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QUALITY ASSURANCE IN RADIOGRAPHY WITH EMPHASIS ON LIGHT FIELD X-RAY BEAM ALIGNMENT

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ABSTRACT

Quality Assurance in Radiography with emphasis on light beam/X-ray beam alignment was carried out on X-ray machines of five different hospitals (coded: H1, H2, H3, H4 and H5) in Jos North Local government area of Plateau State, Nigeria. This test was carried out using eight coins having known positions in the collimator light field, two light fields were considered of area 12.5 cm x 12.5 cm and 22.5 cm x 17.5 cm to represent smaller and larger image sizes respectively. The total misalignment, the sum of the vertical and horizontal values were: 2.0, 2.4, 1.0, 3.0 and 1.8 cm for the 22.5 cm x 17.5 cm collimator light field size and 2.1, 2.3, 0.8,2.5 and 1.7 cm for 12.5 cm x 12.5 cm collimator light field size corresponding to H1, H2, H3, H4, and H5 respectively. All the X-ray machines of the five selected hospitals showed satisfactory compliance of X-ray beam / Light field congruency test. However, it was found that significant differences in total misalignment of collimation of the X-ray machines in H3 and H4 between the smaller and the larger image sizes and hence need for collimator adjustment. This shows that the collimator light field is to allow simulation and visualization of the size, shape, and location of the X-ray field and it is important that the light field be approximately congruent to the X-ray field.

Keywords: X-ray beam; misalignment; x-ray machines; light field congruency

INTRODUCTION

Quality Assurance [QA] in diagnostic radiology is the planned and systematic action that provides adequate confidence that a diagnostic X-ray facility will produce consistently high quality images with minimum exposure of the patients and healing arts personnel. The determination of what constitutes high quality will be made by the facility producing the images. Quality assurance actions include both "quality control techniques and "Quality Administration" procedures (Walter& Richard, 1992).

Quality control techniques are those techniques used in monitoring or testing and maintenance of the components of an X-ray system. The Quality control techniques thus are concerned directly with equipment (Machines). A diagnostic imaging quality assurance program is a regulatory requirement in the hospitals. An ineffective quality assurance program can lead to poor radiographs and increase unnecessary radiation dose to both patients and staff (World health organization, 2008). The goal of a radiology quality assurance program is to ensure the quality radiographs for accurate diagnosis. The code of safe practice for the use of X-rays medical diagnosis requires that each X-ray facility has an appropriate quality assurance program in radiation protection, to ensure accurate diagnosis, and to keep doses as low as reasonably achievable. This requires a system of regular checks and procedures. (Geoffrey and Justice, 2011)

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Hassan, et al (2011) covered a study on the quality assurance of diagnostic X-ray machines and assessment of the absorbed dose to patients and found out that The quality of an X-ray beam depends on high voltage across the machine, the thickness and the nature of the total filtration, and the properties of the target. The difference in doses due to the applied voltage (kVp) was found to range from 2.66 to 3.8. Therefore, it is recommended that recalibration should be repeated at regular intervals to establish dose levels applicable to current radiological practice that influence received patient doses. The compound and expanded uncertainties accompanying these measurements are 4 ± 0.35% and 8 ± 0.7%, respectively.

Dabukke, et al (2018). covered a research on Quality Control Parameters of Illumination, Collimation and Half Value Layer on X-Ray General Radiography and Mobile Radiography, the results of the illumination test on general and mobile radiography pass the test because the results of illumination test ≥ 100 Lux. Testing the quality of X-ray beam (HVL) produced by general radiography and mobile radiography variation of tube voltage of 70 kilo Volt, 80 kilo Volt and 20 mAs. From the filter variations used, the filter that used increased, radiation dose increased, and the filter increased case the radiation dose is decreased and the quality of the beam will increased. It will conclude that both of the radiography is still on tolerance limits.

