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Research Article

Evaluate the dose received by CT scan of the brain from the eye and thyroid

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Abstract

Background and objective: Nowadays, irradiation thyroid is very important as an acute organ in CT scans of the brain. Due to the increasing usage of CT scans for diagnosing diseases, the purpose of this Research is to evaluate the received dose from the eye and thyroid in brain CT scans.

Methods: In this research, while performing CT scan of the brain for irradiation of thyroid and eye were examined in phantom and patients by using Thermo luminescence Dosimetry dosimeter in Shahid Modares Hospital. The dosimeters were placed on the surface of the organs in the X-ray field.

Results: In this study, the absorbed dose of sensitive eye and thyroid was read by the reader in terms of Nanocollen and then converted to mSv by using a calibration curve. In the 3 patient's brain CT scans, the average of received dose from the left eye was 29.13 mSv, the average of received dose from the right eye was 27.51 mSv and the average of received dose from thyroid was 46.08 mSv. In 3 phantom brain CT scans, the average received dose from the right eye is 26.35 mSv, the average received dose from the left phantom eye is 25.71 mSv and the average received dose from the phantom thyroid is 35.22 mSv.

Conclusion: According to the results, the received dose in patients and phantom are numerically close to each other. It is suggested that phantoms be used instead of the patient in dosimetry research.

Keywords: Thermo luminescence Dosimetry, CT scan, phantom, X-ray, Absorbed Dose

Background and objective

CT scan 1 means computed tomography scan. This method is one of the cross-sectional and lateral imaging methods of body organs in medicine that combines 2D images and creates a 3D image by geometric processing, which results in the rotation of the X-ray rotates around the central axis of a piece of organ.

In recent years, imaging using CT scans has increased. Innovation in manufacturing technology and increasing the image quality in the device, has led to an increase in clinical applications for CT scan[1].

Among the common diagnostic methods, CT scan has allocated the largest portion in the cumulative dose in patients due to medical imaging. This higher dose portion due to the increase in dose is not only in a test but also an increase in the demand for CT scan[2].

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In CT scan, after the patient's body is placed on the table and its head is in the gantry area and the condition of the device is adjusted according to the area to be imaged, X-rays need to be formed after leaving the tube. The collimator is located immediately after the tube to change the thickness of the X-ray. In fact, the beam collimator affects two parameters: the dose received by the patient and the image quality. A collimator located instantly after the tube to change the thickness of the X-ray. In spite of the fact that the ray's collimator affects two parameters: the received dose from the patient and the image quality. The collimator usually contains from two parallel blades that adjust the ray thickness as the blades move closer and farther.

X-rays are converted into a strip by a limiting collimator and pass through the patient's body. Some of the radiation energy is absorbed as it passes through the body and the rest of the radiation is measured as an output ray from the patient's body. After conversion into computer language, it is stored in the computer memory, then after the first pulse of radiation was sent to the patient and measured, and also the X-ray lamp made a very small rotational motion, the X-ray was irradiated again and re-measured then stored in the computer memory. This step is repeated several hundred or several thousand times depending on the device till that all the information about the particular organ is stored in the computer memory.

The increase of different types of CT scans, concerns about exposure excessive radiation for patients and staff of these departments have increased and many factors such as ray energy, filtration, collimator, ray current intensity and patient size affect the received dose of patients.

As an example, we can mention the brain CT scan that the received dose of organs in the brain CT scan depends on the manufacturer and the parameters of the brain CT scan[3]. In CT scan, the brain, eyes and thyroid are considered as sensitive organs[4, 5]. Thyroid cancer has been reported in many people who have been exposed to ionizing radiation[6].

