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Adjuvant brachytherapy for endometrial cancer: Advantages of the vaginal mold technique

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ABSTRACT

PURPOSE: Treatment of endometrial carcinoma in the adjuvant setting includes in most cases vaginal brachytherapy. In our institution, we use the customized vaginal mold technique. Herein, we report the advantages of this personalized applicator in terms of target coverage, normal tissue preservation, the incidence of air pockets, and its potential impact on dosimetry.

METHODS AND MATERIALS: A total of 15 patients receiving postoperative vaginal cuff high-dose-rate brachytherapy with the mold applicator technique were enrolled in this prospective data collection study. Patients were treated with either two or four fractions of 5 Gy prescribed to the clinical target volume, which consisted of an irradiation of the vaginal cuff and the upper third of the vagina. Target coverage; dose to organs at risk, in addition to the volume; and the dosimetric impact of air pockets surrounding the mold were evaluated.

RESULTS: In 15 patients, a total of 27 air pockets were identified. The average number of air pockets per patient was 1.8 (range, 0–4), with the average total air pocket volume being 0.1 cc (range, 0.01–0.54). The average dose reduction at 5 mm from the air pocket was 26% (range, 6–45%). The minimal clinical target volume coverage reported was 95% and the maximal dose received by 2 cc of the bladder, rectum, and sigmoid never exceeded 110% of the prescribed dose.

CONCLUSIONS: Vaginal cuff high-dose-rate brachytherapy using the molded applicator provides personalized tailored treatment in terms of anatomical conformity. This translates into a dosimetrical advantage with smaller and fewer air pockets than reported in the literature with the use of cylinders.

Keywords: Endometrial cancer; HDR brachytherapy; Vaginal mold; Air pockets

Introduction

Vaginal brachytherapy has been reported as an effective prophylactic treatment in the postoperative setting with minimal side effects in the prevention of vaginal cuff relapses of uterine carcinomas (1, 2). Vaginal cuff brachytherapy can be used alone or subsequent to external beam radiotherapy (EBRT) depending on the patient's pathologic risk factors for recurrence. These include patient age, high tumor grade, lymphovascular space invasion, deep myometrial invasion, tumor size, tumor extension to the cervix or vagina, and lymph node involvement (3). Worldwide, many different applicators have been used; the most common was the single-line source vaginal cylinder (3, 4). With the application of three-dimensional imaging in gynecologic brachytherapy treatment planning, defects in conformity of cylinders to the vaginal walls and cuff have been reported (5, 6). Although the largest cylinder that can be fitted into the vagina was chosen to allow optimal apposition of the vaginal mucosa against the cylinder, air pockets forming could not be prevented. Recent studies have identified the presence of an average of one air pocket per patient (5), resulting in reduced radiation dose to the vaginal mucosa (6). In addition, any improper placement of the applicator could result in target under- and/or overdosage to normal tissue. Thus, impairing local control and increasing complications.

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Conflict of interest: None.

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At our institution, the endocavitary brachytherapy technique is based on the molded applicator and has been used widely in clinical practice. It is reasonable to suppose that an applicator adapted to vaginal anatomy would be more conformal. The present report constitutes a brief description of this technique with a stress on the presence of air pockets, their effect on dosimetry, and the potential place of molded applicators in the modern era of brachytherapy.

