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Technical Note

A unique approach to high-dose-rate vaginal mold brachytherapy of gynecologic malignancies

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ABSTRACT

PURPOSE: Patients with cervical and vaginal cancer sometimes have a less straightforward approach for choice of brachytherapy treatment owing to the tumor's location and clinical presentation. The staff at Royal Brisbane & Women's Hospital in Queensland, Australia, is trying to solve this problem by the use of an old technique in a new approach called vaginal molds. With a patient-specific vaginal mold, the appearance of the applicator and the dose distribution can be customized to provide an optimal treatment for each patient.

METHODS AND MATERIALS: The technique used at the Royal Brisbane & Women's Hospital uses a flexible two-part putty, moulded to the shape of the vagina, in which standard catheters (flexible implant tubes) are incorporated, in a pattern designed to permit a dose distribution more conformal to the target volume.

RESULTS: The presented technique is efficient and improves the accuracy of a homogeneous target cover and sparing of organs at risk for vaginal mold brachytherapy treatments at our institution.

CONCLUSION: This technique offers a customizable option when traditional cylindrical- or dome-type applicators cannot be used, or provide inadequate dose coverage. Molds to match the patient anatomy can be created quickly, while allowing flexibility in positioning of catheters to achieve the desired dose distribution.

Keywords: Brachytherapy; Vaginal mold; Applicator; Fusion; Cervical cancer; Vaginal cancer

Introduction

Treatment of the vaginal vault region with brachytherapy is well established for vaginal recurrences of endometrial cancer (1–3) and vaginal cancer (4–11).

Brachytherapy is often recommended as treatment option (12–15) for the vaginal region (16–22); and at the Royal Brisbane and Women's Hospital (RBWH), brachytherapy has become a standard component of the treatment of the vaginal vault. Every year, RBWH treats approximately 100 brachytherapy patients and approximately 30 of these patients receive vaginal brachytherapy treatment. Owing to the rapid dose fall-off in high-dose-rate (HDR) brachytherapy, it is essential that the chosen applicator has the best contact with the tissue to avoid tumor underdosage and undesired dose to the organs at risk (OARs). Patients requiring treatment of the vaginal cavity sometimes have a less straightforward approach for choice of brachytherapy techniques owing to the locality and shape of the tumor and size and shape of the vaginal vault itself. A standard cylindrical vaginal applicator has a uniform diameter and is designed to produce an even dose around the surface of the applicator. To produce this dose distribution, the cylindrical applicator needs to be in good contact with the vaginal mucosa (23). For patients with irregular vaginal vault configurations owing to either surgical scarring or tumor shape, good contact may not be achievable. Although a number of commercial applicators are available (24–26), none of these can provide the necessary contact with the gross tumor or the patient's anatomy. Previous work shows the benefits of brachytherapy techniques using molds

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(16–22). At the RBWH, a patient-specific vaginal mold technique has been applied for patients where a standard cylindrical applicator is not ideal.

We present a unique catheter configuration, which is used within the mold to achieve enhanced and more homogeneous dose coverage of the target and to spare the OARs compared with standard catheters placement. To save waiting time for the patient, the three-dimensional (3D) reconstruction of the catheters and the creation of a treatment plan in Oncentra MasterPlan version 4.3 (Nucletron, Veenendaal, The Netherlands) are completed using CT images of the mold without the patient. At the time of the patient's first HDR brachytherapy treatment, the CT images of the mold, with a complete plan, are fused with the patient's pretreatment CT images and minor adjustments can be made to optimize the plan for the patient.

Methods and materials

Patient selection

Patient selection is determined by clinical examination by an experienced radiation oncologist with gynecologic brachytherapy expertise. Often an initial attempt at using a standard cylindrical applicator is made before deciding on using a patient-specific mold (Fig. 1). The inclusion criteria for patients-prescribed adjuvant vaginal vault brachytherapy for endometrial carcinoma are those with vault anatomy that does not conform closely to the surface of the standard cylindrical applicator. These patients have in general an irregular vault scar creating a prominent "dog-ear" on either end of the scar that would increase the distance further from the surface of the standard applicator. Patients with recurrent endometrial cancer in the vaginal canal or primary vaginal cancers require individualized molds with catheter placement chosen such that localized dose escalation can be achieved to the gross disease while the remainder of the vagina can be treated to a lower dose.

