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Does Availability of Image Post-Processing Facility on Digital Radiography Systems Influence Radiographers' Attitude Towards Proper Radiographic Technique? A Single Center Study

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Background: *Radiographers working in the Department of Radiology,University of Uyo Teaching Hospital (UUTH) Uyo started using Carestream Computed Radiography (CR) system in November 2012. The CR system has capability for image post-processing following radiographic exposure. Post-processing parameters include adjustment of contrast, latitude, brightness and cropping of images. These parameters may produce a final image that is quite different from what was initially acquired. The need for post-processing and the parameter adjusted can be an indicator to collimation andExposure factors (kVp, mAs), adopted by the radiographer during image acquisition.*
Aim: *To assess the influence of radiographic image post-processing on radiographers' attitude towards adopting proper radiographic technique*
Methodology: *A total of 1000 post-processed radiographic images of different body parts in commonly performed examinations were analyzed. The final post-processed, printed images were compared with the acquired images before post-processing with a view to ascertaining the diagnostic acceptability of the primary image before post-processing.*
Results:*Radiographers at UUTH used image post-processing tools excessively. Out of the 1000 radiographic images analyzed, contrast adjustment was highest at 91%, brightness, 83%, cropping, 86% and latitude, 22%.*
Conclusion*: It may be concluded that Radiographers gave little attention to proper radiographic technique selection and collimation, knowing that the radiographic image can be post-processed on the computer console. This does not augur well for patient radiation protection.*

Keywords: *Computed Radiography, radiographic image, post-processing, radiographic technique, radiographers*

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I. Introduction

Computed radiography (CR) and digital radiography (DR) are the commonly used terms for digital radiographic detectors. Computed radiography makes use of a photostimulable storage phosphor that stores the latent image with subsequent processing using a stimulating laser beam and can be adapted to a cassette-based system similar to that used in screen-film (SF) radiography. Historically, DR has been used to describe a digital x-ray imaging system that reads the transmitted x-ray signal immediately after exposure with the detector in place[1].

In November 2012 the Department of Radiology, University of Uyo Teaching Hospital began the installation of new sets of imaging equipment which included a new CarestreamDirectView Classic® Computed Radiography System (Carestream Health, Rochester, New York). Following an in-house training by the contractor, the CR system was subsequently put to use. Prior to this, radiographers in the department were using screen-film radiography. The acquisition of a good radiographic image using the screen-film set-up tended to require more careful technique from the radiographers. The cassette size had to be appropriate, collimation had to be exact and technique factors religiously selected according to body parts. This was to make sure a diagnostically accepted image was acquired and repeat exposure avoided, saving the patient and the radiographer from over-exposure to radiation.

There are several differences and advantages of Digital Radiography over screen-film radiography. These advantages make work somewhat easier for the Radiographer. Repeat of radiographic examinations are less because regardless of exposure technique, images taken can be post-processed. Storage phosphor responds to a wide dynamic range of x-ray exposures. This latitude gives flexibility in selectingradiographic technique factors without worrying about under-exposure or over-exposure[2].Unlike film–screen systems, the said flexibility and wide dynamic range in Digital radiography makes it relatively easy to unknowingly overexpose the patient[3]

In modern practice however, protection of patients from possible harmful effects of ionizing radiation is an important factor while considering image quality. ALARA (As Low As Reasonably Achievable) is a principle that stipulates that whenever ionizing radiation has to be applied to humans or animals, exposure should be as low as reasonably achievable. In other words, use only as much radiation as required to produce an optimal diagnostic image, not necessarily the bestpossible image quality that can be produced, if such image requires more radiation dose to the patient[4].

In developed countries where Dose Reference Levels (DRLs) are in use, radiographic exposures have been optimized during the transition from screen-film to digital radiography. Studies have shown that patient dose had suddenly increased in DR over conventional radiography for several body parts following the early days of transition. Optimization of practice, use of Automatic Exposure Controls and adherence to DRLs has helped to bring the doses down to acceptable levels[5]. The same is not the case in Nigeria including the University of Uyo Teaching Hospital. There is no AEC in use, no DRL and no exposure technique chart. A proper radiographic technique aims to reduce radiation dose to the patient by applying proper collimation to the body part being imaged, using recommended FFD and selecting optimalexposure factors for body each part. In UUTH, post-processing parameters adjusted in the CR system include contrast, latitude, brightness and cropping of images. The on-screen adjustment of these parameters produce a final image that is slightly or sometimes markedly different from what was initially acquired. The need for post-processing and the parameter adjusted is an indicator of the level of collimation and exposure factors (kVp, mAs), adopted by the radiographer during image acquisition and mayalso indicateother physical factors like patient bulk and equipment outputthat may have affected the dose received by the patient[4, 6, 7, 8].

