PTV Margin Reduction Study for 2-Phase Image-Guided VMAT Prostate Treatment

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INTRODUCTION

The use of daily image-guided radiotherapy for prostate VMAT treatments allows for the verification of target location, which reduces the setup errors and improves the treatment accuracy. Reducing the geometric uncertainties by image-guidance enables us to consider the reduction of Planning Target Volume (PTV) margin.

AIM

The aim of this study is to determine if the reduction of the phase I prostate PTV margin for the CBCT-guided VMAT treatment can still ensure the Clinical Target Volume (CTV) coverage while further reducing the dose to the rectum.

METHOD

- Five patients already treated using 2-phase protocol for the intact prostate, seminal vesicles and pelvic nodes using daily CBCT-guided are chosen.
- For Phase I IGRT, the bony match is done along with the soft tissue match to ensure the prostate and seminal vesicles coverage.
- Two VMAT plans are created from the CTV and OARs on the planning CT for each patient. Each plan has a different PTV margin for the CTV of the prostate + seminal vesicles: one with current CTV+10mm, except 7mm posteriorly margin and one with proposed CTV+7mm, except 5mm posteriorly margin.
- The pre-treatment CBCTs from fractions 1, 5, 10, 15, and 20 with the translational shift recorded at the time of the treatment are imported to the Pinnacle treatment planning system. The CTVs, rectums, and externals are contoured on each CBCT image to account for daily changes in anatomy.
- Plans with different PTV margins were mapped from the planning CT to the daily CBCT data to assess the effect of daily changes in patient's anatomy on DVH objectives and dependence on the PTV margin.

RESULTS

- The CTV dose on the planning CT compared to the cumulative result of all CBCTs (cum. CBCT) is shown in the Table 1 for each patient in the study.
- The V100% CTV dose for the CT planning data is 98.90%±1.68 and 99.33%±0.7 for current and reduced margins respectively and the V100% CTV dose for the cumulative daily CBCT data is 98.70%±2.09 and 99.22%±0.93 for current and reduced margins respectively.
- CTV cumulative dose for the VMAT plan with reduced PTV margin for CT data and daily CBCT data is shown in Figure 1, assuming the CTV is in the position as contoured for a particular CBCT.
- The rectum and CTV dose for VMAT plans with clinical PTV margin and reduced PTV Margin for a patient is shown in Figure 2.
- The mean dose to rectum is lower for the reduced margin plans by average of 2.43% for CT planning data and 2.26% for the cumulative daily CBCT data.

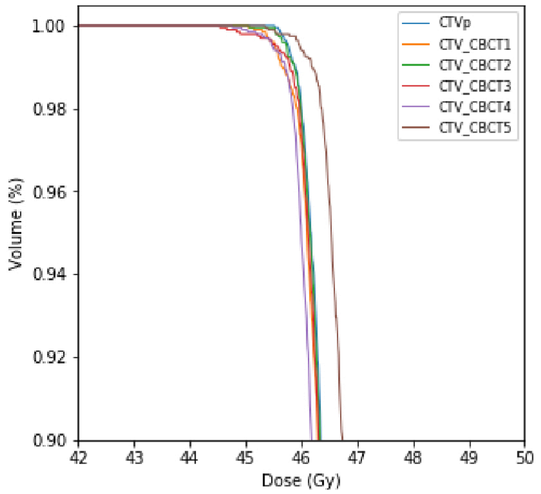

Figure 1. **Comparing CTV dose for plan with the reduced PTV margin on CT data (CTV_p) and daily CBCT data for a patient**

Patient	Plan on Clinical PTV Margin		Plan on Reduced PTV Margin	
	Plan CT	Cum. CBCT	Plan CT	Cum. CBCT
1	100%	100%	100%	100%
2	96.11%	95.14%	98.36%	97.67%
3	98.52%	98.47%	98.87%	98.83%
4	99.91%	99.92%	99.87%	99.88%
5	99.96%	99.95%	99.54%	99.63%

Table 1. **V100% CTV dose for plan CT and cumulative daily CBCTs**

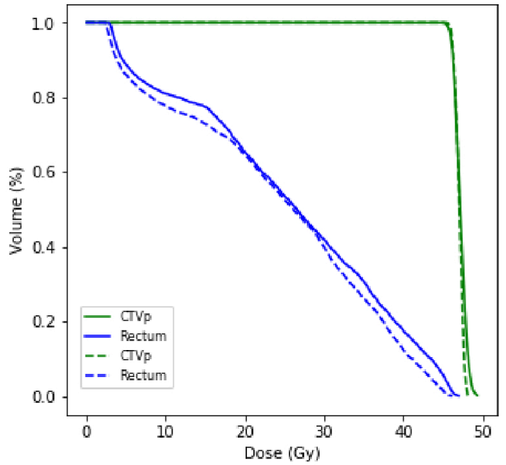

Figure 2. **Comparing CTV dose and rectum dose on CT data for the plan with clinical PTV margin (solid line) and the plan with reduced PTV margin (dashed line) for a patient**

CONCLUSIONS

The result from dose calculation for CT and daily CBCT data shows that CTV coverage can be achieved by reducing the PTV margin. Based on this study, a reduced margin of CTV is implemented in our GU protocol with the sufficient coverage for the prostate and reduced dose to the rectum.

REFERENCES

Gill et al. Determination of PTV margins for prostate IMRT. Journal of Applied Clinical Medical Physics 2015; Vol. 16, No. 6, 252 – 262

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