

Effect of different source-to-image distance on radiation dose and the quality of image in posteroanterior hand X-ray examination

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Conflict of Interest Disclosure Statement

• The authors declare that they have no conflict of interest.



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Introduction

- Ionizing radiation is used very widely in medical imaging which provides the diagnostic information about the health condition of patients. Nevertheless, it is harmful to the living organisms therefore principle of benefit against risks need to be applied.
- The radiation associated carcinogenic risk from medical imaging examinations has been a growing concern among patients.
- X-ray plain radiography uses low amounts of radiation as compared to the CT and Fluoroscopy. However, the linear non-threshold model states that there is a risk of occurrence of cancer even at low radiation dose (Lin, 2010).



Introduction

- Source-to-image distance (SID) is one of the factors among the others that influence the radiation dose to patients and image quality in X-ray examinations.
- Tugwell, et. al, 2014, reported that 50.13 % of reduction in entrance surface dose (ESD) when SID was increased from 110 cm up to 140 cm.
- Joyce, et. al, 2013. found that when SID was increased, image quality reduced in terms of geometric un-sharpness and magnifications of the anatomical structure for certain X-ray examinations



Introduction

- In clinical settings, the SID is adjusted using measuring tape attached to the X-ray tube.
- However, this method is ignored by some radiographers when hand extremities X-ray examinations are involved.
- In this study upper extremities of the hand area were included. Because the number of hand injuries cases at hospitals is higher compared to other upper extremities such as the forearm, elbow and humerus.



Objectives

To investigate the effect of different SID on ESD and quality of image for posteroanterior (PA) projection.



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Methodology

- The Siemens Multix Top system was used selecting 55 kVp and 1.6 mAs.
- The SID selected was 95, 100, 105, 110 and 115 cm.
- The anthropomorphic hand-wrist phantom was placed over the cassette with the third metacarpophalangeal joint as the centre of the anatomical structure.





Methodology

- Twelve nanoDot OSLDs at various locations on the hand phantom were placed.
- The ESD readings were repeated for three times at each SID in order to record an average value.
- Signal-noise-ratio (SNR) was calculated using ImageJ for image quality evaluation.

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Location	Anatomical Structure
1	Distal phalanx of fifth digit
2	Distal phalanx of fourth digit
3	Distal phalanx of third digit
4	Distal phalanx of second digit
5	Metacarpophalangeal (MCP) joint of fifth digit
6	MCP joint of fourth digit
7	MCP joint of third digit
8	MCP joint of second digit
9	Distal phalanx of first digit
10	MCP joint of first digit
11	Mid carpal
12	1 inch distal of radius/ulna



Radiographs obtained at various SIDs.





Location	Anatomical Structure
1	Distal phalanx of fifth digit
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 There is a significant decrease in mean ESD (p<0.05) as the SID increased.

 However, variation in ESD at different locations and SID was recorded.

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Comparison with the findings of other studies

Radiation Dose to Hand	This Study	Jibri et al ²⁰¹⁶	Abdelhalim ²⁰¹⁰	USA ²⁰¹⁵	UK ²⁰⁰⁹
ESD (mGy)	0.034 – 0.056	1.1 - 1.44	0.089	0.13	0.08



- In terms of image quality, results show that SNR increased with the increase in SID.
- The difference in SNR ranges from 17 34%.
- This reflects the improvement image quality with the applied SID.

SNR values at different SIDs

SID (cm)	95	100	105	110	115
SNR	8.01	9.93	11.85	9.67	9.61



• The inconsistency in measured radiation dose at different locations show the inhomogeneous exposure to hand.

• The specific range of SID which needs to be noted in order to reduce the exposure to the patient and maintain/produce an adequate image quality.



Conclusions

- The increase in SID lowers the ESD without adverse impact on image quality (95 cm 115cm).
- Radiation dose mapping of the hand need to be considered instead of assuming the uniform amount of radiation dose to hand.
- Measurement of accurate dose to hand extremities is important because of the effects of ionizing radiation on bone marrow
- It is suggested that in terms of radiation dose to patient SID need to be adjusted manually when upper extremities of the hand Xray examinations are performed.

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Thank you for your attention