II. Methodology

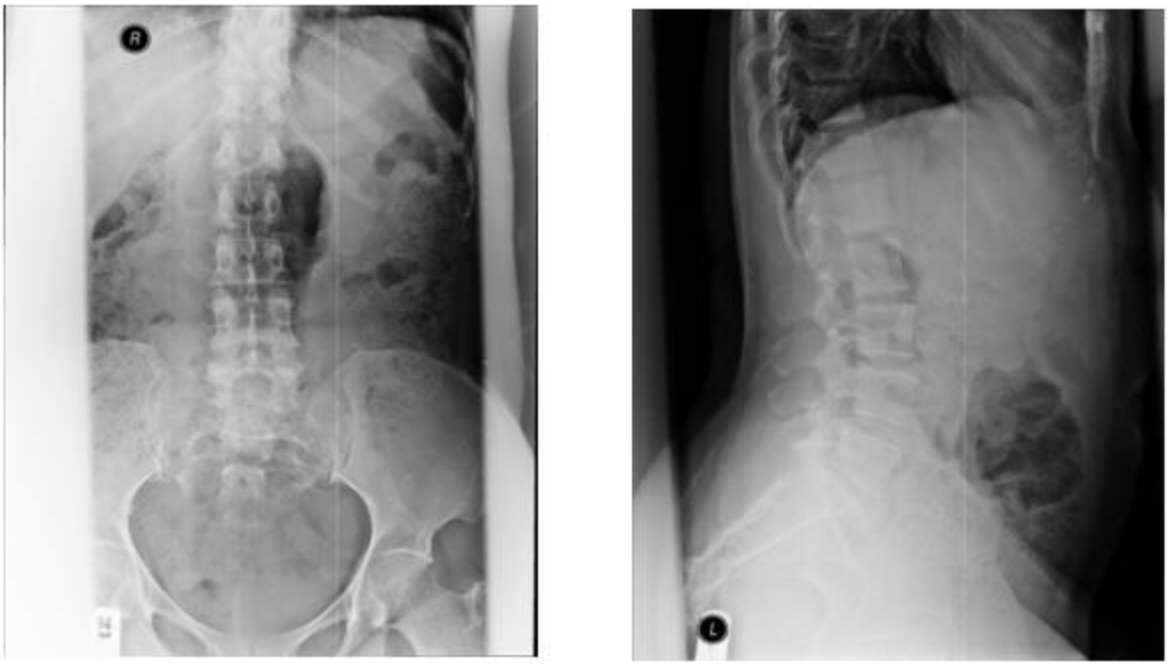
A total of 1000 post-processed radiographic images in commonly performed examinations were reviewed. The images were retrieved from the Carestream CR Internal Hard Drive covering the period January – October 2013. They included Chest, Cervical spine, Lumbar spine and pelvic images. The four parameters considered for post-processing included **cropping**, which is a secondary form of collimation; **brightness** which makes the image lighter or darker; **latitude** which increases or decreases the width of the image and **contrast** which increases or decreases the noise ratio.The final post-processed, printed images were compared with the acquired pre-processed images with a view to ascertaining the diagnostic acceptability of the primary image before post-processing was applied. An experienced Radiographer critiqued each pre-processed image and scored it as pass or fail and confirmed whether there was need for post-processing or not. Data was analyzed using Microsoft Excel 2007 and results presented using tables, charts and simple percentages.

III. Results

Chest image remains the most requested examination in the studied center as it is with many places around the world[9]. Chest represented 44.5% of the images analyzed while cervical spine constituted the lowest at 11.7% (Table 1).

