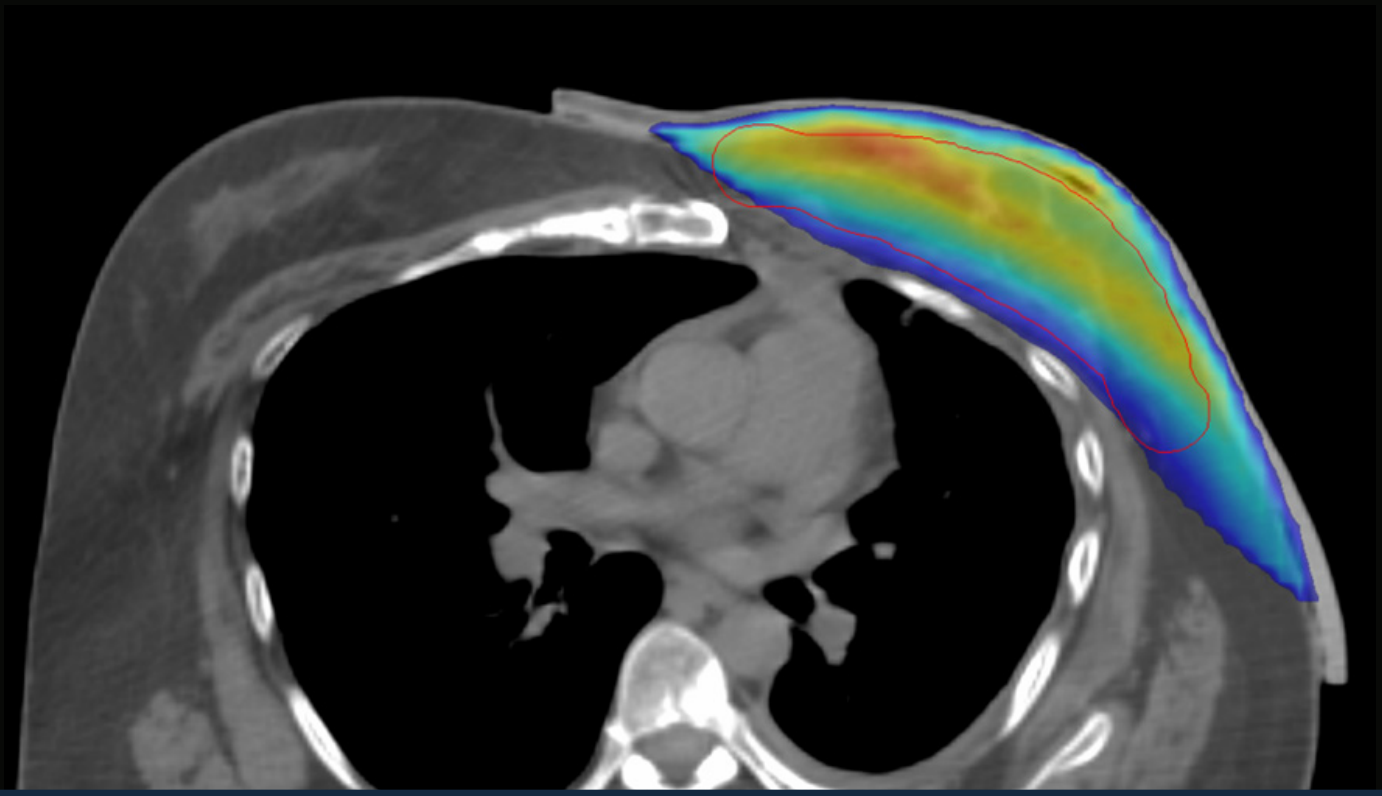

Patient Case Study:
Post-Mastectomy Left Breast EBRT Using 3D Printed Bolus

CENTRO MÉDICO ABC
ABC Medical Center
Mexico City, Mexico

Overview

Adaptiiv Medical Technologies Inc. (Adaptiiv) provides cancer centers with regulatory cleared software to design patient-specific radiotherapy accessories that can be 3D printed.

This case provides an example of how Adaptiiv's software can be used to generate a customized uniform thickness bolus for an irregular surface region. 3D printed bolus enhances clinical precision, improves operational efficiency, and provides greater access to personalized care.

