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CANCER CENTER

Patient Case Study: Modulated Electron Bolus - Leg

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Overview

Adaptiiv Medical Technologies Inc. (Adaptiiv) provides cancer centers with the hardware, software, and materials to design and 3D print custom radiotherapy accessories.

The following case demonstrates the application of Adaptiiv's technology used in clinical radiation oncology through custom 3D modulated electron bolus creation. This case is a great example of how Adaptiiv's software can be effectively used to create electron plans that conform to the target volume and provide superior sparing of surrounding normal tissue compared to conventional techniques.

Patient History

42 year old male with HIC, high viral load, and low T cell count of 7 that presents with a 2 year history of painful, dusky, and violaceous minimally scaling plaque on the right foot that is slowly enlarging.

Diagnosis

Subtle vascular proliferation in dermis with accentuation around eccrine glands, suspicious for Kaposi's sarcoma.

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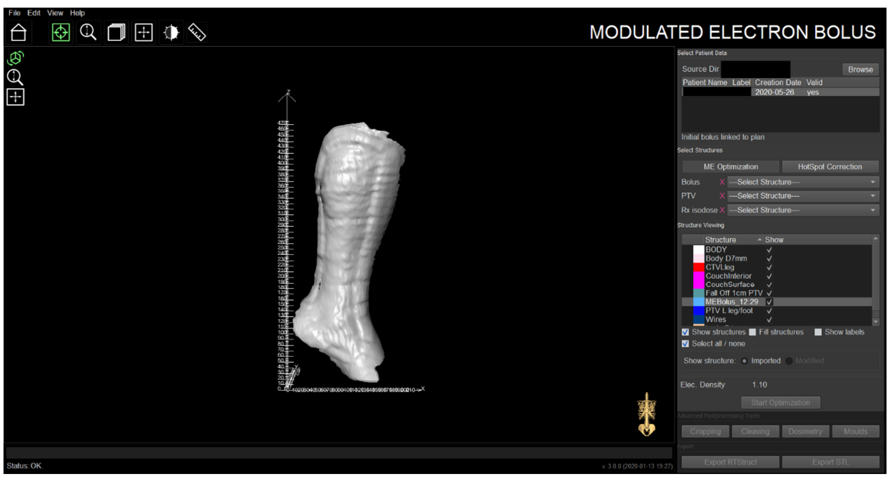
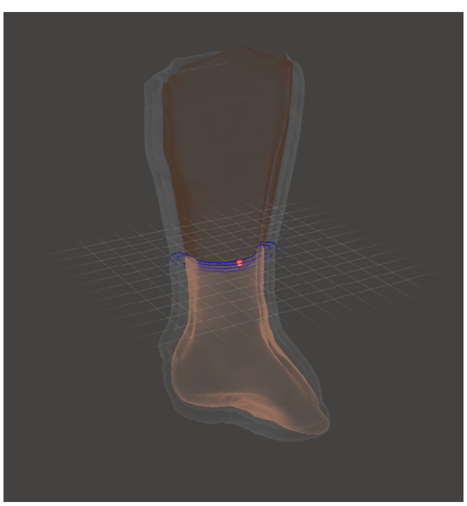
Fabrication and Treatment

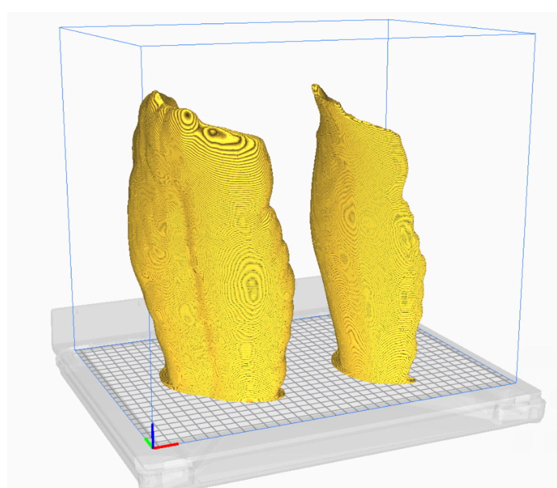
The patient's area of involvement was wired at time of simulation. A clinical target volume (CTV) was created from the CT based on the wires with a depth of 0.3 cm.

