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EVALUATION OF IMAGE QUALITY OF PLAIN PELVIS ANTERIOR POSTERIORRADIOGRAPHS AT UNIVERSITY OF MAIDUGURI TEACHING HOSPITAL, NIGERIA.

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ABSTRACT

Background: The usefulness of a diagnostic radiograph depends on the quality of the image produced. Image quality (IQ) refers to the accuracy with which the examined anatomic structures are reproduced on the image receptor. Regular quality assurance (QA) testing has been recommended for sustaining good practice in diagnostic imaging

Objectives: To determine the quality of pelvis radiographs and its common faults.

Method: A retrospective study was conducted on plain pelvis radiographs produced at UMTH between 2014 and 2016, was assessed using European Commission Guidelines

Data Analysis: Descriptive statistics such as frequency and percentages were generated from the data and analyzed using a statistical package for social sciences (SPSS Version 21.0).

Result: A total of 163 adult plain AP pelvis radiographs consisting of both male and female were evaluated. Out of the reviewed radiographs 55.2% (n=90) were obtained using computed radiography (CR) system while 44.8% (n=73) were obtained using film screen system. Based on the technical parameters only 61.0% (n=99) were adequate, these are those that met all the technical parameters while 39.0% (n=64) of the radiographs were poor. The overall image quality score for pelvis radiographs was found to be 59.2% (n=96) met the recommendation criteria defined by CEC while 40.8% (n=67) were inadequate. This is due to poor radiographic technique and ineffective quality assurance/control program.

Conclusion: Pelvis radiographs were having a good quality in UMTH within the period studied.

INTRODUCTION

The usefulness of a diagnostic radiograph depends on the quality of the image produced. Image quality (IQ) refers to the accuracy with which the examined anatomic structures are reproduced on the image receptor. Regular quality assurance (QA) testing has been recommended for sustaining good practice in diagnostic imaging [1]. Image quality is usually defined for specific tasks and could be studied physically or subjectively, the aim of quality control (QC) is to define the levels of acceptability of radiographs in order to satisfy set clinical targets [2]. The best way to assess quality of an image is perhaps to look at it because human eyes are the ultimate receivers in most image processing environment [3]. The reliability and validity of image quality assessment methods are crucial in medical imaging [4]. The Basic Safety Standard (BSS) require attention to the image quality and to consider corrective actions if patient exposure do not provide useful diagnostic information and do not yield medical benefits to patients. Image of poor quality have been reported in earlier studies to be as much as 15-40% of all images. Poor quality images result in unnecessary radiation exposure to patients through repeated radiographic examination [5]. The objective of image quality assessment is to provide computational models to measure the perceptual quality of a given image [6]. Quality control (QC) is important because it reduces practices that could adversely affect expected patient outcomes and therefore justify the process of patient irradiation [7]. A plain radiographic examination is the most common basic examination whereby the clinical image quality should systematically assessed by the organization. A diagnostic adequate plain radiographic examination improves patient care and reveals the competence of a radiographer [8]. Image quality (IQ) is likely to be compromised when imaging obese patients. As the thickness of the body part under investigation increases the quantity of scattered radiation increase. A number of techniques exist which can sustain image quality [9]. AP pelvis radiography was chosen for this work because the pelvic region includes the reproductive organs which are the 2nd most radiosensitive organ, according to the ICRP, 2007. Also because AP pelvis has been reported to be 3rd most frequently performed examination in the diagnostic centers [10]. Therefore, this study was aimed to determine the quality of pelvis radiographs and its debilitating factors

METHODS

A retrospective survey study was conducted. Pelvis radiographs, obtained between January 2014 and December 2016, in the radiology department of University of Maiduguri Teaching Hospital (UMTH) were reviewed. Ethical clearance to conduct the research was obtained from the research committee of the institution. Quality assessment was done in two parts: first was identification of technical parameters such as patient's identification, presence of anatomical marker, evidence of adequate collimation, patient rotation, penetration and use of Gonad shield.Second was assessment of image quality from the guidelines recommended by the European commission was adopted these were: Visualization of the sacrum and its intervertebral foramina, visualization of the pubic and ischial rami, visualization of the neck of the femora, visualization of the pelvis as judge by the imposition of the symphysis pubis over the midline of the sacrum, visualization of the sacroiliac joints and visualization of the spongiosa and corticalis, and of the trochanters.

