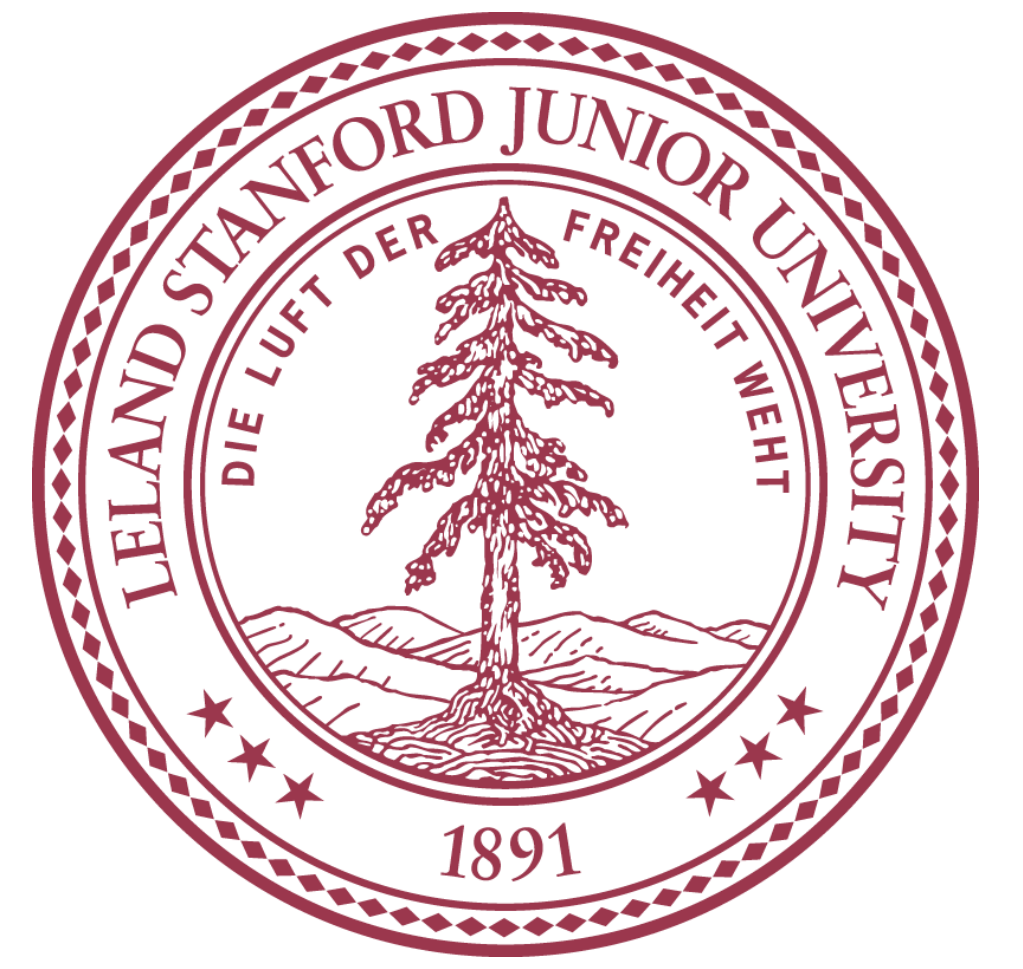


Image-guided Radiation Therapy (RT) for Rectal Cancer Using Cone Beam CT (CBCT)



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Purpose

Uncertainty in targeting rectal tumors when treating with intensity modulated radiation therapy (IMRT) is a consequence of rectal motion due to filling and deformation. On-board CBCT was used to quantify the degree of rectal motion and volume change during RT. We evaluated the CBCT as a tool to measure the accuracy and precision of a simulated IMRT treatment delivery model for rectal cancer.

