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Impact of Consecutive Spot Errors on Beam Delivery Accuracy in Carbon Ion Radiotherapy: Log-Based Analysis

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Background / Aims:

- The continuity of spot scanning errors is employed as a trigger to interrupt beam delivery in scanning carbon ion radiotherapy (CIRT)
- We aims to investigate the number of consecutive spot errors that affect dose accuracy

Subjects and Methods:

- Machine log file analysis for 48 CIRT plans for patient-specific quality assurance
- Error definition: 0-3mm for position displacement, 0-30% for size variation
- Evaluate errors in proximal, medial, and distal depths of spread-out bragg-peak (SOBP)
- Dose accuracy: difference (%) between plan and measurements dose
- Statistical analysis: Spearman correlation & Wilcoxon rank-sum test
- Threshold for the number of consecutive errors using Youden-index

Result:

- The number of consecutive spot size errors was significantly correlated with dose difference $\geq 3\%$ in distal depth of SOBP ($p < 0.05$)
- The number of consecutive spots with size variation $> 20\%$ was significantly higher at dose difference $\geq 3\%$.

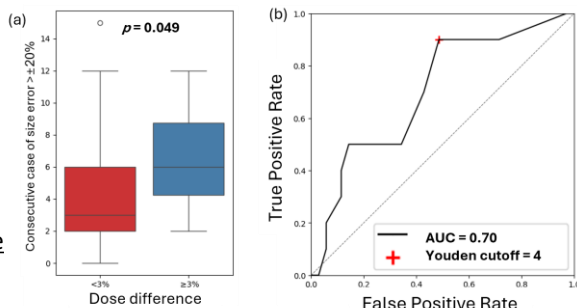


Fig 2. Consecutive error analysis for distal depth

- Fig 2-3 show boxplot and receiver-operating characteristic when classifying dose difference $\geq 3\%$ using consecutive spots with size variation $> 20\%$
- Threshold for consecutive spot size variation $> 20\%$: 4 for distal depth, 17 for any depths

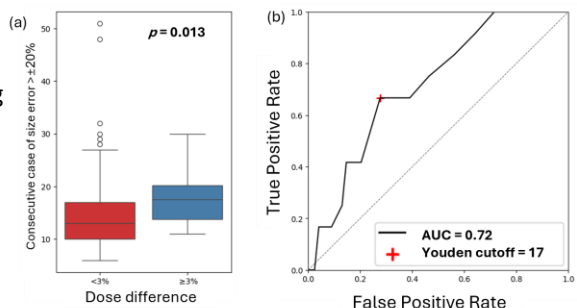


Fig 3. Consecutive error analysis for combining all depths

Conclusion:

- Consecutive spot errors with size variation $> 20\%$ are recommended to be fewer than 20