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CT Taramalarında Hastanın Kilosuna göre Alınan Dozun Değişimi

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Anahtar kelimeler
BT;
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Öz

Tüm radyoterapi işlemi sırasında çekilen Bilgisayarlı Tomografi (BT) görüntüleri, tedavi portalı tasarımı, planlaması ve hasta pozisyonunun sağlanması için önemlidir. Ancak bu BT taramalarında hastanın aldığı doz, planlama doz hesaplamalarına dahil edilmez. Özellikle adaptif tedavilerde kritik organların limit dozlarının hesaplanmasında günlük BT taramalarından alınan doz çok önemli hale gelmektedir. Bu çalışmada, Monte Carlo tekniğinin kullanıldığı NCICT kodu ile hastaların bazı kritik organları olan kalp ve karaciğerin aldığı dozun hastanın ağırlığına göre değişimi araştırıldı.

Variation of the Dose by the Weight of the Patient in CT Scanning

Keywords
CT;
Phantom;
NCICT;
Monte Carlo

Abstract

Computed Tomography (CT) images taken during whole radiotherapy procedure is important for treatment planning, portal design and providing patient position. However, the dose received by the patient in these CT scans are not included in the planning dose calculations. Especially in adaptive treatments, the dose received from daily CT scan becomes very important in calculation of the limit doses of critical organs. In this study, with the NCICT code, which use the Monte Carlo technique, the change of the dose absorbed by some critical organs of the patients, namely the heart and liver, according to the weight of the patient, was investigated.

1. Introduction

Computed tomography (CT) is a device for diagnostic imaging using ionizing radiation. Patients are exposed to some amount of radiation with the application of the examination, and radiation dose loading occurs in the relevant region or organs of their bodies. Since the radiation used is ionizing, it is necessary to know the patient doses and to optimize the dose image.

Although computed tomography is very useful for patients, there are concerns about the potential risks of exposure to radiation; especially, for much more sensitive pediatric patients (National Research Council 2006). CT is very important in pre-treatment planning in cancer patients and in maintaining the position of the patient throughout the treatment. However, the dose given by CT before and during the treatment is not taken into account in the TPS of cancer patients. Therefore, knowledge of the absorbed dose of the tissues exposed to Bremsstrahlung x-rays emitted from CT scanners for these patients will enable better conformal treatment planning.

Dose measurements in computed tomography are possible with the use of certain systems and devices. However, these procedures are time consuming and cannot be repeated for every patient. For this reason, Monte Carlo simulation techniques, which are a reliable calculation method, can be used to calculate the radiation dose.

The calculation method, which used in this study, adopted by the ICRP to evaluate various dose descriptors including organ doses for CT patients using pediatric and adult reference voxel phantoms and Monte Carlo simulation of x-rays, was developed by Lee *et al.* (2015).

2. Materials and Method

The algorithm, which used in calculation of absorbed dose in NCICT code, is based on the study of Turner et al. (2010) that $CTDI_{vol}$ can be used as a normalization factor to account for differences among CT scanners. The algorithm is explained by the Eq. (1) and expressions given in Lee *et al.* (2015):

$$D(\text{organ, age, gender,spectrum}) = \sum_{z=SS}^{z=SE} DC(\text{organ, age, gender, spectrum, } z) \times \text{CTDI}_{\text{vol}} \quad (1)$$

Eq. (1) requires two calculations, DC and $CTDI_{vol}$, which were expressed in Lee *et al.* (2015), Reiser *et al.* (2004), AAPM (2011) and the $CTDI_{vol}$ could derive from the Eq. (2).

$$\text{CTDI}_{\text{vol}}(\text{make, model, spectrum}) = \frac{n\text{CTDI}_{\text{w}}(\text{make, model, spectrum})}{\text{Pitch}} \times \left(\frac{I \times t}{100}\right) \times k_{\text{OB}} \quad (2)$$

Absorbed organ dose per unit air kerma were calculated using Monte Carlo-based NCICT for heart wall and liver for adult male and female phantoms (variable weight and constant height (170 cm)). Radiation exposure was simulated by selecting the predefined chest as the area for the 200 kV voltage and 100 mAs current-time value of the irradiation geometry. Fig. 1 shows the input screen used in the calculation and a 170 cm tall female phantom with different masses.

In CT, a situation that requires control in the acquisition of images is the application of high doses and one of the important factors this, the radiation of healthy tissues and critical organs (medulla spinalis, kidney, heart, lung). Although radiation tolerance doses vary greatly depending on the organizational state of the tissue (hierarchical, flexible or hybrid tissues) and the volume irradiated, they are usually lower than the doses that should be administered. Therefore, it is necessary to try to give as few doses as possible within the target volume.

