The Use of Robotic in Gynaecology

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Gynaecologists were the first surgeons to use laparoscopy. Diagnostic laparoscopy and laparoscopic tubal ligation were commonly performed by gynaecologists since 1970s. In the last decade, operative laparoscopy has gained widespread acceptance. Almost all gynaecological procedures can now be performed by laparoscopy which has gradually become the standard of care. Today, most gynaecological centres are capable of performing basic laparoscopic procedures. However, relatively few gynaecologists possess the skills to perform more advanced laparoscopic procedures such as hysterectomy and myomectomy.

Laparoscopic surgery is performed using long instruments inserted into the abdomen through trocars and the image is viewed on the monitor. It avoids the morbidity of a large abdominal incision and shortens both the hospital stay and recovery period. However, there are inherent problems with this technique. Firstly, the two-dimensional image on the monitor results in the loss of depth perception and surgical precision. Secondly, the use of long instruments operating at a greater distance from the tissue magnifies hand tremor and further reduces operative precision. Thirdly, the limited degree of freedom of the instrument tips restricts the surgical angles in accessing the pathology and tissues planes. Fourthly, the inability to feel the organs directly reduces tactile feedback and increases the risk of inadvertent tissue trauma during manipulation. Lastly, the inferior ergonomic position adopted by the surgeon during surgery increases fatigue and discomfort, compromising performance and dexterity. These limitations make suturing and knot-tying, the basic techniques in open surgery, very difficult and contribute to the steep learning curve often associated with complex laparoscopic procedures especially those requiring intra-abdominal suturing such as myomectomy and tubal re-anastomosis.

Robotic technology was introduced into surgical practice in an attempt to attenuate some of these limitations. Robotic instruments clearly provide superiority in some aspects of the surgery. The increased degrees of freedom (“wrist action”) allow the surgeon to easily reach behind structures and negotiate difficult surgical angles. By adjusting movement scaling, hand tremor is significantly reduced, thereby increasing operative precision. The ergonomics of the operating surgeon is significantly improved by operating in the sitting position and facing directly forward toward the 3-D operative image. By using the robotic system, surgeons can now operate in an ergonomic position with restoration of proper hand-eye coordination, improved quality of vision, enhanced dexterity with increased degrees of freedom. Surgical robot has the potential to enable a laparoscopic approach to procedures that are presently performed by laparotomy due to the technical difficulties intrinsic to laparoscopy.

The first commercial application of robotics in laparoscopic procedures was as a surgical assistant and functioned as a laparoscope holder. The device was called Automated Endoscopic System for Optimal Positioning or AESOP® (Computer Motion Inc., Goleta, CA). It provides a steady, hands-free image and the endoscope was moved using a foot pedal and later voice activation. Although the voice interface is appealing, it is still cumbersome. Robotic control of the laparoscope can allow both the surgeon and assistant to use both hands for a surgical procedure3. This is critical for complex gynaecological procedures.

The world’s first robot assisted gynaecological surgical procedure reported was a case of tubal reanastomosis with the ZEUS Robotic System (Computer Motion, Goleta, CA, USA) in 19994. The system has three remotely controlled robotic arms, allowing a single surgeon to manipulate the laparoscope and two laparoscopic surgical instruments simultaneously. The robotic arms are separated units also attached to the sides of the operating table. The arm that holds the laparoscope is AESOP which is directed by voice commands. The arms that hold the surgical instruments are controlled by two handles housed in a mobile console that can be positioned anywhere in the operating room or in a different location. A computer controller translates the surgeon’s movements from the handles to the robotic arms.

The first robotic surgical system that integrates the control of both the laparoscope and surgical instruments into a single unit is the da Vinci Robotic Surgical System (Intuitive Surgical, Inc., Mountain View, CA, USA). In gynaecology, it was first reported to be used in laparoscopic tubal reanastomosis5 and later laparoscopic hysterectomy6. The system is a computer-driven surgical tool with two major components: a mobile console and a surgical arm unit. The mobile console, which is operated by the surgeon with two handles and three foot pedals, controls the three, and in the latest model four, mobile arms of the robot, intra-abdominal manipulations, camera movements, and unipolar coagulation (Figure 1). The console can be positioned anywhere inside or outside the operating theatre. However, the Food and Drug administration
regulations require that the console be placed in the same room as the operative table except in telesurgery. The image is provided by the Insite Vision System through a 12 mm endoscope, with either zero- or 30-degree lenses, comprising of two laparoscopes fused together. The surgeon operates in a sitting position and looks through a binocular three-dimensional (3-D) viewing monitor (Figure 2). The image is displayed above the hands of the surgeon so that it gives the surgeon the illusion that the tips of the instruments are an extension of the control grips, thus giving the impression of being at the surgical site. The movements of the surgeon are digitalised, scaled at 1/1, 1/3, or 1/5, and transmitted by computer to the intraabdominal instruments without noticeable delay. The extraabdominal movements of the instruments controlled by the robotic arms have four degrees of freedom. The intraabdominal articulations of the micro-instruments at 2 cm from the tip are comparable to those of the human hand and wrist, with the same degrees of freedom.

Robotic surgery using the da Vinci Robotic Surgical System has been applied successfully in cardiac, urologic, paediatric, foregut and colo-rectal surgery. In the literature to date, robotics has been reported to be used to perform different procedures: tubal reanastomosis; hysterectomy, ovarian transposition; repair of vesicovaginal fistula; sacrocolpopexy. Currently, there are no published reports or series on robot-assisted myomectomy and radical hysterectomy with pelvic lymphadenectomy. However, several abstracts on these procedures have been presented at scientific meetings.

In Hong Kong, the first robot-assisted gynaecological surgery was performed by the author at the Prince of Wales Hospital in July 2006 (Figure 3). It was a total laparoscopic hysterectomy using the da Vinci Robotic Surgical System. Robot-assisted procedure is generally performed with the patient under general anaesthesia and in the dorsal lithotomy position, using four trocars. A 12-mm trocar is required for the laparoscope. It is placed either in the umbilicus or supraumbilical position depending on the size of the uterus. Two specially designed 8-mm trocars are placed in the right and left lower abdomen, 2-3 cm below and about 8 cm away from the primary trocar. These trocars are attached to the operating arms of the robot which is placed in between the patient’s legs. A fourth trocar of 5 or 10 mm is placed somewhat midway between the primary port and one of the 8-mm ports, depending on the configuration of the operating theatre. This serves as an accessory port for suction and irrigation and suture to be brought into the pelvis.

Laparoscopic surgery has revolutionised the concept of minimally invasive surgery for the last 3 decades. Robotic-assisted surgery is one of the latest innovations in the field of minimally invasive surgery. However, robotic surgery is still in its infancy and its uses and efficacy have not yet been well established. The extremely high cost of the system and its instruments almost prohibits its widespread and routine use. The system is large in size and the robotic arms are relatively cumbersome. A large operating room is required to house both the surgical team and the robot.

There is no tactile or haptic feedback from the system and the surgeon has to rely on visual cues to assess the tensile strength of tissue and sutures. Despite these, robotic surgery has a shorter learning curve than conventional laparoscopy. It is envisaged that the surgical robots will make minimally invasive surgery easier and more efficient, and allow procedures that are performed by laparotomy to be accomplished by laparoscopy. Currently, the use of the robots may not be cost-effective for gynecologic procedures that are already performed by laparoscopy. Other potential problems such as malpractice liability, credentialing, and training requirements need to be addressed to ensure the safe introduction of robotic systems in surgery.
References


MEETING FACILITIES of The Federation of Medical Societies of Hong Kong

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