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Patient History and Description

A 40-year-old female was initially diagnosed in 2017 with infiltrating ductal left breast cancer. The patient received 3 courses of chemotherapy and immunotherapy, after which local progression to the breast and skin remained. Radical palliative radiotherapy using conformal EBRT was prescribed in 2020.

Fabrication and Treatment

An initial CT of the patient was acquired using a slice thickness of 2 mm. In the TPS, an 8 mm thick uniform bolus was created, including a 20 mm margin around the PTV to ensure appropriate coverage. The outer contour of the body was initially auto-segmented, followed by manual editing to make it as smooth as possible. The conformal EBRT plan consisted of two tangential fields. An electron boost was also prescribed for the residual primary tumour.

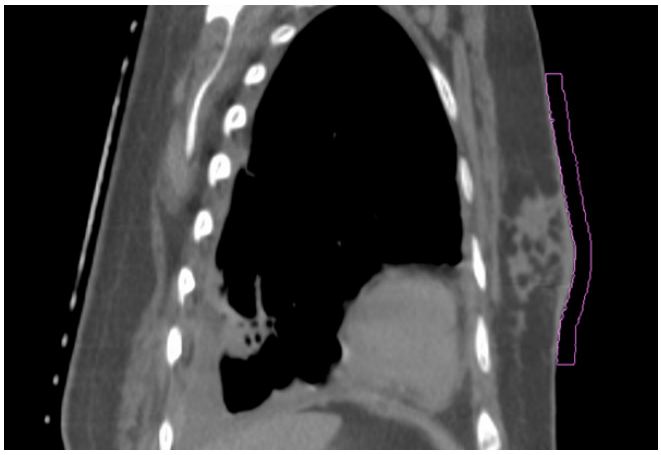

Figure 1: Sagittal view of bolus structure placement.

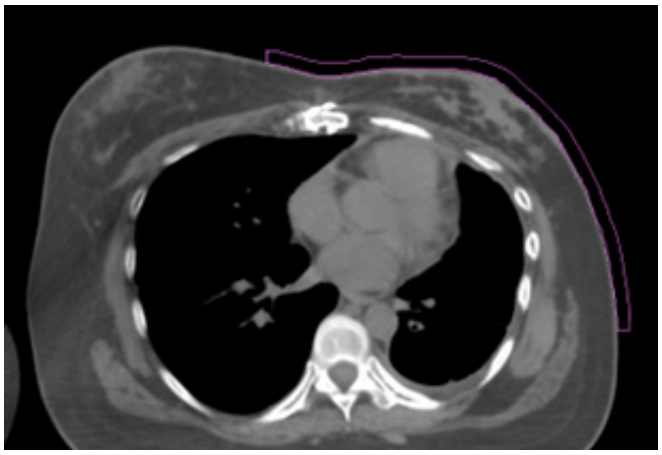

Figure 2: Axial view of the bolus structure in the TPS.

The CT data, external body contour, and bolus structure were imported into Adaptiiv software in DICOM format. The bolus model was generated and customized in Adaptiiv's 3D bolus software using the bolus sturucture from the TPS. The bolus was 3D printed using fused deposition modelling (FDM) printing and polylactic acid (PLA filament), which has a relative electron density of 1.13. To obtain a homogeneous density, the bolus was printed with 100% infill. The approximate printing time was 18 hours. After printing, support structures were removed and the edges and burrs were sanded for patient comfort.

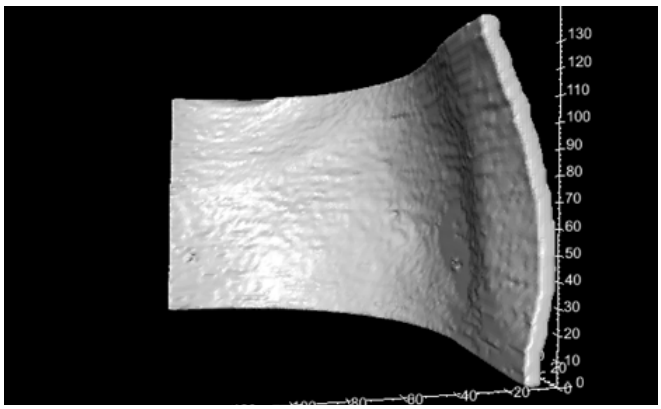

Figure 3: DICOM data was imported into Adaptiiv software and used to generate a simple bolus model.

