Evaluation of Image Quality of Plain Abdominal Radiographs at University of Maiduguri Teaching Hospital, North-Eastern Nigeria.

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Abstract

Objectives: To determine the quality of abdominal radiographs, and common factors that affect them.

Method: A retrospective non experimental study was conducted on abdominal radiographs produced at UMTH between 2010 and 2015, assessing its quality using European commission guidelines and radiographic technical parameters as criteria.

Data Analysis: Descriptive statistics such as frequency and percentages were generated from the result and the data was analyzed using a trial version of statistical package for social sciences (SPSS Version 16.0).

Results: A total of 260 adult abdominal radiographs were evaluated of which 79.2% (n=206) were supine and 20.8% (n=54) were erect abdominal radiographs. Out of the radiographs studied, 21.2% (n=55) were obtained using computed radiography system while 78.8% (n=205) were obtained using film-screen system. Based on the radiographic technical parameters only 50.6% (n=132) were of optimal quality. While 49.4% (n=128) of the radiographs were sub-optimal quality. The overall image quality score for abdominal radiographs was 3.8% (n=10) optimal and 35.8% (n=93) very poor. This is due to poor radiographic technique and ineffective quality control protocol.

Conclusion: The Abdominal radiographs were of very poor quality in UMTH within the period studied.

Keywords: image quality, Abdomen, Radiographs.

I. Introduction

Image quality is a characteristic of an image that measures the perceived image degradation. Image quality is a broad term which can mean different thing to different people. For instance, a Radiologist when viewing a radiograph may be interested primarily in the diagnostic value of an image while Radiographer may focus on how well the images represent the anatomy [1].

Image quality of a radiograph is determined by the imaging process and the characteristics of the equipment and the imaging system variables selected by the operator. It is not a single factor but is a composite of contrast, blur, noise, artifact [2]. Medical image quality is also related to the subjective interpretation of visual data. It represents the clinical information contained in the image. It is more important that the observer interpret the image appropriately than whether the appearance of the image is pleasing to the eye. The ideal set of parameters to describe image quality should measure the effectiveness with which an image can be used for its intended purpose [3].

Regular quality assurance (QA) testing should be carried out for sustaining good practice in diagnostic imaging is important because it reduces practices that could affect expected patient outcomes and therefore justify the process of patient irradiation. It aims to ensure that every image produce is of diagnostic value in order to satisfy set of clinical targets [4].

Assessment of image quality (using physical or visual techniques) is a low order task as the results are commonly used to infer whether an image is fit for its intended purpose. Studies of image quality are essential for optimization of the radiography processes in any clinical settings [5].

Guidelines have been set up by the European Commission (EC) for assessing the basic aspects of quality for clinical radiographic images dependent on techniques and imaging performance [3].

Generally, high image quality provides maximum information, improve the chance for correct diagnosis and ultimately contribute to quality patient care.

Plain abdominal radiography can be readily obtained within a short period of time to help a physician arrive at a correct diagnosis [6], thus, it is among the commonly requested investigation for patients with abdominal symptoms, particularly in the Accident and Emergency (A & E) departments [7]. They can also be used in assessing levels of patient preparation for contrast based examinations of the gastrointestinal tract (GIT) [8].

Plain abdominal x-ray involves exposing part of the body (Abdomen) to a dose of ionizing radiation to provide the image of the organs within the abdomen and the common projections are the Antero-posterior Supine and Erect. Standard abdominal radiograph should include the area from diaphragm to the pubic symphysis [9]. Abdominal x-ray should be performed only for a valid medical reason and with the minimum radiation dose necessary to achieve a diagnostic study [9].

II. Methods

A retrospective survey study was conducted. Abdominal radiographs, obtained between January 2010 and December 2015, 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 complete patient identity, correct placement of anatomical marker, silver lining showing evidence of adequate Collimation, symmetry of anatomical parts showing evidence of no rotation of patient to one side, Blurring (motion) Penetration and Artifact

Second was assessment of image quality from the guidelines recommended by the European commission were adopted [10] these were:

Area of coverage, visualization of kidney outline,visualization of psoas major muscle, visually sharp reproduction of bones and image centralization.

Radiographs were scored optimal quality if all the criteria listed were observed. A score of sub-optimal quality was given to films with three or more, but less than the six listed criteria, while Poor quality was given for films with less than three listed criteria.

