# Image-guided radiotherapy workflow for dose based patient verification using cone-beam CT scans

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## Introduction

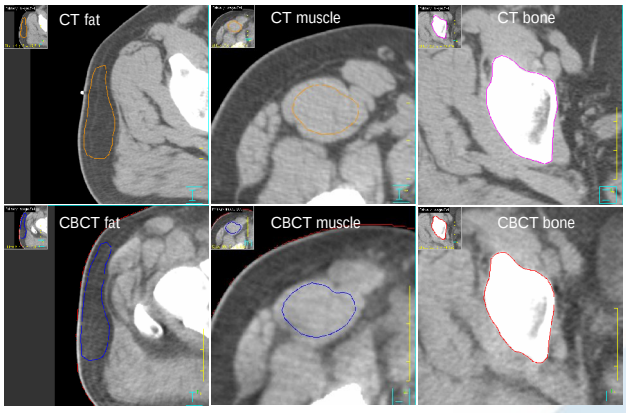
Early implementation of image-guided radiotherapy using cone-beam CT (CBCT) has allowed observations of 3D patient anatomy relative to the planning CT scan, but clinical decisions are ultimately required based on re-planning (i.e. re-calculation of delivered dose) using CBCT scans. However, incorporating treatment re-planning into an efficient image-guided workflow is problematic due to limitations of treatment planning systems (TPSs) and poor consistency of density calibration and image artefacts in CBCT scans. This study reports on the validation of image-guided workflow for treatment re-planning at our institution.

## Materials & Methods

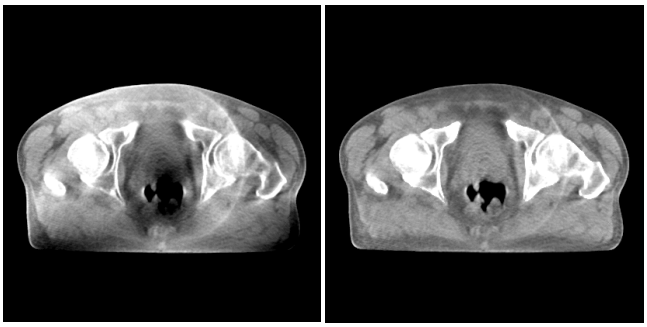
Image-guided workflow was incorporated into the Pinnacle TPS via automated scripts. This allowed all relevant treatment plan information to be stored and imported onto a treatment plan based on the CBCT scan. In addition, CBCT dose calculations were validated using the treatment plans for six prostate IMRT patients, each with at least five CBCT images acquired during treatment. Each CBCT was improved to remove artefacts and spurious variations in density. Dose distributions at each fraction were then calculated using the CBCT scan. CBCT images before and after improvement were compared in terms of the density in different tissue regions. Dose distributions based on the CBCT images were compared to the planned distribution in terms of isocentre dose and 95% isodose position.

## Results

The image-guided workflow is now an efficient process due to the automation of re-planning. The CT numbers in regions of fat and muscle tissue in the improved CBCT were both within 1% of the values in the planning CT, as opposed to 10-20% different for the original CBCT. The average difference in isocentre dose between planning CT and CBCT calculation was 0.1% for the improved CBCT and 3.4% for the original CBCT. Changes in 95% isodose position were less than 2mm in the majority of cases. Changes greater than this were explained by the presence or absence of rectal gas.




*Tissue regions outlines for planning CT and improved CBCT.*



*CBCT image of prostate patient before (left) and after (right) improvement of pixel values.*

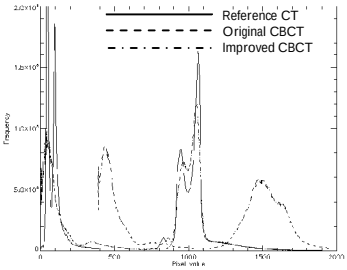
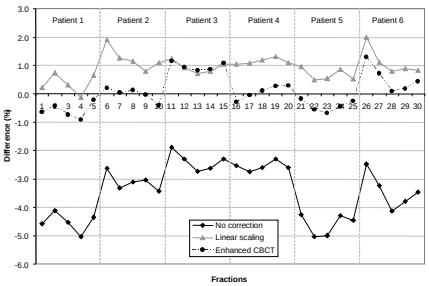
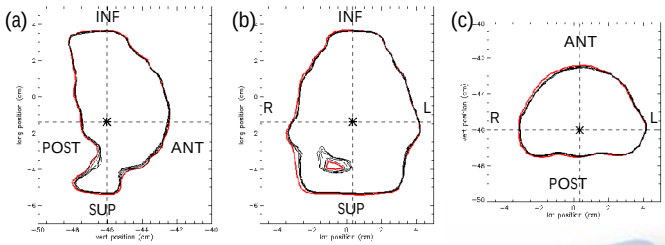



*Image histograms for original CBCT (dashed line) improved CBCT (dash-dotted line) planning CT image (solid line).*

*Difference between isocentre dose calculated using CBCT and using planning CT for different CBCT correction strategies.*




*95% isodose plots for patient 1 showing planned contour in red and CBCT calculated contours in black in (a) sagittal (b) coronal and (c) transverse planes.*

## Conclusion

Image-guided workflow has been implemented into the treatment process and validated with prostate IMRT cases. Improved CBCT images greatly improve the accuracy of the CBCT calculated doses, with differences explainable by observed changes in patient anatomy.

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