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Minimally invasive colorectal surgery learning curve

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Abstract

The learning curve in minimally invasive colorectal surgery is a constant subject of discussion in the literature. Discordant data likely reflects the varying degrees of each surgeon's experience in colorectal, laparoscopic or robotic surgery. Several factors are necessary for a successful minimally invasive colorectal surgery training program, including: compliance with oncological outcomes; dissection along the embryological planes; constant presence of an expert tutor; periodic discussion of the morbidity and mortality rate; and creation of a dedicated, expert team.

TO THE EDITOR

We read with interest the article of Perivoliotis *et al*[1] regarding the change point analysis of the learning curve (LC) in laparoscopic colorectal surgery. Hermann Ebbinghaus[2], in 1885, and Theodore Paul Wright[3], in 1936, introduced the term "learning curve" to express the average learning rate for a procedure for the aviation industry. This term is now used extensively, including in laparoscopic colorectal surgery. Proficiency is obtained when predefined variables reach a plateau and results are comparable with those in the literature[4,5]. Multiple parameters define proficiency in laparoscopic colorectal surgery, but the total number of cases required to complete the LC and obtain proficiency is not conclusively known[6-11]. Current reports vary between 11 cases to 152 cases[6,9,11-13].

The LC process from learning to competence to mastery has been analyzed by the cumulative summation method. This method does not require a large sample size or grouping. Therefore, it is very practical and precise[14,15]. Reports have shown that the surgeon's experience correlates significantly with the safety and feasibility of laparoscopic colorectal surgery. Case selection is another factor that affects the LC because it has not yet been standardized during training[16].

Oncologic efficacy of the laparoscopic colorectal procedure is a crucial parameter in the assessment of learning. This goal is measured by negative surgical distal and circumferential margins and an adequate number of harvested lymph nodes. However, oncologic efficacy should not be compromised and inappropriate resection is not justified regardless of the stage of the training period[6]. The use of well-structured and standardized intra- and perioperative protocols ensures that all patients can benefit from the advantages of minimally invasive surgery[17-19].

We agree with the authors that a specialized team dedicated to colorectal surgery is important. This team must be composed of surgeons, anesthetists, pathologists and nurses and must be supported by specialists with high levels of expertise in colorectal surgery from the diagnostic step to the perioperative period to the follow-up.

The site of colorectal surgery also has an effect on the LC. We would like to emphasize the difference between the LC of colonic surgery and the LC of rectal surgery, particularly the low rectum. Rectal cancer surgery underwent a major breakthrough with the introduction of the circular stapler in the 1970s that facilitated lower anastomoses[21]. This revolutionary tool has greatly facilitated the preservation of the sphincter. In 1988, Heald[22] described the "holy plane" of rectal surgery, which lead to the realization of the importance of tumor-free circumferential margins. Understanding of the fundamental role of total mesorectal excision (TME) in cancer success has steadily grown to become the standard approach for rectal cancer treatment. It has been 30 years since the introduction of the concepts of TME and tumor-free circumferential resection margins. Numerous surgical technological advances have developed over these three decades, improving the ability to perform surgeries with less invasive measures[23].

Adequate margin resection and specific postoperative morbidity (anastomotic leakage) are critical issues in the care of patients with lower rectal cancer. Morbidity following large bowel anastomosis can impact the hospital course of patients undergoing colon resection. Additionally, anastomotic morbidity is quite often influenced by the distance of the suture line from the anal verge. The double-stapled technique is one of the commonly used methods to construct low colorectal or coloanal anastomosis after low anterior resection of rectal cancer[24].