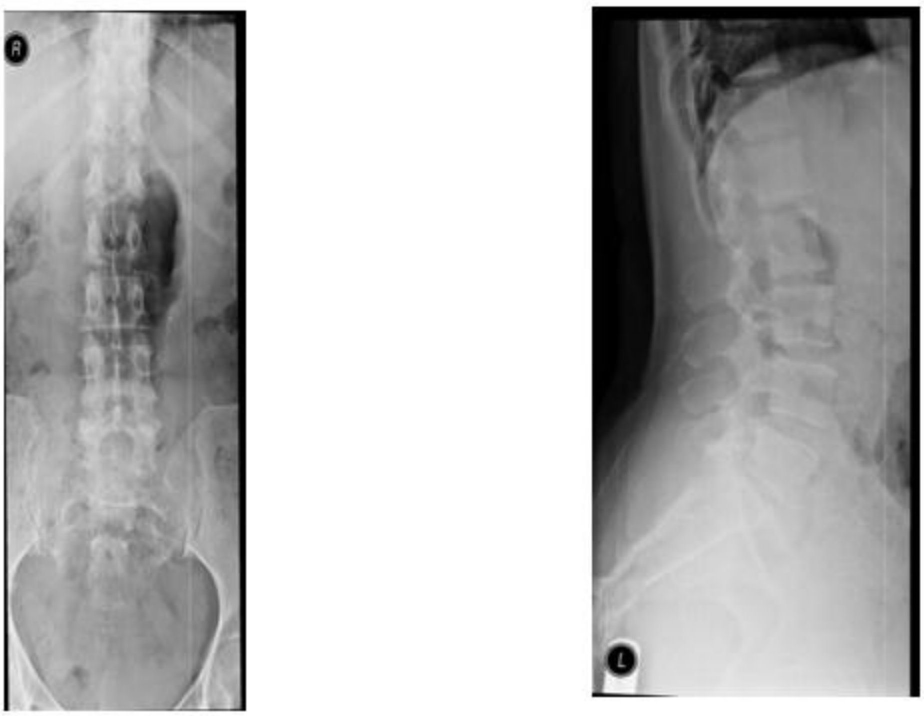
The number of images with contrast adjustment was highest (910), followed by the number of images that were cropped (860). Latitude was adjusted on the least number of images (220) (Figure 3).

Contrast and brightness were the most adjusted parameters on chest images while cropping and contrast were the most adjusted parameters on Lumbar, Cervical and Pelvic images (Table 2)



A

(A poorly collimated lumbar spine image irradiating more tissue mass than necessary)

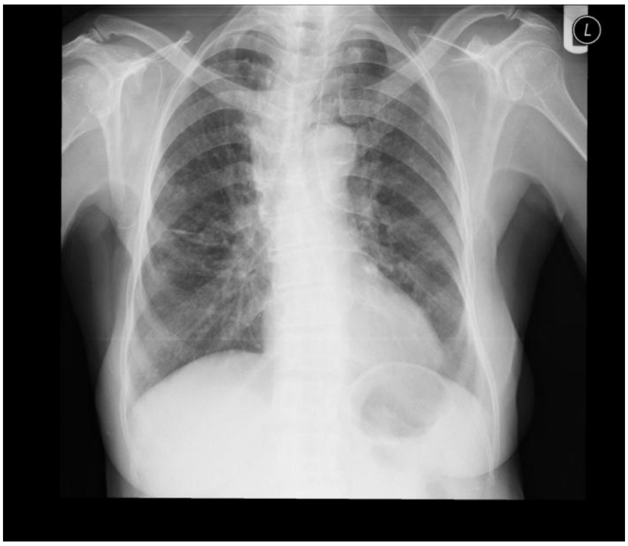


B

Figure 1: Image before post-processing (A) and Image after post-processing (B)

A

(An over-exposed Chest image (High mA Technique) deposits soft radiation on the patient and the final image require increased brightness and decreased contrast adjustment)



B

Figure 2: Image before post-processing (A) and after post-processing/cropping (B)

TABLE 1

Distribution of analyzed radiographic images according to body parts

BODY PART	FREQUENCY	PERCENTAGE (%)
Chest	445	44.5
Cervical spine	117	11.7
Lumbar spine	320	32.0
Pelvis	118	11.8
Total	**1000**	**100.0**

