Dosimetric Comparison of Lung SBRT Treatment Plans Using Varian Truebeam and Vitalbeam

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INTRODUCTION

Stereotactic body radiation therapy (SBRT) has become a widely used high precision radiotherapy delivery technique for many years. The multileaf collimators (MLC) with 5 mm and 2.5 mm leaf widths were used to compare SBRT treatment plans. Multiple studies have shown that using HD120 with thinner leaf width is beneficial to the target dose conformity and/or the steeper dose falloff while sparing organ-at-risks.

AIM

The aim of this study was to compare and evaluate lung SBRT treatment plans using Varian Truebeam equipped with 2.5 mm width HD120 MLC system and Vitalbeam with 5.0 mm width Millennium MLC system.

METHOD

Ten patients with primary lung tumors were selected for this study. All SBRT plans were originally planned on Truebeam utilizing VMAT technique with prescribed total dose 50 Gy in 5 fractions. All plans were approved by the attending physician and delivered entirely. During evaluation, they were re-optimized and calculated using Vitalbeam. Existing structure sets (for Truebeam) including the same planning target volume (PTV) ranging from 12 cc to 52 cc were used to re-plan on Vitalbeam. Treatment planning system was Varian Eclipse (version 15.5) and dose computation was based on Varian AAA (version 15.5.11) with tissue heterogeneity. Optimization and dose calculation were performed using the same beam configurations, calculation algorithm and grid size resolution between the two linac machines. Each plan that was re-planned on Vitalbeam was normalized to the same PTV coverage (D95) that was previously used for Truebeam. The plan isodose distributions and dose-volume histograms (DVHs) were computed and evaluated with respect to PTV max/mean/min dose, conformity index (CI), gradient index (GI), and selected normal tissue constraints.

RESULTS

Among all ten cases in this study, eight plans that were re-planned on Vitalbeam were able to fully meet same dosimetric criteria as their Truebeam plans when each PTV was normalized to the same D95 coverage. Two cases were not able to meet certain dose constraints according to RTOG 0831 protocol. For one case, the PTV was in close proximity to brachial plexus. This particular organ-at-risk constraint was not met (max dose = 32.03 Gy > 30.5 Gy). In addition, minimum dose D100 = 89.2% < 90%, gradient index = 4.01 > 3.96. For the other case, the PTV volume was the smallest among all ten cases (D100 = 89.2% < 90%; GI = 5.21 > 4.73). The axial isodose distributions of selected “passed” and “failed” cases were illustrated in Figure 1 and Figure 2, respectively. The table below demonstrated a few key dosimetric parameters for all ten cases. The eight “passed” cases had some dose variations but not statistically significant between Vitalbeam and Truebeam plans. There were no evidence showing the Vitalbeam plan quality were necessarily inferior to Truebeam plan because of the thicker MLCs.

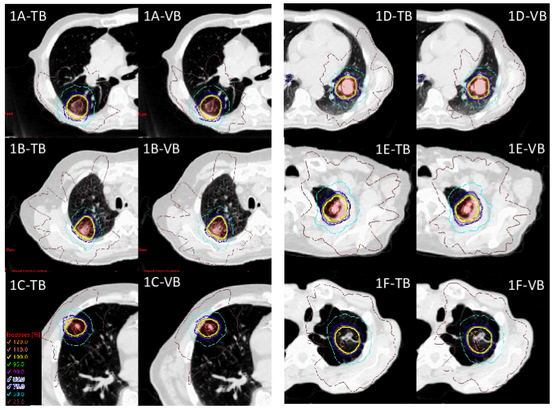

Figure 1 Selected axial isodose distributions for lung lesions generated from two MLC systems. 1A-TB through 1F-TB are the isodose distributions corresponding to Truebeam with HD120 MLC. 1A-VB through 1F-VB are corresponding to Vitalbeam with Millennium MLC.

