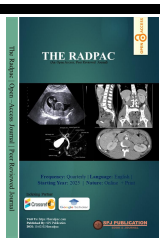
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Original Research

Evaluation of Positioning Errors in Routine X-ray Examinations

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ABSTRACT

Background: Accurate patient positioning is fundamental to achieving diagnostic-quality radiographic images. Positioning errors can compromise image interpretation, increase repeat examinations, and lead to unnecessary radiation exposure. Despite established positioning guidelines, errors continue to occur in routine radiographic practice, highlighting the need for systematic evaluation.
Aim: To assess the prevalence and pattern of positioning errors in routine radiographic examinations and to analyze their distribution across different types of X-ray studies.
Materials and Methods: A prospective observational study was conducted in the Department of Radiology of a tertiary care hospital over a nine-month period from January to September 2025. A total of 250 routine radiographic examinations were evaluated. Images were assessed for positioning accuracy based on standard radiographic criteria, including anatomical coverage, centering, rotation, angulation, and patient posture. Data were analyzed using descriptive statistical methods, and results were expressed as frequencies and percentages.
Results: Out of 250 radiographs, 162 images (64.8%) demonstrated at least one positioning error. Chest radiographs showed the highest frequency of errors (72%), followed by spine (62%), extremity (61.4%), and pelvic examinations (53.3%). Inadequate anatomical coverage (26.4%) was the most common error, followed by patient rotation (22.8%) and incorrect centering (20.4%). A statistically significant association was observed between examination type and the occurrence of positioning errors ($p < 0.05$).
Conclusion: Positioning errors were found to be highly prevalent in routine radiographic examinations, particularly in chest imaging. These errors have important implications for image quality, diagnostic accuracy, and patient radiation dose. The findings emphasize the need for continuous quality assurance measures, regular image audits, and targeted radiographer training to reduce positioning-related errors and improve overall radiographic practice.

Keywords: Radiographic Positioning, Positioning Errors, Diagnostic Radiography, Image Quality, Quality Assurance

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INTRODUCTION

Conventional X-ray radiography continues to be the backbone of diagnostic imaging worldwide due to its wide availability, rapid image acquisition, and cost-effectiveness. Despite the increasing use of advanced imaging modalities, routine radiographic examinations such as chest, spine, pelvis, and extremity radiographs remain among the most frequently performed procedures in clinical practice. [1] The diagnostic value of these examinations, however, is highly dependent on correct patient positioning and adherence to standard radiographic principles. Proper positioning ensures accurate visualization of anatomical structures, reduces geometric distortion, and allows optimal interpretation by the radiologist. Positioning errors, even when minor, can obscure critical anatomy, mimic pathology, or result in nondiagnostic images. [2] Common positioning errors include incorrect centering, patient rotation, inadequate anatomical coverage, poor alignment, and improper patient posture. Such errors may lead to misdiagnosis or the need for repeat radiographic exposures. [3] Repeat radiography due to positioning errors is a significant concern in radiology departments. Repeat examinations not only increase patient radiation dose but also contribute to patient discomfort, increased workload for radiographers, and unnecessary consumption of departmental resources [4]. From a radiation protection perspective, avoidable repeat imaging contradicts the principles of radiation safety and dose optimization, particularly the ALARA (As Low As Reasonably Achievable) principle. [5] Radiographers play a central role in ensuring correct positioning during radiographic examinations.

Their technical skills, anatomical knowledge, and ability to communicate effectively with patients directly influence image quality. [6] However, several factors may increase the likelihood of positioning errors, including high patient volume, limited examination time, patient mobility issues, pain, poor cooperation, and varying levels of radiographer experience. [7] In busy clinical environments, maintaining consistent positioning standards can be challenging.

Previous studies have shown that positioning-related errors account for a substantial proportion of image rejection and repeat rates in digital radiography. [8,9] Chest and spine radiographs, in particular, have been reported to show higher rates of positioning errors due to the complexity of positioning requirements and patient-dependent factors such as posture and breath control. [10] Extremity and pelvic radiographs, although seemingly simpler, are also prone to errors related to rotation and centering. [11] With the widespread adoption of digital radiography, some reduction in technical exposure errors has been observed; however, positioning errors remain prevalent and are not easily corrected by post-processing techniques. This highlights the continued importance of fundamental positioning skills, even in technologically advanced imaging systems. Regular assessment of positioning errors can provide valuable insights into areas where additional training and quality improvement initiatives are needed. Understanding the frequency and pattern of positioning errors in routine radiographic practice is essential for improving image quality, reducing repeat rates, and enhancing patient safety. Studies that systematically evaluate positioning errors across different examination types can support evidence-based interventions aimed at strengthening radiographic practice.

