Recent advances in robotic surgery for colon and rectal cancer: Review article

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Abstract

Background: Colorectal cancer is the third cause of cancer deaths globally. In Egypt, Colorectal cancer is the 7th commonest cancer, about 3.47% of male cancers and 3% of female cancers. Robotic CRC surgery is a recent surgical option for benign and malignant disease. Robotic techniques have more benefits than laparoscopy especially in the pelvic surgeries.

Aims: was to overview the benefits of robotic surgery use in the treatment of CRC like intra-operative feasibility, postoperative complications, duration of hospital stay, morbidity and mortality

Methods: We have searched the literatures in PubMed, Google scholar, Egyptian bank of knowledge and science direct.

Conclusion: Robotic approach seems to bypass most of the of laparoscopic surgery barriers through high-definition 3D vision, physiologic tremorfiltration, motions like human wrist of robotic instruments, control with stable camera, and better ergonomics. The accurate procedures provided by this new technology are in demand especially for a narrow space as pelvic surgery.

Keywords: Robotic surgery; Colorectal surgery; Colorectal cancer; Pelvic surgery.

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Introduction

In Egypt, CRC represents about 3.47% of male cancers and 3% of female cancers **(Hokkam et al., 2019)**.

In 2015, numbers of colon cancer patients (excluding rectal cancer) were estimated more than 3000 patients **(Hokkam et al.,2019).**

Laparoscopic surgeries are widely used for CRC with better shorter outcome in comparison to open surgery **(Bosker et al., 2019)**.

Many barriers of Laparoscopic surgery like loss of 3D vision, loss of human wrist's motion, and the need to use longer instruments, loss of dexterity, long steep learning curve and surgeon exhaustion **(Toritani et al., 2019)**.

Robotic surgery has introduced into the field of gastrointestinal surgery as it could bypass the laparoscopic surgery barriers in CRC with a lot of promises in the colorectal surgery **(Luca et al., 2018).**

In 2002, Robotic CRC surgery was introduced by Weber et al **(Park et al., 2016)** for benign disease by Hashizume et al **(Hashizume et al., 2002),** then for malignant disease by D'Annibale et al **(Pai et al., 2017).**

In this article, we review the characteristics and benefits of robotic CRC surgery**.**

Treatment options of CRC by stage

A. Treatment of stage 0 CRC

Stage 0 represents (T in situ)where the tumor is present in the colonic inner epithelium or the mucosal lining. Surgical removal like polypectomy or a colonoscopic local excision is sufficient. Large mass may require Partial colectomy **(Angarita et al., 2018).**

B. Treatment of stage I CRC

Stage I includes (T1 and T2) tumor is limited to submucosa or muscularis propriaand doesn't invade thenearby organs. Surgical removal through polypectomyor partial colectomy with regional lymph node dissection is sufficient **(Daaboul and El-Sibai, 2017).**

C. Treatment of stage II CRC

Stage II includes stage IIA (pT3N0) where tissues surrounds colon and rectum are invaded, stage IIB (pT4aN0) where the visceral peritoneum is invaded, and stage IIC (pT4bN0) in which the invasion is directed to other structures or organs, but lymph nodes haven't involved yet **(Gunderson et al., 2010)**.

Surgery should include wide bowel segment resection with 5 cm -at least- colon segment of both sides of the resected mass with their lymphatic drainage. 12 lymph nodes at least should be dissected. For lower medium-risk patients with stage II CRC, partial colectomy might be sufficient **(Daaboul & El-Sibai, 2017).**

For high-risk patients, chemotherapy could be used. Patient considered in high risk when: High pT4 stage, Less than 12 lymph node resection, invasion of perineural or lymphovascular tissues, Obstruction or perforation of the bowel, Poorly differentiated histology, Increased (CEA) level, and or Positive margins **(Daaboul and El-Sibai, 2017).**

D. Treatment of stage III CRC

For stage III colon cancer, any size (T1–T4) with regional lymph nodes metastasis, the standard is partial colectomy for the involved colonic segment with regional lymph nodes, and then adjuvant chemotherapy after 8 weeks of surgery. Neoadjuvant chemoradiotherapy, then adjuvant chemotherapy is indicated for rectal cancer, tumor size (T3–T4) with positive lymph nodes **(Arya et al., 2020).**

E. Treatment of stage IV CRC

Stage IV CRC is characterized by distant metastasis. The primary tumor surgical decision in stage IV is multifactorial including the symptoms existence and metastasis resectability **(Feo et al., 2017).**

If the distant metastases and the primary tumor are resectable, primary tumour's curative resection is performed, and resection of the distant metastases. In case of resectable distant metastases but unresectable primary tumor, primary tumor and distant metastases aren't resected, and decide to select another treatment method. In case of unresectable distant metastases but resectable primary tumor, the indication for the primary tumor resection is determined, depending on the clinical feature of the primary tumor and the expectance of the prognosis **(Hashiguchi et al., 2020**).