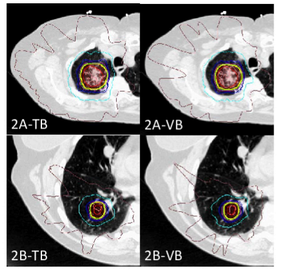

Figure 2 Axial isodose distributions for lung lesion generated from two MLC systems that did not meet certain dose constraints. 2A-TB and 2B-TB are the isodose distributions corresponding to Truebeam with HD120 MLC. 2A-VB and 2B-VB are corresponding to Vitalbeam with Millennium MLC.

PTV location	PTV volume (cc)	PTV dimension (cm)	PTV D95 (%)	PTV max (VB-TB)%	PTV mean (VB-TB)%	PTV min (VB-TB)%	Cord max (VB vs TB)%	CI (VB vs TB)	GI (VB vs TB)	Total MU (VB vs TB)
RLL	47.8	4.0 x 4.3 x 4.5	101.43	-5.0	-0.6	-3.3	23.9 vs 27.0	1.03 vs 1.02	3.84 vs 3.81	2695 vs 2851
LLL	46.1	4.3 x 4.4 x 4.7	101.56	3.2	0.1	-0.1	17.1 vs 23.6	1.03 vs 1.03	3.73 vs 3.72	3162 vs 3031
RUL	31.1	3.3 x 3.7 x 4.4	101.74	4.2	0.9	-2.1	15.3 vs 15.3	1.04 vs 1.03	4.24 vs 4.19	3158 vs 3207
RUL	26.7	3.2 x 3.8 x 4.5	101.87	-6.2	0.2	0	12.1 vs 11.4	1.05 vs 1.06	4.26 vs 4.16	3513 vs 3402
LUL	21.1	3.0 x 3.4 x 3.5	101.21	-0.3	-0.2	1.4	17.1 vs 17.3	1.04 vs 1.04	4.42 vs 4.38	3160 vs 2824
LUL	21.0	3.0 x 3.5 x 4.0	101.18	0.3	0.6	-2.9	11.8 vs 8.8	1.02 vs 1.03	4.42 vs 4.46	2640 vs 2673
RML	19.9	3.0 x 3.3 x 3.3	100.92	-2.6	0.3	-1.2	13.8 vs 15.0	1.02 vs 1.01	4.71 vs 4.53	2569 vs 2729
RML	14.7	2.5 x 3.2 x 3.4	101.55	2.6	0.5	-3.4	7.8 vs 6.2	1.06 vs 1.06	4.62 vs 4.53	2501 vs 2502
RUL	46.1	4.3 x 4.4 x 4.7	101.06	4.1	1.9	-1.4	40.7 vs 47.3	1.03 vs 1.00	4.01 vs 3.88	3472 vs 3398
RML	12.8	2.2 x 2.6 x 3.6	101.3	-1.3	-1.1	-3.6	24.3 vs 23.9	1.04 vs 1.02	5.21 vs 4.67	3242 vs 3126

CONCLUSIONS

The results from ten lung SBRT cases showed no significant differences in terms of dosimetric parameters between thinner (2.5 mm width) and thicker (5.0 mm width) MLC systems. When tumor dimension was larger than approximately 3.0 cm, comparable plan quality can be achieved using either MLC system. The total number of MUs for each “plan pairs” were also relatively comparable. The dose heterogeneity differences which range from -6.2% to 6.3% (difference of PTV maximum dose minus minimum dose; data not shown in table) did not exhibit clear trend that one MLC system is better than the other.

Two of the ten cases were not able to fully achieve the dosimetric objectives due to either PTV in close proximity to an organ-at-risk, or relatively smaller PTV volume. At the same time, the PTV gradient index criteria were not met. This phenomena provided clear indications that lung cancer SBRT patients who need to be planned on Vitalbeam with thicker MLC system warrant careful selection considerations with respect to the tumor locations and/or the tumor sizes.

ACKNOWLEDGEMENTS

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