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THE RADIATION DOSES DIAGNOSTIC X-RAYS AND QUALITY ASSURANCE TESTS FOR DEVICES



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Abstract. Right now estimated the passage surface portions of patients which result from ordinary radiography (chest, head, belly, appendages) by picking instruments in AL-sader. A gathering of patients (10 patient) are chosen for every assessment and the mean portions are determined. The surface dosages with understanding squeezed (ESDpp) were estimated utilizing thermoluminescence dosimeter (TLD) and passage surface dosages with nonattendance of patient (ESDpa) by utilizing versatile ionizing chamber Sweden made. We found that the perusing of thermoluminescence dosimetry (TLD) is more than normal estimation of ionization chamber which are utilized and the diverse originated from the dispersing of radiation in understanding body, the dissipating coefficient to all tests are determined and we found that coefficient extend between(1.05 – 1.1) and this worth is near global qualities which equivalent to (1.09). The patient dosages right now contrasted and worldwide qualities, it is discovered that our qualities are more noteworthy by a range between (1.2-1.7) in many instruments, and the range is shut to (1) at whatever point the instrument is new and the experience of radiographer is acceptable, The estimations of this examination are talked about in detail. For the

significance of (Quality Assurance) we measure seven tests for three instruments in particular, and these tests are (– voltage Test – Test of current Linearity – Test of Linearity of Time – Half Value Layer Test – Beam Alignment Test – Optical and Radiation Field Congruence Test – Focal Spot Test), The tests demonstrated that the gadgets (F, C) breezed through quality confirmation assessments are unfit for work right now, yet the (A) didn't finish most assessments of value affirmation, accordingly prescribed not to utilize this machine.

Introduction. Radiological presentation coming about because of X-beam assessment is one of the most significant modern wellsprings of introduction for mankind. It was discovered that by figuring that about 21% of the complete portion of physical impacts (Total Somatic Dose) and about 10% of the absolute viable portion result from radiography. Hence, it was important to focus on this sort of assessment and arrange all the variables that influence the radiation portion of the patient while keeping up a decent beam of highlights and difference [1].

From the investigation in various emergency clinics and facilities, which use X-beams in the analysis, it was discovered that there are contrasts in presentation components to one assessment, which may prompt an expansion in the radiation portion assimilated in the patient, and among these elements is what is explicit to the idea of the gadget, for example, voltage, quality, current force and sort of combination produced using it Target, center territory, type and thickness of the channel, factors that rely upon down to earth understanding on the gadget, the nature of the assessment, for example, the utilization of the system (Grid) and power (boards), the nature of movies and the chronicle of cases and distinctive fermentation factors, for example, time and temperature. In this manner, it was important to be comfortable with the idea of the various elements, how they influence the patient's radiation portion, and how to get a very much separated, clear-beam picture with the least radiation portion for the patient [2]. Because of the across the board utilization of X-beams in clinical analysis, an expansion in radiological presentation to laborers, patients, and the overall population rose, which required the use of value affirmation programs for radiological gadgets so as to stay away from unexplained radiological introduction. Studies have demonstrated that numerous patients and laborers are presented to over the top and unjustified radiation portions, and a few examinations show The distinction in the measurements that patients get during radiography starting with one organization then onto the next or even inside one establishment because of the absence of congruity of the specialized details of the gadgets utilized. It likewise indicated that ineffectively working gadgets can prompt great radiographs, however patients get radiation dosages in overabundance of as far as possible [3].

The Proposed Method. The reagents are gadgets or frameworks having a place with radiation identification and estimation innovation with both molecule and wave types, and the discovery system depends on numerous common impacts of particles or photons with the material, and the vitality consumed by the radiation that is recognized in the locator is moved to another body, for example, electric flow. To guarantee the wellbeing of laborers in the radiation fields, just as to lessen the portion got by the patient, a quality confirmation program must be applied to indicative radiology divisions in clinical establishments, as it prompts an exact finding without presentation to unjustified radiation dosages. The quality affirmation program is characterized as the composed exertion by laborers in the indicative clinical establishment so as to keep up that there is no adjustment in the specialized details of gadgets after some time. [4] It incorporates:

A thermometers streak.

