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TISSUE EQUIVALENT PERSONAL X-RAY DOSIMETER

Assel B. Shindy[*], Ali H. M. Al-Hashimi[@] &Ghania S. AlThaher[#]

[*]M.B.Ch.B., M.Sc., Radiodiagnosis, Lecturer, Department of Surgery, College of Medicine, University of Basrah. [@] Prof. of Medical Biophysics, Head of the Department of Physiology, College of Medicine, University of Basrah. [#] Assistant Lecturer, Medical Physics, College of Medicine, University of Basrah, IRAQ.

Summary

Absorbed dose from X-ray field of scattered stray radiation was monitored at presumably safety position. Lyoluminescence enhanced sensitivity in organic solid techniques were used to estimate the environmental and personal dosimeter based on tissue equivalent of glutamin amino acid. The cumulated percentage dose received by the person for one month period at safety position were about more than the dose received by the patient in one single exposure (at least 11.6% and 39.5% of chest and hand dose respectively).

Introduction

In recent years there has been an increase in the development and uses of equipment that produces radiation energy in all fields, especially in a medical application. Since the doses received by the sensitive cell may be difficult to estimate directly[1]. It is, therefore, of interest to develop a sensitive, non-destructive and new method of monitoring, x-ray radiation based on tissue equivalent material for worker exposed to ionizing radiation in the vicinity of work sacchadies and amino acids has been used as a very close tissue equivalent to soft tissue materials of human composition[2]. Since Protein, nucleic acid and amino acid are believed to be the most important sites of x-ray radiation action in living cells, therefore molecules of glutamin amino acid were chosen to study the radiation dose that has been absorbed. The measurement of the radiation dose is based on the amount of energy transferred from the radiation field into the medium. Tissue equivalent material is denote as a substance which, when exposed to the same radiation field as the tissue, absorbs the same dose of radiation energy.

Lyoluminescence (LL) is the phenomenon of light emission on dissolution of solids and inorganic biochemical substances which previously been exposed to ionizing radiation such as x-ray radiation[2]. Thus LL provides a means for detecting and investigating

Correspondence to:
Dr. Assal B. Shindi
Department of Surgery, College of Medicine, University of Basrh, Basrah; IRAQ.

radiation damage. The amount of light yield is in general proportional to the radiation doses[3], so that measurement of light yield from irradiated solids may form the basis of a personal dosimeter. The absorbed dose in that chosen dosimetric material is proportional to the absorbed dose in tissue.

The aim of this preliminary study is to use the tissue equivalent amino acid (glutamine) to estimate the scattered absorbed dose from x-ray field (stray radiation) in the position were the person of x-ray operator stand for the period of about one month.

Apparatus and Method

Figure (1) shows the experimental arrangement that has been used to measure the LL light emitted (this system is designed and built in the Department of Physiology). A known mass of powder material, usually about 5mg, was placed in the vessel and 10 ml of the solvent was injected throughout light tight hole at a room temperature. Amplification of the photimultiplier tube (PM) output was connected to voltage-to-frequency converter and scalar so that the total amount of light emitted was electronically integrated. The LL yield was always expressed as the number of counts per mg weight of sample dissolved (or as LL peaked height per mg weight of sample dissolved).

Solvent and Materials

The solvent for LL were prepared as follows:

Quantities of 2mg of Lucigenin, 0.33 gm of Tribium Nitrate Tb $(NO_3)_2$ were dissolved in 250 ml of distilled water and adjusted to pH of 11 using 0.1 N NaOH solution. The mixture then kept in the refrigerator prior to use. All bio-chemical materials were obtained from B.D.H. chemical Ltd. pool, England and used without further purification or treatment.

