Evaluation of Beam collimation status as a Radiation Protection measure in Radiography practice in two Selected Hospitals in North-eastern Nigeria.

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Abstract

Background: Light beam alignment test also known as beam collimation test is an important quality control parameter that ascertains the light beam and radiation beam alignment over an anatomic area of interest on the patient. Beam collimation reduces radiation exposure to the patient by restricting the beam of radiation only to the area of interest thereby reducing film rejection due to image blur caused by scattered radiation and image rejection due to cut-off, which could be as a result of light and radiation field misalignment. As a radiation protection measure in radiography practice, the beam collimation status of the x-ray equipments in the study locality were evaluated against internationally published standard.

Materials And Methods: The beam alignment test of the study was conducted in accordance to the guidelines of the Conference of Radiation Protection Committee Directors (CRCPD) (2009). The followings were used in the test: x-ray cassette (18 x 24 cm) loaded with film, radio opaque (coins) markers, measuring tape and spirit Level. The loaded cassette was exposed to x-ray beam at 55 kVp and 4 mAs. This was sufficient for the blackening of the film. The film was processed and the black area of the processed film (radiograph) is the area covered by the x-ray beam while, the shadow of the coins indicate the boundary of the light beam. The difference between the border covered by the x-ray beam and that of the light beam was measured along (AL) and across (AC) the x-ray couch using a measuring tape. The tolerance limit for the test was set at 1%.

Results: The x-ray equipment in diagnostic room 1 of centre A recorded misalignment of 0.7% along the couch and 1.0% across the couch while the equipment in room 2 recorded misalignment of 7.7% along the couch and 3.9% across the couch. The diagnostic x-ray equipment in room 1 of centre B recorded misalignment of 0.1% along the couch and 0.8% across the couch while that of room 2 recorded 1.1% along the couch and 1.5% across the couch.

Conclusion: The beam collimation status of some of the x-ray equipments in the study is not acceptable as there seems to be no evidence of comprehensive quality assurance programme in the locality. In such cases, patients are exposed to unnecessary high radiation doses.

Keywords: Light Beam, Collimation, Quality assurance

Introduction

Ionizing radiation has found importance in human existence and since the discovery of x-ray by the German Physicist, Wilhelm Conrad Rontgen, in 1895, the application of x-ray, which is an ionizing radiation, in the healthcare sector has kept increasing [1,2]. Consequently, medical exposure to ionizing radiation has become the major source of exposure to mankind [3]. Hence, there is need to ensure the safe use of ionizing radiation in medicine [4]. This calls for the implementation of radiation protection measures in our day-to-today radiography practice [5]. Light beam alignment test also known as beam

collimation test is an important quality control parameter that ascertains the light beam and radiation beam alignment over an anatomic area of interest on the patient [6]. It reduces radiation exposure to the patient by restricting the beam of radiation only to the area of interest thereby reducing film rejection [19] due to image blur caused by scattered radiation and image rejection [20] due to cut-off, which could be as a result of light and radiation field misalignment [12,13,14]. It is worrisome that sometimes the collimator device of x-ray equipment could be faulty and the operators of the equipment may continue exposing the patient without correcting the collimator fault [12]. Consequently, patients are exposed to an unnecessary high radiation dose to their detriment[7].

Irrespective of the numerous benefits of ionizing radiation in health care delivery, it has public health implications [8] because of its deleterious effects to human cells and a great deal is known about the large doses of radiation received in a short period of time [10]. This could result in health effects in exposed individuals and genetic effects in their descendants. The health effects could be acute radiation syndrome, cataract, sterility, fetal defects and even cancer[9]. If this is not addressed, it will affect the population health and can pose a threat to the well being of the general public[8].

To address the problem of radiation exposure to humans, the Internation Commission on Radiological Protection came up with systems of radiation protection which includes the principles of justification of medical procedures and optimization of radiation protection. For any justified medical procedure involving ionizing radiation, there should be optimization of protection [8]. It is based on these principles that this study is embarked on in order to address the menace that could emanate[11], as a result of unwarranted exposure due to poor collimation practice in radiography examination in our setting [16,17,18]. Previous study conducted on the subject matter showed poor collimation practice [2,3,5,6,7] but none was conducted in our locality. Consequently, this study evaluated beam collimation status of the x-ray equipments in the study locality as a radiation protection measure in radiography practice.

