Chapter

# Introductory Chapter: Addressing the Challenges of Laparoscopic Surgery

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## 1. Introduction

The field of surgery has experienced a revolution in the present era with a dramatic shift from the traditional open surgery to minimally invasive surgery (MIS). This has been associated to numerous advantages over open surgery, mainly for patients, such as a reduction of tissue trauma and smaller postoperative scars, which in turn involves shorter hospital stays, reduction of the postoperative pain, and faster recovery.

Apart from all these meaningful benefits, this evolution in surgery also results in many technical challenges for surgeons. Relative to open surgery, surgeons lose direct vision, and only two-dimensional indirect vision through a display is available. This indirect vision sometimes takes the sense of orientation and depth perception away from surgeons. The precise manipulation of the laparoscopic instrument tip is restricted mainly because these instruments are generally slim and long and with limited dexterity. Most of the instruments are straight and do not have flexible tips. This surgical tools also lead to a reduction of sensory feedback during surgery due to surgeons cannot directly touch the organs in the body. Some of these limitations make the development of common surgical procedures in open surgery not as straightforward and simple through minimally invasive surgery.

This book is just a step forward for the readers to learn further the recent surgical techniques and technologies that have emerged in order to deal with the aforementioned challenges in minimally invasive surgery.

Laparoscopic surgeons are required long training time, experience, and practices in order to deal with the technical limitations introduced by laparoscopic surgery and become proficient. Due to the steep learning curve that laparoscopic surgery demands in certain surgical procedures, advanced and structured training programs and methods are constantly being introduced [1, 2]. Recently, there is a paradigm shift from traditional subjective assessment methods of trainees to more objective assessment tools that can accredit surgeons as competent in laparoscopic surgery [3, 4].

Despite the many advantages laparoscopic surgery offers to patients, laparoscopy also entails a number of technical limitations for surgeons. The performance of this surgical technique implies important restrictions on freedom of movement, mainly due to the use of rigid and long surgical instruments with poor ergonomic design, the location of the screens, the use of pedals to control the diathermy system, and by the fixed surgical ports for the instruments. These limitations result in an increased incidence of static postures in surgeons and the adoption and


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maintenance of forced body postures for long periods of time, which potentially affect performance and accuracy during surgery and increase the incidence of physical fatigue and musculoskeletal disorders. In order to address some of these technical limitations, new surgical instruments and devices have been developed aiming to enhance the dexterity, accuracy, and ergonomics of laparoscopic instruments [5]. In addition, new methodological approaches and instrumental techniques for ergonomic analysis have been implemented to improve the working conditions of surgeons, as well as the design of the laparoscopic material [6].

Since the introduction of laparoscopic surgery several decades ago, it has been constantly evolving to the emergence of more sophisticated approaches such as the laparoendoscopic single-site surgery (LESS), natural orifice transluminal endoscopic surgery (NOTES), or transanal surgery, which are intended to reduce the patient's invasiveness and surgical outcomes.

LESS surgery could possibly result in even better postoperative outcomes than multi-port laparoscopic surgery, especially concerning cosmetic outcomes and pain [7, 8]. By reducing the number of transcutaneous points of access, the approach offers numerous advantages including, but not limited to, improving postoperative recovery time and pain, enhancing cosmetics, and minimizing port-related complications. Instrument collision, lack of triangulation, and in-line vision are among the main challenges of LESS surgery. Several techniques and advancements have been introduced to overcome constraints associated with this surgical approach such as novel access devices and curved, articulated, or pre-bent instruments [9, 10]. The feasibility of LESS for almost all types of upper gastrointestinal procedures has been proved [11, 12].

To date, several NOTES procedures have been performed using mainly stomach, rectum, and vagina as the portal of entry into the peritoneal cavity. The main benefits of this surgical technique in comparison to conventional laparoscopic surgery include no scars, less external pain, and lower cost. However, there are also some barriers when using this technique, some of them include difficulty in the closure of enterectomy, anastomotic techniques, spatial orientation, long learning curve, lack of triangulation of instruments, control of hemorrhage, and prevention of the transluminal spread of infection [13]. In order to address some of these technical difficulties in NOTES surgery, novel devices and robotic platforms using a flexible endoscope are appearing as a new trend in the field of MIS [14, 15].

Rectal cancer surgery has undergone a rapid change over the last few decades. We have come a long way from abdominoperineal resection to minimally invasive sphincter-preserving techniques. Minimally invasive surgical techniques have been applied to rectal surgery for several procedures such as transanal polyp excision, local excision of rectal cancer, or transanal total mesorectal excision (taTME), among others [16, 17]. Currently, the two most popular options for local excision are transanal endoscopic microsurgery (TEM) and transanal minimally invasive surgery (TAMIS) [18, 19]. TEM utilizes a rigid platform to access intraluminal lesions in the rectum, maintaining stable the pneumoperitoneum. TAMIS utilizes conventional laparoscopic devices and a single incision port rather than a specialized platform.

One of the technological fields that has most recently affected laparoscopic surgery is robotics. Robotic surgery is a further advancement in the field of laparoscopic surgery, which has gained global acceptance, and a large number of centers are performing robotic surgery as a routine. Laparoscopic robotic surgery has made tremendous progress in a relatively short period of time, resulting in improvements for both the patient and surgeon. Generally speaking, the robot for laparoscopic surgery provides three-dimensional vision, dexterity, and intuitiveness. The majority of robotic surgery applications are in urology, gynecology, and colorectal application, providing comparable clinical results to conventional laparoscopic approaches for the most popular procedures in these fields [20, 21]. The da Vinci surgical system is the most extended robotic platform worldwide for laparoscopic surgery. However, recently many other robotic systems are under development, including additional features such as enhanced portability and force feedback [22, 23].





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