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The Effect of Using 4 Points Locks and 9 Points Locks Masks on Patient Set-Up in Nasopharynx Cancer

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Abstract

The set-up aims to find out the value of the shift that occurs while the patient is undergoing the irradiation process on the X-axis (right-left), Y-axis (caudal-cranial), and Z-axis (anterior-posterior). The procedure for collecting research data is by making direct observations and being involved in measuring set-up shifts. The data used amounted to 20 nasopharyngeal cancer patients. Set-up shift measurement data were taken sequentially from fractions 1-33 for each patient using 4 and 9 points locks masks. Analysis of statistical test data using SPSS version 25, to determine the effect of using 4 and 9 points locks masks on shifts in nasopharyngeal cancer irradiation set-up patients with fraction group: Group 1 (fraction 1), Group 2 (Fraction 2 – 15), Group 3 (16-33) using the Wilcoxon test because the normality test results were not fulfilled. If the p-value ≤ 0.05, there is an effect of using 4 and 9 points locks mask on shifts, while for p-value ≥ 0.05, there is no effect of using 4 and 9 points locks mask on set-up shifts in nasopharyngeal cancer irradiation set-up. The results of the shift in the set-up of 4 and 9 points lock irradiation vertically in the lateral, longitudinal, and vertical directions tend to be positive (left, caudal, posterior). There was no effect of all fraction groups using 4 and 9 points locks on the shift in nasopharyngeal cancer irradiation set-up p-value> 0.05.

Introduction

The use of radiation as a cancer treatment modality has developed rapidly. Radiotherapy has the principle of giving the maximum dose to the area of cancer cells and as little as possible to the area of healthy cells. It is very efficient because of the nature of cancer cells which are more sensitive to radiation compared to healthy body cells [1]. One of the modalities used is the Linear Accelerator which is a device that uses electromagnetic waves and high frequencies to accelerate electron-charged particles through a linear tube. [2]. The electron beam can be used to treat tumors on the surface, or it can be modified by impacting it on a target to produce X-rays so that it can be used to treat tumors that are far from the surface of the body [3].

Radiotherapy until now still plays an important role in the management of nasopharyngeal cancer because it is radioresponsive [4]. Radiotherapy techniques such as intensity-modulated radiotherapy (IMRT) are routinely used to treat nasopharyngeal cancer. Because IMRT delivers a very precise radiation dose to the target with a precise dose gradient at the target limit [5]. This is very important because nasopharyngeal cancer is close to healthy organs, such as the central nervous system, optic structures, and parotid glands. Even based on reports with advanced immobilization devices, positional uncertainty is potentially harmful to patient settings [6].

The quality of radiation therapy administration is highly dependent on the irradiation set-up arrangements, especially the use of masks which are evaluated daily [7]. Geometry inaccuracies in radiation administration are caused by inaccuracies in the shape of the tumor against the radiation beam given. Several causes of shifts in irradiation set-up may occur, including overall patient movement (external set-up variations), internal variations originating from the movement of the tumor against external reference markers and bone structures within the patient [8], and tumor movement within the patient (internal variations)), the set-up variation comes from the daily patient position on the radiation couch. Therefore, to ensure that the tumor gets the right radiation dose, recommendations issued by the *International Commission on Radiation Units and Measurements* (ICRU) suggest determining the Planning Target Volume (PTV) in making a radiation plan. First of all, Gross Tumor Volume (GTV) will be drawn or delineated, namely the volume of the tumor that is visible or palpable. This volume was later expanded into a Clinical Target Volume (CTV) which includes GTV and microscopic spread areas. Then, a margin is created to compensate for geometric uncertainties such as patient and organ movement, which is referred to as PTV [9].

Efforts to improve the accuracy of proper irradiation need to be determined through set-up. This activity aims to obtain data regarding the shifts that occur while the patient is undergoing the radiation irradiation process. Geometry set-up aims to match or prove whether the radiation given to the patient is as planned by the Treatment Planning System (TPS) [10]. Use of masks in nasopharynx cancer irradiated patients to ensure the accuracy of radiation [11]. The mask used in radiation irradiation of nasopharynx patients is a closed thermoplastic mask or head mask to reduce movement [12].