Methodology and Techniques used

The research was carried out in five X-ray centers diagnostic radiology hospitals in Jos north local government area of Plateau state. To carry out the misalignment test, the X-ray source was first positioned over the tabletop so that the indicated distance, Source to Image Distance (SID) from the source to the tabletop is 100 cm and locked in position. The measuring tape was then used to verify the Source to Image Distance (SID). The system was ensured to be on manual

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mode and Visual inspection was then carried out on the collimator to verify that the collimator face (glass or plastic) is clean and transparent otherwise the collimator's face must first be wiped clean before proceeding. The collimator was then positioned perpendicular to the tabletop. The collimator light was then turned on. A loaded radiographic film cassette of 12'' X 10'' was then placed on the tabletop and was centred in the light field. The collimator was then adjusted to give the required light field sizes. The eight coins were then positioned such that it marks the edges of the four sides (Top, Bottom, Right and left) of the light field as shown in figure 2. Two coins on each side, one marking the edge from within the light field and the other from outside the light field, using the 2.25 inches coins as a position marker.With the coins in position and the collimator light field adjusted, the exposure was made to give a medium density using an exposure factor of 60 kVp and 15 mAs. The film is then developed using the manual processor and inspected on a radiographic viewing box.

RESULTS

Table 1: Light Field/X-Ray Beam Alignment Test Results for 12.5 Cm X 12.5 Cm Light Field

MACHINE CODE	MISALIGNMENT				MISALIGNMENT FIELD		TOTAL MISALIGNMENT (cm)	REMARK
	right (cm)	left (cm)	top (cm)	bottom (cm)	y-axis (cm)	x-axis (cm)		
H1	0.3	0.5	0.7	0.6	1.3	0.8	2.1	PASSED
H2	0.9	0.8	0.3	0.3	0.6	1.7	2.3	PASSED
H3	0.2	0.3	0.1	0.2	0.3	0.5	0.8	PASSED
H4	0.2	0.6	0.8	0.9	1.7	0.8	2.5	PASSED
H5	0.8	0.5	0.2	0.2	0.4	1.3	1.7	PASSED

