

The Outcomes and Cost of Hysterectomy: Comparing Abdominal, Vaginal, Laparoscopic, and Robotic Approaches

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Abstract Options for approach to hysterectomy include abdominal, vaginal, laparoscopic or robot-assisted laparoscopic surgery. There are well-documented benefits to minimally invasive modes of surgery compared to traditional abdominal procedures. Despite this fact, the majority of hysterectomies in the United States are still performed via laparotomy. With regard to differentiation between the various minimally invasive approaches, it has been consistently demonstrated that robotic hysterectomy procedures are associated with longer operative times and higher cost. However, the available literature is limited by the small number of randomized or prospective studies comparing surgical approach to hysterectomy.

Keywords Hysterectomy · Cost · Outcomes

Introduction

As the most common non-obstetric procedure among women [1], hysterectomy is most frequently performed for the indications of leiomyomata, abnormal uterine bleeding, and endometriosis [2]. It is estimated that up to 45 % of women who reach the age of 70 will have undergone a hysterectomy during their lifetime [2]. Although surgical removal of the uterus was documented in medical writings dating back to the 1st century B.C., it was not until 1813 that Conrad Langenback performed the first planned, successful vaginal hysterectomy. This was followed by the first successful abdominal hysterectomy in 1853 by Walter Burnham [3]. The

20th century was marked by significant advances in anesthesia, antisepsis, and surgical technique [4]. Laparoscopy, which was initially developed in the 1940's, was applied to hysterectomy in the late 1980s by pioneers Harry Reich and Kurt Semm [5, 6]. Computer-assisted surgery also evolved during the 1990s, and in 2001 the first robotic hysterectomy was performed in Texas [7].

In addition to helping optimize individual patient care, research related to hysterectomy may be used to inform public health decisions. It is, therefore, important to critically compare outcomes related to the various surgical approaches to hysterectomy. In addition, issues of cost must be considered given concerns regarding rising healthcare spending. In this review, the authors will highlight recent, relevant literature regarding outcomes and costs associated with common surgical approaches to hysterectomy for benign disease.

Updated Surveillance Information

In order to draw meaningful conclusions about the impact of various routes of hysterectomy, it is useful to understand the current status of this procedure using surveillance statistics. With analysis of a national inpatient hospitalization database, it is estimated that 433,621 hysterectomy procedures were performed in the United States in 2010 [8•]. This represents a marked decline in hysterectomy volume over time. Case incidence peaked in 2002 when over 600,000 hysterectomies were performed annually in the United States. It is possible that this decline in hysterectomy volume is attributable to increasing use of medical therapies and non-extirpative procedures, or it may reflect a failure to capture outpatient minimally invasive hysterectomy cases using inpatient sampling tools [9].

In addition to the changes in numbers of hysterectomy cases, there is also a shift in the surgical approach with

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increasing use of laparoscopic and robotic techniques [8•, 10, 11]. In the United States in 2009, it is estimated that 56 % of hysterectomies were completed abdominally, 20.4 % were performed laparoscopically, 18.8 % vaginally, and 4.5 % with robotic assistance [9]. This trend toward fewer overall hysterectomies and a higher percentage of cases being completed in a minimally invasive fashion has implications for both patients and physicians. Resident case experience as reported to the Accreditation Council for Graduate Medical Education demonstrates a decreasing exposure to abdominal and vaginal hysterectomy during training, which may in turn affect future practice patterns [12].

Outcomes

A 2009 systematic review on the subject of surgical approach to hysterectomy for benign disease analyzed results from 34 randomized controlled trials [13]. Both vaginal and laparoscopic hysterectomies were found to have superior outcomes when compared to the abdominal approach to hysterectomy, including: faster recovery, shorter hospital stay, fewer infections, and lower blood loss. Of note, laparoscopic hysterectomy was associated with a longer operative time and increased risk of urinary tract injury in this review. It may be that the high risk of urinary tract injury reported in the Cochrane review is reflective of early experience with laparoscopic techniques. Updated information regarding risk of urinary tract injury at the time of hysterectomy from a longitudinal prospective cohort study in Finland demonstrates a marked decrease in risk of ureteral injury with laparoscopic hysterectomy in 2006 as compared to 1996 [14]. In addition, a multicenter case-control study of 135 cases of bladder or ureteral injury and 270 controls found that total abdominal hysterectomy was associated with both bladder and ureteral injury, while laparoscopic-assisted vaginal hysterectomy was associated with increased risk of ureteral injury [15].

Both the American Congress of Obstetricians and Gynecologists and the American Association of Gynecologic Laparoscopists recommend a vaginal or laparoscopic route whenever feasible [16, 17]. Regarding selection of the surgical approach in more challenging hysterectomy cases, a case control study of patients who underwent either robotic or abdominal hysterectomy for uteri weighing greater than 1,000 grams found decreased blood loss and a shorter hospital stay with the robotic approach, despite a longer operative time [18].