Based on research conducted by Lin CG, 2017 concerning a comparison of the use of several masks in irradiating nasopharyngeal cancer patients, he found that the use of masks did not guarantee a decrease in set-up shifts when irradiating nasopharyngeal patients. In addition, one of the hospitals in Jakarta is equipped with a set-up system, where this activity is carried out every day before the radiation irradiation is carried out. Therefore, set-up is of particular concern. The use of masks in nasopharyngeal patients uses two types of thermoplastic masks.[13] The type of 4 points locks the head and shoulders with both sides of the head, both sides of the shoulders, while the 9 points locks the head and shoulders with one side above the head, both sides of the head, both shoulder side. Based on the background, the authors are interested in researching the effect of the use of 4 and 9 points locks mask on patient set-up of nasopharyngeal cancer irradiation with the Intensity Modulated Radiotherapy (IMRT) technique.

Experimental Method

Prepare tools and materials

The Computed Tomography (CT) Simulator used is a CT a modified diagnostic for simulation purposes equipped with the addition of a laser. The examination table has been modified with the addition of a flat table on it, with the aim that the shape of the table is the same as in the radiation therapy room of the CT Simulator aircraft used by the Siemens Healthineers brand with type Somatom Confidence. The CT Simulator has a total of 20 or 64 detector slices with a width bore gantry of 80 cm. The slice Thickness used for image capture is 0.5 mm with a kV voltage of 70, 80, 100, 120, and 140 kV. CT Simulator uses a couch with a type of flat. In sending the image to the TPS using the Direct SPR system. Furthermore base plate is used as a headrest in cancer radiotherapy irradiation examinations nasopharynx, base plate is placed on the inspection table which has been marked for installation base plate [14], [15].

Head and neck masks in nasopharyngeal cancer radiotherapy examination of patients using 4 and 9 point locks mask. The patient immobilization system of 4 point locks is an active component in achieving high-quality radiation therapy, this mask systems has achieved three important goals to improve the quality of radiation therapy care, including precision or accuracy (limit patient movement), reproducibility, and patient comfort. While thermoplastic 9 points locks mask is stronger, less sticky, and has less shrinkage than other thermoplastic [16].

Patient set-up process

The verification process goes through several stages, namely patient preparation, and set-up verification. Patient preparation for the verification stage in the Nasopharynx case does not require special preparation, only the patient is asked to wear patient clothing and remove metal objects worn by the patient, so that the patient feels comfortable and does not interfere with the radiation therapy process. The supporting tools used are base plates and masks as fixation of the patient's body. The use of masks for fixation is significant in irradiating the Nasopharynx with the IMRT technique. Mask fixation devices can reduce set-up error position for the patient and minimize patient movement.

Stages of set-up verification on the Linac equipment through several stages verification scan and image registration. At stages, verification scans generate an image anterior-posterior (AP) and Lateral. On process verification scan, with the case of the Nasopharynx, the area taken for the verification process includes the entire PTV. Image registration is the process of matching the EPID result in image with the CT Simulation result image, matching the image using the menu automatic registration control (ARC), and the shift results will be obtained longitudinal, vertical, and lateral with a correction factor of up to 0.3 cm. If it is greater than 0.3 cm, it is necessary to reposition the patient and repeat the verification stage again.

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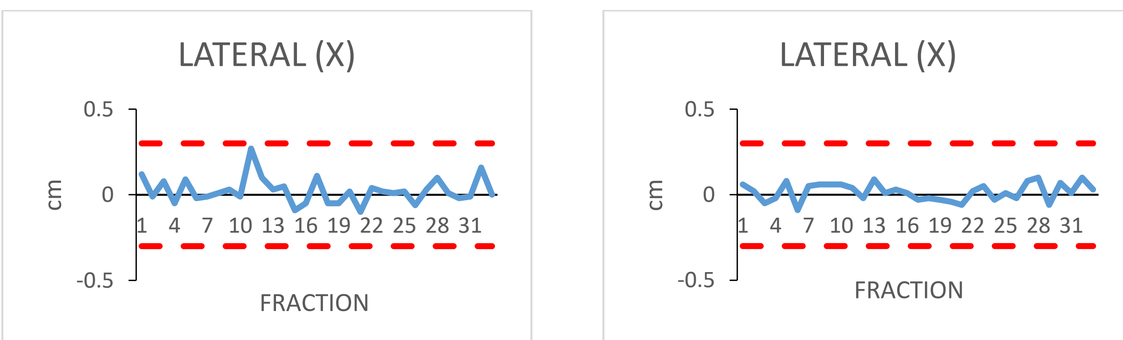
Data Analysis