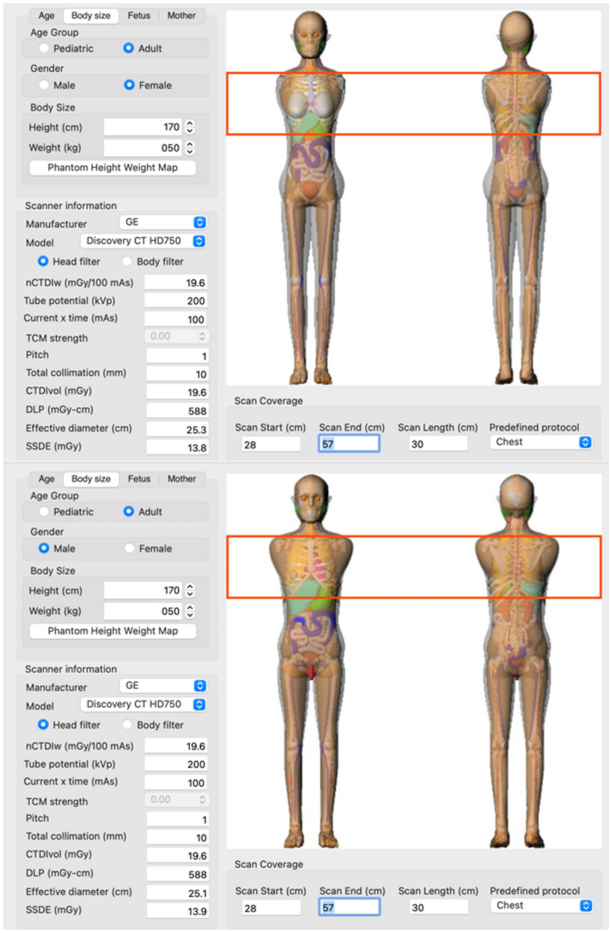

Figure 1. A 170 cm tall female phantom with different masses.

3. Calculations

By using both male and female phantoms with different masses of 170 cm, 200 kV tube voltage, and 100 mAs current-time parameters were selected as constant for the pre-defined scanner and the predefined chest region shots in CT were simulated via Monte Carlo-based NCICT code. Organ doses were calculated for the heart wall and liver, which were determined as critical organs inside the scanned region. The variation of organ

doses for the female and male phantoms are given in Figs. 2 and 3, respectively.

The effective doses obtained in the calculation are given in Fig. 4 for both female and male phantoms.

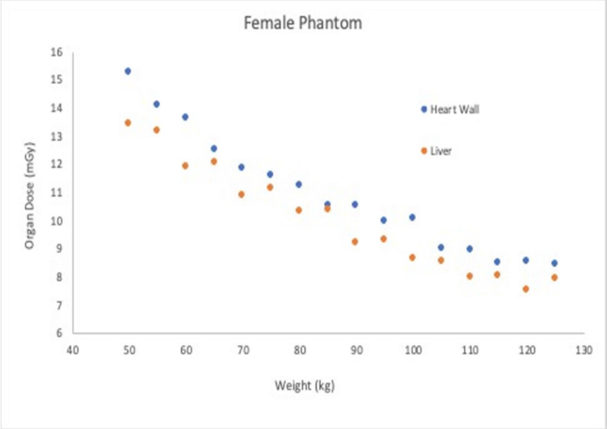

Figure 2. Variation of organ doses by mass for female phantoms of different masses.

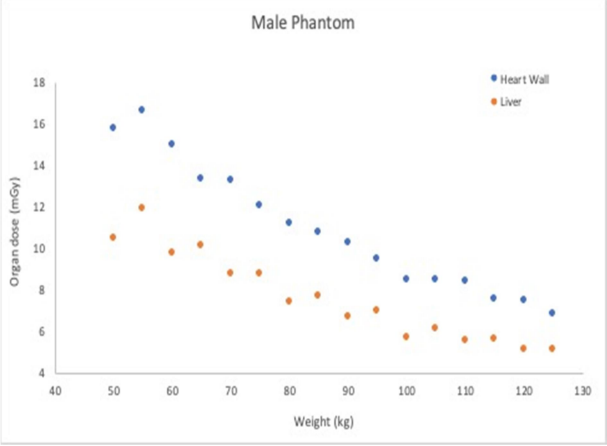

Figure 3. Variation of organ doses by mass for male phantoms of different masses.

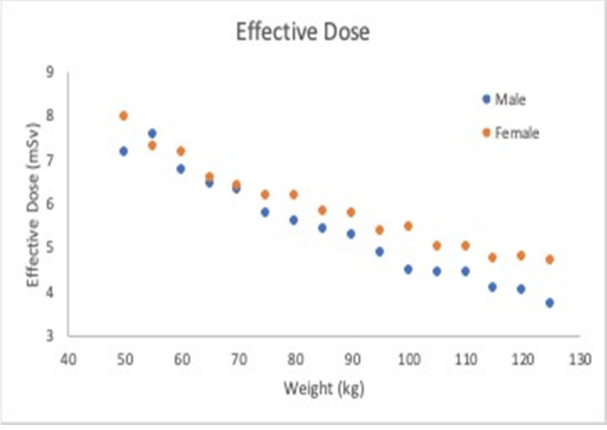

Figure 4. Variation of effective dose by mass for both male and female phantoms.

4. Conclusion

Both male and female phantoms were used in the Monte Carlo-based NCICT code to calculate Heart Wall and Liver organ doses and the effective dose. Although the organ doses for both phantoms decrease with increasing mass, there are irregularities in the values for both the male phantom and the female phantom when the effective doses are examined. When the organ and effective doses are examined, one can see that the code gives varying results for the male and female phantom in 55 and 100 kg masses. These obtained data will be useful for users using ICRP phantoms for Monte Carlo dose calculation to compare the calculation process.

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