10.5005/jp-journals-10033-1204
REVIEW ARTICLE

Robotic Gynecological Surgery: A Clinical Approach

Mohammed Khairy Ali, Ahmed Y Abdelbadee, Sherif A Shazly, Ahmed M Abbas

ABSTRACT

Objective: To provide a review in the available literature in robotic gynecological surgery, focusing on history of robotic surgery, basic setup, advantages and disadvantages of the robotic surgery, uses of surgical robots, the future of the robotic surgery and finally laparoendoscopic single site robotic surgery.

Design: Literature survey.

Conclusion: Although it is not evident that robotic surgery is superior to conventional laparoscopic surgery in surgical outcomes, many studies demonstrate the positive feasibility of robotic assisted laparoscopic surgery in many gynecological fields including cancer. Robotic surgery is considered as a solution for the technical problems of minimal invasive surgery. However, the economic feasibility of robotic surgery still remains as an obstacle which should be overcomed. It is expected with further development of robotic technology that the concept of high cost will be resolved.

Keywords: Single-port laparoscopy, Robotic surgery, Gynecologic surgery.

How to cite this article: Ali MK, Abdelbadee AY, Shazly SA, Abbas AM. Robotic Gynecological Surgery: A Clinical Approach. World J Lap Surg 2013;6(3):156-162.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Operative laparoscopy developed a lot in the last years and the appearance of minimally invasive surgery (MIS) led to advances in general surgery as well. Operative laparoscopy was initiated in the 1970s, while laser and electric energy technology was integrated into laparoscopic surgery in the early 1980s. Now, laparoscopic surgery has become an essential part of surgical treatment for many diseases including cancers. Compared with laparotomy, laparoscopic approach offers several advantages, such as faster return to normal activity, better cosmetic results and shorter length of hospital stay. The technology and techniques related to laparoscopic surgery are still evolving to the direction of easier and less invasive laparoscopic surgery. So wherever in the body a cavity exists or a cavity can be created, laparoscopy is indicated and probably preferable. The limiting factor is the availability of proper instruments, skill and experience of the surgeon. Despite several advantages of laparoscopic surgery, the disadvantages of conventional laparoscopy limit its use. However, the robotic surgery has been developed to overcome on the current limitations of conventional laparoscopy. The use of robots in surgery has been introduced from about 25 years. The first application of a robot in surgery was in neurosurgery then in orthopedic surgery which used a device to aide in total hip replacements, also in the field of urology, transurethral resection of the prostate can be performed by a robot through guidance from a preoperatively constructed three-dimensional (3D) image.[1] Robotic surgery carries with it the potential to transform laparoscopic surgery by providing instruments with distal ends that is similar to the fine movements of the human hand and it can also provide the surgeon with a high-definition, 3D view of the operative field. As this technology grows and develops, the hope is that further development will allow for more precise and even less invasive surgical options beyond laparoscopy and the current forms of surgical robots.[2] The robotic systems begin to be put to many tests, the surgeons are focusing on the surgical robot not as a mechanical device but as an information system, so robotic system should be fused with other information systems. One example of this type of fusion is image-guided surgery, also called surgical navigation. Robot-assisted surgeons will be able to see real-time, 3D images electronically of the operative field that is displayed on the monitor. In other words, on the screen, human anatomy will be appear translucent, and the surgeon will be able to determine the exact location of a lesion and more readily avoid damaging vital structures such as major vessels. In fact, with preoperative scanner images, surgeons could robotically practice their patients' surgery the night before, and the robot's computer could be programmed not to allow its instruments to penetrate vital organs so avoid intraoperative accidents.[3]

