



The effect of time stability on radiation doses resulting from X-ray devices

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Abstract

In this research paper, surface admission doses for patients resulting from conventional radiography were measured in most known tests (chest, head, abdomen, extremities) for selected devices at the Specialist Surgery Hospital and a private clinic in Baghdad and devices from Different origins have a different manufacturing history, and a group of patients (5 patients) was taken for each examination and according to the resulting dose rate. Surface access dose (ESDpp) was measured using (RMI 240) and surface entry without patient (ESDpa) using two ionization chambers, one of which was German-made attached to a ghost of substance equivalent to living tissue, and the other device was a Swedish-made ionization chamber (Dosimax) (Unfors). It has been found that thermal flash readings (RMI 240) are more than the rate of ionization readings used, and the difference in dose comes as a result of the dispersion of radiation in the patient's body. The dispersion factor was calculated for all the tests, and it was found that the factor ranges between (1 - 1.2), which is very close to the calculated global values, which amounted to (1.09). The patients 'dose in this research was compared with the approved international values, and it was found that the radiation dose is greater than the reference dose with a range ranging from (1.1 - 1.5) in most devices, and that the range is close to one whenever the device is new, and the radiographer's experience is good, Because of the importance of quality assurance for X-ray devices (Quality Assurance), time stability was measured for only three of the devices.

The mathematical relationship between time and radiation dose is drawn from which the linear coefficient of time is calculated, as it does not exceed 10% for the two devices (A and B), while the linear coefficient is 45% for the apparatus (C).

Keywords

X-ray measuring device ,Radiation dose, x-ray, quality assurance

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1. Introduction

The X-ray photons either interact with the electrons leaving the atom, or with the entire atom, or the field of the nucleus. In the use of x-rays for diagnosis, the dominant interaction is between photons and electrons of the atom, and as a result of this interaction the photons are either completely absorbed and displaced from the X-ray beam, or the photons are scattered and deviated in random directions and therefore do not carry useful information in the diagnosis, as they are. It does not generate an image of tissue, but rather generates black shadows on the x-ray film called film fog. And when this delusion is dense, it leads to masking the image of the tissue and not being able to see it clearly [1][2].

The photographic film consists of a thin plate of a transparent material of cellulose or polyester known as the base of the film with a thickness of 0.2 mm. It covers one or both sides of an emulsion. It contains a sensitive substance that is a light gelatinous layer that contains crystals of silver halides, mostly silver bromide, AgBr. It is present in medical films (99 - 90%), and to increase the sensitivity of the emulsion, a small amount (10 - 1) of AgI silver iodide is added. The crystal consists of I, Br, Ag ions arranged in a triple grid (Silver Iodobromids (Crystal Lattice)). Because the silver ions move outside the lattice, defects are created in the crystal. And make it an incomplete crystal, when the film is exposed to a radiation beam, the electrons are released from the bromine ion, and a displacement is made inside the crystal until it reaches the center of sensitivity formed by traces of silver sulfide[3][4].

The electron traps attract and neutralize silver ions, and the neutral silver atoms that deposit into the film form a hidden delusion ((Latent image) in the photographic emulsion, and turn into a visual image through chemical processes, as the film is placed in an appearance solution ((development)) to reduce the silver ions exposed to radiation into atoms. The black silver is deposited on the film, then the film is washed to remove the base display materials, and placed in the fixative solution, as the solution interacts with the silver halides that are not exposed to radiation and transforms them into a melted solution, and after washing and drying the film is ready and the radiograph appears where the parts exposed to radiation appear dark while the parts are not irradiated, they appear transparent [5][6].

The aim of the test is to measure the accuracy of the exposure time, and this is done by using a dose or exposure meter placed 100 cm away from the X-ray target. Fixing both the tube voltage peak and the time rate of the current and exposing it to the X-rays for different exposure times, and taking the rate of Each reading plots a graph between exposure time on the x-axis and exposure (dose) on the y-axis[7][8].

