bennedsen AL, Levin Pedersen D, Gögenur I. Routine CT evaluation of central vascular ligation in patients undergoing complete mesocolic excision for sigmoid colon cancer. *Colorectal Dis* 2021; **23**: 2030-2040 [PMID: 33974325 DOI: 10.1111/codi.15723]
- 21 Bertelsen CA, Neuenschwander AU, Jansen JE, Kirkegaard-Klitbo A, Tenma JR, Wilhelmsen M, Rasmussen LA, Jepsen LV, Kristensen B, Gögenur I; Copenhagen Complete Mesocolic Excision Study (COMES); Danish Colorectal Cancer Group (DCCG). Short-term outcomes after complete mesocolic excision compared with 'conventional' colonic cancer surgery. *Br J Surg* 2016; **103**: 581-589 [PMID: 26780563 DOI: 10.1002/bjs.10083]
- 22 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**: 89-97 [PMID: [23982425](#) DOI: [10.1007/s00384-013-1766-x](#)]
- 23 **Wang C**, Gao Z, Shen K, Shen Z, Jiang K, Liang B, Yin M, Yang X, Wang S, Ye Y. Safety, quality and effect of complete mesocolic excision vs non-complete mesocolic excision in patients with colon cancer: a systemic review and meta-analysis. *Colorectal Dis* 2017; **19**: 962-972 [PMID: [28949060](#) DOI: [10.1111/codi.13900](#)]
- 24 **De Lange G**, Davies J, Toso C, Meurette G, Ris F, Meyer J. Complete mesocolic excision for right hemicolectomy: an updated systematic review and meta-analysis. *Tech Coloproctol* 2023; **27**: 979-993 [PMID: [37632643](#) DOI: [10.1007/s10151-023-02853-8](#)]
- 25 **Crane J**, Hamed M, Borucki JP, El-Hadi A, Shaikh I, Stearns AT. Complete mesocolic excision versus conventional surgery for colon cancer: A systematic review and meta-analysis. *Colorectal Dis* 2021; **23**: 1670-1686 [PMID: [33934455](#) DOI: [10.1111/codi.15644](#)]
- 26 **Mazzarella G**, Muttillio EM, Picardi B, Rossi S, Muttillio IA. Complete mesocolic excision and D3 lymphadenectomy with central vascular ligation in right-sided colon cancer: a systematic review of postoperative outcomes, tumor recurrence and overall survival. *Surg Endosc* 2021; **35**: 4945-4955 [PMID: [33977376](#) DOI: [10.1007/s00464-021-08529-4](#)]
- 27 **Xu J**, Mohan HM, Fleming C, Larach JT, Apte SS, Cohen LCL, Miskovic D, Jiang W, Heriot AG, Warrier SK. Complete mesocolic excision versus standard resection for colon cancer: a systematic review and meta-analysis of perioperative safety and an evaluation of the use of a robotic approach. *Tech Coloproctol* 2023; **27**: 995-1005 [PMID: [37414915](#) DOI: [10.1007/s10151-023-02838-7](#)]
- 28 **Oweira H**, Reissfelder C, Elhadedy H, Rahbari N, Mehrabi A, Fattal W, Khan JS, Chaouch MA. Robotic colectomy with CME versus laparoscopic colon resection with or without CME for colon cancer: a systematic review and meta-analysis. *Ann R Coll Surg Engl* 2023; **105**: 113-125 [PMID: [35950970](#) DOI: [10.1308/rcsann.2022.0051](#)]
- 29 **Knol JJ**, Wexner SD, Vangertruyden G. Laparoscopic mobilization of the splenic flexure: the use of color-grading as a unique teaching tool. *Surg Endosc* 2015; **29**: 734-735 [PMID: [25052127](#) DOI: [10.1007/s00464-014-3727-z](#)]
- 30 **De Nardi P**, Elmore U, Maggi G, Maggiore R, Boni L, Cassinotti E, Fumagalli U, Gardani M, De Pascale S, Parise P, Vignali A, Rosati R. Intraoperative angiography with indocyanine green to assess anastomosis perfusion in patients undergoing laparoscopic colorectal resection: results of a multicenter randomized controlled trial. *Surg Endosc* 2020; **34**: 53-60 [PMID: [30903276](#) DOI: [10.1007/s00464-019-06730-0](#)]
- 31 **Ribero D**, Mento F, Segà V, Lo Conte D, Mellano A, Spinoglio G. ICG-Guided Lymphadenectomy during Surgery for Colon and Rectal Cancer-Interim Analysis of the GREENLIGHT Trial. *Biomedicines* 2022; **10** [PMID: [35327344](#) DOI: [10.3390/biomedicines10030541](#)]
- 32 **Willard CD**, Kjaestad E, Stimec BV, Edwin B, Ignjatovic D; RCC Study Group. Preoperative anatomical road mapping reduces variability of operating time, estimated blood loss, and lymph node yield in right colectomy with extended D3 mesenterectomy for cancer. *Int J Colorectal Dis* 2019; **34**: 151-160 [PMID: [30386889](#) DOI: [10.1007/s00384-018-3177-5](#)]



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