Impact of single and high-density diode merge measurement on SNC ArcCHECK for SBRT plans PSQA

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PURPOSE / OBJECTIVES

With the wide-spread and further increasing use of SBRT treatments, additional physics resource maybe needed in SBRT patient specific quality assurance (PSQA) process to satisfy the more stringent requirements compared to non-SBRT IMRT/VMAT plans. Such additional effort may tap into limited or unevenly distributed physics resources in the clinic. The diode merge feature, offered on SNC ArcCheck, increases the diode density for overall measurement at the cost of repeated beam acquisitions. The difference in gamma passing rate (GPR) for PSQA measurements of SBRT plans using in single measurement and high-density diode merge measurements was investigated for (VMAT) SBRT plans.

MATERIAL & METHODS

A retrospective study consisting of 31 SBRT plans, delivered on Elekta Versa linac with Agility MLC system via VMAT, were examined. Plans comprised of various anatomical regions (head and neck to pelvis) delivered using 6FFF and 6X beam energies. SNC ArcCHECK was used with SNC Patient (v8.0) to acquire single and high density diode merged measurement.

The two measurements were evaluated using gamma analysis against composite dose calculated in Raystation (2024A) using 2D Gamma with 3% dose difference, 2mm distance to agreement criteria and 10%-90% dose threshold. Difference in gamma passing rate (GPR) between two measurement was also evaluated by examining the PTV size, and plan modulation factor defined as:

$$Modulation = \frac{Prescription\ Dose}{Total\ MU}$$

and additionally diode ratio between two measurement was evaluated against gamma analysis dose threshold as well.

RESULTS

Minimal difference for GPR was found between single and merged diode measurement with -0.03%±0.37% and 0.51%±0.34% raw and absolute difference, respectively. Plan modulation and PTV size did not indicate strong correlation to GPR difference between two measurements (R^2=0.06, with positive and R^2=0.01 with negative correlations, respectively). Finally, the diode ratio between two measurements decreased with higher GA dose threshold, 1.99, 1.93, 1.78 and 1.64 for 10%, 50%, 75% and 90% threshold respectively.

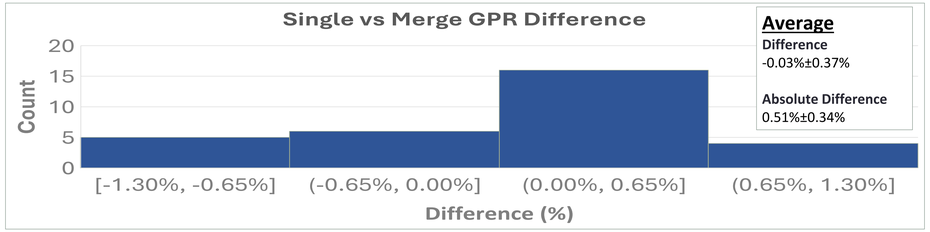

Figure 1: Histogram plot comparison of raw difference in GPR between all the plans between single and merge measurements

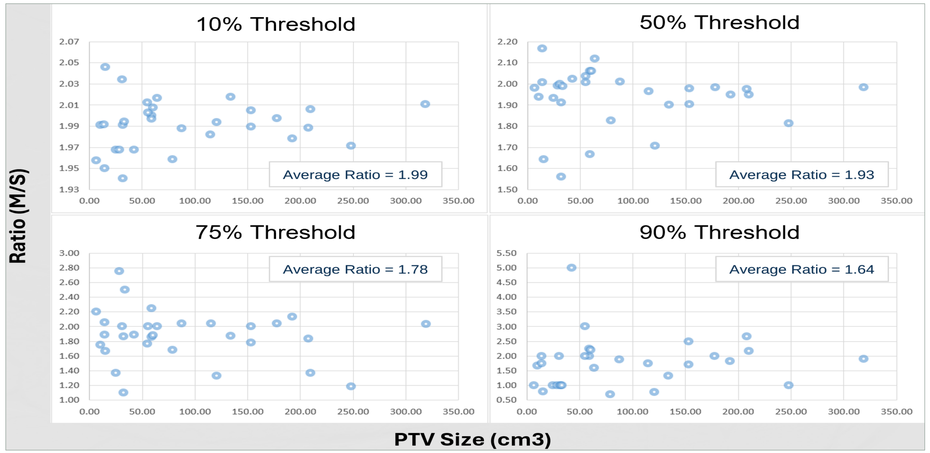

Figure 2: Scatter plot of PTV size and the corresponding ratio of active merge (M) diode to single (S) measurement diode count for varying dose (along with average ratio) for 31 patients

RESULTS

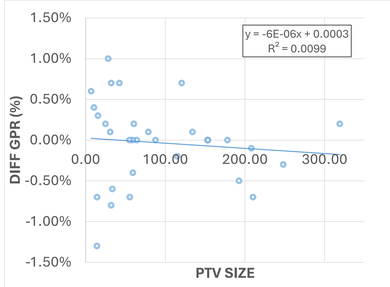

Figure 3: Raw difference in gamma passing rate (10% dose threshold) evaluated against PTV size.

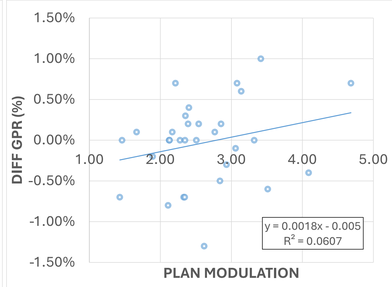

Figure 4: Modulation factor and the corresponding raw difference in gamma passing rate for 31 patients

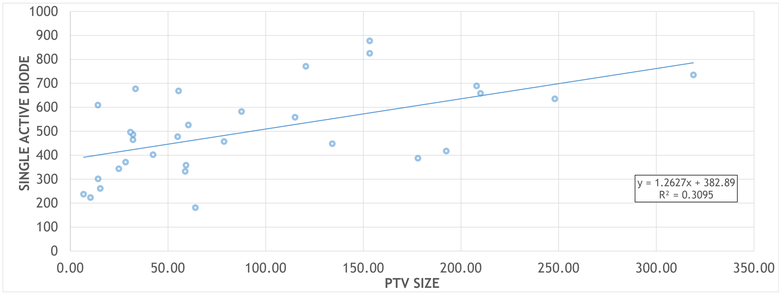

Figure 4: Amount of active diodes in a single measurement (for 10% dose threshold) evaluated for various size of PTV in the study.

SUMMARY / CONCLUSION

We have examined the difference in PSQA measurement from the two acquisition techniques. Minimal difference was found the GPR between two suggesting that for large PTV or less complex SBRT plans single measurement should be sufficient. Based on these results, our institution has elected to require diode merged measurements if the PTV's smallest centroid chord length in all anatomical planes is less than 3 cm. Future work will focus on determining a more rigorous a cutoff threshold for recommending the use of merged diode measurement and examine the dose distribution in context more sophisticated analysis (e.g., Fourier analysis).