13. Laparoscopic and robotic assisted laparoscopic cytoreductive surgery in gynecologic oncology

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Abstract. Advanced laparoscopic procedures are increasingly being used as an alternative to laparotomy in gynecologic oncological surgery. The benefits of advanced laparoscopic procedures compared with laparotomy are clear, including decreased pain, decreased surgical site infection rate, decreased length of stay, quicker return to activity and cosmesis. Recently, the da Vinci robotic system (Intuitive Surgical Corporation, Sunnyvale, CA) has been introduced into minimally invasive gynecologic surgery. The robotic surgical system is an innovative technology that addresses the many of the current limitations of conventional laparoscopy.

However, laparoscopic gynecologic oncological surgery is associated with unique challenges and complications compared with the open gynecologic oncological surgery. Principally, this new technique has to address two questions: is the laparoscopic approach a safe procedure and are the oncological results equal to standard surgery? We discuss in this chapter the laparoscopic cytoreductive surgery in gynecologic oncology (uterine and ovarian tumors) and the recent experience and feasibility of integrating robot-assisted technology into minimally invasive gynecologic oncological surgery.

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Introduction

Since the introduction of explorative laparoscopy, operative laparoscopic techniques have been applied to a variety of benign adnexal and uterine conditions. These successes have prompted the development of laparoscopic techniques for the exploration, staging and resection of pelvic malignancies. Techniques range from full laparoscopic to laparoscopic-assisted procedures in which a portion of the procedure is performed vaginally [1]. Albeit the use of laparoscopy for the surgical management of gynaecological cancer is developed since 1990s, it is still unclear whether laparoscopic gynaecological oncology techniques could achieve adequate oncological resection and staging.

Endometrial cancer

Laparoscopy has been reported to provide the exact staging and treatment of endometrial cancer patients, with a shorter hospitalization stay, an earlier recovery, and an improved quality of life [1, 2]. Nonetheless, the number of patients included in such series was low and additional data are required concerning long-term survival in patients treated with laparoscopic approach. Obermair et al. [3] have reported a retrospective study including 510 stages I–IV endometrial cancer patients who either had a total laparoscopic hysterectomy or a total abdominal hysterectomy. The objective of this study was to evaluate the effect of the laparoscopic approach on patterns of recurrence, disease-free, and overall survival in patients with endometrial cancer. The surgical intent was total laparoscopic hysterectomy in 226 patients (44.3%) and total abdominal hysterectomy in 284 patients (55.7%). Total laparoscopic hysterectomy was converted to laparotomy in 11 patients. Patients undergoing total laparoscopic hysterectomy were younger, heavier, with a higher ASA score and were more likely to present early-stage, well-differentiated tumours, and less likely to have undergone lymphadenectomy. Such selection biases may limit the interpretation of the study. With a median follow-up of 29 months, disease-free survival and overall survival were adversely and independently affected by increasing age, higher stage, higher grade, and by deeper myometrial invasion, whereas the intention to treat (total laparoscopic hysterectomy versus total abdominal hysterectomy) did not influence disease-free or overall survival. Patterns of recurrence were similar in both groups and no port-site metastasis was noted in the total laparoscopic hysterectomy group.

Kalogiannidis et al. [4] published a prospective cohort study without randomization of 169 consecutive patients. Sixty-nine patients (41%) were

treated successfully by laparoscopic approach while 100 (59%) by total abdominal hysterectomy. Four out of 73 patients initially approached by laparoscopy were converted to laparotomy (5.5%). Lymphadenectomy was performed in 40% of the laparoscopic group and 57% of abdominal group (P = 0.03). The median number of pelvic lymph nodes removed by laporoscopic approach and laparotomy was 15 (range 2-31) and 21 (range 2-65), respectively (P = 0.05). Operative time was significantly longer with laparoscopy compared with laparotomy, while blood loss and duration of hospitalization was significantly lower in the laparoscopic group. The recurrence rate in the laparoscopic group was 8.7%, compared to 16% in the laparotomy group (not significant). The actuarial overall survival and disease-free survival for the laparoscopic group were 93% and 91% compared respectively to 86% and 84% in the abdominal group (not significant). In the multivariate analyses histological subtype was the only independent prognostic factor for disease-free survival, while surgical technique was not.