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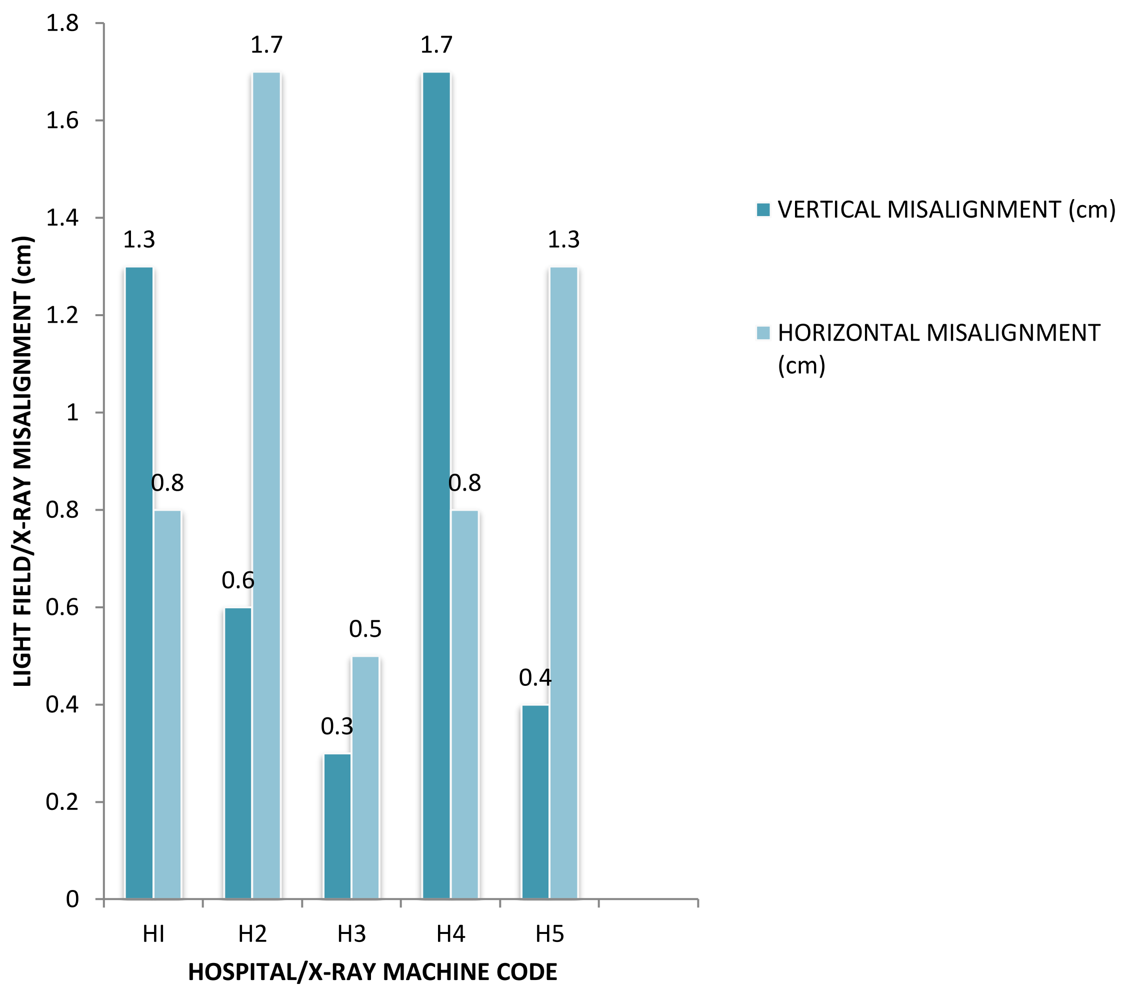

Figure1: A Bar Chat Representing the Light Field/X-Ray beam Alignment Test Results on the 12.5 cm x 12.5 cm Collimator Light Field.

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HOSPITAL /X-RAY MACHINE CODE	MISALIGNMENT				MISALIGNMENT FIELD		TOTAL MISALIGNMENT (cm)	REMARK
	right (cm)	left (cm)	top (cm)	bottom (cm)	y-axis (cm)	x-axis (cm)		
H1	0.6	0.1	0.7	0.6	1.3	0.7	2.0	PASSED
H2	1.0	0.8	0.3	0.3	0.6	1.8	2.4	PASSED
H3	0.1	0.4	0.3	0.2	0.5	0.5	1.0	PASSED
H4	0.4	0.6	1.0	1.0	2.0	1.0	3.0	PASSED
H5	0.9	0.5	0.2	0.2	0.4	1.4	1.8	PASSED

Table 2: Light Field/X-Ray Beam Alignment Test Results for 22.5 Cm X 17.5 Cm Light Field

