

Title: Dosimetric analysis of treatment plan degradation after large shift corrections during image-guided radiation therapy (IGRT) for the treatment of prostate cancer.

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Purpose: The use of IGRT to correct for day-to-day systematic setup errors is essential to minimize the dose variation to the treatment target. We now investigate the dose variations to the surrounding normal structures after IGRT correction. With regards to large shifts of the isocenter, the initial intensively-modulated radiation therapy (IMRT) calculations may no longer be applicable because IMRT delivers precise amounts of dose with small segmented fields based on fixed anatomical locations.

Material and Methods: IGRT CT scans from prostate cancer patients treated with external beam IMRT were examined. Our IGRT system is comprised of a linear accelerator with an in room diagnostic CT-on-rails attached to the same treatment table. Patients with final shift corrections ranging in magnitude from 5mm to 15mm in the anterior / posterior direction were reviewed. Results were analyzed to determine the variations between the initial treatment plan calculations versus the original treatment plan superimposed and recalculated on the daily IGRT CT scans with the appropriate shift implemented.

Results: Even with large shift corrections, neither the PTV coverage nor mean dose to the PTV was significantly affected with the largest difference being 2 – 3%. In addition, the coverage to the prostate gland did not change significantly regardless of the shift magnitude from IGRT. However, rectal dose was significantly affected with mean dose differences ranging from 15 – 25% in severe cases. These differences also increased as shift magnitude increased and were additionally magnified with large changes in treatment planning parameters such as depths and effective path lengths. These existing changes were random and non-specific to any one single parameter, but the overall dosimetric variations for the rectum were significantly affected, particularly with shifts greater than 10mm in the AP/PA direction.

Conclusion: The positional changes of the target, normal tissue, and differences in beam parameters taken individually do not cause significant breakdowns in the original treatment plan, but these changes taken as a whole and compounded, result in dramatic DVH degradation. To our knowledge, this is the first report of dosimetric degradation of initial treatment plans to the surrounding normal structures after IGRT corrections. These changes in dosimetry may be critical, especially when clinicians have based their estimates of current or future side effects/complications on the initial treatment plan DVH. As such, with large shifts to the isocenter and positions of normal tissues surrounding the target, mere IGRT isocentric corrections may not be adequate and further consideration for some type of re-planning maybe needed.