In this study, the population was nasopharyngeal cancer patients who were given therapy using the IMRT technique. The variable consists of two masks 4 and 9 points locks. In the data collection procedure, the researcher made direct observations and was involved in measuring the set-up shift. Lateral measurements are positive to the left of the patient and negative to the right of the patient. Longitudinal measurements are positive in the caudal direction and negative in the cranial order of the patient. At the same time, vertical is positive in the posterior direction and negative in the inferior direction. The data used were from 20 nasopharyngeal cancer patients with 10 patients using 4 points locks mask and 10 patients using 9 points locks mask. Radiation set-up shift measurements were carried out by observing the beam in the lateral, longitudinal, and vertical directions. Set-up shift measurement data were taken sequentially as many as 33 fraction for each patient who used an 4 and 9 points locks mask. Analysis of statistical test data using SPSS version 25, to determine the effect of using 4 and 9 points locks masks on shifts in nasopharyngeal cancer irradiation set-up patient with fraction group : Group 1 (fraction 1), Group 2 (Fraction 2 – 15), Group 3 (16-33) using the Wilcoxon test because the normality test results were not fulfilled. If the p-value ≤ 0.05, there is an effect of using 4 and 9 points locks mask on shifts, while for p-value ≥ 0.05, there is no effect of using 4 and 9 points locks mask on set-up shifts in nasopharyngeal cancer irradiation set-up.

Result and Discussion

Measurement of the set-up shift using 4 and 9 points locks mask in the lateral, longitudinal, and vertical directions in irradiating nasopharyngeal cancer patients. Patient set-up measurements were carried out during irradiation at each given fraction. Fractionation in radiotherapy the distribution of irradiating a proportional dose of radiation to patients who are undergoing radiotherapy treatment, with the aim of fractionation is to increase the effectiveness of treatment while protecting as much healthy tissue as possible. set-up was observed starting from fraction 1 to 33. The set-up results are shown in Figure 1.



a) d)

