Editorial
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The Paradigm of Technological Innovations from Open to Scarless Surgery for Colorectal Cancer

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The global burden of colorectal cancer (CRC) and therapeutic evolutions

The estimated incidence of colorectal cancer (CRC) is expected to increase by 60% with over 2.2 million new cases and 1.1 million deaths by 2030.[1,2] In keeping with this global escalation of CRC, the pedagogy of curative therapies has also been revolutionized. Innovations in bioengineering technologies show tremendous progress in the surgical treatments of CRC with a significant impact on postoperative recovery time, the amount of surgical trauma, and cancer-related morbidity and survival.[3] The 4-year disease-free survival for patients with stages I-III CRC has improved to 85.5% following total mesorectal excision.[4] The following sections of this paper shed light on the surgical developments for CRC that have accounted for less complications and morbidity, rapid recovery, and improved survival.

Surgical management of colorectal cancer (CRC) by laparoscopic and robotic assisted laparoscopic surgery

The management of CRC primarily involves a multi-disciplinary approach that derives services from a number of disciplines - surgery, oncology, radiology, nutrition, and social care.[5] The main reason for integrating these disciplines is driven by the fact that the disease quite often presents at an advanced stage which necessitates neo(adjuvant) therapy and nutritional support during the perioperative period.[6] Traditionally, the mainstay of CRC treatment is surgical therapy that carries the promise of cure even in the presence of metastases. Before the advent of laparoscopy, all surgical therapies were performed by an open technique with a high incidence of anastomotic leakage,[7] wound infection, adhesions and incisional hernia,[8] longer hospital stay, and high morbidity.[9] In the 1990s, laparoscopic surgery revolutionized the landscape of surgical therapies in all disciplines,

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including CRC. However, the learning curve for CRC has remained long and tedious.[10] Nevertheless, the cutting-edge developments in surgical techniques as well as the state-of-the art programs overcame this shortcoming to some extent and offer well-structured accredited platforms for surgical training.[11] The educational reforms that frame the entire training of medical graduates in the work-place environment can potentially enrich the learning avenues for those students who intend to pursue a surgical career.[12] The outright benefits of laparoscopic surgery for CRC are far ranging and include shorter hospital stay, less blood loss, high lymph node yield, less postoperative pain, and rapid return of bowel function compared to the open technique.[13,14] A study by Schwenk et al. has shown a lower incidence of postoperative complications (18.2%) in patients who underwent laparoscopic resection for CRC compared with open surgery (23%).[15]

The two-dimensional video imaging, unstable assistant-held camera platform, limited range of motion, and poor surgical ergonomics undermine the effectiveness and feasibility of laparoscopic surgery for CRC.[16] Although there is convincing evidence of enhanced convalescence and low morbidity by laparoscopic surgery compared to the open technique,[3,17] some reports have shown tumor recurrence at the port sites, which has challenged the oncological safety of laparoscopic surgery.[18,19] Unfortunately, the large incision to retrieve the surgical specimen through the abdominal wall defeats the main purpose of using small incisions by laparoscopic surgery. The three-dimensional video imaging, enormous range of motion, and a very stable camera platform by robotic surgery has overcome some of the pitfalls witnessed during laparoscopic surgery.[20] Interestingly, research has not shown a significant difference in the 5-year disease-free survival as well as for locoregional recurrence between laparoscopic and robotic-assisted laparoscopic surgery.[21] Also, the challenges of wound seeding by cancer cells and large incision for specimen retrieval have been reported with the use of robotic assisted laparoscopic surgery for CRC.[22,23]

Natural orifice transluminal endoscopic surgery (NOTES)

The innovations in bioengineering have recently introduced natural orifice transluminal endoscopic surgery (NOTES) that allows surgical access within the abdominal or thoracic cavities through a natural orifice – either the mouth, anus, urethra, or vagina.[24] Although the overarching benefit of NOTES remains the scarless surgery, this surgical strategy requires visceral perforation and closure such as transcolonic, transvaginal, and transgastric approaches. With NOTES, the concept of scarless surgery has been materialized, recovery is quick even after major surgical procedures, and there is significantly less post-procedural pain.[25] 'Hybrid' NOTES entails the surgical entities that requires some type of transabdominal assistance. In some situations, the majority of the procedure is conducted using transabdominal instruments, whereas other surgeries are predominantly transluminal but need transabdominal assistance.[26] The transvaginal approach has been successfully used for large bowel cancers by intracorporeal anastomosis and transvaginal specimen extraction,[27] nephrectomy,[28] partial gastrectomy,[29] and cholecystectomy.[30] Saad and Hosogi have adopted a new transanal approach that included a standard laparoscopic left colon resection and NOTES by introducing a resectoscope into the rectum, where they removed the specimen through the same route.[31] Lastly, Targarona et al. adopted a transgastric approach for splenic disorders where spleen was extracted transvaginally.[32]

Challenges of scarless surgery by natural orifice transluminal endoscopic surgery (NOTES) and the future

Natural orifice transluminal endoscopic surgery marks a landmark leap in medicine by introducing scarless surgery that uses natural orifices. In addition, benefits of NOTES include better cosmesis, less post-operative pain with early recovery and a short hospital stay. However, despite its great promise, the future of NOTES remains unclear due to profound ethical issues,

procedural challenges and difficulties, and an extremely long learning curve. The pressing technical challenge in NOTES is the narrow operative field with limited maneuverability allowed by the natural orifice. A much higher cost and a long learning curve for NOTES compared to laparoscopic assisted surgery for CRC have also been reported.[33] The cost effectiveness of NOTES is the biggest hurdle against its global application. Compromised sterilization and insecure closure of the penetrations of the stomach and colon pose the greatest challenge to the use of transgastric or transcolonic NOTES.[34] The safety and efficacy of this surgical development needs to be established by further animal and human studies in clinical trials. Once proven safe and feasible, NOTES carries great promise for scarless surgery in the modern era.

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