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# Validation of a novel dosimetry application for measuring the calibration curve of Gafchromic Films

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Introduction

The optical properties of the Radiochromic film, expressed for its optical density (OD), change as the absorbed energy varies. The film to use should be defined in terms of its capability of modification in OD for different dose adsorbed levels, besides of the spatial response and linearity. For this study, we use the GafChormic XR-RV2 film, in a dose range from 0 Gy to 10 Gy, cut in small pieces and irradiated with 100 kVp and 150 kVp energies. The samples will be measured with a spectrophotometer and compared with the result obtained with commercial scanner. The aim of this work is focused on obtaining calibration curves for the same samples of films, using a spectrophotometer comparing the results of measurements with a graphic scanner.

Materials and Methodology

A kilovoltage x-ray beam (50 kVp to 150kVp) from an Xstrahl 150 X-ray therapy Unit used for superficial treatment, was employed in this study. It was calibrated following the protocol described in Report-76 by TG-61 of the AAPM.

The film XR-RV2, is composed in its interior by a block of three layers; the adhesive sensitive (12.0 µm thick), surface (3.0 µm) and active (17.0 µm), and is coated on both sides by layers of polyester one of yellow color and another one of white color, both of 97.0 µm thick. The dose was delivered to the center of the Gafchromic XR-RV2 films by a circular field cone with diameter of 5.0 cm, positioned on a 30.0 x 30.0 x 5.0 〖cm〗^3 solid water phantom with the film at surface. The films, were cut into small samples (4x4 cm2) from the same sheet, and each sample was irradiated with one of two beam qualities (100 kVp or 150 kVp), considering doses from 0 to 10 Gy in steps of 100 cGy calculated at the surface, where the sample with 0 cGy will be measured for background reference.

With at least 24 hours after exposure, the films were scanned by two different methods. First, a graphic scanner Epson-Expression-11000XL, used in day to day film evaluation was employed; this scanner works with a Fluorescent Xenon Lamp and has a resolution of 2400 x 4800 dpi. Afterwards, it is applied for comparison a spectrophotometer LAMBDA 1050, taking into consideration that the white polyester layer in the film does not permit the pass of light, it should be used in reflection mode, which is based on the collection of light reflected by the films, through an integrating sphere that is able to measure a wide range of reflected light from a material as a function of wavelength. This device was chosen for this work, due to its high sensitivity of the absolute reflectance measurements, which improves on traditional methods of testing, by automatically and reproducibly changing the angle of the sample, and it is capable to set the resolution to different levels (down to 0.2 nm).

The spectrophotometer has a double beam, the first one is focused on the non-irradiated film that is placed in position of the standard sample (reference). In the second beam position, irradiated sample films were placed and measured; this reflectance measurement was performed at a wavelength range of 650 nm and 620 nm, where the highest reflectance was obtained. The program allows to measure optical density by reflection, defined as:
OD=log(1⁄R)
Where OD is the optical density and R the reflectance. The doses were defined at the same position of reference points in a square patterns of 1x1 cm2 around the center of the film, defined as a dot matrix, which is evaluated in the scanner as well as the spectrophotometer. This method was applied for establishing the calibration curve for the beam by both devices.

Results

The Gafchromic XR-RV2 film calibration curves were found to be weak dependent of beam energy (approximately lower than 8% difference of the pixel values between 100 kVp and 150 kVp). The Total reflectance has shown in the primary data obtained, to decrease with increasing irradiation doses. This behavior is mainly due to diffuse reflectance, since the specular reflectance is essentially constant with wavelength and slightly dependent on the irradiation dose.

Conclusions

Some of the data obtained in this pilot project, support the hypothesis that the sensitive layer reacts to irradiation more linearly than data measured using standard commercial devices.

The Gafchromic XR-RV2 film can provide acceptable accuracy of dose measurements for kilovoltage x-ray irradiation using small field irradiation, by determination of a its calibration curve. The combination of Gafchromic XR-RV2 film with flat-bed scanner represents a low-cost and viable dosimetry tool for in vivo Dosimetry in irradiation procedures with superficial radiotherapy.

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