Implementation of Tongue & Groove in the Treatment Planning System

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Introduction

Tongue & groove is a characteristic of the multileaf collimator construction to prevent radiation leakage between adjacent leaves. This feature is getting visible in IMRT fields with the step-and-shoot technique when adjacent subfields deliver dose through either the tongue or the groove of the leaf. The construction of the IMRT field depends on the optimisation algorithm in the treatment planning system.

Material and Methods

To prevent dose overestimation in the junction area of two IMRT subfields it is possible to take into account the tongue & groove effect by adjusting the tongue and groove width (TGW) and the additional interleaf leakage transmission (AILT) in the Pinnacle treatment planning system version 8.0m. The dose distribution of two special designed fields with completing multileaf are calculated in the Pinnacle TPS to make the tongue & groove effect visible. Different values for TGW and AILT were chosen. The dose distribution in a plane perpendicular to the beam axis was calculated for a 6 MV photon beam with 120 monitor units in a depth of 5.7 cm of water with a source to surface distance of 95 cm. This dose distribution was transferred to the FilmQA software. An EDR2 film packed in a perspex phantom was irradiated with the same two fields on a linear accelerator Siemens Oncor Impression as reference. A blank film and a calibration film were also irradiated. These films were scanned with an Epson scanner and transferred to FilmQA software to evaluate.

Results

Using the FilmQA software the distribution of the optical density of the film was converted into a dose distribution using the background film and the calibration film. A profile of this dose distribution was taken as an average of five profiles perpendicular to the MLC moving direction by using the PTW FilmAnalyze software. The measured profile was compared to the calculated profile of the treatment planning system. The TGW was finally set to 0.2 cm and the AILT to 0.8 %. The difference in the dose points of the profile with and without TGW and AILT correction is up to 23%. Up to 18% is the difference comparing dose points of the measured and the calculated profile with TGW and AILT correction. Overall the measured and calculated profiles have a good agreement within 1.5%.

Discussion

For the step-and-shoot IMRT technique the Pinnacle TPS optimisation algorithm combines in contrast to the Konrad TPS optimisation subfields in the direction perpendicular to the MLC movement. This prevents errors in the dose application (dose gaps or hot spots) caused by not perfect reproducibility of the MLC positioning in the direction of the MLC movement. But it makes the tongue & groove effects of an imperfect MLC construction visible.
The implementation of the TGW and the AILT in the Pinnacle TPS is a good tool to take into account the MLC characteristic for the optimisation of IMRT. At least it makes visible the deficits of the MLC in the step-and-shoot technique. Including TGW and AILT has shown an improvement in the IMRT verification comparing the calculated and measured dose. The calculated dose distribution from the planning system fits better to the real dose application on the linear accelerator. Although the planning system can not meet for extreme dose gaps caused by the tongue & groove effect (up to 18%).