Impact of the Treatment Margin on Tumor Control and Normal Tissue Complication for Prostate Treatment

To investigate the consequence of treatment margin reduction on normal tissue complication probability (NTCP) and tumor control probability (TCP) of prostate external beam treatment and to provide a guidance for margin selection when the patient’s preference for tumor control and quality of life is considered in the treatment decision.

Intensity modulated rotational radiotherapy plans were generated for 10 prostate patients with 6 different posterior margin sizes from 5mm to 0. The prescription dose is 80Gy for 40 treatment fractions. The dose distributions were recalculated with consideration of the intrafractional motion and the localization error. The statistical uncertainties of the intrafractional motion and the localization error were derived based on the motion tracking data recorded by the Calypso 4D localization system for a large patient population. The systematic error is 0.8mm, the random error is 2mm and the mean shift is 1.7mm toward posterior. The TCP and NTCP were calculated based on the recalculated dose volume histograms (DVH) of prostate and rectum for plans with different margins using an equivalent uniform dose (EUD) based biological model. The 50% tumor control dose (TCD50) of 60Gy for prostate and the median toxic dose (TD50) of 55Gy for rectum were used in the calculation. The gamma50 is set as 2 and 4 for TCP and NTCP calculation. Alpha Beta ratio is 3Gy for the prostate and 10Gy for the rectum.

The minimum dose of the prostate and the mean dose of the rectum dropped with the decrease of the treatment margin as shown in Figure 1(a). When the posterior treatment margin was reduced from 5mm to zero, the EUD of prostate decreased from 83Gy (±0.5Gy) to 81Gy (±0.5Gy) and the TCP dropped from 93.2% (±0.1%) to 91.7% (±0.1%), the EUD of the rectum decreased more significantly from 48.9Gy (±0.4Gy) to 32.5Gy (±0.5Gy) and the NTCP dropped from 13.3% (±1.5%) to 0.03% (± 0.01%) as shown in Figure 1(b).

The treatment margin size affects the dose to the target and the nearby critical structure. More significant impact on NTCP has been observed than on TCP. This gives us some room to consider the quality of the patient’s after-treatment life. A wise choice of treatment margin can be made based on physician’s opinion, patient anatomy and the patient’s preference on the tumor control and the quality of life.

![Figure 1](image_url)

Figure 1, (a) The DVH comparison for prostate and rectum when the treatment margin decreased from 5mm to 0. (b) Rectum NTCP values as a function of the treatment margin.