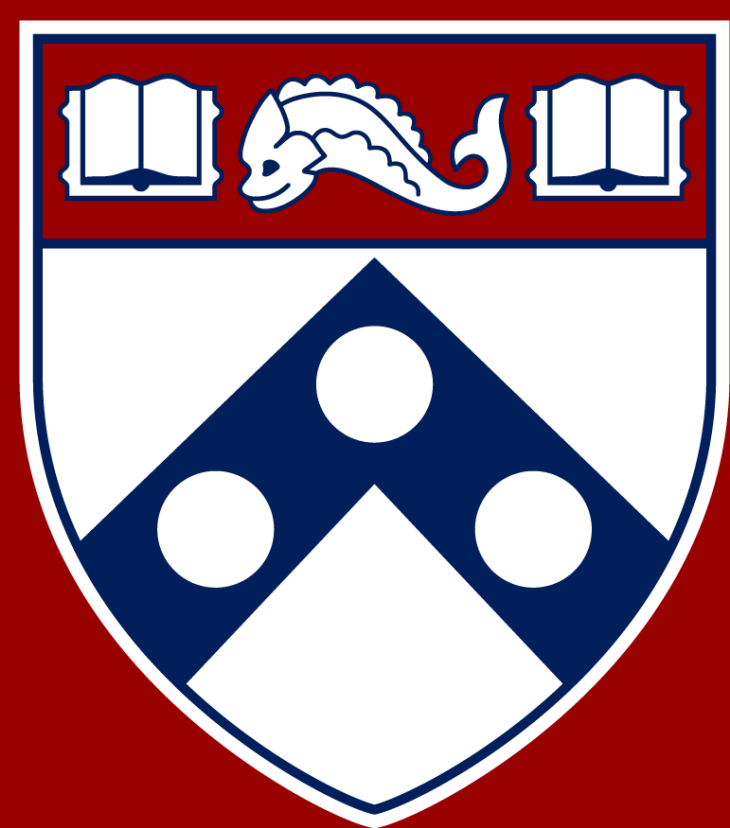
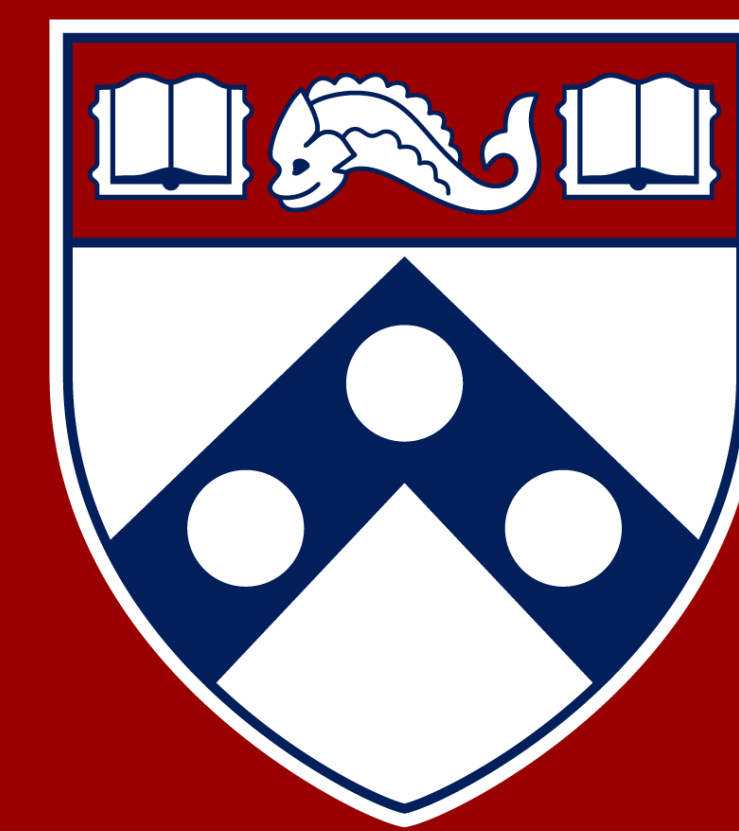




