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Perioperative outcomes of three-port robotically assisted hysterectomy: a continuous series of 53 cases

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Abstract This study evaluated the feasibility and safety of 3-port robotically assisted laparoscopic hysterectomy (RALH), using a consecutive series of women who underwent 3-port RALH in a university hospital. From November 2010 until June 2013 we operated on 53 women, whose mean age was 48.4 ± 7.7 years (range 35–68 years), and mean body mass index was 27.1 ± 5.1 kg/m² (range 19.5–42.9 kg/m²). The indications for hysterectomy were myoma in 31 (58.5 %), adenomyosis in 10 (18.9 %), cervical dysplasia in 4 (7.5 %), neoplasia in 4 (7.5 %), and recurrent polyps or postmenopausal bleeding in the remaining 4 women (7.5 %). We performed total RALH in 50 cases (94.3 %) and subtotal in the others. The median duration of total intervention was 169 min (interquartile range 147.5–206.5 min). The mean weight of the uterus was 209.8 ± 166.6 g (range 36–790 g) and mean estimated blood loss was 72.3 ± 75.9 ml (range 0–300 ml). There were no perioperative complications, in particular no blood transfusions nor conversions to laparotomy. The median hospital stay was 4 days (interquartile range 3–4 days). One patient was reoperated 1 month later for vaginal vault hematoma and another was readmitted 3 weeks post-operatively due to vaginal vault dehiscence after premature intercourse, but did not require reoperation.

Three-port RALH is feasible and safe for simple hysterectomy. We believe this experience using minimum ports to be useful to prepare for robotically assisted single-port hysterectomy.

Keywords da Vinci system · Robotic surgery · Hysterectomy · Robotically assisted laparoscopic hysterectomy · Reduced ports

Introduction

Hysterectomy is the most commonly performed gynaecological surgical procedure. More than 500,000 hysterectomies are performed in the USA annually [1]. The first laparoscopic hysterectomy was performed by Harry Reich in 1988 [2]. Over the past two decades, the use of minimally invasive approaches for hysterectomy has increased. However, in 2005, only 14 % of all hysterectomies were performed laparoscopically in the USA. Robotically assisted laparoscopic hysterectomy has gained popularity, especially in the USA, and might have the potential to help increase the proportion of laparoscopic hysterectomies [3]. Outcomes appear comparable to standard laparoscopic or vaginal hysterectomy, but it is more costly [4–7]. One of the potential benefits for the patient might be reduction of post-operative pain [8]. Moreover, the ergonomics offers an evident benefit for the surgeon, which is rarely quantified.

Laparo-endoscopic single-site surgery (LESS), also referred to as single-port laparoscopy, is one of the recent advances in the field of minimally invasive surgery. The first hysterectomy by a single trocar technique was reported by Pelosi et al. [9] in 1991. Despite these pioneering efforts, gynecological surgeons did not embrace single-site surgery until recently, but at the expense of longer operative time and higher post-operative pain scores as well as discomfort for the surgeon [10, 11]. The use of this technique is still limited in gynecology [12]. With the use of robotic assistance, single-site hysterectomy might become
much easier to perform and pain might be reduced, thus offering a new benefit for women.

In standard laparoscopy, hysterectomy is traditionally performed using 4 ports (one umbilical port of 12 mm and three suprapubic ports of 5–10 mm). It can also be performed with only two suprapubic 5-mm ports, or even smaller 3-mm ports nowadays. Robotic assisted hysterectomy is classically performed with 4–5 ports (12 mm for the optics, 8 mm for the robotic arm trocars and one assistant port of 5 or 10 mm). Since the beginning of our experience in robotic surgery, we decided to use only three ports for all standard hysterectomies, so as to offer similar benefits as in laparoscopy and to prepare for future robotically assisted single-port procedures. Robotic assistance for single-site laparoscopic surgery represents, from our point of view, the potential benefit of robotic assistance in minimally invasive gynecological surgery. The use of a reduced number of ports and instruments is inevitable in single-port hysterectomy, which is challenging for the surgeon. We present our experience with three-port robotically assisted laparoscopic hysterectomy.

**Patients and method**

Implementation of a robotic program took place at our institution in November 2010 after institutional approval from the Geneva University Hospitals. As a center highly trained in laparoscopy and performing laparo-endoscopic single-site surgery (LESS), we decided from the beginning of our program to perform robotically assisted hysterectomy with only three ports as opposed to the standard 4–5 ports advised by Intuitive Surgical and previous reports. We already performed our laparoscopic hysterectomies with the use of only three 5-mm ports. All patients gave their informed consent for the procedure. We started our robotic cases with small uteri and simple cases and enlarged our indications to larger uteri and more complex cases with increase in our experience. Each case was evaluated for its complexity based on preoperative diagnosis, prior pelvic or abdominal surgery, patient’s body mass index (BMI), and uterine size. One experienced surgeon performed the majority of cases with resident and/or fellow assistance, and three other surgeons were progressively introduced to the method. Complex procedures such as pelvic lymphadenectomy or patients with high risk of complex adhesions were not included, and additional trocars were used from the start.

