

Purpose:

IMRT of the prostate consists of multiple stages of treatment planning and dose delivery, each with inherent anatomical uncertainties. Differential filling of the bladder and rectum can displace the prostate during a course of treatment. The purpose of this study was to assess the effectiveness of adapting to these anatomical changes using various CT image-guided adaptive (IGART) strategies.

Methods:

Our computer model is based on the Philips Pinnacle treatment planning system. A multi-fraction simulation of 5-field IMRT (76 Gy/35 fractions) yields the daily dose accumulation in individual tissue elements. Using megavoltage CT studies of 13 prostate cases, cumulated dose distributions are mapped onto the reference treatment plan. Total dose-volume histograms are then processed to estimate the changes in tumor control probability (TCP) and normal tissue complication probability (NTCP) for various IGART scenarios.

Results:

Retargeting of the prostate generally maintains the intended TCP (typically 0.9 versus 0.8 with No Image Guidance) but is often associated with an enhanced risk of rectal toxicity (NTCP rises to 0.05 when Image Guidance is applied). This effect is due mainly to a systematic anterior shift caused by sag in the treatment couch (average 10mm). Without image-guidance, this offset goes uncorrected, resulting in poorer coverage of the target with consistent avoidance of rectal exposure.

Conclusions:

Geometric repositioning without dose re-planning is sufficient to maintain the intended TCP. IGART corrects for sag in the treatment couch and this results in greater risk of rectal toxicity, compared with no IGART. Smaller PTV margins could offset this effect, emphasizing the need for integrated image guided and intensity modulated delivery for optimal results. In the extreme, daily IMRT re-planning based on in-room imaging could exploit maximum benefits of this technology but this would require significantly more computing resources and streamlining of procedures at the treatment console.

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