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Standardizing the MLC Gap and Characterizing Its Effect on the Dosimetric Leaf Gap

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INTRODUCTION

The Dosimetric Leaf Gap (DLG) is a metric that characterizes how much dose gets through Multi-Leaf Collimator (MLC) leaf tips. This is traditionally measured by acquiring the dose of sweeping gap plans of various gap sizes and extrapolating the gap size that would give zero dose[1].

A DLG parameter is used inside the treatment planning system (TPS) to perform dose calculations[2]. DLG values vary per energy and per machine, however a standard value is often used in the TPS so that treatment plans can be transferred between treatment units easily.

It has been found that a systematic error of 1mm in all leaves can impact the equivalent uniform dose of clinical target volumes by 5.6% in head and neck plans[3]. Standardizing the DLG across machines will give more robust treatments that deliver doses more consistent with the planning goals.

Varian TrueBeams have a parameter in service mode that can be used to adjust the physical gap between MLC banks. This gap can be used to influence the DLG of a machine.

AIM

Standardize the DLG across 10 TrueBeams in an enterprise to more closely match the DLG in the TPS, investigate how changing the gap offset on the treatment system affects the DLG, and compare how differences in TPS DLG values and machine DLG values affect portal QA pass rates.

METHOD

For each machine, the following procedure was followed:

1. Perform a set of Portal QA plans that includes the Chair pattern, Pyramid pattern, and two patient plans per energy available on the machine.
2. Measure the DLG using sweeping gap plans.
3. Remove the machine head and verify the gap with a feeler gauge on 1mm and 0.5mm gap dicom files.
4. Change the physical gap by the difference of the measured 6X DLG and the target 6X DLG.
5. Repeat the feeler gauge measurements post-adjustment.
6. Re-measure the DLG with sweeping gap plans post-adjustment.
7. Re-measure the Portal QA plans post-adjustment.

The target DLG was decided based on measurements from our newest TrueBeam which had a much smaller DLG than the TPS.

