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Dosimetry Predictors of Acute Skin Reactions after Whole Breast Radiotherapy

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What was your motivation for initiating this study?

This analysis is part of an extended project to describe acute, early-late and late skin reactions through dosimetric parameters from a 3D structure that is representative of the epidermis, dermis, and hypodermis. The idea is to move from the normal tissue complication probability models based on planning target volume (PTV), which are affected by the institutional contours and are of limited use because they are applicable only in the case of a translation toward a partial breast irradiation (PBI). We are testing the hypothesis that a 3D distribution of the skin is generalisable and independent of the radiotherapy technique; if this is the case, the planner will be able to use new structures to limit the radiation-induced effects in early-stage breast cancer patients.

We analysed a large cohort of 1100 early-stage breast-cancer patients who had been treated at San Raffaele Scientific Institute with 40Gy in 15 fractions.

What is the most important finding of your study?

We defined a a 5mm structure that described the skin of the breast patients in line with the findings by Liu and colleagues on ultrasound images (1).

This structure expressed well-separated average dose-volume histograms (DVHs) for patients with and without toxicity. The impact of the dose was found for DVH points below 34Gy. We decided to use the V20Gy (50% of the prescription dose) as a dose parameter to limit acute toxicity. The dose model showed statistics comparable with those produced by the PTV model. Moreover, we tested the impact of non-dosimetric factors. We developed a multivariable model that included V20Gy, lymph node dissection and hypertension. The final factors had a similar odds ratio in our population so that we could represent the volume response curves stratified by the presence of zero, one or two risk factors (low-, mid- and high-risk groups), with average toxicity of 11%, 16% and 26%, respectively.

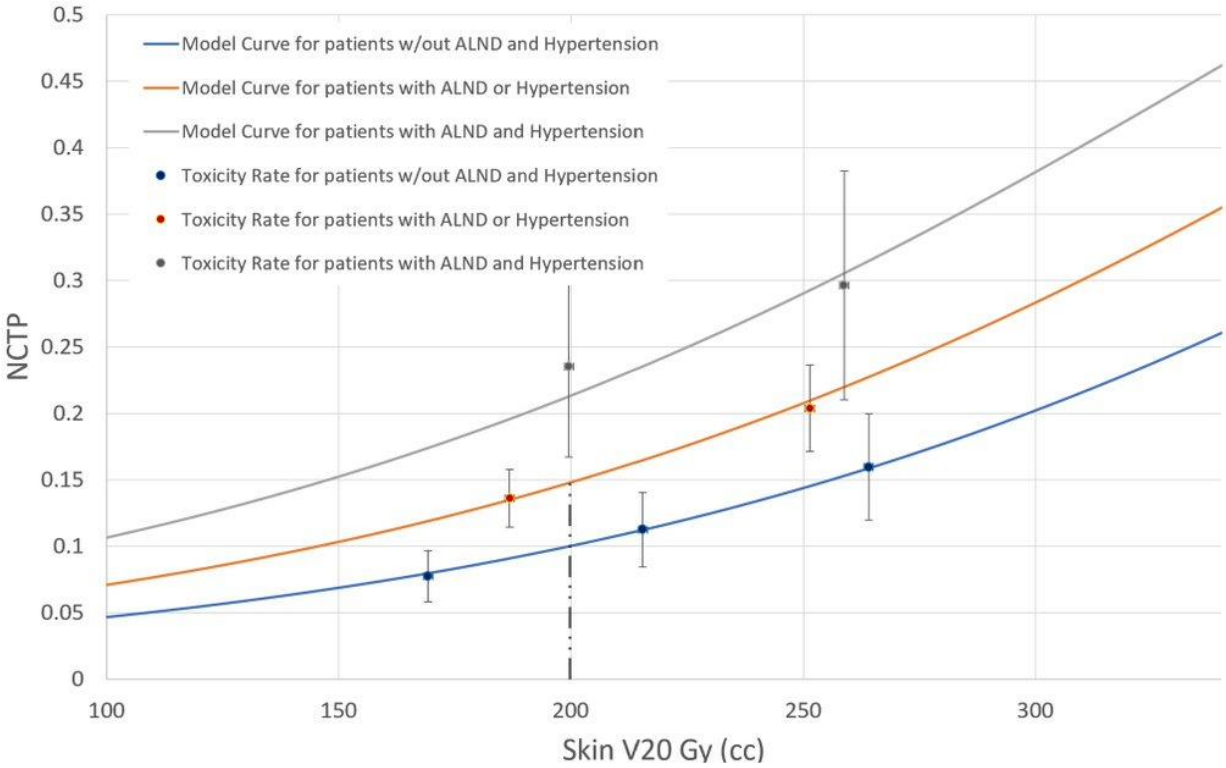
What are the implications of this research?

Analysis is ongoing at our institute to confirm that the model works with other radiotherapy techniques. If the results are positive, we may consider our dose-volume constraint (V20Gy<200cc) for reducing moderate skin reactions after radiotherapy to below 10%.

In our preliminary analysis, we also tested the impact of indirect partial arch irradiation on such a new contour. Without imposing any constraint, we found that such an approach could guarantee a reduction in the skin dose at values of V20Gy below the identified threshold.

The use of the model can limit toxicity, drive a personalised follow-up or the application of local medication, or push patients toward the PBI technique when clinically feasible.

1) T. Liu, J. Zhou, K. S. Osterman, P. Zhang, S. A. Woodhouse, P. B. Schiff, and G. J. Kutcher. Measurements of radiation-induced skin changes in breast cancer radiation therapy using ultrasonic imaging. In 2008 International Conference on BioMedical Engineering and Informatics, volume 2, pages 718–722. IEEE, 2008.



Dose-response curves and observed toxicity rates for pts (i) without any risk factors (blu data), (ii) with axillary lymph node dissection or hypertension (orange data, to simplify the graph, we collapse the classes into one since the OR for the two risk factors were similar), (iii) with all risk factors (grey data). The average toxicity rate for the three curves/classes are 11%, 16% and 26%.

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