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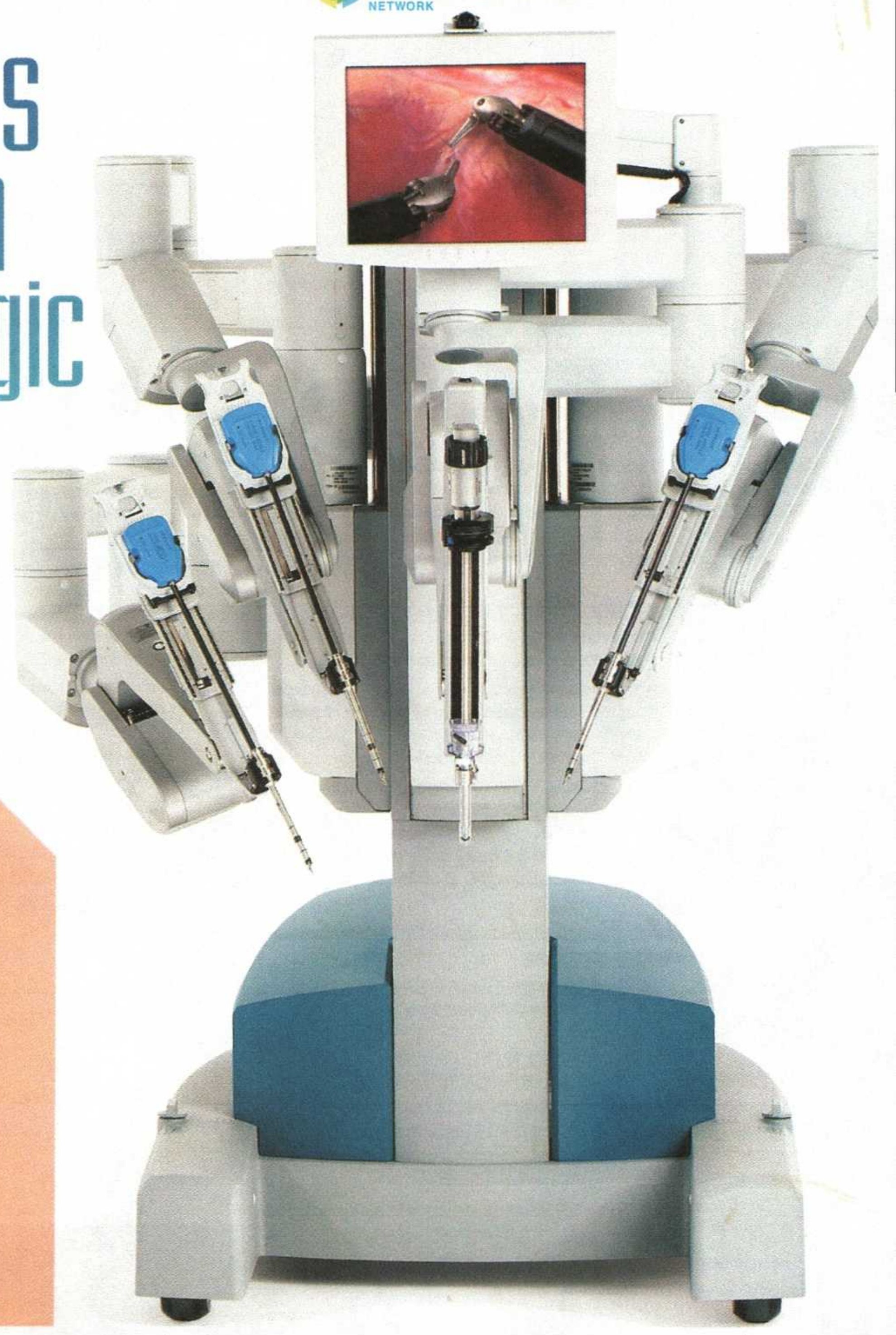

Will robots transform gynecologic surgery?