Querleu et al. [5] reported three patients with stage I, non-invasive or superficially invasive endometrial cancer with vaginal cuff recurrence within 9 months of treatment. They raised the concern that the obligatory use of a vaginal manipulator at the time of surgery may lead to anterograde and retrograde dispersal of tumour cells, with subsequent vaginal cuff and peritoneal metastasis. Little evidence exists to link vaginal recurrence with the use of uterine manipulators or with the omission of tubal occlusion. Sonoda et al. [6] showed that the treatment of low-risk endometrial cancer by laparoscopy is associated with a significantly higher incidence of positive peritoneal cytology when compared with patients operated by laparotomy. The use of an intrauterine manipulator is not necessary required to perform an adequate laparoscopic-assisted procedure, and could prevent the retrograde dissemination of cancer cells into the peritoneal cavity during uterine manipulation. Post-operative high dose rate brachytherapy is an another solution to prevent vaginal vault recurrences [7, 8].

A large randomized prospective phase III trial comparing the effectiveness of laparoscopic surgery with standard surgery in treating patients with endometrial cancer was conducted by the Gynecologic Oncology Group (GOG-LAP2 trial). The inclusion of 2616 patients is completed since 2005 and we are expecting the long-term benefit data [9]. Meanwhile, there is no evidence for prohibiting laparoscopic surgery in patients with endometrial cancer.

Ovarian cancer

Ovarian cancer is initially managed with surgery to confirm the diagnosis, determine the extent of disease (surgical staging), and to perform a

tumour cytoreduction. Careful examination, with the advantage of magnification of the peritoneal surface and multiple random or oriented biopsies may be accomplished laparoscopically.

Laparoscopy seems to be an acceptable technical option to perform restaging of apparently early adnexal carcinomas. Peritoneal staging is indicated, in conjunction with node dissection, in the reassessment of inadequately staged adnexal cancer patients. Using laparoscopic techniques, 18% of patients are upstaged and need adjuvant chemotherapy [10]. Patients definitively classified as stage IA or IB after laparoscopic staging have an excellent prognosis. Husain and her colleagues [11] at the Memorial Sloan-Kettering Cancer Center reported their experience with second-look surgical assessment. They found it to be safe, accurate, and with a low incidence of complications, particularly in the group of patients who had already undergone prior abdominal surgery. They found that the rates of negative evaluations and recurrence rates were comparable between patients undergoing laparoscopy and those undergoing laparotomy [11]. Laparoscopic peritoneal staging may also be proposed in the case of inadequately staged borderline ovarian tumors [12]. It spares the patients from the discomfort of repeat laparotomy. Long-term outcome results suggest that laparoscopic staging accurately detects the patients who need chemotherapy and safely select the patients who can be proposed surgery only.

Neoadjuvant chemotherapy is increasingly used in advanced ovarian, tubal or peritoneal carcinomas, when primary surgery cannot reach optimal cytoreduction. The decision to abort an attempt at optimal cytoreductive surgery is based on the presence of extensive growth in the mesentery, lesser omentum, stomach and duodenum, or posterior hemidiaphragm. Laparoscopy is preferable to exploratory laparotomy is this context, with a shorter recovery and quicker start of neoadjuvant chemotherapy [13]. However portsite metastasis can occurs in approximately 10% of laparoscopies in untreated peritoneal carcinomatosis, but is as chemosensitive as the peritoneal disease and never alters the treatment or outcome [14]. In contrast, Huang et al. [15] reported in 2003 that the occurrence of port-site metastasis after laparoscopy for epithelial ovarian cancer was 19% (6/31 patients) and that the presence of abdominal wall metastases in the entry sites of previous laparoscopy was negatively correlated with survival [15].

