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Verifiction of Organs Absorbed Doses for Patients Examinedby Computed Tomography Using TLD-700

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Abstract: *CT offers an effective diagnosis on lesion and pathology; however, it also delivers a radiation dose to patients.TLD chips was used to measured personal dose in the field of radiation protection. The aim of this study was to evaluatpatient doses from Computed Tomography Diagnosis using TLD-700chips and Compareingit with those measured by using CT ion chamber (nC_{100}/sec) for CT machine (I). TLD-700 samples were exposed to different doses from verses organs (brain, shoulder, chest, abdomen and pelvis) to the CT machine (II). Compare between the output results from CT machine (II) and TLD-700 dose measured.*
We deduced the conversion factor between theTLD-700(nC) samples and measurement doses of CT ion chamber (nC_{100}/sec) and it was found to be 2.17 for the CTmachine (I).
We deduced the relation between the TLD-700(nC_{100}) samples reading versus to output doses from CT machine (II) (nC_{100}/mGy cm^{-1}) for different organs as brain, chest, pelvis, abdomen and shoulders form and found conversion factor to be 2 for the CT machine (II).
Keyword: *CT machine, TLD-700, CT ion chamber.*

I. Introduction

Computed Tomography (CT) becomes more and more important and is frequently used in modern diagnostic techniques. [1] The CT basic principle is based on the possibility to produce images of a two- or three-dimensional object by means of multiple projections of this object. The image is formed by a set of projections of a region of the body. The projections are acquired through several irradiation on the region, at different angles, by a collimated beam, the transmitted radiation being measured by a detector. The detector measurements are processed by a computer that reconstructs the image.

The ionization chamber utilized for CT dosimetry is a non-sealed cylindrical chamber with sensitive length between 10 and 30cm, called pencil ionization chamber. One typical characteristic of this chamber is its uniform response to incident radiations in every angle around its axis. Usually the reading by this type of chamber is expressed in dose or exposure units x length (mGy.cm or R.cm), so as to provide the computed tomography dose index (CTDI), that is the principal dosimetric quantity used in CT [2].

Thermoluminescent dosimeters (TLDs) are commonly employed in the ionizing radiation field to verify absorbed dose calculations at any given location of interest, either in a phantom or directly on a subject (e.g., a patient). Their frequent use is due in part to the TLD's low effective atomic number which is only slightly greater than that of soft tissue. In general, thermoluminescence (TL) phosphors provide optimal performance as dosimeters if they receive uniform, reproducible, and optimal heat treatment before and after use. Extensive literature exists on TL dosimetry and a concise review on TLD behavior and properties provide the basis for the use of TLDs in these studies[3] . Anthropomorphic rando phantom also used to measure organ doses for five main CT examinations.

The aim of this is work, was to evaluate efficiency of TLD samples (TLD-700) to be used to calibrate the output doses form CT machine and measure organ doses usin TLDs and comparing it with those resulted from CT machine.

II. Materials and Methods

CT Ion chamber

CT ion chamber with 10 cm sensitive length model T30017 was used for dose length product (DLP) measurements free in air is connected with PTW electrometer[4].

Thermoluminescentdosimeters (TLD-700)

Lithium fluoride (LiF) TLD-700 supplied by Harshaw ,were employed. A group of TLD-700 chips with sensitive volumes of 0.3×0.3×0.09 cm. Approximately 5% TLD-700 fading in a 12 week period has been reported. TLD-700 chips have demonstrated ±15% sample-to-sample uniformity and within 2% repeatability.

Each TLD-700 chip was assigned an identification number and was individually calibrated, relative to the average response of the entire TLD batch. The relative dosimeter response, termed chip factor, was measured by irradiating the chips individually using a broad beam of Cs-137 gamma rays. The irradiator beam flatness

across the chip was verified different times by simultaneous irradiation of an ion chamber model NE2530, S.N 424, (PTW UINDOSE 10001-10522 Instruments). Experimental acquired doses were in agreement with the expected measurement uncertainty according to annual calibration data and instrument documentation from the irradiator manufacturer. A 2.5% error was achieved when comparing both expected and experimental findings.
A Harshaw model 3500were used to read TLD output (nC). The TLD crystals were annealed prior to every irradiation at the same conditions. The TLD crystals were protected from exposure to light until they were used After annealing and consecutive individual irradiations of the same TLDs groups at both doses, the TLD output was analyzed and only crystals responding within 8% sample-to-sample uniformity and 7% response variability were selected, resulting in a total of 30 TLDs for the study [5] . Response variability was analyzed post irradiation by comparing individual dosimeter output to the group mean of the selected TLD batch.

CT machines

TwoComputed Tomography CTmachines(I &II) of type GE HANGWEI MEDICAL SYSTEM.CT machine (I) was calibrated using CT ion chamber with 10 cm sensitive length connected to PTW dosimtere. TLD-700 samples were put in rod for exposure to the same dose of the machine(I).TLD-700 samples were exposed to different doses from verses organs (brain, shoulder, chest, abdomen and pelvis) to the CT machine (II).

