

## Dosimetry in Phantoms for Intensity Modulated Brachytherapy

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### 1. Introduction

Radiotherapy has two divisions: teletherapy and brachytherapy; teletherapy is related to the interaction of photons with the patient's lesion to be treated, called the external beam. Brachytherapy is a close therapy, the distance between the lesion and the radiation source is practically non-existent or implanted in the tissue to be treated [1].

Vaginal applicators are used to treat tumors extending caudally from the cervix along the vaginal dome. The Fletcher-Suit-Delcos system consists of a probe and ovules. Dose distribution is achieved by careful selection and placement of sources in the probe and ovoids. Intracavitary gynecologic brachytherapy is the most common application of brachytherapy that we will cover in this article, using the intensity modulated technique [2;3].

In this research, a phantom, a simulator object, was built and evaluated to perform analyses with Varian Medical System applicators. These analyses evaluated how radiochromic films respond to interaction with radiation within the phantom, thus validating dosimetry for use with 3D printed applicators made of polylactic acid (PLA) material.

### 2. Methodology

To build this phantom, we used an acrylic box with two circular openings on the front and filled its matrix with a gelatinous material equivalent to water.

A Siemens tomograph was used to estimate the density in Hounsfield units (HU) of the material filling the phantom, as shown in Figure 1.



Figure 1: Siemens SOMATOM go.Sim tomograph.

To evaluate the dose distribution in the phantom, EBT3 radiochromic films were used, which have the advantage of high spatial resolution and ease of use during the radiation measurement process due to their low sensitivity to visible light [4].

The film was positioned on the side of the applicator, in the coronal plane of the phantom, as shown in Figure 2.

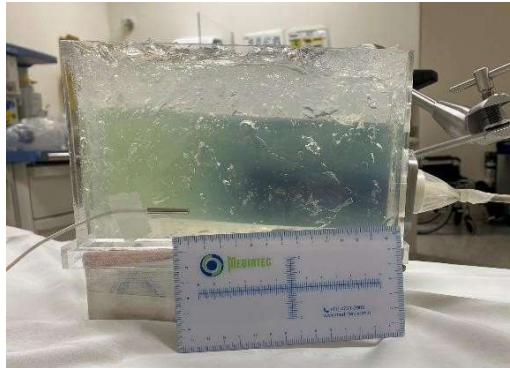


Figure 2: Radiochromic film after irradiation.

Three-dimensional Fricke gel dosimeters containing 0.1 mM xylenol were used inside the phantom to determine attenuation in regions simulating the rectum and bladder, as shown in Figure 5. The interaction of the radiation with the gel affects the dosimeter and causes changes in the physical properties of the material. These changes affect magnetic resonance relaxation, optical density, and the speed of sound in the medium [5].

### 3. Results and Discussion

In Figure 3, it was possible to obtain images of the phantom before irradiation, and consequently the density value of the material in Hounsfield was obtained. The minimum values of -10 HU, the maximum of 23 HU, the mean of 11 HU and the standard deviation of 4 HU were within the expected range for water equivalent tissue, soft tissue, and hard tissue.

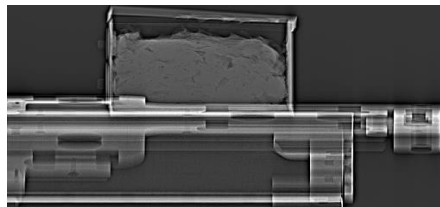


Figure 3: Computed tomography images of the phantom, lateral.

Figure 4 shows the calibration curve of the film irradiated with a dose of 700 cGy. The experimental base used simulates the same brachytherapy procedure for a patient.

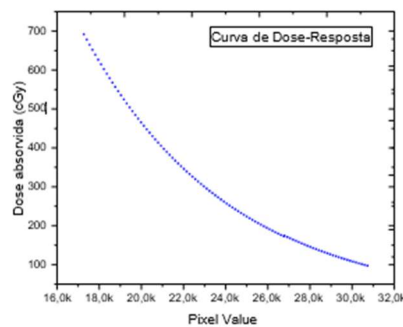


Figure 4: Graph of the experimental dose deposition curve.

#### **4. Conclusions**

Using computed tomography to check the density of the material and dosimetric tests with Radiochromic film, it was possible to show the reliability of the simulator object compared to the planning system. In all the results presented, the radiation emitted by the Iridium-192 source was detected. For prospects, this work consists of testing the phantom with applicators made on 3D printers with beam modulation using lead attenuators. Improvements to this phantom, such as the structure, include fixed simulator objects in the internal part, rectum and bladder and new dosimetric tests.

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