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

Quality assurance of colorectal surgery

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Abstract
Quality assurance in surgery is probably the last decade’s most important topic of debate among colorectal surgeons, producing new surgical standards that led in part to the impressive oncological outcomes we see in many units today. Total mesorectal excision (TME), 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 and this is one of the main reasons why many countries have shifted colorectal cancer surgery only to high volume centres. Defining markers of surgical quality is thus a perquisite 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, but altogether, 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 subspecialisation requirements both at an individual and hospital level.
**Key Words:** colorectal cancer; colon surgery; arterial stump; complete mesocolic excision; surgical quality


**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 we see in many cohorts today. Thanks to TME and CME we have a set of quality markers which 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 a national and institutional level as a perquisite of good practice, thus offering our patients the best chances of cure.

**INTRODUCTION**

The importance of defining quality standards in colorectal cancer surgery cannot be overemphasized and we have Heald’s total mesorectal excision (TME)¹ 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. The principle of TME was well translated into colon surgery by Hohenberger et al² who defined the technique of complete mesocolic excision (CME). CME is based on three main principles: i) dissection in embryological planes to ensure complete removal of an intact mesocolon; ii) adequate proximal and distal margins of 10cm; iii) central vascular ligation (CVL) in order to remove all apical lymph nodes. Through this approach, authors showed 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, where 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\(^4,5\). Also, 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, some would say they were performing quality surgery even before the introduction of CME and that 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 technique 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 technique and improve oncological outcomes of colon surgery.

Quality markers are measurable, quantitative, evidence-based indicators which can objectively predict extent of surgery. While most quality markers indirectly predict
prognosis by quantifying surgery, it is not a perquisite as disease free survival is
dependent on other factors, apart from quality of surgery. Breaking down CME we can
define quality markers for each main component: dissection plane, distal and
circumferential margins, 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 and it’s 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 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, on mesocolonic specimens one 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 of 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 10cm cm distal
and proximal margin is achieved⁵. However, even in CME 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 10cm both distally and proximally. However, in low rectal cancer, a distal margin of 1cm is universally considered safe and adequate in order to perform more sphincter preserving procedures. Some studies showed that even a tumour-free distal margin of less than 1cm is sufficient with comparable oncological outcomes\textsuperscript{8,9,10}.

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 tumour and worrying lymph nodes are not violating the mesorectal fascia and this is now commonly achieved with the advent of neoadjuvant therapy, but not always. One must be careful and should spot tumours that threaten the CRM on preoperative MRI, as in these cases an extramesorectal approach should be considered to ensure negative CRM and this should be signalled by the pathologist on the specimen as a quality indicator.

Another topic for debate is the importance of positive lateral pelvic lymph nodes which should be considered as part of an extramesorectal approach and signalled as a quality indicator of resection in cases where they are found to be invaded on MRI before and after neoadjuvant radiochemotherapy\textsuperscript{11,12,13}. 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\textsuperscript{14}. Persistence of lateral lymph nodes larger than 5mm on postneoadjuvant MRI should be an indication for lateral lymph node dissection, although this topic is not clear cut, some advocating lateral lymph node dissection, regardless of response, if positive on initial imaging\textsuperscript{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, in the posterior plane respecting the mesocolic dissection is sufficient for early tumours, but 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 in order be able to predict risk of local recurrence.

**Quality markers of CVL**

In the present CVL is in our opinion 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, good resection margins, but inadequate CVL, which will translate in poor survival, while some 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 tumour 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 even retrospectively, without using the specimen, and that is by measuring the central vessel stumps on postoperative CT scans, which are performed as part of a routine cancer follow-up\textsuperscript{17-20}. The inferior mesenteric artery (IMA) 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 anytime looking back on past cohorts to assess quality of CVL on an individual or institutional level. Especially on the
right side, CVL is also 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\textsuperscript{21,22} including a meta-analysis\textsuperscript{23}, published at the early stages of CME implementation, concluded that CME is associated with more intraoperative blood loss and higher overall morbidity and mortality. These results have been counterargued by updated meta-analyses\textsuperscript{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, he 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 more if operated in a centre 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 recurrences in colorectal cancer by offering our patients quality surgery, but 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 cohort of patients internationally.
More so, as minimally invasive surgery is evolving, once it becomes more accessible, we will surely witness a wide adoption of robotic surgery over laparoscopy as it has clear benefits and it may increase the confidence of surgeons to adopt CME\textsuperscript{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 one can maintain over the SMV when performing CVL compared to standard laparoscopy\textsuperscript{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\textsuperscript{29}. Indocyanine-green (ICG) is becoming a standard approach for assessing micro-perfusion\textsuperscript{30} and has been used with plausible results for guiding extended lymphadenectomy in CME colectomies in the GREENLIGHT trial\textsuperscript{31}. Preoperative anatomical mapping of SMA and SMV branches on CT scans is a strong recommendation for improving operative time and reducing the risk of intraoperative vascular injuries\textsuperscript{4,32}. Why not have all these tools mixed in a state-of-the-art AI software that can provide real-time integrated mapping of dissection planes, vasculature, and lymph node distribution, thus boosting surgeons’ performance in terms of surgical quality? It is early to say, but realistic indeed.

**CONCLUSION**

After more than a decade since the first formal description of CME, we are now witnessing its maturity. Despite debates, it has a clear oncological advantage over conventional surgery especially in more advanced cases. To better define and standardize surgical technique a series of pathological and radiological markers have been validated and these should become the building block for a unanimously accepted score of quality colorectal surgery.
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