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Geometrical Analysis of IMRT/VMAT on Head and Neck Case Using New and Reused Thermoplastic Mask in Dharmais Hospital National Cancer Center Indonesia

INTRODUCTION

Based on The National Comprehensive Cancer Network (NCCN) Guideline, Intensity Modulated Radiation Therapy (IMRT) is the recommended radiotherapy technique for head and neck cancer cases. The reason is that IMRT is rapidly reaching its maturity in delivering very precise dose distributions with the ability to achieve a high dose in tumor while sparing normal tissue.[1] Thus, the efficacy of radiotherapy can be well maintained. However, its clinical success is limited by its requirement for motion management and reduction of an inter-fractional setup error. [2], [3] In cases where there are many critical organs at risk (OAR) that needs to be spared, such as head and neck cases, certain efforts must be made to ensure accurate positioning of the inter-fraction patient and obtain a repeatable dispensing of the dose, one of those efforts is the use of immobilization device such as a thermoplastic mask.[4], [5] The challenge for health practitioners, especially in low middle-income countries such as Indonesia is to maintain efficacy as much as possible with minimal operational costs. Currently, the mask device for most of the radiotherapy centers in Indonesia is still being reused, with consideration of high operational costs and the recommendation from the mask vendor that stated the mask may be reused. Therefore, this study was aimed to ensure the accuracy of thermoplastic masks and to determine of PTV margin, both new and reused.

METHODOLOGY

The experiments were conducted using Varian Trilogy Linear Accelerator with the IMRT and VMAT technique. In this study, we analyzed systematic and random error calculation in the setup verification of 27 patients with head and neck cases. Patients included in the study were head and neck cancer patients diagnosed as T1-4, N0-3 according to AJCC TNM Staging, 8th edition, and treated in the supine position. Moreover, the patients were randomized and divided into 3 groups: group A (Code A) using a new mask, group B (Code B) using first reused mask, group C (Code C) using a twice reused mask. The randomization and mask allocation was performed by the Radiotherapy Technician (RTT) in CT Simulator. The pre-treatment verification was performed on three directions: lateral (X-axis), vertical (Z-axis), and longitudinal (Y-axis) and the shift was recorded. The random error (σ) was defined as the average of a standard deviation of the shift per patient along with particular directions which can easily quantify systematic error (Σ) along with those directions. The systematic component of the displacement represents the patient movement at the time during the entire course of treatment.[6] The analysis of PTV margin was conducted using random and systematic error data, according to the formula founded by Strome et al. (2002) in their research.[7] Patient verification was performed using CBCT in the Linac machine before the first treatment and every five fractions of the IMRT and VMAT delivery. ICRU 62 reported that the PTV segment is divided into two distinct sub margins, the setup margin which accounts for uncertainties associated with patient setup, and the internal margin which accounts for target motion. [8]

RESULT

The systematic and random errors for new and reuse thermoplastic masks in each direction were listed in Table 1. It could be seen that the systematic error in the new mask (group A/code A) in the lateral, longitudinal, and vertical directions was 2,0 mm, 1,7 mm, and 2,6 mm, respectively. When all three translational coordinates in the mask device with code A were analyzed with random error, the results were 1.4 mm, 1,3 mm, and 1.6 mm. The systematic and random error in each mask treatment within each direction showed the only small difference. The PTV margin of head and neck cancer cases treated with the IMRT technique in all directions is shown in Figure 1. All of them were less than 3 mm. The CTV to PTV margin difference between Code A, B, and C of thermoplastic mask devices also only showed a small difference. This result may be used as a recommendation for head and neck radiotherapy treatment practice guidelines in our hospital.

CONCLUSION

The successful implementation of the IMRT/VMAT on the Head and Neck target requires accurate and reproducible treatment in delivering over 6-7 weeks of the treatment course. We studied the magnitude of daily patient positioning errors corrected by Cone Beam CT image registration. The composite geometric error of three Cartesian the CTV to PTV margin is less than 3 mm and the comparison between each mask (new,

first reused, and twice reused masks) showed no mark difference. This research could be used to justify the use of new and reuse thermoplastic masks in head and neck cases treated with IMRT/VMAT technique in the developing country. To improve treatment efficacy, we encourage other radiotherapy centers to calculate the magnitude of the CTV to PTV margin in the new and reuse the thermoplastic mask.

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