Assessment of Collimation on Adult Plain Chest Radiographs as a Radiation Protection Measure in a Nigerian Teaching Hospital.

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ABSTRACT

Assessment of collimation on adult plain chest x-ray is imperative in ensuring dose is reduced to the minimum level for the patient and the personnel. The objective of this study was to determine the extent of collimation on adult plain chest radiographs and to determine the light beam diaphragm status of the x-ray machines.

A total of 612 chest radiographs were studied retrospectively from June 2013 to June 2014 and the light beam diaphragm status of two functional x-ray machines of Aminu Kano Teaching Hospital (AKTH) were prospectively studied. The assessment of collimation on chest Radiographs in the study reveals that out of 612 chest radiographs enrolled in the study, 93.1% (n = 570) were adequately collimated while 6.9% (n=42) were inadequately collimated**.**

The radiology department of AKTH Kano has two static x-ray machines and the light beam diaphragm tests were assessed. The light beam diaphragm of x-ray unit 1 has misalignment of 1.3% along the table and 0.9% across the table while x-ray unit 2 has 0.6% and 0.9% misalignment along and across the table respectively. The criterion for the assessment of misalignment is 1% of the FFD of the projection. The collimation on plain chest radiographs in AKTH Kano is adequate and x-ray unit 2 of the hospital has light beam alignment within tolerance limit while, unit 1 has light beam misalignment above the tolerance limit.

(Key terms: chest radiograph, collimation, radiation protection)

INTRODUCTION

Chest x-ray is the most common radiographic examination carried out in the Radiology Department. It is known to form a greater percentage of all radiographs because it carries enormous medical information for the purpose of diagnosis and treatment of diseases (Johnson, 2005). It is a non-invasive medical test that helps physicians diagnose and treat medical conditions. Imaging with x-ray involves exposing a part of the body to a dose of ionizing radiation to produce radiographs of the body parts.

Chest x-rays produce images of the heart, lungs, airways, blood vessels and bones of the spine and thorax. It is said to be the first imaging procedure done for patients with symptoms such as persistent cough, shortness of breath, chest pain or injury, fever, pneumonia, heart failure, and other heart problems (Okoye et al., 2011). The increasing demand of chest x-rays for patient diagnosis calls for high level of professionalism by practicing radiographers especially because x-ray is an ionizing radiation which has harmful effects on interaction with biological tissues (WHO, 2004).

The production of high quality radiographs is an intricate process (Joseph et al., 2015). The aim of radiography is to produce quality images which are adequate for the clinical purpose with minimum radiation dose to the patient (Joseph et al., 2015). If optimum performance is to be achieved, assessment of image quality must be made to balance against patient dose. (Joseph et al., 2015). Therefore, it is imperative that referring physicians and radiographers make sure there is justification according to International Commission on Radiological

Protection (ICRP) following any procedure involving ionizing radiation (ICRP, 1991).

Collimation is one of the most effective radiation protection measures for the patient and personnel, because it reduces the area of radiation coverage. It brings about an effective dose reduction and also produces better image quality (Nwobi, 2011). Collimation is performed using cones and collimators. Other methods of limiting x-ray exposure to the patient include use of shield for example gonad shield (Agwu, 1992).

Collimation decreases patient's radiation dose by limiting x-ray exposure to the area of interest. It also has the added benefit of improving the quality of the resulting image (Sheafor, 2011). It is the restriction of x-radiation to the area being examined or treated by confining the beam with metal diaphragm with high radiation absorption power (Farlex, 2013).

The objective of this study was to determine collimation on plain chest radiographs and light beam diaphragm status of the x-ray machines in AKTH Kano Nigeria.

MATERIALS AND METHODS

A retrospective and prospective cross sectional design was used for the study. Chest radiographs taken at AKTH Kano, Nigeria were used for the study. Data were collected using data capture sheet and observation. The data capture sheet includes the rows and columns for age, sex, film size and evidence of collimation. Instrument for the assessment of light beam diaphragm status with radiopaque markers, 30 ×40cm loaded x-ray cassette, measuring tape, a plump and GE x-ray machine with model number 2226680 and serial number 48203HL4, manufactured in July 2007 and Iltalray, housing number-GO95M, type C352. The status of the light beam diaphragm was determined by the formula:

Total AL/FFD X 100 and Total AC/FFD X 100

Where AL= light beam alignment along the table
AC= Light beam alignment across the table
FFD= 100 cm

Criteria for judgment of collimation are as follows: excellent has 4 ways silver lines, very good has 3 ways silver lines, good has 2 ways silver lines, poor has 1 way silver line and very poor has zero silver lines. Adequacy of collimation ranges from excellent, very good and good while inadequacy ranges from poor to very poor.

Criteria for alignment and misalignment are as follows:

1) Alignment: this is alignment or misalignment within the tolerance limit of 1% of the FFD of the projection.

2) Misalignment: this is the misalignment of light and x-ray beam above the tolerance limit of 1% of the FFD of the projection. WHO(2004)

RESULTS

The distribution data based on gender are shown in Table 1. The age range of 40-49 had 19.0% (n= 116) this is the highest chest x-ray examination within the study period and 90 and above had 2%, (n=2), as shown in Table 2.

Table 1: Distribution of Finding Based on Sex.

Sex	Frequency	Percentage
Male	356	58.2
Female	256	41.8
Total	**612**	**100.0**

Table 2: Age Distribution of Study Participants.

Age	Frequency	Percentage
0-9	50	8.2
10-19	57	9.3
20-29	80	13.1
30-39	88	14.4
40-49	116	19.0
50-59	100	16.3
60-69	64	10.5
70-79	34	5.6
80-89	21	3.4
90-Above	2	0.2
Total	**612**	**100**

The assessment of collimation on chest radiograph in the study reveals that out of 612 chest radiographs, 93.1% (n=570) were adequately collimated while 6.9% (n=42) were inadequately collimated as shown in Table 3.

Table 3: Assessment of Collimation on Radiograph.

Collimation	Frequency	Percentage	Adequacy of collimation (%)	Categorization
very poor	9	1.5	6.9%	Inadequacy of collimation
poor	33	5.4		
good	141	23.0		
very good	212	34.6	93.1%	Adequacy of collimation
excellent	217	35.5		
Total	**612**	**100.0**	**100**	

Table 4: Light Beam Diaphragm Test.

x-ray unit	Direction of test	Measurement (cm)	Total Measurement (cm)	% misalignment
1	AL 1 AL 2	1.0 0.3	AL= 1.3	AL= 1.3
	AC 1 AC 2	0.4 0.5	AC= 0.9	AC= 0.9
2	AL1 AL 2	0.3 0.3	AL= 0.6	AL= 0.6
	AC 1 AC 2	0.6 0.3	AC= 0.9	AC= 0.9

The radiology department of AKTH Kano, Nigeria has two static x-ray machines and their light beam diaphragms were assessed. The light beam diaphragm of x-ray unit 1 has misalignment of 1.3% along the table and 0.9% across the table while x-ray unit 2 has 0.6% and 0.9% misalignment along and across the table, respectively, as shown in Table 4.

DISCUSSION

Radiation protection is an effective measure employed by radiation workers to safeguard the patient, personnel and general public from unnecessary exposure to ionizing radiation (ICRP, 2003). Plain chest radiographs in the study were assessed for radiation protection using beam collimation as a criterion. Out of 612 plain chest radiographs assessed for radiation protection practices at AKTH Kano, Nigeria, 93.1% (n =570) were adequately collimated. This implies radiation protection to the patient with respect to collimation on plain chest radiographs at AKTH Kano is adequate.

This is in disagreement to the findings of Ikamaise *et al.,* 2000. Ikamaise et al, 2000 conducted a study on the assessment of chest radiographs for quality assurance and radiation protection in the South Eastern Nigeria. The study involved both public and private health institutions. One thousand (1000) radiographs were collected, out of which 95.2% (n= 952) were inadequately collimated, this could probably be due to the fact that some unqualified personnel were employed to work as radiographers in that study locality.

Ikamaise et al conducted their study in the year 2000 while the present study was conducted in 2014. Fourteen years is good enough for a

transformation to have taken place in a profession. The finding of this study shows adequate radiation protection to the patient in collimation of plain chest radiographs.

The assessment of the light beam diaphragm status of the x-ray machine in AKTH was good. This is because the x-ray unit one (1) has light beam misalignment of 1.3% along the x-ray table and 0.9% across the x-ray table. The light beam assessment of x-ray unit two (2) shows the misalignment of 0.6% along and 0.9% across the x-ray table. The tolerance level of light beam misalignment as given by world health organization (WHO, 2004) is 1%. With the misalignment recorded in this study, attention is only going to be given to the misalignment along the table of x-ray unit one.

CONCLUSION

The collimation on adult plain chest radiographs in AKTH Kano, Nigeria is adequate and x-ray unit 2 of the hospital has light beam alignment within tolerance limit while, unit 1 has light beam misalignment above the tolerance limit.

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