HISTORY OF ROBOTIC SURGERY

The term 'robot' was first introduced to the public in 1921 when the Czech writer Karel Capek described the notion in his play Rossum's Universal Robots. The term 'robot' originated from 'robota,' which means 'work' in the Czech language. For many years, robots have achieved development from simple machines performing the same tasks to a highly sophisticated machine capable of performing very delicate operation. In the surgical field, automated endoscopic system for optimal positioning (AESOP) was the first laparoscopic camera holder by robot. Although AESOP has been used in over 10,000 laparoscopic surgeries, it was only designed to offer greater vision control to the surgeon and to eliminate the need for an assistant who manipulated the endoscope.[4] Computers and technology are increasingly interacting with surgeons both inside and outside of the operating room. The computer's ability to enhance, modify or transform electronic data is changing patient management before, during and after surgery. However, these technologic advancements are having a great influence on the planning and performance of the surgery. Although robots are still unintelligent machines, great steps have been made in expanding their use. Today robots are used to perform highly specific, highly precise, and dangerous tasks in industry and research which not possible with a human work force. Robotics, however, has been slow entered the field of medicine. The lack of fusion between industrial robotics and medicine, particularly surgery, is ended nowadays. Voice-activated robotic arms routinely produce endoscopic cameras, and complex master slave robotic systems are currently approved, marketed, and used for a variety of procedures.[5] The beginning of surgical robots have entered the field of endoscopic surgery to overcome the capabilities of human surgeons beyond the limits of conventional laparoscopy. The history of robotics in surgery begins with the Puma 560, a robot used in 1985 by Kwoh et al to perform neurosurgical biopsies with greater precision. Three years later, Davies et al performed a transurethral resection of the prostate using the Puma 560. This system eventually lead to the development of Probot, a robot designed specifically for transurethral resection of the prostate. While Probot was being developed, Integrated Surgical Supplies Ltd. of Sacramento, CA, was developing ROBODOC, a robotic system designed to cut the femur in hip replacement surgeries. ROBODOC was the first surgical robot approved by the FDA.[6] Also in the mid-to-late 1980s a group of researchers at the National Air and Space Administration (NASA) Ames became interested in using this information to develop telepresence surgery. This concept of telesurgery became one of the main forces behind the development of surgical robots.[7] While these robots were being developed, general surgeons and endoscopists joined the development team and accept it to overcome the limitations of conventional laparoscopic surgery.

Initial clinical trials using robotics in the operating room have shown the ability of the system to enhance the skill of the surgeon to perform technically delicate suturing and dissection. By enhancing the skill of the surgeon, the robot has aided in the development of microsurgical procedures, such as those used in cardiac and infertility surgery, and their advance into the field of endoscopic surgery. The computer interface helps the surgeon perform the microanastomoses using a minimally invasive approach beside the advantages to the patient of such techniques, including reduced recovery time and better cosmoses.[8]

BASIC SETUP

Today, many robots and robot enhancements are being researched and developed. Schurr et al at Eberhard Karls University's section for MIS have developed a master-slave manipulator system that they call ARTEMIS. This system consists of two robotic arms that are controlled by a surgeon at a control console. Dario et al at the MiTech laboratory of Scuola Superiore Sant'Anna in Italy have developed a prototype miniature robotic system for computer-enhanced colonoscopy. This system provides the same functions as conventional colonoscopy systems but it does an inchworm-like movement using vacuum suction. Because this system allows the endoscopist to teleoperate or directly supervise this endoscope, the surgeons believe that this system is not only suitable but may expand the applications of endoluminal diagnosis and surgery.[9] In 1998, Computer Motion which already had manufactured the AESOP developed the ZEUS surgical robot with a 2D imaging system similar to that of standard laparoscopy. On the other hand, the Da Vinci surgical system was introduced which has four robotic arms and obtained US Food and Drug Administration (FDA) approval in 2001, and become the most common robotic system used in the world. The competition between the ZEUS and the Da Vinci surgical systems ended when Computer Motion was introduce into robotic surgery in 2003.[10]

