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Quality training in laparoscopic colorectal surgery: does it improve clinical outcome?

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Abstract Laparoscopic colorectal surgery (LCRS) is a safe, effective and cost-efficient option for the treatment of various benign and malignant conditions. However, its implementation to surgical practice is still limited. That is mainly due to its association with a steep learning curve. We performed a review of the literature to determine whether quality training in LCRS can reduce that learning curve and lead to better clinical outcomes. We concluded that a structured training program with pre-clinical phase focused on basic skill acquisition and a clinical phase focused on mentoring from experts can shorten the learning curve and improve clinical outcomes.

Keywords Laparoscopic colorectal surgery · Training · Mentorship · Quality · Outcome

Introduction

Since Jacobs et al. performed the first laparoscopic colorectal procedures in 20 patients in 1991, much debate has followed this approach [1]. Although the Jacobs et al. recognized the potential for widespread use of laparoscopic colorectal surgery (LCRS) and other authors reported use of this technique to treat a variety of conditions [2, 3], it was greeted with skepticism. The reasons behind that, although not fully understood, appear to have been the steep learning curve associated with the procedures, oncological concerns and early reports of port-site metastases in cancer patients [4].

The emergence of several randomized-controlled trials (RCTs) like the "COST", "COLOR" and "MRC CLASSIC" trials helped put early concerns aside as they demonstrated the safety and oncologic efficacy of LCRS for the treatment of colon cancer [5–8]. They also reported other short-term benefits that are generally associated with minimally invasive procedures such as reduced blood loss, less intense postoperative pain and faster gastrointestinal recovery. More recently, Hemandas et al. reported excellent results of laparoscopic resection for colorectal cancer in "high-risk" patients [9]. The median hospital stay was 4 (2–33) days in the laparoscopic group versus 11 (1–69) days in the open group.

Thanks to its superior results, nowadays LCRS is considered to be the standard of care for colon cancer. That is not the case for rectal cancer, though, as the laparoscopic approach is technically more challenging and associated with disadvantages such as longer operative time [10] and increased rate of positive surgical margins [7].

Aside from the satisfactory results, instrumentation and operative methodology have developed, compared with the pioneering era as laparoscopic surgery has evolved into a high-tech profession. Considering all this evidence, one would expect LCRS to be widely implemented in the care of (at least) colon cancer. However, less than 5% of colon cancers and less than 2% of all rectal cancers are treated laparoscopically in both teaching and nonteaching hospitals in the United States [11]. We believe that the biggest factor contributing to this is the steep learning curve coupled with the lack of quality training programs in LCRS, up until recently.

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Quality training

As quality training we would define the one that is structured, cost-efficient and leads to a good clinical outcome. Laparoscopic colorectal surgery is relatively novel and has been proven to be efficient. Therefore, it generates a need for large-volume training of surgeons before it can be widely implemented into clinical practice. At the same time, it is technically challenging because it requires the ability to identify and dissect tissue planes without the usual tactile interactions and the capability to control multiple blood vessels. In addition, the surgeon has to operate in multiple abdominal quadrants and usually restore intestinal continuity with an anastomosis of colorectal resections [12]. This leads to an extended period of training during which the surgeon has to familiarize himself with all the aspects of the procedure to the point where he will have acceptable results, compared with the standard of practice. In other words, he will have ascended the "learning curve". The learning curve shows the progress in mastering a new method. It is completed when the monitored parameters reach a steady state and when the final results can be compared with literature. The most widely used parameters for assessing competency in laparoscopic techniques for colorectal cancer are operating time, number of harvested lymph nodes, conversion rate and perioperative complications rate.

Conclusive data on the length of the learning curve of LCRS cannot be given at the time, as this depends on the training method, center, patient selection, previous experience and learning aptitude of the trainee among other factors. Therefore, learning curves cannot be used as a mean of comparison between different surgeons or clinics, but they are useful tools to measure individual progress. According to the literature, the learning curve for LCRS ranges from 30 to 70 cases [13–15] with the exception of Simons et al. who reported a learning curve of 11–15 cases in a series of 144 patients in 1995 [16]. Tekkis et al. compared outcomes between right-sided and left-sided resections. Their analysis demonstrated a learning curve of 55 cases for right-sided colonic resections versus 62 cases for left-sided resections [17]. In the European Institute of Telesurgery, in France, the team of Dr Marescaux collected data from 6,335 colorectal interventions and rated the degree of difficulty of 12 laparoscopic colorectal procedures based on a scoring system with a range from 1 to 6 [18]. Sigmoid colectomy achieved the lowest score at 2 (easiest), while reversal of a Hartmann procedure scored the highest at 4.5 (hardest). Therefore, different procedures should be integrated in different stages of the learning curve.

The ideal method of training and credentialing a surgeon in novel surgical procedures has not been established yet. We believe that a systematic, structured and focused approach is the answer to shortening the learning curve and achieving optimal clinical outcome. For LCRS, the most common methods include watching operative videos, animal models, cadaveric models, virtual reality simulator training, assisting during surgery and being mentored by a trainer that has mastered the procedure. The latter is the method mostly described in the literature.

