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# Robotic-Assisted Surgery for the Treatment of Breast and Cervical Cancers

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## ABSTRACT

**Background:** Robotic-assisted surgery facilitates the performance of numerous, complex procedures, namely conferring precision, flexibility, and control that is otherwise unavailable with conventional laparoscopy; and compared to open surgery, robotic-assisted surgery is ostensibly associated with fewer complications, reduced intraoperative complications, and shorter hospital stay duration. Nevertheless, the American College of Obstetricians and Gynecologists and the Food and Drug Administration have criticized the pervasive acceptance of robotic-assisted surgery, given the absence of randomized clinical trial data compared to traditional laparoscopy and open procedures, not to mention the increased surgical cost.

**Conclusions:** While the research data continue to be borne out, surgeons should exercise considerable discretion in selecting the surgical approach from which their patients would derive the greatest clinical benefit.

**Key Words:** Breast cancer, Cervix cancer, Gynecology, Outcomes, Robotic surgery.

## INTRODUCTION

In 1983, the first surgical robot was introduced, a device that ultimately incorporated the development of robotic arms to complement ophthalmologic procedures.[1] The Zeus® system was initially utilized in gynecologic surgery to reconnect fallopian tubes in 1997 and in 2000, the da Vinci Surgery System became the first robotic surgery system approved by the FDA;[2] throughout 2016, there were approximately 1.75 million robotic surgeries (e.g., urology, gynecology, cardiology) conducted in the United States.[3]

Robotic surgery enables the surgeon to achieve increased precision via intuitive instrument handling, tremor elimination, and motion scaling.[4] The advent of this technology was envisioned as a clinical upgrade over conventional laparoscopic surgery, which previously obviated the large incisions inherent in open surgeries. However, despite the prevalence of robotic-assisted surgery, the approach has been assailed because of the untenable assertion that patient clinical outcomes are further enhanced.

## ROBOTIC SURGERY IN GYNECOLOGY

Aarts et al. evaluated the safety and efficacy data from randomized clinical trials involving abdominal hysterectomy, vaginal hysterectomy, laparoscopic hysterectomy, and robotic-assisted hysterectomy for the treatment of benign gynecologic conditions.[5] The study results indicated that vaginal hysterectomy was superior to laparoscopic hysterectomy and abdominal hysterectomy regarding the resumption of activities of daily living, but there was no increased benefit from robotic hysterectomy compared to a laparoscopic hysterectomy. Ultimately, there was no evidence of an overall difference amongst the surgery groups.

In 2015, the American College of Obstetricians and Gynecologists (ACOG) published a committee opinion that impugned the pervasive acceptance of robotic surgery in gynecology, and advocated for randomized clinical trials to validate the procedure's attendant benefits and risks, vis-à-vis traditional laparoscopic and open surgical approaches.[6] The ACOG further criticized the high cost of a robotic hysterectomy, which incorporates greater than $10.7 million per robot, $125,000 in annual maintenance costs, and up to $2,000 per surgery for the single-use instruments.[7]

## ROBOTIC SURGERY FOR CERVIX CANCER

Mendivil et al. retrospectively compared the outcomes for early-stage cervical cancer patients who underwent

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open or minimally invasive (robotic-assisted or laparoscopic) surgery.[8] They reported improved operative morbidity (e.g., estimated blood loss) and reduced hospital stay duration in association with the endoscopic procedures, compared to the subjects treated with an open procedure. Nevertheless, recent early-stage cervical cancer investigations have implicated the use of minimally invasive radical hysterectomy with an increased risk for patient disease recurrence and reduced mortality.[9,10]

Ramirez et al. studied the outcomes of a laparoscopic or robot-assisted radical hysterectomy compared to an open radical hysterectomy for the treatment of early-stage cervical cancer.[10] At 4.5 years, the disease-free survival rate was 86% for the minimally invasive surgery patients and 96.5% for the open surgery group. The minimally invasive surgery patients also exhibited a lower 3-year overall survival (93.8%) compared to the open surgery group (99%). Similarly, Melamed et al. compared the survival rates associated with early-stage cervical cancer patients who underwent minimally invasive surgery vs. laparotomy.[9] They reported a 4-year mortality rate of 9.1% for the subjects who underwent minimally invasive surgery and a 5.3% mortality rate for the patients treated with open surgery. Alternatively, Nam et al. reported similar 3-year disease-free survival rates between early-stage cervical cancer patients with small volume disease who were treated with either a minimally invasive radical hysterectomy or a radical abdominal hysterectomy.[11] Also, in a meta-analysis, Wang et al. recounted an equivalent 5-year disease-free or overall survival in their early-stage cervical cancer patients who underwent a minimally invasive radical hysterectomy or a radical abdominal hysterectomy.[12] Hence, clinicians should be circumspect given the limitations inherent in noninferiority studies[10] and ultimately use their discretion when electing a specific surgical procedure to manage early-stage cervical cancer.

