Robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy with short and long term morbidity data.

Persson, Jan; Reynisson, Petur; Borgfeldt, Christer; Kannisto, Päivi; Lindahl, Bengt; Bossmar, Thomas

Published in:
Gynecologic Oncology

DOI:
10.1016/j.ygyno.2009.01.022

2009

Robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy with short and long term morbidity data

Jan Persson, Petur Reynisson, Christer Borgfeldt, Paivi Kannisto, Bengt Lindahl and Thomas Bossmar.

Department of Obstetrics and Gynecology, Lund University Hospital,

SE-221 85, Lund, Sweden

Corresponding author:

Jan Persson

Department of Obstetrics and Gynecology

University Hospital, SE-221 85 Lund, Sweden

Telephone +4646172520, +4646733522080

Fax +4646157868

E-mail; jan.persson@med.lu.se

Disclaimers: None

Abstract

Objective: To evaluate feasibility and morbidity of robot assisted laparoscopic radical hysterectomy.

Methods: From December 2005 to September 2008 robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy was performed on 80 women. Using a prospective protocol, and an active investigation policy for defined adverse events, perioperative, short and long term data were obtained.

Results: Time for surgery (skin to skin) reached 176 and 132 minutes after 9 and 34 procedures respectively. All tumours were radically removed. Median number of retrieved lymph nodes was 26 (range 15-55). All women had an early follow up (1-3 months) and 43 of eligible 46 women (93%) had a long term follow up ($\geq$ 12 months). In 33 of 80 women (41%) the peri/postoperative period was uneventful. The remainder had one or more mainly mild adverse events, most commonly from the vaginal cuff (*n*=17, 21%) or the lymphatic system (*n*=16, 20%). The proportion of uneventful cases increased significantly over time. Five women were resutured for dehiscence of the vaginal cuff, two women were reoperated for trocar site hernias and one woman had a ureter stricture that resolved following stent treatment. Eight women (14 %) needed 60 days or more to resume spontaneous voiding. One 72-year old woman with disseminated endometrial cancer on autopsy died of pulmonary embolism 31 days after surgery.

Conclusions: Robot assisted laparoscopic radical hysterectomy is a feasible alternative to conventional laparoscopy and open surgery. Effort should be made to ensure proper closure of the vaginal cuff, trocar sites and to develop nerve sparing techniques.

Keywords: Cervical cancer, robotic surgery, radical hysterectomy

Introduction

The adoption of laparoscopic surgery has provided the advantages of minimally invasive surgery also for women with gynecological malignancies. Several studies have demonstrated that laparoscopic surgery is safe for this group of women [1-4]. However, the complexity of the procedures has limited laparoscopic surgery to centres with large volumes of cancer. In many parts of the world, the incidence of cervical cancer, the main indication for radical hysterectomy and pelvic lymph node dissection, has diminished and even larger centres may have a too low case load to maintain and develop good laparoscopic skill.

The da Vinci system (da Vinci ® Surgical System, Intuitive Surgical Inc, CA, USA) was approved for gynecological applications in April 2005 by the Food and Drug Administration of the United States. The system provides instruments with a wrist function at the tip, movement downgrading, tremor elimination, a stable 3-dimension view of the operative field and an ergonomic working position. These features may help the surgeon overcome some of the limitations associated with traditional laparoscopic surgery.

The use of robot-assistance for radical hysterectomies is still in its infancy. A few reports describing the technique are published [5-10]. Magrina et al. report shorter operative time for robot assisted laparoscopy compared with traditional laparoscopy and shorter hospital stay and less blood loss compared with open surgery [9]. Boggess et al. report shorter operative time, less blood loss and shorter hospital stay in favour of the robot assisted approach when comparing with open surgery [10].

Lund University Hospital is a tertiary referral centre for gynecological oncologic surgery with an expected annual case load of 40 radical hysterectomies. Included surgeons had a minimum of five years experience with advanced conventional laparoscopic procedures, e.g. pelvic lymphadenectomies with less case load surgeon C. Four laparoscopic radical hysterectomies have been performed.

Robot assisted surgery was introduced in October 2005 following a training programme for surgeons and operating room teams. From the start, detailed protocols for prospective retrieval of perioperative and follow up data were used. All data were consecutively entered to a computerized quality registry instituted for all robot assisted gynecological procedures on demand of, and approved by, the hospital administration. For the present study, we retrieved the data from women planned for robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy with the aim of assessing feasibility, short and long term morbidity of the procedure. The study was approved by the regional Institutional Review Board.

Subject and method

From December 2005 to September 2008, 110 consecutive women with early stage cervical cancer or stage 2 endometrial cancer were considered for a modified Piver II-III robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy. We excluded women with a compromising cardiovascular/respiratory comorbidity (*n*=5), a uterine size not allowing vaginal retrieval (*n*=4) and known intraabdominal adhesions or multiple midline incision (*n*=6). Five women had open surgery due to limited access to the robot.

The remaining 90 women were offered robot assisted laparoscopy after an information including their option of alternative surgical approaches. All eligible women approved.

In 55 of 70 women with cervical cancer, 120 MBq ^{99m}Technetium was injected superficially at four points in the cervix the day before surgery followed by a lymphoscintigram to identify sentinel lymph nodes as a part of a parallel study. During surgery, the sentinel lymph nodes were detected by a laparoscopic gamma probe (Neo2000® laparoscopic probe, Neoprobe Corporation, Dublin OHIO) and sent for frozen section. The hysterectomy was aborted in favour of radiation therapy if a sentinel node was metastatic.

