

Analysis of couch shifts for each field for proton treatment delivery of Head and Neck cancer patients: *Towards the optimal imaging frequency*

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INTRODUCTION

Intensity modulated proton therapy (IMPT) offers great benefit to head and neck cancer patients due to sharp dose fall off and multi-field optimization (MFO) algorithm. It helps sparing critical normal organs while treating targets with high conformality, which requires robust clinical setup during treatment. Because of high sensitivities to the organ motions, image guided radiation therapy (IGRT) setup is required to treat each fraction of the treatment plan.

AIM

- Head and neck (HN) cancer patients are frequently planned with non-coplanar proton beams, due to the complexity of the patient anatomy and target location.
- Hence, targeting accuracy for all beams needs to be carefully evaluated prior to delivering proton beams, which adds additional time for the patients on the table and also imaging dose to the patients.
- In this study, we analyzed the couch shifts to evaluate whether imaging is required before delivering each field with different couch angle.

METHOD

After an IRB approval, a retrospective analysis was performed for 10 HN cancer patients who were treated with proton beams in 2019. Each plan was made with 2-3 non-coplanar and 2 planar fields. As per our institutional treatment protocol, a CBCT was taken at the beginning of the setup followed by orthogonal kV images before delivering each field. The couch shifts in Cartesian (Longitudinal, Vertical, Lateral) and Angular (Pitch and Roll) coordinates for each field were recorded from the treatment summary on the first two fractions and every fifth fractions thereafter. A net magnitude of 3D shift in Cartesian coordinates was calculated as:

$$R = \sqrt{\Delta Lng^2 + \Delta Vrt^2 + \Delta Lat^2}$$

RESULTS

- There were total 915 Cartesian and 610 angular shift values recorded for 10 patients for all the fields.
- The 305 net shifts values for all 10 patients ranged from 0 to 8 mm.
- Out of 915 Cartesian shifts, 637 were zero and the remaining 278 were non-zero ranging from -5 to +8 mm.
- Similarly, of the 610 angular shifts, 448 were zero and the remaining 162 were non-zero ranging from -2.5° to +3.0°.
- The couch shifts were larger towards the end of the course of treatment.

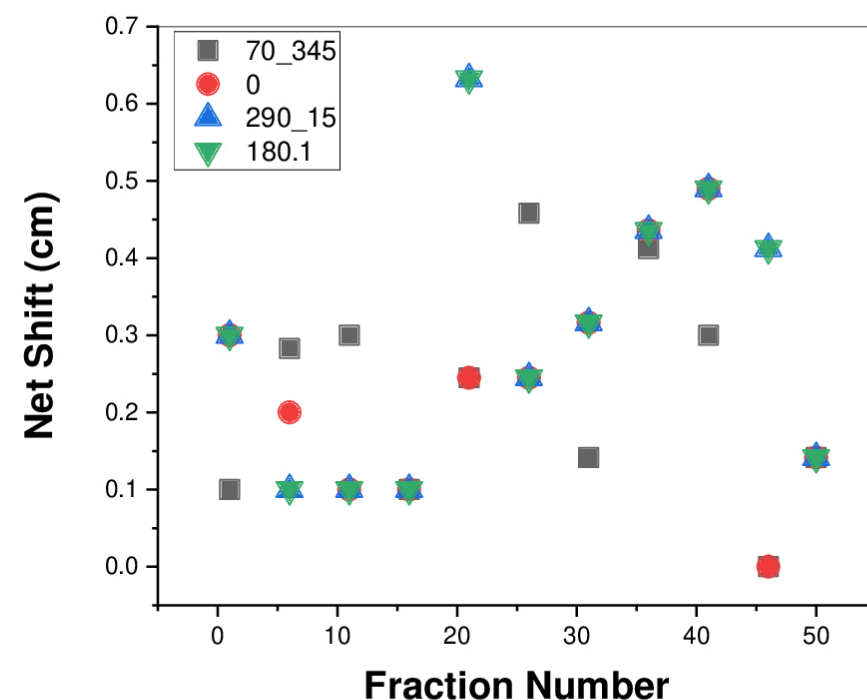


Figure 1: Net shift (cm) with fraction number for a representative patient. The insets are the beam IDs where first number is the gantry angle and the second number is the couch angle in degrees. The sequence of beams delivered was in anti-clockwise.