The patients were placed in the dorsal lithotomy position. All patients had preoperative prophylactic antibiotics [Cefazolin 2 g IV (Kefzol®)] at anesthetic induction. A Hohl uterine manipulator (Karl Storz Company, Tuttlingen, Germany) was placed after appropriate preparation and draping (Fig. 1). This manipulator was moved later on during the robotic procedure by a fellow sitting between the legs of the patient. Patients were placed in a steep Trendelenburg position. We used either the da Vinci S or SI system (Intuitive Surgical®) to perform the procedure as they were the two models available in our institution during that period. We performed insufflations of CO₂ with a Veress needle introduced either in the umbilicus or at the Palmer point in the left upper quadrant. A 12-mm trocar (Ethicon® D12 XT) 150 mm in length was introduced intra- or supra-umbilically depending on the size of the uterus at an intra-abdominal pressure of 25 mmHg. After introducing the da Vinci optic, we placed one 8-mm metallic da Vinci cannula in the left iliac fossa and one 8-mm cannula with outlet in the right iliac fossa at an intra-abdominal pressure of 20 mmHg (Fig. 2). The cannula with outlet was useful to evacuate smoke if necessary. Intra-abdominal pressure was reduced to 12 mmHg during the procedure. We performed the initial diagnostic laparoscopy and survey of the abdomen directly with the da Vinci optics. Adhesiolysis was performed with standard laparoscopic instruments when necessary before docking the robot. We docked the robotic system on the left side of the patient to allow the fellow sitting between the legs to have good access to the vagina for further manipulation and consecutive removal of the uterus. We also used a vaginal extractor (Karl Storz Company) as previously described in a 1994 publication to introduce the sutures and needle for vaginal cuff closure (Figs. 3, 4) [13]. We used either a 0° or 30° optic depending on the size of the uterus. The 30° optic was chosen in a few cases to allow for better visualization and access to uterine arteries, vesico-vaginal fold or culdotomy in some cases of large myomas. We used monopolar EndoWrist scissors and Maryland or fenestrated bipolar grasper (Intuitive Surgical) to perform the procedure. The vaginal cuff was closed robotically with two needle drivers (of which one was a Mega Suture-Cut) with three to four figures-of-eight O polyglyactin sutures (Vicryl® O, Ethicon Endo Surgery, Inc., Cincinnati, OH, USA) on a CT-2 needle. Suture material was introduced through the previously described vaginal extractor, and removed through the 8-mm trocars after having closed the vaginal vault. In cases of subtotal hysterectomy, the patient had preoperative endometrial biopsy as a routine investigation, and we performed telescoping (introduction of an 8-mm da Vinci trocar in a 12-mm laparoscopic trocar) and morcellation through the same incision in the left iliac fossa. When necessary, aspiration of blood was performed by the fellow or resident on the operating field through one of the 8-mm trocars, after removal of one of the robotic instruments, with or without undocking the robotic arm, or at the end of the procedure after undocking the robot. The robotic system was undocked and all trocars were removed.
under direct visualization after checking all the pedicles. The 12-mm trocar received a single deep figure-of-eight 2-0 polyglyconate suture (Maxon®, Covidien, Mansfield, MA, USA) and all skin incisions were closed with 3-0 nylon simple node sutures (Ethylon®, Ethicon Endo-Surgery, Inc.). We analysed variables including age and BMI, medical co-morbidities such as hypertension, smoking and diabetes, and previous abdominal surgery and sexual activity. We recorded the following times: total operative time, defined as first skin incision to wound closure; docking time, defined as the time from the end of diagnostic laparoscopy to placement of the robotic instruments into the patient; and robotic time defined as time spent by the surgeon on the robotic console. In addition, uterine weight, blood loss, transfusion rate, conversions to standard laparoscopy or to laparotomy, addition of one supplementary trocar, intra-operative and post-operative complications, as well as length of hospital stay were monitored and recorded. All patients had a gynecological post-operative examination between 4 and 8 weeks after the procedure.

We performed descriptive statistics alone. Data analyses were conducted using SPSS 18 statistical software (SPSS Inc., Chicago, IL, USA).