We used a four arm da Vinci or da Vinci-S robot. To facilitate an optimal exposure for the gamma-probe scanning, first and foremost in the common iliac area, two assistants' trocars were used (Excel ®12 millimetre Ethicon Inc, Somerville, NJ and Versaseal® Plus15 millimetre, Auto Suture/ Tyco Health care, Oriscany Falls, NY). The probe was used in either of the trocars to achieve an optimal angle for the sidemounted gamma-element. The 15 millimetre trocar was also used for compartmentwize retrieval of lymph nodes in a reinsertable retrieval bag (LINA Medical, Glostrup, Denmark). The port placements and instruments are illustrated in Figure 1. The grasper was used to present the specimen in an appropriate position and to apply adequate tension of the tissue for monopolar dissection. Posterior dissection was finished first to avoid impaired visibility by bleeding from anterior

dissection. A folded swab on a forceps was placed vaginally to help to decide the level for the vaginal transsection and to prevent gas-leakage after opening of the vagina. No vaginal dilator or uterine manipulator was used. Monopolar diathermia was set a 30-40 Watts using the coagulating mode for electrodissection and the cutting mode for opening of the vagina.

Initially, the paravesical and pararectal spaces were developed and sentinel nodes identified. Full uterine blood supply was preserved until the sentinel nodes were found negative. The full lymphadenectomy was performed *en bloc* compartmentwize starting with the common iliac nodes (boundary five centimetres cranial of the bifurcation of the iliac artery), followed by the external iliac nodes (distal boundary the Cloquet's node, lateral boundary the genitofemoral nerve), and the obturator nodes (distal boundary the pubic bone, dorsal boundary the obturator nerve).

A modified Piver II (stage 1A 2 and stage 1b1 <1 centimetres) or Piver III (stage 1b1>=1 centimetres) radical hysterectomy was performed. For the modified Piver II and Piver III we aimed at a shorter vaginal specimen length (minimum two and four centimetres respectively) and a less extended dissection of the sacrouterine ligaments (minimum two and four centimetres from the cervix respectively) compared with the original Piver classification. Technically, we followed a uniform plan for the radical hysterectomy. The uterine vessels were divided at their origin (all tumor stages). The parametria and the ureters were dissected as far distally as possible. The uterus was lifted, the rectovaginal space was opened and the sacrouterine ligaments isolated at appropriate distance. After a dissection of the bladder in the midline, the bladder pillar was isolated followed by division of the lower parametria and paracolpia before the vagina was transsected. To ensure the desired level for the vaginal transsection, the vaginal swab was pushed inwards and then slowly moved back to visualize the level of the distal cervix. We first incised the vagina anteriorly and the following transsection was performed under visual control from the inside of the vagina. The specimen

was removed vaginally using either a tenaculum or a retrieval bag. The vagina was closed from inside using a continuous Vicryl 0 (Ethicon Inc, Somerville, NJ) suture secured with laparoscopic knots. Surgeon A used a figure-of-eight inverting suture whereas surgeon B and C used plain sutures for vaginal closure. The fascia was closed at the site of the supraumbilical optics port and the 15 millimetre assistants' port.

In case of small tumours (<1 centimetre) we usually identified the ileohypogastric nerves by further developing the pararectal space. Vessel loops were used to facilitate nerve sparing dissection to the bladder by pulling the nerves and ureters laterally together.

Bladder catheterization was interrupted when residual urine was less than 100mL once or less than 150mL twice provided that the voided volume was at least 200 mL. Women with persistent inadequate voiding after seven postoperative days were prescribed self catheterization monitored by telephone controls until approved residual urine. All women received antibiotic prophylaxis and low molecular weight heparin according to local treatment protocol. In median, women were discharged on the third postoperative day (range1-9 days).

According to protocol, surgical data, short and long term postoperative complications and time to spontaneous voiding were prospectively registered. During follow-ups, including a vaginal ultrasonography for identification of lymphoceles, women were actively asked and investigated for defined adverse events in particular from the urogenital, neural and lymphatic systems and the abdominal wall.

Data were consecutively entered into a StatView® database (SAS Institute Inc., Cary, NC, USA). For statistical analyses we used Fishers' exact test, Mann-Whitney's test or Kruskall-Wallis' test as appropriate. A value of $p<0.05$ was considered statistically significant.

Results

During surgery, metastatic sentinel lymph nodes were identified in six women and the radical hysterectomy was aborted. Four women were converted to open surgery, one due to an irreversible robot system error, two for anesthesiological reasons and one due to intraabdominal metastases.

Thus, 80 women, 64 with cervical cancer (stage 1A1 *n*=4, stage 1A2 *n*=10, stage 1B1 *n*= 44, and stage 2A *n*=6) and 16 with stage 2 endometrial cancer, underwent the complete procedure. The four women staged as 1A1 cervical cancer after final histology had a radical hysterectomy due to difficulties in the preoperative staging (adenocarcinoma and/or multifocality and/or intracervical lesions proximal to cone specimens). The procedures were performed by either of three surgeons (surgeon A, *n*=38, surgeon B, *n*=22, surgeon C, *n*=20). Median age was 48 years (range 23-86 years) and median Body Mass Index 24.4 kg/m^2 (range 17.5-39.0 kg/m^2). 16 women had a history of one or more previous laparotomies. In 11 women adhesiolysis added a median time of 20 minutes to the procedures (range 5-60 minutes). Surgery was prolonged in seven cases due to reversible system errors. Baseline patients characteristics were evenly distributed among surgeons.

