

Bladder filling before radiation therapy treatments to the prostate

Evaluating volume, dose and reproducibility of constraints



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Background and Objective

The volume of pelvic organs (such as bladder and rectum) can change significantly at time of RT. In order to maintain constant bladder volume and potentially reduce urinary toxicity[1], our department adopted bladder filling protocol for all patients undergoing prostate radiotherapy[2]. The aim of this study is to evaluate adherence to bladder filling protocol and analyzing the factors that might influence differences in the bladder volume (waiting time, disease stage, RT dose, ect.) and their effect on dosimetric parameters.

Methods

Bladder filling was required prior to CT-simulation and each treatment fraction). After voiding, patients are requested to drink 4 cups of water (estimated to be 400cc) during a period of 30 minutes, and avoid any additional voiding until after CT-simulation or treatment. Treatment cone-beam CTs (CBCTs) were imported into the treatment planning system (Monaco® by Elekta), and bladder was contoured on each CBCT. The original treatment plan was applied each CBCT dose constraints for the urinary bladder, according to RTOG 0415, were re-calculated. Demographic data (patient's age, Gleason score etc.) and waiting time were extracted from the medical records. Correlation and regression tests between the demographic data and the calculated data were performed, analyzing change in volume, percentage of change, and adherence to the constraints.

Results and Discussion

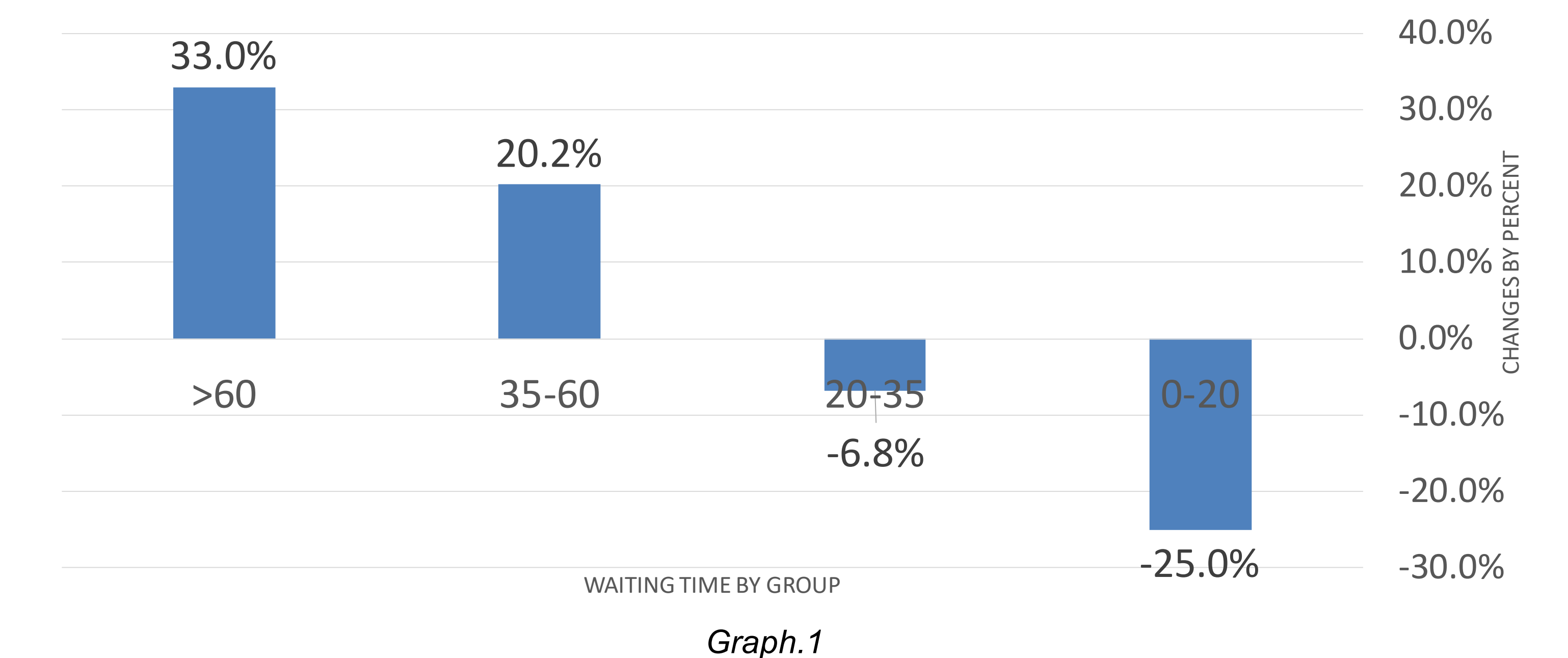
A total of 326 CBCTs from 36 patients were analyzed. The average waiting time for treatment was 42 min [range: 9-158 min,]. Analysis was done on 4 different groups according to waiting times (0-20, 20-35, 35-60, >60 min), on 41, 61, 116 and 103 CBCTs, respectively. Average Bladder volume was 171.7 ml, while average measured volume changes were -25%, -6.8%, 20.2% and 33% respectively (graph. 1). Calculated correlation between waiting time with change in bladder volume and percentage was medium straight ($r=0.48$, $p<0.001$ by regression test).