Results

From November 2010 to June 2013 we operated on 53 women, whose mean age was 48.4 ± 7.7 years (range 35–68 years), and mean BMI was 27.1 ± 5.1 kg/m² (range 19.5–42.9 kg/m²). Thirty patients (56.6 %) had previous abdominal surgery. There were 38 sexually active patients (71.7 %), 15 (28.3 %) had cardiovascular disease and 15 (28.3 %) were smokers (Table 1). The indication for hysterectomy was myoma in 31 (58.5 %), adenomyosis in 10 (18.9 %), cervical dysplasia in 4 (7.5 %), neoplasia in 4 (7.5 %), and recurrent polyps or postmenopausal bleeding in the remaining 4 (7.5 %) women. We performed total hysterectomy in 50 cases (94.3 %) and subtotal in the others. There was adhesiolysis in 17 (32.1 %), and uni- or bilateral salpingectomy or adnexectomy in 26 (49.6 %) patients. One patient had associated Burch colposuspension for stress urinary incontinence. Four surgeons performed 38, 10, 4 and 1 procedures, respectively. The median duration of total intervention was 169 min [interquartile
Table 1 Preoperative characteristics (N = 53)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Age (years), mean ± SD (range)</td>
<td>48.4 ± 7.7 (35.1–68.2)</td>
</tr>
<tr>
<td>Height (cm), mean ± SD (range)</td>
<td>1.61 ± 0.1 (1.47–1.72)</td>
</tr>
<tr>
<td>Weight (kg), mean ± SD (range)</td>
<td>70.0 ± 13.3 (52.0–115.0)</td>
</tr>
<tr>
<td>BMI (kg/m²), mean ± SD (range)</td>
<td>27.1 ± 5.1 (19.5–42.9)</td>
</tr>
<tr>
<td>Nulliparity</td>
<td>8 (15.1 %)</td>
</tr>
<tr>
<td>Menopause, n (%)</td>
<td>13 (24.5 %)</td>
</tr>
<tr>
<td>Diabetes, n (%)</td>
<td>2 (3.8 %)</td>
</tr>
<tr>
<td>Asthma or chronic obstructive</td>
<td>2 (3.8 %)</td>
</tr>
<tr>
<td>Pulmonary disease, n (%)</td>
<td>15 (28.3 %)</td>
</tr>
<tr>
<td>Smoking &gt;5 cigarettes/day, n (%)</td>
<td>15 (28.3 %)</td>
</tr>
<tr>
<td>Sexual activity, n (%)</td>
<td>38 (71.7 %)</td>
</tr>
</tbody>
</table>

Table 2 Operative characteristics (outcomes) (N = 53)

<table>
<thead>
<tr>
<th>Operative outcome</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Operative time (min), median</td>
<td>169 (147.5–206.5)</td>
</tr>
<tr>
<td>(25th to 75th percentile)</td>
<td></td>
</tr>
<tr>
<td>Robotic time (min), median</td>
<td>115.0 (87.0–142.5)</td>
</tr>
<tr>
<td>(25th to 75th percentile)</td>
<td></td>
</tr>
<tr>
<td>Docking time (min), median</td>
<td>10.0 (7.5–14.0)</td>
</tr>
<tr>
<td>(25th to 75th percentile)</td>
<td></td>
</tr>
<tr>
<td>Uterine weight (g), mean ± SD</td>
<td>209.8 ± 166.6 (36–790)</td>
</tr>
<tr>
<td>(range)</td>
<td></td>
</tr>
<tr>
<td>Estimated blood loss (ml),</td>
<td>72.3 ± 75.9 (0–300.0)</td>
</tr>
<tr>
<td>mean ± SD (range)</td>
<td></td>
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</table>

(IQ range 147.5–206.5 min) and the median robotic duration was 115 min (IQ range 87.0–142.5 min). The mean weight of the uterus was 209.8 ± 166.6 g (range 36–790 g) and mean estimated blood loss was 72.3 ± 75.9 ml (range 0–300 ml) (Table 2). There were no peri-operative complications, no addition of a fourth trocar during the procedure and no conversion to standard laparoscopy or to laparotomy. The median hospital stay was 4 days (IQ range 3–4 days). One patient was readmitted 3 weeks post-operatively due to vaginal vault dehiscence after premature intercourse, but did not require reoperation. One patient was reoperated 1 month later for vaginal vault hematoma.

Discussion

To our knowledge, this is the first reported series of RALH with only three ports. Previous RALH series used at least one assistant port and sometimes the third robotic arm. Our study assesses feasibility and safety of RALH without any assistant port. Due to enhanced 3D vision and very precise dissection, RALH is a surgery with minimal bleeding. With a few precautions and a good uterine manipulator, the use of an assistant trocar becomes unnecessary. We started this technique with our first robotic case and our series includes our learning curve. If we compare our series to initial historic series of RALH, our operating times are shorter despite larger uteri [14]. In the first series published by Reynolds and Advincula in 2006, median operating time of RALH was 242 min and mean uterine weight was 131.5 g, compared to 169 min and 209.8 g, respectively, in our series [14]. Mean operating time was shorter (127.82 min) in Kho et al.’s [15] initial series of 91 patients published in 2007, but their mean uterine weight was smaller (135.53 g). More recently, Boggess et al. [16] showed a mean operative time of 122.9 min for more complex benign RALH with a mean uterine weight of 347 g. In two recent randomized trials comparing conventional laparoscopic hysterectomy and RALH, total operative time for RALH was only 106 min in Sarlos et al.’s [17] team and 172.8 min in Paraiso et al.’s [7] team for very similar indications and uterine weights with respect to our series. In their study, Sarlos et al. reported a minimum of 30 RALH performed by each surgeon included in the study before the start, compared to 20 procedures in Paraiso et al.’s study. The lack of experience and the learning curve could partly explain the large difference in total operative time between these studies. Similarly, we believe that the three-port RALH operative time could be reduced with experience and training to reach an operative time close to the duration described in these multiple-port series from more experienced surgeons.