Time for surgery (skin to skin including time for the sentinel node procedure and time for frozen section) reached 171 and 132 minutes after 9 and 34 procedures respectively (Figure 2). Median blood loss during surgery was 150 mL (range 25-1300 mL). Time for surgery was significantly related to Body Mass index of the patients ($p<0.01$). Excluding the first 10 procedures for each surgeon (initial learning curve), the median time for surgery (all surgeons together) was 219 minutes (range 141-310 minutes) for women with the lowest Body Mass Index (range 17.5-24.4) and 279 minutes (range 170-406 minutes) for women with the highest Body Mass Index (range 24.8-39.0). For surgeon A only, the median surgical times were 174 and 206 minutes respectively using the same critera ($p<0.01$).

No patient received intraoperative blood transfusion and no intraoperative complications occured apart from the neural complications described in Table 2. Time for surgery and blood loss differed significantly between surgeons (Table 1).

All 64 women with cervical cancer had radical surgery. 21of them (16 women with stage 1B1 >2 centimetres and five women with stage 2A) were offered postoperative radiation therapy either due to positive lymph nodes (*n*=8, including three cases of micrometastases in sentinel nodes and two cases with no uptake of radiotracer), small cell squamous carcinoma (*n*=1) or less than the eight millimetres of free margins at final histology required according to local treatment protocol (*n*=12). The insufficient margins were all in the circumferential part of the cervix where anatomy restricts anterior/posterior margins. Median number of retrieved lymph nodes was 26 (range 15-55).

All women had the early follow up (1-3 months) and 43 of eligible 46 women (93%) had the long term follow up ($\geq$ 12 months). One woman was lost due to high age, one had moved abroad, and a 72-year old woman with disseminated endometrial cancer on autopsy died of pulmonary embolism 31 days after surgery.

33 of 80 women (41%) had an uneventful peri/postoperative period whereas the remainder experienced one or more mainly mild complications (Table 1). Five women were resutured for vaginal cuff dehiscences. One woman had a ureter stricture temporarily treated with a stent. One woman experienced a reversible partial obturator nerve palsy. In two cases the small bowel was incarcerated through the peritoneal opening at the site of the 15 millimetre trocar despite an intact sutured fascia. Two women had a partial rupture of the rectus muscle close to a robot trocar.

Significantly fewer women had complications when comparing the second and first half of the series of operations for the respective surgeons (28 of 40 compared with 17 of 40, *p*=0.02). For the latter analyses we excluded lymphatic complications as they were evenly

distributed over time and among surgeons and were unrelated to the number of retrieved nodes. Overall complications did not differ between surgeons. However, vaginal cuff dehiscence occurred significantly more often for surgeon B compared with surgeon A (4 of 22 cases compared with 0 of 38 cases, p=0.02).

Time to resume spontaneous voiding is presented in figure 3. There was a significant association with tumour stage (p=0.02) but no association with surgeon.

Three recurrences have been identified after 7, 15 and 14 months respectively, the first two by an optional separate PET-CT follow up programme.

A 65 year old woman with stage 1B1 lymphoepitelioma type squamous epithelial cancer with no sentinel node procedure had a nodal recurrence in the deep presacral/pararectal area.

A 41 year old woman with stage 1B1 medium grade squamous epithelial cancer and postoperative pelvic radiation therapy due to multiple metastatic pelvic nodes had a paraaortic nodal recurrence. No pelvic or paraaortic nodes (benign or metastatic) had detectable uptake of radiotracer. A paraaortic lymph node disessection was not performed.

A 26 year old woman with a stage 1B1 medium grade squamous epithelial cancer and no postoperative radiation therapy recurred with pulmonary metastases.

Discussion

This study indicates that the da Vinci robot is useful for implementing laparoscopic radical hysterectomy in a centre with limited experience of this procedure by traditional laparoscopy and with a restricted case load of cervical cancers. Time for surgery decreased rapidly and short term complications diminished significantly over time. The operating time was comparable with times reported for conventional laparoscopic radical hysterectomies by larger institutions [11-13].

Times for surgery and bleeding differed significantly between surgeons (Table 1). The surgeon with the longest times for surgery and the largest median bleeding had the least experience with traditional laparoscopic surgery. All surgeons intended to follow the defined steps of the surgical procedure. Discrepancies in surgical technique/skill are difficult to define but we believe that the extent of previous experience with advanced traditional laparoscopy affects the performance of robot surgery at least during an introductory phase.

The separate times for the sentinel node procedures were not recorded in our protocol and would have been difficult to define as we finished at least the common iliac node dissection bilaterally while waiting for the frozen section results. Overall, mean surgical time with the sentinel procedure included was 21 minutes longer than for operations without the sentinel node procedure. However, this difference diminished over time as we became more efficient in identifying the sentinel nodes. Seven of the 10 fastest operations included the sentinel node procedure. We intend to publish the details of the sentinel node study separately.

Strengths of this study are the prospective retrieval of data, the relatively large number of included women and the few women lost for follow up. A weakness of this study is the lack of comparison with established surgical techniques. However, this prospective study describes a surgical approach during an introductory phase and a retrospective comparison with previous open radical hysterectomies at our institution would inevitably be biased in favour of

the established technique. Moreover, the differences between surgeons in surgical time and bleeding would further bias such a comparison.