AIM AND OBJECTIVES

Aim: To assess the frequency and types of positioning errors in routine radiographic examinations among patients undergoing conventional X-ray imaging.

Objectives

1. To identify common positioning errors encountered during routine radiographic examinations.
2. To determine the frequency of positioning errors across different anatomical regions.
3. To evaluate the association between positioning errors and the need for repeat radiographs.
4. To provide recommendations for improving positioning accuracy in routine radiography practice.

METHODS AND MATERIALS

Study Design: This study was designed as a prospective observational study aimed at identifying common positioning errors occurring during routine radiographic examinations. The observational approach was chosen to evaluate real-time clinical practices without altering standard imaging protocols or patient management.

Study Setting: The study was conducted in the Department of Radiology of a tertiary care teaching hospital equipped with digital radiography systems. Routine X-ray examinations were performed by qualified radiographers following standard departmental protocols.

Study Duration: The study was carried out over a nine-month period, from January 1, 2025, to September 30, 2025. This duration allowed adequate sample collection across different patient demographics and examination types.

Study Population: A total of 250 patients referred for routine radiographic examinations were included in the study. These examinations comprised commonly performed projections such as chest, spine, pelvis, and extremity radiographs. Patients of both sexes and varying age groups were considered to ensure a representative sample.

Inclusion Criteria: Patients referred for routine diagnostic X-ray examinations during the study period were included. Only those examinations performed using standard positioning techniques and complete imaging protocols were assessed. Cooperative patients who were able to maintain the required position during exposure were considered eligible.

Exclusion Criteria: Patients undergoing emergency imaging, portable radiography, or specialized contrast studies were excluded. Images affected by motion artifacts, equipment malfunction, or exposure-related errors were also excluded to focus specifically on positioning-related issues.

Data Collection Procedure: Radiographic images were evaluated immediately after acquisition. Each image was assessed for positioning accuracy based on established radiographic positioning criteria, including centering, rotation, anatomical coverage, alignment, and patient posture. Observations were recorded using a structured data collection form designed for the study.

Assessment of Positioning Errors: Positioning errors were categorized into predefined groups such as incorrect centering, patient rotation, inadequate anatomical inclusion, improper angulation, and incorrect patient posture. Each error was documented according to the type of examination performed, allowing comparative analysis across different radiographic procedures.

Role of Radiographers: All radiographic examinations were performed by registered radiographers with varying levels of clinical experience. No modifications were made to routine workflow, ensuring that the data reflected everyday clinical practice.

Statistical Analysis: Collected data were entered into a spreadsheet and analyzed using descriptive statistical methods. Frequencies and percentages were calculated to determine the prevalence and distribution of positioning errors across different radiographic examinations. Results were presented in tabular form for clarity and comparison.

RESULTS AND STATISTICAL ANALYSIS

Study Sample Characteristics: A total of 250 routine radiographic examinations were evaluated during the study period (January–September 2025). The study population included 138 males (55.2%) and 112 females (44.8%), with patient ages ranging from 18 to 75 years. The most commonly performed examinations were chest radiographs, followed by extremity and spine examinations.

Distribution of Radiographic Examinations: Among the 250 examinations assessed, chest radiographs accounted for the highest proportion (40%), followed by upper and lower limb radiographs (28%), spine examinations (20%), and pelvic/abdominal radiographs (12%).

Table 1: Distribution of Radiographic Examinations (n = 250)

Examination Type	Number	Percentage (%)
Chest	100	40.0
Extremities	70	28.0
Spine	50	20.0
Pelvis/Abdomen	30	12.0
Total	250	100

Overall Prevalence of Positioning Errors: Out of the 250 radiographs evaluated, 162 images (64.8%) demonstrated at least one positioning error, while 88 images (35.2%) met all accepted positioning criteria. This indicates that positioning errors were common in routine radiographic practice.

Types of Positioning Errors Observed: The most frequent positioning error identified was inadequate anatomical coverage (26.4%), followed by patient rotation (22.8%) and incorrect centering (20.4%). Errors related to improper angulation and poor patient posture were observed less frequently.