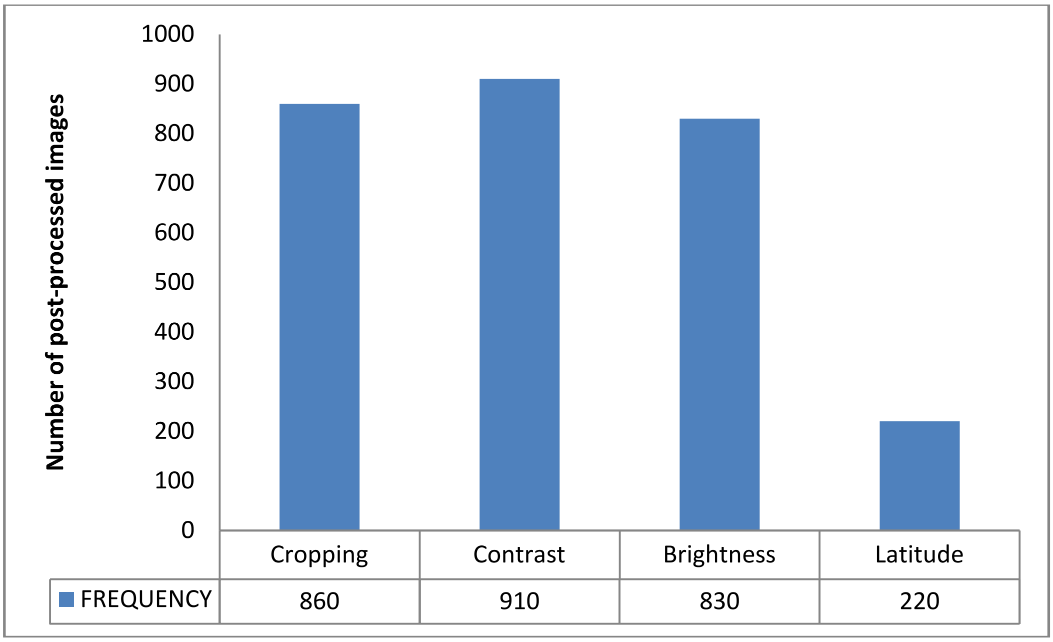


Figure 3: Distribution of post-processed parameters

TABLE 2: Distribution of post-processed parameters according to body parts

PARAMETERS	BODY PARTS			
	Chest	Lumbar spine	Cervical spine	Pelvis
Cropping	372	298	102	88
Contrast	430	296	91	93
Brightness	422	287	83	38
Latitude	0	145	70	5

IV. Discussion

This study aimed at assessing how the availability of image post-processing facilities in modern digital radiography systems affect radiographer's attitude towards proper radiographic technique. In doing this, 1000 radiographic images were analyzed. They included images of the Chest, lumbar spine, cervical spine and pelvis. These radiographic images were taken and passed by the combined effort of 20 different radiographers. Each radiographer had contributed several exposures based on the schedule of duty during the study period which lasted from January – October 2013.

The study showed that most of the radiographic images acquired were post-processed. Contrast was either increased (72%) or reduced (19%) in 91% of the images, 86% images were cropped, 83% had brightness increased (27%) or decreased (56%) while latitude was increased (20%) or decreased (2%) in 22% of the images. The post-processing adjustments were made in order to optimize the images before final printing.

Images that are too dark may suggest longer exposure time or high mA technique. Both are sources of higher exposure to the patient according to McFadden *et al*[6]. The high rate of contrast adjustment during post-processing in the study indicates that the rate of over-exposure and under-exposure was high.

Lack of tight collimation of beam to only areas of interest was probably the biggest issue affecting protection of patients as indicated by this study. Radiographers tend to not want to make mistakes like image cut-off; hence they open the beam wide enough and hope to crop it during post-processing. While this avoids repeat exposure, it gives more radiation to organs other than the ones that should be affected [9]. Poor collimation on lumbar spine x-ray means the gonads are exposed even when they could be spared in some patients. This practice negates the ALARA principle.

While radiation doses were not directly measured in this study, the use of excessive post-processing of images indicates poor radiographic technique. This may be due to lack of adequate training on quality control measures following transition from screen-film radiography to digital radiography. Studies in Europe and America have indicated that there was always a tendency for dose increase following transition to digital radiography. A 5-times higher dose was reported by Aldrich *et al*[3] while Geiger[4] reported doses twice as high in digital radiography compared to screen-film. The good thing in those climes however, is the constant effort to bring the patientdose down through constant research, practice optimization and staff retraining.

V. Conclusion

Computed Radiography which is a variation of Digital Radiography offers multiple advantages and capabilities over screen-film radiography. One of such capabilities is image post-processing. Due to its wide dynamic range, images can be made to look different from what was captured during initial exposure. This has led to neglect of proper radiographic technique by radiographers, with attendant over-exposure, in the hope that the computer can edit the image to whatever they desire.

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