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Research Article

ASSESSMENT OF COLLIMATION PRACTICES IN DIGITAL RADIOGRAPHY: IMPLICATIONS FOR PATIENT RADIATION EXPOSURE IN THE ERA OF DIGITAL IMAGING

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ABSTRACT

In this study, investigated whether collimation practices have deteriorated in the digital era of radiography. This study compared analogue and digital radiographs of the frontal lumbar spine, focusing on areas of diagnostic interest (ADI). By defining the ADI, study aimed to assess the extent of irradiation beyond these areas. Using raw-data of the irradiated field, study evaluated the proportion of the irradiated field outside of the ADI, finding that exhibited a significantly larger mean total field compared to analogue images. Specifically, in a subsample of 39 matched pairs showed a 46% increase in the mean total field size. This suggests that since the introduction of digital radiography, more accurate areas have been irradiated, potentially resulting in patients receiving unnecessary high doses of radiation. These findings underscore the importance of maintaining stringent collimation practices and optimizing radiation exposure in digital radiography to minimize patient risk and enhance diagnostic accuracy.

Key words:- Digital radiography, Collimation practices, Radiation exposure, Diagnostic imaging, Patient safety.

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INTRODUCTION

There was a need to keep the amount of radiation that patients were exposed to as low as was practicable in medical imaging. To achieve this, proper collimation was required [1]. There was a necessity to limit the area of diagnostic interest (ADI) of the irradiated field in order to reduce the dose, because the dose increases with the amount of irradiated area within the field of interest [2]. In daily practice, digital image processing programs can mask an unnecessarily large collimation such that you are not able to see whether the image has been collimated appropriately or if it has been edited electronically [3,4].

Consequently, proper collimation may be less likely to be undertaken if the motivation to do so is reduced. It should be noted, however, that this issue has not been examined in previous studies [5,6]. Therefore, the purpose of this article is to test a hypothesis that collimation practices in the field of radiography have deteriorated since the implementation of digital radiography since its implementation.

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MATERIAL AND METHODS

Before informing relevant staff of the study, the process of gathering the data was completed in order to avoid temporary changes to collimation practices. In order to avoid any temporary changes to collimation practices, the data had to be collected.

Samples

A total of 86 frontal radiographs were included, 50 from each. There were no changes in lumbar spine radiography procedures at either hospital. A study image was eligible if it was taken without fluoroscopic guidance, didn't reveal osteosynthesis materials, and was older than 18 years. Beginning with an arbitrary birthdate, the envelopes were examined for the last four years before 2000. Each hospital's sampled until the stated number was reached.

Collimation

Analog film sizes were measured with a ruler to assess collimation. Neither the radiography rooms' workstations nor the radiography rooms' preliminary images showed the total non-masked irradiated field. Workstation monitors were used to measure using physical rulers. Reduced-size monitors displayed the images. Each analogue and digital image was calculated based on the proportion of irradiated field outside of the ADI that was included in the calculation. Lastly, we compared the digital and analogue proportions outside the ADI. For this study, the ADI was defined based on literature, the standard projection and measurement considerations adopted. The area was defined as the area bordered cranially by vertebra S1, caudally by caudal border of 12th rib, and laterally by vertical lines at the transverse processes on each side. ADI distances were measured from each edge of the total irradiated field. Each measurement was made by the same observer. There were ten analogue and ten digital samples that were examined by this observer twice to assess measurable variations. Analogue measurements showed a mean (maximum) difference of 1.4% (7.8%) and digital measurements showed a difference of 2.0% (7.8%). ADI outside the cranial area was calculated by dividing cranial area height by total height of irradiated field multiplied by 100. There were 4 digital samples and 8 analogue samples without ADI, but they were included otherwise.

A mean irradiated field size of 100 square centimetres was calculated also. A measured mean value was used for analogue samples. Due to the smaller monitors, the measured mean value for digital samples was increased. A comparable ADI in square centimeters was assumed for both digital and analog samples. ADIs for analogue samples are divided by digital samples to calculate the scaling factor. According to digital samples, the total area irradiated by the radiation is equal to the measured area multiplied by f, based on the measured area. In the hospital, digital test samples of an embedded steel ruler supported the assumption that the ADI is the same size in square centimetres. Measured 10.0 cm with the steel ruler The ruler appears vertically at 5.2 cm and horizontally at 4.9 cm on the monitor. To calculate the ADI on this monitor, divide it by 1/(0.526 0.49). A digital samples had a mean area of 751 cm^2, which matched the mean area of analogue samples (773 cm^2). Due to reorganisation of radiography rooms, were unable to acquire test images of a ruler.

Analysis

The Mann-Whitney test was used to compare digital and analogue samples since histograms indicated that data distributions were not normal. As patient age may affect collimation, 39 digital and analog image pairs matched by patient age

RESULTS

In digital samples, irradiated fields were larger. Across both sides of the irradiated field, ADIs were farther away from the outermost edge of the irradiated field. There was also a significant difference between the amount of irradiated area outside the ADI in both digital and analogue samples across both hospitals. A significant effect was observed in samples ($p<0.001$). In the digital group, patients were older. Irradiated area outside the ADI was not affected by age differences. Comparing digital images samples to analogue, 60.9% of irradiated fields were outside the ADI in digital ($p<0.001$). Among the entire study group, the mean digital irradiated field was 791 cm^2, compared to 541 cm^2 in analogue samples.

Table 1: Digital and analogue lumbar spine frontal radiographs: irradiated field outside ADI

	Mean	
	Analogue	Digital
% of total irradiated area outside ADI	43.4	62.7
Distance from ADI to irradiated edge as a percentage of total irradiated height	15.4	22.3
Distance from the edge of the irradiated field to the ADI as a percentage of the total height of the irradiated field	13.9	19.5
In % of total irradiated width, left lateral distance between ADI and edge of irradiated field	11.7	18.5
Irradiated field width as a percentage of right lateral distance from ADI	11.3	20.2

DISCUSSION

After the implementation of digital radiography, we found significantly larger areas of lumbar spine radiographs being irradiated, with marked deterioration in collimation. Radiation dose to patients has increased 46% in the irradiated field size. As the final sample can mask such increases, they may go unnoticed. There is a type of tissue that is radiation-sensitive and there is a greater thickness of tissue in the lumbar region. These doses could be lowered with improved collimation.

Irradiated fields cannot exactly match ADIs in practice [7-9]. Repeated attempts would be required. It may be possible to avoid large radiation doses by returning to the "analogue" collimation technique that was used in the past [10]. As a way to ensure active collimation, consider training radiographers in collimation, standard procedures that don't mask the irradiated area, and automatic collimators that close when new projections are selected.

These consistent findings may also apply to other countries' lumbar spine radiographs. It is not known whether lumbar spine imaging would lead to poorer collimation after digitalization due to specific issues related to collimation. Other digital images may also be affected by our findings, but further research is needed

CONCLUSION

An analysis of the radiographs of the lumbar spine demonstrated that collimation practices have deteriorated since the transition from analogue to digital X-ray equipment has been made. Usually, these practices are carried out with the purpose of causing excessive radiation doses to patients, and they should be stopped.

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