In cancer surgery, obtaining negative postoperative margins is imperative to attenuate disease recurrence rates.[13] While decreased survival was observed with the cervical cancer patients who underwent minimally invasive surgery, this effect was not reported in endometrial and ovarian cancer.[14,15] Perhaps, the decreased survival associated with endoscopic surgery is exclusive to cervical cancer.[9] In the Melamed et al. study, there were no significant group differences regarding positive margins, but nevertheless, margin extent following laparoscopic surgery may have adversely impacted survival outcomes.[16]

## ROBOTIC SURGERY FOR BREAST CANCER

An endoscopic nipple-sparing mastectomy was initially utilized to preserve cosmesis and successfully achieve negative surgical margin status in the treatment of breast cancer.[17] Thereafter, robotic-assisted surgery has garnered significant acclaim, primarily based upon the improved resolution, enhanced magnification, and visualization over traditional laparoscopy;[18] additionally, the results from case series elucidating the safety, technical feasibility, and initial oncologic outcomes have been encouraging.[19] However, few breast cancer studies have compared the efficacy and safety outcomes of robot-assisted surgery to traditional endoscopy or an open procedure.[20] Accordingly, in 2019, the U.S. Food and Drug Administration (FDA) issued a warning against the use of robotic surgery for the treatment of breast and cervical cancers.[21]

The FDA, coinciding with the ACOG committee opinion, disputed the putative safety and efficacy associated with robotic-assisted mastectomy; in particular, the FDA was concerned with the absence of randomized clinical trial data, and expressed their concern with the persistent use of a robotic-assisted mastectomy for the prevention and treatment of breast cancer.[19] The FDA further remarked that until substantive clinical trials have evaluated the safety and relevant cancer-related surrogate markers (e.g., overall survival, disease recurrence, and disease-free survival) in comparison to traditional surgical endeavors, the formal indications and authorization for robotic surgery should not be approved.

## CONCLUSIONS

Robotic surgery overcomes limitations inherent to traditional laparoscopic surgery, namely, enhanced mobility, increased visibility, and facilitated haptic precision.[22] The adoption of robotic surgery is steadily increasing and in 2017, more than 600,000 procedures were conducted in the U.S.[23] Nevertheless, the FDA's safety concerns with robotic surgery and the rising cost of this procedure, which is 25% higher compared to laparoscopic surgery,[24] should be a significant consideration prior to universally accepting this endoscopic approach.

While the reported oncologic efficacy and safety evidence associated with robotic surgery remain scant,[25] we may ultimately ascertain that robotic surgery is neither safer nor more efficacious than traditional laparoscopy surgery and open surgery.[9,10] Consequently, the FDA and the Centers for Medicare & Medicaid Services should remain vigilant regarding the ongoing presence of robotic

surgery and ensure that until the clinical results are borne out (i.e., there is a distinct, incontrovertible clinical benefit derived from robotic surgery), this approach should not be readily integrated into the various surgical disciplines and needlessly considered standard of care practice.[26]

## References


1. Mohammad S. Robotic surgery. *J Oral Biol Craniofac Res*. 2013;3(1):2.

2. Lauterbach R, Matanes E, Lowenstein L. Review of robotic surgery in gynecology—the future is here. *Rambam Maimonides Med J*. 2017;8(2):e0019.

3. Alemzadeh H, Raman J, Leveson N, Kalbarczyk Z, Iyer RK. Adverse events in robotic surgery: a retrospective study of 14 years of FDA data. *PLoS One*. 2016;11(4):e0151470.

4. Randell R, Alvarado N, Honey S, et al. Impact of robotic surgery on decision making: perspectives of surgical teams. *AMIA Annu Symp Proc*. 2015;1057–1066.

5. Aarts JMW, Nieboer TE, Johnson N, Tavender E, Garry R, Willem B. Surgical approach to hysterectomy for benign gynaecological disease. *Cochrane Database Syst Rev*. 2015; 2015;2015 (8):CD003677.

