Quality Control of Conventional X-Ray Machine at Najran University Hospital Radiology Department

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Abstract: ***The mean objective of doing quality control at diagnostic radiology department is improving the performance of x-ray equipment, so as to get high image quality and keep the radiation dose for patients and public in lower limit as possible. Therefore, the aim of this study was to assist and evaluate the conventional x-ray machines at Najran university hospital, radiology department through the quality control tests, and see if there is a radiation leakage during exposing or there is a variation of QC test from the standard limits. This practical study and which was been carried out at conventional x-ray machine, Najran university hospital, radiology department, the QC tests such as radiation leakage, kVp accuracy, reproducibility of KvP, does and time, mAs linearity and exposure time accuracy. Ion Chamber Survey Meter and Unforskvp Electrometer was used in this study for QC purpose. The data and information collected from the results of these tests showed that kVp accuracy, reproducibility of KvP, does and time, mAs linearity, time accuracy were in standard limits. Finally the radiation leakage was measured at four deferent point behind the door (A), wall (B), office (C) and control area (D), the dose rate in setting of 115 kVp and 500 mAs found that all dose rate reading in permissible range.***

Keywords: Quality Control, X-Ray, Radiation

1. Introduction

Testing and calibration of X-ray equipment to ensure quality control in equipment is becoming increasingly significant today when accuracy in diagnosis and effectiveness in treatment cannot compromised at all. Testing and calibration of equipment ensures accuracy, effectiveness and long life of equipment, which ultimately enables one to achieve the highest degree of quality control [(1).]

It is a general experience that optimum imaging with minimum patient and staff doses, moreover, safe operation and long life of X-ray equipment can be assured only by regular measurement of technical parameters and checking of their constancy (i. e. the so-called routine performance testing). These tests are generally known as quality control (QC), while together with the so-called corrective actions and its management it is called (physical-technical) quality assurance (QA) of the equipment [(2).]

Protection of radiation personnel and members of the public shall be assured by adherence to the three basic radiation protection principles of justification, optimization and dose limitation. Doses for radiation personnel and members of the public shall be below their respective individual dose limits. The individual dose limits represent the boundary between unacceptable doses and doses that are tolerable. Doses should be well below these limits and efforts shall be made to keep doses to individuals as low as reasonably achievable (ALARA), economic and social factors being taken into account. In many circumstances, it is feasible to maintain dose rates in areas occupied by radiation personnel at levels that would not lead to doses in excess of the dose limits for the public – namely 20 μSv per week summe over the period normally occupied. In accordance with ALARA this should be done ([3, 4).] There shall be an investigation of the working practice of radiation personnel receiving an effective dose in excess of 5 mSv per year, or one quarter of any of the relevant dose limits for the skin, extremities or lens of the eye [(5).] Quality assurance in medical imaging is a rapidly evolving concept and each facility is encouraged to be continually pursue ways to improve and expand its program ([6).]

2. Martial and Method

This study will be perform on selected Q C tests of conventional x-ray machine at the Najran university hospital radiology department such as kVp accuracy, reproducibility of kVp, time accuracy, mAs linearity, reproducibility of dose and radiation leakage. Use detector to test instrumentation measure such as survey meter to measure radiation dose rate outside x-ray room and also use the Unfors Multi O Meter for measurements of kVp accuracy, mAs linearity and exposure time accuracy.

X-ray machine:
Manufactured for GE healthcare. Milwaukee, W I by Siemens. Model: AL01C II. Manufactured: August \ 2009. Location: Kemnath \ Germany. Type: 5234954. S. N: 2359. . MaximumTension150 kVp Focus sizes Small focus 0.6 mm and large focus 1.2 mm. Maximum power low speed Small focus 15 kW (50 Hz), 16 kW (60 Hz) Large focus 44 kW (50 Hz), 49 kW (60 Hz) Maximum power high speed: Small focus 25 kW (150 Hz), 27 kW (180 Hz) Large focus 68 kW (150 kW), 75 kW (180 Hz) Maximum Current: Small focus 400 mA Large focus 1000 mA Anode degree target angle, 12º Anode heat capacity 300 KHU Anode Heat Dissipation Capacity 40 KHU/min Housing Heat capacity 1, 250 KHU Housing Heat Dissipation Capacity 15 KHU/min Anode rotation 3, 000/9, 700 r. p. m. Anode composition Rhenium & Tungsten faced; Molybdenum Target Anode Diameter 74 mm. Filtration equivalent 0.7 mm Al.

Room size and shielding:
The room housing an x-ray unit shall not be less than 18 m2 for general pur pose radiography and conventional fluoroscopy equipment. The size of room housing the gantry of the CT unit shall not be less than 25 m2. Also not more than one unit of any type shall be installed in the same room

and no single dimension of these x-ray rooms shall be less than 4m Appropriate structural shielding shall be provided for walls, doors, ceiling and floor of the room housing the X-ray unit so that doses received by workers and the members of public are kept to the minimum and shall not exceed the respective annual effective doses as prescribed by the competent authority.

Survey Meter:
Fluke biomedical the Model 451P Ion Chamber Survey Meter is a hand-held pressurized, battery operated unit designed to measure gamma and x-ray radiation above 25 kev, and beta radiation above 1 mev using the latest CMOS and LCD technology. The 451P case is constructed of high strength ABS plastic. A gasket seals moisture out of the unit and provides a cushion for the internal components.