RESULTS

A total of 163 plain adult antero-posterior (AP) pelvis radiographs of both male and female patients were retrieved from the x-ray film archive of University of Maiduguri Hospital. Out of the 163 radiographs, 90(55.2%) were obtained using computed radiography (CR) system while 73(44.8%) were obtained using film screen system. The technical parameters and image criteria based on European commission guidelines used are shown in Table 4.1 and 4.2 respectively. Table 4.1 below shows the total number of radiographic technical parameter were in item one shows 153(93.9%) of the radiographs are having x-ray number and 10(6.1%) does not have, this suggest that majority are having x-ray number. Item two shows that 156(95.7%) of the radiographs have their date of examination and absent in 7(4.3%), this suggest that majority are having date of examination. In Item three it shows in 73(44.8%) of the images name of institution is present and absent in 90(55.2%), this reveal that in majority of the radiographs name of institution were absent. Item four shows that 148(90.8%) of the radiographs have marker and absent in 15(9.2%), this suggest that the majority are having marker. Item five

shows that 67(41.1%) of the radiographs have rotation and 96(58.9%) does not have. This reveals that majority are not having rotation. Item six shows the absent of Gonad shield in all the reviewed radiographs 163(100%). Item seven shows 84(51.5%) of the radiographs were having 0 collimation, 15(9.2%) were having 1collimation, 16(9.8%) were having 2 collimation, 20(12.3%) were having 3 collimation and 28(17.2%) were having 4 collimation. This Suggest that the majority 84(51.5%) are having 0 collimation. Item eight shows penetration is adequate in 72(44.2%) radiographs, inadequate in 64(39.3%) and poor penetration in 27(16.6%). This suggest that the majority 72(44.2%) are having adequate penetration.

Table 1. Result of assessed Radiographic technical parameters

S/N	PARAMETERS	YES	NO
1.	PATIENT'S ID		
	X-ray number	153(93.3%)	10(6.1%)
	Date of examination	156(95.7%)	7(4.3%)
	Name of institution	73(44.8%)	90(55.2%)
2.	MARKER	148(90.8%)	15(9.2%)
3.	ROTATION	67(41.1%)	96(58.9%)
4.	GONAD SHIELD	0(0.0%)	163(100%)
5.	COLLIMATION	0 1 2 3 4	
		84(51.5%) 15(9.2%) 16(9.8%) 20(12.3%) 28(17.2%)	
6.	PANETRAT ION	Adequate Inadequate Poor	
		72(44.2%) 64(39.3%) 27(16.6%)	

Table 2 Commission of European Guideline image criteria

S/N	CEC IMAGE CRITERIA	CODE
1	Symmetrical reproduction of the pelvis as judge by the imposition of the symphysis pubis over the midline of the sacrum	IC1
2	Visually sharp reproduction of the sacrum and its intervertebral foramina	IC2
3	Visually sharp reproduction of the pubic and ischial rami	IC3
4	Visually sharp reproduction of the sacroiliac joint	IC4
5	Visually sharp reproduction of the neck of the femora which should not be distorted by foreshortening or rotation	IC5
6	Visually sharp reproduction of the spongiosa and corticalis and that of the trochanters	IC6

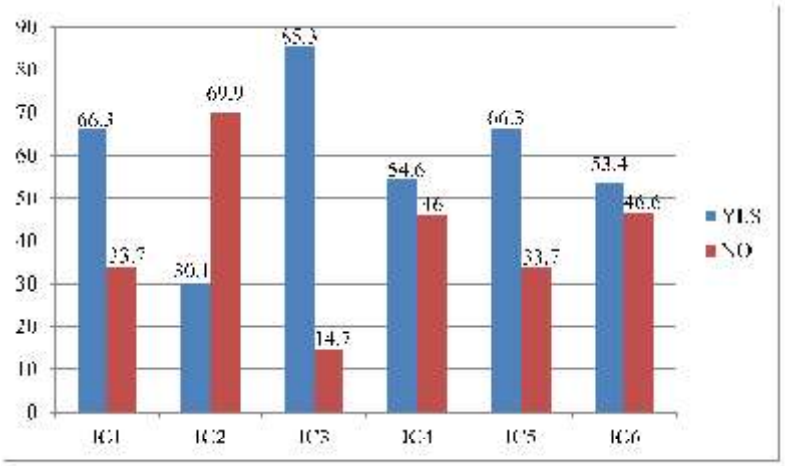

Figure 1 Result of assessed CEC image criteria

DISCUSSION

The efficacy of a diagnostic radiograph is largely depends on the quality of the image produced [11]. Image quality refers to the level of accuracy in which different imaging systems capture, process, stored, compress, transmit, and display the signals that form the image, in other word is the accuracy with which the examined anatomic structures are reproduced on the image receptor. In this study, the pelvis AP radiographs were evaluated based on the Commission of European Guideline image criteria for image quality and radiographic technical parameters (rotation, marker, collimation, patient ID etc.).