B radiation level estimating gadgets.

C quality assurance..

Thermo luminescence Dosemetry (TLD). The premise of the activity of blaze materials is the development of aggravating iotas, on the grounds that the falling particles or photons associate with the glimmer substance, shaping various electrons with bothered vitality, and upon after coming back to steadiness they produce light photons in flashes in the bright area or in the obvious light district, so the materials which can create this marvel can be utilized to identify ionizing radiation [4], yet with two conditions:

– The way toward making flashes should happen when radiation interfaces with the precious stone, and be joined with inciting the gem in another manner all together for the light to transmit.

– The way toward returning electrons to their steady state must be joined by the emanation of light and not by changing over the abundance vitality into heat.

Free electrons and holes are created by ionization, and an (electron-hole) pair frames because of disturbance, and as it comes back to a steady state it produces bright photons. The nearness of enacted polluting influences prompts the arrangement of another degree of bad tempered and stable state inside the illegal band that contains overabundance heat as warmth, which cools because of the bondage procedure, so the tainted gems don't have to work at low temperatures [5].

This light can be palpated or blazing with a thermometer framework and utilizing a Pitman Toledo mode - 654TLD-peruser. These meters require an optical speaker, which is corresponding to the power of the ionizing radiation consumed by the blazing material, and afterward you arrive at the meter to get the sum The tally that speaks to the radiation portion subsequent to adjusting the framework.

(Lithium Fluoride) is put as tablets with a distance across of 30mm. LiF-6 is utilized to quantify neutrons and Lif-7 to gauge X-beams and kama. A cycle begins before the estimation at 100C ° and the estimation cycle at 240C ° and the cleaning and cooling cycle at 300C °, so this gadget should be cooled, and nitrogen gas is utilized for this reason which has an immaculateness of 99.99% and is feeling the squeeze 400 mul/min as There is a channel between the jug and the gadget that makes the gas 100% unadulterated that enters the gadget [5]. Warm glimmer (TLD) is utilized to quantify the inward surface portion (ESD) of all pieces of the body, and Figure (1) outlines the warm blaze gadget (TOLEDO). These tablets are described by:

- Small size
- It has high strength
- It has extraordinary affectability and exactness
- Do not rely upon vitality or portion rate
- It has a wide scope of radiation portion (10-5 - 104) mGy
- Atomic numbers proportional to the body tissues.

Standard Thermoluminescence Calibration. Prior to beginning the way toward estimating any arrangement of tablets for individual presentation, the way toward adjusting the Toledo gadget, and getting ready to gauge the got portions, is done as follows:

1. Find the affectability of the TLD peruser

A gathering of (10) Lif-7 glimmer tablets is taken, which are warmed by a unique stove and the procedure is called Annealing, where the tablets are warmed to a specific temperature (80 °) and for five hours expel any residual dosages of introduction Previously, the radiation foundation of these circles (BG) is estimated by a TLD peruser, after which the plates are presented to a particular portion by the irradiator which contains the source (Sr90/Y90) and the producer of beta particles, as in Figure 1-1 The portion is controlled by deciding the quantity of turns of the gadget and the measure of portion got for every meeting is (0.03 mGy).

–dose received (mGy) = number of cycles x measure of portion got per meeting (mGY)

The (TLD peruser) gadget is introduced on the adjustment affectability of the TLD reaction estimation (99.99), at that point the greater part of these tablets are estimated by the gadget, and the rest of it is to guarantee the exactness of the new affectability and its appropriateness for estimation.

