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EASTERN TIME [GMT-4]

Statistical Process Control Analysis of Adaptive Patient Specific QA On the Elekta Unity MRI-Linac

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INTRODUCTION

- MRI-guided Adaptive Radiotherapy machines, such as the Elekta Unity, are revolutionizing patient tailored radiation therapy by allowing day-to-day treatment plan adjustments.
- The Unity utilizes a daily magnetic resonance (MR) image which allows plan adaptation. In the Unity workflow, plan adaptation can be performed using Adapt to Position (ATP) or Adapt to Shape (ATS) options.
  - ATP represents a virtual shift
  - ATS is a full re-plan with contour adjustments

AIM

Because patient specific adapted plans cannot be measured prior to treatment delivery, an investigation into the measurement QA gamma pass rates of ATP and ATS plans compared to the initial reference plan is needed.

METHODS

- Statistical process control methodology was used to compare ATP and ATS IMRT QA measurements performed on the MR compatible SunNuclear ArcCheck placed on the Elekta QA platform (Figure 1) using a gamma criterion of 3%/2 mm using global normalization and a 10% low dose threshold.
- The reference plans were used to define the Lower Control Limit (LCL) of the gamma pass rates using a 3%/2 mm gamma criteria with a global normalization and a 10% low dose threshold,

$$LCL = \mu - 3\sigma \quad \text{(Eq. 1)}$$

where μ is the mean and σ is the standard deviation of the reference population calculated from the reference data.

- The LCL provided a statistical bound that was used to calculate the one-sided process capability ratio ($C_{p,l}$) for the ATP and ATS plans,

$$C_{p,l} = (\mu - LCL)/3\sigma \quad \text{(Eq. 2)}$$

where μ is the mean and σ is the standard deviation of the experimental population.

- A $C_{p,l}$ value above 1 would indicate that the variability of the test data (ATP and ATS pass rates) is within the inherent variability of the process (reference plan pass rates).

RESULTS

- The LCL of the 56 reference plans was determined to be a gamma pass rate of 0.968.
- The gamma pass rates (3%/2 mm) for the 56 IMRT reference plans (Fig 2A), 424 IMRT ATP treatment plans (Fig 2B), and 54 IMRT ATS plans (Fig 2C) are depicted in Figure 2.
- The $C_{p,l}$ of the measured ATP plans and measured ATS plans after removing outliers due to known machine issues was calculated to be 1.013 and 1.110 for ATP and ATS plans respectively

2.

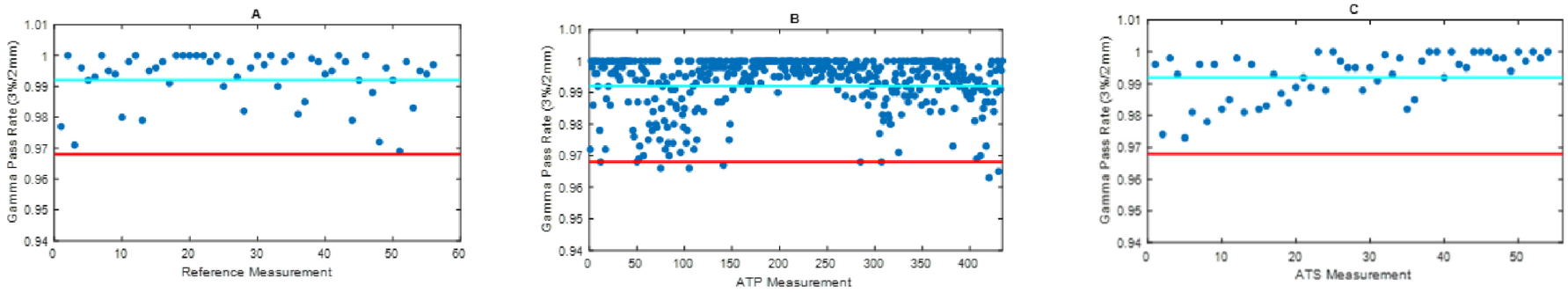

Figure 2: The central line represents the mean (0.993) of the data (cyan), and the LCL (0.968) is drawn in red. 2A: Results of 3%/ 2mm gamma pass rate for 56 reference treatment plans after rerunning one reference plan (blue circle). 2B: 3%/ 2mm gamma pass rate for the 434 ATP treatment plans. 2C: 3%/ 2mm gamma pass rate for the 54 ATS treatment plans.

1.

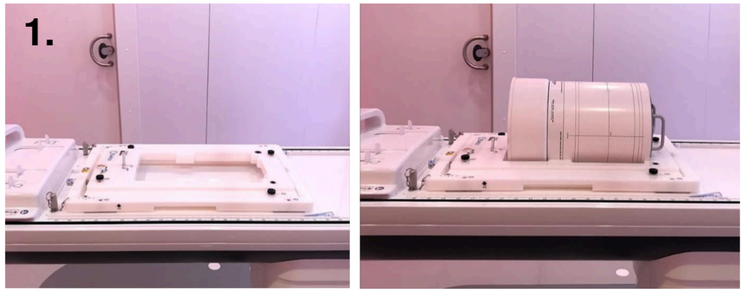

Figure 1: QA platform (left) and QA platform with ArcCheck phantom (right)

CONCLUSIONS

- Through the statistical process control method, the process capability ratio confirms that the gamma pass rates of the ATP and ATS plans are within the statistical variability of the reference plans.
- These results provide confidence in the machine's performance of the ATP and ATS treatment plans compared to the initial reference plan.

CONTACT INFORMATION

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