Investigation of BrachyVision™ Acuros™ using Varian surface applicators

Innovation/Impact: This investigation was performed to verify the capabilities of Acuros™, a new treatment-planning algorithm available for use with BrachyVision™ (Varian Medical Systems, Palo Alto CA) to calculate dose distributions for surface applicators used with the GammaMed plus iX and VariSource iX 192Ir afterloaders.

Introduction: A new treatment-planning algorithm based on a grid-based Boltzmann equation solver has been developed by Varian. This algorithm (Acuros) has the ability to account for heterogeneities during the treatment planning process, and potentially increases the accuracy in dose planning. This is of interest as Varian has developed a set of conical surface applicators with diameters ranging from 10 mm to 45 mm. These applicators allow for conformal dose delivery for the treatment of surface lesions. The geometric and material composition characteristics of these surface applicators indicate the need to account for heterogeneities within the planning region. A comparison study was performed to investigate the dosimetric characteristics of the surface applicators. Acuros was used to calculate depth-dose curves and surface dose distributions of the surface applicators and those values were compared with measured and Monte Carlo calculated depth-dose curves and surface dose distributions.

Methods and Materials: Treatment plans were created in BrachyVision™ (V10.0.39) for each applicator and source combination. A Virtual Water phantom was assigned a CT value of 0 HU and the surface applicator models were set flush to the surface of the phantom. The dose distributions and depth-dose curves were calculated using Acuros™. The dose distributions were normalized to 1 cm depth from the surface. Monte Carlo (MC) simulations were performed with Version 5 of the Monte Carlo N-Particle code (MCNP5) with updated DLC-146 photon cross-sections. Each surface applicator and source was modeled using dimensions and material specifications provided by Varian. A collision kerma tally was used to calculate the dose distributions and depth-dose curves in water for each applicator and source combination. Experimental verification of the depth-dose curves was completed using a prototype small-volume end-window parallel plate ionization chamber (A20-375) (Standard Imaging, Middleton, WI) in a water tank. Relative surface dose distribution measurements were completed using TLD microcubes (1x1x1 mm³) in an acrylic phantom and with EBT2 film on an acrylic phantom.

Results: The GammaMed Acuros-calculated percentage depth-dose curves were within 3.7% of Monte Carlo values and 5.8% of the measured values for the 30 mm applicator (Figure 1) and were within 4.4% of the Monte Carlo and measured values for the 35 mm applicator.

Conclusions: Acuros is able to accurately calculate depth-dose distributions for the homogeneous phantom case in the presence of the Varian 30 mm and 35 mm diameter surface applicators. Investigation of the 40 mm and 45 mm applicators is ongoing.