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Evaluation of electron dose distribution obtained from ADAC Pinnacle system against measurement and Monte Carlo method for breast patients

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Introduction: With the development of dose calculation algorithms for electron beams, 3D RTP systems are available for electron beam dose distribution commercially. However, no studies evaluated the accuracy of dose calculation with ADAC Pinnacle system for electron beams. So, the accuracy of the ADAC system is investigated by comparing electron dose distributions from ADAC system against the BEAMnrc/DOSXYZnrc.

Methods: A total of 33 breast cancer patients treated with 6, 9, and 12MeV electrons in our institution was selected for this study. The first part of this study is to compare the dose distributions of measurement, TPS and the BEAMnrc/DOSXYZnrc code in flat water phantom at gantry zero position and for a 10×10 cm^2 field. The second part is to evaluate the monitor unit obtained from measurement and TPS. Adding actual breast patient's irregular blocks to the first part, monitor units to deliver 100 cGy to the dose maximum (dmax) were calculated from measurement and 3D RTP system. In addition, the dose distributions using blocks were compared between TPS and the BEAMnrc/DOSXYZnrc code. Finally, the effects of tissue inhomogeneities were studied by comparing dose distributions from Pinnacle and Monte Carlo method on CT data sets.

Results: The dose distributions calculated using water phantom by the TPS and the BEAMnrc/DOSXYZnrc code agreed well with measured data within 2% of the maximum dose. The maximum differences of monitor unit between measured and Pinnacle TPS in flat water phantom at gantry zero position were 4% for 6 MeV and 2% for 9 and 12 MeV electrons. In real-patient cases, comparison of depth doses and lateral dose profiles calculated by the Pinnacle TPS, with BEAMnrc/DOSXYZnrc code has generally shown good agreement with relative difference less than +/-3%.

Discussion: For comparisons of real-patient cases, the maximum differences between the TPS and BEAMnrc/DOSXYZnrc on CT data were 10%. These discrepancies were due in part to the inaccurate dose calculation of the TPS, so that it needs to be improved properly.

Conclusions: On the basis of the results presented in this study, we can conclude that the ADAC Pinnacle system for electron beams is capable of giving results absolutely comparable to those of a Monte Carlo calculation.