Case Study: Creation of 3D Printed Bolus for Complex Cases

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Overview

Adaptiiv Medical Technologies Inc. (Adaptiiv) provides cancer centres with the hardware, software, and materials to develop low cost, high performing medical accessories that supersede existing conventional technologies. The following case illustrates the application by Saint Luke's Radiation Oncology Network (SLRON) of Adaptiiv's technology to create a bolus for a VMAT H&N case which required bolus both over and under the patient's immobilization device. This case is a great example of how Adaptiiv's 3D printing software solution can be effectively used in a clinical setting to create a customized bolus for complex situations where standard approaches would fall short.

Description

As the immobilization mask is fixed at points on the treatment couch away from the body, there were significant gaps between the patient surface and mask at the posterior aspects of the treatment volume. Due to this gap, two bolus pieces were required, one outside and one inside the mask. Affixing bolus to the patient surface underneath immobilization equipment can be challenging due to the difficulty accessing the region and ensuring the bolus remains in place for treatment. To overcome this issue, we decided to fill the gap entirely using a 3D printed bolus (see Figure 1). The bolus was contoured to fit in the cavity and conform to the fixation screws present to hold the headrest in place. The external bolus was also 3D printed to ensure precise placement with the desired amount of overlap.

Patient History

An 87-year-old patient was referred to SLRON for adjuvant radiotherapy following the excision of a pT1N0 SCC of the left tragus. His management included excision of this primary lesion along with a superficial parotidectomy and rhombic flap, this showed a pT1N0 SCC, depth of invasion 5mm and closest radial margin 3mm.

Dose Prescription

Due to the location of the primary lesion and margin status, the case was planned to a dose of 50Gy/20# to the primary site with bolus and elective nodal treatment to a dose of 40gy/20#.

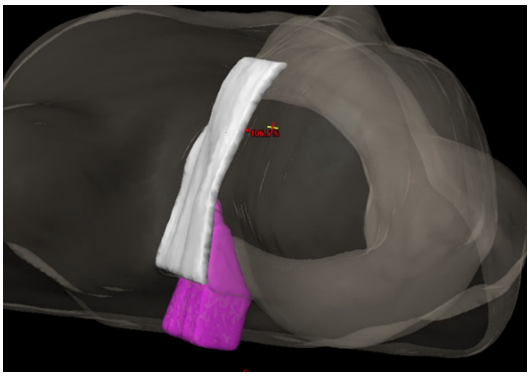

Figure 1.
3D render of both the bolus inside the immobilization mask (pink) and outside the immobilization mask (white).

Results / Findings

The resultant 3D printed bolus was efficient to place during patient setup and resulted in an effective alternative to affixing wet-gauze or other custom bolus using medical tape. CBCT imaging verified that the 3D printed boluses achieved the desired result, fitting to both the body contour and head rest fixations ensuring a consistent and secure placement (see Figure 2). 3D printed bolus is now our default treatment option for H&N cases requiring bolus in difficult to reach locations.

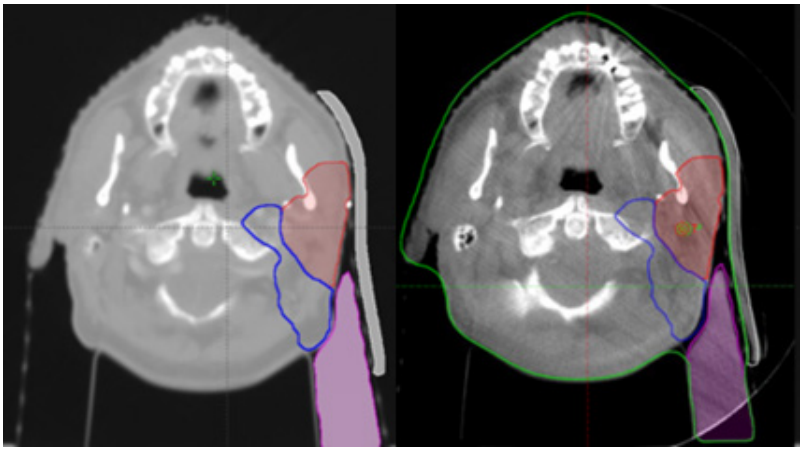

Figure 2.
Left: Planned bolus both inside and outside the treatment mask. The inside bolus was designed to fit within the cavity and immobilization resulting in good contact with the patient skin. Right: CBCT imaging showing the resultant fit on-treatment.

Summary

1. 3D printing can be implemented effectively in the clinical setting to create highly conformal bolus in difficult to reach areas.
2. The use of medical tape was eliminated as the 3D printed bolus was designed to support itself and fill the cavity.
3. The customized 3D printed bolus was reproducibly placed for each daily treatment fraction, without causing discomfort.

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