Our complication rate was higher than rates reported by most other authors, in particular complications from the vaginal cuff and lymphatic system (Table 2 and 3). The active investigation policy for defined types of adverse events used in our study may explain some of this discrepancy. Moreover, loss of genitofemoral nerve innervation and proximal lymphoedema (eight and 12 cases respectively in our study) is neither mentioned nor denied by any other author indicating different definitions of complications.

Some complications may be associated with robotic or laparoscopic surgery *per se.* Leaking of lymphatic fluid through the vagina and/or vaginal cuff dehiscence occurred in 10 (12%) cases. The leaking resolved spontaneously within a couple of weeks but was bothersome and fistulas had to be excluded. Our rate of vaginal cuff dehiscences is equal to the rate reported by Hur et al. for total laparoscopic hysterectomies but significantly higher than for hysterectomies performed by laparotomy (14). Moreover, in our series this complication differed significantly between surgeons. This implies that laparoscopic closure of the vaginal cuff, robot assisted or not, may be less efficient but also that differences in individual surgeons techniques may play a role. In our study the only identifiable difference between surgeons in vaginal closure technique was the use of an inverting suture by surgeon A (no dehiscences). Such sutures may promote an increased area for healing in the vaginal apex as is approximates the raw abdominal sides of the vagina in contrary to the epithelial sides. Moreover, inverting sutures requires the distal stitch to be placed at least 7-8 millimetres from the cauterized vaginal edge, probably beneficial to ensure approximation of thermally non-damaged tissue. We also believe that meticulous tightening of the sutures is important as vaginal leaking short time after surgery preceeded three of five dehiscences.

Time to spontaneous voiding was associated with clinical stage but with large variations within stages. Despite the excellent visualization and dissection properties of the robot bleeding often occurs in the lower parametrium and paracolpium. Extended use of diathermia for hemostasis in this area may have inflicted thermal injury to nearby nerves in some cases. Unfortunately, we did not include separate measurements of the length of the resected vagina and parametria in our protocol which may have provided further information on a possible association between voiding difficulties and the radicality of the procedure.

Two women had a partial rupture of the rectus muscle close to a robot trocar. Strong lateral movements of the robot arms in combination with non-pivotal position of trocars may be the reason.

The incarcerations of the small bowel both occured trough the peritoneal opening at the place for the 15 millimetre assitants trocar despite an intact sutured fascia. To avoid this complication we included a peritoneal suture during the second half of the procedures. No hernias occurred at the da Vinci trocar sites.

In our series, in-patient times were longer than reported by other authors (5-10). There are several explanations: First, as we were pioneers from a European perspective, we initially wanted to gain experience with the procedure and to ensure the women were perfectly fit to go home, in particular the majority of women living in distant parts of the hospital recruitment area. Second, nine women were older than 70 years and were kept longer for socio-medical reasons. Third, initially we often kept women for repeated assessment of voiding if the criteria for approved residual urine were close to be met. Later we abstained from the initial second postoperative day control of voiding. Instead, women were discharged with an indwelling catheter and a scheduled outpatient control of voiding seven days after surgery. Altogether, during the last year, 55% of unselected women were discharged within 48 hours after the surgical procedure.

Apart from the high cost for investment and maintenance of the da Vinci system, we believe the major disadvantage with robot assisted surgery is the relatively long time for nurses preparation affecting the total time for patient in the operating room as well as time for change in between procedures (Table 1). In our series, the median time from patients entry in the operating room (including anesthesia) until onset of surgery was 68 minutes (range 35-123 minutes). So far, we have not been able to significantly diminish that time, probably since we still introduce new nurses into robotics and since we suffer from a constant turnover of anesthesia teams. Considering the times for nurses preparation and cost for the robot it is unclear whether the robot concept is cost efficient compared with laparoscopy or open surgery.

We believe that the implementation of laparoscopic radical hysterectomies at our institution was facilitated by the da Vinci system and that further shortening of surgical time and nurses preparation time is possible. Moreover, once familiar with the da Vinci system we have managed to apply laparoscopic surgery also for rare advanced oncological procedures such as laparoscopic radical trachelectomy, surgery for vaginal cuff recurrencies and removal of bulky nodes and pelvic side wall tumors (15). We do not believe that those procedures would have been laparoscopic at our institution without the robot.

However, it is unclear to which extent the robot facilitates laparoscopic radical hysterectomies at an institution with a previous large experience of traditional laparoscopic radical hysterectomies.

In conclusion, we found robot assisted laparoscopic radical hysterectomy to be associated with a steep learning curve and a diminishing number of complications over time. Effort should be made to ensure an efficient closure of the vaginal cuff. There may be a need for alternative hemostatic techniques allowing less use of diathermia in areas close to the pelvic

nerves. The properties provided by the da Vinci system may facilitate further refinement of nerve sparing techniques.

Article précis

Robotic radical hysterectomy.

Conflict of interest statement

Jan Persson is a proctor for surgery with the Da Vinci Robot.

The authors all declare that there are no conflicts of interest.

References

[1] Schlaert AC, Abu-Rustum NR. Role of minimally invasive surgery in gynecologic cancers. Oncologist 2006;11:895-901. Review.

[2] Querleu D, LeBlanc E, Ferron G, Narducci F, Martel P. Laparoscopic surgery in gynaecological tumours. Bull Cancer 2006;93(8):783-89. Review.