For stage III–IV ovarian cancer, a complete cytoreduction is impossible either because of disease extension or because of the health status of the patient. The volume of the mass, the extent of the disease, the insufficient access to peritoneal and retroperitoneal areas, and of course the risk of peritoneal spillage are limiting factors for the use of operative laparoscopy. However, laparoscopy is probably the most valuable tool for evaluating the

operability, primarily or at the time of interval debulking surgery [1]. It can therefore be used to select candidates for initial complete debulking or for neoadjuvant chemotherapy [16-18]. The accuracy of imaging to predict the possibility of initial complete debulking is poor and preoperative CT predictors should be used with caution when deciding between surgical cytoreduction and neoadjuvant chemotherapy [19, 20]. Identification of risk factors for suboptimal cytoreduction in all published cohorts, are not reproducible in alternate populations [19]. Until prospective, randomized trials have demonstrated that neoadjuvant chemotherapy followed by interval cytoreduction is equivalent in terms of survival outcomes to primary optimal cytoreduction followed by chemotherapy, extreme caution should be used when applying preoperative imaging predictors to decide between primary surgical exploration and neoadjuvant chemotherapy in the medically fit patient. A number of studies have demonstrated an association between the preoperative CA-125 level and the inability to achieve optimal cytoreduction, yet the overall accuracy rates at predicting surgical outcome (ie, optimal *v* suboptimal cytoreduction) were only 50% to 78% with most studies using a CA-125 cut off value of 500 U/mL [20, 21].

Cervical carcinoma

The issue of laparoscopy in the management of locally advanced cervical cancer has been addressed by several authors. In 1990, Canis and colleagues [22] first described the laparoscopic radical hysterectomy. By 1996, Spirtos et al. [23] described a complete pelvic and aortic lymphadenectomy and type III radical hysterectomy which were performed laparoscopically. Other authors evaluated the feasibility and safety of pretreatment laparoscopic surgical staging in the treatment of locally advanced cervical cancer [24, 25]. They contended that pretreatment laparoscopy is the best guideline for individualized concurrent chemoradiation. When compared with magnetic resonance imaging, CT scan or (18)F-fluorodeoxyglucose positron emission tomography (PET) scan, laparoscopic surgical staging was superior in detecting microscopic lymph node metastases [25]. Information garnered from the pathologic examination of paraaortic lymph nodes impacted treatment planning in up to 58% of women and appropriately extended the field in 24% of women with clinical stages IB2 and IIA cervical cancer while sparing 75% with stages IIB–IVA [25]. The use of pretherapeutic laparoscopic surgical staging altered the treatment plan 58% of the time [25].

Marnitz et al. [26] investigated 84 patients with locally advanced cervical cancer who were selected for laparoscopic staging for primary chemoradiation. In that study, they found that removal of more than five

pelvic and/or more than five para-aortic lymph nodes was associated with significantly longer overall survival. Leblanc et al. [25] demonstrated a therapeutic benefit especially evident in patients with a microscopic involvement of paraaortic nodes – unlikely to be detected by imaging – and postoperatively managed with extended-field chemoradiation. In this subset survival was equivalent to node-negative patient managed with pelvic chemoradiation therapy [25]. The authors, as Marnitz et al. [26], concluded that debulking of tumor-involved lymph nodes should be performed prior to primary chemoradiation in patients with locally advanced cervical cancer [25]. However, Kupets et al. [27], based on their statistical analysis, asserted that 1% of stage IB, 2% of stage IIB, and 4% of stage IIIB patients would benefit from the debulking of pelvic lymph nodes. They also concluded that select patients with small central tumor burden and low-volume nodal involvement, but with tumors >2 cm would benefit from debulking [27]. In contrast, the only randomized prospective study [28] about the effectiveness of extraperitoneal lymph node dissection in cervical carcinoma demonstrated, surprisingly, the detrimental effect of extraperitoneal lymph node dissection on patient survival. This study had to be stopped after interim analysis of the early results due to the significantly low survival rate in the extraperitoneal lymphadenectomy group. There were some drawbacks of this study, i.e., low number of patients, method of lymph node dissection, and radiotherapy technique, etc.