Measurements:

The new sensitivity is calculated from the following relationship:

$$\text{New sensitivity} = \text{calibration sensitivity} \times \frac{\text{Known radiation dose}}{\text{Readout rate - radiative background}}$$

(B.G) = 0.04 mGy

Dose received $1.20 \text{ mGy} = 40 \times 0.03 \text{ (mGy)} = \text{Dose (mGy)}$

Table 1. – TLD reader readings

Number of readings	1	2	3	4	5	6	7	8
Read the device	336	353	337	358	350	349	333	343

The average of these readings is 344.9

$$\text{New sensitivity} = 0.35197 = \frac{1.20}{0.04 - 344.9} \times 99.99$$

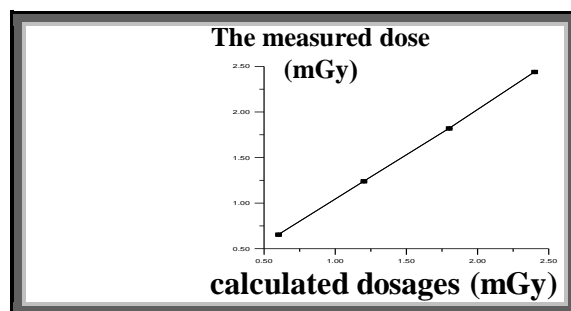


Figure 1. – The relationship between the known doses and the measured doses



Figure 2. – Image of a thermal flash device



Figure 3. – Thermal flash disk irradiation device

Finding the Calibration Curve. A particular arrangement of circles is taken and presented to various courses by the light gadget and the portion is determined in principle additionally, at that point it is estimated by the (TLD peruser) gadget, and the realistic relationship is drawn between the

hypothetically determined radiation dosages and the for all intents and purposes estimated portion by the TLD peruser, and Table 2 Figure 3 shows the measure of this portion.

Table 2. – Measured and known radiation doses of TLD device

calculated dosages(1) (mGy)	The average dose (mGy)	The measured dose (1) (mGy)	The measured dose(2) (mGy)
0.6	0.655	0.650	0.66
1.2	1.24	1.22	1.26
1.8	1.82	1.87	1.77
2.4	2.44	2.45	2.43

Instruments of Radiation Level Measurement. Unfors Instrument. This Swedish-made gadget comprises of a locator that has an ionization chamber associated with a covered wire associated with an advanced gas-filled counter. The gadget is intended for quality affirmation tests as it gauges the portion, time, portion rate and voltage straightforwardly. The most significant element of this meter is its little size, precision in estimation, and the figure (4) shows an image of the Unfors mobile device.



Figure 4. – Image of the Unfors mobile device

Quality Assurance. Quality Assurance Program: - It is a lot of methodology identified with the exhibition, hardware, and X-beam gadgets utilized in clinical diagnostics. It has built up quality confirmation programs and has been endorsed in the principles and laws of most nations on the planet and in the wellbeing models of global associations. The quality confirmation program means to: [6]

- 1 - Improve the picture of the different body tissue structures on the x-beam film or screen.
- 2 - Reducing radiation presentation to patients and laborers.
- 3 - Reducing costs (film utilization, brilliant cylinder life).

This program incorporates two primary lines:

First: Automated tests

Second: - Radiological tests

The primary line incorporates:

X-beam machine sturdiness, non-loss of gadget cutters, just as crafted by pointers, measures, working or cautioning lights, and heading of the X-beam shaft.

With respect to the subsequent line, it incorporates the accompanying tests, which will be clarified in detail:

Check of Voltage kVp. In this test, the difference in voltage between the two ends of the X-ray tube, which represents the anode voltage, is measured, because this voltage has an important relationship with the intensity of the X-ray coming out of the tube and the degree of image clarity.

The amount of voltage recorded on the control panel must be matched with the voltage measured by the devices; because the intensity of the rays The X-ray emitted from the device tube is proportional to the square of the peak voltages [6].

The voltages are measured using the digital scale directly, and the work of these devices depends on the use of two optical devices that convert the X-ray windows from two slices of copper of different thicknesses into a voltage difference that is proportional to the peak of the tube voltage after calibrating the device on such a measurement, and the device is usually placed at a distance of 100cm from The goal of the x-ray machine is exposed to x-rays, so the reading will be correct if the amount of change in voltage ranges between (10-25)%, and we need in the voltage test to two features:

- Precision
- Evidence.

