Utilization of cone-beam CT for offline evaluation of target volume coverage during prostate image-guided radiotherapy based on bony anatomy alignment

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ABSTRACT

Aim: To assess target volume coverage during prostate image-guided radiotherapy based on bony anatomy alignment and to assess possibility of safety margin reduction.

Background: Implementation of IGRT should influence safety margins. Utilization of cone-beam CT provides current 3D anatomic information directly in irradiation position. Such information enables reconstruction of the actual dose distribution.

Materials and methods: Seventeen prostate patients were treated with daily bony anatomy image-guidance. Cone-beam CT (CBCT) scans were acquired once a week immediately after bony anatomy alignment. After the prostate, seminal vesicles, rectum and bladder were contoured, the delivered dose distribution was reconstructed. Target dose coverage was evaluated by the proportion of the CTV encompassed by the 95% isodose. Original plans employed a 1 cm safety margin. Alternative plans assuming a smaller 7 mm margin between CTV and PTV were evaluated in the same way. Rectal and bladder volumes were compared with the initial ones. Rectal and bladder volumes irradiated with doses higher than 75 Gy, 70 Gy, 60 Gy, 50 Gy and 40 Gy were analyzed.

Results: In 12% of reconstructed plans the prostate coverage was not sufficient. The prostate underdosage was observed in 5 patients. Coverage of seminal vesicles was not satisfactory in 3% of plans. Most of the target underdosage corresponded to excessive rectal or bladder filling. Evaluation of alternative plans assuming a smaller 7 mm margin revealed 22% and 11% of plans where prostate and seminal vesicles coverage, respectively, was compromised. These were distributed over 8 and 7 patients, respectively.

Conclusion: Sufficient dose coverage of target volumes was not achieved for all patients. Reducing of safety margin is not acceptable. Initial rectal and bladder volumes cannot be considered representative for subsequent treatment.

Keywords: Prostate; Image-guided radiotherapy; Cone-beam computed tomography; Dose reconstruction; Dose-volume histogram