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Robotic-assisted laparoscopic myomectomy compared with standard laparoscopic myomectomy—a retrospective matched control study

Camran Nezhat, M.D.,[a] *Ofer Lavie, M.D.,*[b] *Senzan Hsu, M.D.,*[a] *James Watson, M.D.,*[c] *Ofra Barnett, Ph.D.,*[b] *and Madeleine Lemyre, M.D.*[a]

[a] Center for Special Minimally Invasive Surgery, Stanford University Medical Center, Palo Alto, California; [b] Carmel Medical Center, Faculty of Medicine, Technion, Hafia, Israel; and [c] Private Practice, San Jose, California

Objective: Compare robotic-assisted laparoscopic myomectomy (RALM) to a matched control standard laparoscopic myomectomy (LM).
Design: A retrospective matched control study.
Setting: Private practice setting.
Patient(s): Premenopausal and postmenopausal women who underwent either robotic-assisted or standard laparoscopic myomectomy.
Intervention(s): None.
Main Outcome Measure(s): Retrospective chart review was performed. Cases of laparoscopic robotic-assisted myomectomies were compared with a matched control group of standard LM. Comparisons were based on Fisher's exact, Mann-Whitney, and exact chi-square tests.
Result(s): Between January 2006 and August 2007, 15 consecutive RALMs were performed at our institution, compared with 35 matched control standard LMs. The two groups were matched by age, body mass index, parity, previous abdominopelvic surgery, size, number, and location of myomas. Mean surgical time for the RALM was 234 minutes (range 140–445) compared with 203 minutes (range 95–330) for standard LMs. Blood loss, hospitalization time, and postoperative complications were not significantly different.
Conclusion(s): The RALM required a significant prolonged surgical time over LM. It appears that in the hands of a skilled laparoscopic surgeon, the RALM does not offer any major advantage. This technology, however, offers exciting potential applications while learning endoscopic surgery. Further studies are warranted to asses the utility of RALM for general gynecologic surgeons. (Fertil Steril® 2009;91:556–9. ©2009 by American Society for Reproductive Medicine.)

Key Words: Robotic-assisted myomectomy, laparoscopic myomectomy, da Vinci robotics, minimally invasive surgery

The primary surgical management of symptomatic leiomyoma for women desiring future fertility or uterine conservation is myomectomy. Today, many cases of intramural and subserous leiomyomas are managed with a laparoscopic myomectomy as a result of the advent of modern minimally invasive surgery techniques (1). The management of leiomyomas endoscopically is one of the more challenging procedures in minimally invasive surgery, and requires a skilled surgeon. Despite laparoscopic benefits such as faster postoperative recovery and potentially fewer postoperative adhesions compared with laparotomy, the overwhelming majority of myomectomies are performed by laparotomy because of the existence of many technical concerns. Computerized enhanced robotic surgery using the da Vinci robotic surgical system has been applied successfully in cardiac surgery (2), urology (3, 4), general surgery (5), orthopedics (6), maxillofacial surgery, ophthalmology (7), neurosurgery (8), gynecology (9–12), and even in the field of surgical gynecologic oncology (13). 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 the minimally invasive technique (14). The RA laparoscopic surgery has the potential to facilitate the surgical procedures by allowing the surgeon to remain seated comfortably while visualizing the abdominal and the pelvic cavities in a three-dimensional (3D) view. It also allows for increased dexterity and precision, which is very important when working with delicate structures. In addition, it scales the surgeon's movements to negate any natural tremor (15, 16). The greatest potential future advantage of

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Reprint requests: Camran Nezhat, M.D., Center for Special Minimally Invasive Surgery, 900 Welch Rd., Suite 403, Palo Alto, California 94304 (FAX: 650-327-2794; E-mail: cnezhat@stanford.edu).

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robotic surgery will be for remote telesurgery, in which the surgeon and the patient may be separated by many miles. This can help to bring the knowledge of experienced surgeons to distant areas with almost no geographic limitations. The feasibility of integrating RA technology in the performance of laparoscopic myomectomy (LM) was already published by us and others (17, 18). However, to date, there have been no published reports comparing the RALM to standard LM.

The objective of our study was to compare the technical procedure, timing, and end results of robotic-assisted laparoscopic myomectomy (RALM) to a matched control standard LM, and to evaluate the contribution of the robot to this specific gynecologic procedure.

