

Laparoscopic Hysterectomy with and without a Robot: Stanford Experience

Camran Nezhat, MD, Ofer Lavie, MD, Madeleine Lemyre, MD,
Ofer Gemer, MD, Lisa Bhagan, MD, Ceana Nezhat, MD

ABSTRACT

Objective: To compare robotic-assisted laparoscopic hysterectomy (RALH) with a matched control group of standard laparoscopic hysterectomy (LH).

Methods: A retrospective chart review of all RALH was performed. All cases were compared with a matched control group of standard LH. Comparisons were based on Fisher's exact, Mann-Whitney, and exact chi-square tests.

Results: Between January 2006 and August 2007, 26 consecutive RALH were performed (10 with bilateral salpingo-oophorectomy). These were compared with 50 matched control standard LH (22 with bilateral salpingo-oophorectomy). The 2 groups were matched by age ($P=0.49$), body mass index ($P=0.25$), gravidity ($P=0.11$), previous abdomino-pelvic surgery ($P=0.37$), and size of the excised uterus ($P=0.72$). Mean surgical time for RALH was 276 minutes (range, 150 to 440) compared with 206 minutes (range, 110 to 420) for standard LH ($P=0.01$). Blood loss, hospitalization length, and postoperative complications were not significantly different. No conversion to laparotomy was reported in either group.

Conclusion: Robotic technology was successfully used for hysterectomy with a similar surgical outcome to that of

standard LH. This technology offers exciting potential applications, especially for remote telesurgery, and to facilitate teaching of endoscopic surgery.

Key Words: Robot, da Vinci, Hysterectomy, Laparoscopy, Gynecology, Surgery.

INTRODUCTION

Hysterectomy is the most common nonpregnancy-related surgical procedure performed in the United States.^{1,2} Approximately 600 000 cases are performed annually.^{1,2} Since the first reported laparoscopic-assisted hysterectomies in the late 1980s to early 1990s,^{3,4} a definite trend toward the laparoscopic route for hysterectomy has been observed.¹ An increase from 0.3% to 9.9% of all hysterectomies has been observed over a 7-year period in the United States.¹ Despite the laparoscopic benefits, hysterectomy via laparotomy remains the most common route.¹ One of the reasons for this slow acceptance is the long learning curve associated with conventional laparoscopy.⁵

Computer-enhanced robotic surgery using the da Vinci Robotic Surgical System (Intuitive Surgical Inc., Sunnyvale, CA) has been applied successfully in cardiac surgery,⁶ urology,⁷ general surgery,⁸ orthopedics,⁹ ophthalmology,¹⁰ neurosurgery,¹¹ gynecology,¹²⁻¹⁷ and even in the field of gynecologic oncology.^{17,18} This technology may enable more surgeons to perform laparoscopic hysterectomy.

The use of robotic assistance (RA) in laparoscopy has been proposed to overcome the disadvantages of traditional laparoscopy while still benefiting from the advantages of a minimally invasive technique. RA laparoscopic surgery has the potential to facilitate surgical procedures by allowing the surgeon to sit comfortably and to visualize the abdomino-pelvic cavity in a 3-dimensional view. It also allows for increased dexterity and precision, which is very important when working with delicate structures and performing fine procedures. In addition, it scales the surgeon's movements to filter out natural tremor.

The feasibility of integrating RA technology in the perfor-

Center for Special Minimally Invasive Surgery, Stanford University Medical Center, Palo Alto, California, USA (Drs Camran Nezhat, Lemyre).

Department of Obstetrics and Gynecology, Carmel Medical Center, Haifa, Israel (Dr Lavie).

Department of Obstetrics and Gynecology, Laval University, Quebec, Canada (Dr Lemyre).

Department of Obstetrics and Gynecology, Barzilai Medical Center, Ashkelon, Israel (Dr Gemer).

Nezhat Medical Center, Atlanta, Georgia, USA (Dr Ceana Nezhat).

We thank Brittany Liedstrand and Babak Hajhosseini, MD, for their contribution to the data collection, as well as Linca M. Nicoll, MD, for writing assistance.

