Commentary

The necessity of a well-structured and qualitative training program for laparoscopic colectomy remains critical

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Laparoscopic colorectal surgery (LCS) is considered as an efficient and safe technique for the management of benign and malignant colonic disorders, presenting all the benefits of minimally invasive surgery such as, reduced blood loss, less postoperative pain, earlier recovery of bowel transit, reduced hospitalization, improved cosmesis, and lower risk of incisional hernia. Despite the fact that all the initial concerns about poor oncological results and increased port-site metastases have already been confuted, LCS is still not implemented to everyday surgical practice.

LCS remains a challenging and technically demanding option as surgeons have to identify and dissect the diseased tissue without tactile feedback, to transect multiple vascular formations, to retrieve a satisfying number of lymph nodes, to operate simultaneously in multiple abdominal quadrants and to perform intracorporeal anastomosis. All the above result in longer operative time, increased risk of perioperative complications and steep learning curve, especially for novice surgeons, because of the lack of a well-structured, cost-efficient and competency-based training program. The conclusions of this study can probably contribute to the general effort of reducing the LCS learning curve.

There are some points throughout this study which worth being mentioned. The described pre-clinical training program for LCS is based on virtual-reality simulator (VRS). Currently, there is a growing amount of evidence supporting that VRS training can lead to improved performance in the real environment of the operating room. From our experience, VRS is presented as an increasingly important part of surgical training for the basic laparoscopic skills (camera navigation, clip applying, hand-eye coordination, suturing, and 2-handed maneuvers) as well as for technical skills and entire procedures, without any ethical issues of live models.

However, we support that the VRS' major drawback is that remains simplified. In some cases, experiencing a stressful environment while performing a small task, should be preferable for trainee in order to familiarize with some unexpected intraoperative complications (1). Other main limitations of VRS include the tactile feedback, no small bowel to recline, no mobilization of splenic flexure and the fact that novices work with a two-dimensional image in a three-dimensional space on simulator, in contrast with the operating environment.

LAP mentor, which is hereby used for the LCS training protocol, is a high-fidelity medical simulator and enables laparoscopic training of basic skills and advanced procedures. The selection of this VRS type offers an important benefit to this training curriculum. Although VRS offers haptic feedback to trainee, this benefit does not exist during real-time LCS. LAP mentor is currently introduced not only as a training tool but also, as a preoperative warm-up method while, there are studies that support this statement for LCS performed in animal models and patients. Araujo *et al.*'s study suggests a single VRS session for novice surgeons before performing sigmoidectomy in animal model (2). So, its role can be beneficial with multiple applications.

One additional strength of this study is the fact that the training protocol is divided into sections which gradually lead novices from gaining basic laparoscopic skills during laparoscopic cholecystectomy to more advanced

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laparoscopic tasks (point-by-point LCS steps), setting as final target the total completion of LCS. Developing gradually all the necessary laparoscopic skills give to the novice the opportunity to deeply understand the whole procedure without performing it mechanically. Moreover, we take in consideration that this study is multicentered and its sample is divided into three groups relating to their surgical experience, satisfying our knowledge about the length of learning curve depending on various factors such as the training method, previous experience, center, and patient selection. Despite the increased cost for a VRS, it is easily reproducible with the benefit of multiple task repetition in a controlled and safe environment instead of real-time operating room.

On the opposite side, it is mentioned that proficiency was rapidly gained for anastomosis. According to our experience, many intermediate, even expert, laparoscopists face difficulties in performing anastomosis during a real-time procedure, especially because of the difficulty in 2-handed maneuvers. Furthermore, the study sample estimated the overall realism of this training method as 3 in a scale of 5, defining as less realistic task the inferior mesenteric vein dissection because of low clipping fidelity. However, this step consists one additional difficulty for surgeons, as a result, we should pay more attention to this VRS ineffectiveness.

It is true that we accept the major role of VRS in LCS training with skepticism. A future multicenter study assessing the effect of this protocol during real-time LCS performance and more trials with larger sample studying the VRS in practice for the LCS training are critically necessary. We believe that a combined training program for LCS divided into a pre-clinical and clinical phase would be more effective in shortening the learning curve of LCS and improve its clinical outcomes. Pre-clinical training in a controlled environment without any risks for patients can include VRS protocol as well as animal and cadaveric models for basic and more advanced laparoscopic skills. Wyles *et al.*'s study recommends fresh frozen cadaveric and animal models for the practice of laparoscopic skills that could not be gained in VRS, like hemostasis (3). Clinical training which consists of watching operative videos, assisting during real-time LCS and being mentored by an expertise surgeon can increase psychomotor abilities and familiarize the novice surgeon with the operating room environment. Many studies support the effectiveness of clinical training while, Crawshaw *et al.*'s study recommends an instructional, brief and narrated preoperative video as a factor which can increase the novices' performance during LCS regardless of their previous training because of the direct visualization, prediction of potential problems and mental practice (4). VRSs open a new era in the minimally invasive surgery training but remain a transitional stage between the simulators for basic laparoscopic skills and cadaveric and animal models as the last ones can train hemostasis, dissection of mesenteric artery and bowel mobilization.

This study overlooked two key issues. Firstly, learning curve is completed when the parameters reach a steady state (plateau) after task repetition. However, we cannot ignore some parameters which are truly associated with the surgical performance in order to accurately estimate the training program efficacy. We have to mention that the number of harvested lymph nodes, the conversion rate, the safe use of electrosurgery, the number of conducted errors, the blood loss, the risk of injury to vital structures and the perioperative complication rate should additionally be estimated during a LCS training program as well as the time of task completion, the number of movements and the path length. Shanmugan *et al.* studied all the associating metrics (n=14) in LCS training program with LAP Mentor and concluded that instrument path length, accuracy of the peritoneal/medial mobilization, and dissection of the inferior mesenteric artery are more accurate for expert laparoscopists while, 8 of 14 metrics represent the surgical experience (5). Although the necessity for decreasing the learning curve of LCS is obvious, we believe that many measures should be taken in order to achieve this goal. The second key issue refers to the fact that there were no equal groups according to the dominant hand as 87.9% of the sample were right-handed while, authors didn't take in consideration this parameter in learning curve estimation.

We explore further the implications of this study's conclusions about the VRS in LCS training. One major limitation of this study is the fact that the effectiveness of this training curriculum is probably related only to laparoscopic sigmoidectomy and not to all the laparoscopic colorectal procedures as they appear more challenging as, for example, very low anterior resection. In fact, laparoscopic surgery for rectal cancer is usually associated with increased rate of positive resection margins and difficult intraoperative maneuvers. Moreover, laparoscopic right colectomy with intracorporeal end-to-end anastomosis is feasible but it can be performed by a limited amount of surgeons. Additionally, laparoscopic resection for transverse colon cancer can be a safe and feasible option despite that

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the complete laparoscopic mesocolon excision remains difficult. Thus, the necessity for specific training in more advanced laparoscopic tasks is obvious in order to establish laparoscopic colectomy in everyday practice.

In conclusion, the ideal method of training in novel surgical techniques has not been established yet. However, an effort for determination of a quality training program in LCS is mandatory in order to reduce its steep learning curve and lead to better clinical outcome. One holistic quality training program which, especially provides to a novice surgeon all the cognitive aspects of the LCS and all the acquired psychomotor skills before performing a real-time surgery, can probably reduce LCS learning curve. Finally, we recommend a systematic training program for LCS consisting of a well-structured pre-clinical phase in combination with a clinical mentor-based phase.

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