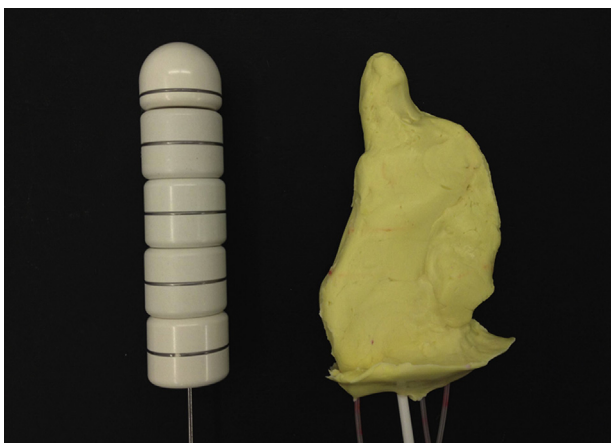

Fig. 1. In this specific case, a patient-specific mold was a better choice for the patient compared with a standard cylindrical-shaped applicator, both to improve dose coverage of the target and for patient comfort.

Choice of mold material

A number of factors should be taken into account when choosing an impression material with the right properties. An ideal impression material for brachytherapy should have dimensional stability and accuracy, be nontoxic and nonirritant to the patient, user-friendly as ease of mixing and setting time, and also cost effective. Ideally, it should also have a similar composition as water. A two-part putty Fricotan (Frisch Labor System, Oberreute, Germany) became the choice of mold material. Fricotan is an elastic and tear-resistant silicone product with a smooth surface consistency.

Phase 1: Initial vaginal impression

The primary mold is created during a pretreatment session several days before the patient's first HDR brachytherapy treatment. The primary mold is based on a vaginal impression made of Fricotan with a central swab stick inserted. The insertion is performed by the radiation oncologist where Fricotan is manually introduced in the vagina. The swab stick provides ease in handling the mold for each insertion providing a more comfortable experience for the patient. Once the Fricotan mix solidifies within 5 min, it is removed from the vagina aided by the swab stick (Fig. 2). No anesthesia is necessary during the procedure. The radiation oncologist delineates the intended extent of the target volume on the surface of the primary mold.

Phase 2: Creating the negative

To introduce catheters within the mold, a negative is produced, which is made by packing alginate (Aroma Fine Plus Normal Set; GC Corporation, Tokyo, Japan) around the mold in an empty plastic container. Alginate powder is combined with water to make a smooth liquid, which is poured into the plastic container. Before it sets, the primary mold is fully submerged in the alginate mix. While waiting for the Alginate to set, standard brachytherapy catheters are glued together in the desired configuration.

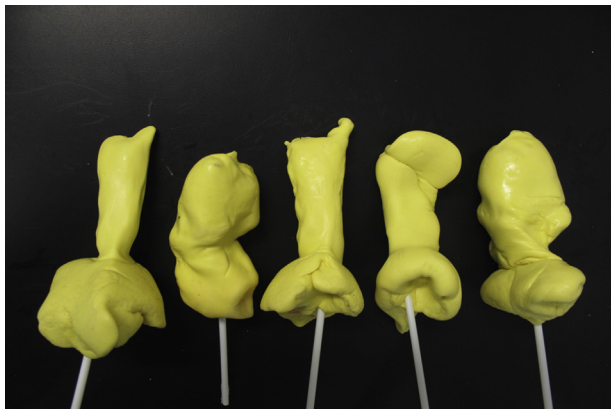

Fig. 2. Initial first impression molds from five different patients.