

Robotic Colorectal Surgery for Neoplasia



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KEYWORDS

- Robotic • Colorectal • Colon • Rectal • Cancer • Neoplasia
- Total mesorectal excision

KEY POINTS

- Robotic colorectal surgery has several advantages to surgeons, including improved visualization, enhanced control, and improved ergonomics.
- Robotic total mesorectal excision (RTME) is currently the main application for colorectal surgeons, and it is associated with a lower rate of conversion to open surgery than its laparoscopic counterpart.
- Outcomes after robotic colorectal surgery are similar to conventional laparoscopy.
- The learning curve for robotic colorectal surgery is short, but surgeons are often already experts in laparoscopy, which makes the number difficult to interpret.

INTRODUCTION

Minimally invasive surgery (MIS) for colon and rectal cancer is now universally accepted as providing equivalent oncologic outcomes to open surgery and offers added benefits, including earlier return of bowel function, shortened length of stay, and better cosmesis. The evidence for laparoscopy comes from multiple well-designed randomized controlled studies, meta-analyses, and case-matched and prospective cohort studies.¹⁻⁸ Laparoscopy, however, has several well-known limitations, including limited range of movement, 2-D vision, requirement of a highly trained assistant, and a long learning curve.⁹

Robotic surgery is in essence laparoscopy with sophisticated equipment designed to overcome these limitations. The key elements of the robotic platform include high-definition 3-D vision, EndoWrist (Intuitive Surgical, Sunnyvale, CA, USA) instruments

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with greater degrees of freedom, and absence of tremors of the human hand to the instrument tips.¹⁰

Colon and rectal surgery was one of the earliest specialties to adopt robotic surgery, with Weber¹¹ and Hashizume¹² reporting the first operations for benign and malignant colorectal disease, respectively in 2002. D'Annibale¹³ and Giulianotti¹⁴ from Europe and Delaney and colleagues¹⁵ from the United States were the early pioneers of this technology, publishing some of the seminal papers in this field.^{11–17}

For the purpose of this article, the term *robot* refers to the da Vinci Si 4-arm system (Intuitive Surgical, Sunnyvale, California). The latest system is known as the Xi and is discussed in detail later. With the dual console system, it is possible to walk a trainee through the operation, with graded responsibility to complete more complex tasks as training progresses. The system also allows a more objective validation of surgical skill and competence using the skill simulator and external animate and inanimate models.

BENEFITS OF ROBOTIC SURGERY

Benefits to the Surgeon

The major advantage of robotic surgery for the surgeon is improved visualization, because robotic imaging includes depth perception akin to open surgery due to the stereoscopic 3-D image, a consequence of a dual telescope system. This allows a more precise dissection and preservation of critical structures, for example, the pelvic autonomic nerves during mesorectal excision.¹⁸ Additionally, the heat generated at the tip of the dual lens system makes fogging and loss of clarity infrequent.

The second benefit is the instrumentation. The double-jointed EndoWrist has improved versatility compared with conventional nonarticulating laparoscopic instruments, and it maneuvers well in tight spaces, such as the pelvis. There is less dependence on a skilled assistant, because the surgeon controls the camera as well as a third operating arm, which can be used for retraction. Robot instruments also eliminate surgeon tremor, allowing for a more controlled dissection. When working in the deep pelvis, especially in obese men, the advantages of robotic instrumentation become the most apparent.

Another important advantage to robotics is improved ergonomics for the operating surgeon. The surgery is performed while sitting down, and the controls can be adjusted to reduce the pain and fatigue of a long, complex operation.¹⁹ Conventional laparoscopy, on the other hand, is known to be associated with a high incidence of neck, back, and shoulder pain, muscle stiffness, headache, visual discomfort, and fatigue.^{20,21}

Limitations

The major issue in robotic surgery is the significant increase in cost compared with laparoscopic and open surgery. The cost increase has 3 components¹⁰: (1) fixed costs of purchase and subsequent machine maintenance, (2) consumables (drapes and instruments with limited lifespan), and (3) increased operative time. Another limitation to robotics is the absence of haptics or tactile feedback. The surgeon understands tissue grip by visual cues, such as tissue blanching or shearing. Therefore, there is potential for suture fray and tissue injury if the surgeon is inexperienced. This is a component of the robotic learning curve, and practice in the dry, porcine, or cadaveric laboratory significantly improves understanding of tissue and suture tensile strength.

Benefits to the Patient

The MIS approach to colorectal surgery has several well-known benefits compared with open colectomy, including smaller incisions, less pain, and a quicker overall

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