Evaluation of PTV Margins for Prostate SBRT

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Abstract

Prostate SBRT requires an expansion on the CTV to create the PTV. There is discussion over how large this expansion should be to adequately account for patient motion during treatment. A 3mm symmetric expansion of the CTV is beneficial for healthy tissue sparing but could lead to underdosing the target if patient movement is significant. Conversely, some institutions believe a 5mm margin is superior and ensures patient movement does not interfere with the treatment. This evaluation was done to compare 3mm and 5mm margins, considering patient motion during treatment and dosimetric differences. Three fiducials were placed in the prostate prior to treatment. CBCTs were taken before and after each fraction of treatment, and patient movement was evaluated by measuring the fiducial shift between the images. To also understand the effect on plan quality, ten patients were planned with both 3mm and 5mm margins. Dose to the target and OARs were compared between plans to understand the dosimetric effect of expanding the PTV margin.

Methods

Three fiducials are placed in the prostate prior to treatment and are visible on the CBCT. CBCTs are taken before and after each fraction of prostate SBRT treatment. Patient movement can be tracked by comparing the fiducial locations before and after treatment and measuring the deviation.

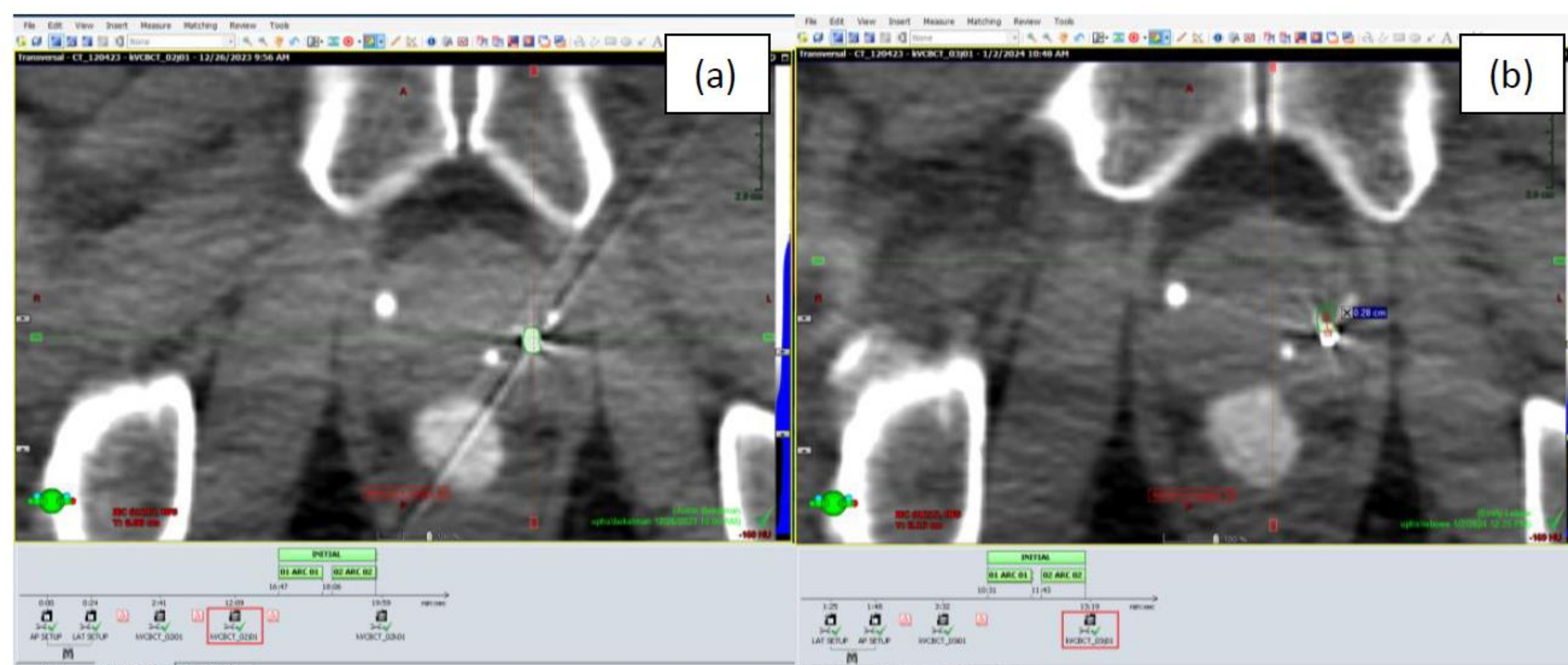


Figure 1. The fiducial drift can be measured by comparing (a) pre-treatment and (b) post-treatment CBCTs.