[3] Pomel C, Atallah D, Le Bouedec G, Rouzier R, Morice P, Castaigne D et.al. Laparoscopic radical hysterectomy for invasive cervical cancer: 8 years experience of a pilot study. Gynecol Oncol 2003;91:534-39.

[4] Chi DS, Abu-Rustum NR, Sonoda Y, Awtrey C, Hummer A, Venkatraman ES et.al. Ten year experience with laparoscopy in gynecologic oncology service: analysis of risk factors for complications and conversions to laparotomy. Am J Obstet Gynecol 2004;191:1138-45.

[5] Sert B, Abeler V. Robotic radical hysterectomy in early-stage cervical carcinoma patients, comparing results with total laparoscopic radical hysterectomy.The future is now? Int J med Robot 2007;3(3):224-28.

[6] Kim TK, Kim SW, Hyung WJ, Lee SJ, Nam EJ, Lee WJ. Robotic radical hysterectomy with pelvic lymphadenectomy for cervical carcinoma: A pilot study. Gynecol Oncol 2008;108:312-16.

[7] Fanning J, Fenton B, Purohit M. Robotic radical hysterectomy. Am J Obstet Gynecol 2008;198:649-51.

[8] Nezhat FR, Datta MS, Liu C, Chuang L, Zakashansky K. Robotic radical hysterectomy versus total laparoscopic radical hysterectomy with pelvic lymphadenectomy for treatment of early cervical cancer. JSLS 2008;12(3):227-37.

[9] Magrina JF, Kho RM, Weaver AL, Montero RP, Magtibay PM. Robotic radical hysterectomy: comparison with laparoscopy and laparotomy. Gynecol Oncol 2008;109:86-91.

[10] Boggess JF, Gehrin P, Cantrell L, Shafer A, Ridgway M , Skinner E et.al. A case-control study of robot-assisted type III radical hysterectomy with pelvic lymph node dissection compared with open radical hysterectomy. Am J Obstet Gynecol 2008;(199):357.e1-357.e.7.

[11] Malzoni M, Tinelli R, Cosentino F, Perone C, Vicario V. Feasibility, morbidity and safety of total laparoscopic radical hysterectomy with lymphadenectomy; our experience. J Minim Invasive Gynecol 2007;14(5):584-90.

[12] Frumowitz M, dos Reis R, Sun CC, Milam MR, Bevers MW, Brown J et.al. Comparison of total laparoscopic and abdominal radical hysterectomy with early-stage cervical cancer. Obstet Gynecol 2007;110(1):96-102.

[13] Putambekar SP, Palep RJ, Putambekar SS, Wagh GN, Patil AM, Rayate NV et. al. Laparoscopic total radical hysterectomy by the Pune technique: Our experience of 248 cases. J Minim Invasive Surgery 2007;14(6):682-89.

[14] Hur HC, Guido RS, Mansuria SM, Hacker MR, Sanfilippo JS, Lee TT. Incidence and patient characterestics of vaginal cuff dehiscence after different modes of hysterectomies. J Minim Invasive Gynecol 2007;14(3):311-17.

[15] Persson J. Kannisto P. Bossmar T. Robot-assisted abdominal laparoscopic radical trachelectomy. Gynecol Oncol. 2008 Dec;111(3):564-7.

Legends to figures

Figure 1

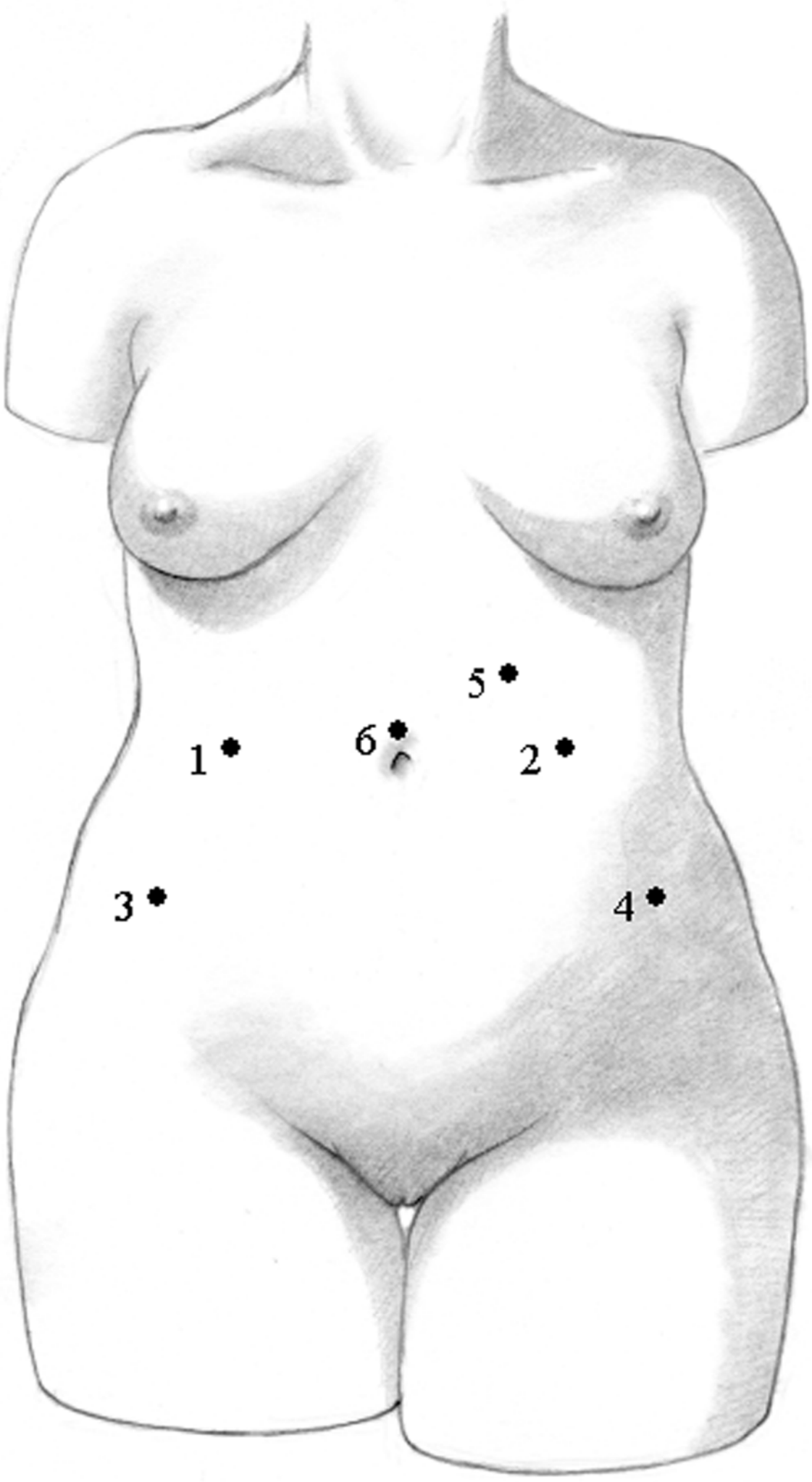
Port placements used for robot assisted laparoscopic radical hysterectomy.

