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CLINICAL ARTICLE

Multicenter analysis comparing robotic, open, laparoscopic, and vaginal hysterectomies performed by high-volume surgeons for benign indications

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ABSTRACT

Objective: To compare perioperative outcomes between robotic-assisted benign hysterectomies and abdominal, vaginal, and laparoscopic hysterectomies when performed by high-volume surgeons. *Methods:* A multicenter data analysis compared 30-day outcomes from consecutive robotic-assisted hysterectomies performed by high-volume surgeons (≥60 prior procedures) at nine centers with records retrieved from the Premier Perspective database for abdominal, vaginal, and laparoscopic hysterectomies performed by high-volume gynecologic surgeons. Data on benign hysterectomy disorders from January 1, 2012 to September 30, 2013 were included. *Results:* Data from 2300 robotic-assisted, 9745 abdominal, 8121 vaginal, and 11 952 laparoscopic hysterectomies were included. The robotic-assisted patient cohort had a significantly higher rate of adhesive disease compared with the vaginal ($P < 0.001$) and laparoscopic cohorts ($P < 0.001$), a significantly higher rate of morbid obesity than the vaginal ($P < 0.001$) or laparoscopic cohorts ($P < 0.001$), and a significantly higher rate of large uteri (>250 g) than the abdominal ($P < 0.001$), vaginal ($P < 0.001$), or laparoscopic cohorts ($P = 0.017$). The robotic-assisted cohort experienced significantly fewer intraoperative complications than the abdominal ($P < 0.001$) and vaginal cohorts ($P < 0.001$), and experienced significantly fewer postoperative complications compared with all the comparator cohorts ($P < 0.001$). *Conclusion:* When performed by gynecologic surgeons with relevant high-volume experience, robotic-assisted benign hysterectomy provided improved outcomes compared with abdominal, vaginal, and laparoscopic hysterectomy.

1. Introduction

Comparisons of robotic-assisted hysterectomy with laparoscopic, abdominal, and vaginal hysterectomy are many [1–3]. Between 2005 and 2013, the percentage of all hysterectomies with benign indications that were performed as abdominal hysterectomies declined from 59% to 22%, as reported in the Premier Perspective database (Premier Inc., Charlotte, NC, USA) (Fig. 1). Surgeons and patients have increasingly favored robotic-assisted and laparoscopic approaches over open approaches owing to the lower perioperative morbidity and shorter recovery that are associated with these surgeries [4–6]. The da Vinci Surgical System (Intuitive Surgical Inc., Sunnyvale, CA, USA) received US Food and Drug Administration clearance in 2005 for use in gynecologic robotic-assisted surgical procedures [7].

Comparative reports can provide insight and opposing views regarding perioperative outcomes and complications among procedures performed by diverse groups of surgeons. Small trials comparing robotic-assisted with laparoscopic and vaginal approaches have demonstrated some bias in favor of non-robotic methods; surgeons in these trials were highly experienced in laparoscopic and vaginal approaches but had limited experience performing robotic hysterectomies [8–10]. To date, comparative reports evaluating outcomes from robotic-assisted benign hysterectomy procedures performed by experienced surgeons are lacking. The aim of the present study was to addresses this gap by evaluating perioperative outcomes from robotic-assisted hysterectomy for benign disease performed by multiple gynecologic surgeons with

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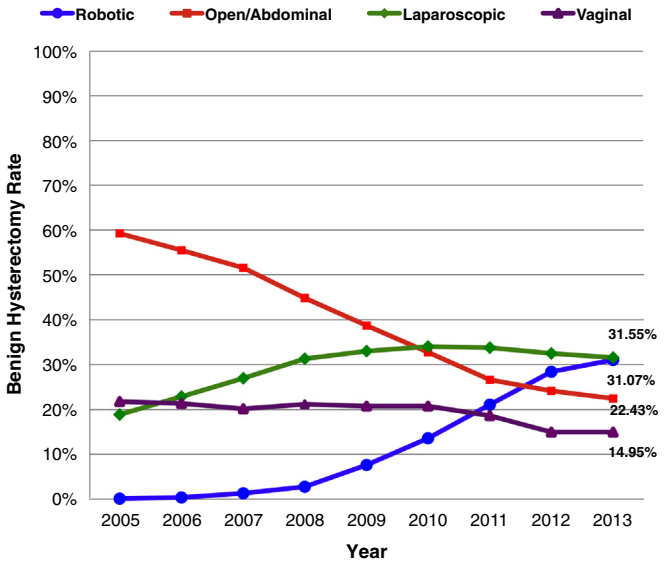

Fig. 1. Trends in the proportion of hysterectomy procedures for benign indications reported in the Premier Perspective database that were performed using robotic-assisted, abdominal, laparoscopic, and vaginal approaches.

high-volume experience in robotic-assisted surgery, and to compare these results to outcomes from vaginal, laparoscopic, and abdominal hysterectomies for benign indications when performed by surgeons experienced (≥60 surgeries) in these surgical approaches.