Materials and methods

A cross-sectional research design was conducted on the x-ray equipments of two radio-diagnostic centres in North-eastern Nigeria in the year 2018. These centres were labeled as centre A and B. Data capture sheet adapted from the publication of the Conference of Radiation Control Programme Directors (2001) was used for the collection of data on beam collimation status. The two centres have static x-ray equipments with tube voltage ranging from 40 to 150 kVp. The specification of the x-ray equipments of the two centres were obtained from the x-ray tube and control panel.

Table 1: Specification of x-ray equipment's used

Diagnostic Centre	Room	EQUIPMENT Model	Manufacturer	Date	Maximum tube potential (kVp)	Total filtration (mmAl)
A	1	Protec	Protec Gmbh and Co. KG	2014	150	0.8
	2	Pleophos-D	Siemens	No date		Not available
B	1	Philips medical system	Philips	2009	150	Not available
	2	GE XR 6000	Hualun medical system co. Ltd	2009	150	1.3

The alignment test of the study was conducted in accordance to the guidelines of the Conference of Radiation Protection Committee Directors (CRCPD) (2001).The following were used in the test:

i. X-ray cassette (18 x 24cm) loaded with film,
ii. Radio opaque (coins) markers
iii. Measuring tape and
iv. Spirit level (also known as range or plumb)

The loaded x-ray cassette was placed on top of a horizontal couch (also known as table). This was achieved by the use of a spirit level. The light beam of the x-ray equipment was collimated on the loaded cassette to an area of 12 cm (across the couch) and 16 cm (along the couch) respectively. Four pairs of coins were placed symmetrically at the borders of the light beam on the cassette (figure 1). The loaded cassette was exposed to x-ray beam at 55 kVp and 4 mAs. This was sufficient for the blackening of the film. The black area of the processed film (radiograph) is the area covered by the x-ray beam while, the shadow of the coins indicate the boundary of the light beam. The difference between the border covered by the x-ray beam and that of the light beam was measured along (AL) and across (AC) the table using a measuring tape. Ethical approval for the study was obtained from the Ethical and Research Committee of the Faculty of Health Science and Technology, Nnamdi Azikiwe University, Nnewi Campus and ethical clearance were also obtained at the data collection centres.