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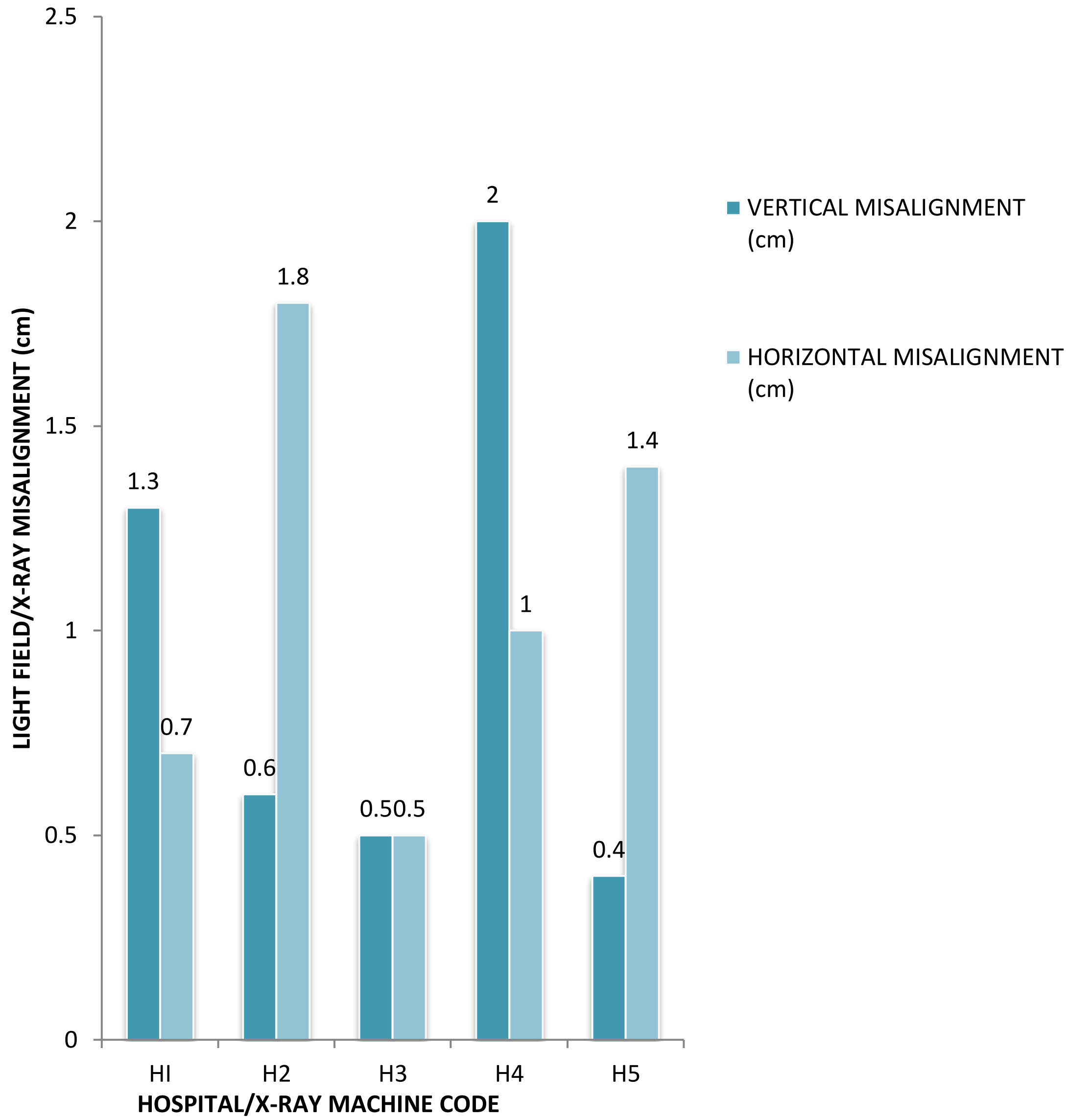

Figure 2: A Bar Chat Representing the Light Field/X-Ray beam Alignment Test Results on the 22.5 cm x 17.5 cm Collimator Light Field.

4.2 DISCUSSION

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Table1 and Figure 1 represents the vertical and horizontal deviation of the light field and X-ray beam misalignments of the 12.5 cm x 12.5 cm collimator light field of the various X-ray centers, the percentage misalignment for the vertical axis were: 1.3, 0.6, 0.3, 1.7, and 0.4cm corresponding to H1, H2, H3, H4, and H5 respectively. While the percentage misalignment for the horizontal axis were: 0.8, 1.7, 0.5, 0.8, and 1.3cm corresponding to H1, H2, H3, H4, and H5 respectively. The most vertically misaligned (1.7cm) correspond to 1.7% of the source to the image distance (SID) was recorded on X-ray machine H4, while H2 recorded the most horizontal misalignment of 1.7cm corresponding to 1.7% of the source to the image distance (SID). H3 was seen to have the least misalignment of 0.3cm and 0.5cm on the vertical and horizontal misalignment test respectively. From the analysis, all X-ray machines observed passed the light field and X-ray beam misalignment test is having misalignments of values below the AAPM set limit of 2.5cm (2.5% of the SID) vertical and horizontal misalignment.