Chen et al. [29] reported a large series of laparoscopic radical hysterectomy and lymphadenectomy for cervical cancer. Between February 2001 and June 2007, 295 patients with cervical cancer (from FIGO stages Ia to IIIb) underwent a laparoscopic radical hysterectomy. Out of 295 procedures, 290 were successful. Para-aortic lymphadenectomy was performed in 156 patients (52.9%), and pelvic lymphadenectomy was performed in all 295 patients. The median blood loss was 230 mL (range, 50-1200 mL). The mean operation time was 162 min (range, 110-350), which included the learning curves of 3 surgeons. In 5 cases (1.7%), conversion to open surgery was necessary due to bleeding (3 cases), bowel injury (1 case), and hypercapnia (1 case). Other major intraoperative injuries occurred in 12 patients (4.1%). Positive lymph nodes were detected in 80 cases (27.1%), lymphovascular space invasion in 54 cases (18.3%), and surgical margins were negative for tumor in all patients. The mean hospital stay was 10.3 days. Postoperative complications occurred in 10.8% patients, ureterovaginal fistula in 5 cases, vesicovaginal fistula in 4, ureterostenosis in 3 cases, deep venous thrombosis in 9 cases, lymphocyst in 4 cases, lymphedema in 5 cases, and 1 case with trocar insertion site metastasis. Other medical problems included 47 cases (15.9%) of bladder dysfunction and 62 cases (21.0%) of

rectum dysfunction or constipation. The median follow-up was 36.45 months (range, 8-76 months). Recurrences or metastasis occurred in 48 patients (16.3%). Of these patients, 43 (14.6%) have died of their disease, and 5 (1.7%) are alive with disease. The overall disease-free survival was 95.2% for Ia, 96.2% for Ib, 84.5% for IIa, 79.4% for IIb, 66.7% for IIIa, and 60.0% for IIIb. Pomel et al. [30] reported a series of 50 consecutive patients with uterine cervical cancer who underwent a laparoscopic radical hysterectomy between 1993 and 2001 at two cancer centres. Thirty-one patients had had previous brachytherapy. Two patients had major urinary complications; one had a bladder fistula and one a ureteral stenosis. Previous brachytherapy did not affect the feasibility of this radical procedure. With a median follow-up of 44 months, the overall survival rate was 96%. Steed et al. [31] compared the peri-operative morbidity and recurrence-free survival of FIGO stage IA/IB cervical cancer patients treated by laparoscopic-assisted radical vaginal hysterectomy with time-matched radical abdominal hysterectomy controls. The authors reported that laparoscopic-assisted radical vaginal hysterectomy was associated with less blood loss but more operative time, and more intraoperative complications, including: cystotomy (seven), ureteric injury (one), and bowel injury (one). There was no difference between postoperative infectious and non-infectious complications. Twenty-two per cent of patients received postoperative radiotherapy for high-risk features in both groups. The 2-year DFS and overall survivals were similar in both groups. These data demonstrate in a large series that early cervical cancer can be treated successfully with laparascopic-assisted radical vaginal hysterectomy with efficacy and recurrence rates similar to radical abdominal hysterectomy. In clinical practice, the three ''minimally invasive'' techniques for radical hysterectomy are not concurrent but complementary, and indication of each method is adapted to the individual patient [13].