Results

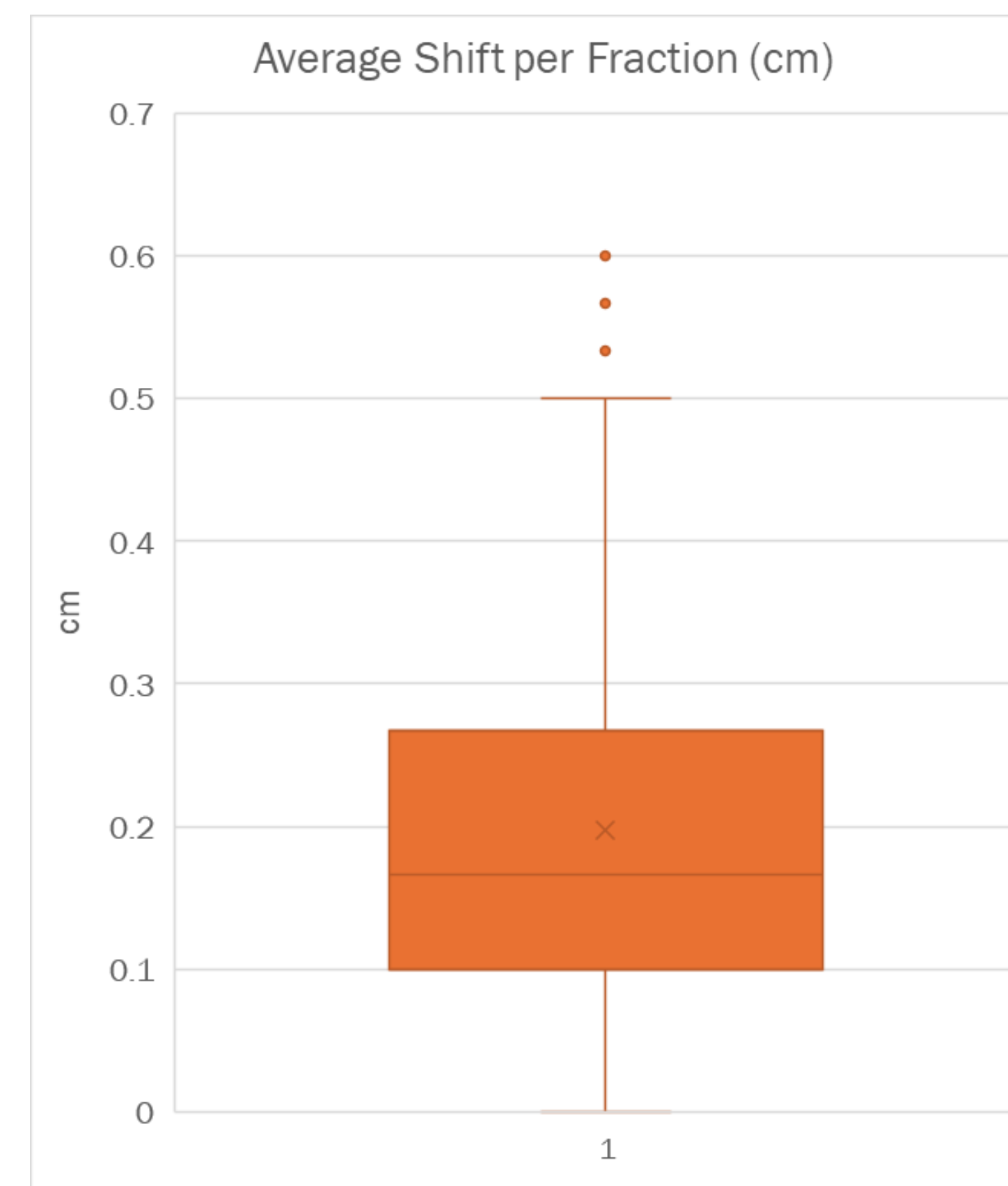


Figure 2 (left). The average measured fiducial shift per fraction of prostate SBRT. **The average shift is 0.197cm**, within the 3mm margin tolerance.

Figure 3 (below). The average shift per fraction plotted as a percentage of the fractions analyzed. **From this plot, it is noted that a 3mm margin is sufficient for 85% of fractions analyzed. A 5mm margin would be needed to cover 95% of fractions analyzed.**