The Zeus system is composed of a surgeon control console and three table-mounted robotic arms. The right and left robotic arms replicate the arms of the surgeon, and the third arm is an AESOP voice-controlled robotic endoscope for visualization. In the Zeus system, the surgeon is seated comfortably upright with the video monitor and instrument handles positioned to maximize dexterity and allow complete visualization of the surgical field. The system uses both straight shafted endoscopic instruments similar to conventional endoscopic instruments and jointed instruments with articulating end-effectors and 7º of freedom.[11] The Da Vinci robotic system consists of three main components: The robotic cart, the vision cart, and the operating console. Four robotic arms are mounted on the robotic cart which can be placed freely next to the patient. The robotic cart connects to the laparoscopic trocars on the patient's abdomen which connected to the operating console through a cable. The Da Vinci surgical system is equipped with a 3D vision system in which double endoscopes generate two images resulting in the perception of a 3D image. In addition, robotic arms with surgical instruments have three or four joint which reproduce the range of motion and dexterity of the surgeon's hand. The surgeon sits at the surgical console and performs the surgery by manipulating the controller in it. The movement is translated from the surgeon's fingers to the tip of the surgical instruments. Despite all of these technologic advancements that make the surgeon nearly autonomous, an assistant is still required for all robot-assisted cases. Their responsibility is mainly instrument exchanges, suction and irrigation, suture introduction and retrieval and additional retraction.[12]

ADVANTAGES OF THE ROBOTIC SURGERY

Robotic surgery offers several advantages over laparoscopy: A 3D vision, wristed instrumentation, and comfortable positioning for the surgeon while performing surgical procedures. The only currently available surgical robot employs two magnifying cameras that when used provide 3D vision to the surgeon with an available high-definition vision system. This enhanced visualization gives the gynecologist the ability to identify tissue planes, blood vessels and nerves while performing the surgical procedure, also decreased blood loss has been reported in robotic surgery. The limited degrees of freedom associated with a standard laparoscopic instrument compared with the surgeon hand decrease the dexterity of the surgeon and his ability to perform delicate procedures like difficult dissections, lymph node removal. Wristed instrumentation allows the gynecologic surgeon to obtain the exact instrument angle available at laparotomy. This also eliminates the fulcrum effect that is present with conventional laparoscopy, where surgeons need to move their hand in the opposite direction to the certain location of the distal instrument tip.[13] With robotic surgery the movements are natural and surgeons move their hands in the direction they want the instruments to move. Three degrees are provided by the robotic arms attached to the abdominal wall trocars (insertion, pitch, yaw), and 4º result from the 'wristed' instruments (pitch, yaw, roll and grip). The terms pitch, roll and yaw are the three characteristics that describe the rotations in three dimensions around the robotic instrument. Pitch is the rotation around the lateral or transverse axis. The yaw is rotation about the vertical axis, and the roll is rotation around the longitudinal axis. The improved dexterity and control allow for finer, more delicate, tremor-free manipulation, dissection, removal or reconstruction of tissue.[14] Fatigue and physical discomfort can become limitations during any surgical procedure. During laparoscopy, surgeons are often suffering from difficult technique to complete the surgical procedure because they need to reach over the patient's abdomen to manipulate the hand controls on the laparoscopic instruments. With robotic surgery, the surgeon sits comfortably at the surgical console and manipulates the hand controls and foot pedals. This may serve to reduce fatigue and discomfort during complex surgical procedures.[15]