Loads of research has been done on the absorption dose of patients using CT scans. For example, in 2014, a study conducted by researchers at the University of Florida on three patients showed that the dose of abdominal and chest organs in the CT scan protocol was less than 32 mg[7, 8, 9]. Another example, in 2002, a study conducted at the University of Mashhad Medical, the absorption dose of sensitive organs such as the thyroid and eye lens was considered in the scan of patients' heads in different conditions. These scans include: normal head scans in people over 16-year-old, regular head scans in people under 16-year-old, sinus scans, eye socket scans and ear scans. Since the eye lens dose is more than the allowable limit in sinus scans, eye socket Axial scan of the ear absorption dose, as result, in prescribing scans and other diagnostic methods, it is necessary to consider the received dose from the patient[10, 11].

Due to the importance of this issue, in this research, for the first time in Shahid Modarres Hospital in Tehran, where many patients in different age groups refer for the CT scan daily, the received dose of eye and thyroid Was taken in CT scan of the brain by using size Thermo luminescence Dosimetry dosimeters. In spite of the fact that Thermo luminescence Dosimetry dosimeters are equivalent to the body tissue, they measure the dose of the same tissue in the radiation of patients at any point inside the tissue. The crystals are placed on the patient's body or placed in the halves inside the human model phantom[12,13].

Also in this research, for the first time, the Phantom was transported to the hospital from the Atomic Energy Organization, and the received dose from the eye and thyroid was measured in a CT scan of the brain. In addition, in all CT scans of this study, the same conditions of the CT scan were the same in terms of current and voltage (voltage 120 kV and current 60 mA).

Method

In Shahid Modarres Hospital, three patients who had referred for CT scan of the brain were satisfied to co-operate with this research. For each patient, three Desimeter of Thermo luminescence Dosimetry were placed in three places of the left eye, right eye and thyroid, then CT scan of the brain was performed. This experiment was also repeated three times for the phantom. The phantom received from the Atomic Energy Organization is shown in picture 1. As can be seen in the picture, the Random Phantom has cross-sections that are fastened with a screw at the end of the head, allowing the researcher to place the dosimeters inside the body.

Figure 1. Phantom with cross-sections and Thermo luminescence

Dosimetry dosimeter mounted on the eye.

According to the research, the amount of received dose recorded for the three patients and the phantom were the same as the measured dose in the Thermo luminescence Dosimetry dosimeter.

The Thermo luminescence Dosimetry dosimeters used in this research were prepared by Parto Payesh Company, the characteristics of which are given in Table 1. The small size of TLD dosimeters and the tissue equivalent of their effective atomic number allow them to be used in patient dosimetry without compromising the quality of medical imaging.

Table 1. Features of TLD_GR200 dosimeter used in this research

Combination	LiF:Mg,Cu,P
Dose range	10^{-7} – 12 Gy
Energy	30 KeV – 3 MeV

In order to remove low temperature peaks, preheating was performed at 100 ° C for 10 minutes in the furnace.

Then the absorbed dose was read by the reader device at a maximum temperature of 240 C with a heating rate of 10 s / c. This reader is connected to a computer with special software installed on it.

This software receives the dosimeter data from the reader and after retrieval, storage processing, displays the output information in the form of a glow curve. As a quantitative measure of TL, the area below the luminosity curve in terms of nanoclons was used.

Since the reader device displays the absorption dose results in nanoclones, the results (Nano-Cologne) are converted to millisievert using the following diagram. After CT scan of patients and phantom, the tablets were removed from the phantom and transferred to the Parto Payesh Company.

This diagram, which is called the calibration diagram, was obtained by using the radiation of dosimeters in the gamma radiation field of Cheshmeh Cesium-137 in

the laboratory of the Atomic Energy Organization of Karaj.
The calibration diagram is drawn based on the radiation of dosimeters in the cesium-137 field, in doses of 1, 3, 5, 10 and 20 mSv. The following picture shows the calibration diagram.