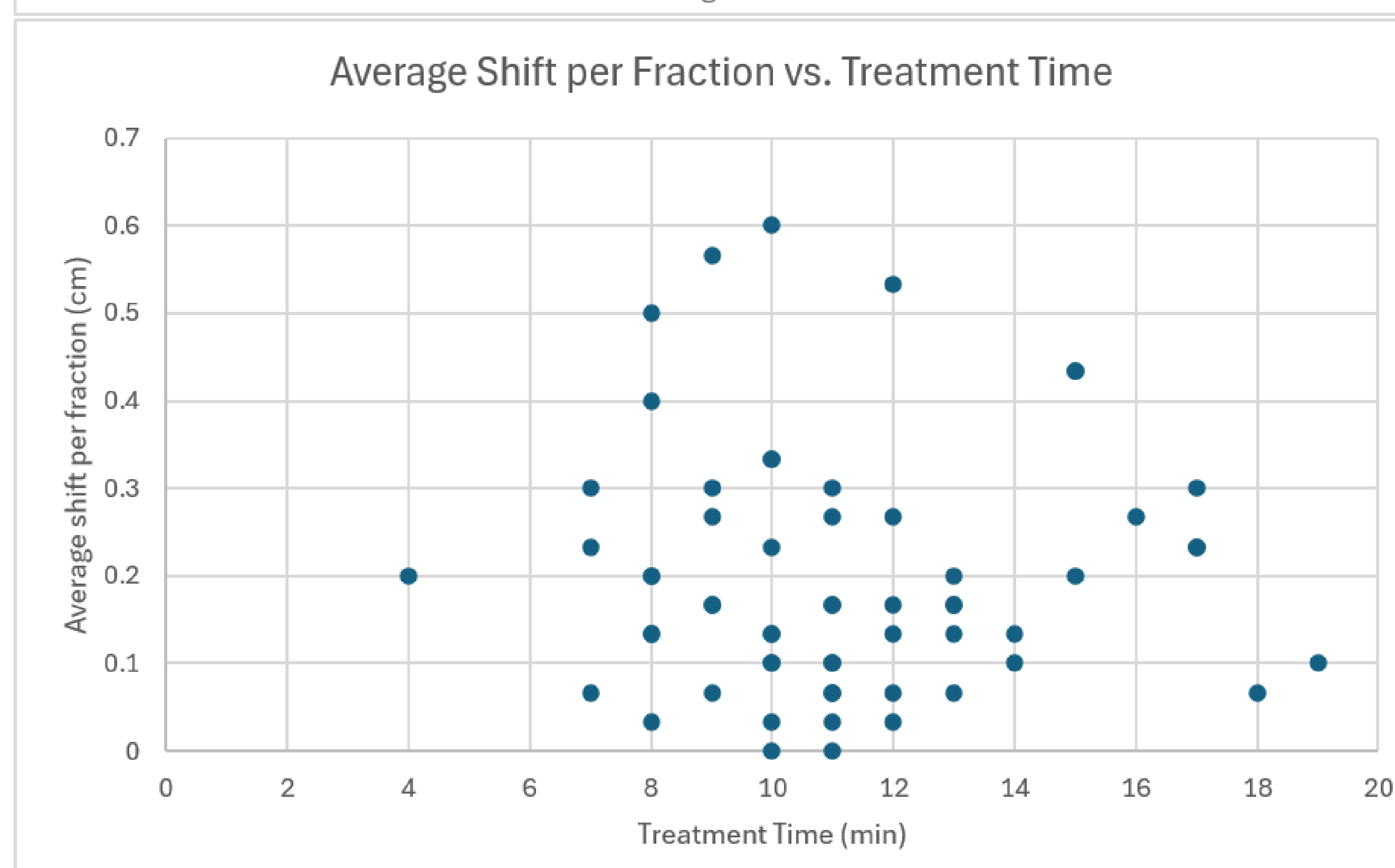