Linearity test mA. The objective of the test is to set up tube current estimation. There are three strategies for estimation, the most significant of which are the accompanying:

Right now, top voltage is fixed (kVp = 70), the presentation time is fixed (0.4) seconds, the present changes unfailingly, and the introduction or portion is estimated a ways off of 100 cm. It ascertains the time pace of current (mAs) for each situation and afterward computes the coefficient of linearity, which ought not surpass 0.1 [6].

Exposure Time Test. Introduction time can be estimated straightforwardly utilizing the gadgets used to investigate the light emission, and such estimations rely upon the state of the radiation wave as the presentation time is set by the makers in a solitary structure, or joined with the current to gauge the sum (mAs). A turntable is utilized as a choice to time estimation for gadgets that are assessed by a full or half wave. Right now, number of spots on the x-beam movie gives time legitimately [6].

Timer Linearity Test. The point of the test is to gauge the exactness of the introduction time, and this is finished by utilizing a meter to quantify the portion or presentation and is set 100 cm away from the objective of the x-ray. Fixing both the pinnacle tube voltage and the normal time of the current and presenting to x-ray for introduction timethe average time takes the rate of each reading and plots Between exposure time on the x-axis and exposure (dose) on the y-axis [7].

Optical and Radiation Field Congruence Test. In this test the beam of light emitted from the lamp is identical to the X-ray beam and the reason for the mismatch is due to the deviation in the lamp location, the mirror and the anode focus point, and this test is done by taking a cassette inside the X-ray film and placed 100 cm from the target of the ray device X. The area of light falling on the film is organized by small L-shaped metal pieces placed at the edges of an area of 20 x 25 cm when the peak voltage (45kVp) and the current amount of current (6 mA.s) [7,6]. This type of test takes place every year or four months for each device, and there is another method for testing in which several beam boresight tests are used, which consists of a flat plate made of copper, which has length measures in the direction of x, y, positive and negative as in Figure (3). The test itself is repeated by placing this plate on top of the film, and then it tests radiation and light match.

Beam Alignment Test. The goal of this test is to know the integrity of the X-ray beam and its fall perpendicular to the film, when the radiation is not perpendicular, this leads to a blurring of the image, and for this the straightening test kit consisting of a 15-cm-long plastic cylinder is used to place the cylinder over the pointing kit on a table The patient is 100 cm away from the x-ray target as in Figure (5) and makes sure that it is leveled by a leveling balance and also by matching the light field with the dimensions of the film. The number and film were exposed to a x-ray beam with a voltage of (8 mAs, 55 kVp). After the film acidification process, the amount of deviation is known [6,7].

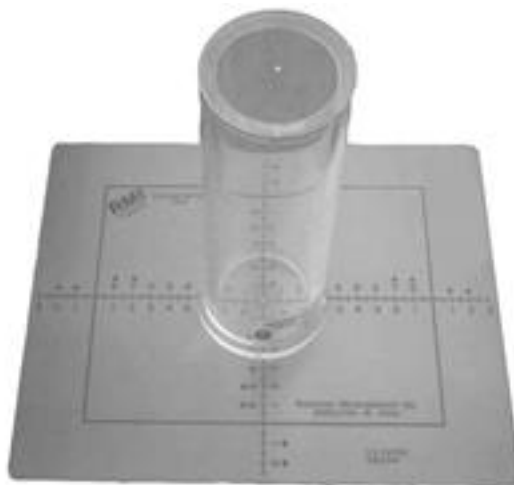


Figure 5. – Repayment Test Kit [6]

Focal Spot Test. The goal of the test is to measure the area of the X-ray focus, because the small area of the focus leads to the formation of an inconspicuous image, so the periodic test is very important to obtain a picture of good quality, and the measurement is done using several star, which consists of a disk that contains tapes that deviate from each other by an amount ($1^\circ - 2^\circ$) and consists of lead 0.05 mm thick and arranged in a circular way. This plate is placed on the lancet and the ray film on the patient's bed and visualized by exposure to x-rays, and there is a lack of clarity in the image in the middle, including the focus area, shown in Figure 6).