III. Results

A total of 260 adult supine (n=206) and erect (n=54) abdominal radiographs of both male (n=160) and female (n=100) were evaluated. A total of 21.2% (n=55) of the radiographs were obtained using computed radiography system while 78.8% (205) were obtained using film-screen cassette.

Results of the evaluation of technical parameters shows that, Presence of Anatomical marker was the highest fulfilled technical parameter as evidenced on 91.5% (n=238) of the radiographs. This is followed by motional blurring having 68.1% (n=177). Penetration was adequate in 55.8% (n=145) of the radiographs, inadequate in 14.2% (n=37) and poor in 30.0% (n=78). A total of 47.7% (n=145) of the radiographs had no evidence of rotation while 52.3% (n=136) showed evidence of rotation. Artifacts were present in 40.8% (n=106) of the radiographs while 59.2% (n=154) had no artifacts. Patient identification was adequate in 21.9% (n=57), inadequate in 66.9% (n=174), and poor in 11.2% (n=29). The least fulfilled technical parameter was beam collimation with only 18.8% (n=49) recorded as adequate, 6.9% (n=18) as inadequate and 74.2% (n=193) as poor/none collimation. The overall radiographic technical parameter shows that 50.6% (n=132) of the abdominal radiographs were of optimal quality while 49.4% (n=128) were of sub optimal quality (Table 1.0).

On the other hand, results of Assessment of image quality of abdominal radiograph showed that; sharp visualization of bone 78.1 %(n=203) as a parameter of image quality has the highest percentage. This is followed by image centralization with 70.8% (n=184) and area of coverage 64.2% (n=167).

Visualization of Kidney outlines 9.6% is the parameter of image quality with the least percentage. Psoas muscle and Liver outlines were visible in 16.9% (n=44) 19.2% (n=50) and invisible in 83.1 %(n=216) 80.8% (n=210) respectively (figure 1.0).

Generally, 3.8% (n=10) of the radiographs were found to be optimal indicating that they fulfilled all the six criteria, 60.4% (n=157) were sub-optimal indicating that the radiographs fulfilled 3 above but less than six criteria while 35.8% (n=93) were poor/none which indicates that the radiographs failed to satisfy a criteria (scoring ≤ 2 criteria).

Table 1.0 Result of Assessed radiographic technical parameters.

S/n	Parameters	Frequency & Percentage (%) of films					
		Adequate		Not adequate		Poor/none	
1	Patient ID	57	21.9%	174	66.9%	29	11.2%
2	Anat. Marker	238	91.5%	-	-	22	8.5%
3	Collimation	49	18.8%	18	6.9%	193	74.2%
4	Rotation	124	47.7%	136	52.3%	-	-
5	Blurring (motion)	177	68.1%	83	31.9%	-	-
6	Penetration	145	55.8%	37	14.2%	78	30.0%
		Present		Not present			
7	Artifacts	106	40.8%	154	59.2%	-	-
		CR cassette		FS cassette			
8	Image receptor	55	21.2%	205	78.8%	-	-

		Supine		Erect			
9	projection	206	79.2%	54	20.8%	-	-

Patient ID= patient identification   FS= film screen
Anat. Marker= anatomical marker
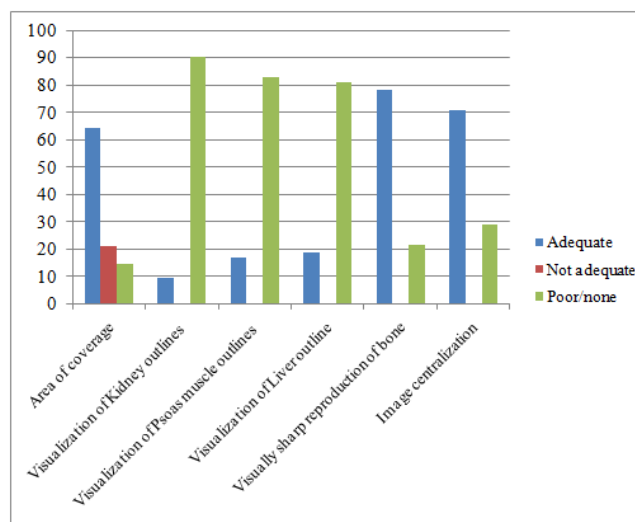CR= computed radiograph

Figure 1.0: Image quality criteria of plain abdominal radiographs

IV.   Discussion

The usefulness of diagnostic radiographs depends on the quality of the produced image [11]. Image quality is the integrated set of perception of the overall degree of excellence of an image [12]. The determination of quality should be conducted by measuring the performance of an observer for a diagnostic task. The outcome from the interpretation of a medical image is a clinical diagnosis and accuracy of that inference about the status of the human anatomy is imperative for successful patient treatment [13].

