Evaluation of Dosimetric Difference between Eclipse 16.1 and Eclipse 18.1 for SRS/SBRT Planning

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ABSTRACT

To evaluate Eclipse (Varian Inc., Palo Alto, CA) version 18.1 (EV181) with the new Enhanced Leaf Model (ELM) and its impact on SRS/SBRT planning compared with Eclipse version 16.1 (EV161).

INTRODUCTION

EV1811 introduced the new Enhance leaf model (Fig1) which provides more accurate modeling of the physical MLC shape than any previous Eclipse versions. SRS/SBRT plans are expected to be more accurate with ELM as small complex field size and highly modulated plan will be better modeled. However, most institutions and hospitals has been using EV161 or lower version with the traditional DLG model, it will be beneficial to evaluate the differences of calculations between EV161 and EV181 and its impact on SRS/SBRT planning to guide clinical planning team through this novel upgrade.

METHODS AND MATERIALS

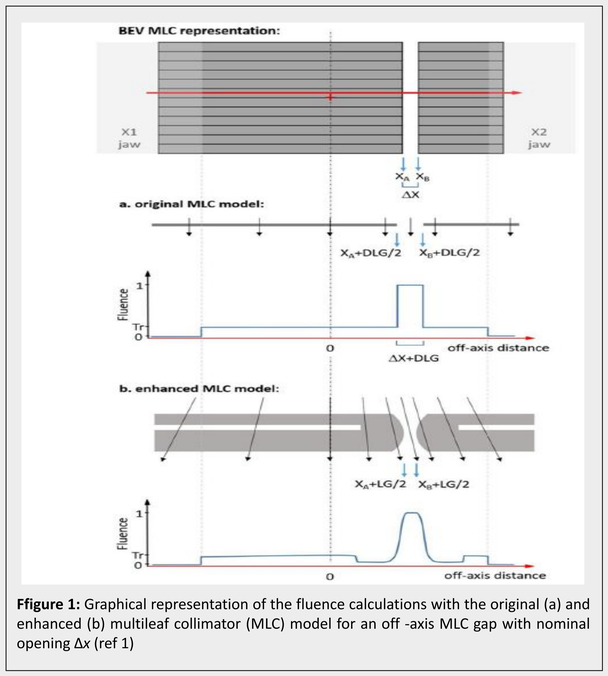
In this study, dose measurement was conducted on a Varian TrueBeam LINAC and dose calculation algorithm utilized was AAA. Phantom study was performed on 30cm^3 cubic water to verify the accuracy of EV181 calculation through comparing calculated dose with delivered dose at 5cm depth using MapCheck 2 (SNC, Melbourne, FL) with various MLC shapes based on gamma pass rate (GP%). MLC shapes utilized included MLC squares, AIDA, CHAIR and MLC Sweep gaps (SWG) 4mm, SWG6mm and SWG20mm. Dose calculation differences between EV161 and EV181 were first evaluated using Static Asymmetric MLC shapes, then with a total of 10 SRS & SBRT cases treated in 2025 including 3 multi-targets (MT) SRS patients (2-3 targets), 2 single target (ST) SRS patients and 5 ST SBRT patients. PTV volume ranged from 1cc to 28.5cc. Treatment plans were optimized in EV161 and calculated in EV161 and EV181 with 1mm dose grid size (DGS) for SRS and 2mm DGS for SBRT. PTV conformity index (CI), Gradient index (GI) and plan Dmax (D0.03cc) from EV161 and EV181 were compared using paired t-test to identify the difference.

