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Commentary

Evolution and Emerging Trends of Laparoscopic Colorectal Cancer Surgery

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Laparoscopy has been a major revolution in colorectal surgery, although it has taken several years to become a popular approach due to the great complexity of laparoscopic colorectal resections. Its slow uptake was also influenced by initial concerns about the oncological safety, especially with regard to lymph node harvesting and metastatic dissemination related to pneumoperitoneum. Over nearly three decades from the first laparoscopy-assisted colectomy, this approach has been demonstrated to improve short-term postoperative outcomes compared to open surgery. These advantages have been enhanced by the clinical application of fast-track protocols, and this combination may also have long-term survival benefits following colorectal cancer resections. In parallel, the oncological safety of laparoscopic colon cancer resection has been established and, subsequently, the same conclusions have been reached with respect to laparoscopic rectal cancer surgery. Several high-quality studies and meta-analyses of randomized controlled trials found laparoscopy as effective as open surgery in terms of lymph node clearance, local and wound-site recurrence, distant metastasis, disease-free and overall survival. Finally, a growing number of non-randomized studies suggest that laparoscopic surgery may be applied with caution for T4 colon cancer. Although short- and long-term oncological outcomes seem to be acceptable, careful consideration is needed, especially for T4b right colon cancer. All the aforementioned evidences, together with increasing experience of surgeons and technical advances, made laparoscopy the recommended surgical approach in colorectal cancer patients [1].

However, colorectal surgery is a dynamic subject that constantly evolves as new technologies and expertise develop and synergize. Standardization of techniques as well as structured training programs including virtual simulation, tutoring and competence assessment contributed to the implementation of laparoscopic colorectal surgery in daily practice. Concurrently, a number of new minimally invasive approaches have evolved to address challenging issues and even improve the results of conventional laparoscopy. They include single incision laparoscopic surgery, robot-assisted laparoscopic surgery, natural orifice transluminal endoscopic surgery with its evolution of transanal minimally invasive surgery, laparoscopically-assisted endoscopic resections. These approaches are not competitive or antagonistic but rather complimentary and all directed towards evolving surgery on the way to its ultimate perfection [2].

Total mesorectal excision (TME) was a milestone in the history of rectal cancer surgery. Performing a perfect dissection along the "holy plane" is of paramount importance to optimize nerve preservation while ensuring adequate oncological clearance. The original principles of TME – historically described in the context of open surgery – are still considered by most surgeons as the gold standard by which all innovative techniques are measured. From a technical perspective, laparoscopic TME poses unique challenges especially for lower rectal cancers, which increase the technical complexity of the procedure and the risk of oncologically incomplete surgery. Robust evidence has shown similar outcomes in terms of distal and circumferential margin involvement as well as quality of mesorectal excision. Nonetheless, the safety of a laparoscopic approach to TME has been argued by two controversial randomized trials that failed to demonstrate a non-inferiority of laparoscopy relative to the traditional open approach. Also, a recent meta-analysis supported a higher risk of non-complete mesorectal excision in patients undergoing laparoscopic compared to open TME. Long-term data are expected to assess the implications that these pathologic outcomes may have on disease-free and overall survival. Robotic and, more recently, transanal approach to TME have been developed as alternative minimal access techniques to overcome the technical drawbacks and limitations of laparoscopic TME. Whether one is better or even equivalent to the others is currently a matter of debate, and the results of randomized controlled trials are awaited. However, it is likely that the best technique should be selected based on patient and tumor specific factors. Surgeon's technical skills and knowledge as well as audited results should also be considered [3].

Anastomotic leakage is still a dreaded major complication following laparoscopic colorectal surgery, with a significantly increased risk in extraperitoneal versus intraperitoneal anastomoses. The usual ways of assessing the integrity of colorectal anastomosis such as the air leak test, direct laparoscopic visualization and inspection of doughnuts may be suboptimal methods for predicting anastomotic complications. Real-time intraoperative assessment of perfusion with indocyanine green has been increasingly considered a potential tool that could be used to ensure adequate perfusion at the anastomotic site. A growing body of literature supports the hypothesis that perfusion assessmen affects intraoperative management and may lead to a reduction in the anastomotic leakage rate. Future studies will need to overcome two important limitations of the existing near-infrared imaging systems that are the subjective evaluation of fluorescence intensity and lack of a quantitative means to measure tissue perfusion.

Although fluorescence imaging was initially introduced as a tool to assess anastomotic perfusion, its applications continue to evolve and may improve patient outcomes in colorectal surgery. Emerging uses include confirmation of traditional anatomic perfusion models, ureter visualization to prevent iatrogenic injury, and preoperative endoscopic tattooing of colorectal neoplasms, which is especially important in the era of minimally invasive surgery. Fluorescence imaging with indocyanine green has also been described to facilitate the identification of the transanal total mesorectal dissection plane, which could potentially help to avoid injuries, such as those to the urethra. Further investigations are needed to implement the use of indocyanine green fluorescence for detection of peritoneal carcinomatosis and liver metastases from colorectal cancer. Future studies will also need to address the development of novel fluorophores [4].