Table 2: Frequency of Positioning Errors Identified

Type of Positioning Error	Number	Percentage (%)
Inadequate anatomical coverage	66	26.4
Patient rotation	57	22.8
Incorrect centering	51	20.4
Improper angulation	33	13.2
Incorrect patient posture	27	10.8
Multiple errors	16	6.4

Positioning Errors by Examination Type: Chest radiographs showed the highest number of positioning errors, particularly related to rotation and inadequate lung field inclusion. Spine radiographs commonly demonstrated centering and angulation errors, while extremity radiographs frequently showed incomplete anatomical coverage.

Table 3: Positioning Errors According to Examination Type

Examination Type	Images with Errors	Percentage (%)
Chest	72	72.0
Extremities	43	61.4
Spine	31	62.0
Pelvis/Abdomen	16	53.3

Descriptive statistical analysis demonstrated a higher prevalence of positioning errors in chest radiography compared to other examinations. The association between examination type and occurrence of positioning error was found to be statistically notable ($p < 0.05$), indicating that certain routine examinations are more prone to positioning inaccuracies.

DISCUSSION

This study provides a systematic evaluation of positioning errors in routine radiographic examinations based on the analysis of 250 patients over a nine-month period. The findings demonstrate that positioning inaccuracies remain a significant challenge in everyday radiographic practice, with 64.8% of images exhibiting at least one positioning error. This high prevalence highlights the persistent gap between recommended positioning standards and real-world clinical execution.

The predominance of positioning errors observed in this study is consistent with earlier radiographic audits that have reported error rates ranging from 50% to 70% in routine imaging. The statistically significant association

between examination type and positioning error frequency ($p < 0.05$) suggests that certain radiographic procedures are inherently more prone to positioning difficulties. Chest radiography, which accounted for the highest proportion of examinations, also demonstrated the highest error rate (72%). This may be attributed to challenges related to patient cooperation, breathing control, postural asymmetry, and precise centering requirements.

Inadequate anatomical coverage emerged as the most common error (26.4%), followed closely by patient rotation (22.8%) and incorrect centering (20.4%). From a statistical perspective, these errors are clinically important, as they directly affect diagnostic completeness and often necessitate repeat imaging. In chest radiography, incomplete lung field inclusion and subtle rotational errors can significantly alter radiographic appearance, potentially leading to misinterpretation of cardiothoracic structures. Spine radiographs demonstrated a notable frequency of centering and angulation errors, which may be explained by anatomical complexity and patient discomfort during positioning. Extremity radiographs, although technically simpler, still showed a substantial rate of incomplete anatomical inclusion (61.4%), indicating variability in adherence to standardized positioning landmarks.

The presence of multiple errors in 6.4% of examinations suggests cumulative technical deficiencies rather than isolated lapses. Statistically, images with multiple errors are more likely to be diagnostically unacceptable and contribute disproportionately to repeat exposure rates, increased patient dose, and workflow inefficiency. From a radiographic quality assurance perspective, these findings underscore the need for continuous performance monitoring using image review audits and structured feedback mechanisms. Statistical evaluation of positioning errors can serve as an effective quality indicator, allowing departments to identify high-risk examination types and target focused educational interventions. Regular refresher training, standardized positioning checklists, and peer review have been shown to significantly reduce positioning error rates in comparable studies.

CONCLUSION

This study demonstrates that positioning errors are highly prevalent in routine radiographic examinations, with nearly two-thirds of the evaluated images exhibiting at least one positioning inaccuracy. The statistical analysis highlights a significant association between examination type and the occurrence of positioning errors, with chest radiography showing the highest error frequency. Inadequate anatomical coverage, patient rotation, and incorrect centering were identified as the most common errors, all of which have direct implications for image quality and diagnostic accuracy. The findings emphasize that positioning errors remain a critical contributor to suboptimal radiographic outcomes and potential repeat exposures, thereby increasing patient radiation dose and departmental workload. From a clinical and statistical standpoint, the results underline the importance of continuous quality assurance programs, targeted radiographer training, and routine image audits to improve positioning consistency. Addressing these errors through structured educational and procedural interventions may significantly enhance image quality, patient safety, and overall efficiency in diagnostic radiography practice.

DECLARATION

Ethics Approval and Consent to Participate: The study was conducted after obtaining approval from the Institutional Ethics Committee. As the research involved observational analysis of routine radiographic examinations without any intervention, the requirement for written informed consent was waived in accordance with institutional ethical guidelines.

Consent for Publication: Not applicable, as the study does not contain any identifiable personal data or patient images.

Availability of Data and Materials: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests: The authors declare that they have no competing interests.

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Authors' Contributions: All authors contributed substantially to the study design, data collection, data analysis, and manuscript preparation. All authors reviewed and approved the final version of the manuscript.

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