On Importance of Accurate Treatment Couch Modeling in SmartArc VMAT Plans

A recent development of Volumetric Modulated Arc Therapy (VMAT) has been steadily gaining popularity in the field of radiation oncology, as it offers a single 360° arc treatment that can be completed in under 2 minutes. Unless posterior gantry angles are completely avoided during treatment, the beams pass through the couch top and supporting rails and get attenuated. To account for couch attenuation some treatment planning systems (TPS), such as Varian Eclipse, utilize a couch model with different densities for couch shell, filling and supporting rails. Nevertheless, there have been studies suggesting that the Varian’s Exact Couch model does not always portray every treatment couch accurately [1, 2]. Other TPS, such as Philips Pinnacle 9.0, do not have a built-in couch model at all. A standard approach in Pinnacle TPS has been removing of the CT couch from the plan, and then avoiding the beam transmission through the rails by manually moving the rails out of the field during treatment. This approach is not applicable for Arc therapy as the treatment is continuous. Moreover, attenuation by the couch top, albeit smaller than for the rails, may still affect the dose distribution and cause underdosing. We investigate the impact of a treatment couch and its modeling using a Pinnacle TPS on the accuracy of dose delivery in SmartArc VMAT plans.

To model the Varian couch on our Clinac 21EX unit we acquired a cone-beam CT of the couch top and the rails. This provided us accurate geometric information about the structure of the couch and the rails, as well as the Hounsfield Units of each couch structure. We created contours of the entire couch and assigned densities to the couch top, filling, and the rails based on the HU values. Ion chamber measurements were then performed with posterior beams in the range of 120°-240°. Gantry angles varied by 1°-5° depending on required accuracy of the measurement. The couch densities were adjusted to depict our calibrated ion chamber measurements (see Fig. 1). We found that depending on the gantry angle the beam can be attenuated by up to 17% when going through the supporting rails, and up to 5% when passing through the couch top. This can result in significant underdosing of certain target areas if the treatment couch is not modeled accurately. In the model, couch top, filling, and rail densities were set to 0.45, 0.0, and 1.25 g/cm³ correspondingly.

SmartArc patient plans (single 360° arcs) were generated with and without the couch model, and verified by IBA Dosimetry MatriXX 2D ion chamber array. Gamma analyses clearly showed underdosed target areas when the couch model was not used in the plans (see Fig 2). Plans that utilized the couch model agreed well with MatriXX measurements.

In conclusion, we showed that the impact of a treatment couch can be significant in radiation therapy, and it is essential to include an accurate model of the couch in the treatment planning system, particularly for SmartArc VMAT plans.