Independent 2D dose calculation of IMRT fields using MapCALC

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Introduction

Quality assurance (QA) for IMRT is usually performed by comparing calculated 2D dose distributions with measurements using film, EPID, or 2D detector arrays, often in combination with an ionization chamber for absolute dose at one point. However, these methods are time-consuming and require access to the linear accelerator. We investigated the potential of a planar dose calculation algorithm for independent IMRT treatment verification, which would make additional patient-specific measurements redundant.

Material and Methods

The algorithm uses an advanced two-source model [1] and has to be commissioned using Linac/MLC-parameters, dose profiles, and output factors measured in a specific dose plane. With this model planar dose and fluence maps of 1 mm^2 spatial resolution are calculated from patient plan data (incl. MLC leaf-map), exported from the treatment planning system (TPS). We used MapCALC, the commercialized algorithm by SunNuclear, and generated a model for a 6 MV Varian linac equipped with a millennium 120 MLC at an SSD of 90 cm and a dose plane depth of 10 cm. This model was then applied to calculate 2D dose maps of 10 clinical IMRT prostate plans (5 fields each) applying sliding window technique. The resulting dose maps were compared to the calculation results of the TPS (Eclipse) using gamma analysis. In addition, we tested the sensitivity of the algorithm to detect artificial errors, created in the MLC leaf maps of randomly selected prostate fields.

Results

The average passing rates for the 3%/3 mm and 2%/2 mm criteria were 99.9%±0.3% (range: 98.3-100%) and 98.4%±1.8% (range: 92.0-100%), respectively, whereby a threshold of 10% was applied. On average, isocenter and maximum dose values of MapCALC and TPS agreed within (0.6±0.7) cGy and (1.6±2.1) cGy, respectively, which corresponds to (0.3±0.4)% and (1.0±1.1)% of the applied dose per fraction. Fig.1 shows the result of an exemplary comparison for an IMRT prostate field. The effect of an artificial lag of a single leaf on the dose map calculated by MapCALC is presented in Fig. 2.

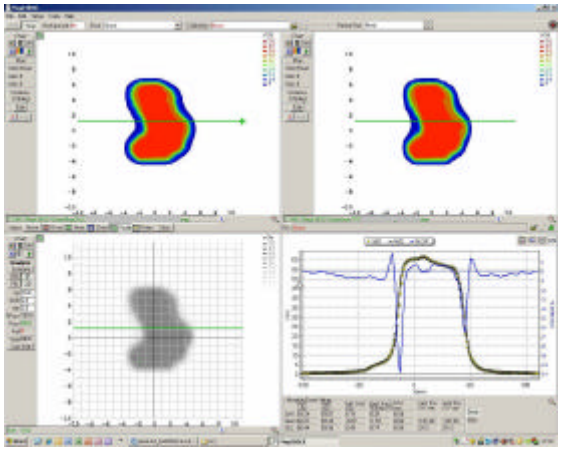

Fig.1: 2D dose plane calculated by MapCALC (top, left) and the TPS (top, right), the result of the gamma analysis (bottom, left) and corresponding profiles (bottom, right).

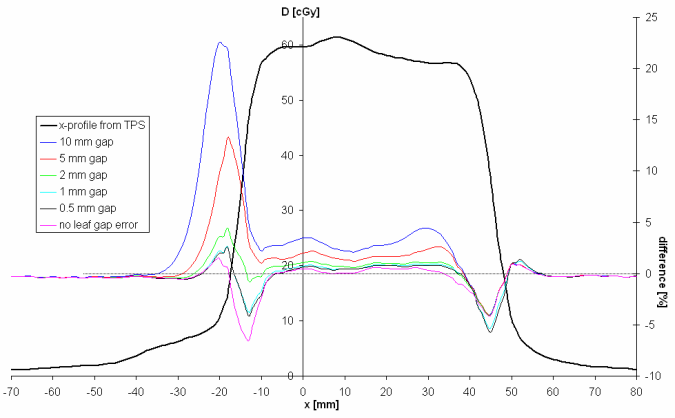

Fig.2: Dose planes with leaf gap errors ranging from 0.5 to 10 mm were calculated with MapCALC. The resulting profiles at the position of the respective leaf were subtracted from the corresponding dose profile of the original dose map calculated by the TPS (curve in black).

Discussion

Our first tests show that MapCALC is a fast and reliable method for patient-specific 2D IMRT-QA of prostate plans. Accurate planar dose maps are calculated within seconds. Our work in progress is the evaluation of 2D dose distribution of more modulated fields - as e.g. in head and neck cases.

References

[1] Yan, G.; Liu, C.; Lu, B.; Palta, J.R.; Li, J.G.: Comparison of analytic source models for head scatter factor calculation and planar dose calculation for IMRT. Phys Med Biol. 53(8) (2008), S. 2051 - 2067