The Use of Advanced and Modern Surgical Techniques in Gynecologic Malignancies – Laparoscopic and Robotic Surgeries vs Laparotomy

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Abstract: Women with early stage cervical cancer can either be treated with surgery or radiotherapy. However most undergo surgery. For women with stage IA2 or IB1 cervical cancer (tumors <4 cm in the greatest dimension that are confined to the cervix), radical hysterectomy is associated with high cure rates. Radical hysterectomy with pelvic lymphadenectomy has been the treatment of choice for patients with most types of gynecologic malignancies. In such patients, either laparotomy (open surgery) or laparoscopy (minimally invasive surgery performed with either conventional or robotic techniques) are surgical methods that are used for the treatment. Traditionally, radical hysterectomy has been performed through open surgery using a laparotomy incision. However, because of the multiple complications of the latter, the use of laparoscopy is becoming more and more popular. Despite the increasing use of laparoscopy, the laparotomy method nevertheless, is not expected to fade off, as it is the only option that can be used in cases where laparoscopy cannot be performed because of some clear and identified contraindications. Both the above mentioned methods have their own advantages and shortcomings. This review aims at exploring and objectively evaluating the use of robotic/laparoscopic surgery in the management of gynecologic malignancies. The main focus of this review is surgery duration, amount of blood loss, recovery period and post-operative complications of robotic/laparoscopic aided surgeries as compared to laparotomy.

Keywords: Robotic surgery, Laparoscopic surgery, Laparotomy, Gynecologic Malignancies.
Introduction
Ever since medicine and surgeries have been practiced, there have been continuous, gradual and enormous improvements in terms of acquiring surgical skills and also instrument and technology wise. Over the past few decades, there has been a considerable leap towards modernization and advancements in surgical approaches in order to decrease the undesirable complications, facilitate access to the required surgical plane and to improve post-operative outcomes. Laparoscopic and robotic surgeries have emerged as an alternative to conventional laparotomy surgeries to alleviate the complications and undesirable effects, and for a better post-operative forecast. It has been found that robotic surgery does improve the clinical outcomes in obese and morbidly obese patients and is associated with improved ergonomics for the surgeon. It can be foreseen that robotic surgical platforms will continue to improve worldwide into the near future and that the role of robotic surgery in gynecological surgery will keep on increasing. While robotic surgery offers considerable technical advantages over conventional laparotomy and is associated with only a modest learning curve, robotic surgery however do have some shortcomings, like technical knowhow, cost, need for sophisticated instruments, to mention but a handful. This review will aim at exploring the advantages and disadvantages of modern robotic and laparoscopic surgeries over conventional laparotomy, in gynecology.

Applications of Robotics in Gynecologic Surgery
Robotic surgery, computer-assisted surgery, and robotically-assisted surgery are terms used to describe technological means using robotic systems to help in surgical procedures.\textsuperscript{[1]}\textsuperscript{[2]}\textsuperscript{[3]}\textsuperscript{[4]}

Robotically-assisted surgery was developed to overcome the limitations of pre-existing minimally-invasive surgical procedures and to enhance the capabilities of surgeons performing open surgery. Robotic surgery is now being used even in gynecology for management of different types of malignancies. Even though gynecologic procedures may take longer with robot-assisted surgery, however, it may be associated with a shorter hospital stay following the surgery.\textsuperscript{[2]}\textsuperscript{[3]}\textsuperscript{[4]}

Robotic Surgery is not very used for the treatment of some conditions, such as: vulvar cancer; because this malignancy is an external disease where there is ready surgical access and in the debulking of advanced ovarian cancer. However, its use is well appreciated in cases of endometrial cancer, early stage cervical cancer and early ovarian cancer.\textsuperscript{[5]}
Hysterectomy

A hysterectomy is surgery to remove the uterus (partial hysterectomy) or both the uterus and the cervix (total hysterectomy). During robotic surgery, the hysterectomy is performed using instruments that are passed through small abdominal incisions. The magnified, 3-D view makes possible great precision, flexibility and control. This system has multiple “wristed” robotic arms that hold surgical instruments. These arms allow the surgeon to make precise, delicate movements in small spaces. Because the “wrists” on the robotic arms rotate a full 360 degrees, they offer more dexterity than the human hand. One of the robotic arms holds a tiny 3D, high-definition video camera. This camera broadcasts up-close video of the surgical area to a screen on the system’s control console. [6]

Reynolds and Advincula were the first to describe their technique and initial experience with robot-assisted laparoscopic hysterectomy in 2005 [7]. Since then, the use of robotic aided hysterectomy has known a significant increase.

