A Method to transform 2D LDR brachytherapy plans into contemporary 3D PDR dose distributions

Emmy Rodenburg (RTT)*, Jennifer Wilkes (RTT), Jan Wiersma (PhD), Rafael Ordoñez Marmolejo (MD), Raquel Dávila Fajardo (MD), Arjan Bel (PhD), Bradley Pieters (MD/PhD)
Department of Radiation Oncology, Academic Medical Center / University of Amsterdam

Introduction

Before 2001 pediatric head and neck (H&N) patients received Low-Dose Rate (LDR) brachytherapy as a part of their treatment.

In the 2D era no information about Dose-Volume Histogram (DVH) parameters of organs at risk (OARs) was available in brachytherapy plans. To enable research on late dose effects for children treated with LDR brachytherapy, 3D dose distributions and DVH parameters are required.

In this study a method was developed to enable calculation of DVH parameters.

Material & Methods

Of 16 LDR plans (1989-2001) only hard-copy CT data, orthogonal x-ray images of the implant and documented 2D dose information were available (fig. 1).

Hard-copy CT data was digitized, transferred to DICOM format and imported in Oncentra Brachy (Elekta, V4.3). OARs were delineated, used catheters were reconstructed (Fig.2,3).

Ir192-LDR line sources from 2D plans were simulated by loading the reconstructed catheters with Ir192-PDR source tracks of the same length, step size 2.5mm. All PDR source dwell times were made equal, but scaled to the documented 2D dose distribution to obtain the 3D dose distribution at time of treatment. Scaling was performed at a 2D LDR isodose level below 30% of the prescribed dose in a plane where the documented 2D dose distribution and transformed 3D dose distribution geometrically match (fig. 2, arrow). Scaling on a low isodose level is done to avoid effects due to the non-uniform isodose distribution very close to a stepping PDR source.

To check the reliability the Total Reference Air Kerma (TRAK) for both plan types were determined and compared. The difference was tested with the Wilcoxon Signed Rank Test for paired variables.

For 7 patients the CT data incorporated the chiasm area. To illustrate the applicability of the method the D0.1cm³ was determined.

Results

Mean TRAK
2D-plan: 0.95cGy/1m (IQR 0.89)
3D-plan: 0.89cGy/1m (IQR 0.74)

Wilcoxon Signed Rank Test for paired variables
Mean difference 2D TRAK & 3D TRAK: statistically not-significantly different from 0 (P=0.45)

Mean Chiasm D0.1cm³
233.6cGy (range 4.6-399.2)

Conclusion

1. With the described method it was possible to transform 2D LDR brachytherapy plans into a 3D dose distribution.
2. This method shows the possibility to use information from 2D LDR brachytherapy plans in scientific studies in which 3D dose information is needed.