Investigation of 6 MV static beams within the Swiss Monte Carlo Plan

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Introduction

Monte Carlo (MC) based dose calculations can compute doses with an accuracy that surpasses that of the conventional algorithms used in radiotherapy, especially in regions of tissue inhomogeneities and surface discontinuities. Currently only very few commercial treatment planning systems (TPSs) support photon MC treatment planning. This is mainly due to the lack of an accurate model of the accelerator radiation source, and long computing time needed to get reasonable statistical accuracy in the calculated dose distributions. The Swiss Monte Carlo Plan (SMCP) [1] developed at the Division of Medical Radiation Physics, Inselspital and University of Berne, overcame these problems by automation of the procedures needed for dose calculation and evaluation. This makes the MC environment very flexible and suitable for photon MC tretment planning. Aim of this study is the investigation of 6 MV beams within the framework of the SMCP.

Material and Methods

For this study dose distributions for 6 MV were simulated in a water phantom using the following parameters: a phase space source; the VMC++ code [2] for the full radiation transport through the individual beam modifiers, such as jaws, wedges and block; the VMC++ code to compute the dose distribution in the phantom for the selected fields with a voxel size of 0.2 cm and a statistical uncertainty of about 0.5%. Simulated depth dose curves and profiles for open fields and fields with beam modifiers (wedges and block), ranging from 3x3 to 30x30 cm^2, were compared with the corresponding measurements using dose difference and gamma analysis. For the commissioning of the block, its density has been used as parameter to match transmission measurements. For the wedged beams (15°, 30°, 45° and 60°) the density and the thickness of the wedges have been adjusted within the range specified by the manufacturer to match the according measurements for the largest field size available. The validation was performed for smaller field sizes down to 5x5 cm^2.

Results

Results for all open fields showed an excellent agreement between measurements and simulations, for the chosen dose difference criterion of ± 1% of D_{max} and the distance to agreement criterion of ±1 mm. The tuning of all wedges lead to an agreement with the corresponding measurement within 1% and 1mm. Similar results have been achieved for the block. For the validation of the tuned wedges, more than 99% of all voxel have a $\gamma < 1$ using a 1%/1mm criterion.

Discussion

The comparison of calculated and measured dose distributions lead to optimization of the simulation parameters such as density and shape of the beam modifiers. The SMCP has been validated so far for a photon beam of 6MV and static fields, but further studies will be carried out for the validation of the SMCP for additional beam energies and dynamic fields.

References

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