Conclusions: The applicability of the VGC analysis on CBCT used for adaptive RT was investigated and found useful. Regarding the difference in image quality between the two systems Truebeam was found superior to Clinac iX. The VGC analysis might find its use for any two imaging systems in the clinic.

PO-0866
A novel method for converting pixel values to Hounsfield units for cone beam CT images
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Purpose/Objective: The purpose of this study is to develop a method for converting pixel values in CBCT images to Hounsfield units (HUs) using the histograms of pixel values for the cone beam computed tomography (CBCT) to calculate the dose distributions on the CBCT images.

Materials and Methods: The simulation computed tomography (sim-CT) and CBCT images of an electron density phantom and 5 prostate cancer patients were obtained. The histograms of pixel values for each slice of the sim-CT and CBCT images of the electron density phantom and of the prostate cancer patients were obtained with an in-house program. To perform correction of the pixel values for each slice of the CBCT images, the shapes of the histograms for each slice of the CBCT images were closed to the shapes of the histograms of the sim-CT images using linear scaling method with a minimum sum of squared differences for the regions of soft tissue and bone. Such CBCT images with converted pixel values were defined as modified CBCT (mCBCT) images. The pixel values of the mCBCT were compared with those of the sim-CT images, and the differences were evaluated. To evaluate clinical significance, the dose distribution on the mCBCT images was compared with the original plan on the sim-CT images by using gamma analysis with a 3% / 2 mm criterion. In addition, the calculated MUs were compared with the original plan.

Results: The linear scaling of pixel values in the CBCT images was successfully applied to the histograms. After the linear scaling, the histograms of mCBCT resembled the histograms of sim-CT. Thus, it is possible to judge pixel values for CBCT images in HUs. However, because the artifacts peculiar to CBCT remained, differences between both HUs were observed (-3.7 ± 33.3 HU for subcutaneous fat, -14.9 ± 24.8 HU for prostate, 11.5 ± 30.8 HU for muscle, 11.7 ± 35.9 HU for bone). The pass rate of gamma analysis (3% / 2 mm) were more than 95%, and the differences in calculated dose using the mCBCT images were less than approximately 1 MU for the monitor unit.

PO-0867
Novel evaluation method of non-rigid image registration algorithms for image-guided adapted radiation therapy
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Purpose/Objective: Non-rigid image registration (NIR) is an essential image processing tool for image-guided adapted radiation therapy. The current radiotherapy process requires three-dimensional (3D) quantification of the registration error, which is not accurately achieved by existing evaluation methods. The objective of this study is to develop a method for 3D evaluation of NIR algorithms.

Materials and Methods: Cone-beam (reference) and planning (moving) CT scan images of fifteen prostate cancer patients were scanned using the VelocityAI (Velocity Medical Solutions) platform, which employs B-spline-based NIR algorithms. The NIR algorithms were evaluated by measuring the distance between two factors: (1) the outlines (reference contours) of the bladder, the dorsal right and left seminal vesicles (SV), the proximal SV, the prostate, and the rectum in the reference images; and (2) other outlines (deformed contours) in the deformed images of the same CT slice. This distance is the difference between two points that indicate the point of intersection of the reference and the deformed contours that cross a straight line every 10° from the center of gravity of the reference contour. However, the difference in direction was determined as being ‘negative’ if it was inside the reference contours for the deformed contours, and ‘positive’ if it was outside the reference contours for the deformed contours.

The measurement values were displayed on a two-dimension (2D) difference map.