Table 1: Phantom study EV181 delivery Vs calculated

(2%2mm, 0% threshold GP%)	6x	10x	15x	6FFF	10FFF
MLC 10x10	99.5	99.4	98.8	99.3	99.9
AIDA	99.9	100	99.1	99.7	99.6
CHAIR	100	99.2	98.2	100	98
swp 4	98.4	99.6	99.8	99.3	99.6
swp6	98.5	99.9	99.8	99.6	99.9
swp20	99.9	100	99.8	99.3	100

RESULTS

In phantom study, GP% using 2%2mm and 0% threshold (THR) for all dose planes were 99.5%±0.6% indicating great match between calculated and delivered dose in EV181 (Table 1). Dose calculation difference between EV161 and EV181 using static asymmetric MLC fields demonstrated 100% GP% (1%1mm, 0% THR) in both transverse dose planes at 5cm depth and coronal dose planes along central axis indicating that ELM may not significantly affecting static MLC shape dose calculations in forward planning. However, for SRS/SBRT patient plans, CI calculated in EV161 (CI^{mean}± CI^{STD}: 1.11±0.01) was increased significantly (p= 0.001) in Ev181 (CI^{mean}± CI^{STD}: 1.29±0.05), along with average Dmax changed from 119% (EV161) to 122% (EV181) signifying the dose difference introduced by ELM in VMAT plans with small fields and complex MLC movement. In addition, GI changed from 5.3±7.6 (GI^{mean}± GI^{STD}) in Ev161 to 5.7±8.3 (GI^{mean}± GI^{STD}) in EV181 indicated 50% and higher dose levels were all affected by ELM although may not be statistically significant (p=0.1). For small field single target VMAT, both EV161 and EV181 calcs GP% are >95% with EV181 passing rate are higher in the high dose region(50%). The difference between EV161 and EV181 calculation is within 3%. For small field multi target VMAT, 181 passing rate is less and the high dose rate pass rate is also inconsistent. The difference between the calculation can be up to 7% difference in GP%.



Ffigure 1: Graphical representation of the fluence calculations with the original (a) and enhanced (b) multileaf collimator (MLC) model for an off -axis MLC gap with nominal opening Δx (ref 1)

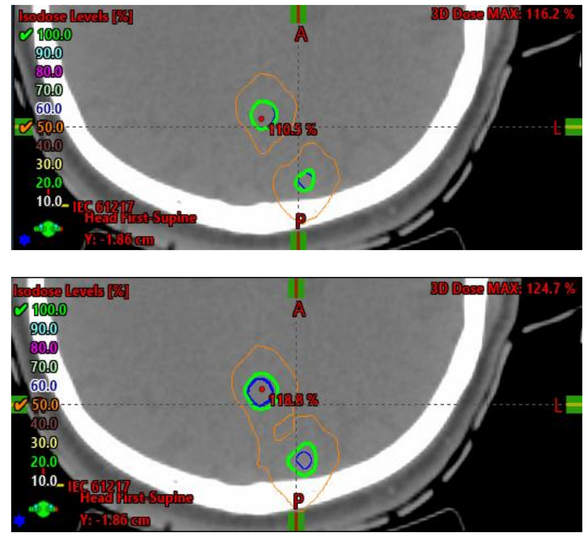


Figure 2: MTSRS calculation difference between EV161 (above) and EV181 (below). PTV contours are in blue. 100% iso-doseline is in green and 50% iso-doseline is in orange. Dmax is also indicated on each plan.

DISCUSSION

Our patient study demonstrated that SRS/SBRT plans were more impacted due to high plan modulation and the MLC edge effect spreads out dominantly in the target and proximity surrounding tissues. MTSRS were more impacted by ELM than STSRS, especially in GI calculations. Figure 2 showed the difference of 100% iso-doseline (IDL), 50% IDL and Dmax between EV161 and EV181. We could see that the 50% IDL which was purposely separated for the two targets in the EV161 plan (above) were connected in the EV181 calculation. Therefore to achieve the same GI requirement, planning team are suggested to fine tune the planning parameters to re-optimize plans in EV181.

CONCLUSIONS

ELM in EV181 impacted dose around MLC edge and may lead to large dose difference for SRS/SBRT plans, therefore EV161 Plans may need to be re-optimized to achieve the same planning goal in EV181.

References

1)Van Esch A, Kulmala A, Rochford R, Kauppinen J, Harju A. Testing of an enhanced leaf model for improved dose calculation in a commercial treatment planning system. *Med Phys*. 2022;49:7754–