Effect of MLC Leaf Width on MLC Leaf Shifting Algorithm for Concurrent Treatment of Prostate and Pelvic Lymph Nodes

Our previous proposed MLC leaf shifting algorithm is an effective strategy for concurrent treatment of prostate and pelvic lymph nodes. For prostate movement along the longitudinal direction, MLC leaf pairs are shifted by the nearest number of leaf widths, if the magnitude of the movement is not a multiple of leaf width. In this study, we evaluate the dosimetric impact of the MLC leaf width and the accuracy of the compensation for the prostate movement using the leaf-shifting algorithm.

On each daily CT, the contours of prostate, bladder and rectum were manually delineated, and the contours of pelvic lymph nodes were transferred from the planning CT after rigid bony registration. Daily prostate shift was obtained from a dual image registration (one aligns to the bones, and the other aligns to the prostate contour). For each patient, three different IMRT plans were created based on a planning CT using three linac machines with different leaf widths of 2.5, 5, and 10mm. For each CT, a specific MLC shifted plan was created for each of the three machines (a total of 153 treatment plans). The positions of the MLC leaf pairs encompassing the prostate were shifted based on the magnitude and direction of the daily prostate movement by using an in-house computer program. The shifted MLC positions were then loaded back to the planning system for dose calculation.

Prostate movement along the longitudinal direction was observed with mean value 1.1 ± 3.7 mm (range: -6 to 6.5 mm). With the MLC-shifting method implemented with 10mm leaf width, organ motion can cause 4.4% dose reduction on prostate CTV D99, which can be reduced to 2.3% with 2.5 mm leaf width plans, and to 1.3% with 5 mm leaf width plans (Figure 1). Dose reduction difference for prostate PTV D95 is 1.4% between 5mm and 10mm leaf width plans. Average dose coverage to lymph nodes does not degrade from planned dose for all three machines, with a difference within 1.5% for CTV D99, and within 1.0% for PTV D95. Compared to the planning dose, the average D5 and D50 for the bladder and D5 for the rectum are close for the three machines, all with a difference within 3% (Figure 2). And the plans with 5 mm leaf width has the lowest average D50 for the rectum (3.9 ± 5.2%).

It is demonstrated that in our case plans with 5 mm leaf width provide sufficient tumor coverage.

Reference: