Comparison of AAA and AXB Dosimetric Performance on Eclipse v18.1

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ABSTRACT

The Anisotropic Analytical Algorithm (AAA) and Acuros XB (AXB) are commonly used dose calculation algorithms in radiotherapy treatment planning. This study compared their dosimetric performance using the IMRT commissioning tests recommended by the TG-119 protocol. Plans were generated in Eclipse v18.1 and calculated with both algorithms using identical monitor units.
Measurements were performed with a Delta4 phantom using flattened and flattening-filter-free photon beams. Agreement between calculated and measured dose distributions was evaluated through global and local gamma analyses using 3%/2 mm, 3%/1 mm, and 2%/1 mm criteria.
Both algorithms demonstrated comparable performance, with gamma passing rates generally meeting accepted clinical standards. The results support the implementation of AXB while maintaining the dosimetric quality achieved with AAA.

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INTRODUCTION

The Anisotropic Analytical Algorithm (AAA) and Acuros XB (AXB) are commonly used dose calculation algorithms in radiotherapy treatment planning. While AAA is a convolution/superposition algorithm, AXB solves the linear Boltzmann transport equation, offering potentially superior accuracy in heterogeneous media. The AAPM TG-119 protocol provides a standardized methodology for assessing dosimetric performance using benchmark IMRT test cases and gamma analysis. This study compares the dosimetric performance of AAA and AXB in TG-119 VMAT plans.

METHODS AND MATERIALS

Test plans were generated following the VMAT TG-119 commissioning test planning, measurement, and analysis guidelines. Four plans were used (C1, C2, C3 and C4), each calculated in Eclipse v18.1 using AAA and AXB with identical monitor units and the same optimization constraints for energies of 6 MV and 10 MV with and without a flattening filter.
Measurements were performed with the Delta4 phantom (ScandiDos) using 6X and 10X beams on a Novalis Tx (NTx, Varian) linear accelerator, and with 6X and 10X FFF beams on a TrueBeam STx (TB, Varian) linear accelerator.
Dosimetric analysis was performed using gamma evaluation (global and local normalization) with criteria of 3%/2 mm, 3%/1 mm, and 2%/1 mm, using ScandiDos Delta4 software.

RESULTS

Both algorithms demonstrated comparable dosimetric performance across all TG-119 test cases and beam energies. With the 3%/2 mm criterion, overall gamma pass rates exceeded 98% in all evaluations, while local gamma pass rates were above 95%, except in two cases (10X with AXB and 6XFFF with AAA).
With the 3%/1 mm criterion, all overall gamma evaluations met the 95% acceptance threshold, except for one 6XFFF case calculated with AAA.
The stricter 2%/1 mm criterion resulted in three AAA evaluations and one AXB evaluation below 90%.
Representative ScandiDos gamma analysis reports and gamma index maps for case three are shown in Figures 1–4.

RESULTS

Table 1. AXB gamma results.

Test TG119	Delta4 Acuros NTx_6X		Delta4 Acuros NTx_10X		Delta4 Acuros TB_6XFFF		Delta4 Acuros TB_10XFFF	
	Gamma Global	Gamma Local	Gamma Global	Gamma Local	Gamma Global	Gamma Local	Gamma Global	Gamma Local
C1								
3%2mm	100,00	95,60	100,00	94,80	100,00	98,90	99,70	95,90
3%1mm	99,80		99,50		100,00		98,70	
2%1mm	97,30		96,50		99,50		95,10	
C2								
3%2mm	100,00	100,00	100,00	99,10	100,00	99,70	99,70	97,80
3%1mm	99,70		100,00		100,00		98,80	
2%1mm	96,20		95,30		98,10		92,00	
C3								
3%2mm	100,00	98,80	100,00	99,00	100,00	98,40	98,80	95,00
3%1mm	99,80		100,00		100,00		97,40	
2%1mm	99,20		97,20		96,00		77,80	
C4								
3%2mm	100,00	99,30	100,00	99,20	100,00	98,90	100,00	99,30
3%1mm	100,00		99,70		100,00		100,00	
2%1mm	96,10		99,00		98,90		96,50	

Table 2. AAA gamma results.