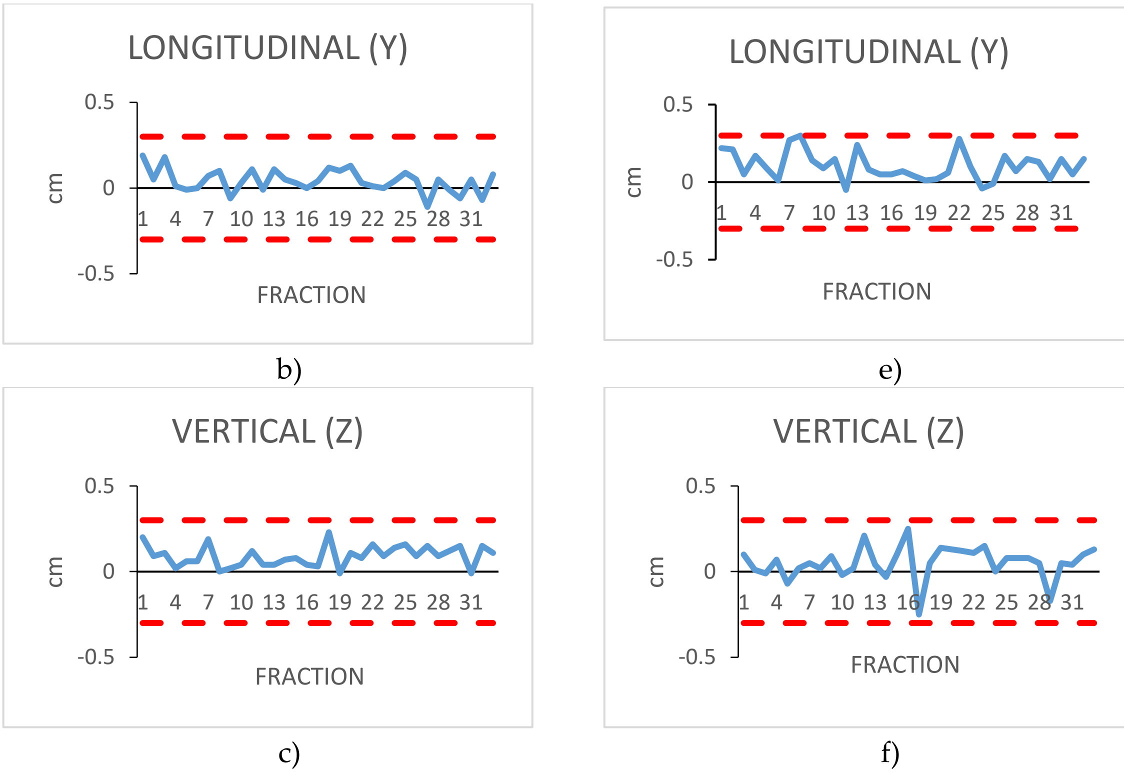
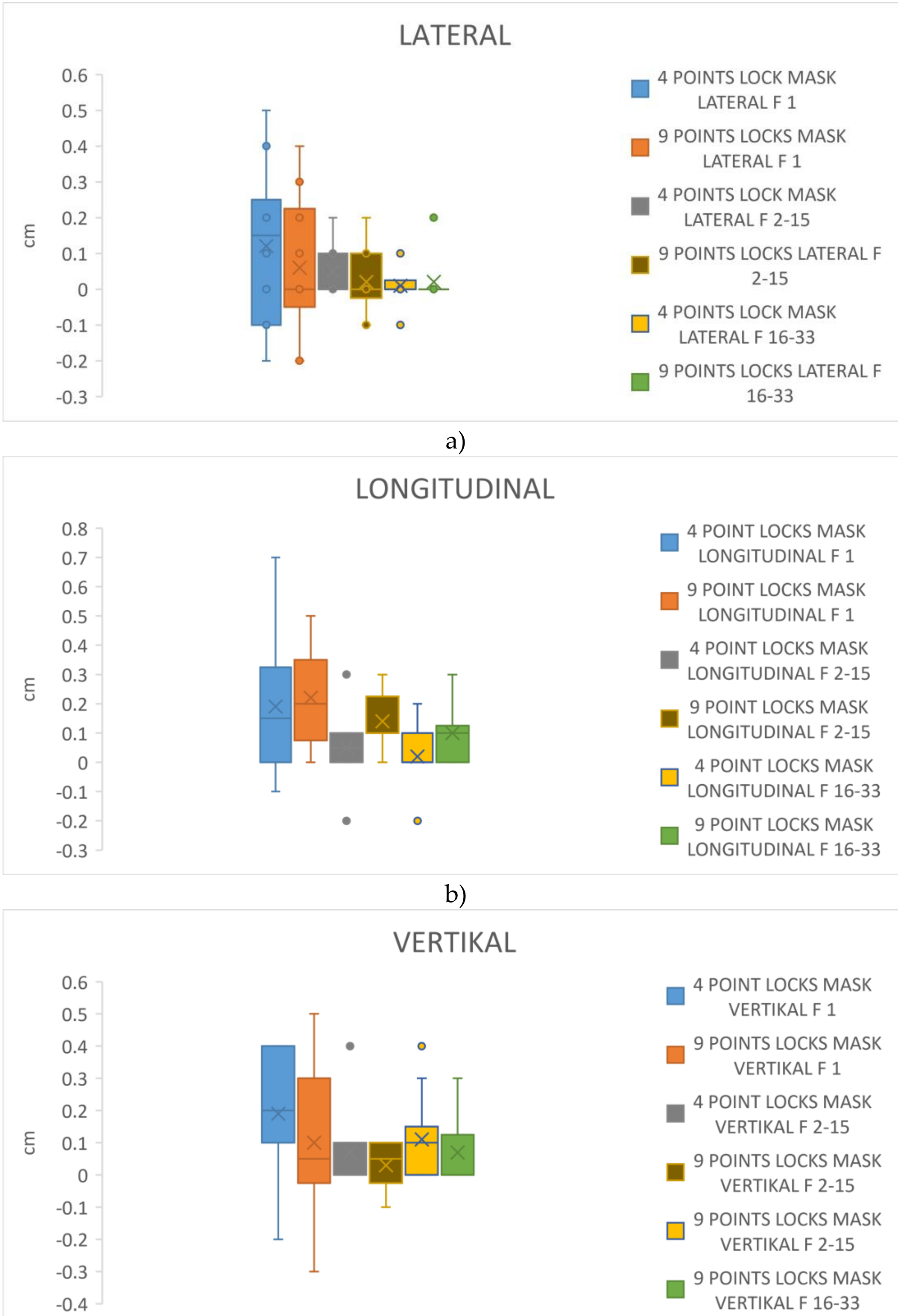


Figure 1. Set-up result 4 points locks mask (a,b,c) dan 9 points locks mask (d,e,f)

Set-up results show that there are shift variations, lateral shifts tend to the positive direction (left), longitudinal shifts tend to the positive direction (caudal), vertical shifts tend to the positive direction (posterior). While the results of the set-up show that there are variations in shifts, lateral shifts tend to be positive (left), longitudinal shifts tend to be positive (caudal), and vertical shifts tend to be positive (posterior).