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GRAND ROUNDS

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MOHAMED N. AKL, MD, AND JAVIER F. MAGRINA, MD

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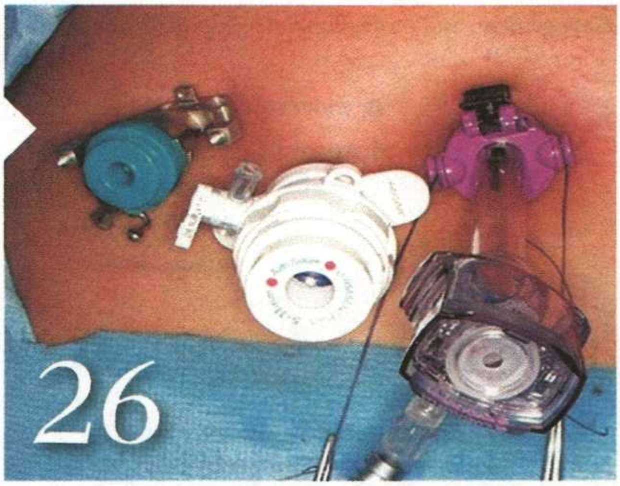

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Will robots transform gynecologic surgery?

Because robotic technology allows surgeons to easily and simply perform complex laparoscopic maneuvers, it has already revolutionized laparoscopic urologic surgery. Will gynecologic surgery be next?

BY **MOHAMED N. AKL, MD**, AND **JAVIER F. MAGRINA, MD**

VIDEO

The surgery video center features robotic hysterectomy for endometrial cancer.
contemporaryobgyn.net/surgvid

The limitations of conventional laparoscopy have catapulted robots into the OR. The da Vinci Surgical System was designed to overcome these limitations by providing the surgeon with better dexterity, precision, and three-dimensional imaging. Introduced in 1999, the da Vinci Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA) gained FDA approval for gynecologic procedures in March 2005.

A decade later, growing numbers of health-care institutions are purchasing the robotic system. Urologists are still considered the system's number one user, but robotic applications in gynecologic surgery have been expanding—and that expansion is reflected in literature reports on robotic applications for general gynecology, urogynecology/pelvic reconstructive surgery, gynecologic oncology, and reproductive endocrinology.

Advantages of robotic technology

Several studies done in the dry laboratory have linked robotic technology with faster performance, better accuracy, faster suturing, and fewer errors when compared to conventional laparoscopic instrumentation.[1-4] Advantages include:

- **Dexterity:** The robotic instrument has "seven degrees of freedom," replicating the full range of motion of a surgeon's hand. In this way, it efficiently facilitates suturing, knot tying and dissection, and helps overcome the fulcrum effect (i.e., the tip of the conventional laparoscopic instrument moves in a direction opposite to the surgeon's hand) that surgeons encounter with conventional laparoscopy (Figure 1).
- **Precision:** Robotic technology is able to increase accuracy and precision by downscaling the surgeon's movements in a ratio that the surgeon can select (e.g., in a 3:1 ratio: when the surgeon's hand moves 3 cm, the tip of the instrument moves only 1 cm). A computer interface eliminates physiologic hand tremors, increasing precision.

COURTESY OF NORTHWESTERN MEMORIAL HOSPITAL

- **Three-dimensional imaging:** The robotic laparoscope has two cameras, one for each eye, which give the surgeon a three-dimensional image at the console (Figure 2).
- **Reduced surgeon's fatigue:** Having the surgeon and the assistant seated during robotic procedures lessens their physical fatigue, especially during longer and more complex procedures (e.g., radical hysterectomy, lymphadenectomy, sacrocolpopexy).

What are its limitations?

- **Lack of tactile feedback** is one limitation of robotics. However, the depth of perception through the three-dimensional vision may compensate for this limitation.
- **Increased cost** is considered another downside of robotic surgery. When comparing the costs of robotics, laparotomy, and laparoscopy, however, a more complex cost-benefit analysis model should be used including hospital stay, time to return to work, and productivity, and not only costs related to the operating room. Additional studies are needed to further investigate this issue.
- **A bulky system and limited vaginal access** also limit robotic surgery. For example, it's more difficult to use a uterine maniupulator during robotic surgery as compared to conventional laparoscopy. As technology becomes more sophisticated in the future, however, these limitations are expected to resolve

FIGURE 1
The dexterity of the robotic instruments replicates the full range of motion of the surgeon's hand.

