Design of a graphical user interface aiding tool for Monte Carlo simulation tuning process for electron beam modeling

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Purpose: It is usually difficult to obtain all the geometric details of a clinical accelerator necessary for accurate modeling of the treatment head. This work is aimed at designing a program that could provide, based on measurements, possible reasons for the dosimetric discrepancy and possible solutions based on empirical equations that are implemented in the program.

Material and Methods: In this work, Monte Carlo simulations were performed for all available electron energies. MCBEAM and MCSIM Monte Carlo codes were used for treatment head simulation and phantom dose calculation. As the incident electron energy is the primary tuning parameter for an electron beam several monoenergies were simulated using Monte Carlo. A series of empirical equations were created that govern several beam parameters (R90%, R80%, R50%, R20%, width at 80% of maximum dose) as a function of energy. The empirical equations were then incorporated in a graphic user interface (GUI) program, which allows for the input of the measured and calculated percentage depth dose curves and profiles. The program could then suggest what should be the next step in the tuning process. By analysis of the measured curve, the program could predict the need for a spectrum to represent the electron beam source. An iterative search was then done to find the best spectrum that would represent the electron source.

Results: Applying the equation for a measured 6MeV beam predicted that a spectrum of energies is needed to represent the electron source. The iterative search was able to predict the energy spectrum with great accuracy.

Conclusion: Our GUI-based program can be a helpful tool for Monte Carlo beam modeling to facilitate the clinical implementation of Monte Carlo simulations for radiotherapy treatment planning and dosimetry verification. It can reduce the modeling time significantly for less experienced Monte Carlo users