Total pelvic exenteration

Total pelvic exenteration is one of the most mutilating surgical procedures performed for gynecologic malignancies. Today, 95% of patients undergoing pelvic exenteration for advanced pelvic malignancy are expected to survive surgery, and 40% to 50% of them are alive 5 years later [32]. Pomel was the first to report two cases of laparoscopic exenteration for gynecological cancer [33]. Ferron et al. published 5 cases in 2006 [32] and Puntambekar 16 cases in 2006 [34]. Laparoscopic exenteration is feasible and made easier and faster using combination of perineal or vaginal approach. Laparoscopic approach seems to be associated with a minimal blood loss (less than 500 cm^3) thanks to modern devices such as the use of harmonic

scalpel or new bipolar energy and the help of laparoscopic magnification [32, 33]. However, hospital stay after pelvic exenteration does not decrease after laparoscopic approach, 27 days (range 13 – 33) [32], except for the Indian series with a median postoperative hospital stay of 3 days. Hospital stay is not dependent on the extent of the scar but one the time required to manage complications of the ''pelvic burn syndrome'' and for postoperative care of urinary diversion (continent or not) and colostomy. Efforts have to be made to improve patient's quality of live. Reconstruction of urinary system is an integral part of anterior or total pelvic exenterative procedures. Continent urinary diversion is a preferred option for urinary tract reconstruction in selected patients. Laparoscopic hand-assisted Indiana Pouch could be performed with less than 2.5 hours [32, 35]. Reconstruction of the vagina has a significant impact on quality of life and body image, especially for young sexually active patient [32].

Operative laparoscopy could prevent unnecessary laparotomies, can reduce morbidity, and leads to a shorter postoperative hospital stay. Patients with recurrent cervical cancer had positive para-aortic lymph nodes in 75 % of cases [36]. Kohler et al. [37] evaluated 41 consecutive patients undergoing explorative laparoscopy to determine eligibility for exenteration. Almost half (48.7%) of the patients avoided unnecessary exenteration for unresectable disease or intra-abdominal spread of disease. Laparoscopic pelvic lymphadenectomies can facilitate detecting patients who are the best candidates for pelvic exenteration [38]. Finally, these preliminary studies have demonstrated that laparoscopic pelvic exenteration is a feasible procedure in experienced hands.

Robotic surgery: A new standard of care?

As total laparoscopic extented hysterectomy is technically a challenging procedure, so far laparoscopic-assisted vaginal hysterectomy is often the techniques of choice, even in adenocarcinoma of the uterus [2]. Laparoscopic surgery has limitations regarding the 2 dimensions (2D) vision, the limited degrees of liberty of the instruments and the discomfort of the surgeon [39]. These factors restrain the development of minimally invasive procedures, specially for complex procedures. Robotic systems have been developed since 1999 in order to overstep these drawbacks, especially for cardiac surgery [39]. The present machines have been called as "robots" but in fact the term of computer-enhanced telemanipulator should be more appropriate [39]. However, the term of robot is commonly accepted. Since the da Vinci surgical system (Intuitive Surgical®, Sunnydale, CA) was approved for gynecology in April 2005, the role of robotic-assisted surgery in gynecologic

oncology continues to evolve [40]. While still in its infancy, the published literature on robotic application to gynecologic cancer is minimal before 2008 [41-52] and increased quickly later on [40, 53-80].