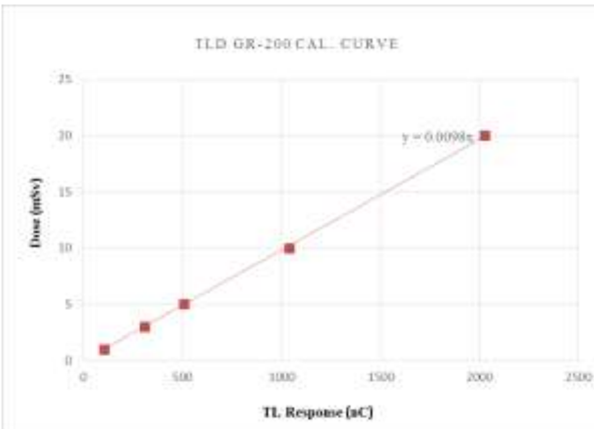

Figure 2. Desimeter calibration diagram

Results

This study was performed in the winter of 1997 in Shahid Modarres Hospital, which has a CT scan of the Brilliance Philips 64 slice model, and due to the large number of patients, three patients in different age groups - in the age group of 10 years, 32 years and 50 years - were selected for this study.
Thermo luminescence Dosimetry dosimeters, manufactured by Parto Payesh Company, were transported to the hospital and installed directly on the patient's eye and thyroid, without any protection. After imaging, the dosimeters were transferred to the company in a dark compartment by CT scan, and the results were converted to mSv after reading on the reader device.
Table 2 shows the amount of received dose of eye and thyroid in patients and the amount of absorption dose in the phantom during CT scan of the brain. For each measurement, a variance was obtained. It is considerable that in young patients the absorption dose is lower than in adults and phantoms, which is normal because anatomy (size) has a high impact on the results.

Table 3 also shows the average of absorbed dose of 2 adult patients and the average of absorbed dose of 3 phantoms. As expected, the results in the patient are very close to the results of dose measurements in the phantom.
Another significant point in Table 3 is the maximum permissible dose per year for individuals in the community, published by ICRP in Journal No. 60[14].

Table 2. Received dose from eye and thyroid in patients and phantom

patients and phantom	Thyroid(MSv)	left eye (MSv)	Right eye(MSv)
Patient (10 years old)	25.31	81.14	10.15
Patient (32 years old)	70.0±79.46	63.0±50.28	72.1 ±79.25
Patient (50 years old)	70.0±37.45	63.0±76.29	72.1 ±24.29
The first phantom	45.6±72.29	05.2±55.27	11.2±43.28
The second phantom	45.6±33.37	05.2±70.26	11.2±13.24
The third phantom	45.6±42.38	05.2±89.22	11.2±51.26

Table 3. Average received dose from eyes and thyroid in patients and phantom

Average dose	Thyroid(MSv)	left eye(MSv)	Right eye(MSv)
Patient	08.46	13.29	51.27
phantom	22.35	71.25	35.26
Maximum allowable dose	30	15	15

As the table shows, despite all the necessary standards in brain CT scan, the amount of absorbed dose to the eye and thyroid is higher than the limit recommended by ICRP.

Discussion and Conclusion

According to the researches, it is expected that by choosing a lower current intensity and a higher potential difference in brain CT scan, the radiation of the organs will be significantly reduced[15].

Because of the shortage of radiologist in many countries, it is often not possible for radiologist to evaluate CT scans in real time at the ED[16]. In such cases, emergency physicians have to interpret the images and manage the patients accordingly before the radiologists' report becomes available. While several studies have compared the predictive accuracy of the interpretation by emergency physicians with that by the radiologist there was no study about the predictive accuracy of the interpretation of early brain CT by emergency physicians in PCAS patients who underwent TTM[17].

For instance, researchers in the Department of Medical Physics of Shahrekord University, investigated that by reducing the current intensity from 150 to 125 mAh on CT scans, the rate of thyroid radiation increased from 101 to 82 mmHg. With increasing the maximum potential difference from 60 to 70 kV, the rate of thyroid irradiation decreased from 72 to 67 mmol[18].

However, in this research, for CT scan of the brain, the voltage in all cases is 120 kV and the current is 60 mA. The average dose received by patients' left eye is 29.13 mSv and the average dose received by a patient's right eye is 27.51 mSv and the average received dose from the thyroid gland is 46.08 mSv.