Anastomotic leak ranges from less than 1% to approximately 25%[25]. It is associated with serious short-term morbidity and mortality and long-term functional compromise. It may also have a negative impact on the oncologic outcomes of colorectal cancer[26,27]. Multiple stapler firings, low tumor location, longer operation time, perioperative blood transfusion and male sex were the most common risk factors of anastomotic leak after the double-stapled technique. Different methods have been devised to improve the outcome of the double-stapled technique, including elimination of dog-ears using sutures, transanal reinforcement of anastomosis, single-stapled transanal transection, transanal pull-through with single-stapling technique, natural orifice intracorporeal anastomosis with extraction of specimen procedure, hand-sewn colonic J pouch and vertical division of the rectum[23,26].

Transanal visual inspection obtained through endoscopy or self-retaining anal retractors may be the only reliable means to assure bowel transection at a proper distance from the distal tumor margin. In 2015, we proposed an original technique of low colorectal anastomosis with transanal control after TME with the removal of the rectal stump suture line avoiding dog-ear formations[28], as described in the TICRANT study[29]. The same technique can be applied to partial mesorectal excision and proximal colorectal anastomosis. The ability to perform low rectal anastomosis with an adequate transanal assessment of distal resection margins, technical adequacy, and transanal repair of any resulting anastomotic defects was a clinical necessity[30-33]. We continue to utilize transanal control after anastomosis fashioning with the reverse air leak test and endoscopic control with fluorescence. These controls are useful because problems can be identified early and repaired intraoperatively, thus reducing the number of complications and ostomies.

Colorectal surgery training programs should also distinguish between colonic surgery and rectal surgery as well as between surgery of the right and left colon. In accordance with what the authors wrote, complete mesocolic excision (CME) follows the principles of TME with central vascular ligation and dissection along the embryological planes[34].

Over the past 30 years, there have been tremendous innovations in minimally invasive colorectal surgery with countless new technologies and approaches[35,36]. Numerous studies have confirmed that laparoscopic surgery is equal to or superior to open surgery. Further studies have focused on single incision, transluminal endoscopic surgery of the natural orifice and most recently on robotic surgery[37,38]. The comparison between the LCs of laparoscopic and robotic colorectal surgery is still under investigation.

A shorter LC in robotic colorectal surgery compared to laparoscopic surgery has been reported. A plateau has been reached after 15-25 cases[12,39]. This is likely due to reducing the differences between laparoscopy and robotics. In our center, we use a robotic approach in colorectal and low rectal cancer surgery. Robotic surgery appears to be less invasive due to three-dimensional vision and better visualization of the anatomical structures; the EndoWrist® (Intuitive, Sunnyvale, CA, United States) allows accurate movements in confined spaces and other intrinsic characteristics of the robotic platform[13,40-43].

For experienced laparoscopists, the LC of robotic surgery seems to be shorter[44]. Flynn *et al*[45] showed that operating times for robotic surgery might be faster than laparoscopy when surgeons are inexperienced with both platforms. This may be related to a superior baseline performance rather than a shorter LC. A selection of the most suitable patients can help surgeons in the early stages of training. A small primary tumor, no previous adjuvant chemoradiotherapy, appropriate body mass index, and few medical comorbidities are ideal characteristics for robotic surgery[46].

In the early stages of learning there are still many difficulties, despite the numerous advantages of the da Vinci robot: preoperative times are longer; the freedom of movement of the robotic arms during the operation is limited by the relatively fixed angle and position; and the lack of force feedback from the robotic arm, which limits the sensitivity of the operator who must judge the effect of pulling and cutting by sight[47-49]. Of note, the rates of disease-free survival and overall survival on a small sample size were similar for robotic and laparoscopic surgery[51].

All innovative techniques with clinical advantages will also have disadvantages when compared to established methods. The key is continued refinement and modification by masters of the craft. More extensive comparative studies are needed to give definitive conclusions regarding the LC in minimally invasive colorectal surgery. Regardless of the approach used, dissection along the embryological planes, correct knowledge of the anatomical and vascularization variants, respect for oncological outcomes, regular tutoring, variation of the surgical approach based on the results, and a dedicated team are essential prerequisites for a colorectal surgery training program.

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PRIMARY SOURCES

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