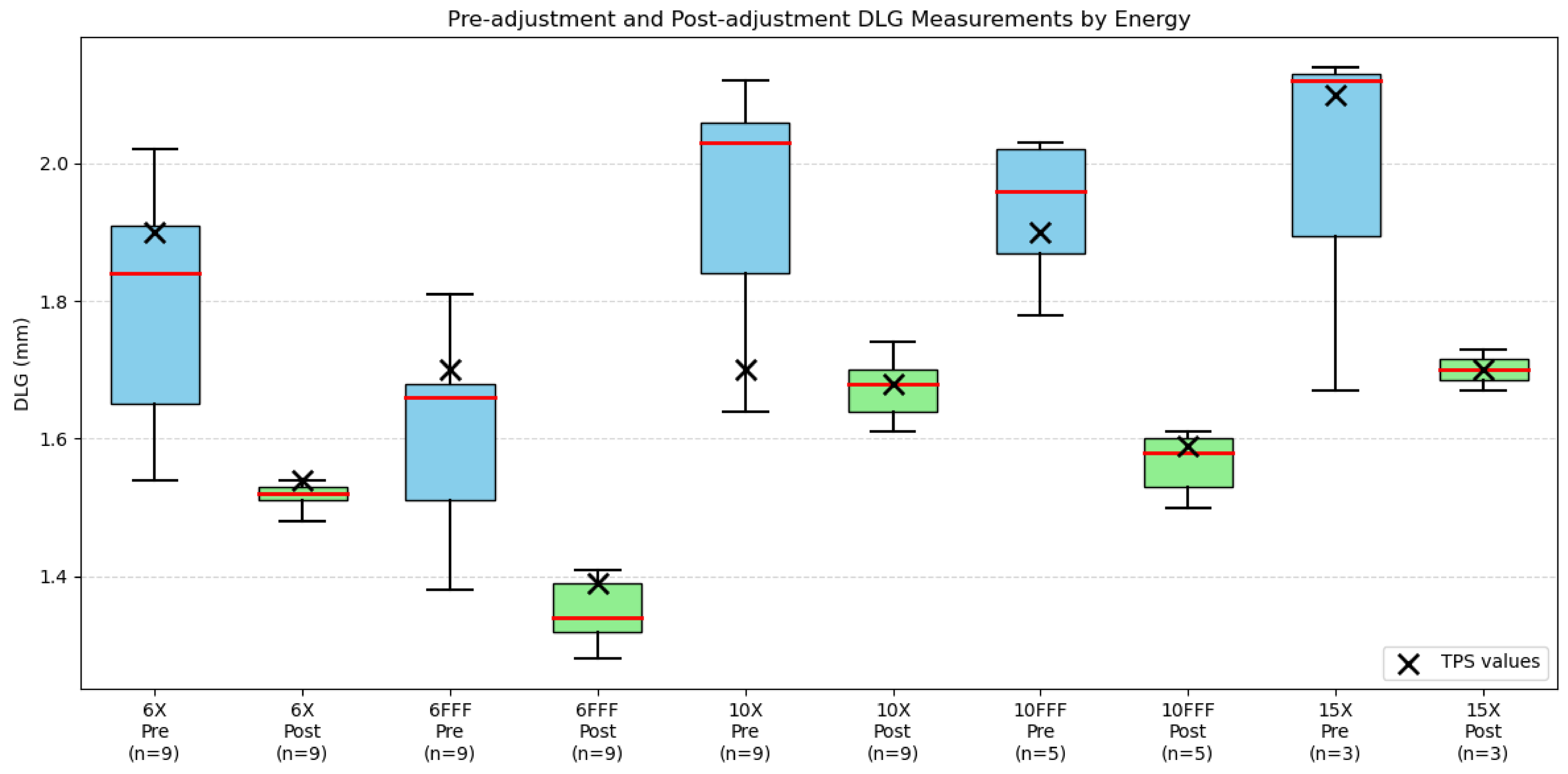

Figure 1. Box plots for the measured DLGs of all machines pre gap adjustment and post gap adjustment per energy

MACHINE VARIABILITY

The median of DLG values decreased by 0.36mm on average after adjustment. The range of DLG values decreased by 0.32mm on average after adjustment.

The maximum range for the pre-adjustment energies was 0.48mm, while the maximum range for the post-adjustment energies was 0.13mm. With the physical leaf gap scaling linearly with the DLG, and using the dose estimates in Mei et al.[3], this translates to machines delivering an equivalent uniform dose difference of 2.7% and 0.7% for clinical target volumes in head and neck plans for the pre-adjustment and post-adjustment machine groups, respectively.

Energy	Original TPS [mm]	New TPS [mm]
6X	1.90	1.54
6FFF	1.70	1.39
10X	1.70	1.68
10FFF	1.90	1.59
15X	2.10	1.70

Table 1. DLG values used in the TPS for dose calculation

LEAF GAP EFFECT ON DLG

The Gap offset parameter that is used to change the physical gap on a machine changed the DLG by the same amount entered in the console.

This allows DLG values between machines to be matched to the DLG value used in the TPS for dose calculations, allowing for more robust treatments within an institution.

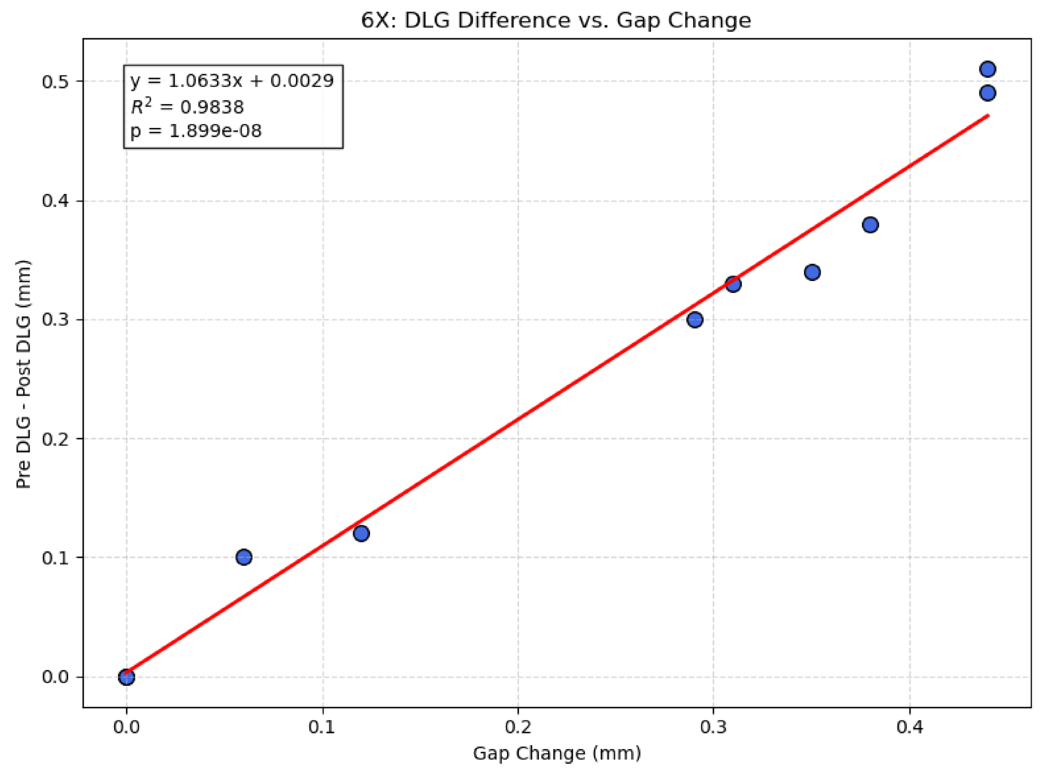

Figure 2. The difference in 6X DLG pre and post gap adjustment vs the gap adjustment entered in the console.