MATERIAL AND METHODS

In this retrospective case–control study we reviewed 15 consecutive cases of RALMs that were performed from January 2006 thru August 2007 at one endoscopic tertiary care center. This data was compared with a matched control group of 35 cases of LMs performed at the same institution and during the same time period. All cases with and without the RA were performed by the senior author (C.N.). The investigation met the internal review board approval at Stanford University Medical Center. The da Vinci robotic surgical system (Intuitive Surgical Inc., Sunnyvale, CA) was used in all the RALM cases. All RA patients were placed in the dorsal lithotomy position. A HUMI uterine manipulator and a Foley catheter were placed. Four trocar sites were inserted: in this series of patients, a 12-mm infraumbilical, 2 midlateral 8-mm, and a 5-mm or 12-mm paraumbilical trocar. All procedures started as a standard laparoscopy, followed by the integration of the robot into the surgical field. After using the robot we then switched back to traditional laparoscopy to perform the end stages of the procedures, which included morcellation, extraction of the excised myomas, hysteroscopy, and\or cystoscopy. Along with the robot standing over the patient, at least three people—the surgeon, a scrub nurse, and a scrub assistant—were involved in each robotic procedure. The surgeon controlled the robot remotely from the console while watching a high-definition, highly magnified 3D image of the area involved. The suprapubic trocar was used by the assistant to provide ancillary laparoscopic instruments as needed by the surgeon.

In the LM group usually four people were involved: the surgeon, two scrub assistants who were minimally invasive fellows, and the scrub nurse. The equipment used for the laparoscopic portion of the procedure included a Ligasure, CO_2 laser, and Kleppinger bipolar system. The instruments used for the robotic portion of the procedure included a needle holder, PreCise bipolar, and scissors.

Statistical Analysis

A retrospective chart review of all laparoscopic robotic-assisted myomectomies (LARMs) was performed. All cases were compared by age, body mass index, number, location, and size of the myomas to a matched control group of standard LMs, which were performed in the same institute by the same surgeon. Comparisons between the study group and the controls were based on Fisher's exact test, Mann-Whitney test, and exact chi-square tests.

RESULTS

Between January 2006 and August 2007 15 consecutive RALMs were performed at our institution. This group was matched against 35 standard LMs performed in the same period and by the same surgeon. As can be seen in Table 1, there was no significant difference between the RALM and the LM concerning age, body mass index, gravidity, and previous abdominal surgery. Size, number, weight, and location of the removed myomas were not statistically different between the two study groups (Table 2). Surgical time for the robotic technique was 234 minutes (range 140–445) compared with 203 minutes (95–330) for the standard LM (P=.03). The average time for assembly of the robot was 14 minutes (range 10–25 minutes), and the disassembly average time was 3 minutes (range 2–7 minutes).

In this facility the robot is draped before the start time, which takes an average of 10 minutes. The type of sutures placed was delayed absorbable, and the technique was interrupted; this was similar in the two groups. Morcellation for hysterectomies and myomectomies were performed as standard laparoscopies at the end of the procedure after

TABLE 1

Demographic charateristics of patients.

	RALM n = 15	LM n = 35	*P value*
Age, years	39 (33–55)	41 (28–55)	.18
BMI	23 (18–31)	24 (19–33)	.55
Previous abdominal surgeries	5 (33)	15 (43)	.17

Note: Values are presented as mean (min–max) or n(%).

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TABLE 2

Characteristics of myomas removed.

	RALM n = 15	LM n = 35	*P* value
Number of myomas removed[a]	3 (1–7)	4 (1–21)	.42
Maximal diameter of removed myomas, cm[a]	5.1 (4–8.5)	6.4 (3–12)	.23
Weight of removed myomas, g[a]	116 (25–350)	156 (15–420)	.11
Patients with intramural myomas[a]	7 (47)	19 (54)	.12

Note: Results are presented as mean (min–max) or n(%).
[a] Mann-Whitney test.

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disassembly of the robotic equipment. There was no significant difference in mean blood loss ($P=.2$) or mean postoperative hospitalization time between the two groups of patients ($P=.12$) (Table 3). No conversion to laparotomy was necessary, and no major complications that necessitated blood transfusion, readmission to the hospital, or the use of additional antibiotics were recorded in the two groups of patients.

The RALM was more costly than the standard LM. The difference in hospital charge comparing RALM versus standard LM was approximately $21,500.00. The average hospital charge at our institution for the RALM was $56,000 versus $34,500 for the standard LM. The costs include the $2.0 million dollars for the robot itself and the $150,000/year in maintenance fees.

