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Robot-assisted versus open radical hysterectomy: A multi-institutional experience for early-stage cervical cancer☆

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Abstract

Objective: To compare perioperative and clinico-pathological outcomes of patients with early-stage cervical cancer who underwent robot-assisted radical hysterectomy (RRH) and open radical hysterectomy (ORH).

Methods: This retrospective multi-center study abstracted demographic, clinico-pathological and perioperative outcomes data from medical records of 491 cervical cancer patients treated with RRH (n = 259) ORH (n = 232) between 2005 and 2011 at two American and one Norwegian University Cancer Centres.

Results: Mean estimated blood loss (EBL) and transfusion rates were less for RRH than for ORH (97 vs. 49 mL, $p < 0.001$, and 3% vs. 7%, $p = 0.018$, respectively). Mean length of hospital stay (LOS) was significantly shorter in RRH versus ORH (1.8 vs. 5.1 days, $p < 0.001$). Mean operative time was longer for RRH than ORH (220 vs. 156 min, $p < 0.001$). Although overall complications were similar ($p = 0.49$), intra-operative complications were less common in the RRH group than ORH (4% vs. 10%, $p = 0.004$). In multivariate regression analyses longer operative time, less EBL and intra-operative complications, shorter LOS, and more pre-operative cone were significantly associated with RRH versus ORH. Recurrence and death rates were not statistically different for the two groups at a mean follow-up time of 39 months ($p = 1.00$ and $p = 0.48$, respectively).

Conclusions: RRH had improved clinical outcomes compared to ORH in the treatment of early-stage cervical cancer in terms of EBL, intra-operative complications, transfusion rates, LOS, and pre-operative cone. Disease recurrence and survival were comparable for the two procedures.

Keywords: Early-stage; Cervical cancer; Robotic radical hysterectomy; Open radical hysterectomy; Intra-operative complications; Morbidity; Recurrence; Survival

Introduction

Cervical cancer is the fourth most common cancer in women with an estimated 528,000 new cases worldwide in 2012. The estimated number of deaths in 2012 from cervical cancer was 266,000 worldwide, accounting for 7.5% of all female cancer deaths.[1]

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The first open radical hysterectomy (ORH) was performed by Ernst Wertheim[2] in 1898, and the technique was modified by Joe Vincent Meigs[3] in 1944 who added pelvic lymphadenectomy to the original Wertheim procedure and published his series of 100 patients.[4] ORH has been the standard surgical treatment for early-stage cervical cancer since then. In the past three decades, gynecologic oncological surgeons have introduced minimally invasive surgical techniques in order to potentially improve both surgical and oncological outcomes while reducing the intra and post-operative complications and morbidity.

The first total laparoscopic radical hysterectomy (TLRH) with pelvic lymphadenectomy was reported by Michael Canis[5] in 1989. Since then, TLRH has gained acceptance as a feasible alternative to ORH due to reported benefits in terms of less blood loss, shorter hospital stay, and less post-operative analgesic needs.[5–9] Despite these advantages, TLRH has not been widely adopted in surgical practice. Lack of adoption has been attributed to the limitations of traditional laparoscopic tools, leading to a prolonged learning curve and ergonomic challenges for surgeons.[10–14]

Robot-assisted laparoscopic (computer-enhanced laparoscopic) techniques utilizing the da Vinci® Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA) emerged in the mid 2000s with the potential to overcome many of the recognized limitations of "straight-stick" laparoscopic tools available for complex gynecologic procedures. The advantages offered by robotic technology include a three-dimensional magnified camera system, tremor filtration, and seven degrees of instrument mobility inside the body ("wristed movement"), and improved ergonomics. There is convincing observational evidence that the intuitive nature of the robotic surgical system also has an additional advantage in terms of a shorter surgeon learning curve compared to traditional laparoscopy.[15,16]

In the last decade, the indications for clinical application of robotic surgery in gynecological oncology have been rapidly expanded. Shortly after the U.S. Food & Drug Administration (FDA) clearance for gynecologic surgery in 2005,[17] the first robot-assisted laparoscopic radical hysterectomy (RRH) for cervical cancer was reported by Bilal M. Sert[18] followed by several larger case series with historical controls demonstrating feasibility and potential benefits of RRH for treating patients with early-stage cervical cancer.[19–24] However, very few well-designed, matched case–control studies with adequate sample sizes have compared the results of ORH versus RRH.[22,25–28] Therefore, in this multi-center retrospective study with sufficient sample size, we did a comparative analysis of our data on early-stage cervical cancer patients who underwent either RRH or ORH with respect to intra-operative, clinico-pathological, and post-operative outcomes. We also reviewed previous comparative studies of such patients on these clinical outcomes.

Materials and methods

Patient samples

After excluding 26 patients who had received neoadjuvant chemotherapy, we identified 491 patients with early-stage cervical cancer who underwent Type II or Type III radical hysterectomy from 2005 to 2011 (Table 1). Cases were recruited from one European center (Oslo, Norway) and two American centers (Chapel Hill, NC and Orlando, FL). The sample distribution was 156 (32%) from Chapel Hill, 170 (35%) from Orlando, and 165 (33%) from Oslo. All patients (RRH = 259 and ORH = 232) were consecutively collected at each institution, beginning from close in time to the initiation of their respective robotic surgery programs.

Data collection

The local institutional review boards (IRBs) of the three centers approved the study for retrospective data collection. The operative, clinico-pathological and survival data were abstracted from the patients' medical records and included: age, body mass index (BMI), skin-to-skin operative time, estimated blood loss (EBL), hospital length of stay (LOS), tumor histology, FIGO stage, tumor size, positive surgical margins, lymphovascular space invasion (LVSI), lymph node yields, positive nodes present, transfusion volume, time to recurrence and/or death, pre-operative cone rate, cervical infiltration, disease recurrence and survival information. Clinic charts were reviewed for intra-operative and post-operative complications. Intra-operative complications happened during the surgery, while post-operative complication happened from end of surgery to 30 days post-operatively. The latter complication was coded according the Accordion Severity Classification 1: mild complications; 2: moderate complications; 3: Severe complications; and 4: post-operative death.[29]

The BMI was calculated as kilograms/meter^2 (kg/m^2). The EBL during operation was dichotomized as $<$150 mL or $\geq$150 mL, but not in the regression analyses. Correspondingly, length of stay (LOS) was dichotomized as $\leq$3 days or $>$3 days, but used as a continuous variable in the regression analyses. LVSI was defined as the presence of malignant cells in cervical stromal epithelial-lined spaces. Cervical tumor size was defined as the greatest measured diameter of the cervical lesion measured by the pathologist on the both cone and gross specimens. Comorbidity concerned the presence of other relevant somatic diseases such as hypertension and previous myocardial infarction, etc. Depth of stromal invasion was measured in millimeters (mm) from the basement membrane and categorized into thirds of the entire cervical stromal width.

Disease recurrence was determined clinically, radiographically, and/or histologically. The time-to-recurrence was calculated from the date of surgery until the patient