Clinical Implementation of portal dosimetry algorithm for three beam-matched Varian TrueBeam LINACs

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INTRODUCTION

EPIDs are extensively used for obtaining dosimetric information of pre-treatment field verification. Linear accelerators with beam-matched capability can increase the flexibility in patient treatment and reduce the economic and social effects caused by machine-down time.

AIM

Beam-matched linacs increase the clinical workflow and patient scheduling because the treatment can be delivered by substitute linac if needed. The patient-specific IMRT QA typically finished on the assigned machine, however, the IMRT QA result on substitute linac need to be within tolerance for patient treatment. We present the PDC algorithm parameter comparison among beam-matched linacs, and statistical IMRT passing rate at another linac.

METHOD

In this study, we compare the portal dose calculation(PDC) algorithm parameters for three beam-matched linacs and the impact on patient-specific IMRT QA analysis.

- Three linacs were installed with dosimetric properties (*photon PDD typically within 0.5%, and symmetry within 1%).* Each PDC algorithm was configured at its machine commissioning time. The later-installed linacs used the same MLC parameters, including DLG and transmission factor.
- The same set of data, including intensity profile and output factors, were used in PDC algorithm configuration. The configuration of the PDC algorithm requires a set of dynamic pyramid-shaped test images to deriving the a-Si single pencil-beam kernel, with weighted sum of 9 Gaussian functions with predefined widths.
- The difference in kernel curves was compared. To further investigate the quality of PDC algorithm, IMRT QAs (6X, 10X) were delivered using the same original plan, and analysis with the same predicted image.
- IMRT/VMAT QA from 100 patients, with total of 149 plans and 409 fields, were delivered to three linacs.

RESULTS

Relative weights of the different Gaussian contributions varied slightly between linacs, while these differences were larger for flattening-filter-free beams.

- *Figure 1 shows the PDC algorithm kernel curve (amplitude vs radius). The kernel curves qualitatively have a good agreement among linacs.*
- *Figure 2 shows the Gaussian width also indicating: same energy beam has close relative weight, except 10XFFF beam.*

The kernel curves (6X, 10X) showed that the photon scattering within a-Si material is similar in current aS1200 panels. The systematic IMRT QA results showed that *1135/1189* fields passed with 2%/2mm criteria, and *54/1189* passed 3%/3mm.

The cross-validation IMRT QA passing rate with 2%/2mm among linacs indicated comparable passing rate distribution(e.g. Linac#3 plan *98.9±0.97%*, *99.04±0.99%*, *99.23±0.87%*)

- Figure 3 shows the patient-specific IMRT QA passing rate for each individual linac's plan delivered on all three linacs with the same plan and same predicted image. The overall mean passing rate are similar, but the relative statistical distribution varies depending on machines.

Therefore, IMRT QA on the planned linac has passing rate compared to IMRT QA done at another linac.

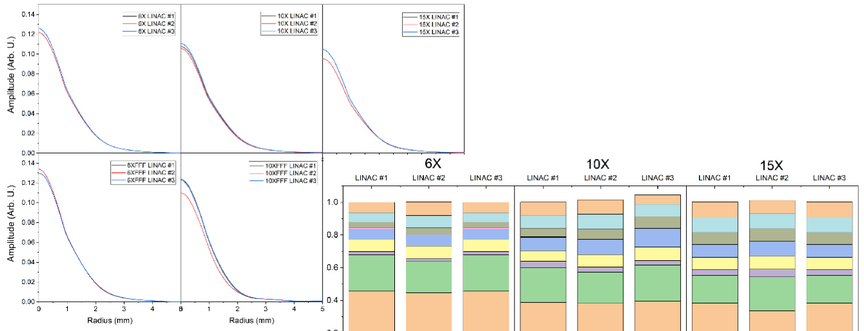

Fig.1 Comparison of PDC algorithm kernel curve with different energy for three beam-matched Truebeam Linac. (Linac#1 and #3) overlapped in 6X, 6XFFF, and 15X

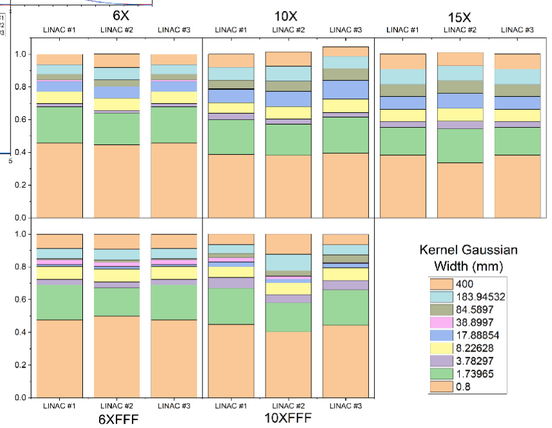

Fig.2 Comparison Gaussian kernel width of PDC algorithms

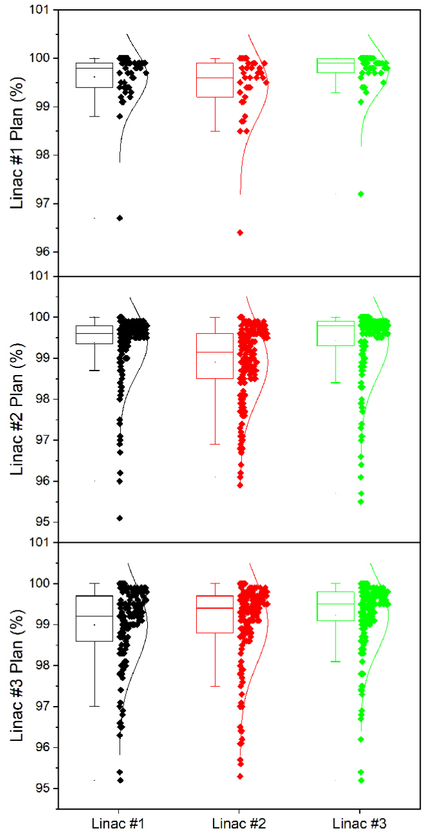

Fig. 3IMRT QA passing rate with EPID (2%/2mm

CONCLUSIONS

- For three beam-matched linacs with the same beam parameters, and PDC parameters in TPS, the optimized PDC algorithms have a good agreement among linacs.
- The linacs IMRT QA on assigned machine can also be within tolerance for another beam-matched linac without further machine-specific IMRT QA validation. The IMRT QA passing rate statistical analysis enables the possibility to relocate patient IMRT treatment on another linac without additional IMRT QA.

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