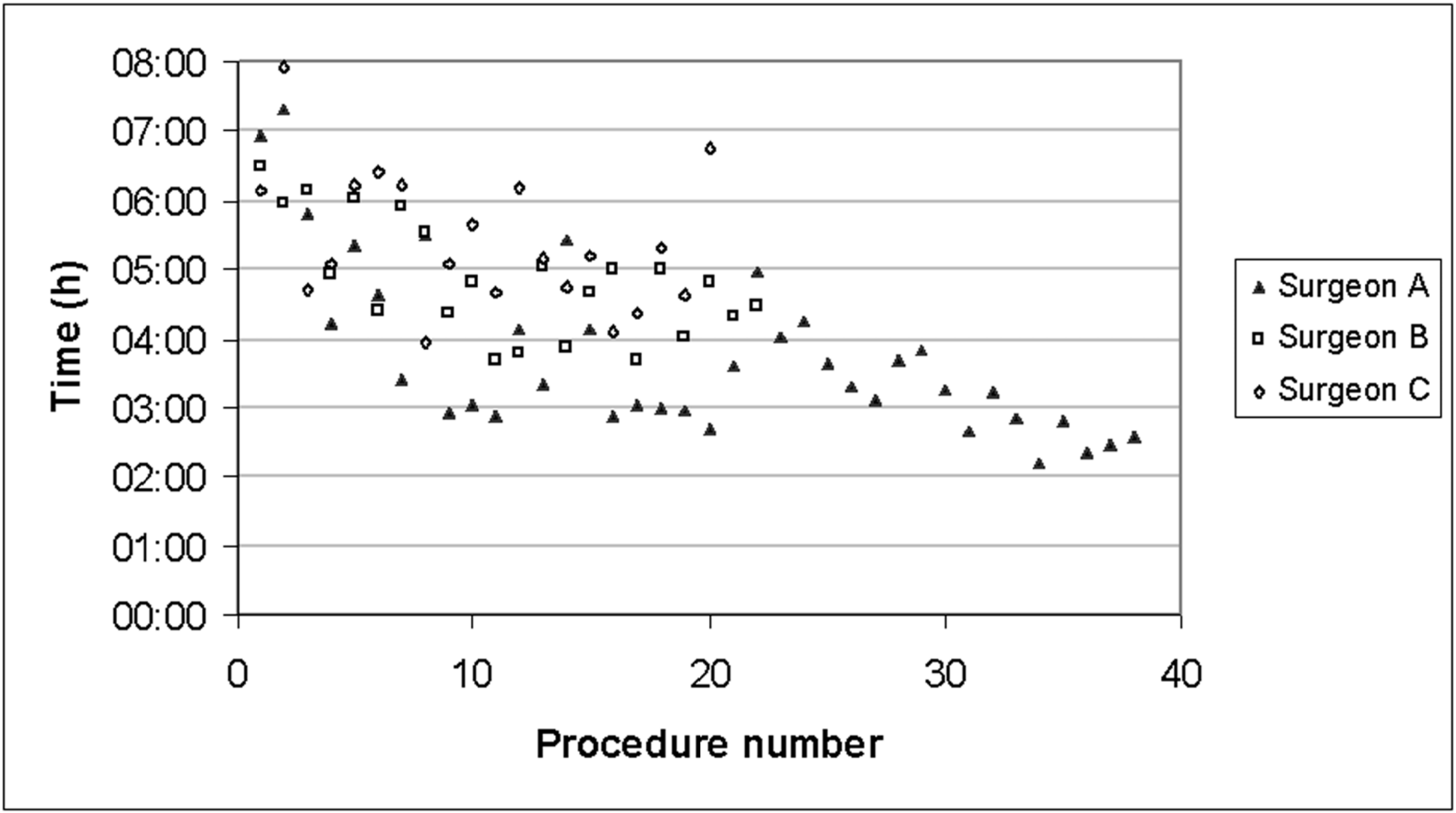
1: Robot (monopolar scissors, needledriver) 2:Robot (bipolar grasper). 3: Robot (grasper). 4: 15 mm assistants port (retreival of nodes, gamma-probe, retraction, suction/irrigation). 5: 12 mm assistants port (gamma-probe, retraction, suction/irrigation). 6: Robot (optics)

Figure 2

Time for surgery (skin to skin including docking of robot) for robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy.