During the procedure, the surgeon maintains complete control of the robot at all times. He or she sits at the control console and maneuver the robotic surgical instruments, using the real-time video as a guide. [6]

Procedure - An overview

- A small incision on the inside rim of the belly button is made. In 90 percent of cases, the hysterectomy can be performed through this one incision. However, some cases require 3 or 4 additional small incisions in the abdomen to accommodate additional surgical instruments. Incisions for a robotic procedure are much smaller than those used for open surgery, so you'll have less tissue trauma and smaller scars than you'd have after a traditional abdominal hysterectomy.
- By using the robotic arms, the video camera and surgical tools are inserted.
- Using the 3D video for guidance, the surgeon carries out the required procedure by using the surgical instruments with the robotic arms.
- An assistant at the operating table repositions instruments, adds or removes surgical devices, and provides other support to the surgeon as needed.

It is to be noted that during a robotic aided hysterectomy, the surgeon can stay in the same room together with the patient or can opt to be in an annexed room or a remote place. The latter uses control devices to direct the surgical instruments to carry out the surgery. The surgeon’s movements are translated into precise and similar actions at the tip of the
Instruments being used.

**How to remove the uterus and other organs through a 1-inch incision?**

After the uterus has been detached, it’s removed from the body through the vagina, thus reducing the risk of complications associated with major abdominal surgery as well as other complications that can result from destroying tissues within the abdominal cavity.

Robotic technology is used to perform total hysterectomies (removal of the uterus and cervix) or partial hysterectomies (removal of only the uterus). [6]

Radical hysterectomy with lymph clearance is the required treatment for patients with early stage cervical cancer (IA2 – IIA). [8] Laparotomy, laparoscopy and Robotic Aided are methods that are being actually used to perform the surgery.

Lonnefors et al. reported no statistically significant difference between laparoscopic and robotic operative times (104 vs. 76 min, P = 0.54) whereas, Paraiso et al. and Sarlos et al. had a statistically significant greater operative time in the robotic groups (Paraiso et al., Laparoscopic 102.7 ± 63.7 vs. Robotic 172.8 ± 89.0 min, P < 0.001; Sarlos et al. Laparoscopic 75 ± 21 vs. Robotic 106 ± 29 min, P < 0.001). [7][9]

**How is a robotic hysterectomy different from a traditional procedure?**

A traditional open hysterectomy requires a 5- to 7-inch incision in the abdomen and a 2- to 3-day hospital stay. In addition to a longer recovery time, patients who undergo a traditional open hysterectomy have visible scarring, increased pain and a higher risk of complications, such as infection at the incision site, and risks of adhesions as a delayed complication. [6][10][11]

Robotic aided hysterectomy has got some definite advantages as compared to the conventional laparotomy: [2][3][4][8][10][12][13][14][19]

- Less intraoperative blood loss,
- Less post-operative pain,
- A shorter length of hospital stay,
- Faster recovery,
- Better cosmetic outcome,
- A lower risk of postoperative complications and
- Better precision due to the 360 degrees rotating tips.

However, like any other surgery, even robotic surgery has some short comings: [8][10][12][13][14]

- Inconvenience to access the surgical plane,
• Need of sophisticated instruments,
• Need of competence and technical skills,
• Injury to viscera and blood vessels,
• Can be time consuming and challenging at times and
• Expensive.

Statistics
A total of 804,551 hysterectomies for benign conditions were performed in the United States during 2009 and 2010. In 2009, there were 242,428 (56.68%) abdominal hysterectomies, 81,446 (19.04%) Total Vaginal Hysterectomies, 86,253 (20.17%) Laparoscopic Hysterectomies, and 17,587 (4.11%) Robotic Hysterectomies. In 2010, there were 202,262 (53.67%) Abdominal Hysterectomies, 71,793 (19.05%) Total Vaginal Hysterectomies, 79,128 (21.0%) Laparoscopic Hysterectomies, and 23,654 (6.28%) Robotic Hysterectomies procedures. The total number of hysterectomies decreased from 427,714 to 376,837, and in relation to all hysterectomies over the time period, the rate of Abdominal Hysterectomies decreased 3%, Laparoscopic Hysterectomies increased 1%, Robotic Hysterectomies increased 2%, while the rate of Total Vaginal Hysterectomies remained unchanged. The use of Robotic Hysterectomies among minimally invasive hysterectomies increased from 9.5% in 2009 to 13.6% in 2010 (P=0.002). Laparoscopic Hysterectomies and Robotic Hysterectomies represented, respectively, 20.6% and 5.1% of the 804,551 hysterectomies performed in the US in 2009 and 2010. [15]