Indications for robotic surgery

Robotic surgery has similar indications as conventional laparoscopic surgery. However, because robotic technology allows surgeons to more easily and simply perform complex laparoscopic maneuvers, the availability of the robot would allow the surgeon to perform more sophisticated procedures than the conventional laparoscopic route, therefore reducing the number of open procedures. For example, a gynecologic surgeon might ordinarily prefer an open procedure over the conventional laparoscopic route for advanced pelvic endometriosis. However, with the availability of the robotic system, which facilitates tissue dissection and suturing, the surgeon may elect the robotic approach, resulting in reduced morbidity, shorter hospitalization, less postoperative pain, earlier return to work, and better cosmetic results compared to an open operation.

Contraindications for robotic surgery

These, too, are usually similar to those of conventional laparoscopy (e.g., immediate need for laparotomy to control bleeding, poor visualization, or exposure). The robotic system usually shortens the operative time of a long endoscopic procedure (e.g., radical hysterectomy, lymphadenectomy, sacrocolpopexy).

On the other hand, it may increase the total time of a short simple procedure (e.g.,

FIGURE 2
This robotic laparoscope with two cameras allows three-dimensional vision at the console.
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POWER POINTS

Some advantages of robotic technology over conventional laparoscopy are better dexterity, precision, and 3-D imaging.

Limitations are lack of tactile feedback, increased cost, a bulky system, and limited vaginal access.

Sacrocolpopexy may be the fastest growing pelvic reconstruction procedure done robotically.

Usually the vaginal route of hysterectomy should be offered first.

adnexectomy, endoscopic sterilization). When you add in the time spent in draping and setting up the robot, docking time, and operating room turnover time, using the robotic system in simple short endoscopic procedures may not be cost effective.

Setting up and docking the robot

The system's two main components are the surgeon's console and the robotic column (Figure 3 and Cover). After endotracheal intubation, position the patient in the dorsal lithotomy position with both arms tucked comfortably. A 12-mm umbilical trocar is placed using the open Hasson technique. Two 8-mm specially designed robotic trocars are placed bilaterally 10 cm lateral to and at the level of the umbilicus. Meanwhile, an accessory 10-mm trocar is placed between the umbilical port and the left lateral port 3 cm cephalad to the umbilicus. When the fourth robotic arm is used, that trocar is placed 10-cm lateral and 10 cm caudal to the right robotic trocar (Figure 4). The operating room table is lowered to the lowest level and enough Trendelenburg is obtained to permit removing the bowel out of the pelvis, up to 30° in obese patients. The robotic column is advanced and placed between the patient's legs.

Next, the robotic laparoscope (InSite Vision System; Intuitive Surgical) is attached to the umbilical trocar, and the two robotic arms are attached to the lateral robotic trocars. The surgeon sits, unscrubbed, at the console. The assistant sits on the patient's left side using the right hand to assist the surgeon through the accessory port (e.g., retraction, introduction of sutures and suction irrigation, vessel sealing, and specimen retrieval) and vice versa for a left-handed assistant.

Instrument selection

A variety of EndoWrist instruments are available for robotic gynecologic surgery; however, the surgeon should limit instrument exchange for an efficient procedure and to minimize cost. For most patients the monopolar spatula or scissors are used with the robotic right arm, and the PK (plasma kinetic) on the robotic left arm. A grasper (Prograsp) instrument is inserted with the robotic fourth arm whenever it's used. When suturing is required, the robotic right instrument is switched for a Mega needle holder, which is also capable of cutting sutures.

Applications in general gynecology

HYSTERECTOMY. The availability of the robotic system should not dictate the route of hysterectomy (endoscopic vs. vaginal). Whenever technically feasible and medically appropriate, patients requiring hysterectomy should be offerred the vaginal approach because morbidity appears to be lower with the vaginal approach than with any other method.[5] Endoscopic hysterectomy is indicated in the following cases:

- lysis of adhesions,
- treatment of endometriosis,
- management of uterine leiomyomata, and/or adnexal masses that complicate the performance of vaginal hysterectomy,
- ligation of infundibulopelvic ligaments to facilitate difficult ovary removal, and
- evaluation of the pelvic and abdominal cavity before hysterectomy.