Correlation after splitting waiting time to the groups is strong ($r=0.99$, $p<0.001$). Constraints failure were seen in 25%, 14%, 6.5%, 7.8% of CBCTs, respectively (graph. 2).

Conclusions

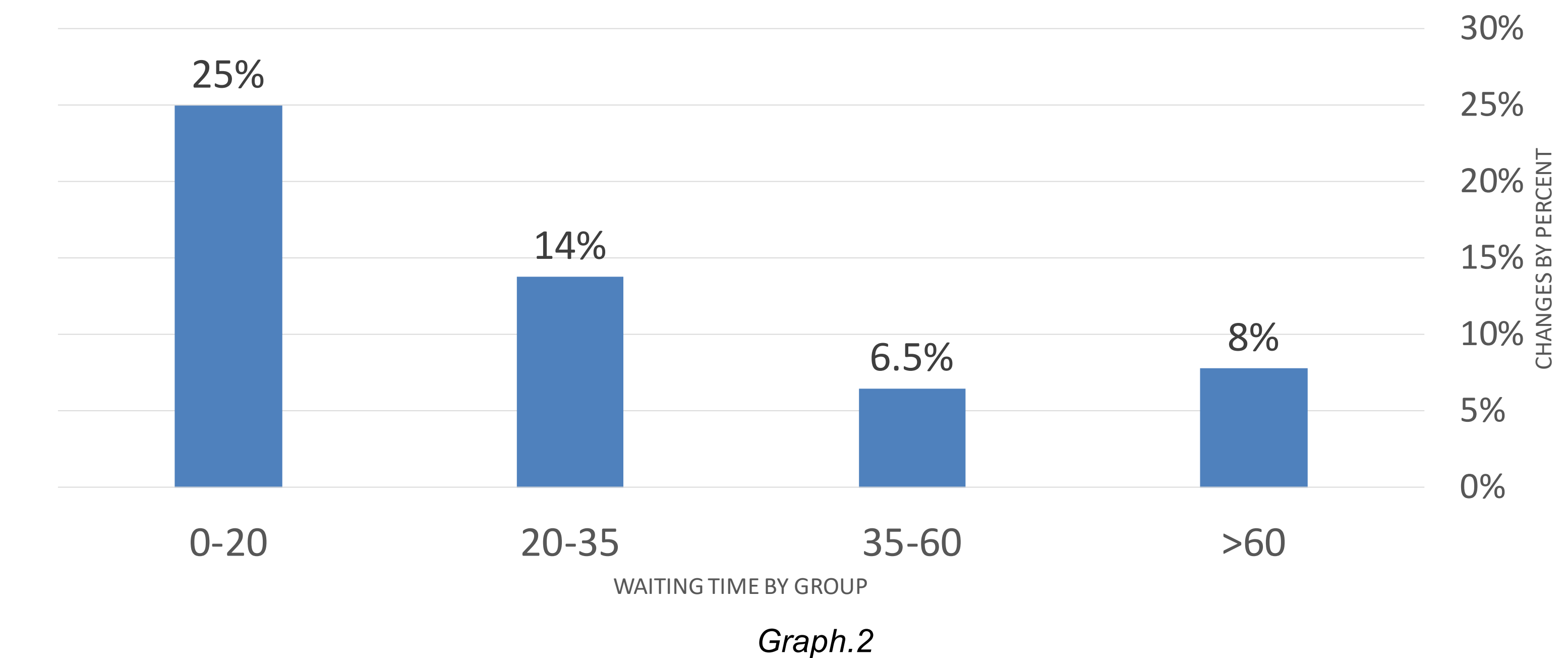
There is a direct and strong relationship between waiting time and the change in bladder volume and dose delivered to the bladder. When radiation therapy is performed at 30 minutes of waiting (as indicated in the protocol) constraints are met, but if waiting time is shorter or longer, deviations might occur, more significantly at shorter waiting times. This highlights the importance of adhering to bladder filling and strict waiting times in prostate cancer patients undergoing radiation treatments.

Bladder volume change by groups



Graph.1

Constraints failure



Graph.2

References

- [1] Naoki Nakamura, Variability in bladder volumes of full bladders in definitive radiotherapy for cases of localized prostate cancer, Epub 2010 Nov 8
- [2] Chiaki Fujioka, Optimal bladder volume at treatment planning for prostate cancer patients receiving volumetric modulated arc therapy, Pract Radiat Oncol. Nov-Dec 2016;6(6):395-401.