Pre-clinical models, like training on animals or cadavers, have been described by some authors as an efficient way to introduce surgeons to the basics of LCRS while posing no risk for patients that would be operated by trainees that are still early on their learning curve. In 1994, Bohm et al. first described the use of porcine and canine models for the practice of skills that could not be taught in simulators, like hemostasis [19]. Recently, Wyles et al. analyzed the data form fresh frozen cadaver and porcine training courses that were part of the English national training program in LCRS [20]. Each model exhibited advantages and disadvantages, but trainee satisfaction was high on both and they were considered superior to simulator training in terms of improving the skills for clinical practice. Rosser et al. from the Beth Israel Medical Center have suggested the use a "hybrid" trainer that combines tabletop, inanimate trainers and virtual reality simulators as a cost-effective, efficient and realistic way to grasp the psychomotor skills necessary for advanced laparascopic colorectal procedures, most importantly ambidexterity [21]. Some authors have reported the introduction of the hand-assisted technique to novice laparoscopists in an attempt to shorten the learning curve of sigmoid colectomy. Chang et al. reported fewer conversions and shorter operating time while training in laparoscopic sigmoid resection [22].

After the surgeon is familiar with the cognitive aspects of a new procedure and after he has acquired the necessary psychomotor skills in controlled, pre-clinical environment, he has to bring those skills to the clinical setting and be involved in actual surgery. The most common training method at this stage is a preceptor or mentor-based program. Up to date, the most comprehensive, systematic and large-scale example is the English National Training Programme (NTP) in laparoscopic colorectal surgery which was set up in 2008 [23]. It is divided into a pre-clinical phase, with various courses, such as cadaveric, immersion, enhanced recovery and lectures as well as a clinical phase when delegates are allocated to specific training centers and perform a number of procedures under supervision of an expert. It should be pointed out that this program was designed for established consultants and is structured in a different way than training schemes for surgical trainees [24]. Since it began, 150 consultant colorectal surgeons in England have enrolled to the NTP and 1,050 supervised

cases have been performed. Furthermore, the proportion of LCRS for elective colorectal resections has risen from 13.8% in 2007 to 33% in 2010. Monitoring the progress of trainees is another important component of such training programs. Miskovic et al. developed a monitoring tool for the NTP. They used it to measure the proficiency gain of the trainees in terms of both the level of support required and the competency level achieved [25].

Aside from the NTP, various other training programs have emerged albeit at a smaller scale and each with its own approach. Hemandas et al. reported that it is possible to use a modular approach to provide effective training in LCRS without compromising clinical outcome [26]. Their trainees performed 96% (142/148) of right hemicolectomy modules, 99% (154/156) of left hemicolectomy modules and 67% (128/192) of rectal resection modules. In Canada, Birch et al. published their results after a one-year-long mentorship program in minimally invasive surgery of the gastrointestinal tract which involved colorectal procedures [27]. Total conversions to open surgery decreased from 14.3 to 6.4% ($P = 0.12$). The number of colorectal resections increased from 11 to 92 ($P = 0.0027$). Intraoperative complications decreased from 17.1 to 7.1% ($P = 0.06$). It is evident that appropriate training is the key to producing satisfactory patient outcomes.

The cost-effectiveness of training is another important issue. Various studies have estimated the total cost of LCRS versus open surgery to be higher, lower or similar. Also, the level of experience of the surgeon performing the procedures varies in literature reports. However, whether it is cost-effective to train surgeons in it, considering the steep learning curve, is another issue. Park et al. analyzed 197 patients with rectosigmoid cancer that underwent laparoscopic ($n = 116$) or open resections ($n = 81$) by a surgeon with no previous experience in laparoscopic colectomies [28]. They defined a transition from an early training period to a late "experienced" period at 37 performed colectomies. Total costs were significantly higher during the 1st period but similar during the 2nd, more experienced period ($7,983/patient versus $7,045/patient; $P > 0.05$). This finding stresses the need for quality training in LCRS since shortening the initial, inexperienced period could make it a more cost-effective option. So, LCRS is safe and cost-effective but does it also relate to improved quality of life for the patient? Bartels et al. conducted a systematic review trying to answer that question [29]. They found that out of nine relevant trials, only five reported an increase in quality of life compared to open surgery and only for the short-term period. Overall, there was no significant difference between the two.

In conclusion, LCRS nowadays is a safe, efficient and cost-effective option for the treatment of various colorectal conditions that has yet to reach its full potential. Those good qualities have greatly increased the need for well-trained specialists. However, LCRS is also associated with a rather steep learning curve. By establishing structured, high-quality training programs, we can satisfy the need for specialists and shorten the learning period, all in the pursuit of a better outcome for the patient.

Conflict of interest The authors declare that they have no conflict of interest related to the publication of this article.

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