

LETTER to the EDITOR

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Quantitative Reporting and Reproducibility in Monte Carlo Investigations of Field Size Effects

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Dear Editor

I read with interest the article entitled “Monte Carlo Investigation of Field Size Effects on Central-Axis Dose Distributions (PDD Curves) and Lateral Dose Profiles” by Alashkar et al. [1]. The authors investigate the influence of photon beam field size on percentage depth dose (PDD) curves and lateral dose profiles using Monte Carlo (MC) simulations, a topic of continuing relevance in radiotherapy physics. While the study addresses a fundamental dosimetric concept and employs an appropriate computational approach, several methodological and reporting limitations restrict its scientific rigor and overall contribution.

Monte Carlo simulation, recognized as an accurate approach for radiation transport modelling in radiotherapy, serves as an independent secondary method for verifying treatment planning system dose calculations [2, 3]. However, the scientific credibility of MC-based results relies on transparent reporting of statistical uncertainty and convergence criteria [3]. In the present study, key simulation parameters, including the number of particle histories, voxel-wise statistical uncertainty, and convergence criteria, are not reported. Established recommendations and clinical practice indicate that Monte Carlo dose calculations should include explicit uncertainty estimates, typically on the order of 1–3% in regions of clinical relevance, to enable reliable interpretation and meaningful comparison of results [4, 5]. In the absence of such information, it is not possible to determine whether the reported differences between field sizes exceed inherent statistical fluctuations.

The qualitative nature of the Results section further limits the impact of the study. Although the authors correctly describe expected physical trends, such as increased surface dose and a deeper depth of maximum dose (d_{max}) with increasing field size, these observations are not supported by numerical values. Monte Carlo techniques are particularly valuable because they enable precise quantification of dosimetric metrics, including surface dose, d_{max} , dose at specific depths, and penumbra characteristics. The lack of tabulated quantitative results and associated uncertainties reduces reproducibility and diminishes the strength of the conclusions [6].

In this context, the supplementary material accompanying the article warrants particular attention. The supplementary figures present PDD curves and beam profiles at multiple depths for all investigated field sizes, as well as a comparative PDD plot across fields. These

materials demonstrate that detailed dose distributions were indeed generated. However, no numerical dose values, uncertainty estimates, or statistical analyses are provided, either in the main manuscript or in the supplementary files. Consequently, while the supplementary figures visually support the reported trends, they underscore a missed opportunity to extract and report quantitative dosimetric parameters that would significantly strengthen the study. Moreover, the supplementary material continues to omit uncertainty information, reinforcing concerns regarding statistical robustness and reproducibility.

Another important limitation is the absence of experimental validation or benchmarking against reference datasets. Despite statements suggesting agreement with experimentally measured dose distributions, no measurements or comparative data are presented. Even limited validation, such as comparison of simulated PDDs for a 10×10 cm² reference field with ionization chamber measurements or published reference data, would considerably enhance confidence in the beam model. Benchmarking against established Monte Carlo frameworks or dosimetry protocols, such as AAPM TG-51 or IAEA TRS-398, is commonly expected in simulation-based dosimetric studies [7–9].

The scope of interpretation in the discussion and conclusion sections also extends beyond what is supported by the methodology. All simulations are confined to a homogeneous water phantom and do not account for patient anatomy, tissue heterogeneities, or realistic treatment planning scenarios. It is well established that heterogeneities and beam modulation can significantly influence field-size-dependent dose behaviour, particularly in small-field conditions [10]. From a clinical perspective, the absence of quantitative dose metrics, experimental validation, and patient-based modelling limits the usefulness of the findings for clinical interpretation or treatment decision-making.

Finally, several additional dimensions could have enhanced the novelty and scientific depth of the work. These include sensitivity analysis of voxel size and transport parameters, investigation of small-field dosimetry effects such as loss of lateral charged particle equilibrium, and analysis of beam energy spectra or off-axis softening as a function of field size. Incorporating any of these aspects, especially in conjunction with the existing supplementary dose distributions, would have extended the study beyond confirmation of well-established dosimetric behaviour.

The authors employ an appropriate Monte Carlo

framework to study an important dosimetric concept, the absence of quantitative reporting, uncertainty analysis, validation, and scope-appropriate interpretation limits the robustness and clinical relevance of the findings. Addressing these issues in future work would substantially improve the scientific value and reproducibility of Monte Carlo investigations of field-size effects in radiotherapy.

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