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The effect of pelvic radiotherapy on vaginal brachytherapy cylinder diameter: Implications for optimal treatment order

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ABSTRACT

PURPOSE: To determine the factors that correlate with cylinder size in vaginal brachytherapy (VB) after hysterectomy for endometrial carcinoma.

METHODS AND MATERIALS: Patients treated for endometrial cancer from January 1, 2003 to December 31, 2013 were reviewed from a single institution. Patients included underwent total abdominal hysterectomy with bilateral salpingo-oophorectomy followed by high-dose-rate VB with or without external beam pelvic radiotherapy (EBRT). According to institutional guidelines, the vaginal cylinder size selected was the largest diameter cylinder the patient could comfortably accommodate. Patient, tumor, and treatment factors were recorded and compared with cylinder size.

RESULTS: Three hundred eighty-one eligible patients were identified, including 121 patients treated with pelvic radiotherapy (RT) before VB and 260 treated with VB alone. On univariate analysis, weight ($p = 0.0004$), body mass index (BMI) ($p = 0.001$), and receipt of pelvic RT ($p \leq 0.0001$) were the only statistically significant factors correlated with vaginal cylinder size. On multivariate analysis, receipt of EBRT retained significance after adjusting for weight or BMI. In patients receiving VB alone, median cylinder size was 3 cm; after pelvic RT, it was 2.5 cm.

CONCLUSIONS: Higher weight and BMI correlated with accommodation of larger cylinder size. Accounting for this, the receipt of EBRT before VB was associated with smaller cylinder size. Dosimetric data show that larger cylinder size provides superior dose distribution. Although historically the VB boost follows EBRT, reversal of this order may be preferred.

Keywords: Vaginal brachytherapy; Pelvic external beam radiotherapy; Endometrial carcinoma

Introduction

Uterine cancer is the leading gynecologic malignancy in developed countries with an estimated 54,870 new cases and 10,170 deaths in the year 2015. This makes it the seventh leading cause of cancer death for women in the United States (1). The primary treatment for uterine cancers includes total abdominal hysterectomy with bilateral salpingo-oophorectomy, and lymph node assessment, when warranted. Depending on clinical and pathologic risk factors, this may be followed by adjuvant therapy (2).

Radiotherapy (RT) has become an integral modality to reduce the rate of locoregional recurrence. This includes the use of postoperative intracavitary vaginal brachytherapy (VB) and/or external beam radiotherapy (EBRT) (2). The American Brachytherapy Society (ABS) has set forth guidelines for proper technique and use of RT in the postoperative setting including the following, "The ABS recommends use of the largest diameter cylinder … that can comfortably fit snugly into the apex of the vagina" (3). This recommendation is based on two principles. First, when dose is prescribed to 0.5 cm depth, the use of a larger diameter cylinder is associated with both a lower surface dose and higher dose at depth beyond 0.5 cm (4). This provides more thorough coverage of deeper paravaginal tissues while potentially reducing the contribution to vaginal

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stenosis. Second, the use of a larger diameter cylinder is associated with fewer air gaps and associated areas of underdosage (5–8).

VB can be used either alone or as a boost in conjunction with EBRT. Although data with regard to sequencing of EBRT and VB are lacking, historically, the VB boost has been delivered after EBRT. At our institution, we have used EBRT first followed by VB as a boost for select high-risk patients. It is well known that RT can result in vaginal stenosis. This may be quite consequential, given the preference toward using the largest cylinder size that the patient can accommodate. The purpose of this analysis was to identify the factors that correlate with cylinder size for patients with uterine cancer treated with total abdominal hysterectomy with bilateral salpingo-oophorectomy and VB with or without EBRT. Our hypothesis was that EBRT may result in vaginal stenosis and so result in the selection of a smaller vaginal cylinder.

Methods and materials

This retrospective review was approved by an institutional review board from a single institution.

Patients

The electronic medical records were queried for all patients treated between January 1, 2003 and December 31, 2013. Inclusion criteria were diagnosis of Stage IA through Stage IIIC2 uterine cancer using International Federation of Gynecology and Obstetrics (FIGO) 2009 staging, treated with hysterectomy with no gross or residual disease left, and receipt of VB using a vaginal cylinder delivered with an iridium-192 high-dose-rate remote afterloader. Patients were included without regard to receipt of EBRT before VB.

Treatment

Shortly before the start of VB, simulation was performed, and the optimal cylinder size was selected based on examination and patient feedback. The institutional policy, common to all treating physicians, has been to select the largest cylinder size the patient could comfortably accommodate. Counseling and reassurance were provided to allay patient anxiety and achieve optimal cylinder size. A segmented single-channel vaginal cylinder kit provided cylinder sizes ranging from 2.0 to 4.5 cm in diameter in 0.5 cm increments (Nucletron; Waardgelder 1, 3905 TH Veenendaal, The Netherlands).

Data collection

Data regarding patient characteristics, tumor characteristics, treatment, and outcomes were obtained from electronic medical records. Patient characteristics collected included date of birth, age at diagnosis, date of diagnosis, height, weight, and body mass index (BMI). Tumor characteristics included FIGO stage, histology, and grade of disease. Treatment information collected for each patient included number of high-dose-rate brachytherapy fractions, total brachytherapy dose delivered (cGy), total length of treatment (in seconds), diameter of vaginal cylinder used (cm), receipt of EBRT, and number of days between last fraction of EBRT to start of first fraction of VB.

Analysis

The Spearman correlation test and Wilcoxon rank sum test were used to evaluate if any factors, including age at time of diagnosis, stage, height, weight, BMI, and use of pelvic RT, correlated with vaginal cylinder size.

Results

Patients

Three hundred eighty-one patients with nonmetastatic uterine cancer who underwent hysterectomy and VB were identified. Two hundred sixty patients were treated with VB alone, and 121 patients underwent EBRT followed by VB. Characteristics of patients and tumor details are outlined in Table 1. There was no significant difference in patient demographic factors between those who received pelvic RT before VB vs. VB alone (Table 2).

The modal regimen for patients who underwent VB alone was four fractions of 5.5 Gy, each prescribed to 0.5 cm depth. The median cylinder diameter was 3 cm. The modal regimen for patients who underwent EBRT followed by VB was 45 Gy to the pelvis followed by three fractions of 6 Gy prescribed to the vaginal surface. There was a median of 4 days between last fraction of EBRT and first fraction of VB. The median cylinder diameter was 2.5 cm (Fig. 1).

Treatments

Patients were treated with one of two regimens.

Correlation with vaginal cylinder size

A univariate analysis was performed using the Spearman correlation test; the three factors that were correlated with vaginal cylinder diameter were weight ($r = 0.18$, $p = 0.004$), BMI ($r = 0.17$, $p = 0.001$), and receipt of EBRT ($r = -0.40$, $p < 0.0001$). Using a multivariate analysis, the receipt of EBRT retained a significant correlation with cylinder diameter after adjusting for either BMI ($r = -0.39$, $p < 0.0001$) or weight ($r = -0.40$, $p < 0.0001$).

Discussion

This article reports on a large series of women with uterine cancer treated with hysterectomy and VB from a single