THERMOLUMINESCENTE DOSIMETRY IN DIAGNOSTIC X-RAYS

BY

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ABSTRACT

Harshaw's TLD-100 micro rods were used for radiation dosimetry during X-ray diagnosis at the Hospital A. C. Camargo, São Paulo. In each case two couples of dosimeters contained in plastic tubes were placed at central beam point on the skin of the patient, one at the entrance and the other one at the exit. Measurements include the following kinds of X-ray examination: cheast, knee, lombar spinal cord and dorsal spinal cord. About 40 patients for each kind of examination were considered, and two different X-ray machines , Giganthos and Neo-Heliopjos, were used. In most of cases high exposures are envolved.

INTRODUCTION

Although radiation exposure of diagnostic X-rays does not amount to a large value, the frequency with which in the modern world a man is subjected to diagnost X-rays could cause biological effects leading to, for example, genetic mutations.

The measurement and the control of patient exposure to X-rays during diagnostic radiology have never been carried out IN Brazil. This statement is true for both routine work and research work.

The estimate natural background for public in general is about 100 mr/year in the gonad; X-rays exposure per person in diagnosis is estimated to be 136 mr/year in the United States and 14 mr/year in England. No such data as these are available in Brazil and this is the reason why we proposed to carry out similar measuremants.

The first measurements were carried out at Hospital A. C. Camargo of São Paulo Association for the Fight against Cancer, although they will be extend to other institutions and clinical establishments.

EXPERIMENTAL PROCEDURES

Harshaw TLD-100 micro rods were used for measurement of X-rays exposure during patient diagnosis. These dosimeters were chosen because they presente several conveniences, such as, small size, high stability, easy handling, high sensitivity and linear response in the exposure region of interest to the diagnostic radiology. TLD-100 is energy dependence particulary for X-rays ranging between 10 Hvp and 200 Hvp. This dependence is, however, not strong, since compared to the response for Co-60 gamma-rays the maximum deviation is of the order of 30% for a given exposure. Furthermore, once the effective energy is determined either by using two different kinds kinds of TL phosphors (the ratio of their responses gives us the effective energy) the correction can be introduced without difficult.

The TL dosimeters were read out in the Harshaw model 2000 Thermoluminescent Analyser belonging to the Solid State Division of Instituto de Energia Atômica of São Paulo. The readings were done in nitrogen atmosfere to avoid triboluminescence effects.

Before beeing used for exposure measurement, TLD-100 materials were given the standard treatment, namely, 400º C for one hour, quick reproducible cooling and then 80º C for 24 hours.

Exposure measurements were performed during actual X-rays diagnosis of chest, knee, lombar spinal cord and dorsal spinal cord using Giganthos X-ray machine provided with a filter equivalent to 1.0 mm Al. Another machine used was Neo-Heliophos with a filter equivalent to 2.0 mm Al.

The dosimeters were placed in the polystyrene tubes, two in each tube, and held on patient skin ordinary bandage. For each radiography one tube with the two dosimeters was placed at the center of incident beam on the skin of the patient and other one at th the central emerging point, again on the surface of the paciant.

RESULTS

Fig. I show the exposure in mr/mas for a fixed distance from the machine, increases proportionally to the square of kvp, confirming previous measurements listed in the literature.

For the exposure measurements at the incident points, standard deviation was estimated to be 8% for Giganthos and 9% for the Neo-Heliophos machines.

Table I gives the average doses patients in each kind of diagnosis. The average values were obtained from about 40 cases for each kind of X-Ray radiography.

We should not that for each kind of radiography there are small i differences from patient to patient as far as distances do the machine are concerned, besides the differences in time and fluctuations on filament currents and kvp. No corrections for these factors were considered yet.

Another observed fact is that no TL reading was obtained for exit exposure in chest X-rays. This is so because actual exposure .at the X-rays incident point is just 80mr, giving rise to an exit exposure less than 10 mr.

The third column in Table I gives the ratio between average exit exposure average incident exposure on trough the surface of the patient. This shows that spinal cords region 99% of radiation is absorbed.

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TABLE 2

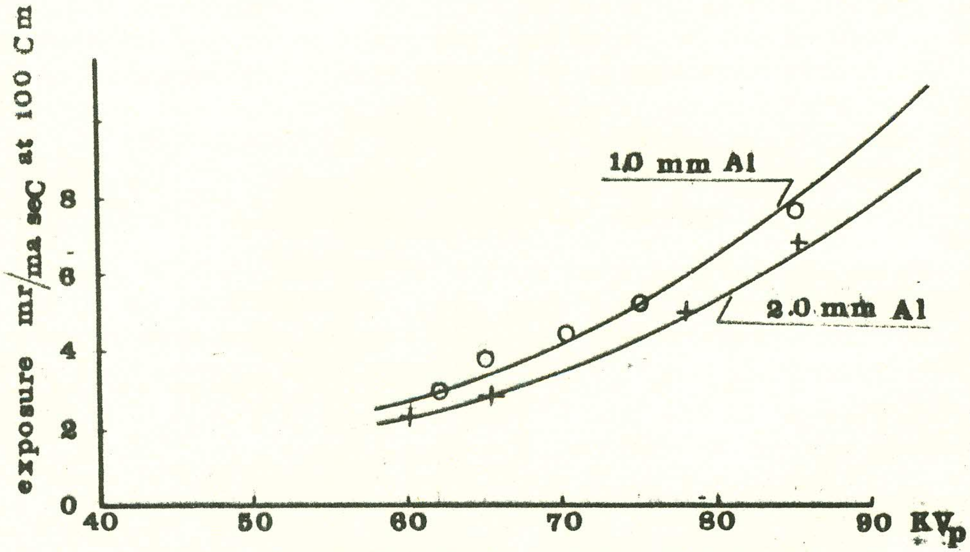
HARWELL (Ardran & Crooks)

Diagnosis	Focus-skin Dist. (cm)	KV_p	Masec	Filter (mm Al)	Skin dose p/ exposure (mr)
Knee	82	82	6	3.0	37
Lumbar spine	66	90	80	3.0	1000
Chest	161	90	3	3.0	6

I.C. – A. P. C. C.

Diagnosis	Focus-skin Dist. (cm)	KV_p	Masec	Filter (mm Al)	Skin dose p/ exposure (mr)
Knee	89	62	125	1.0	490
Lumbar spine	75	75	320	2.0	6500
Chest	176	77	25	1.0	80

FIG. I



CALIBRATION CURVES FOR X-RAY DIAGNOSTIC

TABLE I

AVERAGE DOSES IN X-RAY DIAGNOSES

Diagnosis	Incident Exposure (m r)	Exit exposure (m r)	RATIO Exit/Entrance
Chest P.A.	80±11	< 10	<1/8
Urography	800±60	30±2	~3/80
Knee	490±50	50±10	~1/10
Dorsal spinal Cord	5900±500	50±10	~1/110
Lombar spinal Cord	6500±100	65±10	~1/100