Our only two complications were vaginal vault hematoma in one patient and dehiscence due to premature intercourse (<1 month after surgery) treated conservatively in the other. It is well described that women should defer vaginal intercourse for at least 6–8 weeks after hysterectomy, because sexual intercourse before complete healing of the vaginal cuff is considered the main trigger event [18, 19]. In a 2011 study, Hur et al. [20] reported an overall incidence of vaginal cuff dehiscence of 0.39 % after all types of hysterectomy. The incidence after total laparoscopic hysterectomy was 0.75 % compared to 0.38 % for abdominal hysterectomy and 0.11 % for vaginal hysterectomy. Kho et al. [21] reported a much higher incidence of vaginal cuff dehiscence of 4.1 % after robotic hysterectomy in a series of 510 patients, probably due to the use of monopolar coagulation current of 50 watts. It is well known that we should use electrosurgical techniques that result in minimal thermal spread to minimize tissue destruction and necrosis leading to poor healing. In our institution we use a monopolar point with pure cutting current of low voltage (10–15 watts) during standard laparoscopic hysterectomy to minimize thermal damage. There is no such device available for robotic hysterectomy.
and we use monopolar scissors with pure cutting current of 20 watts. To minimize thermal damage, we try to minimize tissue contact by opening the scissors when possible. We refrain from using coagulation to achieve hemostasis on vaginal cuff vessels and try to achieve it with vaginal cuff closure. At the beginning of our experience we only had the da Vinci S system. For the colpotomy, only coagulation current was available thus creating more thermal damage and potential delay in the healing process. With the da Vinci SI system, we could use monopolar low power current to cut the vagina thus minimizing this problem for further cases.

Comparative studies show longer operative times for RALH compared to laparoscopic hysterectomy, which is also the case in our series. They also show higher costs [5, 17, 22]. To overcome disadvantages of longer operative time and higher costs, we believe that RALH might become beneficial for the patients only if technology improves and leads to less invasive procedures such as single-port RALH. Single-port laparoscopic hysterectomy is strongly limited by all the conflicts between instruments. Robotic assistance might help overcome these difficulties and enhance development of the technique, but only with the emergence of new technology. Currently, robotically assisted single-port hysterectomy is still very challenging and limited to small uteri that can be easily removed through the vagina without any visible scar. The future of robotic surgery is strongly linked with innovation and improvement of technology and with miniaturization, but also with coupling of imaging allowed by computer assistance.

The objective of our study was to show that it is possible to minimize the use of trocars in RALH without compromising its success, and we compared our results to those reported by previous authors using at least one supplementary assistant trocar. In a randomized controlled trial comparing two-port versus four-port laparoscopic cholecystectomy, two-port laparoscopic cholecystectomy resulted in less port-site pain and similar clinical outcomes but fewer surgical scars [23]. We believe these results to be generalizable to laparoscopic hysterectomy, and therefore it should be a goal for each surgeon to reduce the number of ports whenever possible. Since the beginning of our robotic experience we tried to work as efficiently as in standard laparoscopy, where it is now quite usual to perform hysterectomy with only three 5-mm trocars. We believe our study shows that minimizing the number of instruments does not compromise the safety and efficiency of robotic hysterectomy.

The strength of our study resides in the fact that we have a continuous standardized series initiated since the beginning of our robotic programme. Four experienced laparoscopic surgeons, all at the beginning of their learning curve in RALH, progressively started three-port RALH, with the help of young residents with no experience in robotic surgery. Therefore, we believe that our results might be generalizable to other groups. The limitation of this study remains the small number of patients and a larger series is needed to confirm our results and generalize the technique to other groups for all simple hysterectomies.

**Conclusion**

Our study shows that three-port RALH is feasible and safe for simple hysterectomy. We believe this experience using minimum ports to be useful to prepare for robotically assisted single-port hysterectomy, where the use of a minimal number of ports will be mandatory.

**Conflict of interest** Patrick Dällenbach and Patrick Petignat declare that they have no conflict of interest.

**Ethical standard** All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study.

**References**