DISADVANTAGES OF THE ROBOTIC SURGERY

The main disadvantages of robotic surgery applications are the cost, the large size of the robot and console, limited availability within some health systems, lack of tactile feedback, the need to train surgeons, and operating room availability on the use of this technology. The costs associated with robotic surgery include the cost of the unit that can range from 1.4 to 1.6 million dollars and the cost of instrumentation that has limited its uses. Health systems need to perform an investment analysis which gives fixed costs associated with the purchase, high robotic surgical volume is required to improve this calculation. Additional costs that need to be considered include the time and cost of training surgeons and operating room and increased operative time associated with operating room setup as well as the assembly and disassembly of the robotic system during the early phase of the training. There is evidence that with experience in robotic surgery, the operative time can become shorter than with laparoscopy.[16] The bedside assistant may experience difficulty in manipulating laparoscopic instruments through an assistant port because the robotic arms are moving over the patient abdomen at the same time. Although robotic instrument exchange can become more efficient compared with laparoscopy but it still requires attachment of the robotic instruments to the instrument arms before insertion. Another current limitation of robotic surgery is the lack of tactile feedback, so if there are particular structures that the surgeon desires to palpate, they can do by laparoscopy before using the robot or ask the bedside assistant to palpate and confirm the location.[17] Moving the robot to the operating table and attaching the robotic arms to the trocars is often a major disadvantage requiring significant time. With practice and training, this can be performed quickly but in more time that require with laparoscopy. Because the operating table and the robot do not communicate and are not synchronized, once the robotic unit is united, the patient bed cannot be moved in any direction, otherwise, the trocar depth can become incorrectly positioned and abdominal wall as well as visceral trauma could occur. Increased operative time associated with some robotic surgeries which may have associated side effects, including anesthetic complications.[18] Finally the size of both the robotic unit and console become a major consideration. Depending on current operating room size and availability, relocation to a larger operating room may be necessary. Many of these disadvantages could be improved with further development. Table 1 shows the advantages and disadvantages of conventional laparoscopic surgery *vs* robot surgery.

USES OF ROBOTIC SURGERY

Several robotic systems are currently approved by the FDA for specific surgical procedures. The Zeus system and the Da Vinci system have been used in many laparoscopic surgeries, including cholecystectomies, mitral valve repairs, radical prostatectomies, reversal of tubal ligations, in addition to many gastrointestinal surgeries, nephrectomies and kidney transplants. The number and types of surgeries being performed with robots is increasing rapidly as these system accepted by many institutions. Perhaps the most notable use of these systems is in totally endoscopic coronary artery grafting.[19] The amount of data evaluated the robotic surgery is growing rapidly, and the early data are promising. Many studies have evaluated the feasibility of robot-assisted surgery. The studies also found the robot to be most useful in intra-abdominal microsurgery or for manipulations in very small spaces.

Another use for robotic systems is in pediatric laparoscopic surgery. Currently, laparoscopic pediatric surgery is limited by an inability to perform precise anastomoses of 2 to 15 ml. Although laparoscopic techniques may be used to treat infants with intestinal atresia, choledochal cysts, biliary atresia, and esophageal atresia in term and preterm infants, it is not the standard approach because of the technical difficulties.[20] Despite many studies showing the feasibility of robotic surgery, there is still much to be desired. More high quality clinical trials need to be performed and much more experience needs to be obtained before the full potential of these systems can be realized. One of the most important uses of robotic surgery is in gynecological surgery. The surgeon can perform hysterectomy which is the most important procedure in gynecology robotic hysterectomy and is preferable than laparoscopic, vaginal or abdominal hysterectomy. Operative times ranged from 270 to 600 minutes, and blood loss ranged between 50 and 1,500 ml, with an average loss of 300 ml. The average hospital stay was 2 days, with a range of 1 to 3 days.[21]

Robotic surgery is also used in gynecological oncology which is due to a great progression of robotic technology. In 2005, the first feasibility studies in both Europe and the United States were published. The surgeon can mange many malignancies by robotic surgery such as cervical, endometrial and ovarian cancer as well as pelvic lymph nodes removal without port-site metastasis or recurrences which not found with a mean follow-up of 10 months.[22] In reproductive surgery, the robotic surgery is used to evaluate the cases of infertility; robotic myomectomy has many advantages such like as decrease the risk of adhesion and pelvic organ manipulation which affect the fertility. Although the costs and operative times were higher in the robotic myomectomy but the patients had significantly less blood loss and did not require blood transfusions. Another usage of robotic surgery in reproductive surgery is in tubal reanastomosis which perform to treat the tubal blockage due to tubal pathology and this is considered one of microsurgical procedures which can be performed by robotic surgery. Robotic surgery also has a role in urogynecology. Laparoscopic sacrocolpopexy is used as vaginal reconstructive surgery, can be performed by robotic surgery in which the surgeons can perform the presacral dissection laparoscopically, put the mesh, and intracorporeal suturing, which has significant advantages to the robotic approach.[23] Table 2 shows summary of current applications of robotic surgery.