Filters Tes. Filters are placed in front of the X-ray beam because it absorbs low energies that do not contribute to the medical diagnosis process and increases the patient's dose, because X-rays with low energies absorb into the skin according to the photoelectric phenomenon, and all their energies are deposited in it so the dose increases.

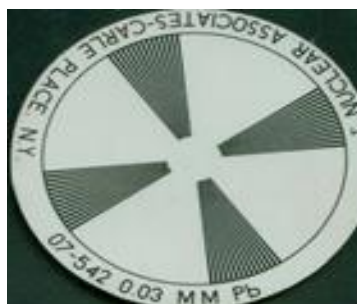


Figure 6. – Star Kit [6]

To test the thickness of the filter, it is necessary to measure the HVL (Half Value Layer), which is the thickness of the filter that absorbs half the intensity of the radiation falling on it. To carry out this test, a group of aluminum plates shall be taken with thicknesses (0, 0.1, 0.5, 1, 2) mm. By taking a portable meter to measure the radiation dose, it is placed 100 cm from the target of the x-ray, and the radiation field is paid to the x-ray to fall to the sensitive size of the counter, and the aluminum plates are placed one after the other in the middle of the distance between the meter and the target of the x-ray or by placing it on the diver after fixing the tube voltage on A certain effort, and taking the time amount of the current 20 millimeters. Secondly, from these measurements, a relationship is drawn between the thickness of the filter (linear scale) and the amount of the radiation dose (logarithmic scale). From the graph, we find the thickness in which the radiation dose decreases

to half its value without using the filter. The experiment is repeated for different values of peak tube voltage, and Table (3) shows the lowest thickness of half of the usual X-ray devices and those used in dentistry.

Table 3. – The lowest half thickness of the aluminum filter in dental rays and other types of rays the lowest half thickness (mm) [7]

Other types of x-rays	Teeth rays	Peak tube voltage
0.4	1.5	40
0.5	1.5	50
1.3	1.5	60
2.1	2.1	70
2.3	2.3	80
2.5	2.5	90
2.7	2.7	100
3.0	3.0	110
3.2	3.2	120
3.5	3.5	130
3.8	3.8	140

Conclusions. *Features of X-Ray Instruments/* Work was done on X-ray devices in the hospitals (Ali Ibn Abi Talib, Al-Sadr, Ibn Al-Baladi) located in Sadr City, and there are (6) devices. Table (1) shows the type of devices, the date of manufacture, and other information about the X-ray devices, and by means of a radiation dose measuring device (unfors).

Table 4. – Specifications of the X-ray Devices

The distance between the film and the SID ray tube	The manufacturer and its history	mAs	Voltages kVp	Type of test	the hospital
130 130	Shimadzu 1980	25 35	70 85	chest	A
85 85	Toshiba 1980	30 35	80 85	Lumbar spine	B
80	Sedecal 2004	25	90	Abdomin	C
60 60	Shimadzu 1989	25 25	75 90	Lumbar spine	D

Radiation doses resulting from diagnostic tests. In this study, new devices with different origins were used. The radiation dose was measured for several patients and different parts of the body, and it is clear from Table (5) that:

A- The ESDpp values for the patient's presence and measured using thermal flash (TLD) are greater than the values measured by the Swedish or German ionization chamber, which measures the dose in the absence of the patient (ESDpa) because the scattered rays in the patient's body lead to increased Radiation dose In Table (5), the dispersion factor resulting from the patient's body was

calculated, which is the ratio between the dose measured by thermal flash tablets (TLD) to the average dose measured by the two ionization chambers, and it was found that this value ranges between (1.05 - 1.1) and is a good approximation of the values The calculated world value of (1.09).

B- The surface entry dosage values for the Spanish-origin X-ray apparatus with the symbol (E) are close to the internationally approved values, because the device is newly imported and is still under maintenance by the company that regularly performs its work performance tests [1, 2, 3].

C- As for the measured dose values for the X-ray machine with the symbol (A), it is about twice the dose recommended 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 in a way Little and in the case of great momentum for patients.

D- 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 that the radiographer is experienced in this field.