Due to the clear benefits of a non-laparotomic approach to hysterectomy, there is increasing emphasis on differentiation among the various minimally invasive modes. Recent literature comparing vaginal to laparoscopic or robot-assisted hysterectomy includes a randomized trial of 108 women undergoing hysterectomy for myomatous uteri. This study

compared total laparoscopic hysterectomy, laparoscopic-assisted vaginal hysterectomy and vaginal hysterectomy; the vaginal approach was associated with faster operative time, less blood loss, and a shorter hospital stay [19]. Looking specifically at women over the age of 65 who underwent vaginal or laparoscopic hysterectomy, a propensity-matched analysis of 80 patients demonstrated non-inferiority of laparoscopic hysterectomy with improved postoperative course [20]. Further, a prospective study of 60 women who underwent robot-assisted hysterectomy and 34 women who underwent vaginal hysterectomy found reduced blood loss, less pain, and a shorter hospital stay in the robotic group, despite longer operative time in that group [21].

With regard to the comparison of the laparoscopic and the robot-assisted approach to hysterectomy, two randomized trials respectively comprised of 53 and 100 patients demonstrated similar outcomes but longer operative time in the robotic groups [22, 23•]. Even with a randomized trial design; however, it is difficult to escape the issues of innate surgeon experience and preference, which may lead to contradictory findings in certain cases. For example, a large retrospective review of robotic and laparoscopic hysterectomy cases found equivalent perioperative outcomes including operative time despite patients in the robotic group having higher mean uterine weight and higher prevalence of severe adhesions and stage III-IV endometriosis [24]. Another retrospective cohort study of over 2,500 patients found a lower risk of readmission among robotic-assisted hysterectomy cases along with a shorter length of stay and less blood loss as compared to laparoscopic, open or vaginal approaches [25]. Using a nationwide United States database for the years 2009 and 2010, a propensity-matched analysis demonstrated similar perioperative outcomes between laparoscopic and robotic hysterectomy; robotic-assistance was associated with a lower incidence of blood transfusion but a higher likelihood of postoperative pneumonia [26••].

Cost

In addition to perioperative outcomes, another important consideration in the current health care climate is that of cost-effectiveness. Healthcare costs are notoriously difficult to define as the true cost of a procedure may encompass more than what is reflected by the hospital charges. For example, when discussing total cost, it is important to include assessment of any related complications, readmissions or associated treatments. Similarly, one may choose to report the cost to society with accounting for lost wages and surgery-associated disability. Despite these challenges, it is critical to consider the economic impact of hysterectomy in light of cost-constrained healthcare systems.

In an attempt to better define the cost of robotic hysterectomy compared to vaginal or abdominal modes, researchers at the Mayo Clinic performed a propensity score matched analysis to estimate hysterectomy-related all-cause costs [27]. They report that robotic hysterectomy is more costly than vaginal hysterectomy, but similar in cost to abdominal hysterectomy. With the aid of a hospital decision support database, a group of Irish researchers calculated the net hospital income with varying types of minimally invasive hysterectomy and found that vaginal hysterectomy was the only mode that generated net income [28]. A retrospective cost analysis of hysterectomy performed for uteri weighing more than 500 grams at a Korean academic hospital also demonstrated lower total hospital cost with vaginal hysterectomy compared to laparoscopic hysterectomy despite longer hospital stays in the vaginal group [29].

Although introduction of robot-assisted laparoscopic surgery may enable physicians to perform hysterectomy without laparotomy, it is associated with substantially higher cost. A cohort study using national data from 2007–2010 estimated over \$2,000 in added cost per case when robot-assistance is employed compared to conventional laparoscopic hysterectomy [10]. These findings were echoed in an analysis of a separate national inpatient database from 2009 and 2010; despite similar perioperative outcomes compared to laparoscopic hysterectomies, robotic cases were associated with an average excess hospital cost of \$2,489 [26]. Similarly, a cost analysis utilizing Finnish data found that the cost of robot-assisted hysterectomy is 1.5–3 times higher than that of other techniques [30]. The incremental cost of robot-assisted hysterectomy is related to increased cost of surgical equipment, maintenance, and longer operative time [31]. Of note, the excess cost attributable to robotics appears to have an inverse relationship with both surgeon and hospital volume of robotic surgery. Though the cost of robotics remained higher than laparoscopy in all scenarios modeled using national database information for laparoscopic or robot-assisted hysterectomy between 2006 and 2012, increasing hospital and surgeon procedure volume was found to decrease the cost differential [32].

Conclusion

Given the improved perioperative outcomes with minimally invasive approaches, abdominal hysterectomy should be reserved for patient scenarios where vaginal, laparoscopic or robotic surgery is not feasible. When deciding between the various minimally invasive approaches, one must take into account variation in cost by approach; vaginal hysterectomy is consistently less expensive than other modes. A limitation of the available literature is the small number of randomized or prospective studies comparing surgical approach to

hysterectomy. Additionally, surgeon-specific and patient-specific issues cannot be overlooked when evaluating such complex decisions.

Compliance with Ethics Guidelines

Conflict of Interest Dr. Sarah L. Cohen and Dr. Jon I. Einarsson each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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