Rando phantom

In order to evaluate radiation organ doses resulting from different CT examinations, direct measurements using TLDs and Rando phantom were done and compared with output dose from the machine. Rando phantom was used because it is much closer to real patient in comparison to mathematical phantom used by CT machine and therefore doses measured using rando phantom will be much closer to reality rather than those calculated. Table-1 shows the physical scanning parameters used for each exam in the study.

Table-1 shows the physical scanning parametersfor each organs

Examination	Scanning mode	KV	mAs/slice	Slice thick. (mm)	No of slices
Brain	Axial	140	150	0.3	40
Shoulder	Helical 0.75 : 1	140	120	0.3	51
Chest	Helical 1.5 : 1	120	100	0.3	29
Abdomen	Helical 1.5 : 1	120	100	0.3	45
Pelvice	Helical 1.5 : 1	120	100	0.3	29

III. Results

linearity and uncertainties of the TLD -700

Individual TLD-700 output linearity and measurement reproducibility were investigated. The annealed batch of dosimeters was irradiated in the Cs-137 irradiator source, which produced a dose rate of 12.92mGy⁄min. Figure (1) shows exposure doses versus TLD output (nC), gives a value of dose 3.8 ⁄nC and a correlation coefficient (r2) value of 0.9906.

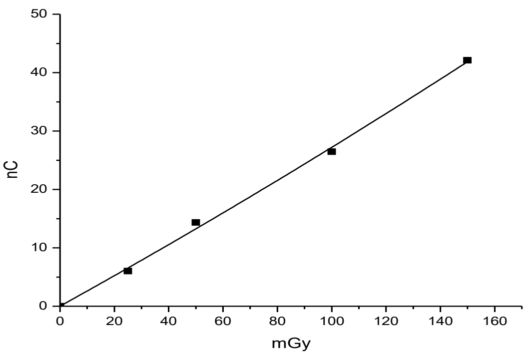

Figure 1: Calibration curve of TLD-700 samples were exposed to different doses with dose rate 12.92mGy⁄min.from Cs-137 source

Charatizationof CT Machines

The Characterization of CT machines (I &II) were studied to assure the efficiency of CT machine, the output dose delivered by CT machine was studied with tube current (mA) and represented in figure 2(a& b) for different tube potential voltage (kV). From this figure, one can notice that output dose is linear with the tube current at 80, 120 and 140 kV that reflect the efficiency of CT machine used in this study.

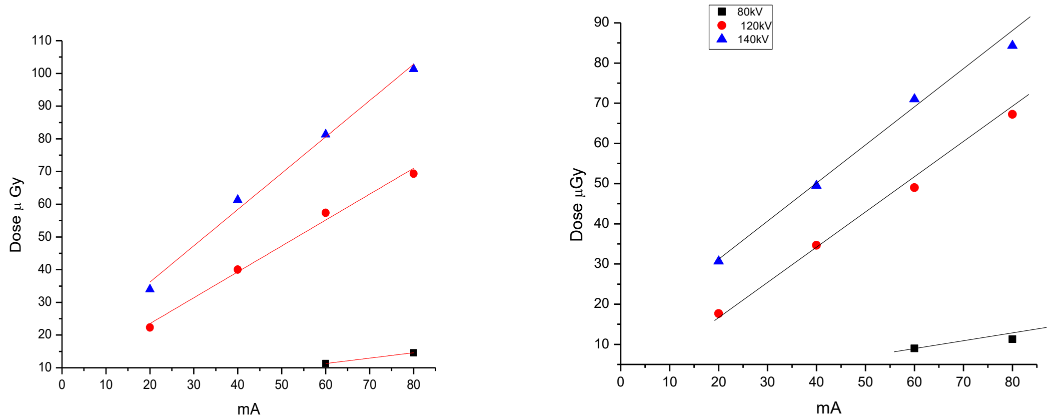

Figure 2 (a,b): Representthe output dose (µGy) verses mA at the tube current at 80, 120 and 140 kV for CT machines(I &II).

TLD-700 response for CT doses

Reading of TLD-700 samples (nC) andoutput doses of CT machaine (I) nC100/sec were represented in figure (3).This figureshowsa linear relation between TLD-700(nC)wesrs dose result from ion chamber(nC100),this reflect that can use TLD-700 samples in unit nC100/sec i.eas the ion chamber dose unit.

The conversion factor from theTLD-700(nC) measurement to doses measuredby ion chamber (nC100/sec) was found to be 2.17 for the CTmachine (I).

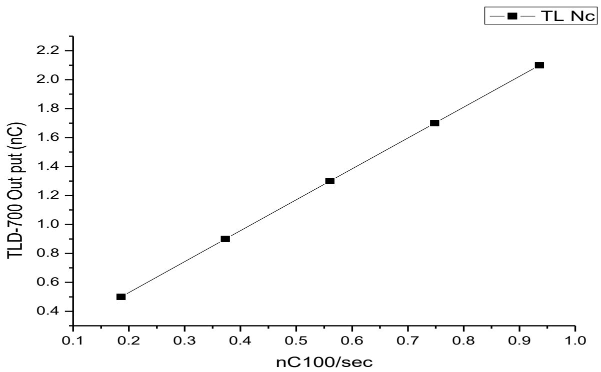

Figure3: Relation between TLD-700out putreading against CT Ion chamber doses for CT machine(I)

Measurement Doses of CT (II) by TLD-700

Figure (4) shows reading of TLD-700 samples (nC100) and output doses of CT machaine (II) (mGy/cm) . From a liear relation of this figure ,conversion factor was found tobe equal to 2 for the CT machine (II).

