GYNECOLOGY

Laparoscopic and robot-assisted hysterectomy for uterine cancer: a comparison of costs and complications

Andrew Zakhari, MD; Nicholas Czuzoj-Shulman, BSc; Andrea R. Spence, PhD; Walter H. Gotlieb, MD, PhD; Haim A. Abenhaim, MD, MPH

OBJECTIVE: Increasingly, robotic surgery is being used for total hysterectomy, bilateral salpingo-oophorectomy, and lymph node dissection for uterine cancer. The purpose of this study was to compare the costs and complications among women undergoing robotic and laparoscopic hysterectomy for uterine cancer.

STUDY DESIGN: We carried out a cohort study using the Nationwide Inpatient Sample (NIS) database between 2008 and 2012 on all women diagnosed with uterine cancer, classifying women as either laparoscopically or robotically treated, excluding laparotomies or vaginal approaches. Logistic regression analyses were used to evaluate the adjusted effect of surgical approach on complication rates.

RESULTS: There were 10,347 women who underwent hysterectomies for uterine cancer either laparoscopically (39%) or robotically (61%). The rate of robotic surgery consistently increased over the 5 year period. Women undergoing robotic surgery had more comorbid conditions (diabetes, hypertension, cardiovascular disease, renal disease, obesity or morbid obesity, and pulmonary disease). In adjusted analyses, women undergoing robotic surgery were more likely to have a lymph node dissection (73.01% vs 66.04%; $P < .0001$) and an admission lasting <3 days (86.01% vs 82.5%; $P < .0001$) compared with those undergoing laparoscopic surgery. The composite endpoint of any complication was similar between both cohorts (20.56% robotic vs 21.00% laparoscopy). In overall and subset analyses, robotic surgery was more costly, with median charges of $38,161.00 compared with $31,476.00 in those undergoing laparoscopic surgery ($P < .0001$).

CONCLUSION: Despite the considerably greater burden of comorbidities in those undergoing robotic surgery compared with laparoscopy, the former have shorter hospital admissions, a greater rate of lymph node dissection, and similar postoperative morbidity and mortality, albeit at greater total cost.

Key words: cancer, laparoscopy, robotic surgery, uterine cancer

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Uterine cancer is the most common malignancy of the female genital tract and in the United States accounts for almost half of all gynecological cancers.[1] It is estimated that more than 50,000 new cases will be diagnosed in 2014.[2] Approximately 90% of uterine cancers arise from the endometrium, whereas the remainder originate from the smooth muscle and connective tissue of the uterus.[3]

The procedure of choice for a newly diagnosed uterine cancer involves a total hysterectomy, bilateral salpingo-oophorectomy, and pelvic and para-aortic lymph node dissection, in accordance with the International Federation of Gynecology and Obstetrics staging system.[4,5] In 2009, the Laparoscopic Surgery or Standard Surgery in Treating Patients With Endometrial Cancer or Cancer of the Uterus (LAP2) study, a prospective, multiinstitutional randomized trial, successfully demonstrated that "comprehensive surgical staging of endometrial cancer can be performed using laparoscopy without increased intraoperative injuries, with fewer postoperative complications, and with shorter hospital stay" as compared with laparotomy.[6]

A follow-up analysis published in 2012 revealed no significant difference

From the Department of Obstetrics and Gynecology (Drs Zakhari, Gotlieb, and Abenhaim), Center for Clinical Epidemiology and Community Studies (Mr Czuzoj-Shulman and Drs Spence, Gotlieb, and Abenhaim), and Division of Gynecologic Oncology, Segal Cancer Center (Dr Gotlieb), Jewish General Hospital, McGill University, Montreal, QC, Canada.

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Corresponding author: Haim A. Abenhaim, MD, MPH, FRCSC. haim.abenhaim@gmail.com

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in long-term survival.[7] Because similar studies also proved the benefits of minimally invasive surgery, laparoscopy became the gold standard for surgical staging of uterine cancer.[8] Despite this, laparoscopy has not gained wide implementation, mainly due to the difficulty in physicians gaining the competence required to perform minimally invasive complex surgeries as a result of the restricted range of motion of the instruments and the counterintuitive movements (fulcrum effect).[9]

Robotic surgery confers multiple potential safety advantages over laparoscopy by virtue of the intuitive control, a wide range of motion and rotation, depth perception, and an ergonomic console, which all lead to an accelerated learning curve.[10-14] Despite these appealing features and the allure of a sophisticated device, there remains a paucity of data comparing the benefits and limitations of this relatively new surgical modality on a large scale. In this study, we seek to compare the costs and complications in addition to the baseline patient characteristics of women undergoing minimally invasive surgery either by robotics or laparoscopy for uterine cancer using a large population database.