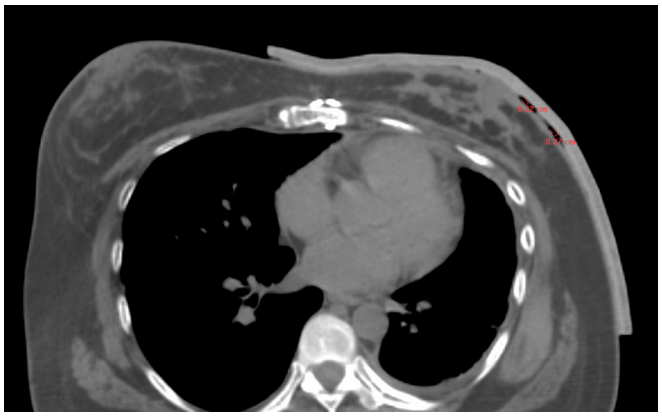

Figure 4: Second CT scan to verify placement, showing a maximum air gap of 3 mm in the ROI.

A second CT scan was conducted to verify bolus placement on the patient, air gaps were measured, and the density of the bolus was inspected. The position of the bolus was verified in all treatment fractions, visually and through CBCT, confirming minimal air gaps.

Dose

A dose of 45 Gy was delivered over 15 fractions using the 3D printed bolus with an additional electron boost (9 MeV) of 10 Gy over 5 fractions to the residual primary tumour without the bolus present. Achieving the prescription dose to the skin was important given the advanced cancer stage and cutaneous infiltration.

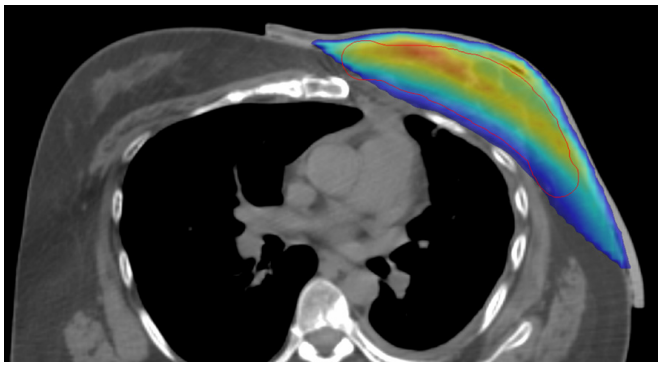

Figure 5: The treatment dose was verified in the TPS via a second CT scan prior to treatment.

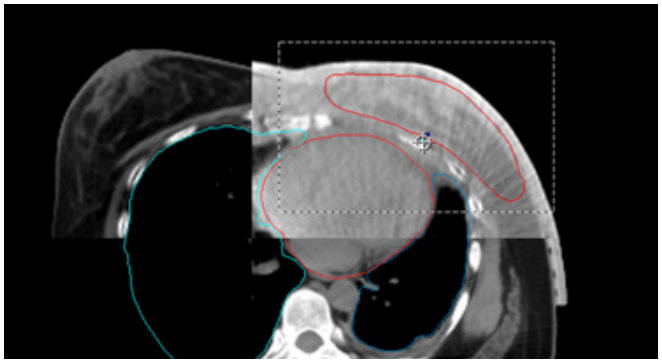

Figure 6: CBCT overlaid on the CT scan.

Results/Findings

A maximum air gap of 3 mm was found in the region of interest and the bolus had a mean density of 85 HU. Dose verification conducted during treatment by using EBT3 film between the 3D printed bolus and the patient's skin. The difference between the expected and the measured dose was ±3%. Clinical response of 80% was achieved one month after radiotherapy.

Summary

1. Dosimetric accuracy was confirmed using EBT3 film with a difference of ±3% between expected and measured dose.
2. Presence of air gaps was minimal, with a maximum air gap of 3 mm.
3. The 3D printed PLA bolus had uniform density, with mean density of 85 HU.
4. Dose to the skin was acceptable and yielded a clinical response of 80% one month after completing radiation therapy.

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