A Method of Creating Bolus for Superficial Tumors using Non-Ionizing Imaging and 3D Printing.

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Introduction

Traditionally, for highly irregular surfaces, wet gauze, cut up bolus or wax has been used to increase surface dose. These are difficult to reproduce or conform properly to the patient's skin due to the manufacturing process. As an alternative, an optical, 3-D image of the patient can be acquired using a simple surface imager and a bolus, which can be 3-D printed to match the patient's facial structure. 3-D printing can eliminate air pockets between the skin/bolus interface and provide a more uniform field for irradiating surface and subdermal lesions.

Materials and Methods

A Rando phantom was scanned using a Kinect with Skanect 3D scanning software. The region of interest was the nose and upper lip for treatment. This image volume was converted to an STL file, and was printed with a Printbot Simple Metal 3D printer, operating on the Cura 15.04.2 software. Wax bolus was made using the 3D printed phantom model as the model. The phantom with the attached bolus was scanned with a GE CT simulator and marked for treatment setup. Contours from a previously treated patient were anonymized and overlaid on the phantom. A VMAT plan was created to this clinical treatment volume using the Monaco planning system using a VersaHD with a 6x energy, as shown in Fig. 2. Two dose points were used for measurements to verify accuracy with OSLDs. OSLDs were read using a Microstarii reader, and were compared with the predicted dose from the Moinaco treatment planning system..

Results

On the CT, the created bolus had a maximum air gap of 4 mm. Most of the area was ~1mm. The mean dose points from Monaco were 180.7 cGy (Superior), 143.5 cGy (Inferior). The mean dose, according to experimental values, was 180.8 cGy for the superior portion of the phantom and 155.2 cGy for the inferior region of the phantom.

Conclusion

Custom bolus using a non-ionizing radiation infrared scanner and 3D printer, is an accurate, efficient, and cost effective method for treatment of surface and subdermal tumors.

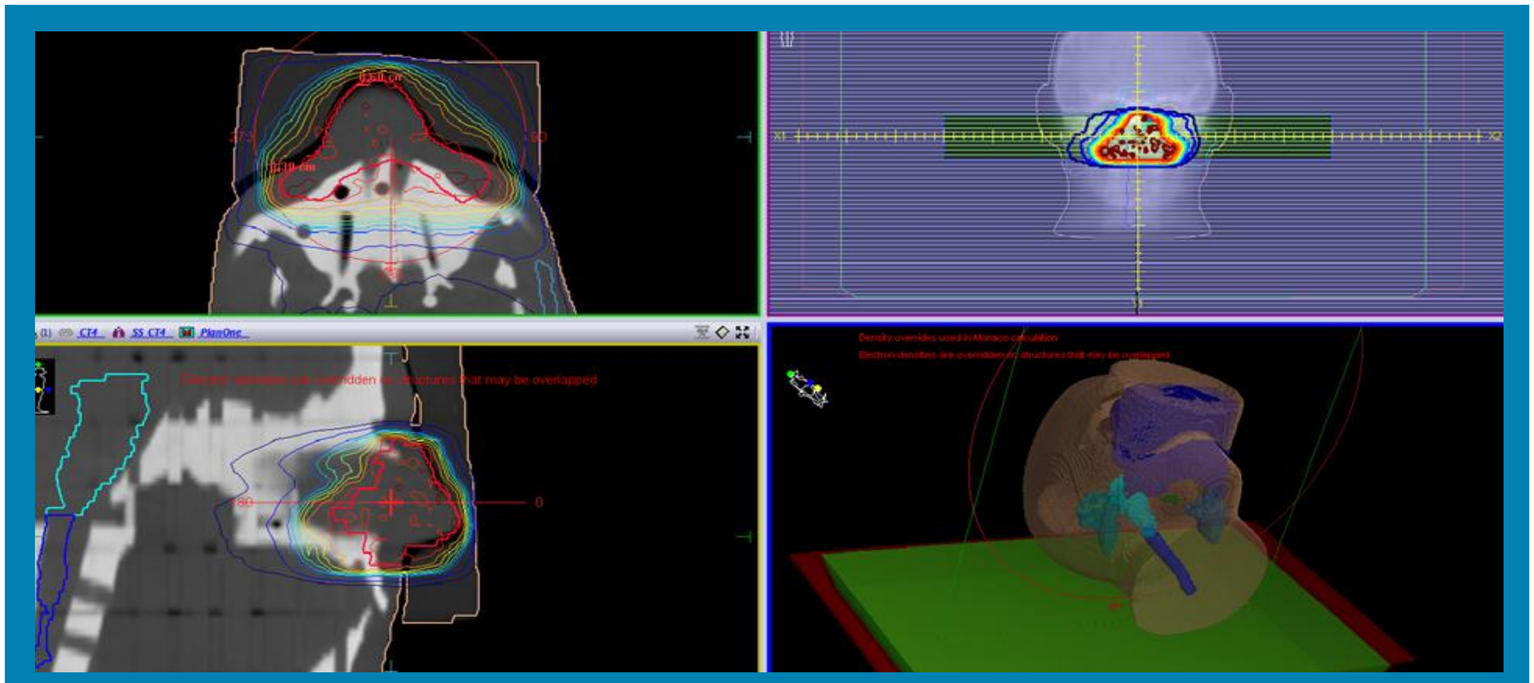

Figure 2: *Treatment plan delivered with predicted dose distribution on Monaco.*

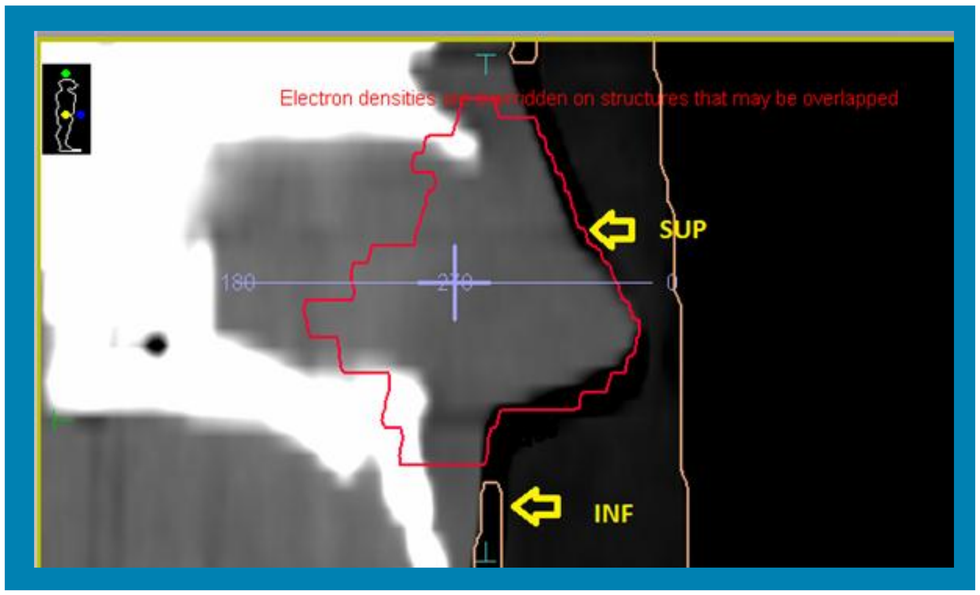

Figure 1*: Dose points from Monaco for OSLD comparison.*

Figure 3: *Construction of the wax bolus with 3D printer.*