Original Article

Delta^4-based Dosimetric Error Detection in Volumetric-modulated Arc Therapy: Clinical Significance and Implications

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Abstract

Background: Volumetric-modulated arc therapy (VMAT) is an efficient method of administering intensity-modulated radiotherapy beams. The Delta^4 device was employed to examine patient data. **Aims and Objectives:** The utility of the Delta^4 device in identifying errors for patient-specific quality assurance of VMAT plans was studied in this research. **Materials and Methods:** Intentional errors were purposely created in the collimator rotation, gantry rotation, multileaf collimator (MLC) position displacement, and increase in the number of monitor units (MU). **Results:** The results show that when the characteristics of the treatment plans were changed, the gamma passing rate (GPR) decreased. The largest percentage of erroneous detection was seen in the increasing number of MU, with a GPR ranging from 41 to 92. Gamma analysis was used to compare the dose distributions of the original and intentional error designs using the 2%/2 mm criteria. The percentage of dose errors (DEs) in the dose-volume histogram (DVH) was also analyzed, and the statistical association was assessed using logistic regression. A modest association (Pearson's *R*-values: 0.12–0.67) was seen between the DE and GPR in all intentional plans. The findings indicated a moderate association between DVH and GPR. The data reveal that Delta^4 is effective in detecting mistakes in treatment regimens for head-and-neck cancer as well as lung cancer. **Conclusion:** The study results also imply that Delta^4 can detect errors in VMAT plans, depending on the details of the defects and the treatment plans employed.

Keywords: Delta^4, dose error detection, dose verification, gamma passing rate, volumetric-modulated arc therapy

Received on: 10-10-2023 **Review completed on: 01-12-2023** **Accepted on: 01-12-2023** **Published on: 30-03-2024**

Introduction

Volumetric-modulated arc therapy (VMAT) is a sophisticated radiation therapy technique that utilizes precision tumor targeting while concurrently minimizing radiation exposure to surrounding healthy tissues. The tumor is exposed to beams of different strengths, which are then rotated in a complete 360° rotation around the patient. The use of VMAT, an advanced approach applied in intensity-modulated radiation therapy, involves the rotating motion of the treatment gantry with respect to the patient. During this process, the shape and intensity of the radiation beam are dynamically adjusted using multileaf collimator (MLC), in addition to altering the gantry speed and dose rate. Machine quality assurance (QA) is performed to verify the precision and reliability of mechanical therapeutic instrument operations.[1-3]

The method described above is used in actual patient care to provide therapy to patients in a variety of anatomical regions, including the head and neck (H and N) as well as the lung. Despite this, the complicated structure of VMAT may increase the probability of mistakes, which may result in variations in the radiation dose that is administered to patients.[4-7] Errors may occur in a variety of contexts, including the calculation of dose, the transmission of data, and the operation of mechanical therapy devices. Problems with the equipment, such as misalignment of MLC, gantry rotation, collimator rotation, and variations in dose delivery, are some of the most common causes of errors. To ensure the administration of accurate therapy to patients, it is advisable to employ a

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Access this article online

Quick Response Code:

Website: www.jmp.org.in

DOI: 10.4103/jmp.jmp_140_23

How to cite this article: Udee N, Commukchik S, Khamfongkhruea C, Kaewlek T, Chusin T, Yabsantia S. Delta^4-based dosimetric error detection in volumetric-modulated arc therapy: Clinical significance and implications. J Med Phys 2024;49:56-63.

patient-specific QA approach to check the accuracy of the dose delivered to the patient before treatment. The treatment plan provided by a patient is reproduced, and the dose distribution within a phantom with a radiation detector is investigated by a comparative analysis with the simulated dose distribution.[8-11] Various methods for conducting QA in rotational therapy have been proposed. These include employing Monte Carlo calculations to verify treatment plans,[12] analyzing log files from the linear accelerator (LINAC),[13] utilizing the electronic portal imager device of the LINAC,[14] employing gel dosimetry,[15-17] and combining ion chamber measurements, film measurements, and commercial systems.[18,19] In the clinical setting, many commercial patient-specific QA technologies have been suggested for use such as Delta^4, COMPASS, OCTAVIUS, and Epiqa.[20-22]

The diode array technology is of special importance due to its ability to assess dose distributions and evaluate the clinical implications of treatment errors. In addition, the array detectors exhibit outstanding reliability regarding their day-to-day repeatability, independence from dose rate variations, high spatial resolution, and adherence to linearity.[23,24] Hence, the primary objective of this study was to assess the efficacy of the patient-specific QA tool used inside our institution, specifically in terms of its ability to detect errors. The study used deliberate faults made by in-house software to examine error situations in H and N and lung designs.

Methods

Treatment planning

This study aimed to explore treatment plans of varying degrees of complexity, including those designed for patients with H and N as well as lung cancer. Five treatment plans that underwent radical radiotherapy with standard fractionation were chosen from our institution's database for each cancer. These plans were designed and optimized for a Varian Trilogy LINAC equipped with a Millennium 120 MLC (Varian Medical Systems, Palo Alto, CA, USA) utilizing 6 MV photons.

All treatment plans utilized the VMAT approach in the Eclipse version 10.1 treatment planning system (Varian Medical Systems, Palo Alto, CA, USA), with the analytical anisotropic algorithm version 10.0.28 for dose calculation. The dose calculation was performed using a grid size of 2.5 mm × 2.5 mm × 2.5 mm. The number of arcs employed in each therapy exhibited variability contingent on the complexity of the tumor shape, including a range of two to four full or partial arcs. Individual plans were designed to increase dose conformity with steep dose gradients and exceptional target coverage while adhering to QUANTEC and RTOG-recommended constraints for critical organs.[25] The H and N plan employed a simultaneous integrated boost approach, delivering 2.12, 1.8, and 1.54 Gy/fraction to three distinct target volumes. In contrast, the lung cancer plans utilized a conventional dose, delivering 2 Gy for each fraction through a sequencing technique.

Intentional errors in the treatment plan

The modified plans were administered utilizing the Delta^4 system (ScandiDosAB in Uppsala, Sweden) to assess the quality of the plans and to evaluate the device's sensitivity. To assess the efficacy of the Delta^4 QA tool in detecting errors, intentional errors were included in the original treatment plans, which are representative of errors commonly observed in regular clinical settings. The original plan was imported as a DICOM RT, and then the treatment parameters were modified using in-house software to create error plans. The study evaluated four intentional error scenarios: collimator rotation at angles of 1°, 2°, and 3°, gantry rotation at angles of 1°, 2°, and 3°, MLC leaf position variations of 1 mm, 2 mm, and 3 mm, and dose delivery with an increase in the number of MU by 1.5%, 3%, and 4.5%, as detailed in Table 1. The level of errors followed the recommendations outlined in AAPM TG 142.[26]

Dose distribution measurement

In this investigation, the dose distribution of both the original and intentional error plans was performed using a Delta^4 Phantom. The Delta^4 Phantom consists of a cylindrical polymethylmethacrylate phantom with dimensions of 40 cm in length and 22 cm in diameter. Embedded within the phantom are a total of 1069 p-type silicon diodes arranged on two orthogonal planes. The detectors were positioned at intervals of 0.5 cm inside the 6 cm × 6 cm field. Specifically, they were placed 5 mm apart in the central area and 1 cm apart in the outside portion.

The dose measurement of the Delta^4 device was synced with the beam pulse for each control point, and the dose distribution was calculated using interpolation of the dose measurements. Before conducting measurements, the Delta^4 phantom underwent calibration and verification procedures in accordance with the manufacturer's procedure. These procedures encompass reference measurements, relative calibration, absolute calibration, and directional calibration. One constraint associated with the delta^4 device is its inability to provide patient anatomy data to evaluate radiation dosage levels.

The Delta^4 phantom was positioned onto the treatment couch, ensuring that its center was precisely aligned with the beam isocenter. Both the original and intentional error plans were

Table 1: Summary of intentional error plans in the study related to head and neck, and lung cancer

Treatment plans	Intentional errors	Magnitude
H and N cancer	Collimator rotation (°)	1, 2, 3
	Gantry rotation (°)	1, 2, 3
	MLC leaf position (mm)	1, 2, 3
	Dose delivery (%)	+1.5, +3, +4.5
Lung cancer	Collimator rotation (°)	1, 2, 3
	Gantry rotation (°)	1°, 2°, 3°
	MLC leaf position (mm)	1, 2, 3
	Dose delivery (%_	+1.5, +3, +4.5

MLC: Multi-leaf collimator, H and N: Head and neck

transmitted to the treatment console and subjected to irradiation using the Delta^4 phantom. Subsequently, a QA study was conducted by comparing the dose distribution calculated and measured on the phantom. Figure 1 illustrates the setup of the Delta^4 on the LINAC treatment couch.

Data analysis

Gamma index evaluation

The investigation primarily aimed to assess the impact of errors in the intention plans by comparing the original and intention error plans. A comparative analysis of dose distributions was conducted using a three-dimensional gamma evaluation method. The gamma index approach, as developed by Low *et al*.,[9] was employed to examine the dosage distribution that was provided and measured. The acceptance criteria of the gamma index technique consist of two parameters: distance-to-agreement and percentage dose difference (DD). These parameters are used to establish the minimal separation between the computed and measured data plans.[7,27,28] To evaluate the effectiveness of the suggested plan, we calculated the gamma passing rate (GPR) using a 2%/2 mm criterion. Treatment plans with a passing rate exceeding 95% were considered satisfactory.

Differences in dose-volume histogram analysis

To assess the detectable degree of error by the Delta^4 measuring device in treatment plans that involve parameter modifications, we conducted a comparative analysis of the anatomical metric with respect to the planning target volume (PTV) and the organs at risk (OAR) in both the original and intentionally error plans. The dose-volume histogram (DVH) was subjected to analysis, and the percentage dose error (DE) was determined by the utilization of the subsequent equation.[11,29,30]

$$DE = \left(\frac{D_{DVHerr} - D_{DVHori}}{D_{DVHerr}} \right) \times 100$$

where DE represents the percentage of DEs, D_{DVHerr} represents the dose value of the dose value of deliberate error plans, and D_{DVHori} represents the original plan. A DVH analysis was conducted on the PTV and selected OAR within the anatomical treatment region. The PTV was subjected to dose limitations for the maximum dose (D_{max}) and the dose received by 95% of its volume ($D_{95\%}$). In the context of H and N cancer, our analysis focused on two key factors: D_{max} and the volume of the parotid glands that got more than 30% of the prescribed dose (V_{30}), as well as the D_{max} for the spinal cord. In the context of lung cancer, several factors were taken into consideration, including the D_{max} received by the lungs, the volume of lung tissue that got more than 20% of the prescribed dose (V_{20}), the D_{max} received by the esophagus, and the maximum dose as well as the volume of heart that received more than 30% of the prescribed dose (V_{30}).

Figure 1: The Delta^4 phantom was placed in a certain location on the linear accelerator treatment couch

Correlation analysis

The statistical relationship between the percentage of DE and the GPR was examined through the use of Pearson's correlation coefficient (r).[30,31] The present methodology quantifies the magnitude of a linear correlation between the two variables, utilizing a scale from + 1 to − 1. The value of the Pearson's correlation coefficient indicates the degree of strength in the association. The correlation between the DVH analysis and the gamma index was deemed significant when the P value was below 0.05.

Results

Gamma index evaluation

The verification findings of the H and N plans, as shown in Figure 2, indicate that intentional errors led to a decrease in the percentage of the GPR as compared to the original treatment plans. Several kinds of parameter levels had the capability to identify a greater number of errors. The average GPR caused by intentional adjustments in collimator rotation fell within the range of 79.56%–95.18%. The occurrence of gantry rotation errors led to an average range of GPR between 93.62 and 97.68, whereas MLC position errors resulted in an average GPR range of 89.78–97.72. The increased number of monitor units (MU) led to a resultant average of GPR ranging from 49.04 to 91.7.

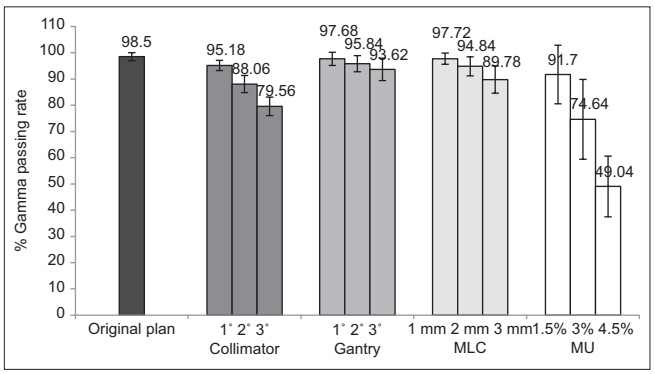

Figure 2: The average gamma passing rate of head and neck cancer treatment plans with Delta^4. MLC: Multi-leaf collimator, MU: Monitor units

The validated outcomes of lung designs are depicted in Figure 3. The findings indicated that adjusting the rotation of the collimator had led to an average GPR range of 85.72–96.44 for the error-generated plans. The observed discrepancies in treatment plans that arose from adjustments made to gantry rotation exhibited an average range of GPR values between 95 and 98. The repositioning of MLC had yielded an average range of GPR from 86.74 to 98.64. Conversely, increasing the number of MUs had led to an average GPR range of 40.58–91.52, with corresponding errors.

Differences in dose-volume histogram analysis

The analysis focused on the DVH-based metrics of the PTV and OAR in the H and N, and lung treatment plans utilizing the Delta⁴ system. The original plan and intentional errors included collimator rotation, gantry rotation, MLC leaf position, and dose delivery. Figure 4 illustrates the example DVH from the Delta⁴ system for the H and N, and lung cases with the original, 1 mm, 2 mm, and 3 mm MLC position error plans. The use of DVH analysis may provide further support in evaluating the results. However, it is crucial to realize that DVH analysis only pertains to structures replicated in the phantom and does not include an assessment of the patient's anatomical characteristics.

Tables 2 and 3 present the DE of the PTV and OAR in the original and intended plans for H and N, and lung treatment plans, respectively. Table 2 presents the D_{max}, $D_{95\%}$, and V_{30} mean percentage DD of the H and N plans between intentional error and the original plans calculated using the treatment planning system for PTV, parotid, and spinal cord. For example, the results in the dose distribution comparison differ somewhat from the gamma evaluation comparison. The dose distribution comparison of PTV, the 2° collimator rotation resulted in a lesser difference from the original plan, whereas in the gamma evaluation comparison, the inverse was observed.

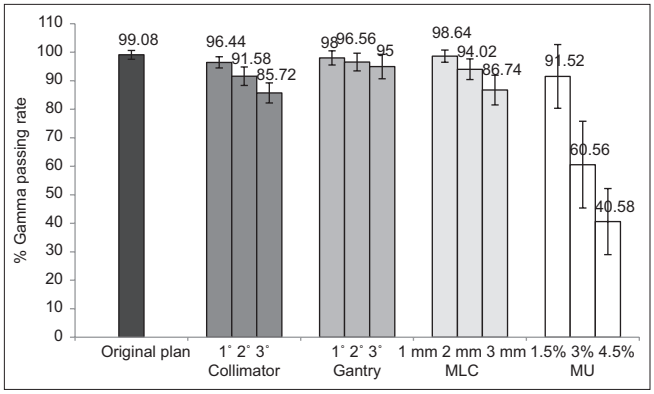

Figure 3: The average gamma passing rate of lung cancer treatment plans with Delta⁴. MLC: Multi-leaf collimator, MU: Monitor units

Table 3 presents the D_{max}, $D_{95\%}$, $V_{20,}$ and V_{30} mean percentage DD of the lung plans between intentional error and the original plans calculated using the treatment planning system for PTV, lung, esophagus, and heart. In the dose distribution comparison of PTV, the 2° collimator rotation resulted in a lesser difference from the original plan, whereas in the gamma evaluation comparison, the inverse was observed. For instance, the results of the dose distribution comparison and the gamma rating comparison are not the same. In the dose distribution comparison of PTV, the 3 mm MLC position resulted in a smaller deviation from the original plan, while the opposite was observed in the gamma evaluation comparison.

Correlation analysis

Table 4 displays the statistical correlation (*R*) results, together with their corresponding *P* values, between the DE and GPR regarding the treatment plans for H and N, and lung cancers. Pearson's correlation coefficients indicated a slight association between the DE and the GPR for H and N, and lung plans. The *R*-values ranged from 0.12 to 0.67. Significant statistical evidence was seen for both H and N and lung plans, as all calculated *P* values were found to be less than the predetermined significance level of 0.05. An inverse relationship was established between the gamma passage rate and the DVH dosage measurements, indicating a reduction in the latter as the former increased.

Discussion

The objective of this study was to assess the efficacy of the patient-specific QA tool in detecting errors. This was done by comparing the GPR acquired from conventional pretreatment VMAT QA verification, and the DE derived from DVH dosage metrics, and examining the association between GPR and DE. The gamma index study conducted to verify the treatment plans for H and N, and lung cancer revealed a notable reduction in the GPR as the magnitude of mistakes in the treatment plans increased.

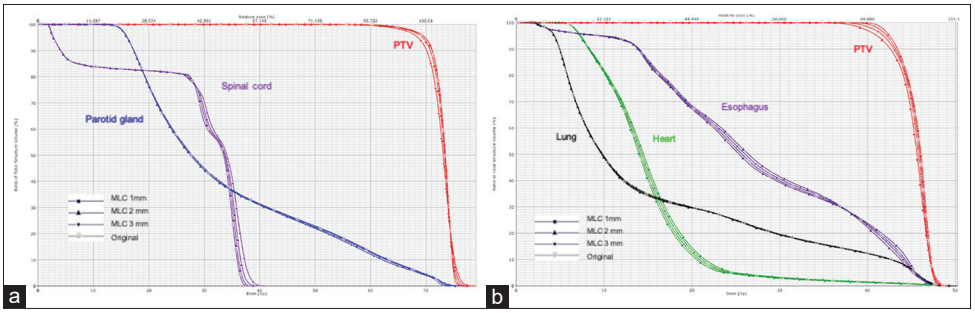

Figure 4: Dose volume histogram from the Delta⁴ system for the head and neck (a) and lung, (b) Case with the original, 1 mm, 2 mm, and 3 mm multi-leaf collimator position error plans. PTV: Planning target volume, MLC: Multi-leaf collimator

In addition, it was verified that the errors arising from the rotation of the gantry in the treatment plan led to a minor alteration in the GPR. Furthermore, no changes were observed in the dose distribution of the treatment plan at each monitored point, indicating that Delta^4 can detect fewer errors compared to other error-generated plans. The Delta^4 measurement equipment is capable of detecting errors in H and N cancer treatment plans resulting from gantry rotation adjustments of 3°. The Delta^4 system exhibits limitations in its ability to identify complications arising from identical rotations within lung cancer treatment plans. This implies that the dose distribution in the treatment plans for lung cancer remains secure, even in the presence of a substantial variation of up to 3° gantry rotation. Nevertheless, the lack of error detection may be attributed directly to the rotation, hence limiting the general efficiency of the Delta^4 system.

Table 2: Present the dose error of the planning target volume and organs at risk in the original and intended plans for head and neck treatment plans

	PTV (%)		Parotid (%)		Spinal cord (%)
	D_{max}	$D_{95\%}$	D_{max}	V_{30}	D_{max}
Collimator rotation (°)					
1	0.93	3.26	1.03	14.79	2.65
2	0.93	3.80	1.55	21.34	2.65
3	0.47	3.80	0.52	21.78	3.54
Gantry rotation (°)					
1	1.40	2.72	0.52	13.77	2.65
2	0.93	2.72	0.52	12.75	2.65
3°	1.40	2.17	0.00	13.77	2.65
MLC position (mm)	1.40	2.72	0.00	15.10	1.77
1					
2	0.93	3.26	0.00	17.66	2.65
3	0.93	3.26	0.52	17.49	3.54
MU increasing (%)					
+1.5	0.00	1.63	1.03	17.97	4.42
+3	1.40	0.00	2.06	20.27	6.19
+4.5	3.26	1.63	4.64	23.28	7.96

PTV: Planning target volume, MLC: Multi-leaf collimator

The intentional changes to the collimator rotation in the treatment plan have the potential to impact both the radiation dosage delivered to the malignant tumor and the excessive radiation dose received by healthy organs. These modifications can further compound errors in the treatment plan. Consequently, the Delta^4 measurement apparatus can detect discrepancies at an inclination of 2° in both H and N and lung cancer treatment plans. The observation of the collimator angle inaccuracy of 3° aligns with the findings of Fredh *et al*.,[32] researched the failures of treatment regimens using different dosage measurement equipment. The data indicate that the Delta^4 measurement equipment did not successfully identify a 2° rotation mistake in the treatment plan for prostate cancer. However, it is worth noting that similar errors may be identified in treatment plans for H and N cancer as well as lung cancer.

The errors discovered in the treatment plan, leading to the displacement of the MLC, suggest that Delta^4 could detect inaccuracies within a range from 2 mm to 3 mm in both the H and N, and lung cancer treatment plans, particularly when there are modifications in MLC placements. The adjustment of radiation intensity is necessary to effectively target malignant tumors since it influences the radiation dose that encompasses the cancer cells, hence necessitating changes in the locations of the MLC. Hence, the intentional error of inaccuracy resulted

Table 3: Present the dose error of the planning target volume and organs at risk in the original and intended plans for lung treatment plans

	PTV (%)		Lung (%)		Esophagus (%)	Heart (%)	
	D_{max}	$D_{95\%}$	D_{max}	V_{20}	D_{max}	D^{max}	V_{30}
Collimator rotation (°)							
1°	0.83	4.00	1.67	0.98	0.53	3.21	9.68
2°	1.25	4.00	1.67	0.36	0.53	4.13	10.14
3°	0.83	5.00	1.67	0.25	0.00	4.13	9.79
Gantry rotation (°)							
1°	1.25	4.00	2.09	0.98	0.53	3.67	9.68
2°	1.67	4.50	1.67	0.80	1.06	3.67	9.57
3°	1.67	4.50	1.67	0.76	1.06	3.21	9.57
MLC position (mm)							
1	1.25	4.00	2.09	1.20	0.53	2.75	8.43
2	1.25	4.50	1.67	1.70	0.00	1.83	6.95
3	1.25	5.50	1.26	1.81	0.53	1.38	5.24
MU increasing (%)							
+1.5	0.42	2.50	0.42	2.17	1.06	2.29	3.53
+3	2.50	1.00	1.67	2.68	2.66	0.92	4.56
+4.5	3.75	0.50	2.93	3.59	4.26	0.92±	1.82

PTV: Planning target volume, MLC: Multi-leaf collimator

Table 4: Presents the statistical correlation coefficients (*r*) and their associated *P* values for the relationship between dose error and gamma passing rate in treatment plans related to head and neck, and lung cancer

Treatment plan	Structure	DVH metric	Collimator rotation		Gantry rotation		MLC position		MU increasing	
			r	*P*	*r*	*P*	*r*	*P*	*r*	*P*
H and N	PTV	D_{max}	−0.38	0.037	−0.42	0.027	−0.45	0.024	−0.56	0.010
		$D_{95\%}$	−0.47	0.042	−0.47	0.001	−0.36	0.037	−0.45	0.020
	Parotid gland	D_{max}	−0.29	0.024	−0.15	0.017	−0.35	0.024	−0.37	0.010
		V_{30}	−0.41	0.012	−0.67	0.006	−0.54	0.026	−0.65	0.009
	Spinal cord	D_{max}	−0.44	0.023	−0.26	0.039	−0.46	0.044	−0.42	0.001
Lung	PTV	D_{max}	−0.44	0.034	−0.19	0.034	−0.47	0.020	−0.41	0.014
		$D_{95\%}$	−0.47	0.024	−0.25	0.024	−0.54	0.035	−0.32	0.025
	Lung	D_{max}	−0.35	0.023	−0.57	0.041	−0.53	0.039	−0.29	0.000
		V_{20}	−0.19	0.015	−0.57	0.048	−0.15	0.028	−0.54	0.037
	Esophagus	D_{max}	−0.26	0.034	−0.66	0.007	−0.28	0.035	−0.61	0.000
	Heart	D_{max}	−0.16	0.026	−0.19	0.023	−0.19	0.038	−0.60	0.017
		V_{30}	−0.37	0.026	−0.45	0.036	−0.12	0.026	−0.40	0.026