Bolus was created in Varian Eclipse treatment planning software and exported to Adaptiiv software to generate a modulated electron bolus. Shell mould STL files were generated and exported. The size of the 3D bolus mould exceeded the 3D printer build volume so it needed to be split into two parts for 3D printing. 3D printing was done on an Ultimaker S5 and Ultimaker 3+ in PLA, 0.2 mm layer height, 70 mm/s print speed, 5% infill, with no supports required. Print time was just over 24 hours.



MEB leg bolus generated in Adaptiiv software and the resulting 3D printed MEB leg bolus.





Corresponding images from Autodesk Meshmixer showing splitting of bolus into 2 parts.

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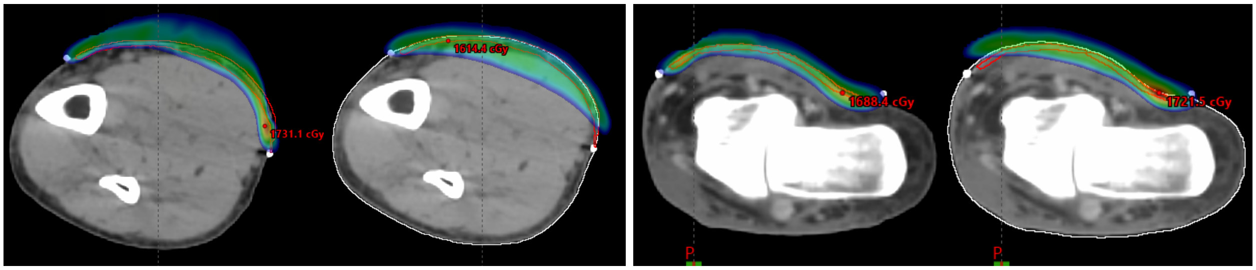
Results and Findings

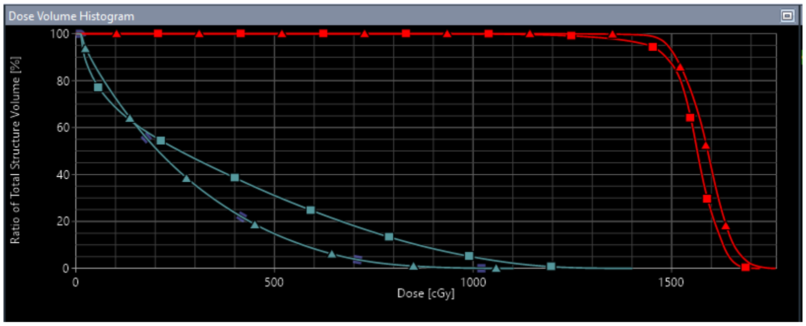
A plan comparison was performed using the modulated electron bolus and uniform thickness bolus. The conformity index (CI), as defined by the volume receiving 95% of the prescription divided by the target volume, was 2.47 with the modulated electron bolus and 3.25 with the uniform thickness bolus.

When the modulated electron bolus was used, target coverage was improved most at the edges of the target where the patient's leg obliquity prevented adequate dose coverage with the uniform bolus. In the modulated plan, 92.8% of the target volume received the prescription vs. 87.1% in the uniform thickness bolus plan.

Normal tissue at a depth of 1 cm beyond the target volume was better spared with the modulated electron bolus compared to uniform thickness bolus. The maximum dose to this area was 73.5% of the prescription dose in the modulated electron bolus plan, versus 93.5% in the uniform thickness bolus plan. The volume of tissue at this depth receiving 50% of the prescription was decreased from 90 cc with the uniform thickness bolus to 15 cc with the modulated electron bolus.



The above image sets compare the 95% isodose color wash. In each image set, the modulated electron bolus is on the left and the uniform thickness bolus is on the right.



This image shows the target volume (red) and the normal tissue avoidance (teal). Squares represent the uniform thickness bolus plan and the triangles represent the modulated bolus plan.

Summary

1. The Adaptiiv software solution was used to create a patient-specific modulated electron bolus with superior fit compared to wax bolus.
2. In the 3D modulated electron bolus plan, the dose was more conformal, the lateral target coverage increased, and the deep normal tissues were better spared when compared to the same plan using uniform thickness bolus.