Figure 3. Time to resume spontaneous voiding following robot assisted laparoscopic radical hysterectomy in women with early stage cervical cancer.


5
6
1
2
3
4


08:00
07:00
06:00
05:00
04:00
03:00
02:00
01:00
00:00
Time (h)
0
10
20
30
40
Procedure number
Surgeon A
Surgeon B
Surgeon C

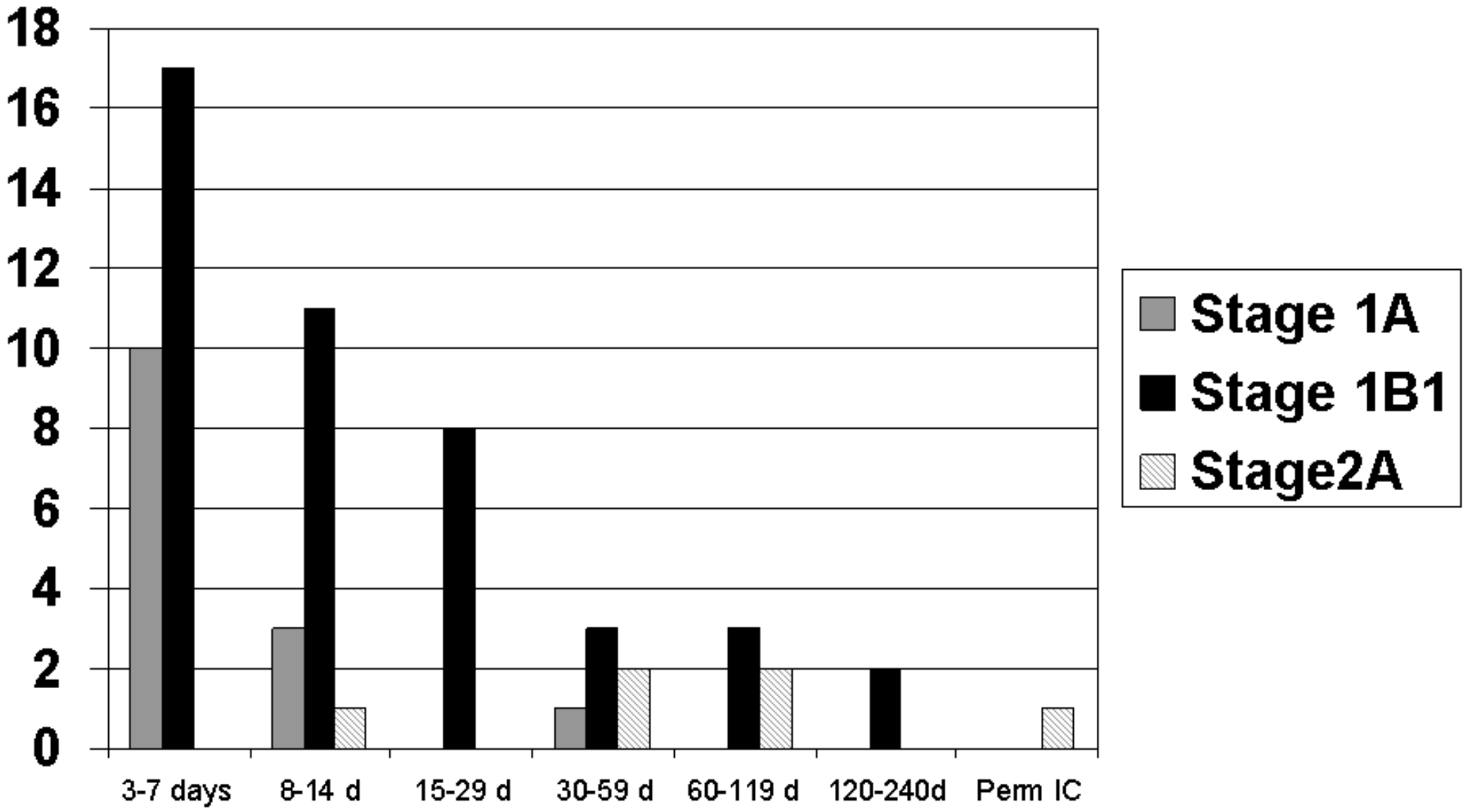

18
16
14
12
10
8
6
4
2
0
3-7 days
8-14 d
15-29 d
30-59 d
60-119 d
120-240d
Perm IC
Stage 1A
Stage 1B1
Stage2A

Table 1. Times and bleeding recorded during robot assisted laparoscopic radical hysterectomy and pelvic lymphadenectomy.

