Dose Modification Factor Analysis of Multi-Lumen Brachytherapy Applicator with Monte Carlo Simulation

Multi-lumen partial breast irradiation applicators are used when an asymmetric dose is desired, usually to spare critical structures. RTOG-0413 specifies that the distance from the applicator surface to the skin must be greater than 5mm, and that the maximum skin point dose must be <145% of the prescription dose. At the minimum applicator-to-skin distance other considerations need to be made in regard to planned and delivered dose. In this instance, the applicator is very near the air outside the skin and the lung, both poorly scattering media. This poses a problem because many treatment planning systems assume a density of 1 g/cm³, water, over all space. This would cause the treatment planning system to over-estimate the dose delivered due to scatter.

The dose modification factor (DMF) parameter quantifies the difference in dose due to lack of scatter. It is defined as the ratio of the dose rate at 1cm beyond the applicator surface with full scatter (TPS assumption) to the dose rate with a finite thickness beyond the applicator [1]. A model of the Contura® (SenoRx, Inc.) was created with MCNP Visual Editor V16d. This model includes all dwell positions used in the virtual plan and is shown in Figure 1. An example of the type of plan to be run with this model is shown in Figure 2.

This model and subsequent simulations will be used as a comparison with real measurements taken by Sherman et al. This will be done for the purposes of verifying the effects seen and a way to run more varied measurements in a virtual environment.

References: