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Evaluation and Comparison of AAA and AXB Dose Calculation Algorithms for Lung SBRT on TrueBeam STx with Eclipse 13.6

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Abstract: This study aims to comprehensively evaluate and compare lung Stereotactic Body Radiation Therapy (SBRT) dose distribution using the Eclipse v13.6 treatment planning system and TrueBeam STx linac data, employing two dose calculation algorithms: Analytical Anisotropic Algorithm (AAA) and Acuros External Beam (AXB). Utilizing thirty-five 4DCT lung SBRT datasets, dose calculations were performed with both algorithms, maintaining consistent setup conditions except for the varied calculation algorithm. Evaluation criteria included tumor dose distribution Conformity Index (CI), Homogeneity Index (HI), Gradient Index (GI), D2cm, V105%, Dmax and organs-at-risk (OAR) doses, assessed via Dose Volume Histogram (DVH) analysis. Additionally, linac parameters such as Monitor Unit (MU) and Beam on Time (BoT) were analyzed. Both algorithms met dose criteria for tumors and OAR tolerance. Minor differences were observed in tumor distribution indices, with AXB's Gradient Index showing proximity to ideal values. Although AXB exhibited slightly higher OAR doses, differences were statistically insignificant. AXB also demonstrated reduced average MUs and BoT. This comparative analysis underscores the efficacy of both AAA and AXB algorithms in ensuring dose conformity and OAR tolerance in lung SBRT planning, with AXB potentially offering improvements in efficiency and patient safety.

Keywords: *Analytical Anisotropic Algorithm (AAA), Acuros External Beam (AXB), lung SBRT, treatment planning system (TPS), dose distribution.*

I. INTRODUCTION

Within the spectrum of prevalent cancers globally, lung cancer holds the highest mortality rate among all cancer types. According to statistics provided by the Global Cancer Observatory (GLOBOCAN), in 2022, there were approximately 2.21 million new cases of lung cancer and approximately 1.8 million deaths worldwide. In Vietnam, this translates to 24,426 new cases and 22,597 deaths [1].

Radiation therapy stands as a primary treatment modality for lung cancer, employing advanced techniques such as Intensity Modulated Radiation Therapy (IMRT), Volumetric Modulated Arc Therapy (VMAT), and Stereotactic Body Radiation

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Therapy (SBRT). SBRT, an external beam radiation therapy method, precisely targets tumors outside the skull by delivering a high dose of radiation in one or a few fractions [2]. This approach offers numerous advantages, including non-operative and non-invasive treatment, exceptional precision, and the capacity to concentrate radiation on the tumor site. Consequently, SBRT presents a promising alternative for patients with early-stage lung cancer or those ineligible for surgery due to comorbidities.

The TrueBeam STx, developed by Varian Medical Systems, USA, represents an advanced linear accelerator system extensively utilized in radiation therapy for precise tumor treatment. Equipped with state-of-the-art technologies for image-guided radiosurgery and radiotherapy, the TrueBeam STx enables clinicians to administer highly accurate and effective treatments. Notably, it excels in treating challenging-to-access tumors and offers a diverse range of treatment modalities, including SBRT. Its sophisticated motion management capabilities allow for real-time adjustments to accommodate tumor and patient motion during treatment, ensuring precise dose delivery while minimizing radiation exposure to healthy surrounding tissues [3, 4].

The 108 Military Central Hospital has installed a TrueBeam STx linear accelerator system, accompanied by the Eclipse 13.6 treatment planning system featuring two dose calculation algorithms: the AAA and AXB. Each algorithm employs distinct physical methods and corrections to calculate dose distributions, particularly addressing dose corrections for heterogeneous areas characterized by significant density variations, such as the chest area or regions containing air cavities.

While numerous overseas studies have investigated the dose distributions between the AAA and AXB algorithms and their accuracy in various radiation therapy techniques [5-7], the specific application of these algorithms in the context of lung cancer SBRT remains unexplored in Vietnam. This gap in research underscores the importance of our study. Our research aims to fill this gap by evaluating and comparing the planning dose distribution indices for the tumor, specifically PTV, dose distributions on Organs at Risk (OAR), and radiation parameters in SBRT for lung cancer patients. We specifically focus on the comparison between the two widely used dose calculation algorithms, AAA and AXB. By conducting this study, we seek to provide valuable insights and reference recommendations for clinicians and radiation therapy practitioners in Vietnam regarding the selection of appropriate dose calculation algorithms for lung SBRT. This will contribute to optimizing treatment planning and improving patient outcomes in the local context.

II. MATERIALS AND METHODS

A. TrueBeam STx linac

The beam data acquired from the TrueBeam STx linac during the commissioning process are subjected to rigorous processing and quality assurance procedures. Once validated, these datasets are meticulously imported into the Eclipse 13.6 Treatment Planning System (TPS). Here, they serve as the cornerstone for dose calculations for all patients undergoing radiotherapy. By leveraging these meticulously curated datasets, clinicians can accurately model and predict the radiation dose distribution within the patient's anatomy. This precise dosimetric information is crucial for optimizing

treatment plans and ensuring the effective delivery of therapeutic radiation doses to target volumes while minimizing exposure to surrounding healthy tissues. The integration of these high-fidelity beam data into the Eclipse 13.6 TPS underscores its pivotal role in facilitating evidence-based and scientifically grounded radiotherapy treatment planning practices.

B. Treatment Planning System: Eclipse 13.6 and Dose Calculation Algorithms

The treatment planning system Eclipse 13.6, coupled with the TrueBeam STx linear accelerator, runs on a 64-bit Windows operating system. Eclipse 13.6 TPS plays a pivotal role in radiotherapy clinical practice, with the AAA algorithm being predominantly utilized for calculating lung SBRT dose plans.

Analytical Anisotropic Algorithm (AAA):

The AAA algorithm utilizes the superposition of spatially closed scattering kernels obtained from Monte Carlo simulations and individually accounts for each primary photon, scattered photon, and secondary electron. The basic physical parameters are pre-calculated via Monte Carlo simulation and calibrated to the actual beam data measured during the Beam Configuration step to ensure compatibility with accelerator beam data for clinical use [8]. Dose calibration in a heterogeneous environment is achieved using a radiation ratio scale of cumulative dose functions. The final dose represents the total dose resulting from the superposition of photons and electrons. Due to its relatively fast computer calculation time and high accuracy compared to the Monte Carlo method [8] [9], the AAA algorithm is a rational choice for routine clinical radiotherapy.

Acuros External Beam (AXB) algorithm:

The AXB algorithm is founded upon the principles of radiation transmission as described by the Boltzmann theory. This theory elucidates the trajectory of radiation particles, encompassing neutrons, photons, and electrons, as they traverse and interact with their surrounding environment. The algorithm is based on the linear Boltzmann transport equation (LBTE), a linearized variant of the Boltzmann transport equation, which postulates that radioactive particles interact solely with their environment rather than amongst themselves. LBTE is a differential equation that accounts for both spatial and energetic variations within a population of radioactive particles. By employing the linear Boltzmann transport formula, accurate determination of dose within a specified volume of material is achieved, with direct incorporation of the effects of density inhomogeneities into the distributed dose to patients [10] [11].

C. Dose calculation in the Treatment Planning System

The study was conducted by using the Eclipse v13.6 treatment planning system (Varian, USA) of the TrueBeam STx Linac at the 108 Military Central Hospital. Thirty-five 4DCT datasets of patients undergoing lung SBRT were planned using the VMAT technique on Eclipse 13.6. The VMAT plans typically comprised three non-coplanar arcs with treatment table degrees of 0°, 10°, and 350°, respectively, with the gantry rotation angle adjuted based on the tumor's location in the right or left lung. All plans utilized 6 MV FFF photon beams with a maximum dose rate of 1400 MU/min. The irradiated tumor volume of the selected plans ranged from 4.1 cm^3 to 175 cm^3, with a mean of 34.73 ± 20.44 cm^3.

Initially, 27 out of 35 plans were generated by using the AAA calculation algorithm, while the remaining 8 plans utilized the AXB calculation algorithm. All plans underwent dose measurements for plan quality assurance and were administered to actual patients. Subsequently, new plans were recalculated from the original SBRT plans by switching the calculation algorithm from AAA to AXB and vice versa. The optimization of these treatment plans retained the initial conditions, including the prescribed dose (total dose, fractions, interval between doses), number of arcs, dose weights, photon beam, and other constraints, with the only modification being the dose calculation algorithm.

To maintain consistency and comparability across all plans, both original and revised, a normalization process was implemented. This ensured that each plan delivered 100% of the prescribed dose to cover 95% of the tumor volume. This standardization allowed for a reliable evaluation of dose distribution and treatment efficacy. Furthermore, all plans employed a 6 MV flattening filter-free (FFF) photon beam, chosen for its advantageous characteristics in delivering high doses efficiently and precisely. The selection of this photon beam energy aimed to optimize treatment outcomes while minimizing radiation exposure to surrounding healthy tissues. By adhering to these standardized protocols, we aimed to ensure robustness and reliability in our comparative analysis of the two dose calculation algorithms, AAA and AXB.

D. Evaluation of the radiotherapy plans

The evaluation of SBRT plans for lung cancer radiotherapy involves assessing the dose distribution within the tumor and the dose to organs-at-risk using correlation indicators on the Dose Volume Histogram (DVH) [12] [13]. Additionally, the study includes a comparison of irradiation parameters of the linac, such as the Monitor Unit (MU) number and Beam On Time (BoT).

Metrics for evaluating dose distribution within the tumor

The evaluation of dose distribution within the tumor volume (planning target volume - PTV) and dose spillage outside the PTV includes metrics such as the Coverage Index (Q), Conformity Index (CI), Homogeneity Index (HI), Gradient Index (GI), Gradient Measure (GM), D2cm, V105%, and maximum dose within the target (Dmax). Lung SBRT plans are assessed for dose distribution based on criteria outlined in RTOG 0813 and RTOG 0915 [12] [13].

Table I. Indicators in evaluating dose distribution within the tumor

Index	Formula	Ideal value	Reference
Q	$Q = \frac{D_{min}}{D_P}$	Q = 1	RTOG (1993) [14]
CI	$CI_{RTOG} = \frac{PIV}{TV}$	0.9 < CI < 1.2	RTOG (1993) [14] Davis J. N. [15]
	$CI_{Paddick} = \frac{(V_{PTV100})^2}{V_{PTV} \times V_{100}}$	CI = 1	Paddick [16]
HI	$HI = \frac{D_5 - D_{95}}{D_P}$	$1 < HI \leq 1.1$	RTOG (1993) [14]

	$HI = \frac{D_{max}}{D_P}$	HI = 0	Wu Qiuhen [17]
GI	$GI = \frac{PIV_{half}}{PTV}$	3.0 < GI < 5.0	Paddick [16]
GM	$GM = r50\%_{eq} - r100\%_{eq}$		Hoffman D. [18]

D_{min}: Minimum dose; D_{max}: Maximum dose; D_P: Prescription dose; V_{PTV}: PTV Volume; V_{PTV100}: Volume of PTV receiving 100% of D_P; V_{100}: Volume covered by 100% isolines; D_5, D_{95}: Minimum dose delivered to 5% and 95% volume of PTV; PIV: Prescription Isodose Volume (cm^3), TV: Target Volume (cm^3); PIV_{half}: Volume covered by 50% of D_P (cm^3); $r50\%_{eq}$, $r100\%_{eq}$: spherical radius calculated from the volume enclosed by the 50% and 100% dose lines (cm);

- D2cm refers to the maximum dose at a distance of 2cm from the surface of the PTV in all directions, calculated as a percentage (%) of the prescribed dose. In lung SBRT, the D2cm dose curve facilitates the assessment of the impact of the dose area between 50% - 80% of the prescribed dose on surrounding healthy tissues.

- V105% represents the volume outside the PTV that receives at least 105% of the prescribed dose, calculated as a percentage (%) of the PTV.

Metrics for assessing dose distribution to organs-at-risk

In the context of SBRT, the tolerance dose for organs-at-risk is contingent upon the specifics of the dose fractionation regimen, encompassing parameters such as the total dose administered, the number of fractions delivered, and the interval between fractions. Guidance on tolerance doses for healthy organs under various SBRT treatment regimens, spanning from 1 to 5 dose fractions, is provided by the AAPM TG-101 (2010) [2], RTOG 0813 and RTOG 0915 [12] [13]. According to RTOG 0915 criteria, SBRT treatment planning for lung cancer attains approval when the tolerance dose to organs-at-risk aligns with predefined criteria:

- The volume of organs-at-risk outside the treatment volume receiving cumulative doses exceeding 105% (>105%) does not surpass 15% of the PTV.

- According to RTOG 0915 [12], the volume of normal lung tissue receiving a dose of 20 Gy (V20) should be limited to less than 10% of the total lung volume. Additionally, minimizing the volumes of healthy lung tissue receiving doses of 5 Gy and 10 Gy (V5, V10) is recommended to mitigate the risk of pulmonary complications.

- Maximum doses (Dmax) to organs-at-risk including the heart, lungs, ribs, spinal cord, skin, stomach, and esophagus as stipulated by RTOG 0813 and RTOG 0915.

Furthermore, this study also took into account additional parameters such as Monitor Unit (MU) number, Beam on Time (BoT), and p-value (to assess the statistical significance of the dose calculation results) to obtain a more comprehensive understanding of the two algorithms.

III. RESULTS AND DISCUSSION

Both the initial plans and those revised with alternative algorithms demonstrate robust adherence to the specified criteria for dose distribution within the tumor and tolerance levels for critical organs-at-risk, including but not limited to normal lung tissue, the spinal cord, esophagus, heart, and skin, as delineated

by the RTOG 0813/0915 guidelines [12] [13]. The comprehensive evaluation revealed that all plans consistently achieved satisfactory outcomes in terms of these key parameters, underscoring the efficacy and reliability of the treatment planning process. This robust compliance with established standards signifies the ability of the proposed treatment strategies to effectively deliver therapeutic doses to target volumes while minimizing the risk of adverse effects on surrounding healthy tissues.

A. Evaluation and comparison of dose distribution indicators within the tumor

In Table II, a comprehensive comparison is provided regarding various parameters characterizing dose distribution within the tumor, employing both the AAA and AXB calculation algorithms. Among these parameters, the Conformity Index (CI), which evaluates the conformity of the prescribed dose to the target volume, shows minimal deviation between the two algorithms. Specifically, the average CI values, as assessed by both Paddick and RTOG criteria, reveal marginal differences, with the AAA algorithm yielding values of (0.92 ± 0.02) and (0.99 ± 0.03), while the AXB algorithm produces values of (0.92 ± 0.04) and (1.00 ± 0.05), respectively. These findings suggest a high level of agreement between the algorithms in achieving optimal dose conformity.

Similarly, indicators such as the Homogeneity Index (HI), representing the uniformity of dose distribution within the target volume, exhibit insignificant changes between the AAA and AXB algorithms. Additionally, parameters including D2cm (%) and the maximum dose to the Planning Target Volume (PTV) remain relatively stable across both calculation methods.

However, noteworthy differences emerge in indices such as the Gradient Index (GI) and Gradient Measure (GM), illustrated in Figures 1 and 2, which reflect the extent of dose reduction in surrounding healthy tissues. Here, the AXB algorithm demonstrates superior performance, as evidenced by lower GI and GM values compared to those obtained with the AAA algorithm. Specifically, the AXB-calculated plans exhibit GI values of 4.10, representing a 3.7% increase over the AAA-calculated plans, and GM values of 1.11, indicating a 2.7% improvement. These differences are statistically significant, underscoring the efficacy of the AXB algorithm in minimizing radiation exposure to healthy tissues.

Furthermore, the Coverage Index (Q), a critical parameter assessing the extent of dose coverage within the PTV, displays slight variations between the two algorithms. Notably, while both algorithms maintain Q values within the optimal range of 0.8 to 0.9, the AXB algorithm yields a slightly lower Q value compared to the AAA algorithm. This observation suggests a more conservative approach to dose coverage with the AXB algorithm, potentially minimizing the risk of dose overflow beyond the target volume.

Lastly, the V105% indicator, denoting the volume of tissue receiving doses exceeding 105% of the prescribed dose, demonstrates excellent control within both the AXB and AAA-calculated plans. With V105% values of 0.17% for both algorithms, the findings indicate effective mitigation of high-dose regions outside the PTV, ensuring that the majority of high-dose points remain contained within the target volume.

In summary, the detailed analysis of dose distribution parameters reveals nuanced differences between the AAA and AXB algorithms, with the latter demonstrating

superior performance in minimizing radiation exposure to healthy tissues while maintaining optimal dose conformity and coverage within the target volume. These findings underscore the importance of algorithm selection in optimizing treatment planning for lung SBRT, with implications for enhancing treatment efficacy and reducing the risk of radiation-related complications.

The indicators CI, HI, D2cm, V105%, and Dmax of the PTV demonstrate equivalence between the two algorithms, with statistically insignificant fluctuation amplitudes.

Table II. Comparison indicators of dose distribution on the tumor of lung SBRT plans between AAA and AXB algorithms

Indicators		**AAA algorithm** (Mean±SD)	**AXB algorithm** (Mean±SD)	**p-value**
CI	RTOG	0.99 ±0.03	1.00 ± 0.05	0.82
	Paddick	0.92 ± 0.02	0.92 ± 0.04	0.97
HI	RTOG	1.46 ± 0.07	1.48 ± 0.09	0.164
	Wu_2000	0.41 ± 0.06	0.44 ± 0.08	*< 0.05 (0.0015)*
GI		3.95 ± 0.37	4.10 ± 0.40	*< 0.05 (0.0009)*
GM (cm)		1.08 ± 0.19	1.11 ± 0.19	*< 0.05 (0.0007)*
Q (%)		0.90 ± 0.03	0.87 ± 0.03	*< 0.05 (0.002)*
D2cm (%)		51.62 ± 4.32	52.49 ± 4.39	0.13
V105% (%)		0.17 ± 0.05	0.17 ± 0.04	0.41
Dmax on PTV (%)		146.70 ± 6.80	148.25 ± 8.58	0.16

The comparison of average values is subject to uncertainty, and the evaluation indicators do not fully capture the data fluctuations between the two algorithms. Graphical representation of individual data from 35 patients for each pair of values calculated by the AAA and AXB algorithms reveals no discernible differences.

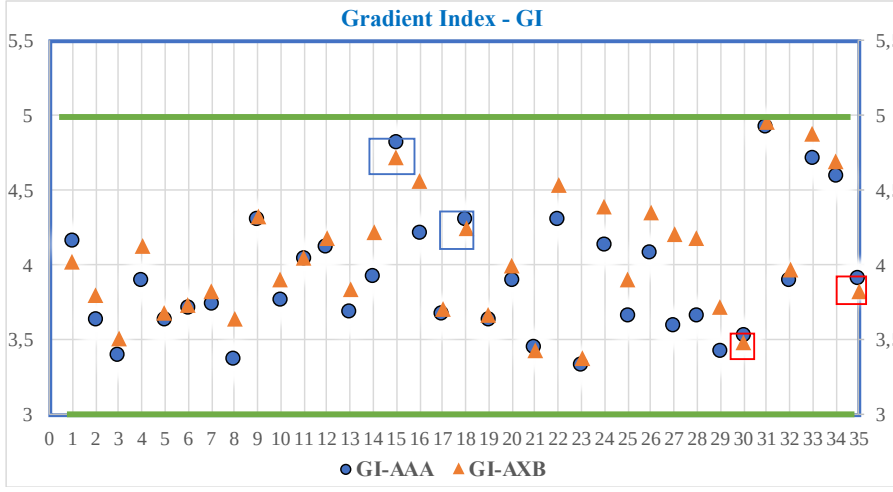

Fig. 1. Comparison of Gradient Index of lung SBRT plans between AAA and AXB algorithms

