A theoretical evaluation of transmission dosimetry in 3D conformal radiotherapy

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Contents

List of Tables

List of Figures

Abstract

Two-dimensional transmission dosimetry in radiotherapy has been discussed in the literature for some time as being a potential method for *in vivo* dosimetry. However, it still remains to become a wide spread practice in radiotherapy clinics. This is most likely due to the variety in radiotherapy treatment sites and the challenges they would present in terms of detection and interpretation at the transmitted dose level. Thus, the full potential and limitations of applying transmission dosimetry in the presence of dosimetry errors still need to be demonstrated.

This thesis is a theoretical evaluation of transmission dosimetry using the Pinnacle^3 treatment planning system. The accuracy of predicting reliable and accurate absolute transmitted dose maps using the planning system dose algorithm for comparison with measured transmitted dose maps was initially investigated. The resolution in the dose calculations at the transmitted level was then evaluated for rectilinear and curved homogeneous phantoms and rectilinear inhomogeneous phantoms, followed by studies combining both surface curvature and heterogeneities using anthropomorphic phantoms. In order to perform transmitted dose calculations at clinically relevant beam focus-to-transmitted dose plane distances using clinical patient CT data it was first necessary to extend the CT volume. Finally, the thesis explored the efficacy of applying transmission dosimetry in the clinic by simulating realistic dosimetry errors in the planning system using patient treatment plans for a prostate, head and neck, and breast CRT (Conformal Radiotherapy) treatment. Any differences at the transmitted dose level were interpreted and quantified using the gamma formalism. To determine whether the transmitted dose alone was a sufficient indicator

of the dosimetry errors, the magnitude in transmission dose differences were compared with those predicted at the midplane of the patient. Dose-Volume Histograms (DVHs) were also used to evaluate the clinical significance of the dose delivery errors on the target volume and surrounding healthy tissue structures.

Signed Statement

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

SIGNED: ..... DATE: .....

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Publications in refereed journals

1. **P. Reich** and E. Bezak, "The use of a treatment planning system to investigate the potential for transmission dosimetry in detecting patient breathing during breast 3D CRT," *Australas. Phys. Eng. Sci. Med.* 31(2), 110-21 (2008).

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International

1. Mohammadi, E. Bezak, and **P. Reich**. "Using a Scanning Liquid Ionization Chamber EPID for Prostate and Head and Neck Treatments". *World Congress on Medical Physics and Biomedical Engineering*. 2006. Seoul, South Korea.

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1. **P. Reich**, E. Bezak, and M. Mohammadi. "The effect of simulated patient set-up errors on transmitted dose in 3D prostate CRT". *Postgraduate Student Papers Night*. Adelaide, Australia. 2005. Sponsored by ACPSEM, SAMBE and EACBE (SA branches).

2. **P. Reich**, E. Bezak, and L. Fog. "Transmission dosimetry using Pinnacle 3D treatment planning system: towards an online in vivo dosimetry verification system". *Postgraduate Student Papers Night*. Adelaide, Australia. 2004. Sponsored by ACPSEM, SAMBE and EACBE (SA branches).

To my parents