It has also been proven that in obese patients, robotic and laparoscopic surgeries are better than laparotomy in a sense that there is better recovery, less risk of wound infection, early mobilization and also all the above mentioned advantages. [12]

Other surgeries using Robotic Aided or Laparoscopy
Other surgeries have also been carried out using the modern techniques and instruments. However, not many studies have been carried out over the other surgeries. To name, but a few, myomectomy, endometriosis, sacrocolpopexy and some other benign gynecologic cases. [5]

Application of Laparoscopy in Gynecologic Surgery
The use of laparoscopic procedures in gynecology has been constantly increasing over the years with a lot of benefits [16]. This method can be used to manage both early stages of gynecological cancers, and even late stages. It has been proven, that laparoscopic procedures
are safer than conventional laparotomy. Lymphadenectomy is also feasible through laparoscopy. The first laparoscopy to be performed on a human was done in Sweden in 1910 by Hans Christian Jacobaeus.

A laparoscopic (minimally invasive) hysterectomy is performed through 3 or 4 small incisions in the abdomen. This procedure is less invasive than a traditional open hysterectomy and gives the surgeon a 2D view of the surgical area. Laparoscopic surgical instruments are different in that they don’t give the same full range of motion as the “wristed” robotic arms.

**Procedure - An overview.**

There are two types of entries for laparoscopy:

- The open (Hasson) technique.
  
  When using this technique, incision through the abdominal wall is made under direct vision. It is advantageous in the sense that when using this technique, insufflation of the abdomen and attaining pneumoperitoneum is easier, there is less risk of blind puncture complications such as trauma to vessels and viscera, and also it yields a better anatomical repair of the abdominal wall incision.

- The closed (Veress needle) technique.
  
  In this technique, the Veress needle punctures through the layers of the abdominal wall. When the needle enters the cavity, the surgeon will experience a give through or a clicking sensation which is the protective sheath clicking when it recoils. This indicates that the needle entered the abdominal cavity. Most commonly the Veress needle is inserted in the umbilicus as there is no fat or muscle between the skin and peritoneum. However, if there are other underlying causes such as herniation or adhesions, then the umbilical access is to be avoided.

**Access points for laparoscopy.**

![Fig. 1 The access points for abdominal entry in laparoscopic surgery. L-H = Lee-Huang point; P = Palmer's point; U = umbilical point.](image-url)
The left upper quadrant or Palmer’s point was introduced by Raoul Palmer whereby the Veress needle is inserted 3 cm below the left subcostal in the midclavicular line. [Fig. 1][16] This technique is used in patients with obesity and previous laparotomy. [16]

The middle upper abdomen or Lee-Huang point is centrally between the xiphoid process and the umbilicus. [Fig. 1] This technique was introduced by Lee et al. and is indicated in patients with high risks of sub-umbilical adhesions. Access through this point is better in cases of gynecologic malignancy and in patients with previous abdominal surgery. However, in patients with a history of previous surgery in the supra-umbilical region, this access point is contraindicated. [16]

The umbilical point is the point where the Veress needle is typically inserted, usually by prior lifting of the abdominal wall. [Fig. 1] However, in patients with suspected periumbilical adhesions or if pneumoperitoneum couldn’t be attained after 3 attempts, then this access point should be avoided. [16]

Retrospective studies in patients with early-stage cervical cancer have shown that laparoscopic radical hysterectomy has got some definite advantages over conventional laparotomy approaches. It has been shown that laparoscopy is associated with less intraoperative blood loss, less post-operative pain, a shorter length of hospital stay, faster recovery, better cosmetic outcome and a lower risk of postoperative complications as compared to open abdominal radical hysterectomy. [2][8][10][12][13][14] A meta-analysis of 27 randomized controlled trial that compared laparoscopy and laparotomy for benign gynecological procedures, concluded that there is a 40% lower risk of minor complications after laparoscopic gynecology surgery than after laparotomy. [16]

**Advantages of laparoscopic surgery:** [2][11]

- smaller incisions and thus lower post-operative morbidity,
- faster postoperative recovery, shorter length of hospital stay and quicker commencement of adjuvant radio-therapy or chemotherapy,
- lesser risk of formation of adhesions,
- more cosmetic outcome and
- less post-operative pain.

**Disadvantages of laparoscopic surgery:** [11][16]

- difficult to remove large tumors,
- has a potential risk of trocar site metastasis,
- risk of trauma to vessels and viscera and
in some cases vision and range of movement can be limited.

The Use of Laparotomy in Gynecologic Surgery

The word laparotomy has a Greek origin and consists of two parts, ‘lapara’ referring to ‘the soft parts of the body between the costal margin and hips’ and ‘tome’ meaning ‘cutting’.  