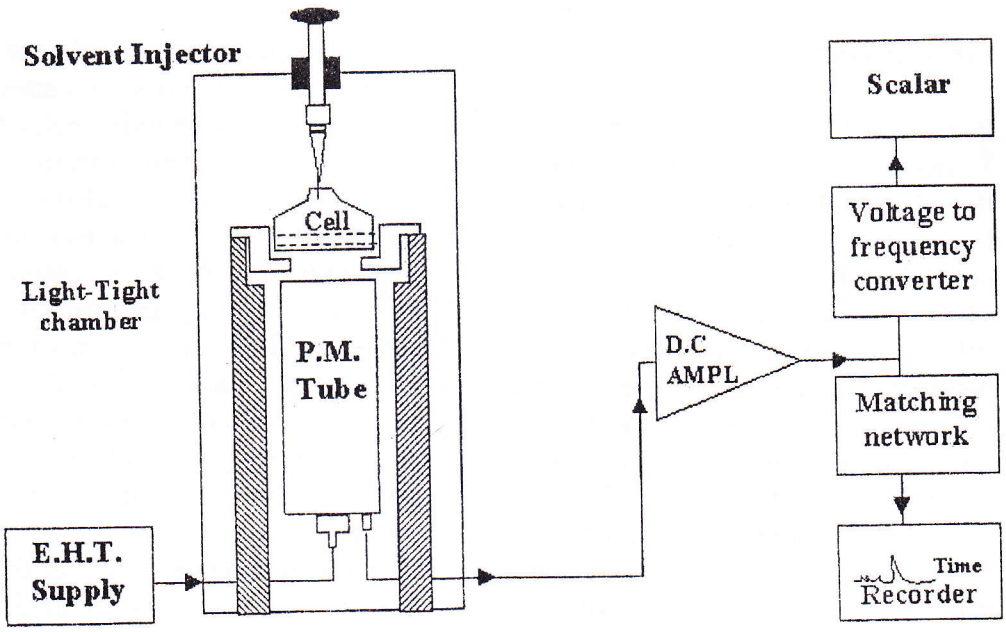

Figure 1. The lyoluminescence reader

Irradiation Procedure

A small, constant mass glutamine powder was stuffed into a clean, dry polythen bag. The bag was then placed under the x-ray source in fixed predetermined position. Also samples were placed in position where the X ray operator stand for different time interval. After the irradiation, the samples were transferred to a small clean, dry and stoppered polythene bottles.

Result and Discussion

The LL in organic solid can be considered as a special case of chemi-luminescence. The techniques established in Physiology Department - College of Medicine at Basrah University, since 1994 and used as a sensitive tool to estimate the environmental and personal dosimeter based on the tissue equivalent[2], which could not be easily achieved by other techniques[1]. The sensitivity of LL phosphor was increased by using enhancer with the solvent. In this study a cocktails of enhancers were prepared as a best suitable solvent (see solvent and materials).

The LL signal peak high for sample previously exposed to X-ray field were (25 +1.34) cm and (20 + 1.37) cm for chest X-ray, 85kv and X-ray for hand, 65kv respectively. The LL peak height for sample placed at position of the control window were (2.3+0.11) cm. The relative percentage of personal accumulated dose for one-month work to the direct chest dose is about (9.3%) and relative percentage of personal accumulated dose to the direct hand dose is about (11.624%), for the same period of one-month of work. This mean for one year of work, the accumulated dose received by the person at that position will be 11.6% of a single chest dose and 39.5% of a single hand dose. This means that in one year the X-ray operator will received a dose of more than the patient received in one single exposure at least 11.6% and 39.5% of chest and hand dose respectively.

The accumulated biological effectiveness depends on many factors such as age, time and duration of the exposure, target received the dose and the target sensitivity[4]. However, certain body tissues, e.g. the gonad, are more sensitive to radiation than others. Weighting factors relative to whole body as 1.0 have therefore been assigned to the various individual organs reflecting the relative radio-sensitivity of each organs (Table 1).

Table 1. The weighting sensitivity factors recommended by the international comity of radiation protection (ICRP)[5,6]

Tissues	*Weighting factors*
Gonads	0.25
Breast	0.15
Red bone	0.12
Lung	0.12
Thyroid	0.03
Bone	0.03
Remained	0.30
Total	1.00

The effective dose equivalent is the sum of the products of dose equivalent and sensitivity weighting factor for each organ exposed.

The short-term effects arise soon after the exposure to radiation and may subside quite quickly. The long-term effects become apparent years after the exposure to radiation. The risk of effects occurring is increased as exposure to radiation increases, but the effect is not inevitable[4,7].

The dose equivalent limit (DEL) is known as maximum permissible dose (MPD)[4]. A DEL is not absolute level of safety, below which we are safe and above which we are unsafe. The DEL is a very low dose, below the threshold for non-stochastic effects (effects which are not subjected to the laws of chance) and carrying an acceptably low risk of

stochastic effects (effects obey the law of chance and probability). Special categories of people such as radiographers, who work with radiation for the long periods, are set a higher DEL than that for the general population. It is reassuring to know that in practice the doses received by radiographers are considerably below the DEL, reflecting the attention, which is devoted to this aspect of radiation protection.

The code of practice stipulates that classified staff must have the doses they receive at work continuously monitored. To achieve this a small pocket dosimeter is required besides the protective measure, which must be applied.

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References

1. Faber M. Ultraviolet radiation dosimetry and safety standards. WHO (1989) 10.29-31.
2. Ali H.M. Al-Hashimi. A study in lyoluminescence dosimetry of incorporated Beta emitter in tissue equivalent saccharides and amino acids. Bas J. Science 1998; 16A(1): 67-78.
3. Barrison, W.M. The radiation chemistry of peptides and proteins in the relation to radiation sterilisation of high protein foods. (1981) Lawrence Berkeley Laboratory, University of California, Report LBL - 8928.Rev.
4. Ball JL and Moore AD. (1986). Essential physics for radiographers. 2nd ed. Black well scientific publication.
5. ICRP report (1962 d). Clinical dosimetry. NB. Ghard book 87, (U.S. Govt printing office, Washington. D.C.).
6. ICRP report 24 (1979). Determination of absorbed dose in patient irradiated by beam of X or γ rays in radiotherapy procedures. (U.S. Govt printing office, Washington D.C.)
7. Efficacy and radiation safety in interventional radiology (2000) World Health Organization(Geneva).[Hand book].