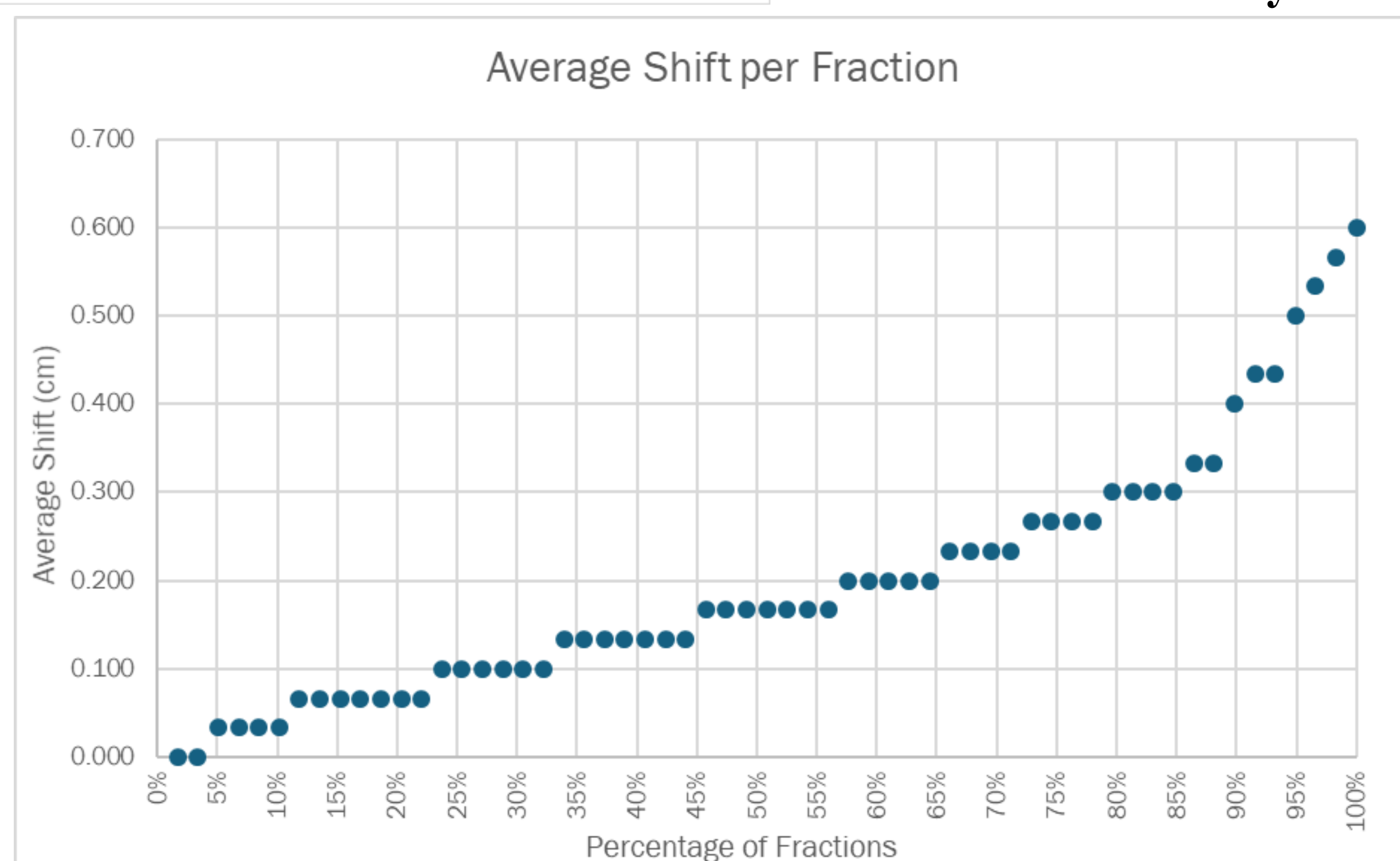


