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Dissertations-Kurzfassung

Optimization of Film Dosimetric Accuracy, Evaluation of Different Dose Calculation Algorithms and Implementation of an Advanced Treatment Technique for Breast Cancer into Clinical Routine

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Radiotherapy treatment paradigms for breast cancer are safe and effective. Potential for further improvement is to be found in the area of more complex treatment techniques for further sparing organs at risk and improving doses homogeneity as well as implementing refined dose calculation algorithms such as Collapsed Cone and Monte Carlo. This thesis laid the foundation to introducing a new intensity modulated treatment technique for breast cancer in our department by comparing different candidate techniques and evaluating the delivery accuracy with different dose calculation algorithms providing the reference dose. First, extended commissioning of self developing Gafchromic® EBT films, used for quality assurance of intensity modulated radiotherapy (IMRT) plans, and the Epson Expression™ 1680pro scanner was performed. It could be demonstrated that Gafchromic® EBT films are insensitive to pressure and temperature. In addition, scan direction dependency was investigated. A difference of around 5% between two different scan positions (0° and 90° film position) was determined. Scanning in short intervals <2min should be avoided since it causes errors of up to 1.6% particularly in low dose areas. In the second part of this work, the accuracy of dose prediction based on different dose calculation algorithms implemented in commercially available planning systems was investigated. The patient anatomy was imitated using an anthropomorphic phantom comprising left and right lung, spinal cord and left breast attachment. Exactly the same conventional plans with two tangential wedged fields were generated on a phantom in six radiotherapy departments. A total of three plans were generated in MasterPlan® 1.4, two in TMS® 6.1 and one plan each in PrecisePLAN® 2.03, Pinnacle3® 7.6c and Eclipse®. The dose distributions were calculated in MasterPlan® with Pencil Beam (PB) and Collapsed Cone (CC), in Pinnacle® with CC, in TMS®, PrecisePLAN® and Eclipse with a PB algorithm. The plans were verified locally with Gafchromic EBT films. Dosimetric results from this study showed that all participating planning systems are able to predict the delivered dose reliably in the clinical routine inside the breast tissue independent of dose calculation algorithm used. The agreement between the calculation and measurement were in this area ±3% in all cases. Significant differences in the dose calculation accuracy were seen inside the lung. The film dosimetric results demonstrated that the PB algorithms *overestimated* the dose applied to the lung by up to 23%. The CC algorithms showed more realistic dose predictions. However, the CC *underestimated* the dose by up to 6% in all cases. Finally, three treatment techniques for breast cancer, a conventional, multi field technique (MFT) and a tangential IMRT were compared with one another regarding homogeneity of the applied dose distribution. The efficiency of the plan creation as well as delivery was similar in all three treatment techniques. The plans were verified using EDR2 and Gafchromic® EBT films. The films were scanned using different scan procedures. The dose measured with EDR2 film showed spots failing the gamma analysis with 5% PDD and 3 mm DTA for the conventional and MFT. Also the Gafchromic® EBT films, uncorrected as well as corrected with field homogeneity correction matrix based on an exposed film, showed some red spots by the gamma analysis using 5% PDD constrains. The best agreement with the calculation was detected using Gafchromic® EBT films corrected with a field homogeneity correction matrix based on an unirradiated film. It could be shown that using a tangential IMRT technique enables improvement of the dose distribution homogeneity in comparison to the conventional and MFT technique. Therefore, the film evaluation confirmed the improved homogeneity of the dose distribution in comparison to the conventional and MFT. Taken together, these results led to the clinical implementation of tangential IMRT after evaluating this technique with regard to potential benefit and delivery accuracy, part of which was performed in a multicenter setting.