EDITORIAL

Editorial Process: Submission:00/00/0000 Acceptance:00/00/0000

Advancements in Minimally Invasive Surgery for Colorectal Cancer: A Paradigm Shift

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Asian Pac J Cancer Prev, **26 (5)**, 1479-1481

Dear Editor

Minimally invasive surgery (MIS) has revolutionized the treatment landscape for colorectal cancer, offering patients a range of options that prioritize precision, faster recovery, and improved functional outcomes. As surgical techniques continue to evolve, methods such as laparoscopic surgery, robotic-assisted surgery, transanal total mesorectal excision (TaTME), and natural orifice specimen extraction surgery (NOSES) are becoming increasingly integrated into clinical practice. This editorial explores these innovative techniques, their advantages, and the ongoing discussions surrounding their long-term effectiveness in terms of tumor prognosis, highlighting the paradigm shift that MIS represents in the management of colorectal cancer.

Laparoscopic surgery has been foundational in minimally invasive approaches. Key studies have confirmed its safety and efficacy compared to traditional open surgery. For example, the MRC CLASICC trial found no significant differences in circumferential resection margin (CRM) positivity or complication rates between laparoscopic and open methods, although laparoscopic anterior rectal resection had a higher CRM positive rate. Long-term outcomes, including five-year overall survival (OS) and disease-free survival (DFS), showed no significant differences, suggesting laparoscopic techniques can achieve similar oncological results. However, debates persist regarding their long-term implications [1]. The COLOR series [2] and COREAN [3] studies echoed these findings, noting benefits like reduced bleeding and faster recovery, while studies such as ALaCaRT [4] and ACOSOG Z6051 [5] raised concerns about CRM negative rates and mesorectal integrity, indicating that laparoscopic surgery may not always be non-inferior to open surgery.

Robotic-assisted surgery offers significant advancements in treating ultra-low rectal cancer, addressing challenges posed by traditional laparoscopic techniques. It provides improved dexterity and visualization essential for navigating the narrow pelvic cavity during these complex procedures. The 2017 European ROLARR study found no significant differences in conversion rates to laparotomy or circumferential resection margin (CRM) positivity between robotic and laparoscopic methods [6]. In contrast, the 2023 Korean COLRAR study suggested that robotic surgery may lower CRM positivity rates while maintaining comparable completion and postoperative complication rates [7]. Furthermore, a 2022 randomized controlled trial from Zhongshan Hospital demonstrated that robotic-assisted abdominoperineal resection (APR) resulted in fewer complications and lower conversion rates than laparoscopic surgery, along with better urinary and sexual function outcomes, reinforcing the benefits of robotic assistance in improving surgical results for patients [8].

Transanal total mesorectal excision (TaTME) is a significant advancement for mid- and low-position rectal cancer, allowing for direct visualization of the mesorectal plane via a transanal approach. This technique facilitates precise resections with minimized influence from pelvic anatomy. TaTME has demonstrated lower circumferential resection margin (CRM) positivity rates and improved functional outcomes compared to conventional total mesorectal excision (TME) [9]. Randomized controlled trials confirm its safety and efficacy, making it a valuable option for select patients. The TaLaR study, a phase 3 noninferiority trial conducted across 16 hospitals in 10 Chinese provinces with 1,115 patients, revealed no significant differences in intraoperative (4.8% for TaTME vs. 6.1% for laparoscopic TME) or postoperative complications (13.4% for TaTME vs. 12.1% for laparoscopic TME). Both techniques achieved high successful resection rates (TaTME at 98.9% vs. laparoscopic TME at 98.7%). The Spanish Ta-LaTME study further indicated advantages for TaTME, including a significantly lower conversion rate to laparotomy (2% for TaTME vs. 20% for laparoscopic TME) and reduced local recurrence rates (1.8% vs. 6.1%) [10]. However,

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additional multicenter randomized controlled trials, such as COLOR III and ETAP-GRECCAR 11, are needed to obtain comprehensive medium- and long-term data on the efficacy of TaTME for colorectal cancer treatment [11].

Natural orifice specimen extraction surgery (NOSES) is another innovative approach in colorectal surgery, allowing specimen removal through natural body cavities, thus avoiding abdominal wall incisions. Early studies indicate a low incidence of postoperative complications and favorable long-term outcomes [12]. A significant 2022 study in China involving 5,055 colorectal cancer patients reported a 14.1% overall complication rate and a 4.9% anastomotic leakage rate. Among 701 patients followed for over a year, the three-year OS rate was 93.2%, with an 82.2% DFS rate and a local recurrence rate of 3.6%. The rapid recovery associated with NOSES, alongside its oncological efficacy, positions it as a compelling option for early-stage colorectal cancer [13]. As surgical techniques evolve, NOSES represents a significant advancement in safer, more effective colorectal cancer treatments. Ongoing research and larger studies may further validate its role as a standard approach.

As minimally invasive surgery for colorectal cancer advances, several key considerations arise. While short-term outcomes for laparoscopic, robotic, TaTME, and NOSES techniques are generally positive, debates about their long-term oncological safety and efficacy continue. The variability in study designs, patient populations, and surgical techniques complicates direct comparisons, underscoring the need for high-quality randomized controlled trials to draw definitive conclusions.

In conclusion, the advancements in minimally invasive surgery for colorectal cancer mark a significant evolution in surgical practice, prioritizing patient outcomes through techniques such as laparoscopic surgery, robotic assistance, TaTME, and NOSES. Each method offers unique benefits, including reduced postoperative complications and improved recovery times, which enhance the overall patient experience. However, ongoing debates concerning the long-term oncological efficacy and safety of these approaches highlight the necessity for further research and multicenter randomized controlled trials. It is essential to continue exploring these innovative techniques while maintaining a critical focus on their long-term implications for patient prognosis. As the field progresses, a collaborative approach involving surgeons, researchers, and patients will be paramount to establish best practices and improve survival rates in colorectal cancer treatment.

Author Contribution Statement

A.N. and M.K. contributed to methodology, conceptualization, and investigation. M.H.A. and A.S.-D. managed formal analysis and investigation. S.S. and M.K. focused on methodology, investigation, and drafting the original manuscript. H.N. and A.M. were involved in investigation and writing. M.K. and A.R. also contributed to investigation. A.N. and S.S. conducted additional investigations. M.K. and A.S.-D. handled data curation, while H.N. oversaw project administration. A.N. and M.K. were responsible for writing, reviewing, and editing.

Acknowledgments

The authors sincerely thank all contributors whose invaluable insights and efforts were essential to the successful completion of this manuscript.

Declarations

Ethics approval and consent to participate: Not applicable

Conflict of interests

The authors declare that they have no conflict of interest.

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