DVH: Dose volume histogram, MLC: Multi-leaf collimator, MU: Monitor unit, PTV: Planning target volume, H and N: Head and neck

in a significant discrepancy in the radiation dosage within the treatment plan.[33,34]

The findings of the study utilized for determining treatment regimens exhibit notable disparities in comparison to the research conducted by Heilemann *et al*.[35] The findings indicated that Delta^4 can identify errors in the positioning of the MLC within a range of 2 mm in treatment plans designed for prostate cancer. In addition, errors were detectable within a range of 3 mm for H and N plans. These observations relate to previous studies. In a study conducted by Honda *et al*.,[36] the researchers evaluated the efficacy of VMAT on 10 prostate cancer patients. Regarding MLCs, the Detal^4 device could detect positional errors that exceeded the criterion of 2.0 mm.

The intentional error of the treatment plan, specifically the increase in the number of MU, led to a drop in the GPR compared to other errors. This is due to the rapid changes in radiation dose within both the malignant tumor and the adjacent healthy organs resulting from the treatment plan adjustments. Consequently, the Delta^4 measurement instrument can identify a greater number of errors within the treatment plans. There was evidence of a 1.5% rise in the number of MU observed in the treatment regimens developed for H and N cancer, and lung cancer. The findings suggest that the efficacy of Delta^4 detection was contingent upon both the nature of the errors produced and the characteristics of the treatment plans. Previous studies have documented similar findings in the existing body of research.[32,35,37] The Delta^4 system efficiently recognized the errors that arose from increasing the number of MU, although it was able to identify the errors in gantry rotation plans to a lesser extent.

The current investigation revealed no detectable differences in the DE between the initial and deliberate strategies employed in H and N, and lung treatment plans. The observed greater DE was found in the OAR that exhibited a significant dose gradient. This occurrence may be attributed to the inadequate spatial resolution of the detecting equipment. It was observed that the parotids of H and N plans exhibited larger DD in V_{30}, whereas the heart of lung plans had higher DD in V_{30}. According to Szczurek *et al*.,[11] the interpolation of the observed dosage in a high dose gradient leads to a DD and the detection of a lower dose in the high dose region.

The study's findings indicated that the R values obtained from the association analysis between GPR and DE were moderate. The correlation between GPR- and DVH-based metrics for willful errors in gantry rotation, collimator rotation, MLC location, and MU increase, respectively, is intermediate. The research works conducted by Mohamed Yoosuf *et al*.,[38] Szczurek *et al*.,[11] Mohamed Yoosuf *et al*.,[38] Stasi *et al*.,[31] and Infusino *et al*.[30] indicated a modest correlation between GPR and DVH.

Compared to the application of the GPR, the investigation of DVH metrics generated by the Delta^4 system yielded new information that supported earlier conclusions regarding dosimetric errors and dose distribution. In addition, it has been demonstrated that the DVH evaluated with dosimetrist parameters and dose-tolerance limits was preferable for patient-specific QA verification in VMAT. As a result, it was crucial, when making clinical decisions, to consider the evaluation of the treatment plan that was conducted through DVH research.

Conclusion

Verifying treatment plans before the administration of therapy has the potential to minimize the risk of radiation DEs for patients. The Delta^4 measurement equipment can assess discrepancies that may have arisen in the treatment plans for H and N, and lung cancers. Essentially, the Delta^4 system has the capability to identify and detect errors by several means, such as adjusting the rotation of the collimator, modifying the rotation of the gantry, altering the positions of the MLC, and increasing the number of MU. The efficacy of error detection depended on the specific error plans devised and the corresponding treatment plans.

The degree of sensitivity to errors introduced was based on the particular plan in question, and different systems can identify different types of errors. The gamma assessment pass rates of the QA methods exhibited modest associations with the reported deviations in the DVH.

Acknowledgments

The authors would like to express their appreciation to Naresuan University for providing financial support. They also gratefully acknowledge the Radiation Oncology Unit at Chulabhorn Hospital, Thailand, for providing the necessary instrumentation and dose measurement.

Financial support and sponsorship

This study was funded by Naresuan University (Grant No. R2560C100).

Conflicts of interest

There are no conflicts of interest.

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