Table 2 and Figure2 represent the light field and X-ray beam misalignment test using a larger collimator light field of 22.5 cm x 17.5 cm. It was observed that, H1, H2, H3, H4, and H5 had vertical misalignment of 1.3, 0.6, 0.5, 2.0, and 0.4cm, with a horizontal misalignment corresponding to 0.7, 1.8, 0.5, 1.0, and 1.4cm respectively. X-ray machines (H4 and H2) recorded the highest vertical and horizontal misalignment of 2.0cm and 1.8cm respectively corresponding to 2cm and 1.8cm of the source to the image distance (SID). Even though H4 recorded the highest misalignment value, this value was seen to be below the AAPM 2.5cm (2.5% of SID) set limit for vertical and horizontal misalignment. Hence H4 passed the light field and X-Ray misalignment test. The least misaligned as shown in figure 1 were H5 representing

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the least vertical misaligned corresponding to 0.4cm while H3 represents the least horizontal misaligned corresponding to 0.5cm.

The total misalignment, that is the sum of the misalignments recorded at the top, bottom, left, and right sides of the light field and X-ray beam in the 12.5 cm x 12.5 cm collimated light field a shown in Table 1 was: 2.1, 2.3, 0.8, 2.5, and 1.7cm corresponding to H1, H2, H3, H4, and H5 respectively. For the 12.5 cm x 12.5 cm collimator light field, it was shown that the most misaligned was H4 and the least misaligned was H3, while the sum of 22.5 cm x 17.5 cm collimated light field recorded the following values: 2.0, 2.4, 1.0, 3.0, and 1.8cm corresponding to the total misalignment of H1, H2, H3, H4, and H5 respectively. For the 22.5 cm x 17.5 cm collimator light field it was shown that the most misaligned was H4 and the least misaligned was H3.Considering the vertical misalignment of the 12.5 cm x 12.5 cm collimator light field, the range (numerical difference between the most and least misaligned) was 1.4cm while the horizontal was 1.2cm. The range on the vertical and horizontal misalignment test of the 22.5 cm x 17.5 cm collimator light field were, 1.6cm and 1.3cm respectively and the range of the total misalignment on the 12.5 cm x 12.5 cm and the 22.5 cm x 17.5 cm were, 1.7cm and 2.0cm. The light field and X-ray misalignment test carried out on the five X-ray machines using the 12.5 cm x 12.5 cm and the 22.5 cm x 17.5 cm collimated light field shown similar correlation. In comparison with pervious works done on assessment of quality control tests on beam alignment, collimation and x-ray beam filtration by Ismail et al., 2015, Okeji et al., 2016, Akagerger et al., 2016 and Ike-Ogbonna et al., 2017, result of some of the studied hospitals have good level of compliance with the recommended standard for most of the x-ray machines ,while some showed a high level of machines non compliance to the recommended standard

Conclusion and Recommendation

Quality radiographic practice in diagnostic radiology departments is very important for reduction of radiation doses to patient, personnel and members of the public. Light field and X-ray beam misalignment has a significant effect in the quality of radiographic examinations and may result to radiographic repeat and exposure of areas with little or no diagnostic interest hence increase in patient radiation dose. Therefore, there should be a routine light field and X-ray test on X – ray equipment to check and correct unwanted exposure and maintaining international safe practices. Some of the X-ray machines need manual adjustment for the X-ray beam to become perpendicular to the image receptor (Ike-Ogbonna, et al 2017).

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