2. Materials and Methods

1- Dosimax

This device consists of a portable semiconductor type (solid state) detector and is intended to detect relatively high-energy photons (X-rays). This detector is characterized by its small

size, because the density of the semiconducting material, and it has a very fast response time and has The ability to change the thickness of the semiconducting material, to suit the required measurement conditions. It is also surrounded by a filter similar to the tissues of the body, and in this photo diode detector, which has a great ability to sense X-rays, the detector is linked to a type (Dosimax) to give the dose rate, radiation dose, measurement time and voltage as shown in Figure 1

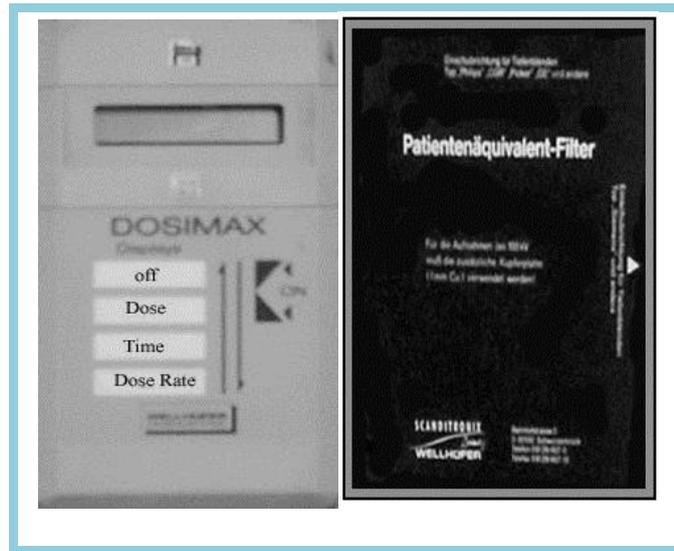


Figure (1) represents an image of a device.

2- Unfors Instrument

This Swedish-made device consists of a detector that has an ionization chamber connected to a coated wire connected to a digital counter. The principle of this device's work is to collect electrons on the anode as a result of the fall of X-ray photons on the cathode.

The device is designed for quality assurance tests as it measures the dose, time, dose rate and voltage directly.

The most important features of this meter are its small size, accuracy in measurement, and the figure (2) shows a picture of the Unfors mobile device.



Figure (2) represents the image of the Unfors device

3- RMI240

The device is designed on the basis of differential absorption of X-rays through filters. This device uses four consecutive and parallel chambers to determine radiographic properties, which include kVp voltages, exposure time, linear current mA as well as dose and dose rate [51].

The device is of high sensitivity and special for quality assurance tests for X-rays as in Figure (3), and the work of this device depends on the use of bioluminescence that converts the window X-rays from two strips of copper of different thicknesses to a voltage difference that is proportional to the peak of the tube voltage, and after calibrating the device It is placed under the target of the X-ray machine and exposed to it.



Fig (2) image of the RMI 240 X-ray machine

3. Results and discussion

Work was done on X-ray machines in the Specialized Surgeries Hospital in Medical City, and there are (3) devices. Table (1) shows the type of devices, the date of manufacture, and other information about X-ray devices.

Table 1 - specifications of the X-ray machines that were worked on

SID	mAs	Voltage kVp	Type of examination	The manufacturer and its history	hospital	NO
130	25	70	AP Chest	SIEMENS 1995	Yarmouk	A
130	35	85	LAT			
85	30	80	AP lembar	SIEMENS 2003	Alzafaranyi	B
85	35	85	spinal LAT			
80	25	90	AP abdomen	SIEMENS 1980	Alsaadr	C

Work was done on X-ray machines in the Specialized Surgeries Hospital in Medical City, and there are (3) devices. Table (1) shows the type of devices, the date of manufacture, and other information about X-ray devices.

There are many chest exams in this hospital, so ten patients were taken to examine the chest for each device and for each projection (projection) so that the error in measuring doses was the least possible, while the other tests took at least five patients for each examination and took the average of these readings, the tests included adults from Gender, Table (1) shows the type of devices, date of manufacture and other information .

X-ray devices, for the purpose of measuring radiation doses in practice, TLD-100 thermal tablets were used that are small in size and do not interfere with patient examinations because they are transparent and can be attached to the patient's body, as well as radiation dispersed from the patient's body.

For the purpose of the x-ray quality assurance test, devices of different origin and date of manufacture were chosen, which are three devices bearing the English letters (C, B, A).

To perform this test, we fix the current at a specified value by the control panel of the X-ray machine and the distance between the detector and the tube voltage is one meter and a time (0.1) seconds, and the radiation dose is measured for several values of the voltage, the device voltage is measured using portable and voltage devices installed on the control panel [9][10][11].

Table (2) show the radiation doses measured in the ionization rooms and the thermal flashing tablets, as well as the voltages of the mobile device and the voltage registered on the control panel.