This research work has shown that the overall image quality score for plain pelvis AP radiographs was found 59.2% (n=96) to be adequate and 40.8% (n=67) are poor and for the overall technical parameter was found 61.0% (n=99) to be adequate and 39.0% (n=64) are poor out of the 163 radiographs reviewed. This is in contrast with the study conducted by Inah *et al*., [12] reported that good image performance was 68% of the radiographs as all the criteria for good image were met. Joshi and Bhusal [13] also reported out of the studied radiographs, only 13% fulfilled all the image criteria, the rest 87% lacked one or more of the criteria, in this study it was reported that the quality of the pelvic radiographs depends on skill of radiographer, equipment condition, and co-operation of the patients. The difference in the result of this study compare to other work is due to variation in equipment type and age, departmental protocol and technique, Radiographer training.

All image quality criteria assessed obtained scores above 50%. However, IC2 (visualization of the sacrum and it intervertebral foramina) appear to be area of comparatively reduced quality. This could be due to poor or inadequate penetration of the x-ray beam which is as a result of improper selection of the exposure factors by the Radiographer or due to weak chemical when using a film screen system. This can be overcome by proper selection of exposure factor based on body part under examination and also replace chemical appropriately.

For the technical parameters, the use of gonad shield is necessary in pelvis radiograph unless it obscures the anatomy of interest. The gonad shield is different for male and female patients. This study showed no evidence of usage of gonad shield. Optimization of technique is necessary in terms of ALARA [14]. In this work collimation was adequate in only 17.2% (n=28) of the 163 reviewed radiographs while 82.8% (n=135) had poor collimation, This is not in line with a work done Inah *et al.,* [15] which reported that only 1.1% out of the 194 radiographs reviewed had adequate collimation while in 98.9% of the radiographs collimations were poor, also Joshi and Bhusal [16] found that only 41.7% of the radiographs had adequate collimation while inadequate in 58.2%, this is due to poor beam restriction during radiographic procedure, which is one of the bad practice in relation to radiation protection in the medical imaging department. This study shows only 16.6% (n=27) have poor penetration, inadequate in 39.3% (n=64) and has adequate penetration in 44.2% (n=72), this shows disparity with a work conducted by Shettima *et al*., [17], the work revealed that penetration was adequate in 55.8%, inadequate in 14.2% and poor in 30.0% of the 260 reviewed radiographs, The disparity could be due to selection of improper exposure parameters and also due weak chemical when using a film screen system. Rotation is one of the technical factor studied, the result from this study shows patient rotation in 41.1% (n=67) while 58.9% (n=96) showed no evidence of patient rotation, this does not match with a study done by Shettima *et al*.,[18], out of the 260 radiographs reviewed only 47.7% of the radiographs had no evidence of rotation while 52.3% showed patient rotation due to patient's comfort and ability to maintain position during examination, similarly in a work done by Inah *et al.,* [19], it shows that 52% of the assessed radiographs had no evidence of patient rotation while 43% were labeled 'fair' and 5% of the images showed evidence of poor patient positioning. Joshi and Bhusal [20] found out that rotation is one of the major causes of poor image quality, the study found rotation in 60.9% and no rotation in only 39.1% of the radiographs reviewed, the dissimilarity in these studies could be due to improper positioning during the procedure by the radiographer or due to patient condition that makes it difficult for them to adopt the proper position. Anatomical marker is the highest fulfilled technical parameter as evidenced show 90.8% (n=148) of the radiographs has anatomical marker while absent in only 9.2% (n=15). Various studies showed the most fulfilled technical parameter is presence of anatomical marker, Shettima *et al*.,[21] study

showed the presence of anatomical marker on 91.5% of the reviewed radiographs, Similarly in a study done by Inah *et al.,* [22] 93.6% had anatomical marker. Also in a work done by Egbe *et al* [23] in which the study was carried out in 3 hospitals, the results are as follows 86%, 52.6%, and 54.55% showing the presence of anatomical marker. Anatomical marker is the most fulfilled parameter in most study because a film cannot be pass for reporting without anatomical marker, and also marker serves as the first step in identifying anatomical region under examination especially during film reporting in other to avoid misdiagnosis. In this study patient's ID was categorized into presence of x-ray number, date of examination and name of institution. This revealed 93.3% had x-ray number while absent in 6.7%, 95.7% had the date of examination present while absent in 4.3%, 44.8% had name of institution present and absent in 55.2%. In general patient's ID was adequate in 78.1% (n=127) while absent in 21.9% (n=36) of the radiographs reviewed which is lower than the result of Inah *et al* [24] which shows correct patient's identification in 93% of the 194 films studied, 4% were poorly identified and no evidence of patient's identification in 3% of the reviewed radiographs, The result of this study is lower than that of Inah *et al*., because they have higher sample size (194) than this study (163).

CONCLUSION

Pelvis radiographs produced in the University of Maiduguri Teaching Hospital during this study have an overall average image quality performance in compliance with the European commission guidelines.

RECOMMENDATION

The result obtained in this study discovered that radiographic technical parameters are the factors that attributed to poor image quality. This suggests the need for improvement of image quality through quality assurance/quality control program and optimization of radiographic procedure to improve image quality performance in the area of study.

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