Fluorescence imaging is also emerging as a powerful tool for lymphatic mapping and sentinel lymph node identification. This information has the potential to change the operative strategy when lymph nodes are found outside of the traditional resection field, indicating the need for extended lymphadenectomy in selected cases. In low rectal cancer surgery, this might lead to a tailored approach for performing lateral pelvic lymph node dissection that is not routinely carried out in western countries. Although it has been associated with improved survival and recurrence rates, establishment of criteria to accurately predict lateral lymph node status as well as standardization of this challenging technique is necessary in the future [5].

Intraoperative evaluation of lymph flow pattern may also be a promising technique to identify appropriate central vessels to be dissected as well as determine the appropriate separation line of mesentery in colon cancer surgery [6]. This may be particularly suitable for tumors that have variable drainage and vascular supply, as those located at the transverse colon and flexures, or in patients undergoing re-operative surgery, in whom the lymphatic-bearing tissue was excised.

With regard to the extent of lymphadenectomy, the principles of complete mesocolic excision (CME) have been applied to colonic surgery. CME has been associated with improved specimen quality and oncological outcomes compared with conventional colon resections, especially for stage-III neoplasms. Concerns have arisen about an increased risk for intraoperative complications and the possibility of reproducing CME by laparoscopy. Moreover, the evidence for its oncological benefit is not conclusive. In the future, identifying the tumour, lymphatic map and involved nodes in real time may allow the surgeon to remove all oncologically relevant tissue with precise mesocolic margins, thus helping to optimize and individualize CME instead of performing a radical CME. This may lead to the principle of fluorescence-guided precision surgery for colorectal cancer [7].

Technological advancements of imaging systems have led to an expanding use of three-dimensional (3D) laparoscopy in colorectal surgery, especially in right colectomy. 3D vision has proved helpful in reducing operative times and improving surgeons' proficiency in difficult intracorporeal tasks like suturing. Future robust clinical research is required to investigate the potential benefit of 3D laparoscopy on patients' outcomes and surgical training [8].

Among the last achievements in imaging technology, virtual reality and 3D printing appear to be attractive in terms of surgical training and education, preoperative planning accuracy and optimization of treatment strategy. Virtual reality exploration using CT scan-based 3D models seems to be a promising approach for both preoperative simulation and intraoperative navigation. It can provide an enhanced understanding of crucial anatomic details, including vascular variations, thus contributing to improve safety of laparoscopic colorectal resections [9]. A further advance in real-time information would be represented by augmented reality, which is a fusion of projected computer-generated images and real scene. However, its application to bowel surgery is technically very challenging. Current clinical uses of 3D printing are still limited and include enhancing patient education before stoma construction, improving the understanding of complex pelvic anatomy before TME, planning resection of colorectal liver metastases as well as evaluation of their response to chemotherapy, and guiding implantation of electrodes for sacral neuromodulation. Future applications are expected, including 3D bioprinting which combines 3D models with stem cell research to create replacement organs [10].

References

1. Manceau, G., Panis, Y. (2016) Laparoscopic colorectal surgery: why, when, how? Updates Surg, 68(1): 3-5.
2. Sehgal, R., Cahill, RA. (2014) Advanced laparoscopic surgery for colorectal disease: NOTES/NOSE or single port? Best Pract Res Clin Gastroenterol, 28(1): 81-96.
3. de Lacy, FB., Chadi, S., Berho, M., Heald, RJ., Khan, J., Moran, B., et al. (2018) The Future of Rectal Cancer Surgery: A Narrative Review of an International Symposium. Surg Innov, 25(5): 525-535.
4. Keller, DS., Ishizawa, T., Cohen, R., Chand, M. (2017) Indocyanine green fluorescence imaging in colorectal surgery: overview, applications, and future directions. Lancet Gastroenterol Hepatol, 2(10): 757-766.
5. Matsuda, T., Yamashita, K., Hasegawa, H., Oshikiri, T., Hosono, M., Higashino, N., et al. (2018) Recent updates in the surgical treatment of colorectal cancer. Ann Gastroenterol Surg, 2(2): 129-136.

6. Watanabe, J., Ota, M., Suwa, Y., Ishibe, A., Masui, H., Nagahori, K. (2016) Real-Time Indocyanine Green Fluorescence Imaging-Guided Complete Mesocolic Excision in Laparoscopic Flexural Colon Cancer Surgery. Dis Colon Rectum, 59(7): 701-705.

7. Chand, M., Keller, DS., Joshi, HM., Devoto, L., Rodriguez-Justo, M., Cohen, R. (2018) Feasibility of fluorescence lymph node imaging in colon cancer: FLICC. Tech Coloproctol, 22(4): 271-277.

8. Arezzo, A., Vettoretto, N., Francis, N.K., Bonino, M.A., Curtis N.J., Amparore, D., et al. (2018) The use of 3D laparoscopic imaging systems in surgery: EAES consensus development conference 2018. Surg Endosc, [Epub ahead of print]

9. Guerriero, L., Quero, G., Diana, M., Soler, L., Agnus, V., Marescaux, J., et al. (2018) Virtual Reality Exploration and Planning for Precision Colorectal Surgery. Dis Colon Rectum, 61(6): 719-723.

10. Emile, SH., Wexner, SD. (2018) Systematic review of the applications of three-dimensional printing in colorectal surgery. Colorectal Dis, [Epub ahead of print].