Figure (4) show the relationship between the radiation and voltage dose by fixing the current at the values (100, 200) mA for the following devices (C, B, A).which show that the device

(E) It is more stable than the other two devices because it is newly manufactured and under company maintenance. The increase in voltages does not increase the radiation dose, but it leads to the interaction of incident radiation with the patient's body and consequently the increase in the dispersed rays. This is the reason that the relationships between radiation and voltage doses are non-linear[12][13][14].

Table (2) Time stability test for X-ray devices (C, B A)

X-ray device C kVp =70 ,mA=30 ,distance=100cm			
Time	mAs	Unfors mGy	mGy/mAs
0.1	3	0.735	0.245
0.2	6	2.496	0.416
0.3	9	4.383	0.487
0.4	12	6.216	0.518
0.5	15	8.895	0.593
Coefficient of Linearity = 0.41			
X-ray device B kVp =70 ,mA=30 ,distance=100cm			
0.1	3	1.35	0.45
0.2	6	2.76	0.46
0.3	9	4.14	0.46
0.4	12	5.52	0.46
0.5	15	6.9	0.46
Coefficient of Linearity = 0.01			
X-ray device A kVp =70 ,mA=30 ,distance=100cm			
0.1	3	1.065	0.355
0.2	6	2.202	0.367
0.3	9	3.357	0.373
0.4	12	4.644	0.387
0.5	15	5.88	0.392
Coefficient of Linearity = 0.049			