THE FUTURE OF THE ROBOTIC SURGERY

Robotic surgery is in its infancy. Many disadvantages will be resolved with the time. The surgeons will overcome the obstacles such as malpractice liability, training requirements. Many of current advantages in robotic assisted surgery ensure its continued development and expansion. One

Table 1: Advantages and disadvantages of conventional laparoscopic surgery *vs* robotic surgery

	Conventional laparoscopy	*Robotic surgery*
Advantages	Well-developed technology	3D visualization
	Affordable and available	Improved dexterity
	Proven efficacy	7º of freedom
		Elimination of fulcrum effect
		Elimination of physiologic tremors
		Ability to scale motions
		Microanastomosis possible
		Telesurgery
Disadvantages	Loss of touch sensation	Very expensive
	Compromised dexterity	High startup cost
	Limited degrees of motion	May require extra staff to operate
	The fulcrum effect	
	Amplification of physiologic tremors	New technology
	Loss of 3D visualization	Unproven benefit

Table 2: Summary of current applications of robotic surgery

Orthopedic surgery	*Neurosurgery*	*Gynecology*	*Cardiothoracic surgery*	*Urology*	*General surgery*
• Hip arthroplasty • Knee surgery • Spine surgery	Radiosurgery	Hysterectomies Ovarian resection Tubal reanastomosis	CABG Mitral valve repair	Nephrectomy Prostatectomy Ureter repair	Cholecystectomy Gastric bypass Adrenalectomy Bowel resection Esophagectomy

Table 3: Summary of trials of the operations done by robotic in gynecology

References	*Year*	*Type of study*	*No. of patient*	*Type of operation*	*Duration of the surgery (min)*	*Blood loss (CC)*	*Hospital stay (day)*	*Complications rate (%)*	*Conversion to other method (%)*
Magrina, Kho et al.	2008	Pros-pective	27	Robot-assisted laparo-scopic radical hysterec-tomy	185	100	1.9	32.5	0
Estape, Lamrou et al.	2009	Pros-pective	32	Robot-assisted laparoscopic radical hysterectomy	2.4 hours	130	2.6	18.8	0
Maggioni, Minig et al.	2009	Pros-pective	40	Robot-assisted laparoscopic radical hysterectomy	272	78	3.7	32.5	0
Seamon, Cohn et al.	2009	Retro-spective	105	Robot-assisted laparoscopic staging surgery in endometrial cancer	242	99	1	12.9	
Cardenas-Goicoechea J et al.	2010	Retro-spective	275	Robotic staging of endometrial cancer	237	109	1.88	0	1
Soto E et al.	2011	Retro-spective	124	Robotic hysterectomy	150.8	131.5	2.2	0	0
ElSahwi KS et al.	2012	Retro-spective	155	Robotic staging of endometrial cancer	127	119	1.5	1 death	0
Madhuri TK et al.	2012	Pros-pective	104	Simple and radical hysterectomy	-	155.24	3	0	0
Cardenas-Goicoechea J et al.	2013	Retro-spective	432	Robotic staging of endometrial cancer	218	187	1.96	0	0
Nakib G et al.	2013	Retro-spective	6	Robotic assisted surgery for adnexal pathologies	117.5	-	-	0	0

