Cleveland Clinic

Using Shifting Planned Dose Matrix to Evaluate Daily Dose Changes for IMRT Prostate Treatment

Samah Ferjani, Guangshun Huang, Qingyang Shang and Ping Xia
Cleveland Clinic, Cleveland, OH

INTRODUCTION

Summation of daily DVH from KV-cone beam CT (KV-CBCT) to obtain a composite dose volume histogram (DVH) is challenging. Directly translating the planned dose matrix according to measured daily prostate displacements provided a common reference frame for a composite DVH from daily DVHs. The purpose of this study is to evaluate the shifting planned dose matrix method compared to the dose recalculation method using daily KV-CBCT

METHODS AND MATERIALS

Six patients, who received concurrent IMRT treatment for prostate and pelvic lymph nodes with 124 daily CBCTs, were selected for this study. Contours for CBCTs were transferred from the planning CT after soft tissue registration for prostate and bony registration for pelvic lymph nodes. Using the same planning beam configurations, we re-calculated doses for these CBCTs after shifting to corrected treatment isocenters. The planned dose matrix translation was performed by an in-house program written in MATLAB and incorporated with Computational Environment for Radiotherapy Research (CERR) software. The corresponding daily DVH was obtained by shifting the planned dose matrix according to shifts of treatment isocenters.

The dose matrix is recorded in a 3-D array, with a fixed step size in each direction, δx, δy and δz. The volume of a voxel in the dose matrix is determined by $\delta x \times \delta y \times \delta z$. Suppose the measured shifts of the prostate are dx, dy and dz, then the imagined shifts of the dose matrix would be $-dx$, $-dy$ and $-dz$ if the prostate were shifted back to its original location. If counted in number of steps, the shifts are $sx = int(dx/\delta x)$, $sy = int(dy/\delta y)$ and $sz = int(dz/\delta z)$. So, for the shifted dose matrix, its element is translated from the old static one with the following relation.

$$D^{new}(i,j,k) = D^{old}(i-s_x, j-s_y, k-s_z).$$

To compare these two methods, selected endpoint doses for tumor targets and sensitive structures were extracted from DVHs.

RESULTS

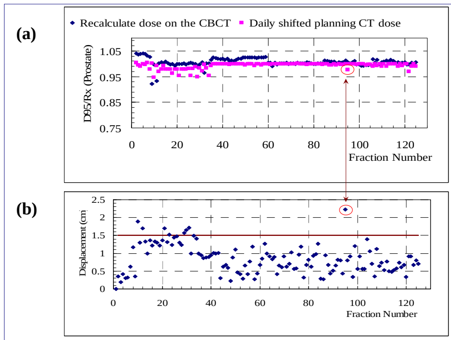

Figure 1: **(a)** *D95 for the daily shifted planning CT dose method and the recalculated dose on the CBCT for the prostate as a function of the fraction number.* **(b)** *The daily displacement calculated based on the contour shift as a function of the fraction number.*

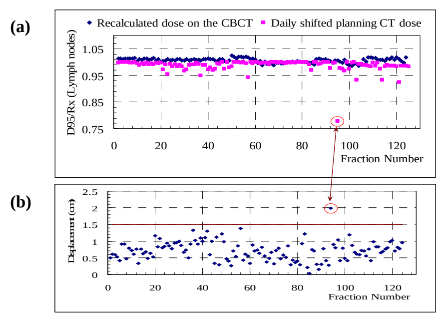

Figure 2: **(a)** *D95 for the daily shifted planning CT dose method and the recalculated dose on the CBCT for the lymph nodes as a function of the fraction number.* **(b)** *The daily displacement calculated based on the bony shift as a function of the fraction number.*

RESULTS

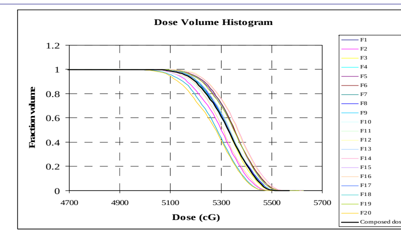

Figure 3: *The individual and composite DVHs of the prostate for a total of 20 fractions.*

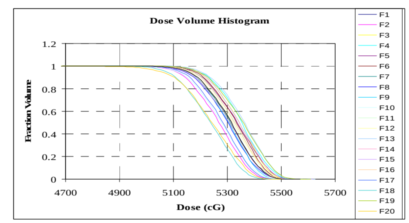

Figure 4: *The individual and composite DVHs of the lymph nodes for a total of 20 fractions.*

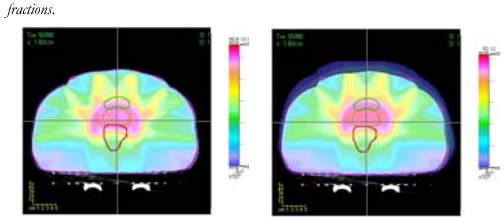

Figure 5: *Color map images showing: a) the dose distribution of the first fraction for a patient with 20 fractions. b) The composite dose distribution.*

CONCLUSIONS

- For prostate displacement less then 1.5 cm, the dose matrix shifting method resulted in 93% and 98% fractions within 5% differences from the recalculation method for D95 of prostate and pelvic lymph nodes, respectively. These numbers decreased to 58% and 71% when 2% dose difference criterion was used.
- Allowing 5% daily dose difference, shifting planned dose matrix provides effective means to evaluating daily dose changes for concurrent IMRT treatment for prostate and pelvic lymph nodes. The utility of this tool is to provide a common coordinate frame to obtain composite dose distributions.