Robotic-assisted laparoscopic surgery for hysterectomy and pelvic organ prolapse repair

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The robotic platform is a tool that has enabled many gynecologic surgeons to perform procedures by minimally invasive route that would have otherwise been performed by laparotomy. Before the widespread use of this technology, a larger percentage of hysterectomies and sacrocolpopexies were completed via the open route because of the lack of training in traditional laparoscopic suturing, knot tying, and retroperitoneal dissection. Additional deterrents of traditional laparoscopic surgery adoption have included the lengthy learning curve associated with development of advanced laparoscopic skills; and surgeon preference for the open route because of surgical ergonomics, decreased operative time, and more experience with laparotomy. Level I evidence regarding robotic-assisted laparoscopy in benign gynecology is sparse, with most of the data supporting robotic surgery comprised of retrospective cohorts. The literature demonstrates the safety and efficacy of robotic-assisted laparoscopy for hysterectomy and pelvic organ prolapse repair; however, most level I data show increased operative time and cost. The true indications for robotic-assisted laparoscopy in benign gynecology have yet to be discerned. A review of the best available evidence is summarized. (Fertil Steril® 2014;102:933–8. ©2014 by American Society for Reproductive Medicine.)

Key Words: Hysterectomy, laparoscopy, minimally invasive surgery, pelvic organ prolapse, robotic-assisted surgery, sacrocolpopexy

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The benefits of minimally invasive surgery for benign gynecologic conditions include a shorter hospital stay, faster recovery and return to baseline functioning, less intraoperative blood loss, and less postoperative pain (1–6). Adoption of minimally invasive surgery has greatly increased with implementation of the robotic platform since its 2005 FDA approval in gynecologic surgery. Robotic-assisted laparoscopic surgery has allowed more surgeries to be performed by a minimally invasive route because it is easier to learn than traditional laparoscopic surgery. Although, use of the robotic platform has been shown to be safe and feasible in procedures for benign hysterectomy and pelvic organ prolapse, good evidence is lacking to show its superiority or clear indications for its use (7). The objective of this review is to summarize the best available evidence regarding robotic-assisted laparoscopy for hysterectomy and pelvic organ prolapse repair and to enhance the reader's knowledge regarding these procedures.

ROBOTIC-ASSISTED LAPAROSCOPIC HYSTERECTOMY FOR BENIGN DISEASE

Background and History

The trend toward increased minimally invasive hysterectomy with widespread adoption of robotic-assisted laparoscopic hysterectomy (RLH) and an increase in traditional laparoscopic hysterectomy has been eloquently chronicled in a retrospective cohort study by Wright et al. (6). The investigators analyzed over 260,000 women who underwent hysterectomy for benign gynecologic disorders in 441 hospitals across the United States from 2007 to 2010 and demonstrated that the rate of laparoscopic and robotic hysterectomies increased

Received May 15, 2014; revised August 5, 2014; accepted August 7, 2014.

M.F.R.P. has received a research grant from Coloplast, Inc. (grant no. COLC1405MP), and research support from American Medical Systems, Boston Scientific Corporation, and A-Cell (grant no. CA2012-001).

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Fertility and Sterility® Vol. 102, No. 4, October 2014 0015-0282/$36.00

http://dx.doi.org/10.1016/j.fertnstert.2014.08.010

significantly, while the rates of vaginal hysterectomy stayed stable and abdominal hysterectomy declined. Robotically assisted hysterectomy increased from 0.5% to 9.5% of all hysterectomies from 2007 to 2010. During the same period, laparoscopic hysterectomy rates increased from 24.3% to 30.5%, and abdominal hysterectomy rates decreased from 53.6% to 40.1%. Vaginal hysterectomy rates declined minimally from 21.7% to 19.8%. The overall complication rates were similar for robotically assisted and laparoscopic hysterectomies.

Indications for Robotic-assisted Laparoscopic Hysterectomy

With regard to the specific indications for RLH, certain subgroups—obese women (8) and patients with large uteri (9) in retrospective cohorts—have been shown to potentially benefit from robotic-assistance compared with conventional laparoscopy. A retrospective cohort study by Nawfal et al. (8) examined the outcomes of 135 patients undergoing RLH. Of these women, 23.4% were of normal weight (body mass index [BMI] <25), 52.7% were obese (BMI >30), and 27.1% were morbidly obese (BMI ≥ 35). The investigators found no association with BMI of blood loss, duration of surgery, length of stay, or complication rates.