That said, however, having the robot available would allow the surgeon to perform the more complex hysterectomies robotically rather than doing an open procedure when the conventional laparoscopic route is difficult to achieve. Robotic simple hysterectomy is one of the most common robotic procedures in gynecologic surgery, and case series have shown its safety and feasibility.[6-8] The largest case series of robotic hysterectomy (91 patients) reported a mean docking time of 2.9 (+/- 1.7) minutes and average console and operating times of 73 (+/- 30) minutes and 128 (+/- 35), respectively.[9]

MYOMECTOMY. Robotic technology also facilitates the dissection of the myoma and suturing of the uterine incision. In a retrospective case-matched study comparing robotic myomectomy to open myomectomy, investigators reported longer operative times in the robotic group [mean: 231 (+/- 85) minutes vs. 154 (+/- 43) minutes, P<.05], but decreased blood loss [mean: 195 (+/- 228) mL vs. mean 364 (+/- 473) mL, P<.05] and shorter length of stay [mean: 1.4 (+/- 0.9) days vs. 3.62 (+/- 1.5) days, P <.05] when compared with the laparotomy group.[10]

Applications in urogynecology and pelvic reconstructive surgery

SACROCOLPOPEXY. This is probably the fastest growing pelvic reconstructive procedure performed robotically. The procedure involves extensive suturing and knot tying, which is simplified by the robotic system. There are four main studies on robotic sacrocolpopexy.

- The first study reported on 30 patients with robotic sacrocolpopexy with a mean follow-up of 24 (range 12–36) months. The mean operative time was 186 minutes. Two patients (6.9%) had recurrent prolapse at 7 and 9 months postoperatively. All except one patient were discharged on the first postoperative day.[11]
- The second study reported on 15 patients who underwent robotic sacrocolpopexy. The researchers reported a mean operative time of 317 minutes, average blood loss was 81 (range, 50 mL–150 mL), and the average hospital stay was 2.4 days.[12]
- The third study compared 73 cases of robotic sacrocolpopexy to 105 cases of open sacrocolpopexy and reported longer operative time (328 vs. 225 minutes) and shorter hospital stay (1.3 vs. 2.7 days) in the robotic group compared to the open group.[13]
- In our case series of robotic sacrocolpopexy (80 patients), the mean operative time was 197.9 (+/- 66.8) minutes. After completing the first 10 cases, our mean operative time dropped significantly by 25.4% (64.3 minutes, 95% CI; 16.1–112.4, P=<.01. The average operative time for the last 30 cases was 167.3 minutes.[14]

FISTULA REPAIR. Robotic vesicovaginal and ureterovaginal fistula repair has been reported through small case series and case reports.[15,16] In a case series of seven patients with vesicovaginal fistula, the researchers reported an average operative time of 141

FIGURE 3
The surgeon's console
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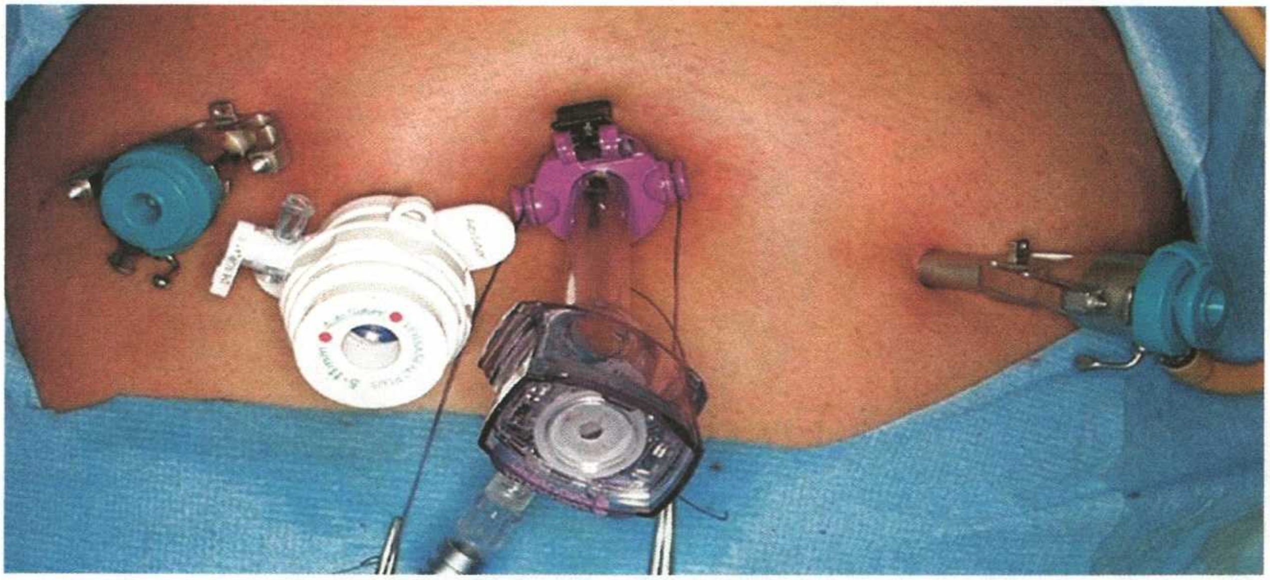