Robotic systems enhance 3D vision, magnification, dexterity, precision, and might therefore support surgeons in delicate laparoscopic interventions (Figure 1). Robotic surgery can overcome two main problems of laparoscopic surgery, i.e. the limitation of four degrees of freedom of the instruments and the 2D vision on a TV screen. The first application in gynecologic surgery with computer-enhanced telemanipulator was microsurgical tubal reanastomosis [81]. The advantages of the robot are evident in this indication, providing stereovision with magnification and instruments 6 degrees of freedom, tremor filtrering, and improving the quality of surgeon's tasks due to a perfect ergonomic position. The second application concerned vaginally assisted hysterectomy [82]. Pelvic and paraaortic lymph node dissections were associated in the procedure. This experience suggested that robotic surgery is a safe and effective alternative to conventional laparoscopic surgery. Robotic assistance enhances the precision of anatomic dissection and increases the feasibility of performing laparoscopic extended hysterectomy for most surgeons. Position and orientation of the robot create an ergonomic environment for the surgeon and the assistant and give a direct pelvic access. The ports must be placed in such a manner to avoid robotic arms interference and to optimize visualization of the operating field. Robotic surgery establishes a straight foot-hand-eye axis that do not exist in conventional and laparoscopic surgery. It restores the three-dimensional view that is lost in laparoscopic surgery. With the da Vinci System, the surgeon is completely immersed in the operative field without external stimulations; in classical laparoscopy, if the surgeon focuses on the TV screen, he has the whole operative
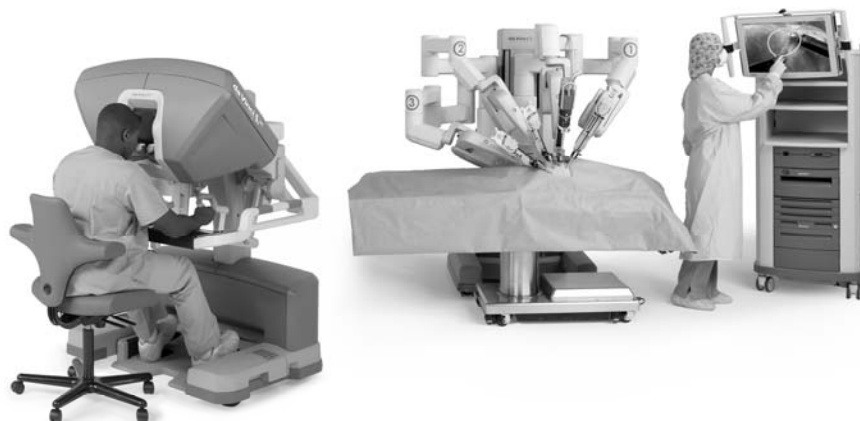

Figure 1. Surgeon using *da Vinci* Si console in the foreground with nurse at vision cart and the patient cart with the four arms (photo courtesy of intuitive Surgical, Sunnyvale, California).

theater in his visual field. The system seems to be the most beneficial for intra-abdominal microsurgery or for manipulations in a narrow space and difficult of access. The other major advantage is the easiness of suturing in reconstruction such as biliary tract, proximal gastrojejunostomy, pyelo-ureteral syndrome, or as in gynecologic surgery vaginal closure [48]. While a skilled robotic bedside assistant is essential, the robotic surgeon has the additional advantages of a stable camera and direct control of endoscope movement [40].

We think that hysterectomy assisted by the robot has several advantages in comparison with classical laparoscopic hysterectomy: the vaginal time is deleted, the hemostasis is better particularly for paravagin and paracervix hemostasis, the dissection of the ureter after crossing with uterine artery is easier and more precise. However, no objective evidence has shown advantages of the computer enhanced telesurgical device in comparison with classical laparoscopy. Seamon et al. [40] compared outcomes between robotic versus laparoscopic hysterectomy and lymphadenectomy in patients with endometrial cancer A cohort study was performed by prospectively identifying all patients with clinical stage I or occult stage II endometrial cancer who underwent robotic hysterectomy and lymphadenectomy from 2006–2008 and retrospectively comparing data using the same surgeons' laparoscopic hysterectomy and lymphadenectomy cases from 1998–2005, prior to robotic experience. 181 patients (105 robotic and 76 laparoscopic) met inclusion criteria. There was no significant difference between the two groups in median age, uterine weight, bilateral pelvic or aortic lymph node counts, or complication rates in patients whose surgeries were completed minimally invasively. Despite a higher BMI (34 vs. 29, $P < 0.001$), the estimated blood loss (100 vs. 250 mL, $P < 0.001$), transfusion rate (3% vs. 18%, RR 0.18, 95%CI 0.05–0.64, $P = 0.002$), laparotomy conversion rate (12% vs. 26%, RR 0.47, 95%CI 0.25–0.89, $P = 0.017$), and length of stay (median: 1 vs. 2 nights, $P < 0.001$) were lower in the robotic patients compared to the laparoscopic cohort. The odds ratio of conversion to laparotomy based on BMI for robotics compared to laparoscopy is 0.20 (95% CI 0.08–0.56, $P = 0.002$). The mean skin to skin time (242 vs. 287 min, $P < 0.001$) and total room time (305 vs. 336 min, P b 0.001) was shorter for the robotic cohort. Although this series is limited by its nonrandomized design, the comparison between classical laparoscopy and assisted robotic laparoscopy concerns a new concept of criteria because the benefit of computer enhanced laparoscopy is obvious for the surgeon. With the aid of this robotic system, difficult laparoscopic interventions may become easier and safer to perform with decreased fatigue for the surgeon. The robot leads to surgeon discomfort and risk of chronic musculoskeletal occupational injury, particularly during longer procedures. Indications for minimal