Figure 4. Average fiducial shift vs. treatment time. **No correlation was found.**

Replanning

Ten sample prostate SBRT cases were planned with 3mm and 5mm margins. To make the planning process as similar as possible between the cases, optimizer settings were copied from the 3mm to the 5mm plan and general strategy was the same. Equivalent time was also given to each plan. The two plans were then compared to better understand the effect of expanding the PTV margin.

Prostate SBRT Objective	% Pass	% Fail
PTV 4000 D95%[cGy] >=4000	100%	0%
PTV 4000 D99%[cGy] >=3600	100%	0%
BladderWall D0.035cc[cGy] <=4200	80%	20%
BladderWall D50cc[cGy] <=1825	100%	0%
FemoralHeads D10cc[cGy] <=3000	100%	0%
FemoralHeads D10cc[cGy] <=3000	100%	0%
RectalWall D0.035cc[cGy] <=4200	80%	20%
RectalWall D33%[cGy] <=3900	100%	0%
RectalWall D50%[cGy] <=2400	100%	0%
RectumSuperior D0.035cc[cGy] <=3000	100%	0%
RectumSuperior D10cc[cGy] <=2500	100%	0%
SmallBowel D0.035cc[cGy] <=2900	100%	0%
SmallBowel D10cc[cGy] <=1950	100%	0%
PenileBulb D0.035cc[cGy] <=3150	90%	10%
PenileBulb D3cc[cGy] <=2500	100%	0%
PenileBulb Mean[cGy] <=1000	90%	10%
Urethra D0.035cc[cGy] <=4050	90%	10%
Urethra+3mm D0.035cc[cGy] <=4200	60%	40%
Skin D0.035cc[cGy] <=2000	100%	0%

Figure 5. Table of all the objectives used to evaluate the prostate SBRT plans. For the 10 replanned cases, all 19 objectives were met with the 3mm PTV margin. When replanned with 5mm, some of the constraints were no longer met. The percentage of 5mm PTV margin plans that did and did not meet the constraints are found in this figure.

Conclusions

The analysis of pre- and post-treatment CBCTs showed that a PTV margin of 5mm is necessary to include the average patient movement in 95% of treatment fractions. To better account for patient movement during treatment, a 5mm margin would be advised. To make this change in the planning process, more time and consideration would need to be given in the optimization to reduce OAR dose, with specific care given to the bladder wall, rectal wall, and the urethra + 3mm structures.

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