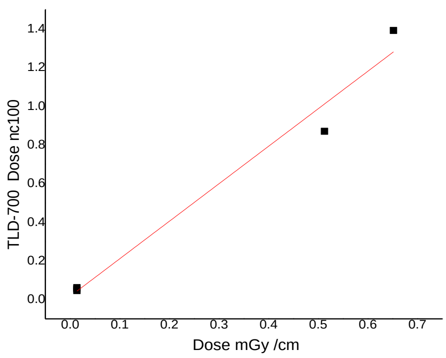

Figure 4: Realation between CT dose obtained by TLD-700 Samples and output doses from the machine (II)

Evaluation of Patient doses for different cases from CT machine (II)

In order to evaluate radiation organ doses resulting from different CT examinations, two different methods were followed, first, The patient doselength product (CTDIvol* length of scan in mGy*cm) [6] was measured by TLD-700 and CT dose obtained from the machiane (II). Figure(5) shows output doses from CT machine (II)(nC100/mGy cm^{-1}) for different organs as brain, chest, pelvis, abdomen and shoulders corresponding to the TLD-700 doses reading after correcting to the conversion factor. Because of modeling differences between mathematical phantom used by CT machine for different examinations, and Rando phantom used to measure radiation doses, and also the effect of spiral scanning which is applied mostly in scanning, the organ doses obtained by the two methods were expected to show considerable differences for most of the organs.

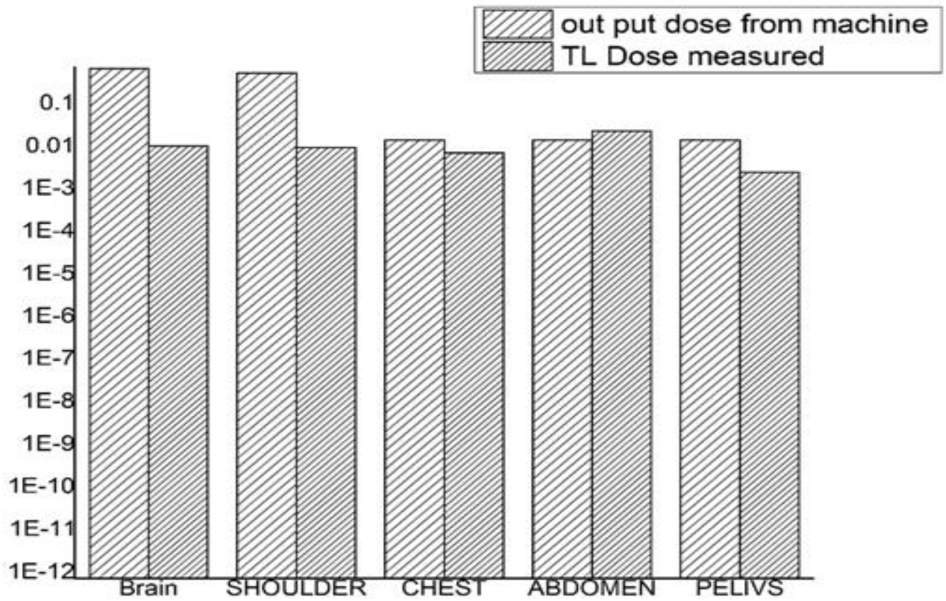

Figure 5 : This instogram shows the difference between reading of TLD-700 samplesand output dose of CT machine (II) for different organs.

This variation between dose obtained by TLD-700 and that obtained by CT machine may be attributed to many reasons which was back on the CT machine. For brain, shoulder and pelivsthere was a significant decrease in TL measured doses which could be due to shelding effect of bony structure in the investigated organ, also, the tilt angle which applied in most of head examinations and not accounted by CT calculation algorithm. TL doses from chest were slightly decreased from CT doses could be due to the effect of ribs and presence of air cavities in lung. For abdomen there was a slightly increase in measured TL doses which could be due to large volume of air cavity especially in colon.

IV. Conclusion

From this work, we concluded that TLD is an applicable technique not only for patient dosimetry but also for the calibration of CTmachine. Linear relation obtained for the tube current reflect the efficiency of the CT used.The selection of methods to evaluate radiation doses are of important role in investigating exposures in diagnostic radiology. In this study we believe that the rando phantom is much closer to real patient and TLD which is tissue equvilant material.The organ doses obtained by the two methods were expected to show considerable differences for most of the organs, showing the importance to calculate the patient dose for whom diagnostic by CT. However to save time and effort, it is preferable to follow calculation techniques after further corrections and enhancement in methods of simulation and calculations.

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