Adjuvant chemotherapy in CRC is to prevent postoperative recurrence. Systemic chemotherapy is to treat unresectable progressive CRC **(Shinagawa et al., 2018).**

Robotic surgery in colorectal cancer

I. Historical view

In 1985 Robotic surgery was firstly documented through PUMA 560 robotic surgical device in neurosurgical field. In 1987, robotic cholecystectomy was done**.** In 2000, da Vinci robotic system was approved from the FDA for surgical procedures **(Peters et al., 2018).**

In 2002, Robotic CRC surgery was announced by Weber et al **(Park, et al., 2016)** for benign disease by Hashizume et al **(Hashizume et al., 2002)** for malignant disease by D'Annibale et al **(Pai et al., 2017).**

II. Types of surgical robots

A. Active systems: Autonomously work but remain under the surgeon's control.

B. Semi-active systems: pre-programmed by surgeons for robotic surgery.

C. Master–slave systems: Neither automatic nor pre-programmed, But depend completely on surgeon activity. The da Vinci® and ZEUS are examples **(Lane, 2018).**

III. Da Vinci surgical robotic system

Itis the commonest robotic surgical system. In 2012, more than 200,000 robotic surgeries have been performed **(Swayamjyoti et al., 2014).**

IV. Indications and Contraindications for robot assisted colorectal surgery

A. Indications

Where the robotic approach is available, it could be the standard especially for rectal resections **(Gomez Ruiz et al., 2020**).

B. Contraindications: according to **(Xu et al., 2018).**

Patients with Intolerance to General Anaesthesia, Bleeding tendency, Pregnant, Severe obesity, Extensive metastasis to the abdomen or pelvis, Critical Tumor bowel perforation or obstruction, Extensive abdominal adhesion, massive ascites, haemorrhage, or shock

V. Patient selection

Itis the key especially in the learning stages. It is recommended to select patients with BMI <30, Age <75 years, No previous pelvic or intra-abdominal surgery, T1/T2 tumors, the proximal rectal tumors, No history of neo-adjuvant chemo-radiotherapy, and no history of other comorbidity **(Swayamjyoti et al., 2014).**

VI. Patient preparation:

Bowel preparation (by phosphate enema)is controversial in CRC surgery. It's recommended to have Low residual food 3-4 days before operation, Normal feeding up to 6 hours before operation, drinks up to 2 hours before operation, and 500 mL IV fluid per hour

-as tolerated by the patient- is recommended Intra-operative **(Xu and Qin, 2016).**

Benefits and limitations of robotic surgery

I. Benefits to the surgeon: according to **(Ashrafian et al., 2017).**

A. Improved visualization via the stereoscopic 3-D image, provide better dissection and protection of critical structures**.**

B. Fogging and unclear image isn't frequent as the heat generated at the tip of lens system.

C. The double-jointed EndoWrist instruments enable to multi directions motion.

D. No need for a skilled assistant, as the operatorcan control the camera and retract tissues through the third operating arm.

E. Robot instruments can filter surgeon tremor, leading to a more controlled dissection.

F. The surgeons can operate while sitting down, that reduce the pain and tiredness of the surgeons.

G.Short learning curve.

II. Benefits to the patient: smaller incisions, less pain, and a faster recovery in comparison to open and laparoscopic techniques **(Casillas Jr et al., 2014).**

Rate of conversion to open surgery for robotics (0%–4.9%) is lower compared with laparoscopy (7.3%–34%) **(Yamamoto et al., 2009)**

III. Limitations

A. the high cost. **B.** Prolonged operative time. **C.** Absence of tactile sensation that could cause tissue injury if the surgeon hasn't enough experiences **(Herron and Marohn, 2008).**

Advanced Techniques in Robotic Surgery

Robotic technology develops rapidly likes self-optimized positioned arm, smart stapling techniques, better reachable instruments, and ultra-rapid vessel sealers. Complete bowel reconstruction could be performed robotically **(Marecik et al., 2019).**

Recently, a single port site robotic surgery is reported**.** Better identification of vascular anatomy and lymph node dissection in real time during surgery can be performed via the intraoperative near-infrared fluorescence (INIF) imaging system **(Bae et al., 2015).**

Surgical robots are going to be smaller with more processors, motors and sensors. New robotic systems are able to create data to be used for future self-learning and improvement and provide bloodless field that could be achieved by laser haemostatic control for micro bleeders and ultra-rapid vessel sealers **(Marecik et al., 2019).**

Multiple new robotic technologies are now under development like automatizaion and tissue recognition where the robot can follow the proper tissue plane selected by the surgeons **(Belsley, 2011**).

Conclusion

Robotic CRC surgery is globally increased that seems to bypass most of the of laparoscopic surgery barriers providing high-definition 3D vision, physiologic tremor filtration, motions like human wrist of robotic instruments, in addition to control with stable camera, its technical safety and oncological safety have been proven, However, the high cost may restrict its wide use especially in developing countries. However, in our opinion young generation should start gaining the skills of this promising surgery.

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