A laparotomy is a surgical procedure involving a large incision through the abdominal wall to gain access into the abdominal cavity. It is also known as a celiotomy. The first successful laparotomy was performed without anesthesia by Ephraim McDowell in 1809 in Danville, Kentucky. He excised an ovarian cyst from a lady who was then 46-year-old and the latter then survived to 78. 

Laparotomy can be subdivided into diagnostic and therapeutic. The former, also known as exploratory laparotomy is used when the nature of the disease is unknown and laparotomy is considered the best option to identify the cause. Whereas the latter, is when the cause is known and laparotomy is used to treat the disease.

Laparotomy hysterectomy, also referred to as abdominal hysterectomy is a surgery performed through a large abdominal incision, carried out to remove the uterus with or without the ovaries, fallopian tubes and cervix.

Depending on the reason for the hysterectomy, the surgeon can opt for either removing the uterus along with the cervix - termed as total abdominal hysterectomy, or to preserve it, which is called supra cervical or subtotal abdominal hysterectomy.

In the case of abdominal hysterectomy, the incision can be either a midline (vertical) one, or a transverse lower abdominal incision (horizontal). The type of incision depends on many factors, including the reason for the hysterectomy, the need to explore the upper abdomen, the size of the uterus and the presence of any scars from prior abdominal surgeries. For instance, hysterectomies performed for endometriosis, large fibroids and gynecologic cancers are done mainly through a vertical incision.

Based on a retrospective study published in the American Journal of Obstetrics and Gynecology, it has been proven that laparotomy surgeries formed thicker and more extensive adhesions as compared to laparoscopy surgeries.

The aim of the above study was to establish if there was any difference in adhesion formation post laparotomy as compared to laparoscopic surgery.

Study Design: Ninety female hogs underwent pelvic and para-aortic lymphadenectomy: 40 with trans-peritoneal laparoscopy, 40 with extra-peritoneal laparotomy, and 10 with trans-
peritoneal laparotomy. Three weeks after the initial surgery, a laparotomy was performed to assess adhesion formation.

Results: The trans-peritoneal laparotomy group had significantly higher adhesion formation, with a 100% (10 of 10) adhesion rate. In the trans-peritoneal laparoscopy group, 12 of 40 hogs (30%) had adhesions develop versus 8 of 38 (21%) in the extra-peritoneal laparotomy group ($p = \text{not significant}$). Also no differences were found in the trans-peritoneal laparoscopy and extra-peritoneal laparotomy groups when comparing adhesion thickness or the total surface area of adhesions. More anterior abdominal wall adhesions were noted in the extra-peritoneal laparotomy group (5 of 38) than in the trans-peritoneal laparoscopy group (0 of 40, $p = 0.02$).

Conclusions: Pelvic and para-aortic lymphadenectomy performed with trans-peritoneal laparoscopy does not increase adhesion formation when compared with extra-peritoneal laparotomy in a porcine model. The trans-peritoneal laparoscopy (and extra-peritoneal laparotomy) approach also induces significantly fewer adhesions than trans-peritoneal laparotomy. (Am J Obstet Gynecol 1998; 178: 499-503.)

It is considered that with the start of robotic aided gynecologic surgeries and based on the proven numerous advantages that accompany it, laparotomy surgeries will considerably decreased. Because the decision on the method to be used is on an individual basis, laparotomy will nevertheless not fade off. [18]

**Conclusion**

Laparotomy has been the conventional surgical technique over several decades. However, with new techniques and advancements in the medical field, aiming towards modernization and patients’ welfare, laparoscopic and robotic aided surgeries have known a new dawn. Robotic gynecologic surgery has proven to be feasible, safe and with equivalent clinical outcomes in comparison with laparoscopy and with better clinical outcomes compared with laparotomy. Based on previous studies, robotic aided surgery has proven to have some definite medical and technical based advantages which include better surgical wound healing, lesser hospital stay, early mobilization, lesser risk of post-operative complication, improved ergonomics, visualization with three-dimensional capabilities, dexterity and range of motion with instrument articulation, and tremor filtration.

It however poses some challenges such as the steep learning curve, costs, and operative times, these can nevertheless be overcome with greater experience, with implementation of
Robotics in high volume centers and with improved training of surgeons and robotic teams. Robotics may provide additional benefits over other approaches in the obese patient population and in higher complexity cases. With such advancements, it is expected that in the near future, robotic aided surgery will overcome previous conventional methods and will minimize the use of laparotomy in gynecology.

Comparing the retrospective studies, it can therefore be concluded that despite the shortcomings, robotic aided surgery has a promising future and is more beneficial to the patients than the conventional laparotomy.

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