E- The surface entry dose values measured by the TLD are closer to the reference values, because the sensitive size of this meter is a substance equivalent to the live tissue, and it 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 room (Unfors) Swedish, but rather the dose of live tissue, which is close to the dose of patients.

F-The average dose measured in this research for all devices in this study is an approximation to the reference dose of the International Atomic Energy Agency (IAEA), but it is generally greater than the reference doses with a range of those from (1.2 - 1.7) times, as in Table (6), although this The increase does not constitute a line for patients, but it is preferable that the dose be less than that according to the ALARA Law in radiation protection, because the increase in the dose is not justified and this increase is due to the following:

- * Introduced some devices to work in this study, and one of them has been used for 25 years continuously.

- * Most radiographers of these devices lack expertise and good training on these devices.

- * The absence of a program for quality assurance measurements for these devices in Iraq, and there is no great interest in the radiation risks of patients, and the only important thing is to obtain a picture of good quality that the doctor can diagnose easily, because the radiographer uses a few kVp, and high exposure (mAs) to The image is good, formed to be the opposite by using high kVp and few (mAs) to have a low dose and good image quality.

G-Most of the films used in the measurement are of poor quality and require a high exposure time to obtain a good image.

Table 5. – Surface entry dosages measured by thermal flash disks and portable devices, and their comparison with the International Atomic Energy Agency (IAEA) values and the dispersion coefficient indication (8)

The device	Type of test	Dose mGy		Dispersion coefficient	Values IAEA mGy
		TLD	Unfors		
A	chest	± 1.95 ± 0.1	1.85 ± 0.1	1.05 1.06	A
B	Lumbar spine	± 1 14.8 1.32±41	± 1.1 13.65 2.1±38	1.08 1.07	B
C	Abdomin	± 1.2 18.1 ± 1.3 48.8 0.6±8.2	± 1.45 16.9 ± 1.8 45.4 1.2±7.85	1.07 1.07 1.05	C
D	Lumbar spine	59 ± 2 0.8±23	± 3.5 54 1.5±21	1.09 1.09	D
E	Skull	± 0.2 0.73 ± 0.65 5.4 ± 1.2 46.3 0.63±14.6	± 0.3 0.68 ± 0.5 5.1 ± 1.2 43 0.6±13.5	1.07 1.06 1.08 1.08	E

Table 6. – Radiological doses measured by radiography of a group of devices in a hospital Iraq in current research compared to global potions [9]

Type of test	معدل الجرعة mGy	Values IAEA mGy	The measured dose IAEA
chest	0.63 1.85	0.4 1.5	1.6 1.2
Lumbar spine	17.3 45.1	10 30	1.7 1.5
Skul	7.17 5.1	5 3	1.4 1.7
Abdomin	14.1	10	1.4

Quality assurance tests. Voltage Stability Test. The test of voltages is acceptable if the standard deviation in the measurement is less than ± 5% or if the fluctuation in its measured and recorded values is acceptable if the percentage of fluctuation ranges between (3 - 10)% for devices with three phases and is used in this research, and the oscillation constant is measured From the following law [8]:

$$\text{Volatility\%} = \frac{\text{measured (kVp)} - \text{recorded (kVp)}}{\text{measured (kVp)}} \times 100\%$$

Table (7) shows the amount of fluctuation in the measurement of voltages when the current is fixed (200) mA for device (A) is 18.4%, which is higher than the specified values, and also the

standard deviation in the measurement is greater than 5%, that is, the device does not meet warranty specifications Quality (QA), as for the two devices (F, C), the volatility value in the voltages is 3.58% and 5.56%, respectively, under the same conditions, which is less than the limits set for this fluctuation, which is 10%, and the standard deviation values are less than 5%.