Results: The 2D difference map of the bladder indicated a large error of +3 to +8 mm in the upper region. The dorsal right and left SVs showed an overall error of -3 to +3 mm, while the error pertaining to the proximal SV was -4 to -1 mm around the prostate interface. The error pertaining to the prostate ranged from -2 to +1 mm in the
PO-0868
Optimal atlas size within OnQ rts™ for automated contouring of head and neck anatomical structures

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Purpose/Objective: Our Institution uses OnQ rts™ developed by Oncology Systems Limited (OSL) UK, to assist with the contouring of normal anatomical structures for head and neck IMRT treatment plans. The auto-contouring module is one of multiple modules within the OnQ rts™ software; it uses Atlas Based Auto Segmentation of CT image data, applying rigid and deformable image registration. This is followed by post-processing tasks applied to individual structures of the head and neck to produce Organ at Risk contours. The atlas is populated with a library of contoured clinical CT scans. The OnQ rts™ software is currently used clinically with an atlas of thirty patients, based on a preliminary recommendation from OSL. The contours are evaluated by a specialist head and neck Radiographer who manually edits contours as required; a process that takes approximately one hour per patient. The purpose of the project was to assess how the number of atlas cases affected the accuracy of the automated contours generated by OnQ rts™ in order to determine the optimum number.

Materials and Methods: The clinical contours for the last eleven patient cases were objectively compared against automated contours using OnQ’s Contour Analysis tools; Conformity Index (CI), Mean distance to Conformity (MDC) and Error volume histogram. The process was repeated using the same test patients for atlas sizes of 10, 20, 10, 5 and 1.

Results: Figure 1 shows the variation of MDC with atlas size, averaged over the eleven test patients for the key anatomical structures. The MDC and CI remained approximately constant for atlases with as few as ten cases. For atlas sizes smaller than ten, the accuracy of the contours appeared to decrease, as the value of MDC increased and the CI decreased. The MDC for optical structures such as the optic nerves, globes and lens did not appear to show any variation with atlas size.

Conclusions: The results indicate that an atlas size of ten patients may be sufficient for automated contouring of head and neck patients. The results suggest that the post-processing tools within OnQ rts™ are sufficiently robust to achieve accurate contours from a basic starting point for head and neck treatments. If standard procedures are used and patient setup is consistent. Previous work indicated that a thirty case atlas required on average one hour editing time in preparation for clinical use. Based on the results of this study, one would not expect a ten case atlas to increase this time. Further work should include quantification of the sensitivity of small atlas sizes to the specific choice of atlas cases and additional investigation into the impact of atlas size on contours for optical structures.

PO-0869
Automated cross-modal 3D contouring algorithm for prostate 3D ultrasound-CT co-registered images

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Purpose/Objective: In the case of prostate radiotherapy treatment, manual segmentation is a tedious task, subject to inter and intra observer variability. If an automated segmentation algorithm is used, the information extracted from a single imaging modality might not reliably reproduce the outlining accuracy achieved by a physician drawing contours on fused CT-US scan. The iterative automated contouring algorithm here proposed makes a simultaneous full and direct use of the whole 3D information available from the two different imaging modalities; this way, their respective specific border definition capabilities are combined and enhanced. The purpose of this work is to show that the algorithm can produce contours similar to the ones manually drawn on CT-US fusion for prostate patients, and evaluate quantitatively the differences.

Materials and Methods: The introduced contouring algorithm uses features which are sufficiently general to be adaptable to the two different imaging modalities. Multi-scale, three-dimensional information on the target shape and on the characteristics of structures near the target border is extracted during the training process. This information is then used during the iterative procedure of automated segmentation. Tenclinical cases of prostate cancer patients from three different hospitals were used for training and testing using a cross validation approach. For each clinical case, co-registered CT and 3DUS image datasets were available. Each patient was manually segmented by a qualified clinician on the fusion dataset.

Results: An example of superposition of CT and 3D US images with the cross-modality automated segmentation contour is shown in Figure 1a. The comparisons between manual and automated segmentation obtained in the case of single modality (CT) and cross-modality (CT-US) are shown in Figure 1b and 1c respectively. The comparison between Figure 1b and 1c (axial view) shows that the upper edge of the prostate is better characterized by the cross-modality than by the single modality; this is because the information extracted from the US scan helps the iterative process to achieve a better segmentation result. The values obtained using a modified version of the mean distance to conformity (MDC) metric are reported in Table 1 for the 10 datasets. These values represent the average distance that all outlining points in the surface must be moved in order to achieve perfect conformity with the contours defined manually.

![Figure 1](image-url)