exciting possibility is expanding the use of preoperative (computed tomography or magnetic resonance) and intraoperative video image to get better guide to the surgeon in dissection and identifying pathology. The nature of robotic systems also makes the possibility of long distance intraoperative consultation or guidance possible and it may provide new opportunities for teaching and assessment of new surgeons. The Zeus robotic surgical system already made a device called SOCRATES that allows surgeons at remote sites to connect to an operating room and share video and audio, to use a 'telestrator' to highlight anatomy, and to control the AESOP endoscopic camera. Although these systems have greatly improved dexterity, they should be developed with the instrumentation or to be incorporated in the full range of sensory input. More standard mechanical tools and more energy directed tools need to be developed.[24]

LESS ROBOTIC SURGERY

Recently a less invasive alternative to conventional laparoscopy or robotic surgery has been developed which is laparo-endoscopic single-site surgery (LESS), also known as single-port surgery. Single-port laparoscopy (SPL) enhances the cosmetic benefits of MIS while minimizing the potential morbidity associated with multiple incisions. The primary advances in LESS as applied to urologic and gastrointestinal surgery demonstrate that the techniques are feasible provided that both optimal surgical techniques and optimal instrumentation are available.[25] The principle concept of LESS is to place all of the laparoscopic ports through the same incision. Now various devices designed to overcome the technical challenges for LESS have been developed and introduced in endoscopic surgery, those devices include laparoscopic ports designed to apply multiple instruments through a single incision, flexible and long endoscopes and articulating variable length instruments. In addition, the Da Vinci robotic platforms with articulating instruments can be integrated into LESS for many surgical procedures.[26] The first experience with robotic LESS was reported by Haber et al then Kaouk et al who reported the first robotic single-port transumbilical surgery in urology by performing a successful radical prostatectomy and nephrectomy. The ability of the robotic arms to enable more degrees of freedom and triangulation at the surgical site facilitate the surgical success.

The robotic LESS is a novel technique which has developed for performing various endoscopic surgical procedures. The surgeons use advances in minimally invasive techniques and technological innovation, including use of the newest generation of port systems that allow several conventional laparoscopic or robotic instruments to be handled simultaneously through a single operating trocar. Other innovations that facilitated the single-port surgical approach included articulating laparoscopes and instruments and multifunctional 5 mm laparoscopic instruments such as the LigaSure Advance™ which allow tissue fusion, vessel sealing, spot coagulation and endoscissor functions in one instrument.[27] Potential advantages of single-port robotic surgery over conventional multiport laparoscopy include the advantages of the robotic system and also the single-port surgery which give better cosmoses from a hidden umbilical scar and a fewer trocar incisions has been used, a possible decrease in morbidity related to visceral and vascular injury during trocar placement as well as decrease postoperative wound infection, hernia formation and elimination of multiple trocar site closures, 3D visualization, improvement of dexterity are obtained by robotic system. No effect of fulcrum is reported in LESS robotic surgery as well as micro-anastomosis become possible. But LESS robotic surgery has increased the number and size of ports required so the typical robotic surgical procedure should include three 8 mm ports and two 12 mm ports.[28] Triangulation is needed for proper dissection; at same time it provides effective traction and counter traction, it is difficult with SPL and becomes easy with robotic surgery. Instrument crowding is the most important problem in single-port surgery not present with using robot. This is due to the development of streamlined profile camera systems which used instruments of different lengths. Instrument and robotic arms crowding can also be overcomed by using 5 mm not 8 mm robotic trocars and by using a 30º robotic camera down or up depending on the case. This modification enables spacing of the robotic arms as far possible from the camera arm. Several single-port devices are available including the SILS Port Multiple Instrument Access Port, GelPort, Uni-X Single-Port System and ASC R-port laparoscopic access device. The major problem with the various single-port devices is gas leaking and structural integrity in response to the movement of robotic arms. There are also some patient-related limitations because the surgeon used the umbilicus as the entry point, this limit patient who would be appropriate for robotic-assisted single site surgery.[29] Single port laparoscopic Surgery (SPLS) is considered a feasible approach for many endoscopic surgical fields especially in gynecological endoscopic surgery like single-port hysterectomy and adnexectomy. SPLS is also used in the field of gynecologic oncology; SPLS may be applied to adnexal surgery in patients with adnexal tumors, prophylactic oophorectomy in patients with high risk of developing ovarian cancer, and hysterectomy in patients with preinvasive cervical carcinoma. With technical advances in the robotic system more complicated procedures in gynecologic oncology, such as radical hysterectomy and endometrial cancer staging surgery might be conducted with SPLS in the near future.[30] Table 3 shows summary of trials of the operations done by robotic in gynecology.