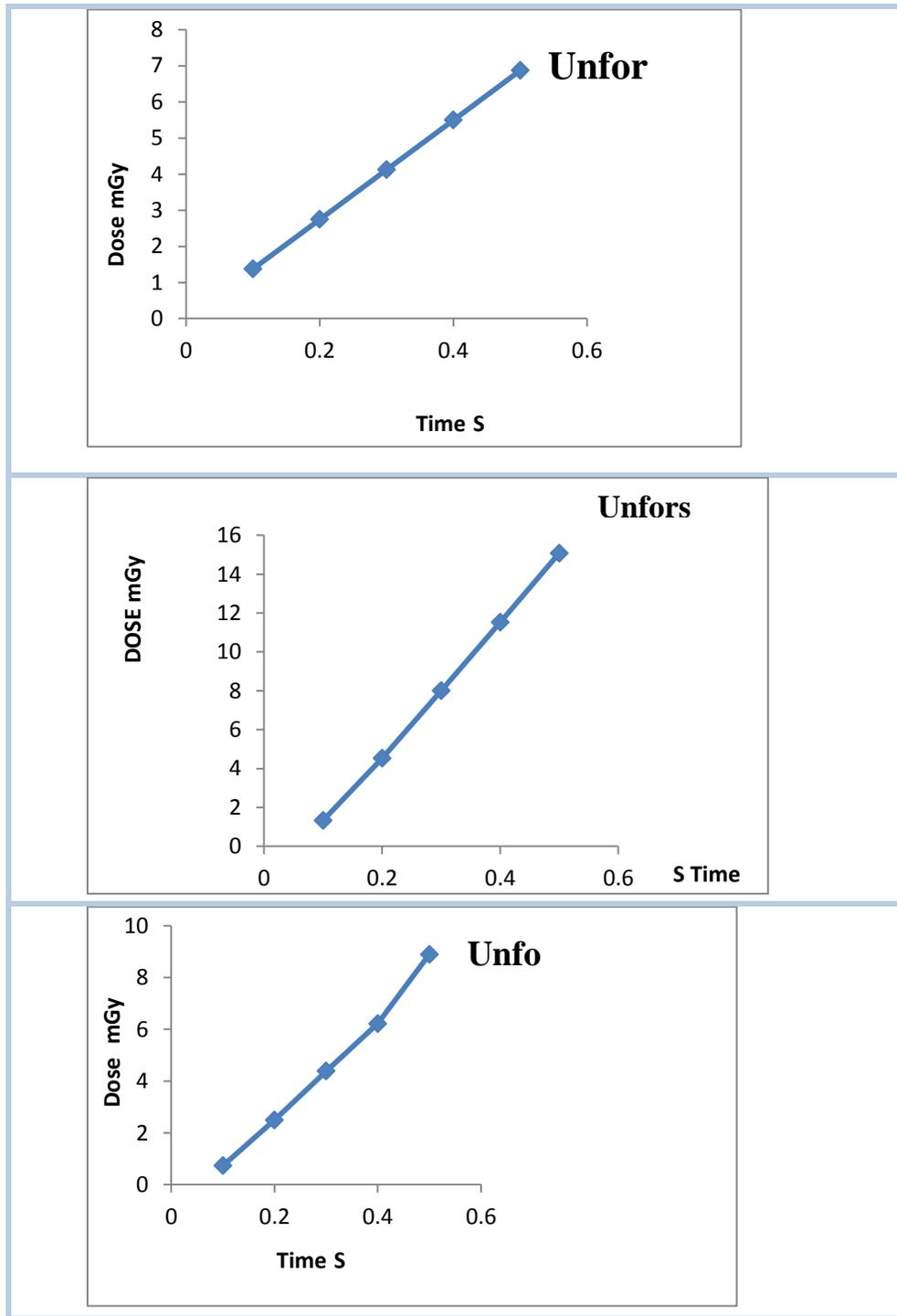


Fig (4) Time stability with radiation dose

Test of Time Linearity

To perform this test, we fix the voltage ($kVp = 70$) and the current ($mA = 30$), and place the detector 100 cm from the x-ray tube, then calculate the time rate of current (mAs) for several values of time, and then calculate the accuracy of the measurement which does not exceed 10%, and draw a relationship between time and radiation dose.

From Figure (4) we notice the time stability of the two x-ray devices (F, E), in contrast to the (C) ray machine, which is less stable than the other two devices, and the table represents (2) Radiation dose with constant voltage and current[15][16].

In this study, many new devices with different origins were used, as mentioned above, the radiation dose was measured for several patients and for several parts of the body, and it is clear from the two tables that the values of the surface entry dose for the Spanish-origin X-ray apparatus with the symbol (E) are close to the international values approved, and that Because the device is newly imported and is still under maintenance by the company that tests its work performance periodically.

As for the measured dose values for the X-ray machine with the symbol (C), it is about twice the recommended dose globally, because the device is a quarter of a century old and did not undergo quality assurance tests previously, and these measurements show that the device is not fit for measurement, so the hospital administration uses it less frequently. The state of great momentum for patients.

The surface entry dose values for the X-ray machine with the symbol (F) are close to the reference values even though it is 10 years old, and this is due to the fact that it is a private sector device that maintains it well, in addition to the radiographer who is a retired person with experience in this field .

The surface entry dose values measured by the German-born Dosimax mobile device are closer to the reference values, because the sensitive size of this meter is a material equivalent to living tissue, which is exposed to X-rays, so the reading value of the dose in the air is not the same as in the case of the ionization chamber (Unfors) is Swedish in origin, but rather the dose of live tissue which is an approach to the dose of patients[17].

Table (3) represents surface entry dose measured by thermal flash disks and portable devices, and their comparison with the values of the International Atomic Energy Agency and the dispersion coefficient indication.

Table (3) represents surface entry dose by thermal flash disks and portable devices

Values IAEA	Factor Dispersion	Dose mGy		Type of examination	No
		Unfors	Dosmax		
10 30 5	1.07 1.07 1.05	1.45±16.9 1.8± 45.4 1.2±7.85	1.2± 18.1 1.3± 48.8 0.6± 8.2	abdomen AP lembar spinal LAT Skull PA	C
1.5 5 30 10	1.07 1.07 1.08 1.06	0.3±0.67 0.7±6.5 2.1±39 1.2±12.1	0.2 ±0.75 0.5± 0.7 1.2±42.2 12.8±1	Chest AP Skull AP lembar spinal LAT abdomen AP	B
0.4 3 30 10	1.07 1.06 1.08 1.08	0.3±0.68 0.5±5.1 1.2±43 0.6±13.5	0.2±0.73 0.65±5.4 1.2±46.3 0.63±14.6	Chest AP Skull PA lembar spinal AP abdomen LAT	A

4. Conclusions

The exposure time can be measured directly using the devices used in analyzing the beam, and such measurements depend on the shape of the ray wave, as the exposure time is set by the manufacturers in the form of a single, or combined with the current to measure the amount (mAs).

The rotating disk is used as an alternative to measuring time for devices that straighten a full wave or half wave, and in this case the number of spots on the X-ray film directly gives the time .

The aim of the test is to measure the accuracy of the exposure time, and this is done by using a dose or exposure meter placed 100 cm away from the X-ray target. Fixing both the tube voltage peak and the time rate of the current and exposing it to the X-rays for different exposure times, and taking the rate of Each reading plots a graph between exposure time on the x-axis and exposure (dose) on the y-axis.

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