Methods and materials

The study population was based on 15 consecutive patients with pathologically proven carcinoma of the endometrium who received adjuvant high-dose-rate (HDR) brachytherapy to the vaginal vault, either alone or subsequent to EBRT between May and November 2013. The treatments studied were the first fractions only, where CT scanner was available. As previously reported, the intracavitary brachytherapy technique at our institution is based on the vaginal mold technique, which has been already published (7). Briefly, the first step consisted of a vaginal size assessment using a low-dust alginate impression, then choosing between three sizes of preset acrylic molds based on the size of the vaginal impression. In most of the cases where the vagina had a round shape, three catheters were inserted in each mold, two laterally and one in posterior position. The purpose of these three catheters was to achieve a more homogeneous dose distribution. Rarely and in case of a smaller or flatter vagina shape, only two catheters were designed laterally to minimize mucosal hot spots and avoid higher dose to the bladder and rectum. Holes were made in the walls of the applicator to prevent mold displacement by inducing mucosal herniation (Fig. 1). The range of molds available in use varied in width and thickness: small (30×25 mm), medium (40×35 mm), and large (50×40 mm), respectively. All were 55-mm long. The mold was chosen to be the closest in size to the vaginal impression. A careful clinical examination was systematically conducted before this procedure to ensure healing of the vaginal vault and assessing for any residual tumor. The mold was then inserted into the vagina. In-room orthogonal radiographic localization images (anteroposterior and lateral view) were taken after each application to ensure that the mold was inserted in the same orientation. This was achieved by evaluating the position of radiopaque markers placed into the catheters and on the surface of the applicator in relation to pelvic bony structures. To have similar bladder filling between patients, a Foley catheter was inserted with 7 cc balloon inflation of diluted contrast dye and the bladder was completely drained during CT and treatment. The CT images through the pelvis were obtained without intravenous contrast injection at 3-mm intervals and transferred to the treatment planning system (TPS). The mold, bladder, rectum, and sigmoid were contoured. Primary clinical target volume (CTV_1) was defined as 5 mm from the surface of the vaginal mold in its cranial 3-cm portion targeting the upper third of the vagina (4). The CTV_2 was defined as 5 mm from the surface of the vaginal mucosa and thus taking into consideration the volume of the air pockets. The CTV_1-based three-dimensional planning using dose–volume parameters was performed. The dose of 5 Gy per fraction was prescribed to the CTV_1. Each treatment plan was evaluated for the presence of air pockets in the cranial 3 cm of the vagina. The air pockets were contoured in the axial plane and the corresponding volumes were calculated by the TPS (Fig. 2). Anisotropic loading of the three catheters was required to optimize target coverage and protect organs at close vicinity of the vaginal walls or any overlying small bowel (8). Relative dwell

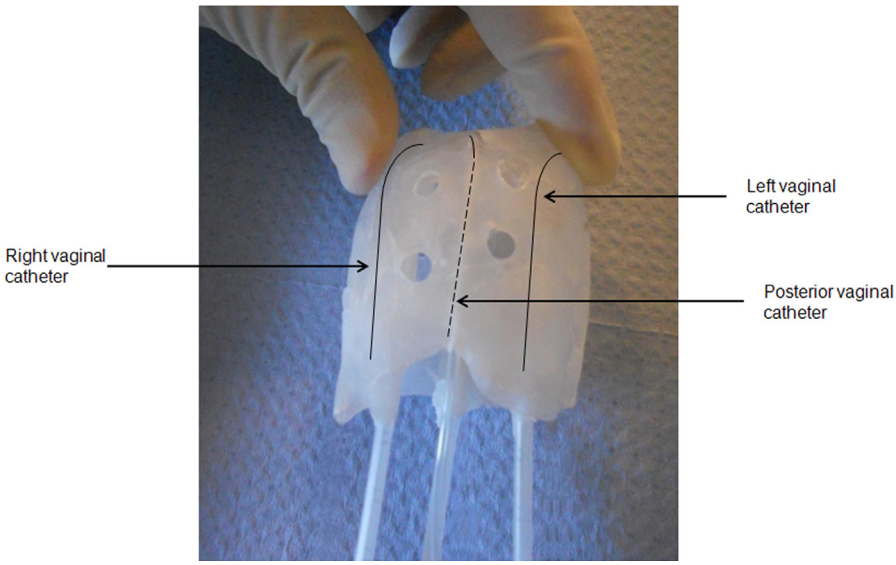

Fig. 1. Molded applicator for vaginal high-dose-rate brachytherapy. Lateral catheters and posterior catheter positioning are represented.