The purpose of the study was to contribute to the presently limited literature of perioperative outcomes [11–13] from robotic-assisted benign hysterectomy procedures, and to evaluate those outcomes over the same period with outcomes from laparoscopic, abdominal, and vaginal hysterectomies that had also been performed by high-volume gynecologic surgeons.

2. Materials and methods

The present retrospective cohort study evaluated baseline, intraoperative, and 30-day postoperative outcomes from multiport robotic-assisted, abdominal, laparoscopic, and vaginal hysterectomies performed for benign indications. All hysterectomies performed for benign indications between January 1, 2010 and September 30, 2013 were included and the only exclusion criterion was the presence of malignancy. The institutional review board of each study institution granted approval or exemption for the study protocol and the need for informed consent from patients was waived.

Data from robotic-assisted benign hysterectomies performed by high-volume gynecologic surgeons who had completed at least 60 robotic-assisted benign hysterectomies prior to the study were included. Experience of 60 surgeries was selected based on the reported 50–91 surgeries required to reach surgical proficiency in robotic-assisted techniques [14,15]. The robotic-assisted surgeries were performed at nine medical centers in the USA by a diverse group of seven physicians with pelvic pain, oncology, urogynecology, and infertility sub-specialties. Retrospective data were collected from the medical records of all eligible patients at the surgeons' institutions and were recorded by each institution's research coordinator in a validated electronic database.

Data on abdominal, laparoscopic, and vaginal hysterectomies were obtained from the Premier Perspective database and included all eligible patients with benign indications who underwent surgery during the study period. The annual surgical case volume of benign hysterectomy procedures performed between 2008 and 2012 was used to determine high-volume experience for each surgeon who contributed to the database. To be included in the analysis, surgeons had to have performed at least 60 surgeries in the respective approach prior to the study period.

Data from the high-volume hysterectomy cohorts in the Premier database were available from hospitals throughout the USA. Patients were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes and patients had to have 30-day follow-up data available to be included. Patient follow-up data included age, presence of comorbid conditions (specifically, body mass index [BMI calculated as weight in kilograms divided by the square of height in meters] ≥40, the presence of adhesive disease, or large uterus [>250 g]), indications for surgery, hysterectomy type and concomitant procedures, conversion to open surgery, presence of intraoperative and postoperative (≤30 days) complications, intraoperative and postoperative blood transfusions, inpatient or outpatient designation, inpatient length of hospital stay, and hospital readmission or reoperation related to the primary surgery through the 30-day postoperative follow-up period. Patients were considered to have adhesive disease if patient records included a diagnosis of adhesive disease and/or if pelvic and/or intra-abdominal adhesiolysis was performed at the time of the hysterectomy. Current procedural terminology codes distinguishing hysterectomies with uteri larger or smaller than 250 g were only available for vaginal and laparoscopic procedures.

Perioperative complications were determined by reviewing ICD-9-CM diagnosis codes for morbidity not present on admission and were classified as intraoperative or postoperative. Postoperative complications were further categorized as having been surgical (including bleeding, wound disruption, surgical-site infection, abscess, hematoma, seroma, fistula, postoperative prolapse of vaginal wall, incisional or port-site hernia, peripheral neuropathy), medical (including post-hemorrhagic anemia, fever, adverse medication effects, dehydration, hypokalemia, septicemia, shock, transfusion reactions), genitourinary (including urinary retention, urinary tract infection, acute renal failure, hydronephrosis, ureteric obstruction), gastrointestinal (including paralytic ileus, nausea/vomiting, bowel obstruction), respiratory (including pulmonary collapse, hypoxemia, pneumonia, pulmonary insufficiency, acute respiratory failure, pleural effusion), thromboembolic events, pain, cardiovascular (including cardiac arrhythmias, cardiac arrest, acute myocardial infarction), and central nervous system (including syncope and collapse, altered consciousness/mental status, convulsions, intracranial hemorrhage). Hemorrhage complications were defined as bleeding that complicated a procedure or that required a blood transfusion. Necessitated reoperations were determined from a review of ICD-9-CM procedure codes. Reoperation categories included repair of intraoperative injury, wound repair/reconstruction, genitourinary and gastrointestinal procedures, control of hemorrhage and vascular procedures, fistula repair, and non-specific general exploratory or diagnostic surgery.

Data analyses were performed using SAS version 9.2 (SAS Institute Inc., Cary, NC, USA). Standard univariate methods were used to express the mean, standard deviation, and 95% confidence intervals for continuous variables. Discrete variables were expressed as proportions and percentages and were compared using the χ^2 test. Continuous variables were compared using the Student t test. Tests for trends were performed using the Jonckheere–Terpstra test. In all instances, two-sided $P < 0.05$ was considered significant.

3. Results

Data were retrieved for 2300 eligible patients who underwent robotic-assisted hysterectomy for benign indications at the nine institutions during the study period. Patient data were obtained from 4 (44%) teaching and 5 (56%) non-teaching hospitals. Patient records were retrieved for 9745 abdominal, 8121 vaginal, and 11 9521 laparoscopic hysterectomies from the Premier Perspective database. The abdominal, vaginal, and laparoscopic procedures were performed at 405 hospitals, including 118 (29.1%) teaching and 287 (70.9%) non-teaching hospitals.

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