vary from 2-32 mAs at 100 cm FFD and linearity coefficient is calculated for each machine as shown in table 3.

Table 3: Linearity for SiemenX-ray machine in AbuAlkmaar hospital of Al-Mansoura hospital at kV=81, SID=100, time=500

Machine No.	Linearity Coefficient
M1	0.10
M2	0.20
M3	0.09
M4	0.08
M5	0.07
M6	0.08

The mAs linearity in this study for six X-Ray units is vary from 0.07 to 0.09 which was in the tolerance limit (<0.1) except two machines linearity is out the limit 0.1 and 0.2 which indicate that this two X-ray unit need urgent calibration.(FDA,1999).

3.3 Linearity of Tube Kilo-Voltage

Applied tube voltage is directly proportional with output dose. As the kilo-voltage increases by one the dose increases by 28% of a dose as presented in figure (1).

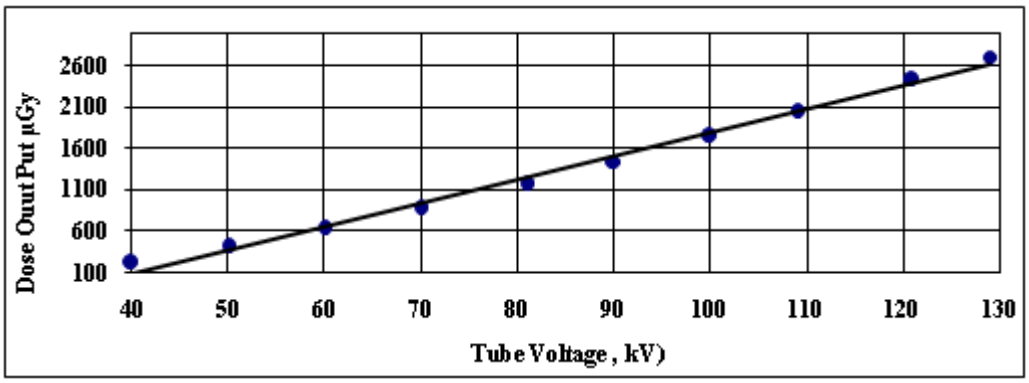

Figure 1: Relationship between tube voltage kV and Dose output, mGy

From figure (1) a tube voltage (kV) can convert into air absorbed dose by equation (1)

$$y = 28.22x - 1028 \quad (1)$$

Dose in µGy/kV = 28.22, so 1 µGy= kV x 28.22

Beam Quality

Half value layers were calculated as shown table 4. that thickness has an ability to prevent the hazard of soft X-ray, by reducing the surface doses during X-ray imaging.

Table 4: Measurement of the Half value thickness

Machine No.	*Half Value Layer, mm*
M1	2.31
M2	2.40
M3	2.70
M4	2.32
M5	2.60
M6	2.40

Half value layer, is exceeding the minimum value, passed above 2.3 mm Al at 70 KeV. This is within the accepted value of FDA (FDA,1999).

Focal spot size using STAR resolution pattern.

The results of focal spot size estimation are presented as shown in table 5. The estimated focal spot size was compared with assigned value stated by the manufacture and was within the tolerance level ± 0.3 nominal focal spot. The size of the radiation source has considerable impact upon the resolution in the image. The result of focal spot size was in range from 0.87 to 1.52 mm and was within the range published by (AAPM, 1981, FDA,1999and Plotti,1995) respectively.

Table 5: Focal spot sizes for some conventional X-ray machines

Code	*"Nominal size" mm*	*Acceptable size, mm*	*Estimated size, mm*
M1	1.3	1.6	1.52
M2	1.0	1.3	1.008
M3	0.9	1.2	0.870
M4	1.0	1.3	1.07
M5	1.0		1.12
M6	1.2	1.5	0.87

X-ray Beam Alignment

The beam alignment was calculated as shown in table 6.The measured X-ray beam alignment provided to align the center of the X-ray field with respect to the center of the image receptor lower than 2 percent of the source-image receptor distance(SID) as mentioned in (FDA,1999).

Table 6: X-ray Beam Alignment %.

Machine No.	*Perpendicularity, cm*
M1	0.7
M2	0.4
M3	0.6
M4	0.3
M5	0.5
M6	0.6

4. Discussion

The output of the system was evaluated using a fixed and reproducible geometry (AAPM-1991).Coefficient of variation for dose output was 0.003. All the calculated dose

coefficients were lower than the tolerance levels of AAPM, (AAPM, 1990, 1981).Time Reproducibility will mean the degree of agreement between several measurements of the exposure time at the same indicated time on the X-ray control panel. The accuracy and reproducibility of the timer stations on diagnostic X-ray equipment are important because they directly timer reproducibility affect the mAs and hence the amount of radiation emitted(AAPM-1991). The coefficient of variation of time reproducibility was 0.001. timer reproducibility was good and resulted normal reference radiation dose.Peak tube potential –kVp provides a measurement of the peak electrical potential across the X-ray tube when it is operating. The X-ray tube kVp is most critical. A small error of this variable will have a greater effect on the final radiographic image than will an equivalent variation in any of the other parameters such as tube current (mA), exposure time, target film distance. The X-ray intensity reaching the image receptor after the beam (AAPM-1991). Peak tube potential –kVp was 0.01 and within kV accuracy as mentioned in American Association of Physics where the measured kVp within ±5 kVp of the set value between 65 and 95 kVp, which are used in **(AAPM-1991)**and close to values published by**(Ismail, 2015)**.Kilo-voltage Accuracy was studied for Siemen X-ray machine in AbuoAlkhair hospital of Al mansoura hospitaland was ranged from 1.5 to 3.5 % and was within kV accuracy as mentioned in American Association of Physics in Medicine. KV accuracy was good at all kVp stations. Time Accuracy was studied for Siemen X-ray machine in AbuoAlkhair hospital of Al-Mansoura hospital and it was ranged from 0.5 to 4.1 % and was within the time reproducibility as mentioned by (AAPM.1991)., Time accuracy was good at all time station. Linearity of X-ray machine was studied and coefficient of linearity was lower than 0.1. Half Value Layer, HVL for Siemen X-ray machine at AbuoAlkhair hospital of Al-Mansoura hospital was studied at 70 kVp, and at 20 mAs, 100cm source to image distance. Half value layers were constant at energies close to that value given by (FDA,1999). So HVL has an ability to prevent the hazard of soft X-ray by reducing the entrance skin doses during X-ray imaging.

5. Conclusion

Reproducibility of dose output was ranged from 0.1 to 0.7 %, of time was ranged from 0.2 to 3.1 and of high voltage was ranged from 0.1% to 0.7% which is lower than the tolerance limit. Kilo-voltage and time Accuracy were within the tolerance levels. The quality assurance tests of X-ray machines under study obtained accurate and timely diagnosis. As the kilo-voltage increases by one the dose increases by 28% of a dose. The measured HVL thickness has an ability to prevent the hazard of soft X-ray by reducing the surface doses during X-ray imaging. The obtained focal spot size was small leads to obtain at a good image quality.

The findings support of the importance of the on-going quality assurance program toensure the stability of parameters that affecting on patient doses. The quality assurance program should generalize for all hospitals to ensure the quality of the X-ray machines under services.

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