Gafchromic XR Type-R Film for Breast Skin Dose determination during low kV Intraoperative Radiotherapy

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Background

Intraoperative radiotherapy (IORT) using a low kV, miniature X-ray source (XRS) has the potential to impart the same clinical benefit as several weeks of post-operative external beam radiotherapy (EBRT), in a high dose single fraction. IORT facilitates partial breast irradiation by delivering a radiation dose in a spherical pattern to a clinically relevant margin of the tumour bed. It is important to quantify the skin dose because of the larger dose fraction and smaller target volume compared to whole breast irradiation [1].

Gafchromic XR Type-R film (GC-XRR) (International Specialty Products, Wayne, NJ) has been specially developed for the measurement of absorbed dose of low energy photons and has the added advantage that dose readout is a simple procedure [2]. The use of other methods of in-vivo dose determination such as TLDs, MOSFETs and diodes is more complex.

Methods

GC-XRR radiochromic film (Lot no. L04A50XRR) was used for this study. It consists of three layers with a 100 µm top layer of translucent yellow dye which acts as a protective barrier, a 15 µm active middle layer and a 100 µm white, opaque base layer providing image reflection. The top layer enhances the contrast of the radiation induced chromatic changes that occur in the film.

A miniature XRS (Carl Zeiss AG, Oberkochen, Germany) operating at 50 kV and 40 µA with a measured half-value layer of 0.11 mm Al was used to obtain a plot of the film response in terms of net reflection density versus absorbed dose from 1 to 10 Gy in increments of 1 Gy (Fig. 1). A reflection densitometer (X-Rite Inc., Grandville, MI) was used to read the optical density at each exposure. Three readings were taken and the average value was used.

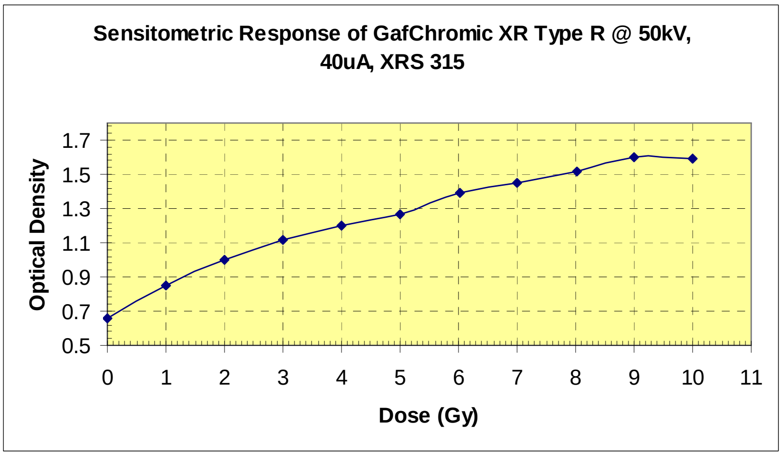

Figure 1: Sensitometric Response of GC-XRR film @ 50kV, 40uA.

To obtain the breast skin dose, four pieces of the calibrated film each 1.5 cm x 1.5 cm were wrapped in sterile film in the operating room before being placed by the surgeon concentrically around the wound site prior to irradiation. The spacing of the films was intended to give an indicative value of the average skin surface dose. After treatment, the optical density of the films was measured and the absorbed dose interpolated from the sensitometric response curve.

Results

We used GC-XRR film on twelve patients (on going) in order to quantify breast skin dose during low kV IORT. The prescribed dose was 5 Gy to a uniform 1 cm margin in the tumour cavity after excision. Treatment times ranged from 16.81 to 33.11 minutes (mean = 26.41) and the applicator sizes were 5.0 cm in two cases, 4.5 cm in seven cases, 4.0 cm in one case and 3.5 cm in two. The absorbed doses ranged from 0.90 to 6.15 Gy with a mean of 3.01 Gy. This is comparable with TLD doses determined at an earlier stage of the Targit trial [3].

Conclusions

Initial results indicate that GC-XRR film is a valid alternative to TLD for the determination of breast skin surface dose during low kV IORT. It is easy to use in the operating room, requires no prior preparation, provides a direct read-out and has the potential to provide dose distribution information.

References

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