Similar findings have been reported with laparoscopic hysterectomy in obese women. Orady et al. (9) retrospectively reviewed outcomes of patients undergoing RLH for enlarged uteri. They found a correlation between increasing uterine size and procedure duration. However, an increase in procedure duration did not translate into an increase in length of stay or complications. A few investigations demonstrated improved outcomes in the subgroups listed herein, including reduced blood loss, decreased postoperative pain, and shorter hospital stay, that were associated with RLH compared with vaginal hysterectomy, laparoscopic-assisted vaginal hysterectomy, and total laparoscopic hysterectomy (9–12).

Another indication is surgeon preference because many surgeons who are not well trained in traditional laparoscopic hysterectomy or vaginal hysterectomy may prefer RLH. Additional research comparing standard laparoscopic and robotic-assisted laparoscopic surgery is needed to help characterize the advantages and disadvantages of robotic laparoscopic surgery and to determine concurrently which patient groups would benefit from robotics over other methods (7).

Outcomes and Cost

Robotic-assisted laparoscopy was developed to overcome the technical difficulties encountered with conventional laparoscopy, yet there are limited, well-designed data that investigate this premise. There have been a few retrospective cohorts that directly compare conventional laparoscopic with RLH. The largest published retrospective study compared 100 patients who underwent conventional laparoscopic hysterectomy before adoption of the robotic platform compared with 100 patients who underwent RLH (13). The mean operative time (skin to skin) was 27 minutes longer in the RLH group than for the conventional laparoscopic hysterectomy group ($P<.001$). However, the prerobotic cohort had longer operative times when compared with the last 25 surgeries in the robotic cohort (92.4 minutes vs. 78.7 minutes; $P=.03$). The conventional laparoscopic hysterectomy group had twice the mean blood loss, a 0.5-day longer hospital stay, and a twofold higher rate of conversions to laparotomy when compared with the robotic group. Nezhat et al. (14) compared 26 RLH procedures with 50 matched controls who underwent laparoscopic hysterectomies. Mean surgical time for RLH was 276 minutes compared with 206 minutes for traditional laparoscopic hysterectomy. Blood loss, length of stay, and postoperative complications were not statistically significantly different.

The first published prospective cohort included 40 women undergoing RLH with conventional laparoscopic hysterectomy and showed mean operating times of 109 minutes in the robot group versus 83 minutes in the conventional laparoscopic group ($P<.05$) (15). Despite a slightly increased hospital stay for conventional laparoscopic hysterectomy versus RLH (3.9 days vs. 3.3 days, respectively), the cost was statistically significantly less for the conventional laparoscopic hysterectomy group ($2,861 vs. $5,410).

The same investigators evaluated a randomized trial comparing RLH and conventional laparoscopic hysterectomy in 95 patients (16). In all cases, two surgeons expert in both routes performed the procedures. The study found longer operating times in the RLH group compared with the conventional laparoscopic hysterectomy group (106 vs. 75 minutes). Although there was a greater improvement in postoperative quality of life 6 weeks after RLH versus conventional laparoscopic hysterectomy, there was no difference in postoperative analgesic use or return to normal activities. A randomized trial comparing 53 patients undergoing RLH and conventional laparoscopic hysterectomy showed statistically significantly longer operative time (skin to skin) and surgical time (wheels in to wheels out) in the robot group (77 minutes longer and 72 minutes longer, respectively) (17). All cases were performed in part by an expert conventional laparoscopic staff surgeon who had performed at least 10 prior RLH procedures with a gynecologic fellow or resident in training.

Most investigations have demonstrated increased costs associated with RLH (16, 18, 19). Wright et al. (6) reported that the total cost associated with RLH was $2,189 more per case than for conventional laparoscopic hysterectomy. Most investigators have attributed the increased cost to the lengthier operative times and disposable equipment. Critical analyses of comparative trials often include surgical bias as a limitation of the investigations. It is common to have faster operative times for procedures in which surgeons are expert as compared to procedures that they are new to or learning. Moreover, it is reported that the learning curve affects operative times in robotic surgery, showing that times continue to improve and plateau after 40 to 50 cases (20). The second randomized trial previously mentioned (17) has been criticized for surgical bias because the investigators had only performed 10 RLH procedures before patient enrollment.