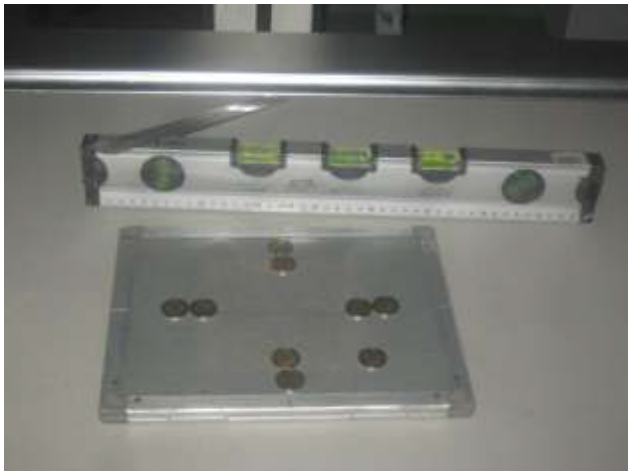

Figure 1: practical set up for light beam collimation test

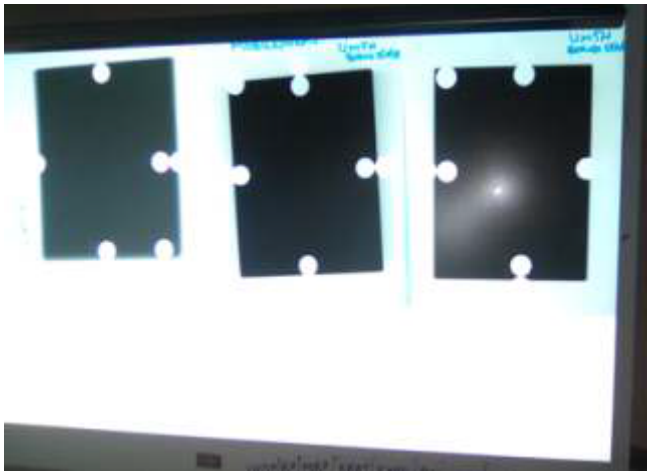

Figure2: Radiograph for light beam collimation test

RESULTS

Table 2: Light beam collimation test for centre A and centre B

Centre	Room	Direction	Measurement (cm)	Total measurement (cm)	Percentage misalignment
A	1	AL_1	0.5	AL = 0.7	AL = 0.7
		AL_2	0.2		
		AC_1	0.5		
		AC_2	0.5	AC = 1.0	AC = 1.0
	2	AL_1	3.8	AL = 7.7	AL = 7.7
		AL_2	3.9		
		AC_1	1.6		
		AC_2	2.3	AC = 3.9	AC = 3.9
B	1	AL_1	0.0	AL = 0.1	AL = 0.1
		AL_2	0.1		

Centre	Room	Direction	Measurement (cm)	Total measurement (cm)	Percentage misalignment
		AC_1	0.3		
		AC_2	0.5	AC = 0.8	AC = 0.8
	2	AL_1	0.5	AL = 1.1	AL = 1.1
		AL_2	0.6		
		AC_1	0.5		
		AC_2	1.0	AC = 1.5	AC = 1.5

Key: AL = Along the couch,AC = Across the couch

The table 2 showed light beam collimation test at centre A and centre B. Both centre A and B recorded light/x-ray beam misalignment of greater than 1% which is unacceptable.

Discussion

The result of this study on light beam collimation test is in tandem with the findings in previous studies [2,3,5,6,7] Ike-Ogbonna *et al* [6] conducted a study on the assessment of beam alignment and collimation on some selected x-ray equipments in Plateau State, Nigeria. Twelve x-ray equipments were included in the study out of which 10 had their light/x-ray beam alignment unacceptable. It was concluded by acknowledging misalignment in most of the x-ray equipments studied and recommends corrective action on the equipments as light/x-ray beam misalignment negatively affects patient dose and image quality. Ida *et al* [3] conducted light/x-ray beam alignment test on 5 x-ray equipments in Kaduna State, Nigeria. The result of the study showed that all the centres recorded light/x-ray beam misalignment of more than 1%. The finding of a study by Joseph *et al* [2] on beam alignment test was contrary to the result of this study. They conducted beam alignment test on three x-ray units in Katsina State, Nigeria, and the result of their study showed that all the three x-ray units passed the alignment test with an error of less than 2%. But going by the WHO standard of 1% tolerance limit in misalignment, some of the x-ray equipment that passed the misalignment test at less than 2% may not pass the same test at 1% tolerance limit.

One of the reasons for the unacceptable light beam misalignment is improper quality assurance practice. This is because a proper quality assurance practice timely identifies equipment fault and executes the recommended corrective actions. The source of light beam of an x-ray tube is a light bulb that is situated adjacent to a 45^0 reflective mirror in the collimator assembly of an x-ray tube. The function of the bulb is for illuminations while the mirror which is placed at 45^0, reflects the light beam towards the x-ray couch. The area covered by the light beam is expected to be the total area that would be covered by the x-ray beam. Consequently, the light beam is used for patient positioning. In case of a misalignment beyond the tolerance limit, there is likely going to be image cut-off, which may necessitate repeat examination as well as increase radiation dose to the patient. Sometimes, the Radiation workers who are conscious of light beam misalignment of their equipment tend to open the light beam over the patient wider than just the diagnostic area of interest so as to avoid image cut-off. Such practice is unprofessional and should be discouraged. This is because, the more the area of the light beam, the more the radiation dose to the patient which implies poor radiation protection practice.

Conclusion

The beam collimation status of some of the x-ray equipment's in the study is not acceptable as there seems to be no evidence of comprehensive quality assurance programme in the locality. In such cases, patients are exposed to unnecessary high radiation doses.

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