DISCUSSION

The numerous benefits of MIS are better cosmetic results, reduced operative morbidity, reduced postoperative pain, and shorter length of hospital stay compared with laparotomic surgery. MIS has taken the place of laparotomy and became essential in many surgical fields. However, technical difficulties have prevented the widespread of MIS. Over the last three decades, laparoscopic technologies have developed, and robotic surgery using the Da Vinci system has been introduced. Although it is not evident that robotic surgery is superior to conventional laparoscopic surgery in surgical outcomes, many studies demonstrate the positive feasibility of robot-assisted laparoscopic surgery in many field including cancer. Robotic surgery is considered as a solution for the technical problems of MIS. However, the economic feasibility of robotic surgery still remains as an obstacle which should be overcomed. It is expected with further development of robotic technology and the Da Vinci robotic platform, the concept of high cost will be resolved. Robotic surgery has many advantages like 3D vision with high-definition vision system; increase the dexterity of the surgeon and his ability to perform delicate operations, and comfortable positioning for the surgeon while performing surgical procedures because the surgeon sits on robotic console away from the patient. However, there are some disadvantages to the robotic surgery like high cost, the large size of the robot set up, and there is no tactile feedback during operation. But with the future, the robotic surgery will be progressing and its disadvantages will be resolved with the time.

