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A Dosimetric Validation of the Acuros XB Algorithm in the Clinic for Volumetric Modulation Arc Therapy Plans

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INTRODUCTION

Modern radiation therapies such as intensity-modulated radiation therapy (IMRT) and volume modulated arc therapy (VMAT) demand from dose calculation algorithms higher accuracy and computation speed.

AIM

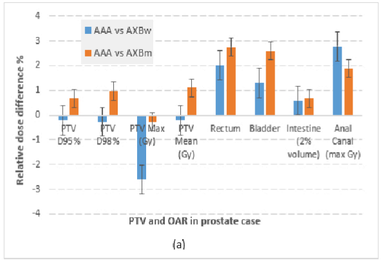
The goal of this study was to verify the dosimetric performance of Acuros XB (AXB, Varian Medical Systems, Palo Alto, CA) in VMAT plans and compared to the calculation algorithm of the previous version, Anisotropic Analytical Algorithm (AAA, Varian Medical Systems, Palo Alto, CA).

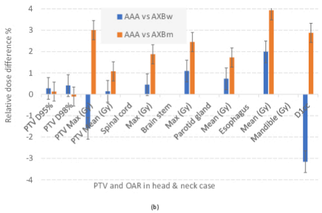
METHOD

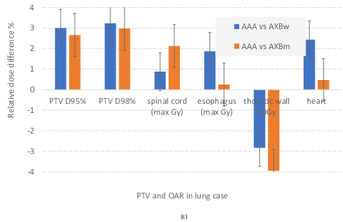
Ninety-five complex VMAT plans for different pathologies planned using Eclipse treatment planning system (TPS). For all VMAT plans, the dose distributions were calculated using AAA and two dose reporting modes in AXB (dose-to-water, AXBw, and dose-to-medium, AXBm) with same plan parameters. For dosimetric evaluation, the dose-volumetric parameters were calculated for each planning target volume (PTV) and interested organs at risk. The differences between AAA and AXB were statistically calculated with paired t-test.

RESULTS

The AAA and AXBw DVHs were close and AXBm showed varied in case of prostate and head & neck, which did not exceed within 2.0%. However, the DVHs AXBw and AXBm were similar for OAR because AXBm are based on each material. The maximum planning target volume (PTV) calculated by AAA was trended to be overestimated with relative dose difference by 3.23% in lung case. The absolute mean values of the relative dose differences were 1.1 ± 1.2% and 2.0 ± 1.2% when comparing between AAA and AXBw, and AAA and AXBm, respectively







The relative dose difference for PTV and organ at risk (a) case of prostate (b) case of head & neck (c) case of lung. Statistical error indicates standard error.

The mean dose-volumetric parameters of PTV and normal tissues for lung cases. Statistical error indicates standard deviation. $p_{A\text{-}m}$: p-value for the comparison of dose-volumetric parameters between AAA and AXB_m. $p_{A\text{-}w}$: p-value for the comparison of dose-volumetric parameters between AAA and AXB_w.

PTV	Prostate (Gy)				
	AAA	AXB_m	AXB_w	pA-m	$p_{A\text{-}w}$
$D_{95\%}$	75,53 ± 0,6	74,69 ± 0,4	74,96 ± 0,3	<0.0001	<0.0001
$D_{98\%}$	74,28 ± 0,5	73,89 ± 0,3	74,68 ± 0,3	<0.0001	<0.0001
D_{max}	79.43 ± 0.4	78,25 ± 0.4	80,59 ± 0.6	0.002	0,001
	Head & neck (Gy)				
$D_{95\%}$	68,97 ± 0,8	68,58 ± 0,6	68,88 ± 0,6	0,027	0,026
$D_{98\%}$	68,52 ± 0,6	68,59 ± 0,3	68,64 ± 0,8	0,042	0,005
D_{max}	74,84 ± 1,2	73,86 ± 0,9	74,59 ± 1,0	0,003	0,007
	Lung (Gy)				
$D_{95\%}$	50,01 ± 0,9	48,68± 0,5	48,51 ± 0,4	0,001	0,001
$D_{98\%}$	48,37 ± 1,1	46,93 ± 0,8	46,81 ± 0,6	0,003	0,002
D_{max}	60,21 ± 0,4	60,12 ± 0,5	60,06 ± 0,5	0,001	0,002

CONCLUSIONS

The dose difference between AAA and AXB are small in regions that have densities close or low to water. The AXB is more accurate than the AAA for dose predictions when air medium is involved. Our results show that dose calculated to medium by AXB can be used clinically.

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