Relating anatomical variations and patient features with dose-reconstruction accuracy of a 3D dose-reconstruction approach using CT scans of recently-treated children

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Purpose

Reconstructing 3D dose distributions for pre-1990 pediatric 2D radiotherapy plans is challenging, but key to research on late adverse effects. We studied the relation between dosimetric accuracy, anatomical variation, and other patient features of a 3D dose-reconstruction approach using CT scans of recently-treated patients, rather than phantoms.

Materials and methods

CT-scans of 22 Wilms' tumor patients (age:2.5-5.3yrs; n boys/girls:11/11) treated between 2004 and 2015 were included. Two clinical plans as applied to a 4-year-old boy and girl with a left-sided Wilms' tumor served as references. Each plan was applied to the CT scans of the other 21 patients, adjusted to correct for anatomical differences as visible in digitally-reconstructed-radiographs, and the resulting dose was calculated. Deviations in reconstructed dose, with respect to the reference dose, in organs-at-risk (spinal cord, right kidney, liver, and spleen) were characterized by the mean dose error normalized by the prescribed dose (DE_{mean}). Deviations in organs' location relative to a reference point (ΔO_{loc}) and in organs' shape captured by the Dice coefficient (DC) were calculated. We estimated the Pearson's correlation between DE_{mean}, on the one hand, and ΔO_{loc}, DC, gender, age, height, and weight, on the other hand.

Results

Average(range) DE_{mean} values were: spinal cord:3(0-8)%; right kidney:6(0-20)%; liver:9(0-20)%; and spleen:23(0-80)%. DC and DE_{mean} in the right kidney were moderately negatively correlated (r^2=0.41). DE_{mean} in the liver was uncorrelated with any of the tested parameters. A positive correlation was found between ΔO_{loc} and DE_{mean} in the spleen (r^2=0.68). No correlations (r^2<0.2) were found between DE_{mean} and gender, age, height, and weight.

Conclusions

The dose-reconstruction accuracy is primarily related to similarity in internal anatomy and not to patient features like height and weight. For a dose-reconstruction approach utilizing CT scans of recent patients, a more advanced selection strategy for the CT scan to be used is therefore needed.