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## Technology in Medicine

# Emerging technology in minimal access surgery

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### ABSTRACT

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Surgical care has undergone a dramatic change over the past couple of decades with the introduction of more advanced technology into patient care. Image guided and video endoscopic procedures not only minimize the trauma of access, but also allows more precision in instrumentation through small ‘ports’ or through anatomic conduits (e.g., arteries, veins) or natural orifices (e.g., mouth, anus, vagina). The patient benefits substantially in terms of the short term problems of pain and wound infection and also the long term problems related to hernias and adhesions. However the techniques require acquiring an entirely new skill set for the surgeons and getting familiar with the working of the complex devices, notwithstanding the occasionally prohibitive costs. This article will introduce the latest in image-guided surgery, 3D laparoscopy including robotics, the newest energy sources and the latest in simulation based training and operative planning.

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Laparoscopic surgery has brought about a tremendous change in surgical care in the past couple of decades. With new innovations in digitization, optics, instrumentation and recording technology there is now a radical change in how surgical procedures are performed.<sup>1</sup> The advantages of laparoscopic surgery in terms of postoperative morbidity are already beyond debate. It greatly diminishes the incidence of postoperative pain, wound infection, incisional hernias and symptomatic adhesive bowel obstruction in the future. It is basically an image-guided surgery through small incisions in the abdominal wall and obviously diminishes the trauma of access to the patient. The smaller size of the surgical incisions however present some real challenges to the operating surgeon. Apart from requiring an entirely novel skill set for the surgeons it also comes with its own set of drawbacks. Recent advances in technology aims at overcoming these limitations and making surgery safe for the patient. Apart from better instrumentation the entire amalgamation of digital display

and storage allows more and more procedures to be performed and achieved for surgical training. The marriage of surgery and technology brought about various innovations and are being considered below.

## 1. 3D vision

Laparoscopic imaging on the display monitor is generally monocular compared with the binocular and three-dimensional view in open surgery. This is because traditional telescopes have a single-lens system. Binocular imaging currently available in robotic platforms uses provides the surgeon with a truly immersive three-dimensional view. These are also currently being tried out in routine laparoscopic surgery but necessitates 3D monitors and compatible 3D glasses. Although a little cumbersome they are currently being

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**Fig. 1 – Integrated OR.**

developed and are undergoing trials to demonstrate superior advantages to the surgeon.<sup>2</sup>

### 1.1. Video documentation

With the current state of High Definition video recording there has been a radical change in the way laparoscopic surgery is being performed. Static images or videos of entire procedures can be edited and stored or achieved online for documentation of findings or for surgical training purposes. These images can be attached to the medical record and stored using Radiologic picture archiving and communication system (PACS) images.<sup>3</sup> In this way, they are available for the radiologist, pathologist, and other consultants for real time consultation and videoconferencing resulting in better patient care.<sup>1,3</sup> An advantage of modern monitors is its ability to display multiple pieces of information on the imaging screen. Most data are nowadays available digitally and can be routed to any display device. This includes real time display of intraoperative ultrasound, flexible endoscopy or fluoroscopy, or preoperatively acquired images (e.g., computed tomography (CT) or Magnetic resonance imaging (MRI) scans) simultaneously with the laparoscopic images using picture-in-picture, split screen, or quad split screen displays.

### 1.2. Integrated operating room

This provides digital information on multiple displays and controlled by the operating surgeon either through soft touch buttons on the camera head, touch screen displays or by voice control. The large flat panel displays multiple images on the screen including laparoscope, flexible endoscope, ultrasound, fluoroscopy and even CT and MRI images. The central display in the surgical field is a touch screen, allowing the surgeon to control everything from image routing to the operating room ambience using voice controls or touch screens in the surgical field (Fig. 1). The surgical team has access to multiple monitors that can be moved to ergonomically convenient positions to display the surgical images and other digital information.<sup>1</sup>

Any image can be recorded to document the surgical findings. The images or video clips can be simultaneously superimposed with voice recordings or texts or can be edited later. This provides valuable documentation of the surgical findings for the medical record that can be accessed remotely with appropriate security and privileges.

### 1.3. Minilaparoscopy

Having realized the tremendous benefit to the patients of laparoscopy, there has been a desire for diminishing the injury of access to internal body cavities. Several approaches have been developed and are being evaluated to assess potential benefit over traditional laparoscopic surgery. The goals are to diminish postoperative pain, accelerate surgical recovery, and improve cosmetic outcome while maintaining the safety and effectiveness of the surgery. One approach is to miniaturize the diameter of the surgical instruments and telescopes further termed 'minilaparoscopy'. As camera light sensitivity and image quality improve, high-quality images can be obtained through progressively smaller laparoscopes. In minilaparoscopy, surgeons can insert instruments as small as 2 mm into the body cavity through needle-sized incisions, leaving almost no scar. Unfortunately, the reduced access size necessitates improvement and increased precision in instrument design. These instruments are however less robust and more limited in curvature than 5- or 10-mm instruments. The main advantage of minilaparoscopy appears to be a somewhat improved cosmetic outcome, but various studies did not show much overall advantage compared with the widely used conventional laparoscopic procedures.<sup>4</sup>

## 2. Laparoscopic ultrasound

The use of ultrasound in the operating room by surgeons as well as by endoscopists is increasing. Current guidelines and recommendations in the use of laparoscopic ultrasound (LUS) involve assessment of organ systems including Hepatobiliary,

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