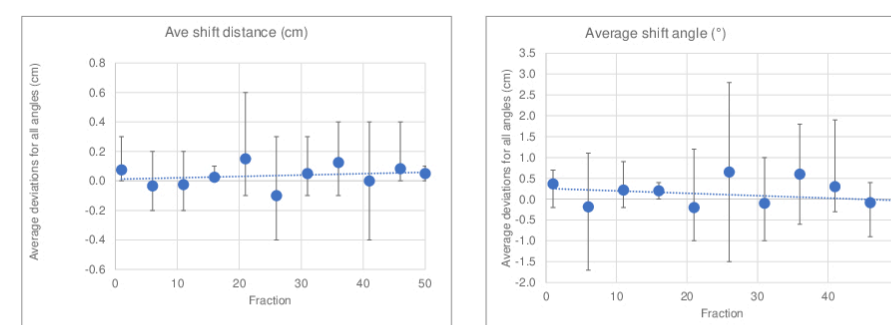


Figure 2: Average deviation for all the beams in cartesian coordinates (cm) and angular coordinates (°) with standard deviation versus fraction number for a representative patient.

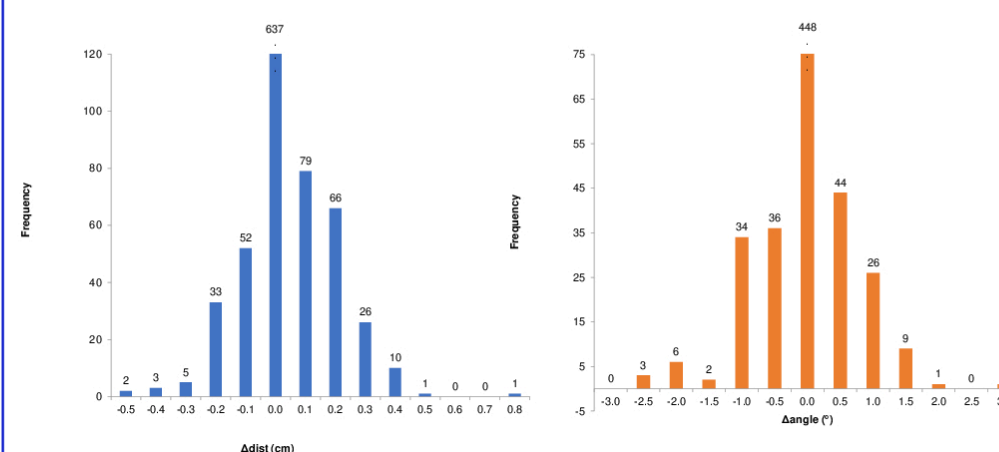


Figure 3: Illustration of the statistics for the couch shifts. A) Cartesian shifts in centimeters. B) Angular shifts in degrees, for 10 patients.

- The shifts are beyond the robotic 6DOF couch tolerance and it's very random based on many factors, i.e. patient health status on the day of treatment, patient weight loss, etc.

CONCLUSIONS

- This work proposed the necessity and frequency of imaging before delivering each field of head and neck (H&N) cancer patients undergoing intensity modulated proton therapy (IMPT).
- The shifts are clinically significant, that can cause significant dosimetric differences.
- The results of this study affirm that orthogonal kV imaging is required prior to delivering each field of H&N treatment plans with multiple non-coplanar beams.
- The shifts are more towards the end of the course of treatment, which may be due to patient losing weight and slightly loose fit of immobilization devices.
- Further analyses are warranted to assess correlation of couch shifts for different patient populations such as different body mass index, patient condition, or treatment day of the week.

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