PORTAL QA

Two sets of measured images were taken pre-adjustment and post-adjustment. These were compared against the predicted images using the original TPS DLG values. Then the post-adjustment measured images were also compared against predicted images recalculated with a TPS updated with the target DLG values.

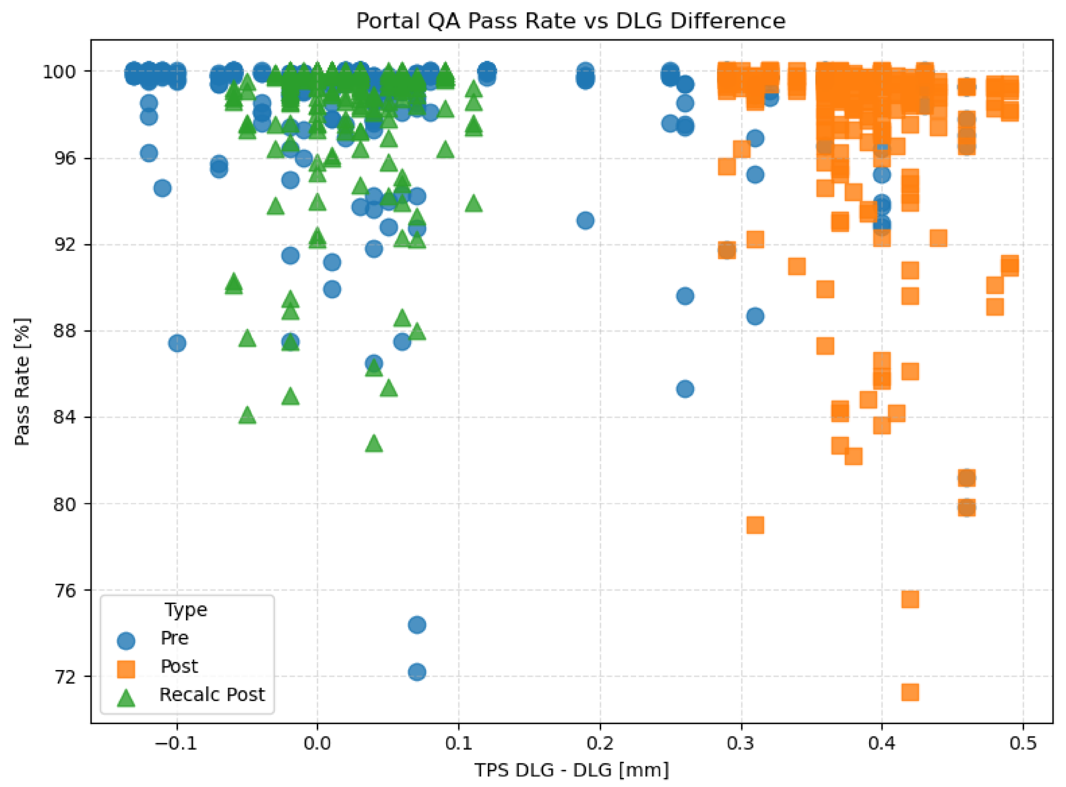

Figure 3. 2%/2mm criteria gamma pass rates for all portal QA plans against the difference in the measured DLG and TPS DLG.

CONCLUSIONS

The variability of the DLG between machines was significantly reduced by changing the physical leaf gap offset.

The change of the physical leaf gap showed a consistent relationship with the DLG, making it an effective way to tune the DLG on a machine.

The gap adjustment had minimal effect on Portal QA pass rates.

REFERENCES

1. Arnfield, M.R., Siebers, J.V., Kim, J.O., Wu, Q., Keall, P.J. and Mohan, R. (2000), A method for determining multileaf collimator transmission and scatter for dynamic intensity modulated radiotherapy. Med. Phys., 27: 2231-2241. https://doi.org/10.1118/1.1312190

2. Vieillevigne, L., Khamphan, C., Saez, J. and Hernandez, V. (2019), On the need for tuning the dosimetric leaf gap for stereotactic treatment plans in the Eclipse treatment planning system. J Appl Clin Med Phys, 20: 68-77. https://doi.org/10.1002/acm2.12656

3. Mei, X., Nygren, I. and Villarreal-Barajas, J.E. (2011), On the use of the MLC dosimetric leaf gap as a quality control tool for accurate dynamic IMRT delivery. Med. Phys., 38: 2246-2255. https://doi.org/10.1118/1.3567148

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