SUBMISSION TOPIC: Dose prediction, optimisation and applications of photon and electron planning

Dosimetric Impact of Thickness Variations in Moldable High-Density Boluses for 6MV VMAT Treatments

Javier Sanchez-Esperon, Fernando Picon-Garcia, Nerea Lopez-Martin, Ana Isabel Sanchez-Fernandez, Santiago Velazquez-Miranda,

HUVR

Purpose/Objective

Moldable high-density boluses (HDB) are appreciated for their adaptability, minimizing air gaps and preventing the re-build-up effect that can underdose the treatment surface. However, their variable thickness during adaptation raises dosimetric concerns. This study evaluates the impact of these variations on dose distribution in superficial radiotherapy.

Materials/Methods

Initially, we applied a direct 6MV photon field to a staircase of varying HDB thicknesses (eXaSkin, 1.7 g/cm^3, by Anatge) to observe surface dose variation. A 75% thickness variation resulted in only an 8% change in surface dose. Based on these findings, we tested a more clinically relevant model using a reduced staircase with thicknesses of 3, 7, and 12 mm.

The experimental setup included the IBA 'I'mRT' test phantom layered with stepped HDB thicknesses (Figure 1). Gafchromic EBT3 films, addressing potential uncertainties in TPS calculations at high-density change interfaces, were placed beneath the bolus and at a 10 mm depth. A rectangular target volume of 1 cm thickness was defined below the HDB.

The phantom was scanned using a Siemens SOMATOM Confidence® RT Pro CT scanner, and the treatment plan was developed in the Varian Eclipse™ Treatment Planning System with the Acuros XB Advanced Dose Calculation algorithm (version 16.1). A 220° VMAT arc was optimized (PTV ≥ 95% Rx, Dmax ≤ 107%, cork [Body - (PTV + 3mm)] ≤ 70% Rx, equal priority), with the isocenter set between the bolus and the phantom surface (Figure 2). The plan was delivered on a 6MV TrueBeam linear accelerator equipped with a Varian Millennium™ 120 MLC.

Results

For a direct 6MV photon field applied to a staircase of varying thicknesses of this HDB, a 75% thickness variation—representing extreme cases within the typical range of variability for moldable bolus applications—resulted in only an 8% change in surface dose, demonstrating minimal sensitivity to thickness differences under simplified conditions.

In the case of VMAT, surface dose measurements showed no dependency on this HDB thickness (Δdose surface < 2%) within the considered range of thickness variations. Gamma analysis of the control films yielded a 95% passing rate under standard criteria (2%/2 mm).

Conclusion

This specific HDB maintains consistent dose buildup under the extreme thickness variations tested. Thickness differences showed no significant impact on surface dose uniformity or dose distribution in VMAT treatments for superficial lesions. These results confirm its reliability as a clinical tool, providing adaptability and dosimetric stability for advanced radiotherapy.

References

- T. Al-Sudani et al. *Dose build-up characteristics with eXaSkin bolus during 6MV radiotherapy: MOSkin dosimetry results*. 2019 J. Phys.: Conf. Ser. 1154 012024.
- Al-Sudani TA et al. *eXaSkin: A novel high-density bolus for 6MV X-rays radiotherapy*. Phys Med. 2020 Dec;80:42-46. doi: 10.1016/j.ejmp.2020.09.002. Epub 2020 Oct 20. PMID: 33096418.
- M. Ortiz Seidel et al. *Dosimetric characterization of eXaSkin: High-density bolus for photon use*. Reports of Practical Oncology and Radiotherapy, June 2013, Volume 18, Supplement 1, Pages S355
- Santiago Velázquez et al. *New high-density bolus: A new approach for the treatment of superficial tumors with photon*. May 2012, Radiotherapy & Oncology, Volume 103, Supplement 1, Pages S473–S474.

