GYNECOLOGY

Impact of robotic technology on hysterectomy route and associated implications for resident education

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OBJECTIVE: We sought to compare the proportion of benign hysterectomies performed vaginally and the mean number of hysterectomies with resident involvement by route before and after robot implementation.

STUDY DESIGN: This multicenter, retrospective cohort study using nonsynchronous controls was conducted through the Society of Gynecologic Surgeons Fellows' Pelvic Research Network. The route of hysterectomy for benign disease was compared for 1-year periods before (prerobot) and after (postrobot) robotic introduction at 4 academic institutions. We reviewed medical records and recorded patient demographics, hysterectomy approach, preoperative and postoperative diagnosis, and resident involvement.

RESULTS: In all, 1440 hysterectomies were included: 732 in the prerobot group and 708 in the postrobot group. Median age was 46 years and mean body mass index was 29.5 (standard deviation, 6.9). The proportion of hysterectomies performed via the vaginal route decreased from 42.5% prerobot to 30.5% postrobot ($P < .0001$) and via the abdominal route from 22.1% prerobot to 16.5% postrobot ($P = .001$). The proportion of hysterectomies performed laparoscopically increased from 1.6% prerobot to 11.9% postrobot ($P < .0001$). At a mean of 2.3 years after introduction of the robot into an institution, hysterectomies performed using robotic assistance accounted for 23.3% of hysterectomies for benign disease. Mean uterine weight was similar in the prerobot and postrobot groups. Resident involvement in all hysterectomies done via all routes other than robotic increased from 81.0% prerobot to 88.6% postrobot; however, residents were involved in only 58.9% of robotic hysterectomies.

CONCLUSION: The proportion of hysterectomies performed vaginally has significantly decreased since the adoption of robotic technology at institutions included in this study. The proportion of hysterectomies with resident involvement is lower with a robotic approach than any other route.

Key words: resident education, robotic hysterectomy

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Hysterectomy is one of the most common surgical procedures in the United States with approximately 600,000 procedures performed per year.[1] Hysterectomy can be performed using vaginal, abdominal, or laparoscopic approaches and with robotic assistance. Total vaginal hysterectomy (TVH) has been recommended by the American Congress of Obstetricians and Gynecologists (ACOG) as the route of choice because it is associated with better outcomes and fewer complications compared to other routes.[1] All graduating obstetrics and gynecology residents should be able to independently perform a TVH after completing residency.[2] However, a study in 2008 by Kenton et al[3] reported that only 79% of graduating residents believed they could independently perform a TVH. Since that publication, the median number of TVH performed during training has decreased from 29 in 2008 to 18 in 2011.[4] Although the number of TVH needed to reach competency is unclear, Jelovsek et al[5] reported that at least 21 are needed to achieve minimum competency.

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Robotic-assisted surgery was approved by the Food and Drug Administration in 2005 and the number of robotic-assisted hysterectomies has steadily increased.[6] Since volume and experience impact a surgeon's preferred hysterectomy route, it is important to understand the effect of robotic-assisted hysterectomy on resident education.[1] Our primary objective was to compare the proportion of benign hysterectomies performed vaginally before and after robot implementation. Our secondary objective was to compare the mean number of hysterectomies with resident involvement by route before and after robot implementation.

Materials and Methods

We performed a multicenter, retrospective cohort study using nonsynchronous controls through the Society of Gynecologic Surgeons Fellows' Pelvic Research Network. Any hospital system performing robotic-assisted hysterectomy with a residency program and a fellow in the Fellows' Pelvic Research Network was eligible to participate. Four institutions representing the Northeast, South, Midwest, and West regions of the United States participated; institutional review board approval was obtained at each institution. Hysterectomy procedures were collected from Jan. 1 through Dec. 31, 2007, or from the year prior to robot implementation. One site collected from 2005. The other 3 collected from 2007 (prerobot) and from Jan. 1, through Dec. 31, 2011 (postrobot). We chose to collect postrobot procedures from 2011 because all participating institutions acquired the robot at least 1 year prior to Jan. 1, 2011. Therefore, all institutions had at least 1 full year of robotic experience prior to the point of our data collection. Hysterectomies were identified based on *Current Procedural Terminology* or *International Classification of Diseases, Ninth Revision* coding depending on the system used at each participating institution. Only hysterectomies coded for benign indications were eligible for inclusion. We decided to exclude gynecologic oncology cases because the majority of resident training in benign TVH likely does not come from gynecologic oncologists. Hysterectomies performed for emergent indications including cesarean hysterectomy were also excluded as these would not be performed robotically.

We obtained a list of all hysterectomies performed at each institution, removed cases based on our exclusion criteria, and stratified the remaining cases by month within the prerobot and postrobot time periods. We selected a stratified over a simple random sampling scheme to account for seasonal variation in case characteristics, even though case volume and the distribution of procedure types were expected to vary little by month. Thus, random selection of a fixed number of cases per month was expected to obtain a representative annual case distribution for these years. We used the uniform random number function in Excel (Microsoft, Redmond, WA) or the random sampling procedure in SPSS (IBM Corp, Armonk, NY) to randomly select a maximum of 20 cases per month at each institution. If an institution had <20 cases in a given month, then all cases were reported from that month. We chose to limit data abstraction to 20 cases a month to minimize the burden of data acquisition and improve the feasibility of this study. Statistical power estimation was based on an expected 1000-1500 eligible cases per time period. Assuming a 5% decline in the frequency of TVH procedures from 22% in the prerobot period to 17% in the postrobot period, a total of 2000-3000 cases would provide power of 79-93% to detect this difference at the 5% significance level. This power calculation was performed prior to knowing which institutions would chose to participate in this study.

Charts were reviewed and demographic and clinical variables were recorded including factors that may influence the decision for hysterectomy route such as parity, medical comorbidities, prior abdominal or pelvic surgery, insurance type, and indication for surgery. We also recorded hysterectomy approach, pathology-reported uterine weight, concurrent procedures, and resident involvement. Resident involvement was dichotomized as present or absent based on resident inclusion in the operative report.

Hysterectomies were categorized as TVH, total abdominal hysterectomy (TAH), abdominal supracervical hysterectomy, laparoscopic-assisted vaginal hysterectomy (LAVH), total laparoscopic hysterectomy (TLH), laparoscopic supracervical hysterectomy, total robotic-assisted hysterectomy, and supracervical robotic hysterectomy. We defined TVH as any hysterectomy performed completely via a vaginal approach from incision though clamping and suturing of the uteroovarian ligaments. LAVH was defined as any hysterectomy performed from combined laparoscopic and vaginal approaches regardless of how much of the procedure was done by either route. The exception to this was that any hysterectomy performed laparoscopically with only vaginal cuff closure performed vaginally was considered TLH.

Data analysis was performed with SAS 9.3 (SAS Institute, Cary, NC). Categorical variables were compared using χ^2 or Fisher exact test, continuous parametric variables using *t* test, or analysis of variance and nonparametric data using Wilcoxon rank sum or Kruskal-Wallis test. The assumption of normality for continuous variables was examined by histograms. We adjusted for study site as a fixed effect, as opposed to a random effect, using Mantel-Haenszel test for categorical variables, analysis of variance for normally distributed continuous variables, and the van Elteren test for variables that deviated from normality. Two-tailed *P* values were presented with $P < .05$ considered statistically significant. A sensitivity analysis was performed to assess the impact of differences between our planned sample and the final sample of cases on the representativeness of procedure type distribution in each time period.

Results

In all, 2184 hysterectomies that met inclusion criteria were performed at the 4 sites during the prerobot time period, ranging from 128—977 per year by site,