FIGURE 4
Robotic trocar placement

minutes (range 110 to 160). Mean blood loss was 90 mL, and no significant intraoperative or postoperative complications were observed.[17]

Applications in gynecologic oncology

Conventional laparoscopy in gynecologic oncology remains underutilized due to the difficult learning curve, longer operative time, the need for a well-trained surgical assistant, and technical issues. Incorporating robotic technology into the gynecologic oncology surgical practice may overcome these challenges. From our experience, the robotic learning curve appears to be relatively short as compared to conventional laparoscopy. However, further studies are needed to compare the learning curve of both approaches. Recently, several publications have reported using the robotic system for gynecologic oncology procedures, such as radical hysterectomy and endometrial cancer staging.[18-20]

Our published data on robotic radical hysterectomy showed similar mean operating times when compared to laparotomy (robotic: 189.6; laparotomy: 166.8 minutes) and significantly shorter time when compared to conventional laparoscopy (189.6 vs. 220.4 minutes, $P<.05$). There were no significant differences in intra- or postoperative complications among the three groups. Nodal count was similar among the three groups.[21]

Another study comparing staging for endometrial cancer via laparotomy and robotics showed that the robotic procedure was longer (283 vs. 139 minutes, $P<.0001$), had less blood loss (66.6 mL vs. 197.6 mL, $P< .001$), and had shorter length of stay (40.3 vs. 127 hours, $P<.0001$) with comparable node yields (17.5 vs. 13.1, $P=0.11$).[22]

Applications in reproductive endocrinology

Robotic tubal anastomosis is the main procedure performed robotically in reproductive endocrinology.[23,24] A study comparing robotic to outpatient minilaparotomy tubal anastomoses showed longer operative times in the robotic group [mean: 229; range: 205–252 minutes] when compared to the minilaparotomy group [mean: 181; range: 154–202 minutes ($P=.001$)]. Hospitalization times, pregnancy, and ectopic pregnancy rates were not significantly different. Patients returned to work an average of 1 week earlier and a median of 2 weeks earlier after robotic surgery ($P=.013$) when compared to minilaparotomy.[25]

Where should you start?

To implement robotics in your practice, you should start by:

- Getting familiar with the da Vinci equipment and instrumentation and with operating the robot in the dry lab and on animals in a controlled environment. A mandatory training course is provided by Intuitive Surgical addressing this part of the robotic education. We recommend attending the course with your partner, assistant, perioperative nurse, and scrub nurse. Creating a robotic team is a must for rapid success.

- Attending robotic conferences and hands-on workshops.
- Having a proctor present in the operating room for the first several surgeries.
- Reading the current literature and technique on the procedure that you will be performing is very helpful.
- Patient and case selection is quite important. We recommend that you start with simple cases on nonobese patients with no history of previous surgeries before advancing to more complex procedures.
- Monitor your progress by keeping track of your docking time, console time, operative time, complication rates, and conversion rate. This will help you to compare your progress with the published data and your colleagues and will highlight your areas of mastery or those that need improvement. COG

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