Figure 1: Model 451P & 451P-DE-SIIon Chamber Survey Meter

Unforskvp Electrometer (Unfors Multi O Meter):
1The meter is designed with the aim to make the measurement procedure simple and straightforward. The UnforsMult-O-Meter is extremely easy to use. Only two buttons are used to control the instrument: On/Off TheUnforsMult-O-Meter kVp, dose, rate, mA, mAs, time, pulse, dose/frame – allin one exposure

Figure 2: Unfors Multi O Meter used in measuring

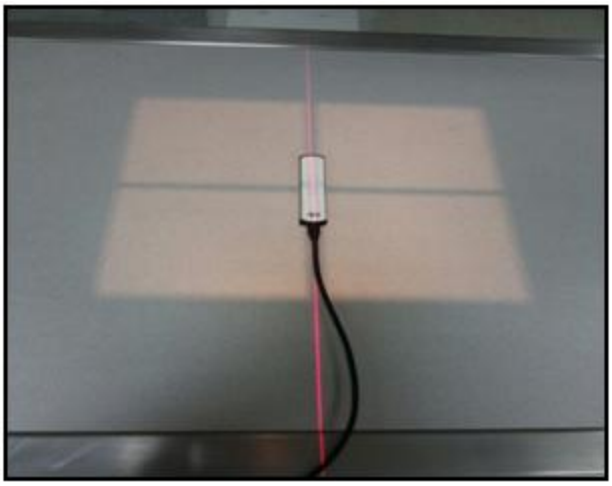

Figure 3: The ionization champers set up at assda100cm

3. Result

Table 1: kVp accuracy

Setting kVp	Reading kVp	Percentage Error
50	48.44	- 3.12%
60	58.36	- 2.73%
70	75.46	7.8%
90	89.99	- 0.01%

Percentage error = (reading value-set value) ×100set value

Table 2: Time accuracy

Setting time	Reading time	Percentage Error
2.47	2.33	- 5.66%
1.55	1.56	0.64%
1.19	1.22	2.52%
0.89	1.22	37.0%

Percentage error = (reading value-set value) ×100 set value

Table 3: Reproducibility of kVp: (Set kVp= 70, mA = 400, mAs= 0.4)

Setting kVp	Reading kVp
70	67.38
70	69.80
70	65.87
70	68.58
Average	67.9075
SD	1.679630416
CV%	2.473409293

Coefficient of variation CV%= $\left(\frac{\text{SD}}{\text{average}}\right) \times 100$

Table 4: Reproducibility of dose: (Set kVp= 70, mA = 400, mAs= 0.4)

Setting kVp	Setting Ma	reading dose
70	400	14.35
70	400	14.22
70	400	14.55
70	400	14.18
Average	14.325	
SD	0.16663333	
CV%	1.163234415	

Table 5: Reproducibility of time: (Set kVp= 70, mA = 400, mAs= 0.4)

Setting kVp	Setting mA	reading time
70	400	1.11
70	400	1.11
70	400	1.11
70	400	1.11
Average	1.11	
SD	0.0	
CV%	o. o	

Table 6: mAs linearity: (Set kVp =80)

mAs	Dose	mGy/mAs	LC%
2.0	0.1012 mGy	0.051	-
4.0	0.2072 mGy	0.052	0.970874%
8.0	0.4184 mGy	0.052	0%
16.0	0.8491 mGy	0.053	0.952381%
32.0	1.737 mGy	0.054	0.934579%
63.0	3.464 mGy	0.055	0.917431%

LC% $=|X_1-X_2|/(X1+X_2)$ Where X_1&X_2 are the average mGy/mAs

Table 7: Radiation leakage: (Set kVp=115, mA =500, mAs =0.38)

Point area	Dose rate reading
A	1.3 µSv/hr
B	0.6 µSv/hr
C	0.5 µSv/hr
D	0.8 µSv/hr

A: door, B: wall, C: office, D: control panel.

4. Desiccation

In this study some of quality control tests of x-ray machine at the Najran university hospital they done. The kvp accuracy for x-ray machine was examined by setting the source to detector distance at 100 cm of exposure, time at 0.4 sec for different kV intervals from 50-90 kV as shown in table (1) and percentage error of kV accuracy was presented, all the kVp reading in range of limitation except one reading in70kVp setting the percentage error was 7.8% according to the fixed standard forms of the quality control of radiology devices drawn up by Iran's Atomic Energy Organization titled as the quality control criteria of diagnostic radiology devices in 2008. Standard values for quality control tests are of voltage accuracy test a difference less than or equal to 5% between the values of voltage adjusted on the device and measured values is acceptable.

In addition time accuracy for x-ray machine was checked by variation the time interval from 0.89-2.47second as shown in table (2) and percentage error of time was calculated all the percentage error in range of limitation (± 10%) according to AAPM report no74 [(8).] Except one of percentage, 37%in setting time 0.89 and the reading time 1.22sec as shown in table2. The assessment of the voltage repeatability and reproducibility of kVp, irradiation time and the dose of x-ray tube as shown in table (3), (4) and (5) respectively. The coefficient of variations less than or equal to 5% in the measured values are acceptable.

Also the researcher assessed mAs linearity of the x-ray tube at setting kVp 80 and mAs range from 2-64 as shown in table (6) the linearity coefficient is in range of limit of ±5% in the measured as shown in table (6). Finally the researcher evaluated the radiation leakage by measured dose rate in setting of 115 kVp and 500 mA s behind the door (A), wall (B), office (C) and control area (D) found that all dose rate reading in permissible range as shown in table (7).

5. Conclusion

The study concluded that all quality control tests conducted for the X-ray machine in the Radiology Department of Najran University Hospital were within standard limits and the researcher recommended that there is a need for more additional tests such as image quality testing.

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