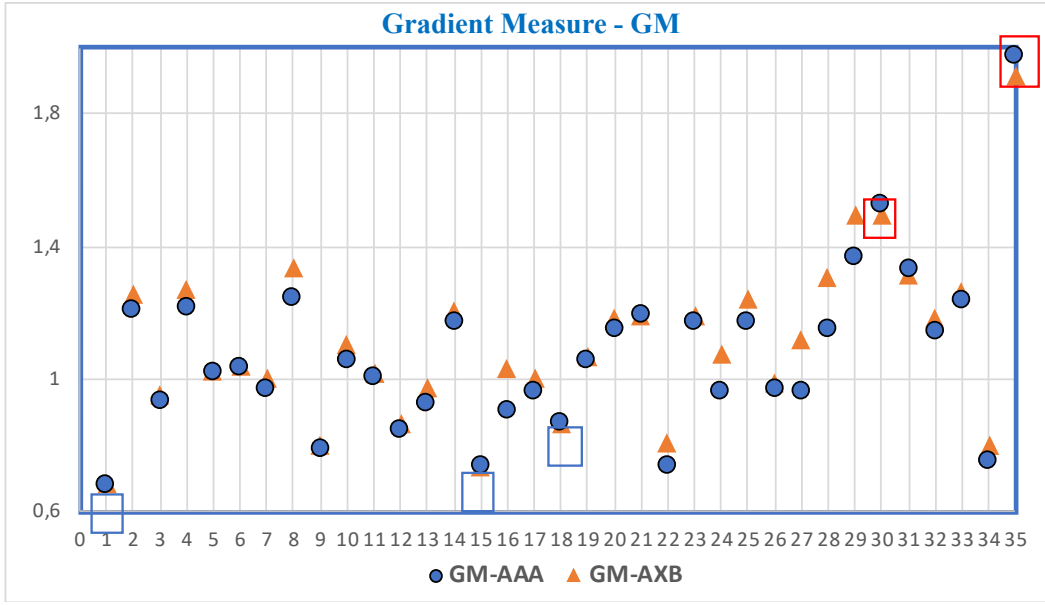

Fig. 2. Comparison of Gradient Measure of lung SBRT plans between AAA and AXB algorithms

B. Evaluation and comparison of dose distribution indicators on Organs-at-risk

All plans demonstrate that the maximum doses to organs-at-risk, as calculated by both the AAA and AXB algorithms, remain well below the tolerance doses established for each organ. This indicates effective dose control within organs-at-risk adjacent to the Planning Target Volume (PTV), ensuring compliance with maximum dose limitations as outlined by RTOG 0813/0915 [12][13]. The comparison of dose distribution to organs-at-risk between the two algorithms reveals nuanced differences, with slightly higher values observed in AAA compared to AXB for most indicators. However, these discrepancies are within acceptable limits and do not significantly impact the overall treatment outcome.

Moreover, the evaluation of dose distribution to organs-at-risk highlights the robustness of both algorithms in accurately predicting and controlling radiation doses. Despite minor variations, both AAA and AXB algorithms demonstrate the ability to maintain doses well below tolerance thresholds, indicating their efficacy in minimizing the risk of radiation-induced toxicity to critical organs.

A detailed comparison of the results obtained with the AAA and AXB algorithms for lung cancer SBRT is presented in Table 3, providing comprehensive insights into the performance of each algorithm across various organs-at-risk. This analysis serves to inform clinicians and radiation oncologists in selecting the most suitable dose calculation algorithm based on specific treatment requirements and patient characteristics, ultimately optimizing treatment planning and ensuring the delivery of safe and effective radiotherapy.

Table III. Comparison of dose distribution to organs-at-risk of lung SBRT plans between AAA and AXB algorithms

Organs-at-risk	AAA algorithm (Mean±SD)	AXB algorithm (Mean±SD)	p-value
Normal lung			
PTV mean dose (cGy)	5589 ± 508	5663 ± 519	**0.03**
PTV max dose (cGy)	7074 ± 734	7140 ± 776	0.159
Mean dose on lung (cGy)	329.66 ± 120.28	343.60 ± 119.0	**0.0003**
Normal lung dose V5 (%)	14.51 ± 5.35	15.00 ± 5.21	0.51
Normal lung dose V10 (%)	8.93 ± 3.84	9.28 ± 3.82	0.78
Normal lung dose V20 (%)	4.01 ± 2.02	4.20 ± 1.99	0.65
Dmax (cGy)			
Heart (2800)	183.89 ± 14.47	187.78 ± 149.28	0.19
Esophagus (1880)	257.52 ± 122.97	256.89 ± 125.29	0.61
Spinal cord (1360)	169.83 ± 100.47	170.75 ± 100.62	0.63
Skin (3320)	59.93 ± 31.10	58.55 ± 29.86	0.52
Rips (<1cc, 3200)	514.53 ± 292.48	510.23 ± 284.4	0.36

According to RTOG 0915 guidelines, the lung volume receiving a 20 Gy dose (V20) should ideally be less than 10% of the total lung volume. Additionally, minimizing the volumes receiving lower doses, such as 5 Gy and 10 Gy (V5 and V10, respectively), is essential to mitigate the risk of pulmonary complications.

