

Study of Patient Setup Error and Inter-Fractional Organ Motion for Prostatectomy Patients Using CT-On-Rails

Purpose: A retrospective study was conducted on daily translation corrections of patient positioning based on CT-On-Rails technology to improve our external beam radiotherapy QA program for prostatectomy patients.

Methods and Materials: 479 daily translational corrections obtained from 13 consecutive prostatectomy patients were considered. Before each treatment, each patient immobilized in vacuum bag was positioned based on skin markers. After which a 3D daily CT image of the patient was acquired using CT-On-Rails. Translational correction in lateral, longitudinal, and vertical directions were obtained by matching soft tissues surrounding patient's prostate bed region in the daily and treatment planning CT images. These corrections reflect the combined positioning error from manual setup and inter-fractional organ motion/deformation. Basic statistical analysis of these corrections was performed. ANOVA analysis using the translational corrections as response variables and week days or patient study ID as explanatory variables were performed to search for possible dependence of positioning error on individual patient and weekday.

Results: Average patient positioning errors in lateral, longitudinal, and vertical directions were small (-0.4mm, 1.4mm, and -0.1mm respectively with standard deviations of 5.4mm, 5.0mm, and 7.3mm). The two statistically significant ($p < 0.05$) but weak correlations were observed between corrections in longitudinal and lateral directions ($r = 0.10$), and between longitudinal and vertical directions ($r = 0.18$). ANOVA analysis showed statistically significant ($p < 0.05$) difference in individual patient positioning error in all three directions. No such finding was observed for weekdays.

Conclusions: For prostatectomy patients, without CT-On-Rails, the patient positioning error was patient dependent and the biggest uncertainty was in patient anterior/posterior direction. The performance of our therapists was consistent without significant residual patient setup error. CT-on-rails based imaging guidance before individual prostatectomy patient daily radiotherapy was effective in patient positioning error reduction.