6. Committee opinion no. 628: robotic surgery in gynecology. *Obstet Gynecol*. 2015;125(3):760–767.

7. Bouquet de Joliniere J, Librino A, Dubuisson JB, et al. Robotic surgery in gynecology. *Front Surg*. 2016;3:26.

8. Mendivil AA, Rettenmaier MA, Abaid LN, et al. Survival rate comparisons amongst cervical cancer patients treated with an open, robotic-assisted or laparoscopic radical hysterectomy: a five year experience. *Surg Oncol*. 2016;25(1):66–71.

9. Melamed A, Margul DJ, Chen L, et al. Survival after minimally invasive radical hysterectomy for early-stage cervical cancer. *N Engl J Med*. 2018;379(20):1905–1914.

10. Ramirez PT, Frumovitz M, Pareja R, et al. Minimally invasive versus abdominal radical hysterectomy for cervical cancer. *N Engl J Med*. 2018;379(20):1895–1904.

11. Nam JH, Kim JH, Kim DY, et al. Comparative study of laparoscopico-vaginal radical hysterectomy and abdominal radical hysterectomy in patients with early cervical cancer. *Gynecol Oncol*. 2004;92(1):277–283.

12. Wang YZ, Deng L, Xu HC, Zhang Y, Liang ZQ. Laparoscopy versus laparotomy for the management of early- stage cervical cancer. *BMC Cancer*. 2015;15(1):

13. Wood WC. Close/positive margins after breast-conserving therapy: additional resection or no resection? *Breast*. 2013;22-(Suppl 2):S115–S117.

14. Conrad LB, Ramirez PT, Burke W, et al. Role of minimally invasive surgery in gynecologic oncology: an updated survey of members of the Society of Gynecologic Oncology. *Int J Gynecol Cancer*. 2015;25(6):1121–1127.

15. Bregar AJ, Melamed A, Diver E, et al. Minimally invasive staging surgery in women with early-stage endometrial cancer: analysis of the National Cancer Database. *Ann Surg Oncol*. 2017;24(6):1677–1687.

16. Melamed A, Keating NL, Clemmer JT, et al. Laparoscopic staging for apparent stage I epithelial ovarian cancer. *Am J Obstet Gynecol*. 2017;216(1):50.e1-50–50.e12.

17. Leff DR, Vashisht R, Yongue G, et al. Endoscopic breast surgery: where are we now and what might the future hold for video-assisted breast surgery? *Breast Cancer Res Treat*. 2011;125(3):607–625.

18. Park HS, Lee J, Lee DW, et al. Robot-assisted nipple-sparing mastectomy with immediate breast reconstruction: an initial experience. *Sci Rep*. 2019;9(1):15669.

19. Lai H-W, Toesca A, Sarfati B, et al. Consensus statement on robotic mastectomy-expert panel from International Endoscopic and Robotic Breast Surgery Symposium (IERBS) 2019. *Ann Surg*. 2020;271(6):1005–1012.

20. Hwang RF, Hunt KK. The emergence of robotic-assisted breast surgery: proceed with caution. *Ann Surg*. 2020;271-(6):1013–1015.

21. US Food and Drug Administration. Caution when using robotically-assisted surgical devices in women's health including mastectomy and other cancer-related surgeries: FDA safety communication [press release]. Available at: https://www.fda.gov/medical-devices/safety-communications/caution-when-using-robotically-assisted-surgical-devices-womens-health-including-mastectomy-and. Accessed April 25, 2019.

22. Coleman MG, Hanna GB, Kennedy R. National Training Programme LAPCO. The national training programme for laparoscopic colorectal surgery in England: a new training paradigm. *Colorectal Dis*. 2011;13:614–6.

23. Childers CP, Maggard-Gibbons M. Estimation of the acquisition and operating costs for robotic surgery. *JAMA*. 2018; 320(8):835–836.

24. Sheetz KH, Claflin J, Dimick JB. Trends in the adoption of robotic surgery for common surgical procedures. *JAMA Netw Open*. 2020;3(1):e1918911.

25. Dhanani NH, Olavarria OA, Bernardi K, et al. The evidence behind robot-assisted abdominopelvic surgery: a systematic review. *Ann Intern Med*. 2021;174(8):1110–1117.

26. Daniel GW, Rubens EK, McClellan M. Coverage with evidence development for Medicare beneficiaries: challenges and next steps. *JAMA Intern Med*. 2013;173(14): 1281–1282.