

AbstractID: 10088 Title: Effects of Optical density instability of Gafchromic EBT film on IMRT dosimetry

**Introduction:**

Intensity-modulated radiation therapy (IMRT) has become the most popular treatment modality because it provides superior conformal tumor dose coverage and sparing of critical structures in comparison with conventional conformal beam therapy. To achieve the goals of IMRT, challenges such as verification of dose calculation accuracy has to be resolved. Single point dose measurement using ionization chamber, thermoluminescent detector or diodes is not enough. Radiographic and Gafchromic films are used to measure two-dimensional dose distribution and verify dose calculated by the treatment planning system. The Gafchromic EBT films are easier to handle and prepare than radiographic films because they are not sensitive to room fluoroscopic lights and do not require chemical or physical processing. Further, Gafchromic films are composed from a tissue equivalent material and have flat energy response in comparison with radiographic films. However, the Gafchromic film has lower radiation sensitivity than radiographic films and the optical density continues to grow with time after irradiation which is the subject of this current study.

**Materials and Methods:**

Several phantom plans were generated from actual IMRT patient treatment plans. For each phantom plan, dose was calculated onto a phantom (30x30x20 cm<sup>3</sup>). Several Gafchromic films were exposed to IMRT beams. A Gafchromic film was set at 10 cm depth in the phantom and exposed to all IMRT beams that belong to phantom plan. A second calibration film (Step Wedge – SW) was exposed to step doses from nearly 30 cGy to 300 cGy to create sensitometric curve in order to convert optical density (OD) to dose. Both the IMRT film and the calibration film were exposed in the same session. These films were then digitized using a Vidar Dosimetry Pro16 scanner. The dose distribution from the IMRT film calculated using RIT software was then compared with the corresponding 2D-dose distribution derived from Eclipse treatment planning system. Dosimetric parameters such as the “Dose Difference” and the “Gamma” were used to evaluate dose variation between the exposed film and treatment planning. Both the Gafchromic IMRT and calibration films were scanned using the Vidar scanner several times post-irradiation. In order to investigate the effect of OD growth on the Gafchromic film dosimetry, early scanned calibration films were used with late IMRT films and vice versa. This includes 3 IMRT and 3 calibration films: (A) early films that were scanned at 10 minutes post-irradiation, (B) intermediate at 75 hr post-irradiation, and (C) late at 150 hr post-irradiation. The dose distribution from the different IMRT films was compared with the 2D dose distribution from treatment planning which was used as a benchmark.

AbstractID: 10088 Title: Effects of Optical density instability of Gafchromic EBT film on IMRT dosimetry

### Results and discussion:

The plot of OD versus dose for different scan times after exposure of the calibration film is shown in figure 1. The dose distributions from IMRT film calibrated with a synchronized film (i.e. films scanned at the same time after irradiation) provide the best match with 2D dose distribution from treatment planning. Figure 2 shows from a typical plan that the dose difference is the smallest (0% peak dose difference with <5% FWHM) for the IMRT film calibrated with synchronized film. Large discrepancies of peak dose difference nearly 5% and 10% are produced when IMRT films C and A, were calibrated with non-synchronized calibration films A and C respectively.

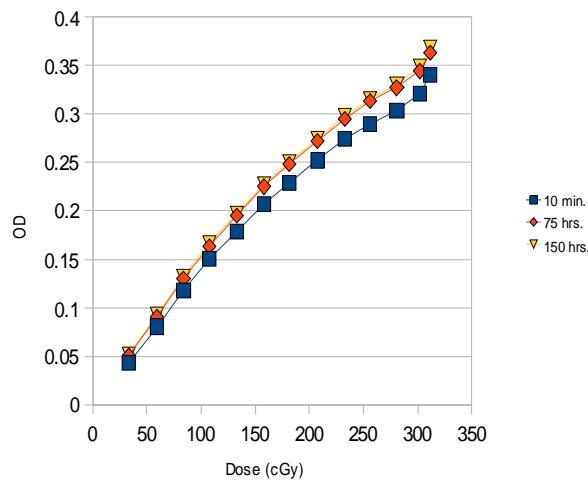


Figure 1: OD versus Dose

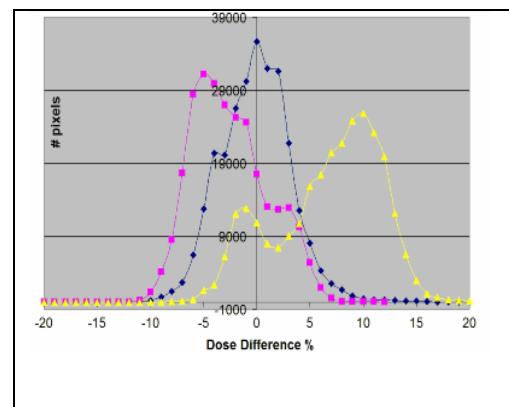


Figure 2: Dose difference - Blue: SW- 10 min, IMRT - 10 min; Red: SW -10 min, IMRT - 150hrs; Yellow: SW - 150 hrs, IMRT - 10 min.

Though Gafchromic film dosimetry is affected by low sensitivity and optical density growth with time post-irradiation, based on the results of this study the gamma passing rate (distance to agreement of 5 mm and dose difference of 5%) was better than 95%, when IMRT films were synchronized with calibration films which makes Gafchromic film appropriate for IMRT dose verification. Further, the Gafchromic EBT film has a wider dynamic dose range from nearly 10 cGy to 900 cGy in comparison with EDR radiographic films that saturates at nearly 400 cGy. This makes Gafchromic film more appropriate than radiographic film for stereotactic body radiation therapy in which large single or hypo-fractionated doses are delivered.

### Conclusions:

A time difference between radiation exposure and digitization of the IMRT and calibration films can cause dose difference between measurement and calculation. We recommend that a patient filmed scanned X hours after exposure be calibrated with a step wedge calibration that was also scanned X hours after exposure.