Camran Nezhat, MD, is in the speaker bureau for the following companies: Aragon Surgical, Baxter, Genzyme, Intuitive Surgical, Lumenis, Stryker.

Address reprint requests to: Address correspondence to: Camran Nezhat, MD, Deputy Chief Department of Obstetrics and Gynecology, Stanford University, Center for Special Minimally Invasive Surgery, Stanford University Medical Center, 900 Welch Rd, Ste 403, Palo Alto, CA 94304, USA. Telephone: (650) 327-8778, Fax: (650) 327-2794, E-mail: cnezhat@stanford.edu

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mance of laparoscopic hysterectomy has already been established both by us and by others.¹⁹⁻²⁴ However, to date, only one report has been published comparing RALH with standard LH.²⁵ Payne and Dauterive²⁵ compared 100 consecutive cases of RALH with 100 consecutive cases of LH. An important limitation of their study was the fact that analysis was done by intention-to-treat. Consequently, 32 patients underwent either a vaginal or an abdominal procedure and were kept in the analysis, which can strongly influence surgical parameters. None of the women in our study required conversion to a non-laparoscopic approach. Therefore, our analysis evaluates only the minimally invasive approach.

The objective of our study is to compare the procedure, timing, and complications of RALH to a matched control of standard laparoscopic hysterectomy and to evaluate the contribution of the robot to this specific gynecological procedure.

METHODS

Charts of every RALH performed between January 2006 and August 2007 were reviewed. All cases were compared with a matched control group of women who underwent standard LH during the same period. Matched parameters were age, body mass index, gravidity, and previous abdominal surgery. Comparisons were based on 2-tailed Student *t* test, Fisher's exact, Mann-Whitney, and exact chi-square tests.

RESULTS

During the study period, 26 consecutive RALH were performed at our institution. Fifty controls were selected following the above criteria. As illustrated in **Table 1**, the 2 study groups were comparable for age, body mass

index, gravidity, and previous abdominal surgery. Mean weight of the removed uteri was not significantly different between the RALH group [255 g (range, 67 to 1200)] and the LH group [322 g (range, 47 to 1700)] ($P=0.72$). In the RALH group, 10 patients had bilateral salpingo-oophorectomy (38%) compared with 22 patients (44%) in the control group ($P=0.08$).

The mean surgical time for the robotic technique was 276 minutes (range, 150 to 440), compared with 206 minutes (range, 110 to 420) for the standard LH ($P<0.001$). There was no significant time difference whether concomitant bilateral salpingo-oophorectomy was performed or not ($P=0.3$). The average time was 12 minutes (range, 10 to 23) for the assembly of the robot and 3 minutes (range, 2 to 5) for disassembly.

No significant differences occurred in the blood loss ($P=0.53$) and duration of postoperative hospitalization between the 2 groups of patients ($P=0.11$) as presented in **Table 2**.

No conversion to laparotomy was necessary, and no major complications necessitating blood transfusion, readmission to the hospital, or the use of antibiotics were recorded in the 2 groups of patients. No patient developed a vaginal vault dehiscence.

DISCUSSION

The new millennium has brought with it a worldwide interest in RA surgery with the promise of increasing applications for minimally invasive surgery. Because these technologies promise to help overcome the current limitations of the surgeon and equipment, the potential exists for more sophisticated procedures to be done endoscopically and even remotely by a wider variety of surgeons.

Table 1.
Patient Demographics

	RALH*† (n=26)	LH*† (n=50)	P Value
Age (y)	46 [33-63]	47 [39-74]	0.486
BMI	25.4 [18-42]	26.7 [19-34]	0.246
Previous Abdominal Surgery	10 (38)	21 (42)	0.374
Nulligravidity	5 (19)	13 (26)	0.109

*RALH=robot assisted laparoscopic hysterectomy; LH=laparoscopic hysterectomy.

†Data are presented as mean [min-max] or n (%).