The cause shift can be caused by several things such as set-up errors that occur during the irradiation process, both systematic and random errors. Systematic errors occur during the administration of radiation to each fraction and are closely related to the radiotherapy planning process. This will have an impact on shifting the cumulative dose distribution in the target organs. Random errors resulted in an unclear dose distribution [17]. In addition, for the treatment of nasopharyngeal cancer, it is very important to pay attention to the position of the patient's shoulder, especially if the supraclavicular nodule area is irradiated when wearing a mask. Using masks can also cause a shift because the patient loses weight, and the tumor volume is reduced. Another reason for the shift in set-up in the use of masks is that the mask is sagging, this happens due to changes in the patient's position, shape, or size (for example, changes in body weight, hair loss, masks that don't fit) [10]. Furthermore, data analysis was carried out from faction groups: Group 1 the early fraction (fraction 1), Group 2 the middle fraction (fraction 2-15), and Group 3 the final fraction (fraction 16-33) as shown in Figure 2.



c)

Figure 2. Analysis of the use of 4 and 9 points locks mask in a) the lateral, b) longitudinal and c) vertical directions

The results of the analysis showed that the shift in irradiation set-up found that the greatest refresh rate occurred in fraction 1 and the value varied greatly for all patients using 4 and 9 points locks mask, while for fractions 2-15 and 16-33 the shift in set-up did not occur and tended to be the same in both masks. Then the Wilcoxon test was carried out to determine the effect of using using 4 and 9 points locks mask on the shift in nasopharyngeal cancer irradiation set-up shown in table 1.

Table 1. Test results of the effect of using 4 and 9 points locks on set-up

Group	**Lateral**		***p-value***
	4 points locks	**9 points locks**	
Group 1 (1)	0.12±0.22	0.06±0.19	0.719
Group 2 (2-15)	0.05±0.07	0.02±0.09	0.429
Group 3 (16-33)	0.01±0.05	0.02±0.06	0.709

a) Shift set-up lateral

Group	**Longitudinal**		***p-value***
	4 points locks	**9 points locks**	
Group 1 (1)	0.19±0.23	0.22±0.18	0.436
Group 2 (2-15)	0.05±0.12	0.14±0.09	0.087
Group 3 (16-33)	0.02±0.10	0.01±0.09	0.02*

*significant differences

b) Shift set-up longitudinal

Group	**Vertical**		***p-value***
	4 points locks	**9 points locks**	
Group 1 (1)	0.19±0.18	0.10±0.23	0.319
Group 2 (2-15)	0.07±0.12	0.03±0.08	0.257
Group 3 (16-33)	0.11±0.13	0.07±0.10	0.257

c) set-up longitudinal

From the test results it was found that overall there was no effect of the use of orfit masks and klarity on shifts in lateral, longitudinal and vertical set-up of nasopharyngeal cancer irradiation. As is well known, a mask is a positioning aid to prevent the patient's body movement when administering radiation irradiation. The 9 points locks mask is stronger, non-sticky, and has less shrinkage than other thermoplastic masks, while the characteristics of the ofrit mask are precision or accuracy (limit patient movement), reproducibility, and patient comfort. The 4 and 9 points locks mask each of which functions to lock the mask so that the mask does not come off during irradiation so that the patient's position remains the same as when in the CT Simulator.

Apart from using the same basic material, namely thermoplastic, the fact is that the cause of the shift in irradiation set-up is influenced by many factors other than using a mask, such as errors when positioning patients, simulations or when irradiating. In addition, changes in patient shape and size that can occur are due to changes in the position and shape of the radiation target [18]. Based on research by Jing Jia, et al 2015 found that there were no significant differences in the set-up shift markers using crosses and circles in the calibration phantom and anthropomorphic, besides that it is better before the set-up measurement is carried out it mandatory to ensure the laser position is appropriate, operator error who does not set up laser correctly can cause differences in reference points [19]. The limitation of this study is the lack of sample data which affects the results of data analysis, although this study includes a relatively small sample, it does not mean it is not representative of the population.

Conclusion

The results of the shift in the set-up of 4 points locks mask irradiation on the vertical, longitudinal, and lateral tended to be positive. The results of the shift in the set-up of 9 points locks mask irradiation on the vertical, longitudinal, and lateral tend to be positive (left, caudal, posterior). There was no effect of all fraction group using 4 and 9 point locks mask on the shift in nasopharyngeal cancer irradiation set-up p-value> 0.05.

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