REFERENCES

1. Ayala Yanez R, Olaya Guzman EJ, Haghenbeck Altamirano FJ. Robotics in gynecology. Background, feasibility and applicability. Ginecol Obstet Mex 2012;80(6):409-416.
2. Al-Badawi IA, Al-Aker M, Tulandi T. Robotic-assisted salpingostomy for ectopic pregnancy. J Obstet Gynaecol Can 2010;32(7):627-628.
3. Bandera CA, Magrina JF. Robotic surgery in gynecologic oncology. Curr Opin Obstet Gynecol 2009;21(1):25-30.
4. Bocca S, Stadtmauer L, Oehninger S. Current status of robotically assisted laparoscopic surgery in reproductive medicine and gynecology. Reprod Biomed Online 2007;14(6):765-772.
5. Nezhat C, et al. Robot-assisted laparoscopic surgery in gynecology: scientific dream or reality? Fertil Steril 2009;91(6): 2620-2622.
6. Mettler L, et al. Robotic assistance in gynecological oncology. Curr Opin Oncol 2008;20(5):581-589.
7. Lenihan JP Jr, Kovanda C, Seshadri-Kreaden U. What is the learning curve for robotic assisted gynecologic surgery? J Minim Invasive Gynecol 2008;15(5):589-594.
8. Jung YW, Kim SW, Kim YT. Recent advances of robotic surgery and single port laparoscopy in gynecologic oncology. J Gynecol Oncol 2009;20(3):137-144.
9. Chen CC, Falcone T. Robotic gynecologic surgery: past, present and future. Clin Obstet Gynecol 2009;52(3):335-343.
10. Bartos P, et al. (Da vinci robotic surgery in gynaecological oncology: a critical interim appraisal). Ceska Gynekol 2007; 72(5):354-359.
11. Schreuder HW, Verheijen RH. Robotic surgery. BJOG 2009; 116(2):198-213.
12. Advincula AP. Robotic surgery in gynecology. Foreword. Clin Obstet Gynecol 2011;54(3):373-375.
13. Behera MA, et al. Cost analysis of abdominal, laparoscopic and robotic-assisted myomectomies. J Minim Invasive Gynecol 2012;19(1):52-57.
14. Bell MC, et al. Comparison of outcomes and cost for endometrial cancer staging via traditional laparotomy, standard laparoscopy and robotic techniques. Gynecol Oncol 2008;111(3):407-411.
15. Beste TM, Nelson KH, Daucher JA. Total laparoscopic hysterectomy utilizing a robotic surgical system. JSLS 2005; 9(1):13-15.
16. Boggess JF, et al. A comparative study of 3 surgical methods for hysterectomy with staging for endometrial cancer: robotic assistance, laparoscopy, laparotomy. Am J Obstet Gynecol 2008; 199(4):360 e1-9.
17. Brenot K, Goyert GL. Impact of robotic surgery on obstetric-gynecologic resident training. J Reprod Med 2009;54(11-12): 675-677.
18. Degueldre M, et al. Robotically assisted laparoscopic microsurgical tubal reanastomosis: A feasibility study. Fertil Steril 2000;74(5):1020-1023.
19. Elliott DS, Chow GK, Gettman M. Current status of robotics in female urology and gynecology. World J Urol 2006;24(2): 188-192.
20. Falcone T. Laparoscopic surgery. Foreword. Clin Obstet Gynecol 2009;52(3):303.
21. Fanning J, et al. Robotic radical hysterectomy. Minerva Ginecol 2009;61(1):53-55.
22. Hoekstra AV, et al. Robotic surgery in gynecologic oncology: impact on fellowship training. Gynecol Oncol 2009;114(2): 168-172.
23. Goldberg JM, Falcone T. Laparoscopic microsurgical tubal anastomosis with and without robotic assistance. Hum Reprod 2003;18(1):145-147.
24. Holloway RW, Patel SD, Ahmad S. Robotic surgery in gynecology. Scand J Surg 2009;98(2):96-109.
25. Holub Z. Robot-assisted laparoscopic surgery in gynecology: scientific dream or reality? Ceska Gynekol 2007;72(1):3-4.
26. Escobar PF, et al. Robotic-assisted laparoendoscopic single-site surgery in gynecology: initial report and technique. J Minim Invasive Gynecol 2009;16(5):589-591.
27. Sanchez-Salas R, et al. Laparoendoscopic single site in pelvic surgery. Indian J Urol 2010;28(1):54-59.
28. Lue JR, Murray B, Bush S. Single port robotic hysterectomy technique improving on multiport procedure. J Minim Access Surg 2010;8(4):156-157.
29. Mencaglia L, et al. Single port entry: are there any advantages? Best Pract Res Clin Obstet Gynaecol 2013 Jun;27(3):441-455.
30. Magrina JF, Kho R, Magtibay PM. Robotic radical hysterectomy: technical aspects. Gynecol Oncol 2009;113(1):28-31.

ABOUT THE AUTHORS

Mohammed Khairy Ali (Corresponding Author)

Assistant Lecturer, Department of Obstetrics and Gynecology Woman's Health Center, Assiut University, Assiut, Egypt, Phone: +208824621, 201005537951, e-mail: mohammedelkosy@yahoo.com

Ahmed Y Abdelbadee

Assistant Lecturer, Department of Obstetrics and Gynecology Woman's Center Hospital, Assiut University, Assiut, Egypt

Sherif A Shazly

Assistant Lecturer, Department of Obstetrics and Gynecology Woman's Health Center, Assiut University, Assiut, Egypt

Ahmed M Abbas

Assistant Lecturer, Department of Obstetrics and Gynecology Woman's Health Center, Assiut University, Assiut, Egypt