Evaluation of Patient Specific Quality Assurance Using Receiver Operator Characteristic Analysis

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INTRODUCTION

When performing VMAT pre-treatment QA, different systems have different optimum choices, each can yield quite different results. In order to assess the capacity of QA to detect specific type of errors, find the optimal parameters of a test and move toward *evidence based* QA procedures, the Receiver Operator Characteristic (ROC) analysis has been used.

AIM

To use the ROC analysis to determine the gamma function parameters and threshold that can be used during patient specific quality assurance for VMAT plans.

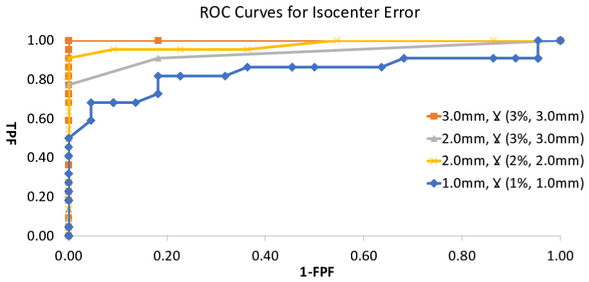
METHOD

13 VMAT plans for head & neck cases were delivered as planned. Two errors were introduced, isocenter shift in order of 1.0, 2.0, 3.0, 4.0 and 5.0mm. The second error was a modification of beam MU either by increase or decrease by 1%, 2%, 3%, 4% and 5%. Dose calculations were performed using Eclipse V.13 and plans were delivered by Varian 2100C/D linear accelerator with 120 leaf MLC. Dose measurements were performed using PTW Octavius II with Detector 729 array. Five gamma function criteria were used 1%/1mm, 2%/2mm, 3%/3mm, 4%/4mm and 5%/5mm

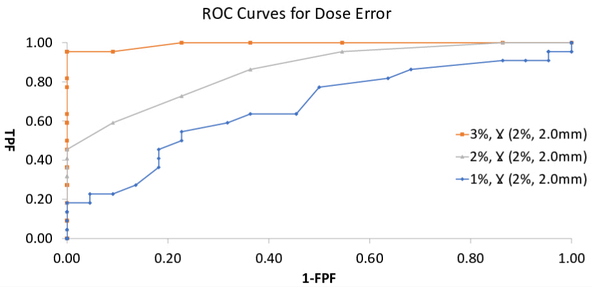
ROC curves were produced for each Gamma function criteria. For each curve the area under the curved AUC was calculated. Ideal thresholds were selected by finding point where sensitivity and specificity are close to 100% on the ROC curve.

RESULTS

From the AUC plots we can notice that the system detectability improve with reducing the gamma criteria, also it depend on the magnitude of error that we want to detect. For 3.0 mm shift the system detectability is perfect, and it will continue to be perfect for 2.0 mm if we reduce the gamma function criteria to 2%,2mm and 1%,1mm. while it shows a poor behavior to detect 1.0mm.



For the dose error the system detectability is perfect for 3% difference (AUC is 0.99 for 2%,2mm gamma function criteria), while it drops down by 15% for 2% dose error (for the same gamma function criteria), and by 35% for 1% dose difference.



The ideal threshold to detect 2mm isocenter shift error is 96% for 2%/2mm gamma function criteria, and 100% for 3%/3mm. To detect 3mm error the ideal threshold is 85.5 for 2%/2mm gamma function criteria, and 98.5 for 3%/3mm as shown in the table blow

	Gamma function criteria		
Isocenter shift error (mm)	1%, 1mm	2%, 2mm	3%, 3mm
1.0	73.0	98.0	100
2.0	62.5	96.0	100
3.0	52.5	85.5	98.5

For the dose difference error, the ideal threshold to detect 3% error is 94.5% for 2%/2mm gamma function criteria, and 100% for 3%/3mm as shown in the table blow.

	Gamma function criteria		
Dose error (%)	1%, 1mm	2%, 2mm	3%, 3mm
1.0	77.0	99.0	100
2.0	72.5	98.0	100
3.0	72.5	94.5	100

CONCLUSIONS

ROC method is a useful tool that help to understand our QA equipment and their ability, and to decide what Gamma criteria to be used depending on type of error and its variation

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