Test TG119	Delta4 AAA NTx_6X		Delta4 AAA NTx_10X		Delta4 AAA TB_6XFFF		Delta4 AAA TB_10XFFF	
	Gamma Global	Gamma Local	Gamma Global	Gamma Local	Gamma Global	Gamma Local	Gamma Global	Gamma Local
C1								
3%2mm	100,00	99,00	100,00	98,00	97,60	92,40	100,00	96,00
3%1mm	99,80		100,00		93,90		100,00	
2%1mm	99,00		98,50		91,00		96,30	
C2								
3%2mm	100,00	100,00	99,70	99,40	100,00	98,20	99,70	98,50
3%1mm	100,00		99,40		96,30		97,70	
2%1mm	97,50		93,40		89,60		89,90	
C3								
3%2mm	100,00	99,60	100,00	99,40	98,80	94,90	99,40	97,60
3%1mm	100,00		100,00		98,00		98,40	
2%1mm	98,60		97,70		93,10		85,00	
C4								
3%2mm	100,00	100,00	100,00	99,80	99,70	97,00	99,70	99,30
3%1mm	100,00		100,00		97,70		99,30	
2%1mm	99,00		99,80		91,70		95,90	

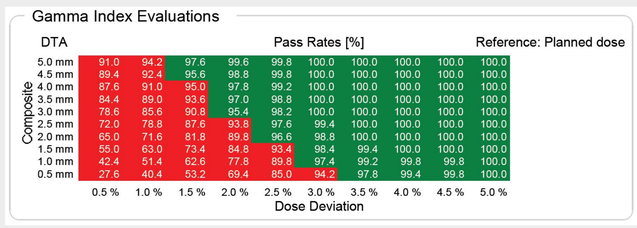

Figure 1. ScandiDos gamma analysis report for case three calculated with AXB (10XFFF).

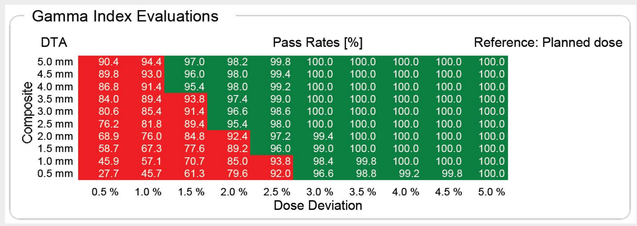

Figure 2. ScandiDos gamma analysis report for case three calculated with AAA (10XFFF).

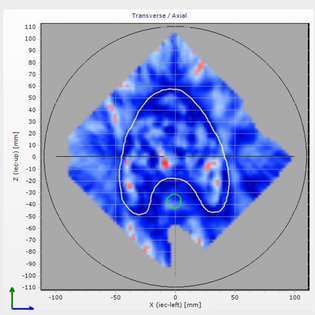

Figure 3. Gamma index map for case three calculated with AXB using the 3%/2 mm criterion.

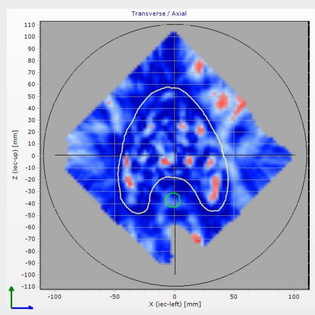

Figure 4. Gamma index map for case three calculated with AAA using the 3%/2 mm criterion.

DISCUSSION

Both AAA and AXB demonstrated comparable dosimetric performance for the TG-119 VMAT test cases, achieving gamma passing rates consistent with accepted clinical standards. Case 3 was selected as a representative example because it yielded the lowest gamma passing rate under the most stringent evaluation criterion (2%/1 mm).
The ScandiDos gamma analysis reports and gamma index maps (Figures 1–4) illustrate the agreement between calculated and measured dose distributions for both algorithms. As expected, the stricter 2%/1 mm criterion increased the sensitivity of the analysis, resulting in greater variability in gamma passing rates. Although AXB showed fewer evaluations below the 90% acceptance threshold than AAA, the observed differences were small and did not affect the overall clinical acceptability of the plans.
The consistent agreement observed across all TG-119 test cases and beam energies indicates that both algorithms provide reliable dose calculations for VMAT commissioning. These findings support the use of AXB as an alternative dose calculation algorithm while maintaining dosimetric consistency with treatment plans previously commissioned using AAA.

CONCLUSIONS

AAA and Acuros XB demonstrated comparable dosimetric performance for TG-119 for VMAT plans. Both algorithms met accepted clinical gamma criteria, and the small differences observed under more stringent evaluation conditions did not compromise plan quality. These results indicate that implementing Acuros XB during the commissioning process can be done without degrading the quality of treatments previously commissioned with AAA.

REFERENCES

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