Table 2.
Operative Outcomes

	RALH*† (n=26)	LH*† (n=50)	P Value
Operative Time (min)	276 [150-440]	206 [110-420]	0.01
Blood Loss (mL)	250 [100-1000]	300 [110-750]	0.53
Hospital Stay (d)	1.00 [1-1]	1.05 [1-3]	0.11

*RALH=robot assisted laparoscopic hysterectomy; LH=laparoscopic hysterectomy.

†Data are presented as mean [min-max].

We hope that these enabling technologies will facilitate a transition from laparotomy to laparoscopy as the standard of care.

In the gynecologic literature, there are reports of RA laparoscopy for hysterectomy,¹⁹⁻²⁵ myomectomy,¹³ tubal reanastomosis,^{26,27} sacral colpopexy,¹⁶ tubal ligation,²⁷ salpingo-oophorectomy,²² ovarian cystectomy,²² and radical hysterectomy.¹⁷ Since the first hysterectomy on a human performed using computer-enhanced technology was reported in 1998,²⁰ a few small series have reflected the experience of other centers using the robot for hysterectomies.^{16,19,23-25} We have multiple publications reflecting our considerable experience with RA technologies,^{12,16,22} which extends so far as to include the laboratory testing phase of research and development for the present robotic technology with renowned robotic innovators, Ajit Shah, PhD, and Phil Green from the Stanford Research Institute.

Our most recent publications include a large series of 136 gynecologic procedures performed with the da Vinci robot²² that established the feasibility of the RA approach for all major gynecological procedures.

Our current comparison of RALH with standard LH suggests that RALH is feasible without contributing any additional morbidity. The length of hospital stay and blood loss were comparable in the standard LH and the RALH. Overall, patient's BMI and uterine size did not limit our ability to complete RALH in this series. All suturing was performed with the assistance of the robot.

Laparoscopic hysterectomy performed with the assistance of the robot took significantly longer compared with standard LH. A significant portion of this additional surgical time was contributed by the assembly and disassembly of the robot which depends, in turn, on the experience of the surgical staff with robotic equipment. In our facility, the robot is draped before start time, which takes an average of 15 minutes and was not included in the calculation of the total operative time. Reynolds and Advincula¹⁹ noted in their unpublished data comparing standard LH and RALH that 60 additional minutes were required while robotic technology was used, which is similar to our results. Operative time has been shown to decrease as the surgeon and his or her team becomes more experienced. Lenihan et al²⁸ showed that duration of surgery keeps decreasing for the first 50 robotic cases that a surgeon performs.

We have found that the advantages of RA laparoscopic surgery include providing a 3-dimensional view of the

operative field, decreasing fatigue and tension tremor of the surgeon through ergonomic positioning, and improving dexterity and surgical precision through the 7 degrees of freedom provided by robotic instrumentation.¹⁶ We noticed that these advantages provided by the robot enabled the operator to handle tissue and perform the procedure more easily. We noted also that the learning curve for suturing was shorter than that for laparoscopy, which could allow a less-skilled laparoscopist to perform such a task.

We are also excited about the potential for RA in telepresence surgery, which could allow an expert surgeon distant from the patient to guide the robot in performing a perfect surgery regardless of his or her actual geographic location.

The disadvantages include increased operating time for assembly and disassembly, the bulkiness of the equipment, and the increased cost.¹⁶ Some have reported a higher rate of vaginal cuff dehiscence after RALH.²⁹ We did not experience this complication in our patients.

CONCLUSION

RALH has similar outcomes to that of conventional LH, and our study did not demonstrate any major advantages over standard LH. It would seem that robotic assistance might have useful applications in the learning period for less-experienced surgeons and for gynecological procedures requiring small and delicate surgical movements in a limited and fixed visual field (ie, tubal anastomosis, cystectomy, oophorectomy, adhesiolysis, and lymph node dissection). The current incarnation of robotic technology should be considered an early prototype, as we anticipate the advent of smaller, less expensive, and more user-friendly robots will be developed to make robotic surgery both faster and more cost effective. Robotic technology also has exciting potential for future applications as in long-distance telesurgery, bringing the expertise of experienced surgeons to distant and remote areas. Our vision is to ultimately have a smart robot to perform "perfect" procedures automatically with the surgeon acting only as its guide.

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