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Cardiac dose control and optimization strategy for left breast cancer radiotherapy with Non-Uniform VMAT Technology

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PURPOSE

In this study, a novel in house designed new technology named "non-uniform VMAT", which was on the basis of conventional VMAT model, was applied to help cardiac dose control and optimization, ensure the target dose and liberate manpower at the same time in the left breast cancer radiotherapy.

MATERIALS & METHOD

NU-VMAT model (shown in Fig.1) based on I_{GM} (gantry movement index, detailed in formula below) was established to optimize the VMAT MLC movement and modulation intensity in certain gantry angle. ESAPI which embedded in Eclipse ® was used to connect TPS and our optimization program.14 patients with left breast cancer after breast-conserving surgery undergoing radiotherapy were retrospectively involved. Dosimetric parameters including Dmax, Dmin, Dmean of PTV; V5, V10, V20 of left lung; V5, D20,D30 and Dmean of heart, machine MU and delivery time of IMRT, VMAT, and NU-VMAT plans were evaluated for plan quality and delivery efficiency.

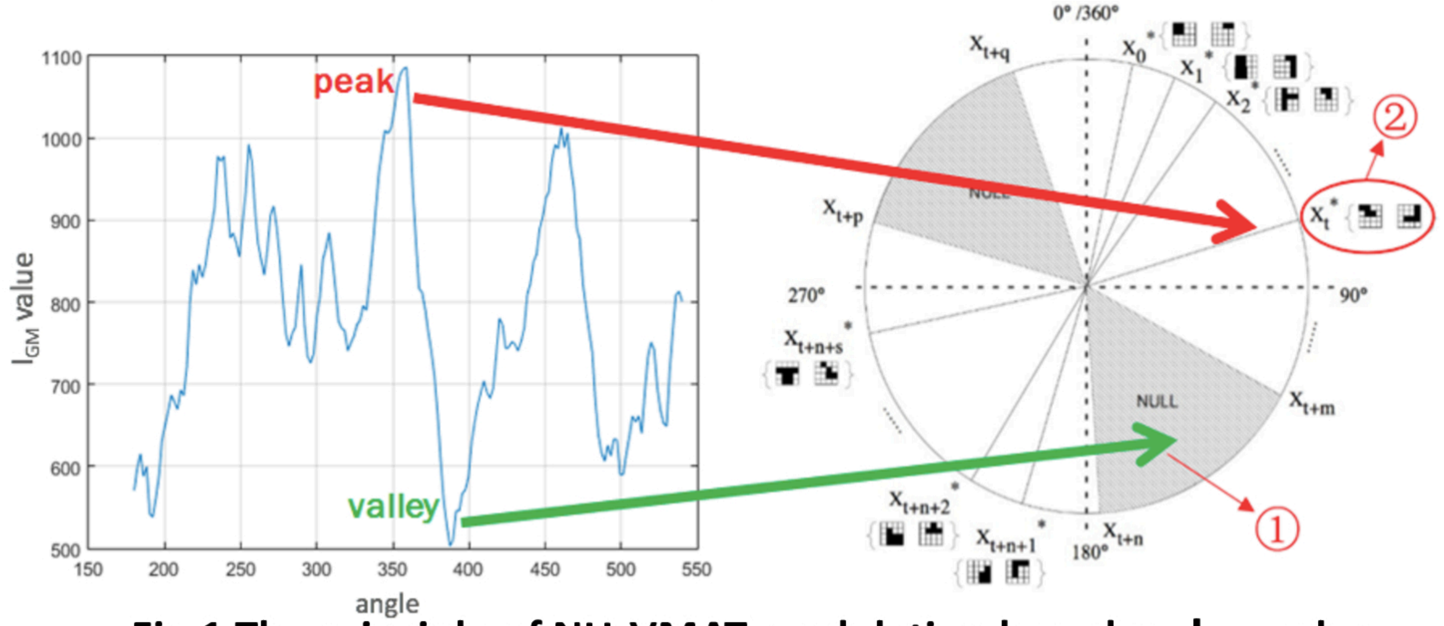

Fig.1 The principle of NU-VMAT modulation based on I_{GM} value

$$I_{GM(n)}(s) = \sum_{K-K}^{K} \{g(\delta_\alpha|\mu, \sigma^\alpha) * A_K * [MU(s) - MU(s+k)]\}$$

Where $g(\delta_\alpha|\mu, \sigma^\alpha)$ is the Gaussian function with $\mu = 0$, MU is the cumuiative monitor units, and A_K is defined as follows:

$$A_K = \sum P_i\left(\left|x_i^A(s+k-1) - x_i^A(s+k)\right| + \left|x_i^B(s+k-1) - x_i^B(s+k)\right|\right)$$

Where $x_i^A(s+k)$ and $x_i^B(s+k)$ are the i^{th}MLC leaf positions at banks A and B at the $(s+k)^{th}$ station control points. Intuitively, I_{GM} is the local geometric modulation weighted by the corresponding segmental MU per gantry angle.