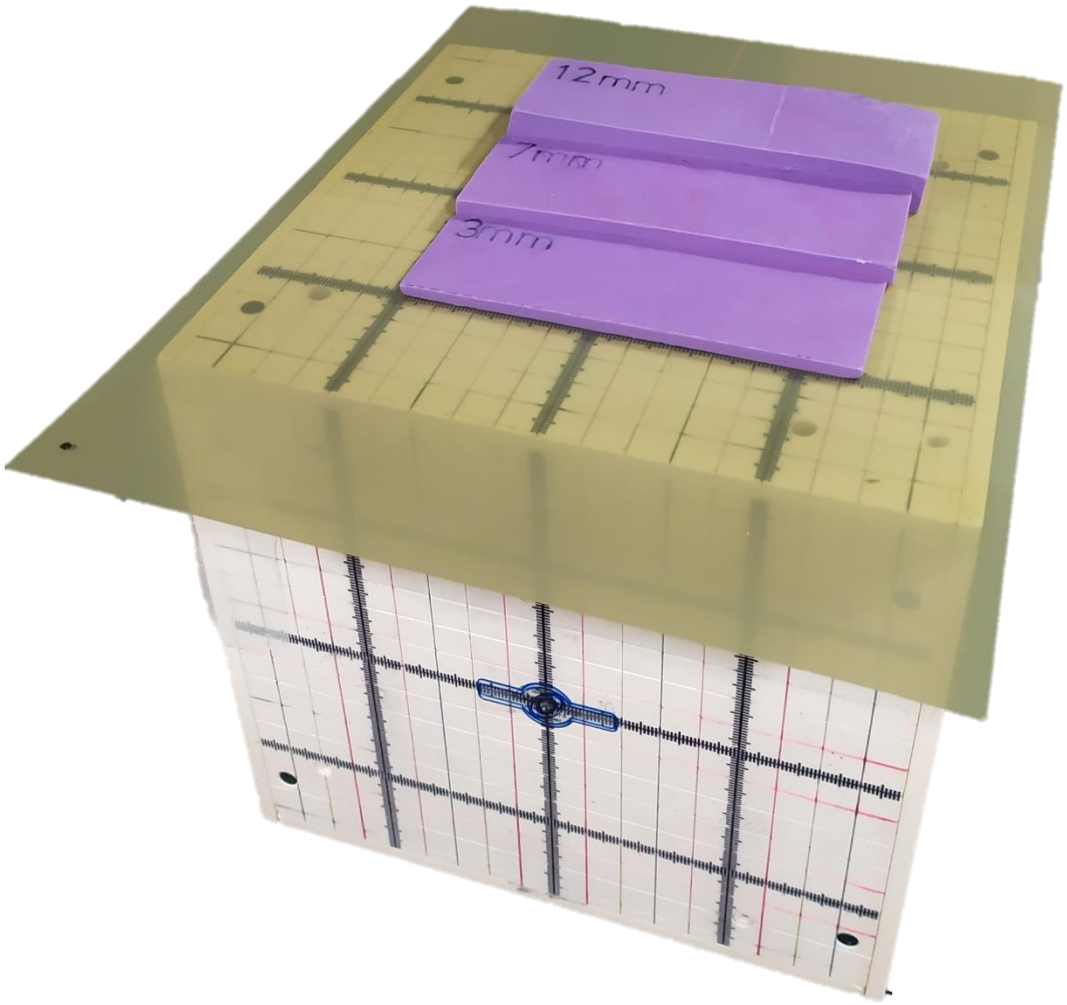


Figure 1. Diagram of the IBA 'I'mRT' test phantom with stepped HDB thicknesses.

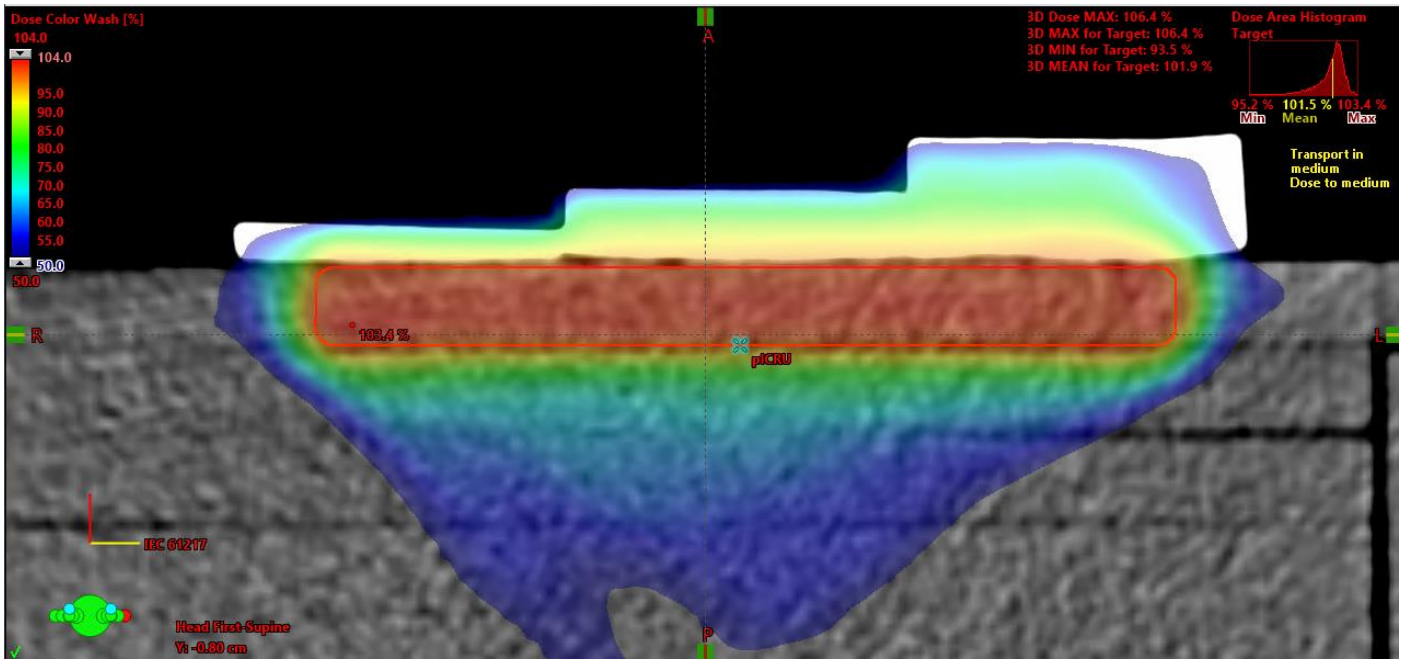


Figure 2. Schematic of the VMAT arc plan and isocenter placement.