Reproducibility of Lung SBRT Delivery On Beam-Matched Truebeam Linear Accelerator: A Multi-Linac Study

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INTRODUCTION

Volumetric modulated arc therapy (VMAT) delivers highly conformal dose distributions in a short period of time, thereby, has been used combined with flattening filter free (FFF) beams to treat lung cancer patients who needs stereotactic body radiotherapy (SBRT). The reproducibility of the delivery of a VMAT (i.e RapidArc by Varian Medical Systems) SBRT plan on a linac is affected by dynamic multileaf motion during treatment, precise rotation of multi-ton gantry assembly, and dose-rate variations requiring turning or detuning of complex electronic components, which takes the complexity of radiation dose delivery to a whole new level [1][2].

AIM

Our study aims to find if the delivery quality of the same lung SBRT plan is reproducible on beam-matched Truebeam linacs (Varian Medical Systems, Palo Alto, CA) equipped with Millennium 120 leaf MLC, and eventually to help us determine if we can perform the same SBRT treatment on different Truebeams (TB).

METHOD

- 5 patients with stage I/II NSCLC who received SBRT in 2019 and 2020 were randomly selected. Their VMAT treatment plans were generated in an Eclipse treatment planning system.
- A total of 19 QA fields were delivered to the Electronic portal imaging device (EPID) on 3 beam-matched TBs.
- 6xFFF beam was used with the dose rate of 1400 MU/Min.
- Treatment plans delivered to EPIDs were analyzed in Portal Dosimetry (Varian Medical Systems, Palo Alto, CA). 2%, 2mm gamma criteria was used in our clinic. Maximum Gamma (MG) and Average Gamma (AG) were also compared. A statistical study was performed for the gamma passing rate, MG, and AG.

RESULTS

- The average difference of the passing rates between TB1 and TB2, TB1 and TB3, and TB2 and TB3 were -0.37%±0.51%, -0.06%±0.52%, and 0.32%±0.56%, respectively.
- Among 57 comparisons of the passing rates for 19 fields, 71.9% (41/57) of them was within the difference of 0.5%.
- The most difference of passing rates was 1.5%.
- The most difference of MG was found between TB1 and TB3 (0.18±0.40).
- The least difference of MG was found between TB2 and TB3 (0.04±0.31).
- The least difference of AG was found between TB1 and TB3 (0.01±0.02).
- The most difference of AG was found between TB1 and TB2 (0.04±0.01).

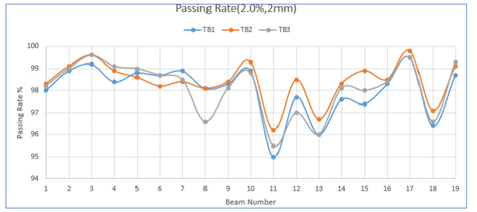


Figure 1: Passing Rates of 19 Beams on 3 TrueBeams

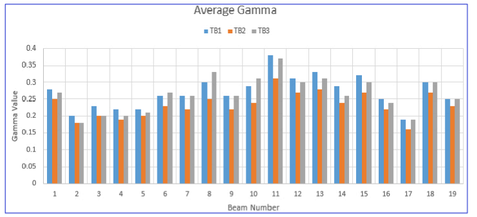
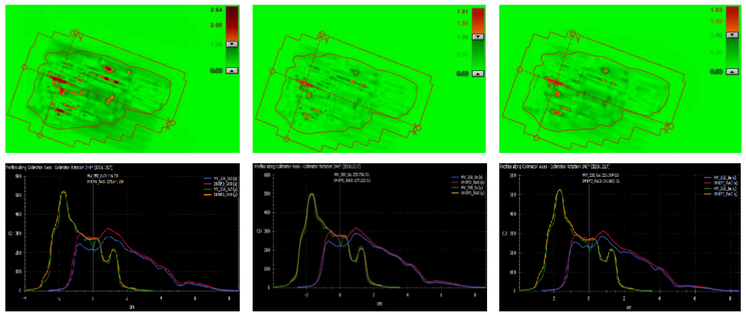


Figure 2: Average Gamma of 19 Beams on 3 TrueBeams

- Passing Rates of 19 Beams on three TBs were shown in Figure 1. Most of the beams have similar Passing rate (within 0.5% difference). Some beams such as Beam 8, Beam 11, and Beam 15 had difference in passing rate as large as 1.5%.
- The average difference of the average gamma between TBs are all within 0.1 as shown in Figure 2.
- In Figure 3, we compared the gamma evaluation and corresponding profiles along X and Y Axes of the collimator for Beam 11 measured on 3 TBs. And the gamma evaluation from TB1 indicates where the "hot spots" were located. On the other hand, the gamma evaluation from TB2 showed why it had a higher passing rate comparing with the one from TB1. The gamma difference from TB3 is better than the one from TB1 but worse than the one from TB2.



Passing Rate on TB1: 95.0% | Passing Rate on TB2: 96.2% | Passing Rate on TB3: 95.5%

Figure 3: Comparison of Gamma Evaluation and Profiles along Collimator Axes on Beam 11

CONCLUSIONS

- The factory quality control of all 3 TBs in our clinic is top-rated.
- Measured with EPIDs on 3 beam-matched TBs, the delivering quality of lung SBRT VMAT plans using 6MV-FFF beams is reproducible using 2%, 2mm criteria and meet our expectation for clinic use.

ACKNOWLEDGEMENTS

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