Materials and Methods

The Nationwide Inpatient Sample (NIS) is the largest inpatient health care database in the United States. It is sponsored by the Agency for Healthcare Research and Quality and is an integral part of the Healthcare Cost and Utilization Project.[15] National estimates and trends garnered from the NIS aid epidemiologists and policymakers to understand health care and burden of disease in the United States. As of 2011, the NIS samples hospitals across 46 states, which represent more than 8 million discharges (approximately 20% of all hospital admissions in the United States). Information is collected on demographics, medical conditions, procedures, length of stay, and cost.

We carried out a retrospective cohort study comparing patients with a diagnosis of uterine cancer who underwent surgical treatment either laparoscopically or robotically. Patients with a diagnosis of uterine cancer between 2008 and 2012 inclusively were identified using the *International Classification of Diseases*, ninth revision (ICD-9), diagnostic code 182. Only those who underwent hysterectomy were included, either robotically (ICD-9 code 17.4x) or laparoscopically (ICD-9 codes 54.21, 68.41, 68.61, 68.71). Among those who had a vaginal hysterectomy, only those with laparoscopic assistance were included and were categorized under laparoscopy (ICD-9 code 68.51).

Patient characteristics of interest were age (younger than 40, 40−49, 50−59, 60−69, 70−79, and 80 years old or older), weight (obesity or morbid obesity identified with ICD-9 codes 278.00 and 278.01, respectively), comorbidities (including hypertension, cardiovascular disease, pulmonary disease, or renal disease), income (divided in quartiles), insurance status (Medicare, Medicaid, private, or no insurance), and race (white, Hispanic, African-American, or other). Cardiovascular disease was identified using ICD-9 codes for ischemic, hypertensive heart disease, chronic rheumatic heart disease, cerebrovascular disease, and other disorders of blood vessels or lymphatics.

The outcomes of this study were total in-hospital charges per admission and overall hospital-related perioperative morbidity. Secondary outcomes included lymph node dissection, conversion to open, length of stay in hospital, and in-hospital death. Perioperative morbidity was assessed as a composite endpoint incorporating intraoperative complications (inadvertent laceration of other organs or structures ICD-9 code 998.2) or postoperative complications: fever, sepsis, transfusions, myocardial infarct, venous thromboembolism, acute kidney injury, urinary retention, respiratory failure, pneumonia, ileus, *Clostridium difficile* colitis, wound infection, seroma, or hematoma. Conversion to laparotomy was identified using the ICD-9 code V64.41.

The data obtained were descriptively analyzed, contrasting the baseline patient characteristics by surgical group. Comparative analyses were carried out using logistic regression, adjusting for differences in patient characteristics. Age was divided into 6 categories as previously described and each comorbidity (hypertension, cardiovascular disease, pulmonary disease, renal disease, diabetes, and obesity/morbid obesity) in addition to patient race was adjusted for individually to obtain our results.

The median in-hospital charge per admission was first calculated by surgical group (laparoscopy or robotic) and was then rerun based on the following variables: 3 or more days of admission, performance of lymph node dissection, obesity, morbid obesity, age 80 years or older, and conversion to open. Linear regression was used to calculate the adjusted incremental difference in charges per admission between a robotic and laparoscopic surgery. For statistical analysis, all calculations were performed using commercially available SAS software (version 6.1; SAS Enterprise Guide, Cary, NC). This study used exclusively publicly available data; hence, according to the Tri-Council Policy statement (2010), institutional review board approval was not required.

Results

A total of 36,744 women between 2008 and 2012 in the NIS database were diagnosed with uterine cancer. Of these, 27,878 were treated surgically. Patients undergoing vaginal or abdominal hysterectomy numbered 17,531 and were excluded. The remaining 10,347 women underwent hysterectomy for uterine cancer either laparoscopically (n = 4034; 39%) or robotically (n = 6313; 61%). Robotic cases began being recorded as of September 2008. Figure 1 shows the patient flow. Over the 5 year period among all minimally invasive surgical approaches, an impressive decline in open (from 73.0% to 43.7%) and less in laparoscopic surgery (12.4% to 9.8%) was observed with a corresponding increase in robotic cases (12.6% to 44.2%). Figure 2 illustrates this trend in approach over the study period.

Table 1 compares the baseline characteristics of women who underwent either laparoscopic or robotic-assisted hysterectomy for uterine cancer. Both