The doses to healthy lung tissue, represented by V5 (%), V10 (%), and V20 (%), calculated using the AXB algorithm, do not exhibit significant increases compared to those calculated using AAA; it is illustrated in Figure 3. However, there are slight elevations observed in the mean lung dose (cGy) and PTV mean dose when using the AXB algorithm, with increases of 4.2% and 1.3%, respectively, compared to AAA algorithm. Figure 4 compares of mean and maximum dose on PTV between AAA and AXB algorithms.

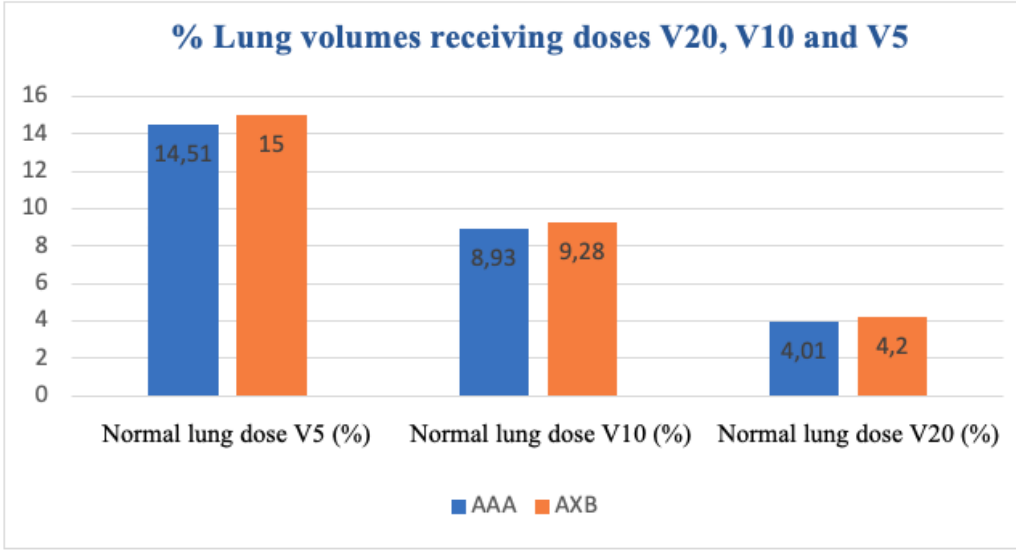

Fig. 3. Comparison of healthy lung volumes receiving doses V20, V10 and V5 (%) of lung SBRT plans between AAA and AXB algorithms

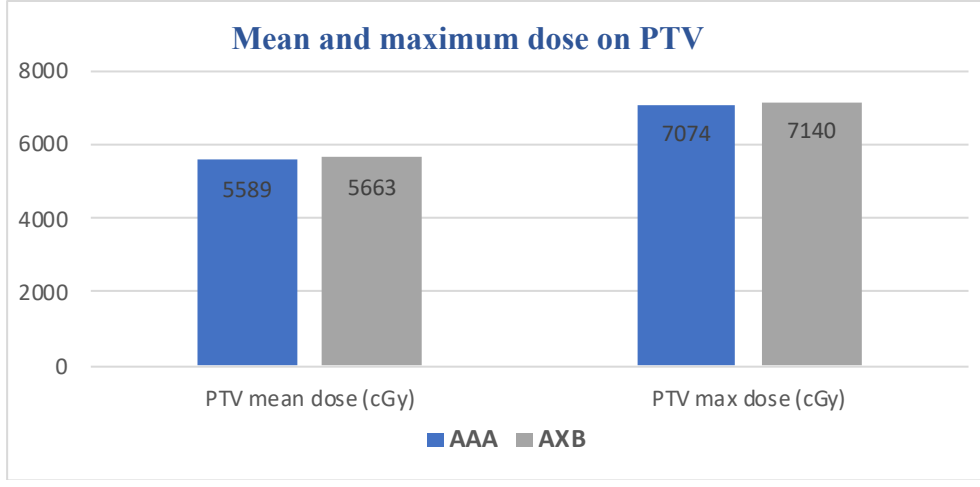

Fig. 4. Comparison of mean and maximum dose on PTV of SBRT plans between AAA and AXB algorithms