invasive surgery may be extended. The authors attributed most of the decrease in time to the superiority of the robotic platform and the increased autonomy of the primary surgeon. In addition, a previously skilled laparoscopic surgeon and a consistent and well-trained bedside assistant were also essential to proficiency and may be potential factors accounting for shorter operative times in the robotic cohort. The decreased blood loss and lower transfusion rates were due to advantages afforded by the robotic platform including improved optics and surgeon dexterity. After the first experiences with the robot, a lot of team can perform extended hysterectomy in oncology surgery, as well as through laparotomy.

Although laparoscopic staging for gynecologic malignancies in obese patients is technically possible with 100–40% of the patients undergoing at least pelvic lymphadenectomy [59], morbid obesity is one of the limiting factors for widespread application of minimally invasive surgery of endometrial cancer. Seamon [40] and Gehrig [59] demonstrates that robotic surgery in obese women is feasible with a potential lower rate of conversion to laparotomy when compared to laparoscopy, and with shorter operative time, less blood loss, increased lymph node retrieval and shorter hospital stay thanks to the robot. While still considered a limitation to minimally invasive surgery, obesity may be less restricted factor for robotic surgery when compared to conventional laparoscopy for endometrial cancer patients.

The rate of complications of robotic hysterectomies ranging from 6 % to 19 % [48, 54, 61, 82, 83] were similar to these for classical laparoscopy, ranging from 6 to 28 % [30, 83, 84]. From some retrospective publications [30], and from the prospective randomized eVALuate study [84], it seems that complication rates have increased in laparoscopic hysterectomies, especially those involving the urinary system and during the learning curve. As with any surgical procedure, particularly a new technology, complications are seen if enough procedures are performed. The blood loss and the lymph exsudation in series was mainly the consequences of section of the paracervix and paravagin in the extended hysterectomy according to Piver II [48, 82]. The risk of major complications during classical laparoscopic hysterectomy, highlighting in the eVALuate study [84], could decrease with telerobotic-assisted laparoscopic, afforded by the robot's magnified three-dimensional view and the enhanced range of motion and dexterity. The conversion for the robotic surgery is between 0 % and 4 % [48, 54, 61, 83, 85] in comparison with laparoscopic surgery within the range of the published studies (range, 0-23%) [9, 84-86].

Boggess JF et al. recently published a case-control study of robotic-assisted type III radical hysterectomy with pelvic lymph node dissection for cervical cancer performed in 51 patients compared with 49 patients who