RESULTS

(1) The I_{GM} curves after NU-VMAT optimization were converged more significantly than VMAT I_{GM} curves (Fig.2);

(2) The lowest mean cardiac dose (562.63±45.61, 794.57±52.42, 538.00±60.93cGy by IMRT, VMAT, ar NU-VMAT respectively, p=0.531) w obtained by NU-VMAT technique (Fig.3);

(3) Total MU and delivery time for VMA were comparable with NU-VMAT p fraction, and they both significantly less than that of IMRT (p <0.05).

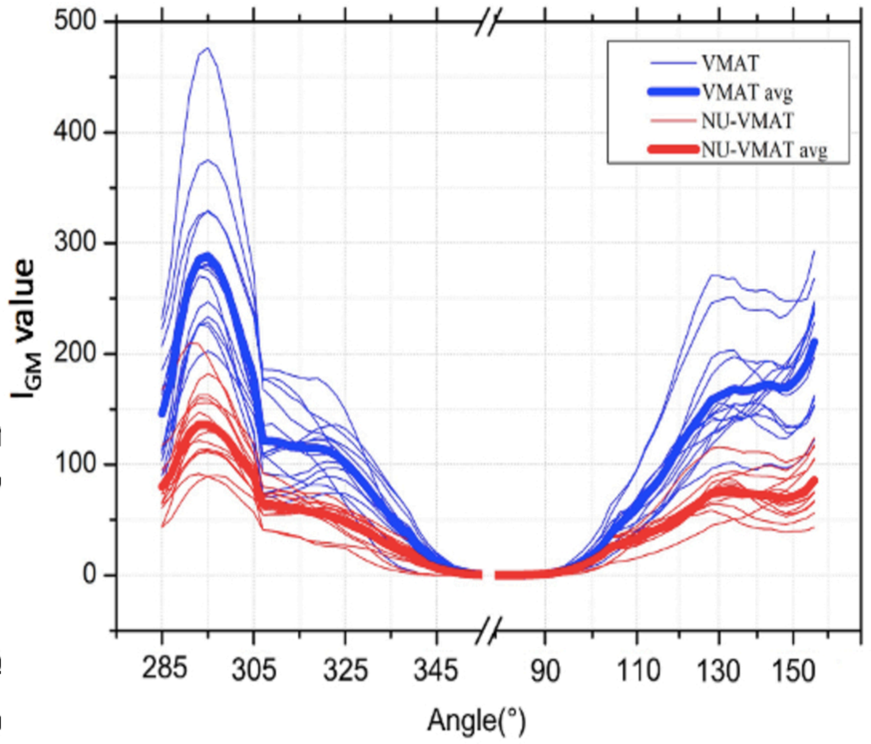

Fig.2 The optimized I_{GM} curves of VMAT and NU-VMAT plans for 14 breast cancer cases

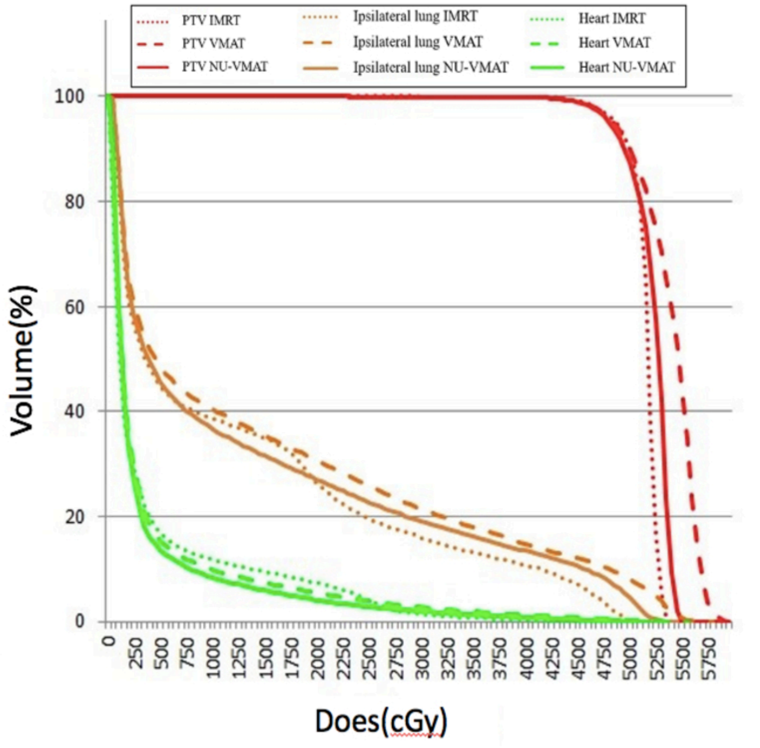

Fig.3 Comparison of the average DVH of all the cases under the three techniques

CONCLUSIONS

The new NU-VMAT could obtain the optimization strategy of cardiac dose control , reduce the average radiation dose of heart automatically and reasonably, and improve the dose delivery efficiency significantly in left breast cancer radiotherapy.

CONTACT INFORMATION

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