C. Evaluation and comparison of irradiation parameters for the linac

Table IV illustrates that in the treatment planning for lung SBRT, the AXB algorithm yields a smaller mean value of MU and BoT compared to the AAA algorithm. In this study, the calculated irradiated beam on time plan by the AXB algorithm was reduced by an average of approximately 7 seconds, with the MU being approximately 1.6% lower. The BoT significantly impacts work efficiency and productivity, with reductions aiding in limiting random errors during the irradiation process. Simultaneously, minimizing the required number of MUs emitted during radiotherapy helps mitigate the risk of side effects on patients and equipment wear. Figure 5 provides a comparative analysis of the SBRT plans' beam on time calculated by the AXB and AAA algorithms.

Table IV. Comparison of irradiation parameters of SBRT plans between the AAA and AXB algorithms

Parameters	**AAA algorithm** (Mean)	**AXB algorithm** (Mean)
MU	3895	3723
BoT (s)	167	160

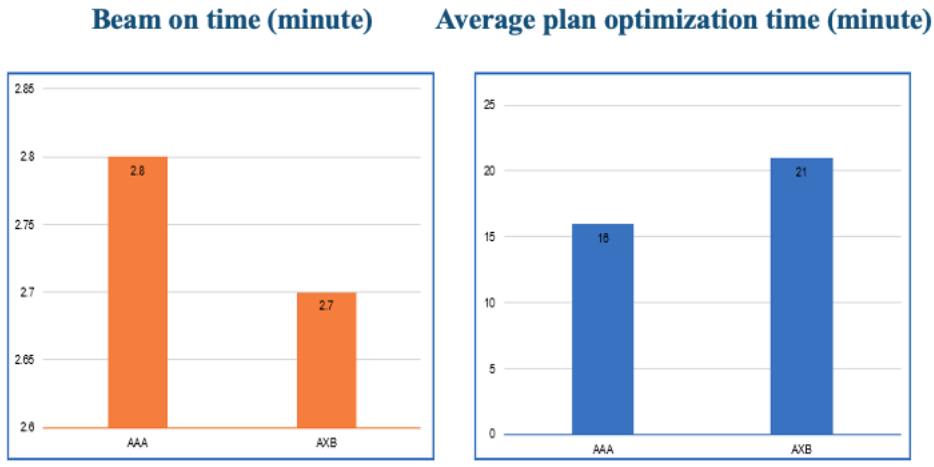

Fig. 5. Comparison of beam on time and average plan optimization time of SBRT plans between the AAA and AXB algorithms

IV. CONCLUSIONS

The results of this study demonstrate robust adherence to specified criteria for dose distribution within the tumor and tolerance levels for critical organs-at-risk in lung SBRT. Both the initial plans and those revised with alternative algorithms consistently achieved satisfactory outcomes, indicating the efficacy and reliability of the treatment planning process. The comprehensive evaluation revealed that all plans effectively delivered therapeutic doses to target volumes while minimizing the risk of adverse effects on surrounding healthy tissues, in accordance with RTOG 0813/0915 guidelines.

The detailed analysis of dose distribution indicators within the tumor revealed nuanced differences between the AAA and AXB algorithms. While parameters such as the CI and HI showed minimal deviation between the algorithms, significant differences were observed in indicators like GI and GM, where AXB demonstrated superior performance in minimizing radiation exposure to healthy tissues. Additionally, the Q and V105% indicator demonstrated effective control of high-dose regions within the target volume, with slight variations observed between the algorithms.

The evaluation of dose distribution to organs-at-risk highlighted the robustness of both AAA and AXB algorithms in accurately predicting and controlling radiation doses. Although minor variations were observed, both algorithms maintained doses well below tolerance thresholds, ensuring compliance with maximum dose limitations for critical organs. Furthermore, AXB

yielded a smaller mean value of monitor units MU and BoT compared to AAA, indicating potential improvements in work efficiency and patient safety.

Overall, these findings underscore the importance of algorithm selection in optimizing treatment planning for lung SBRT. Clinicians and radiation oncologists can use this information to make informed decisions based on specific treatment requirements and patient characteristics, ultimately enhancing treatment efficacy and patient outcomes. Further research is warranted to explore additional dosimetric parameters and refine treatment planning algorithms for improved precision and efficacy in lung SBRT.

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