Despite the short period of follow-up, outcome regarding pregnancy was available in the two groups. In the RALM, one (6.7%) patient achieved pregnancy, whereas three (7.5%) of the patients in the LM group achieved pregnancy ($P=.9$).

DISCUSSION

The new millennium has brought with it a worldwide interest in robotic-assisted surgery (RAS), with the promise of allowing minimally invasive surgery to be more precise and fine tuned so that more sophisticated procedures can be done endoscopically and even remotely by more surgeons (19, 20). In the gynecologic literature there are reports of robotic-assisted laparoscopy for tubal ligation (21), tubal reanastomosis (20), sacral colpopexy (21), salpingo-oophorectomy, ovarian cystectomy (12), and even robotic-assisted laparoscopic hysterectomy (22). Recently, we published 136 gynecologic procedures performed with RA (12, 17). The conclusion of our previous report was that the robotic-assisted laparoscopy is feasible for all major gynecologic procedures. We did, however, emphasize one weakness of the da Vinci system. We found that it might not be suitable for procedures necessitating panoramic vision and more wide-angled movements like morcellation performed for myomectomies and hysterectomies.

Our current study aimed at investigating the use of the RAS for laparoscopic myomectomies and comparing it to a matched control standard LM to assess the contribution of the RAS specifically to myomectomies. The laparoscopic myomectomy has provided a minimally invasive alternative to laparotomy for the treatment of intramural and subserous leiomyomata. Several comparative trials showed postoperative morbidity was less and recovery was faster in laparoscopic procedures compared with laparotomy procedure (23, 24). Conversely, operative time is usually significantly longer with the laparoscopic approach, especially in cases where there are more than four myomas or when the largest myoma has a mean diameter of >6 cm (18, 23). Previously, Advincula et al. (18) reported on 31 patients who

TABLE 3

Operative outcomes.

	RALM n = 15	LM n = 35	*P* value
Operative time, min	234 (140–445)	203 (95–330)	.03
Blood loss, mL	370 (150–500)	420 (110–750)	.20
Hospital stay, days	1.00 (1–1)	1.05 (1–3)	.12

Note: Results are presented as mean (min–max).

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underwent RALM. Their study showed the feasibility of integrating robot-assisted technology when performing a laparoscopic myomectomy to overcome the technical limitations of conventional laparoscopy seen with this particular procedure.

Our comparison of RALM to a standard LM suggests that RALM is feasible, has a shorter learning curve (17), and does not add any additional morbidity to the LM.

However, the laparoscopic myomectomies performed with the assistance of the robot were significantly longer compared with standard LM. This additional surgical time was mainly attributed to assembly and disassembly of the robot and substituting the instrumentation for the robotic arms during the procedure. All tissue suturing was performed with the assistance of the robot. We found that having the 7 degrees of freedom and the 3D visual image provided by the robot enabled the operator to handle tissue and perform the procedure more easily. We also noted that the learning curve for suturing was less steep than that for laparoscopy, which could allow a less skilled or experienced laparoscopist to perform safe suturing in a shorter time period. In our series of myomectomies, hemostasis and suturing of the myometrium were performed with the assistance of the robot; however, morcellation as well as cystoscopy or hysteroscopy if necessary were performed in the standard way after disassembly of the robot from the surgical field. This suggests that the current instrumentation does not allow one to perform the entire laparoscopic myomectomy with only the assistance of the robot.

An additional drawback of the RALM is the increasing size of the port site incisions. The robot requires a 12-mm instead of 10-mm central port and two 8-mm instead of 5-mm ports to control the robotic arms as well as an additional port for the assistant. As minimally invasive surgeons we should be aware of the possible complications and patients' complaints resulting from this increased size of incisions as well as the need for prolonged anesthesia time required when using the robot.

In conclusion, our data does not show there to be any advantages of RALM compared with standard LM. The role of the robot may be better reserved for the initial learning period of endoscopic surgeons as it is an enabling device for suturing in a 3D environment. It shortens the learning curve and enables the novice endoscopic surgeon to master laparoscopic surgery earlier.

The current robotic technology should be considered an early prototype. Smaller, cheaper, and easier to use robots will be needed to make robotic surgery both faster and more cost efficient than the traditional techniques. This technology, however, has exciting potential for future applications, especially in long-distance telesurgery, which could deliver the expertise of advanced laparoscopic surgeons to different areas of the world.

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