In this study, the abdominal radiographs were evaluated based on the radiographic technical parameters and image quality criteria defined by commission of European Communities (EC). Out of the 260 abdominal radiographs studied, only 50.6% (n=132) were adequate, these are those that met all the listed technical parameters while 49.4% (n=128) of the radiographs were inadequate. This is in line with a study conducted by inah *et al.,* [14] in which 194 radiographs were reviewed. They reported that only 57% (n=108) of the radiographs were adequate while 43% (n=83) of the radiographs had technical faults.

Collimation is one of the technical factors studied. Previous studies by Inah *et al.,* [14] reported that only 1.1% (n=2) of the radiographs had adequate collimation while 98.9% (n=192) were inadequate. Egbe *et al.,*[7] also found that only 47.8% (n=100) had adequate while 52.2% (n=110) were not adequate. Collimation was rated as inadequate in about 50% (n=22) of the images [15]. This varies from the present study which found that beam collimation is the most common factor that affect the quality of the radiographs with only 18.8% (n=49) having adequate collimation while 74.2% (n=193) had poor collimation. This may be due to misalignment of the beam or improper collimation during procedures which reveals poor adherence to radiation protection rules in the hospital. Adoption of proper beam collimation will reduce the potential harmful effect of ionizing radiation and improve the quality.

Another technical factor assessed in this study was the patient rotation. Egbe et al., [16] found that 40% (n=84) of the radiographs had rotation due to poor patient positioning, Muhammed et al.,[17] reported 16%, Inah *et al.,* [14] reported 47.7% (93) and Oliveira et al.,[15] reported 20% (9). In this study we found that 52.3% (136) of the radiographs had rotation which is not in agreement with the above reported values. Moreover the value from this research is higher than their findings; so may be differences in the condition of patient in the different studies, patient's comfort and ability to maintain position during examination.

Artifacts were present in 40.8% (n=106) of the radiographs studied and most of the artifacts found in this study were due to improper fixation (thiosulphide deposit) affecting most of the radiographs produced in 2012 and 2015. This should be in agreement with Jeanne *et al.,*[18]who discovered that the major causes of poor quality images were due to the existence of artifacts with 75% and 100% of the radiographs being affected in hospital 1 and hospital 3 respectively.

With regard to the image quality criteria assessed,kidney outlines were visualized in 9.6% (n=25) of the radiographs while psoas major muscle outlines was visible in 16.9% (n=44). This is most likely due to the selection of improper exposure factors.

Another criteria studied was the area of coverage. In a study carried out by panthagani *et al.,*[19]. It was reported that 56% of the radiographs were fairly covered while 28% were poorly covered. This is higher than the present study which found 21.2% were fairly covered and 14.6% were poorly covered.

In the present study we found that the overall image quality score for abdominal radiographs was 3.8% (n=10) adequate, 60.4% (n=157) not adequate and 35.8% (n=93) very poor this could probably be due to old machines. This is in contrast with the studies conducted by Egbe *et al.,* [16] who reported 50.9% adequate and 6.61% poor and most probably repeated or rejected. In the same vein, Muhammed *et al.,* [17] found that more than 40% of the radiographs were not adequate majorly due to overexposure. Ahmed *et al.,* [20] on the other hand found that up to 70.4% of the radiographs were adequate while 19.3% were not adequate. Jameela *et al.,* [21] reported that the observed high percentage of poor image quality is likely due to an absence of quality assurance (QA) program in the study areas. We strongly believe that the disparity in the result of this study from other studies is due to variations in adopted protocols and techniques, personnel training and expertise as well as equipment type and age of the equipment.

V.   Conclusion

Abdominal radiographs produced in Univeristy of Maiduguri teaching hospital north eastern Nigeria reveals technically good individual criteria image performance but possess overall sub-optimal quality. A lot of improvement is needed in the area of study and this will largely be achieved by the implementations of QA programmes.

VI.   Recommendation

The result obtained in this study discovered that the factors attributed to low image quality include poor radiographic technique and ineffective quality control protocols. This indicates the need for improvement of quality assurance programme and optimization of radiographic procedure to enhance image performance in the study area.

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