About Phantom: The average received dose from the left eye of the Phantom is 25.71 mSv, the average received dose from the right eye of the Phantom is 26.35 mSv, the average received dose from the thyroid phantom is 35.22 mSv and the absorbed dose inside the thyroid is 38.42. These absorbed doses are very important both for the surface and for the inside of the organ, and all radiologists in the CT scan section are advised to use thyroid protection and eye protection for patients during CT scan of the brain.

The results in patients and phantoms are close to each other, so the phantom can be used instead of the patient in dosimetry. Another advantage of using a phantom is that it is possible to place dosimeters inside the body.

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Conflict of interests

None.

Authors' contributions

The authors are the same

Reference

[1] Gabusi M, Riccardi L, Aliberti C, Vio S, Paiusco M. Radiation dose in chest CT: assessment of size-specific dose estimates

based on water-equivalent correction. Physica Medica. 2016 Feb 1;32(2):393-7.

[2] Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. New England Journal of Medicine. 2007 Nov 29;357(22):2277-84.

[3] Valentin J. The 2007 recommendations of the international commission on radiological protection. Elsevier; 2008.

[4] Mazonakis M, Tzedakis A, Damilakis J, Gourtsoyiannis N. Thyroid dose from common head and neck CT examinations in children: is there an excess risk for thyroid cancer induction?. European radiology. 2007 May;17(5):1352-7.

[5] Parry RA, Glaze SA, Archer BR. The AAPM/RSNA physics tutorial for residents: typical patient radiation doses in diagnostic radiology. Radiographics. 1999 Sep;19(5):1289-302.

[6] 1. Hall E. Radiobiology for the radiologist. 8th ed. LWW; 2018.

[7] Lavoie L, Ghita M, Brateman L, Arreola M. Characterization of a commercially-available, optically-stimulated luminescent dosimetry system for use in computed tomography. Health physics. 2011 Sep 1;101(3):299-310.

[8] Buls N, Pagés J, de Mey J, Osteaux M. Evaluation of patient and staff doses during various CT fluoroscopy guided interventions. Health physics. 2003 Aug 1;85(2):165-73.

[9] Rogalla P, Stöver B, Scheer I, Juran R, Gaedicke G, Hamm B. Low-dose spiral CT: applicability to paediatric chest imaging. Pediatric radiology. 1999 Jul;29(8):565-9.

[10] Tavakoli MN. Absorption dose of thyroid and ocular lens in head and neck imaging by CT scan. Mashhad Medical University. 2002; 45 (75):18-9.

[11] Darby SC, Wall BF. The genetically significant dose from diagnostic radiology in Great Britain. Radiological Protection Bulletin. 1981:3-7.

[12] McKeever SW. Thermoluminescence of solids. Cambridge University Press; 1988 Oct 27.

[13] McKeever SW, Moscovitch M, Townsend PD. Thermoluminescence dosimetry materials: properties and uses.

[14] Cember H. Introduction to health physics. Introduction to health physics. 1969.

[15] Moudi E, Hadian H, Monfared A, Haghanifar S, Deilam G, Bahemmat N. Assessment of radiation exposure of eyes, parotid and thyroid gland during panoramic radiography. World Journal of Medicine and Medical Science Research. 2013;1(3):044-50.

[16] Hunter TB, Krupinski EA, Hunt KR, Erly WK. Emergency department coverage by academic departments of radiology. Academic radiology. 2000 Mar 1;7(3):165-70.

[17] Kartal ZA, Kozacı N, Çekiç B, Beydilli İ, Akçimen M, Güven DS, Toslak İE. CT interpretations in multiply injured patients: comparison of emergency physicians and on-call radiologists. The American journal of emergency medicine. 2016 Dec 1;34(12):2331-5.

[18] Saeeb M, Fatehi D. Evaluation of thyroid radiation in brain CT scan and routine cranial radiography using different values of current intensity and potential difference without thyroid shield. Journal of Shahrekord University of Medical Sciences. 2011; 3 (2).

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