Current linearity test. It is noted from Tables (3), (4) and (5) that the dose values measured by TLD disks and the two portable devices are very close within experimental and statistical errors, and that the Swedish device values are closer to them than the global values for the measurement accuracy in this device, and that the relationship is linear for the devices (E, C) and non-linearity of the device (A). For the purpose of finding the linear coefficient, the amount of linear coefficient was calculated from the law [9]

$$\text{linearity coefficient} = \frac{(\text{Maximum dose / mAs})_{\text{super}} - (\text{Maximum dose / mAs})_{\text{lower}}}{(\text{Dose / mAs})_{\text{super}} + (\text{dose / mAs})_{\text{lower}}}$$

It was found that the linear coefficient of the device (A) equals 0.2 which is greater than the largest specified value which is 0.1, and for the other two devices (E, C) they are within the specified values (0.07, 0.01) because it is less than 0.1 as shown in Table (7).

Table 7. – they are within the specified values (0.07, 0.01) because it is less than 0.1 as shown in Table (7).

kVp = 90		distance = 100cm			
Linear coefficient	average mAs	The average Max dose	average mAs	average Min dose	The device
0.2	160	14.47	9.8	1.345	A
0.01	140	20	8	1.163	C
0.07	28.8	10	10.3	1.433	F

Time stability test. It is noted from Table (8) that the percentage of time stability does not exceed 10% for the two devices (E, C) by applying the law of linear coefficient while it reaches 45% for the device (A), meaning that the time stability of the device is very bad.

Test half for the filter. From Table (8) it is clear that the thickness of the filter ranges between (0.62 - 2.5) mm and that the approved values for the half thickness should not be less than 1.8 mm when the kVp = 70)) For the device (A), the half thickness of the filter is less than the limits set [2, 3, 4]. Therefore, this device does not apply to quality assurance contexts. As for the two devices (E, C), the values are within the limits set, especially for the device (C).

Package integrity test. We see from Table (8) that the alignment is not good, because the X-ray beam is about 3 ° away from the vertical axis of the device (A), while we notice from Table (8) that the straightness is good, because the image of the beam beam is symmetrical around the point of intersection of the two axes and that the beam of rays The x-ray is about 1.5 ° from the horizontal vertical intersection of the device (C).

Examination of the light and radiation fields. It is noted from Table (8) that the congruence between the optical and radiation fields of apparatus A) is not good, but it is within the limits set [2, 3, 4] which is 2% of the distance between the source and the film, i.e. 2 cm in this case, but the convergence is good for the device (C).

Radiation focus area test. Note from Table (8), the focus area of the X-ray machine (A) is (2.26 mm * 2.44mm), and it is slightly larger than the established limits, as can be seen from Table (8), the focus area of the X-ray machine (C) is (1.90 mm * 1.98 mm), which is within the limits set [2, 3, 4]

Table 8. – Quality Assurance Tests for the Three X-ray Devices and their Comparison

with International Values [10]

Values IAEA	device (E)	device (C)	device (A)	Tests
10 %	5.56 %	3.58 %	14.8 %	kV _p
0.1	0.07	0.01	0.2	Linear current
0.1	0.049	0.01	0.41	Linear time
mm 2.1 ≤	mm1.8	mm2.15	mm0.62	Half thickness
° 1.5 ≥	°1.5	°1.5	°3	Straightening the package
cm2 ≥	cm0.6	cm0.3	cm0.8	Congruence
1.75mm 2.25 mm	————	1.90 mm 1.98 mm×	2.26 mm 2.44 mm×	Focus area

In general, as shown in Table (8), the quality assurance tests indicate that the devices (E, C) have succeeded in these tests and they work within the international specifications, while the device (A) failed in most of the tests, therefore it should not be used for examination because it Patients are exposed to high doses, and images are not good, so radiographs will repeat imaging, exposing patients to additional unexplained doses. It is noted that:

1- The doses measured in this study are higher than the global doses due to:

A - Focusing on one device and not others in many tests.

B - Lack of experience for radiographers.

C - Not implementing quality assurance programs.

D - Change (kVp and mAs) to get a good image regardless of overdose.

E - Not taking into account the thickness of the patient by radiographers to choose the appropriate kVp and mAs workers, and the process is done in an estimated manner.

2- The use of poor films, which calls the doctor to restore the x-ray again.

3 -The X-ray machine (A) does not meet the required technical specifications because it did not pass the quality assurance tests.

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