Materials & Methods

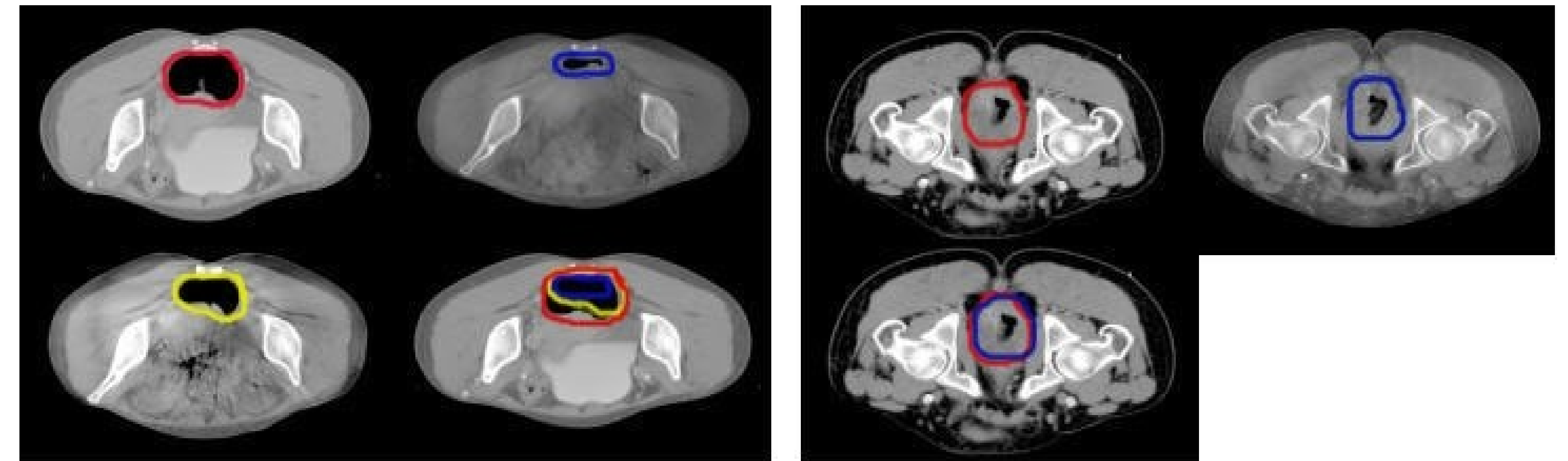
Nine patients (8 rectal cancer, 1 anal cancer) underwent > 1 CBCT during a course of RT using Varian Trilogy. Each CBCT scan had a field of view of 17 cm in the superior-inferior direction and was co-registered to its respective simulation CT scan by matching bony anatomy. Rectal volume (RV) contours were drawn on the simulation CT scan and subsequent CBCT scans. All two-dimensional measurements were taken at the superior, middle and inferior aspects of the CBCT scans. Parameters studied included: lateral (LAT) and anterior-posterior (AP) dimensions, geometric center displacement, RV, and degree of RV overlap. The paired RV from the simulation CT scan and a CBCT scan or two different CBCT scans were matched

and the percent RV overlap was calculated. IMRT plans were generated for the 8 rectal cancer patients and forward calculation were applied to the subsequent CBCT scans. IMRT constraints were 95% bowel < 45 Gy, mean bladder dose < 30 Gy and Dmax femoral head < 45 Gy. GTV plus 1.5 cm and the pelvic nodes were prescribed to 45 Gy. A cone down to GTV plus 1.5 cm was prescribed to 50.4 Gy.

Results

Maximum changes for any patient in the cohort in the LAT dimensions were 2.54 (superior), 2.6 (middle), and 1.98 cm (inferior), (**Figure 1**). In the AP direction, they were 2.44, 3.77, and 2.53 cm respectively. The mean deformation change in the LAT and AP directions were 0.71 and 0.94 cm respectively. Distances from the geometric center for each patient, between paired CT scans were recorded: maximum distances for the cohort were 2.24 (superior), 3.77 (middle), 2.53 cm (inferior). The mean was 0.92 cm. The mean percent RV overlap for an individual patient ranged from 34.8% - 87.2% (**Table**). Seven of 8 patients had adequate rectal coverage despite rectal motion and deformation. Adequacy of a plan was defined as having > 90% RV covered by 50.4 Gy in all CBCT scans. The single patient with inadequate rectal coverage (81% RV covered by 50.4 Gy) had a very low mean percent RV overlap (patient # 4 - 36.4%), (**Figure 2**).

Figure 1



A. Representative patient with significant RV deformation. Top left: simulation CT with RV contoured. Top right: CBCT # 1. Bottom left: CBCT # 2. Bottom right: overlap of all three RV contoured on the simulation CT.

B. Representative patient with minimal RV deformation. Top left: simulation CT with RV contoured. Top right: CBCT #1. Bottom Left: overlap of both RV contours on the simulation CT.

Patient	Mean % RV Overlap
1	40.8
2	34.8
3	87.2
4	36.4
5	52.5
6	73.9
7	57.7
8	80.7
9	72.2

Table. Mean % RV overlap for individual patients.

