Radiation Medicine and Protection 6 (2025) 284–290

Contents lists available at ScienceDirect

Radiation Medicine and Protection

journal homepage: www.radmp.org

Original article

X-ray beam collimation in radiography: a study of compliance among radiographers

Islam Kleib[a], Maram Alakhras[a,*], Alaa Oteir[a], Dana S. Al-Mousa[a,b]

[a] Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan
[b] School of Dentistry and Health Sciences, Charles Sturt University, Wagga Wagga, NSW, Australia

ARTICLE INFO

Managing editor: Xianhua Guo

Keywords:
Radiation dose
Collimation
Radiation protection
Beam restriction
Digital radiography

ABSTRACT

Objective: To assess collimation practices and quantify the irradiated area outside the area of diagnostic interest (ADI).
Methods: 1503 radiographs (627 females and 876 males) of seven body regions for patients with age groups (≤1 year, 1–12 years, 13–17 years, 18–65 years, ≥65 years) from three major (A. governmental, B. university affiliated, and C. private) hospitals in northern Jordan were included. For each radiograph, the length and width of the irradiated area and of the ADI were measured. Then the ratio factors (RF), the irradiated area outside ADI, and the percentage of irradiated area outside ADI were calculated. Kruskal-Wallis and Mann-Whitney-U tests were used to examine the differences in ADI, the irradiated area outside ADI and RF according to age and gender. A regression analysis identified variables associated with RF and irradiated area outside ADI and its percentage.
Results: The RF ranged from 1.7 to 3.5. Patients aged ≤1 year exhibited significantly higher irradiated area outside ADI (722.1 cm^2), RF (3.7), and the percentage of irradiated area outside the ADI (72.7%) compared to other age groups ($P < 0.001$). The actual collimation, area of ADI, and the irradiated area outside the ADI were significantly higher in males than those in females ($P < 0.001$). Hospital A had a significantly higher irradiated area outside the ADI (871.4 cm^2), RF (3.1), and percentage of irradiated area outside the ADI (67.2%) than other hospitals ($P < 0.001$), which can be due to high patient volume in governmental hospitals and less time to pay attention to patient protection.
Conclusions: This study found inadequate X-ray beam collimation practice among radiographers in all participating hospitals, the radiation fields were at least two times larger than the ADI. This raises the importance of educating radiographers on collimation techniques and ensuring that all hospitals adhere to standardized collimation practices.

1. Introduction

A collimator is an essential part of an X-ray machine that is used to restrict the radiation output to the imaging area referred for diagnosis.[1,2] Collimation reduces extra radiation to the patient due to reduced primary radiation field and it is crucial for improving image quality since it decreases the amount of scattered radiation that is generated.[3] In accordance with the ALARA (As low as reasonably achievable) principle, every examination should be optimized for obtaining a quality diagnostic image while minimizing the patient dose.[4] It has to be acknowledged that for optimizing patients' radiation exposure, collimating the primary beam to the area of diagnostic interest (ADI) as recommended by the International Commission on Radiation Protection (ICRP) is needed.[3]

In digital radiography (DR), the importance of collimation arises from the fact that the initial image processing and histogram analysis rely on proper pre-exposure collimation.[5] When collimation is improper, a wider histogram for radiographic examinations will be produced due to higher exposure data than is expected. Therefore, the anatomical region of interest may be inappropriately scaled, resulting in a grayer image with reduced image details.[5] Improper collimation may also require the use of a higher tube voltage (kV) to maintain a uniform detector exposure which may increase production of scattered radiation and decrease image quality.[6]

Previous studies reported that the X-ray field size may not be correctly applied by radiographers due to high workloads, convenience, and larger DR plates.[4,7,8] Electronic collimation, which is also called

* Corresponding author.
E-mail address: mmalakhras@just.edu.jo (M. Alakhras).

https://doi.org/10.1016/j.radmp.2025.09.003
Received 13 April 2025; Received in revised form 13 September 2025; Accepted 17 September 2025
Available online 19 September 2025