underwent open radical hysterectomy [87]. There were significant differences between the groups with regard to operative blood loss (p < 0.0001), operative time (p = 0.0002), and lymph node retrieval (p = 0.0003), all of which were in favor of the robotic cohort. Hospital stay for robotic group was 1 day, compared with a 3.2-day average hospitalization for the open cohort. The authors' conclusion was that robotic type III radical hysterectomy with pelvic node dissection is feasible and may be preferable over open radical hysterectomy in patients with early-stage cervical cancer. Minimally invasive surgery for oncology diseases progresses cautiously, concerned by the learning curves of specific procedures. In literature, only a few surgeons published about total laparoscopic radical hysterectomy with pelvic lymphadenectomy for malignancy diseases, showing difficulties to repeat, teach and spread this operation. On the contrary, operative efficiencies with the robot can be achieved within the first 15 cases [87], in comparison with the 20 – 100 cases necessary for a surgeon to reach stable operating times and lymph node yields [30, 88-90]. Moreover, as Boggess demonstrated the laparoscopic approach is not necessary in moving to a robotic approach because the Boggess's team did not have experience with laparoscopic radical hysterectomy.

A phase III randomized clinical trial comparing laparoscopic or robotic radical hysterectomy with abdominal radical hysterectomy in patients with early stage cervical cancer is being performed with the group of the American Association of Gynecologic Laparoscopists [70]. The aim of the study was to show the equivalence of the laparoscopic or robotic approach versus the abdominal approach following a 2-phase protocol. 740 patients must be enrolled.

For advanced diseases, only few data are reported in the literature. Vergote et al. [79] reported the surgical technique used in 5 patients undergoing retroperitoneal para-aortic lymphadenectomy using the robotic Da Vinci system and Magrina et al. developed a robotic technique for extraperitoneal aortic lymphadenectomy in cadavers followed by its application in a patient with an advanced cervical cancer [91]. In the next future, the series about robotic pelvic exenteration will be published [62].

The drawbacks of da Vinci system is a lack of tactile and tensile feedback that accounts for 11 % of ruptured suture material [81]. With animate lab training and 3D imaging, the surgeon can appreciate tension that the robotic arms are exerting and learns to adapt its strength. This process is very close to the one mastered in microsurgery. The second drawback is represented by the cost of the system, 1,6 million euros, with 200 € for each use for each instrument and 10 % of the price for the annual maintenance fee for repair and service as well as software upgrades to the system. Cost

effectiveness issues will be the major factor limiting the wider use of robotic systems. The equipment is expensive, but costs will decrease as the market expands and when competitors enter the market. Surgical robotics will have longevity only if demonstrated to be ''better medicine'', not better business [92].

In view of that, it is essential to decide which procedures are most likely to benefit from telerobotic-assisted laparoscopic system. We believe it is justified to use this system in operations that are carried out within confined spaces, like extended hysterectomy with pelvic lymph nodes dissection, where the advantages of the system are clearly appreciable to the surgeon, specifically dexterity enhancement and accuracy. The third drawback is the dimensions of the cart. The improvement could be the integration of robot's arms in the ceiling of the operative room. A new design of tools with "snake" mobility can adapt to specific conditions. The computer aided ports placement and virtual reality would ease the procedures.

Conclusions

Smaller incisions, less postoperative pain, and shorter hospital stays are welcomed by women suffering from gynecologic cancers. Laparoscopic cytoreductive surgery in gynecologic oncology is a feasible and safe procedure that is associated with fewer intraoperative and postoperative complications as opposite to traditional open procedures. Long-term outcomes after laparoscopic surgery are most likely equivalent to those after abdominal surgery for cervix carcinoma. For endometrial cancer, we are waiting the long-term benefit of a randomized trial. Robotic telemanipulation systems have been introduced recently to enhance the surgeon's dexterity and vizualisation in videoscopic surgery in order to facilitate refined dissection, suturing and knot tying. Robotic surgery clearly introduces new tools for minimally invasive surgery and will expand its technical possibilities and medical indications. Robotic technology better facilitates the surgical approach as compared to laparoscopy for technically challenging operations performed to treat primary, early or advanced gynecologic cancer. Its role in ovarian cancer is just starting to be explored. Although patient advantages are similar or slightly improved with robotics, there are multiple advantages for surgeons. Because of relatively recent incorporation of robotic technology, long-term oncologic results must be examined in the future.

Acknowledgement

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