Data recorded during surgery minutes, mL as appropriate (median, range)	**All surgeons** *n*=80	**Surgeon A** *n*=38	**Surgeon B** *n*=22	**Surgeon C** *n*=20	**Statistics**
Total time for patient in operating room*	355 (238-563)	293 (238-425)	388 (289-465)	414 (349-433)	$p<0.001$
Total time for surgery (skin to skin)	262 (132-475)	199 (132-438)	290 (220-389)	311 (237-475)	$p<0.001$
Consol time	215 (118-341)	170 (118-300)	250.5 (188-332)	257 (165-341)	$p<0.001$
Surgeons start up time **	20 (8-53)	17 (8-48)	20.5 (14-53)	25.5 (16-38)	$p=0.003$
Surgeons finishing time***	14.5 (5-49)	10 (5-40)	14 (5-29)	19.5 (6-49)	$p=0.03$
Estimated bleeding (ml)	150 (25-1300)	150 (25-400)	150 (50-650)	300 (100-1300)	$p=0.005$

* Includes start and finish of anesthesia and OR-nurse preparations.

** Time from first skin incision to onset of consol surgery including docking of robot. Includes women requiring adhesiolysis before docking and situations with reversible system errors.

*** Time from end of consol surgery to last stitch in skin including dedocking of robot.

Table 2.

Complications following robot assisted radical hysterectomy and pelvic lymphadenectomy.

Type of complication	**Complications until 1-3 months follow-up.** *n= 80*	**Complications at one year follow-up.** *n= 43**
No complication	33 (41%)	25 (58%)
Vaginal cuff:		
Dehiscense	4 (5%)	1 (a)* * (2%)
Lymphatic leaking	8 (10%)	-
Infection	7 (9%)	-
Hematoma	2 (3%)	-
Vault prolapse	-	2 (a) (5 %) (1 rad)
Short vagina	1 (1%)	2 (a+r) (5 %) (1 rad)
Lymphatic:		
Proximal lymphoedema	12 (15%)	4 (r) (10%)
Mild distal lymphoedema	1 (1 %)	4 (3a,1r) (10%) (3 rad)
Severe distal lymphoedema	-	2 (a) (5 %) (2 rad)
Lymphocyst	6 (8%)	2 (r) (5 %)
Neural:		
Genitofemoral nerve injury	8 (10%)	6 (r) (15%)
Partial obturator nerve palsy	1 (1 %)	1 (r) (2 %)
Abdominal wall:		
Port site hernia	3 (4 %)	1 (r) (2 %)

Port site muscle rupture	2 (3 %)	2 (r)	(4 %)
Hematoma	2 (3 %)	-	
Port site metastases	-	-	
Vascular:			
Postop hemoglobin	10 (13%)	-	
<90 g/L and/or transfusion			
Ovarian vein thrombosis	1 (1 %)	-	
Pulmonary embolism	1 (1%)	-	
Infection:			
Pneumonia	1 (1 %)	-	
Pyelonephritis	1 (1 %)	-	
Fever of unknown origin	2 (3 %)	-	
Urinary:			
Ureter stenosis	1 (1 %)	-	
Positioning:			
Arm / shoulder / leg pain ***	7 (13 %)	-	

More than one complication may have occurred for a single patient.

*16 of 43 women at the one-year follow up had postoperative pelvic radiotherapy.

**(a)= additional complication. (r)= remaining complication. (rad)= radiotherapy. Number within brackets indicate the number of women for each category.

*** All women had surgery time exceeding 5 hours

Table 3. Complications following robot assisted radical hysterectomy and pelvic lymphadenectomy as reported by other authors.

Complication type by author	**Boggess JF et.al.**	**Magrina J et.al.**	**Fanning et.al.**	**Nezhat FR et.al.**	**Kim YT et.al.**	**Sert B et.al.**
Cases (*n*)	51	27	20	13	10	7
Study type	Case-control	Case-control	nd*	Case-control	Retrospective	nd
Follow up (months) (mean/median)	nd	31	24	12	9	14
Overall complication rate (%)	8%	15%	10%	38%**	8 %	71 %**
Lymphatic	1 (2%) Distal lymph-edema	1 (4%) Distal lymph-edema	0 (0%) sd ***	0 (0%) nsd	0 (0%) nsd	2 (28%) Lymphocele
Vaginal cuff	2 (4%) Abscess Cuff dehiscensce	0 (0%) sd	0 (0%) nsd	1 (8%) Lymphatic leaking	0 (0%) nsd	0 (0%) nsd
Neural	0 (0%) sd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd
Port site hernia	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd
Port site metastases	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd	0 (%) sd	0 (%) nsd

Vascular	0 (0%) sd	1 (4%) postop. blood transfusion	0 (0%) sd	0 (0%) sd	0 (0%) sd	1 (14%) DVT
Infection	0 (0%) sd	0 (0%) sd	0 (0%) sd	1 (8%) Cl. difficile enterocolitis	1 (10%) Pneumonia	1(14%) UTI
Urinary	0 (0%) sd	0 (0%) sd	2 (10%) Cystotomy Uretero-vaginal fistula	2 (15%) Cystotomy	0 (0%) sd	1 (14%) Cystotomy
Positioning	0 (0%) nsd	0 (0%) nsd	0 (0%) sd	0 (0%) nsd	0 (0%) nsd	0 (0%) nsd
Other	1 (2%) abdominal pain, readmitted	2 (8%) Pneumo-thorax Pleural effusion	0 (0%)	1 (8%) Ileus	0 (0%)	0 (0%)
Conversion	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Bleeding (mL) (mean/median)	96	133	300	157	355	71
Recurrent disease	nd	0 (0%)	2 (10%)	0 (0%)	0 (0%)	0 (0%)

* nd = not defined
** Proportion of uneventful cases unknown
*** sd = specifically denied, nsd = not specifically denied