Conclusions

Significant rectal motion and deformation exist during a course of RT and is patient specific. On-board CBCT is an effective means to evaluate IMRT target coverage for the treatment of rectal cancer. In this setting, CBCT was confirmed as a valuable tool for adaptive RT guidance.

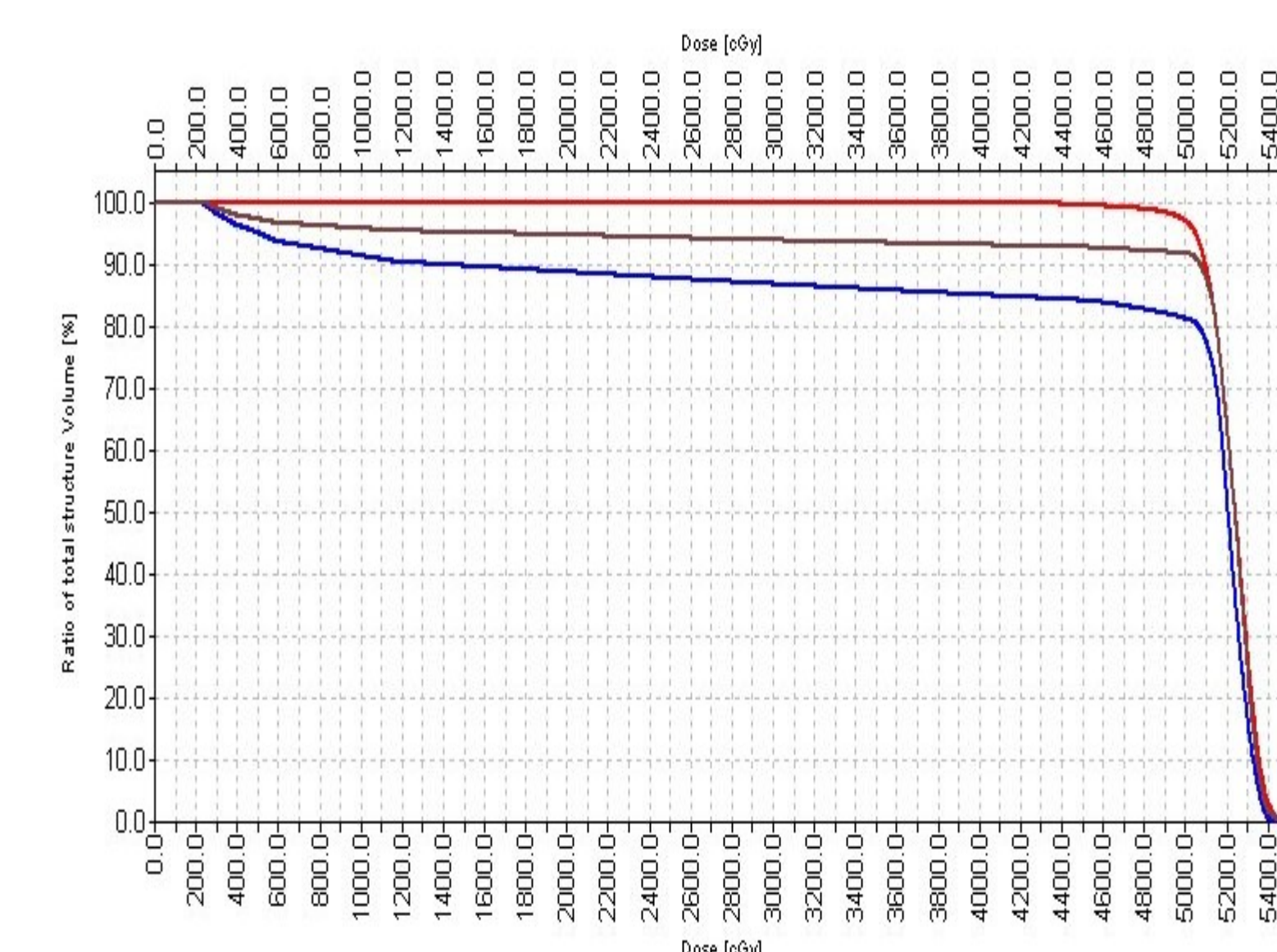


Figure 2. DVH for patient # 4 with inadequate rectal coverage. Red- Rectal coverage based on planning CT. Brown, blue-rectal coverage based on 2 subsequent CBCTs.

